Transactions of the Wisconsin Academy of Sciences, Arts and Letters. volume II 1873/1874

Madison, Wis.: Atwood & Culver, Printers and Stereotypers, 1873/1874

TRANSACTIONS

OF THE

WISCONSIN ACADEMY

OF

SCIENCES, ARTS, AND LETTERS.

VOL. II. 1873–4.

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CONTENTS.

ERRATA.

Page 104, 5th line from bottom, for "them" read "those."
105, last line on page, for "glacy" read "glassy."
108, 5th line from top, place colon after "Wisconsin."
108, 8th line from top, and wherever else it occurs, for "copper bearing rocks," read "Copper-Bearing."
108, 9th line from top, for "lower silurian" read "Lower Silurian."
109, 7th line from top, for "rivers," read "rivers,—"
109, last line, for "its" read "their."
111, 5th line from top, for "schists, one" read "schists. One."
111, 4th line from bottom, for "feet, a" read "feet. A."
111, 4th " " erase "its."
112, 17th " " for "Keweenau" read "Keweenaw."
112, 8th " " for "northeasterly" read "northerly."
116, 15th " " for "occupies" read "occupy."
118, 13th " " for "it" read "they."
126, 19th " " for "coglomerate" read "conglomerate."
127, 12th " " for "dift" read "drift."
132, 11th " " for "phenomena" read "phenomenon."
135, 7th " " for "five" read "fine."
141, 7th " top, for "silver. And" read "silver; and."
143, 14th " bottom, and elsewhere, for "tertiary" read "Tertiary."
143, 9th and 10th line from bottom, for "testiary" read "Tertiary."
150, 14th line from top, for "mates" read "mats."
150, last line, after "sand" insert "above."
152, 5th line from below, for "they" read "it."
193–202, wherever it occurs, for "Bouy's" read "Prony's."
198, 15th line from bottom, for "Hetz" read "Metz."
237, 6th line and elsewhere, for "Earl" read "Eorl."

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*Deceased.

CHARTER.

AN ACT TO INCORPORATE THE "WISCONSIN ACADEMY OF SCIENCES, ARTS AND LETTERS."

The people of the State of Wisconsin, represented in Senate and Assembly, do enact as follows:

SECTION 1. Lucius Fairchild, Nelson Dewey, John W. Hoyt, Increase A. Lapham, Alexander Mitchell, Wm. Pitt Lynde, Joseph Hobbins, E. B. Wolcott, Solon Marks, R. Z. Mason, G. M. Steele, T. C. Chamberlin, James H. Eaton, A. L. Chapin, Samuel Fallows, Charles Preusser, Wm. E. Smith, J. C. Foye, Wm. Dudley, P. Engelmann, A. S. McDill, John Murrish, Geo. P. Delaplaine, J. G. Knapp, S. V. Shipman, Edward D. Holton, P. R. Hoy, Thaddeus C. Pound, Charles E. Bross, Lyman C. Draper, John A. Byrne, O. R. Smith, J. M. Bingham, Henry Bæ!z, Ll. Breese, Thos. S. Allen, S. S. Barlow, Chas. R. Gill, C. L. Harris, J. C. Squires, George Reed, J. G. Thorp, William Wilson, Samuel D. Hastings, and D. A. Baldwin, at present being members and officers of an association known as "The Wisconsin Academy of Sciences, Arts, and Letters," located at the city of Madison, together with their future associates and successors forever, are hereby created a body corporate by the name and style of the "Wisconsin Academy of Sciences, Arts and Letters," and by that name shall have perpetual succession; shall be capable in law of contracting and being contracted with, of suing and being sued, of pleading and being impleaded in all courts of competent jurisdiction; and may do and perform such acts as are usually performed by like corporate bodies.

SECTION 2. The general objects of the Academy shall be to encourage investigation and disseminate correct views in the various departments of science, literature and the arts. Among the specific objects of the Academy shall be embraced the following:

1. Researches and investigations in the various departments of the material, metaphysical, ethical, ethnological and social sciences.
2. A progressive and thorough scientific survey of the State, with a view of determining its mineral, agricultural and other resources.
3. The advancement of the useful arts, through the applications of science, and by the encouragement of original invention.
4. The encouragement of the fine arts, by means of honors and prizes awarded to artists for original works of superior merit.
5. The formation of scientific, economical and art museums.
6. The encouragement of philological and historical research, the collection and preservation of historic records, and the formation of a general library.
7. The diffusion of knowledge by the publication of original contributions to science, literature and the arts.

SECTION 3. Said Academy may have a common seal and alter the same at pleasure; may ordain and enforce such constitution, regulations and by-laws as may be necessary, and alter the same at pleasure; may receive and hold real and personal property, and may use and dispose of the same at pleasure: *provided*, that it shall not divert any donation or bequest from

the uses and objects proposed by the donor, and that none of the property acquired by it shall, in any manner, be alienated other than in the way of an exchange of duplicate specimens, books, and other effects, with similar institutions and in the manner specified in the next section of this act, without the consent of the legislature.

SECTION 4. It shall be the duty of the said Academy, so far as the same may be done without detriment to its own collections, to furnish, at the discretion of its officers, duplicate typical specimens of objects in natural history to the University of Wisconsin, and to the other schools and colleges of the State.

SECTION 5. It shall be the duty of said Academy to keep a careful record of all its financial and other transactions, and, at the close of each fiscal year, the President thereof shall report the same to the Governor of the State, to be by him laid before the Legislature.

SECTION 6. The constitution and by-laws of said Academy now in force shall govern the corporation hereby created, until regularly altered or repealed; and the present officers of said Academy shall be officers of the corporation hereby created, until their respective terms of office shall regularly expire, or until their places shall be otherwise vacated.

SECTION 7. Any existing society or institution having like objects embraced by said Academy may be constituted a department thereof, or be otherwise connected therewith, on terms mutually satisfactory to the governing bodies of the said Academy and such other society or institution.

SECTION 8. For the proper preservation of such scientific specimens, books and other collections as said Academy may make, the Governor shall prepare such apartment or apartments in the Capitol as may be so occupied without inconvenience to the State.

SECTION 9. This act shall take effect and be in force from and after its passage.

Approved March 16, 1870.

CONSTITUTION.

NAME AND LOCATION.

SECTION 1. This association shall be called "The Wisconsin Academy of Sciences, Arts and Letters," and shall be located at the city of Madison.

GENERAL OBJECTS.

SECTION 2. The general object of the Academy shall be to encourage investigations and disseminate correct views in the various departments of Science, Literature, and the Arts.

DEPARTMENTS.

SECTION 3. The Academy shall comprise separate Departments, not less than three in number, of which those first organized shall be:

1*st*. *The Department of Speculative Philosophy*—
Embracing:
Metaphysics;
Ethics.

2*d*. *The Department of the Social and Political Sciences*—
Embracing:
Jurisprudence;
Political Science;
Education;
Public Health;
Social Economy.

3*d*. *The Department of the Natural Sciences*—
Embracing:
The Mathematical and Physical Sciences;
Natural History.
The Anthropological and Ethnological Sciences.

4*th*. *The Department of the Arts*—
Embracing:
The Practical Arts;
The Fine Arts.

5*th*. *The Department of Letters*—
Embracing:
Language;
Literature;
Criticism;
History.

SECTION 4. Any branch of these Departments may be constituted a Section; and any section or group of sections may be expanded into a full Department, whenever such expansion shall be deemed important.

SECTION 5. Any existing society or institution may be constituted a Department, on terms approved by two-thirds of the voting members present at two successive regular meetings of the Academy.

SPECIAL OBJECTS OF THE DEPARTMENTS.

SECTION 6. The specific objects of the Department of Sciences shall be:

1. General Scientific Research.
2. A progressive and thorough Scientific Survey of the State, under the direction of the Officers of the Academy.
3. The formation of a Scientific Museum.
4. The Diffusion of Knowledge by the publication of Original Contributions to Science.

The objects of the Department of the Arts shall be:

1. The Advancement of the Useful Arts, through the Applications of Science and the Encouragement of Original Invention.
2. The Encouragement of the Fine Arts and the Improvement of the Public Taste, by means of Honors and Prizes awarded to Works of Superior Merit, by Original Contributions to Art, and the Formation of an Art Museum.

The objects of the Department of Letters, shall be:

1. The Encouragement of Philological and Historical Research.
2. The Improvement of the English Language.
3. The Collection and Preservation of Historic Records.
4. The Formation of a General Library.

MEMBERSHIP.

SECTION 7. The Academy shall embrace four classes of governing members who shall be admitted by vote of the Academy, in the manner to be prescribed in the By-Laws:

1st. Annual Members, who shall pay an initiation fee of five dollars, and thereafter an annual fee of two dollars.

2d. Members for Life, who shall pay a fee of one hundred dollars.

3d. Patrons, whose contributions shall not be less than five hundred dollars.

4th. Founders, whose contributions shall not be less than the sum of one thousand dollars.

Provision may also be made for the election of Honorary and Corresponding Members, as may be directed in the By-Laws of the Academy.

MANAGEMENT.

SECTION 8. The management of the Academy shall be entrusted to a General Council; the immediate control of each Department to a Department Council. The General Council shall consist of the officers of the Academy, the officers of the Departments, the Governor and Lieutenant-Governor, the Superintendent of Public Instruction, and the President of the State University, the President and Secretary of the State Agricultural Society, the President and Secretary of the State Historical Society, Counsellors *ex-officiis*, and three Counsellors to be elected for each Department. The Departmental Councils shall consist of the President and Secretary of the Academy, the officers of the Department, and three Counsellors, to be chosen by the Department.

OFFICERS.

SECTION 9. The officers of the Academy shall be: a President, who shall be *ex-officio* President of each of the Departments; one Vice-President for each Department; a General Secretary; a General Treasurer; a Director of the Museum, and a General Librarian.

SECTION 10. The officers of each Department shall be a Vice-President, who shall be *ex-officio* a Vice-President of the Academy; a Secretary, and such other officers as may be created by the General Council.

SECTION 11. The officers of the Academy and the Departments shall hold their respective offices for the term of three years, and until their successors are elected.

SECTION 12. The first election of officers under this Constitution shall be by its members at the first meeting of the Academy.

SECTION 13. The duties of officers and the mode of their election, after the first election, as likewise the frequency, place and date of all meetings, shall be prescribed in the By-Laws of the Academy, which shall be framed and adopted by the General Council.

SECTION 14. No compensation shall be paid to any person whatever, and no expenses incurred for any person or object whatever, except under the authority of the Council.

AMENDMENT.

SECTION 15. Every proposition to alter or amend this constitution shall be submitted in writing at a regular meeting; and if two-thirds of the members present at the next regular meeting vote in the affirmative, it shall be adopted.

BY-LAWS.

ELECTION OF MEMBERS,

1. Candidates for membership must be proposed in writing, by a member, to the General Council and referred to a Committee on Nominations; which Committee may nominate to the Academy. A majority vote shall elect. Honorary and corresponding members must be persons who have rendered some marked service to Science, the Arts, or Letters, or to the Academy.

MEETINGS.

2. The regular meetings of the Academy shall be held as follows: On the 2d Tuesday in February, at the seat of the Academy; and in July, at such place and exact date as shall be fixed by the Council; the first named to be the Annual Meeting. The hour shall be designated by the Secretary in the notice of the meeting. At any regular meeting, ten members shall constitute a quorum for the transaction of business. Special meetings may be called by the President at his discretion, or by request of any five members of the General Council.

DUTIES OF OFFICERS.

3. The President, Vice President, Secretaries, Treasurer, Director of the Museum and Librarian shall perform the duties usually appertaining to their respective offices, or such as shall be required by the Council. The Treasurer shall give such security as shall be satisfactory to the Council, and pay such rate of interest on funds held by him as the Council shall determine. Five members of the General Council shall constitute a quorum.

COMMITTEE .

4. There shall be the following Standing Committees, to consist of three members each, when no other number is specified:

On Nominations.
On Papers presented to the Academy.
On Finance.
On the Museum.
On the Library.
On the Scientific Survey of the State; which Committee shall consist of the Governor, the President of the State University, and the President of this Academy.
On Publication; which Committee shall consist of the President of the Academy, the Vice Presidents, and the General Secretary.

MUSEUM AND LIBRARY.

5. No books shall be taken from the Library, or works or specimens from the Museum, except by authority of the General Council; but it shall be the duty of said Council to provide for the distribution to the State University and to the Colleges and public Schools of the State, such duplicates of typical specimens in Natural History as the Academy may be able to supply without detriment to its collections.

ORDER OF BUSINESS.

6. The order of business at all regular meetings of the Academy or of any Department, shall be as follows:

Reading minutes of previous meeting.
Reception of donations.
Reports of officers and committees.
Deferred business.
New business.
Reading and discussion of papers.

SUSPENSION AND AMENDMENT OF BY-LAWS.

7. The By-Laws may be suspended by an unanimous vote, and in case of the order of business a majority may suspend. They may be amended in the same manner as is provided for in the constitution for its amendment.

REPORT OF THE PRESIDENT.

His Excellency, WILLIAM R. TAYLOR,

Governor of Wisconsin:

SIR—I have the honor to submit the following report of the Wisconsin Academy of Sciences, Arts and Letters for the period commencing September 13, 1872, and ending February 12, 1874:

The work of the Academy, since the date of my last report, has steadily progressed, although the number of active members has not very considerably increased.

The publication of the first volume of Transactions, by order of the legislature, inspired confidence in the permanency of the institution, and has encouraged members to bestow much laborious effort upon their investigations. It also had the effect to gain for the Academy an honorable standing among organizations of like character throughout the country, and has even secured to its objects and early labors the attention and favor of a large number of the learned societies of Europe.

Since the success of every organization of this kind must depend upon the extent to which it is able to enlist the services of the best cultured and most original minds in the community, and since the coöperation of such persons cannot reasonably be asked for unless the fruits of their investigations are sure of being published to the world, it is an occasion for congratulation that the legislature has shown a disposition to

make permanent provision for the annual printing and publication of the Academy's Transactions.*

Of the Several Departments.

The department of Speculative Philosophy was only organized at the late annual meeting, and has, of course, had no development. It is represented, however, by interesting and valuable papers in the collections herewith presented.

The department of the Social and Political Sciences has yielded results of importance, though but few, considering the great breadth of its range and the large number of persons who might with reason be expected to give it the benefit of their services. Embracing Education, Health, Social Economy, Political Economy and Jurisprudence, it presents a variety of distinct fields of great interest and practical importance for the scientific inquiry of nearly every class of intelligent citizens, and should be instrumental of much good by directing public attention to errors of principle and practice in social life and governmental affairs, as well as in contributing something to the progress of social science itself.

The department of the Natural Sciences continues to hold its precedence as the most active and productive section of the academy. Its membership includes a considerable number of professors connected with the State University, Lawrence University, Beloit College, the State Normal Schools, and other institutions of learning, besides many scientific gentlemen not so connected. It is worthy of remark that some of these have not only been willing to give to the academy the time necessary to the solution of important scientific problems, but also to expend considerable sums of money in order to the making of original observations and studies in the open field of nature.

* Since the writing of this report, the legislature has, by unanimous consent, made provision, in the new law relating to public printing, for the future *biennial* publication of the Transactions, in uniform style with the first volume.

The department of Arts has not hitherto met the expectations of those who were active in its organization. The large number of intelligent gentlemen engaged in agriculture, mining and manufactures, as well as the considerable number of engineers, architects and builders, who have had both scientific training and practical experience, and are competent to make valuable contributions to the useful arts, would seem to warrant the expectation that, under the new efforts to be put forth by its officers, this department will have a more satisfactory development.

Effort has been made to induce the artists of this state to unite their forces and effect the organization of a department of Fine Arts, but, so far, without success. Art has had but little cultivation, as yet, anywhere in America. Enough has been done by American artists, however, to demonstrate that we have artistic *genius* of a quality to insure to our art a rank in the future second to that of no other modern nation. An impetus has already been given to it by the introduction of art education into many of the schools at the east, and a few of those at the west—a movement fraught with interest, whether art be considered in relation to its refining influence upon the mind of the rising generation, or with reference to its bearings upon the progress of the industrial arts.

An art department, even though it should, for a time, simply fulfil the offices of an Art Union, bringing artists frequently together for mutual aid and encouragement, leading to the gradual formation of a public art museum, and, by its co-operation with the educational authorities, promote the needed cultivation of art in all its various branches, would render a very important service to the state and to the cause of American civilization.

The Department of Letters, though it has not made rapid growth, is nevertheless in a prosperous condition. It is in the management of gentlemen of deep and varied culture, who have both prepared and secured for it several papers of real

value, and whose zeal in the work is a sure pledge of its success.

The Library.

It is not the policy of the Academy to build up a separate library, but rather to coöperate with the State Historical Society in sustaining and strengthening the Scientific, Art and Literary Departments of its already extensive Library. This it will be able to do in a large degree by securing an exchange of the Academy's Transactions with those of kindred institutions throughout the world, provided its own publications are regularly issued at short intervals—annually, if possible—and have sufficient value to command the respect of learned and scientific bodies having like ends in view. It may be assumed that the Academy will also be able to render some service by indicating, as the result of its members' experience, the most important deficiencies of the Society's Library, especially in the scientific departments, which are as yet but very imperfectly supplied.

The friends of the State Historical Society should therefore regard the Academy as another, and deeply interested organization, resolute in its purpose of promoting the steady and rapid growth of an already extensive and valuable collection of books, in order that it may early become a great State Library, rich in all its departments.

The Scientific Museum.

The scientific collections of the Academy have made a less rapid increase than we were warranted in expecting, under the circumstances. Under the provisions of the statute providing for the survey of the lead region, Mr. John Murrish, Commissioner, collected and sent to the Academy a considerable amount of material, most of which has been placed in the museum, although it has not yet been systematically arranged and labelled.

Chapter 292 of the laws of Wisconsin, "an act to provide for a complete geological survey" of the state, contains the following provision:

"SECTION 3. It shall be the duty of said geological corps, in the progress of the examinations hereby directed, to collect such specimens of rocks, ores, fossils, minerals, etc., as may be necessary to exemplify the geology of the state; sets of these specimens shall be deposited with the Wisconsin Academy of Sciences, Arts and Letters, and the State University, and with each one of the incorporated colleges of the state, and with each of the normal schools, provided application be made to the chief geologist before the commencement of the field work."

Under this provision there has doubtless been collected, during the past year, much valuable material illustrative of the geology and mineralogy of Wisconsin; but, up to this date—doubtless owing to the lack of time on the part of the commissioner to make a proper classification and division of the specimens—little or nothing has been derived from this source.

For such collections as were sent in by Commissioner Murrish and were without shelf-room for their display, his Excellency, Governor Washburn, made suitable provision by the construction of additional cases.

A large museum, illustrative of the several Departments of Natural History, is still and for some time must continue to be a desideratum in Wisconsin. None of those formed by the collegiate institutions of the State are as yet anything like adequate to the wants of their Scientific Departments, much less to the needs of specialists. It is one object of the Academy to meet this want. And when it has so far advanced as to have the means of securing exchanges of specimens with the numerous scientific associations in various parts of the world with which we are seeking to establish relations, it will possess extraordinary facilities for the formation of such collections as will greatly subserve the uses of Science and of Scientific Education in the State.

But, in order to do this, one requisite is still wanting—namely, the means of properly rewarding the labor of preparing specimens and conducting the business of exchange. Add this to the labor of keeping the records of meetings, conducting the correspondence, home and foreign, and attending to the preparation, printing and distribution of the Transactions —all of which has hitherto been performed gratuitously by the President and General Secretary—and it must be apparent that the Academy cannot fairly begin the fulfilment of its mission without pecuniary resources sufficient to salary a Secretary, who shall give his entire time and efforts to its work. And when thus provided, there will immediately arise necessities for yet further means to meet the incidental expenses of office and Museum.

I therefore desire to emphasize these pressing needs of the academy, in order that the purposes for which its scientific department was organized may be kept distinctly before its friends, and that measures may the sooner be put in operation for realizing the funds so clearly requisite to the success of the academy. It is believed that when the objects of the academy come to be better understood, the number is not few of those who will so far appreciate their importance as to regard it a privilege to take Life Members', Patrons', or even Founders' certificates, or to otherwise contribute to its pecuniary resources.

The Treasurer's Report.

The present financial condition of the Academy is shown by the report of the Treasurer for the fiscal year ending February, 1874.

The Results of Work Done

By members of the Academy since the date of the last published report, are chiefly embodied in the following papers:

"Population and Sustenance," by Dr. G. M. Steele, LL.D., President of Lawrence University.

"The Rural Classes in England in the Thirteenth Century," by Prof. W. F. Allen, A. M., State University.

"Vexed Questions in Ethics," by Rev. F. M. Holland, A. M., Baraboo.

"Requisites to a Reform in the Civil Service of the United States," by Dr. J. W. Hoyt, President of the Academy.

"On the Classification of Animals," by Dr. P. R. Hoy, M. D., of Racine.

"On Some Peculiarities of the Fauna of Wisconsin," by Dr. Hoy.

"On the Relation of the Sandstone Conglomerates and the Limestone of the Azoic of Baraboo Valley," by Prof. J. H Eaton, A. M., of Beloit College.

"Results of an Analysis of the Black River Falls Iron Ore," by Prof. R. Irving, M. E., State University.

"On the Geographical Distribution of the Quartzite of Sauk and Columbia Counties," by Prof. T. C. Chamberlin, A. M., State Normal School, Whitewater.

"On the Metamorphic Rocks of Portland, Dodge County, and other Localities in the State," by Prof. R. Irving, M. E., State University.

"On the Occurrence of Gold and Silver in minute quantities in the Quartz of Clark County," by Prof. R. Irving, M. E.

"Railway Gauges," by Prof. W. J. L. Nicodemus, A. M., C. E., State University.

"Fish Culture in Wisconsin—and its Claims upon the State," by Dr. J. W. Hoyt, President.

"On General Correlations," by E. D. Reade, C. E., Milwaukee.

"The Metaphysical Basis of Science," by Prof. S. H. Carpenter, LL. D., State University.

"On Several Points in the Pronunciation of Latin and Greek," by Prof. S. S. Haldeman, LL. D., Cor. Member, Philadelphia.

"Results of the Analysis of certain Ores and Minerals," by Prof. W. W. Daniells, M. S., State University.

"Analysis of the Madison Building Stone," by T. E. Bowman, State University.

"Discussion of evidence bearing upon the Method of Upheaval and Fluctuations of the Quartzite of Sauk and Columbia Counties, by Prof. T. C. Chamberlin, A. M., State Normal School, Whitewater.

"Potentials and their Application to Physical Science," by Dr. John E. Davies, M. D., State University.

"On the Relative Import of Language," by Prof. John B. Feuling, Ph. D., State University.

"On the Place of Natural History in Primary Education," by Dr. P. R. Hoy, Vice President.

"Remarks upon the late Rt. Rev. Bishop Armitage, President of the Department of Social Science," by the President of the Academy.

"On Ranks and Classes among Anglo-Saxons," by Prof. Wm. F. Allen.

"On the Naming of America," by Prof. J. D. Butler.

"On the Origin of the word 'Church'"—by Prof. John B. Feuling.

"On the Strength of Materials," by Capt. J. Nadir, of U. S. Corps of Topographical Engineers.

"On the Age of the Copper Bearing Rocks of Lake Superior," and "On the Westward Continuation of the Lake Superior Synclinal." By Prof. Roland Irving.

"On Records of Marriages," by Rev. F. M. Holland.

"Progress of the Science of Hydraulics," by Prof. W. J. L. Nicodemus, A. M., C. E.

"On some Sample Applications of the Potential Function," also papers on "Molecular Vortices in Electro-Magnetism," and on "Magnetic Rotary Polarization of Light," by Prof. John E. Davies.

"On the Measurement of the Years of Yore," by Dr. Edmund Andrews, M. D., L.L. D., late President of the Chicago Academy of Sciences

"The Philosophy of Evolution," by Dr. S. H. Carpenter.

"On Peculiarities of the Fauna of Wisconsin," by Dr. P. R. Hoy.

"Effects of a Duty on Imports upon the Value of Gold," by Hon. John Y. Smith.

On behalf of the Academy, I have the honor to be,

Very respectfully,

Your Excellency's obedient servant,

JOHN W. HOYT,
President.

MADISON, February, 1874.

DEPARTMENT OF SPECULATIVE PHILOSOPHY.

THE METAPHYSICAL BASIS OF SCIENCE.

BY PROF. S. H. CARPENTER, LL. D.,
University of Wisconsin, Madison.

All knowledge is essentially one. The object-matter upon which intellect exerts itself, does not affect the subjective act of knowing. Physics, when stripped of that which is merely contingent, becomes metaphysics. Physical science deals with object-matter, and discusses the signs by which nature communicates her message—that is, phenomena. Metaphysical science has to do with the subject-mind, and discusses the meaning of the message. The one converts God's hieroglyphics into easily-intelligible language; the other translates this language into Idea. If this be true, there must be a unity of method in all science, however great the diversity of the object-matter investigated. This method is subjectively determined, that is, by the constitution of the mind, and not by the particular form of matter upon which intellectual energy may be exerted. If there is an essential unity in all knowledge, it is because there is a corresponding unity of method in all mental activity. It is only when we look upon what is to be known, that truth separates into sciences; but particular truths become particular sciences only under assumed relations to the whole of which they form a part.

Objectively considered, science is classified knowledge; subjectively viewed, it is the laws or principles according to which knowledge is classified. Every actor implies an act—every

thinker a thought. We may therefore universally make this dual classification, according as we view the mental operation involved, or the attributes of objects which form the subject of thought. The possibility of science is conditioned upon the possibility of classification. Mere knowledge is not science, as the world ought to have learned by costly experience. Even classified knowledge may not be science; it becomes science not through previous classification, but in the act of being classified, and therefore only as the principle of classification is apprehended—that is, only as the particular application of the law of generalization is distinctly recognized. A man may know a book and know nothing more; he knows the science only when he is capable of making the book for himself. Mere knowledge thus differs from science in that the one is held only by the apprehensive powers of the mind, while the other passes beyond these into the reflective or ratiocinative. Pure science, then, must be wholly abstract. The forms and substances of Nature with which the scientific student deals, are only the discrete figures of the young mathematician, to be thrown aside with advancing knowledge. Matter is only the staff on which the mind leans, while too feeble to go alone. It is not the finely chiseled statue that renders a man a sculptor; it is the conception which is therein embodied. A day-laborer may have cut the stone, but only the artist could conceive the idea. So in science, we care but little for the particular results at which we arrive, compared with the laws, according to which the results have been attained.

But conceptions cannot be communicated without being rendered objective. The ideal of the artist is locked up in his own mind, until on canvas, in marble, or by means of some other physical symbol, he communicates his high imaginings. Matter, then, according to the present constitution of things is the condition of intellectual communication. Law cannot be studied as abstract law; it can be studied only while acting, and that which exhibits this activity must be matter—some-

thing which will always and uniformly obey. There can be no conception of force except as acting, and the sole medium of such activity is matter. Thus again, matter is the condition of all communication from nature to man. Science is thus, in a measure, determined by the conditions of its discovery and communication. But we must distinguish between an invariable condition and that which is thus conditioned. Matter is not science; it is only the condition of its discovery and communication. Air is not hearing; it is the condition of hearing. We do not study matter for the sake of the matter when we study science, but for the sake of the law communicated to us in these changes of matter, and Law is a metaphysical, not a physical idea. Reason, not sense, apprehends it. Law is, so to speak, formulated in the physical, but it is not material. Matter is only the vehicle of science, as language is the vehicle of thought.

It is plain, then, that just as in mathematics we have a division into pure and mixed, according as we deal with matter in the abstract or in the concrete, so we may in any science make a corresponding division, according as we confine our attention to the laws revealed by matter or to the matter revealing the laws: in other words; just as we give attention to the ideas of the message, or to the language in which it is communicated. The language must first be learned, but the words used to communicate the message may be separately understood, and yet the meaning of the message wholly missed. Knowing only the one makes a charlatan; knowing the other makes a savan. The sciences based upon this objective study of Nature are denominated Natural Sciences; and because they lisp the first syllables of Nature's message to man, they should be his primary teachers. It is by their aid that the universal message of God to man must be read. They form, as it were, a public highway leading from Nature to God. But the difficulty is that observing men become so absorbed in admiring some splendid piece of Divine engin-

eering that they stop to gaze and wonder, until losing sight of everything above and beyond, they refuse to advance, fondly imagining that they have reached the end of the journey.

The science based upon this subjective study of Nature is called metaphysics. Logic has been defined as "The Science of Thought;" it should be termed "The Science of Thinking." It is not a dead body which we are studying by dissection, but a living, vital Force, which we study by observing its activities. We find here the same error which we find elsewhere — a stopping with the material symbol, and an ignoring of the intellectual force which clothed itself with the symbol. Astronomy is not the science of circles and spheres, ellipses and ellipsoids, but of the Force whose sensible utterances are given in these curves. We might as well call Painting the science of pictures, or Sculpture the science of statues. So Language, the medium of thought, is only a symbol, less material indeed than pictures and statues, but still physical. What we want in "The Science of Thinking" is not the knowledge of symbols, but the knowledge of that which is symbolized. The chemist does not care for the compounds he finds in his retort; he seeks after the truth which these compounds formulate. Metaphysics and Physics evidently agree in this; that both are seeking to frame an articulate utterance of the Idea given in the diverse manifestations of Force — the Idea which includes all Potencies, the summing up of all phenomena into that final generalization which includes the intellectual as well as the material, until at last we reach the essential unity of all Truth.

Science, then, is classification, or the discovery of the principles of classification, rather than an arbitrary acquaintance with things classified. Every science, however, must have an objective expression—that is, must be formulated. In this, both metaphysical and physical science agree; the only difference in this respect is, that in Physics, Nature gives us in the first place the material interpretation of the idea — that is,

the basis of classification—which we have only to translate into idea: while in metaphysics, we first have the idea to which we must furnish the objective utterance. We see here the precise difference between what is called the logical and the natural method—the one being usually called the reverse of the other. The difference is not so much a difference in intellectual procedure as in objective expression. For instance: The botanist has before him the whole range of vegetable forms. He notes resemblances and differences, and groups plants into species and genera, but his work is not ended when these are named and known, and their qualities discovered. He is seeking amidst these multifarious forms for the law of vegetable growth and reproduction. Every organ of the plant is the symbol of an idea, and these ideas form the science of Botany. These Ideas are metaphysical—that is intellectual, and only their sensible manifestation is physical. The symbols of these Ideas, being given in Nature, must be learned from observation before they can be used intelligently, just as words must be learned before one can speak a language. Mastery of the means of expression is as essential to the communication of ideas as is the possession of the ideas themselves. The botanist observes an individual plant, and notes its characteristics. He observes others which possess some of these characteristics whilst others are wanting. He forms a class-type from these agreeing attributes, and gives this new collocation of characteristics a name. Nature never presents this class-type absolutely; it is found nowhere but in intellect. What has the botanist done but to retranslate the communication of Nature into Idea, and then to express this idea by less complicated and less physical symbols? Man's province in this case is simply to interpret the hieroglyphics of Nature into a more readily comprehended language—to express that simply which nature has expressed confusedly. The scientist restricts himself to the interpretation of a single class of symbols, as the Botanist to plants, the Zoologist to animals, but the

end sought in each case is the same—that is, to change all these physical utterances of Nature into Idea, and to secure for this Idea a method of expression involving the least possible materiality of symbol—that is, to change individual facts and phenomena into general principles, which, because abstract, are unchangeable. When this has been done, the work of the Naturalist ceases, but the work of Man, the Thinker is not done; it is only just begun. By assuming the ultimate expressions of the various natural sciences as individual and not as typical, we can treat the truths reached by them precisely as the Botanist treated plants, and, rejecting points of of difference, may find in them all some central idea. This is the province of the metaphysician. Hs seeks the law of Idea, he determines the law of Thinking, just as all other laws are determined, from a study of the symbols formulating its expression in Nature. When this law has been distinctly enunciated, and freed from all intermixture with the contingent, then the work of the metaphysician ceases, the *summum genus* has been reached. The truths communicated in the symbols of Nature, have been correlated and enunciated, and finally translated from the dialect of man the physical into the language of man the intellectual. Physical science determines the separate words of this message of God, the letters of which are scattered throughout Nature. Metaphysics combines these words into propositions which enunciate a distinct truth. There is therefore neither conflict nor variation between the method of Logic and the method of Nature. The movement of both is in the same direction; the only difference is in the point of starting. And another truth no less important, which follows from the foregoing discussion, is that the method of Nature is fundamental to the method of Logic. Physics should precede metaphysics, but not exclude it; both are essential to every true science, and physics, which stops with physics, leads man by dazzling promises into some Utopian desert only to leave him there to die of hunger. And it is no less true that metaphys-

ics, without this basis in experimental science, is illusory and untrustworthy, wherever the original data are necessarily empirical.

Two conditions are thus necessary to all science: a body of knowable truth capable of being systematized; and an intelligence capable of apprehending and systematizing it. One of these conditions is physical and one is metaphysical; and all true science must be the resultant of Law and Idea, the Objective and the Subjective, the twin forces of Nature and Man. If either of these conditions be wanting, there can be no true science, for science can neither be "evolved from the depths of the personal consciousness," nor can the scattered letters of scientific truth, as given in nature, arrange themselves into the words of a significant message. Knowledge must be classified before it is science, and that which classifies can only be intellect—discovering and enunciating this classification according to the laws of mental action. As prominence is given to one or other of these two conditions we have the division into Logical and Natural, but the fundamental principle of classification is the same in both—it being simply the law of intellectual action—just as the law which governs the action of the levers of a loom will determine the pattern of the woven fabric. There can, therefore, be no conflict between the methods of Logic and those of Nature. The determining element in all classification, whether of the phenomena of Mind or of the grosser phenomena of Matter is uniformly and always the same—the law of intellectual action.

Science then resolves itself into a determination of this Law of mental activity, so that in an ultimate analysis, all science is metaphysical, just as all science primarily is physical. Here, as elsewhere, Law can be studied only in its objective manifestations. The Law of Thinking can be educed only from expressed Thought, but the Law is not objective thought, any more than the idea of the sculptor is marble, or the conception

of the painter is paint. The simplest expression of thought is not the syllogism but the logical proposition. Now, it is plain that if the proposition is the formulation—the material representative of thought—if we study it as we study other natural symbols, we will find in it the fundamental Law of Thinking, and ultimately the fundamental Law of all Science: just as, if it were possible to reduce all elementary substances to one, the chemist would be able to find in that one a condensed expression of chemical science.

What then is a proposition? Simply stated, it is the assertion of relation between two terms; or more abstractly, it is the reference of an individual to its species—the assertion of a classification. We find here the same duality which we noticed above. If we give prominence to the individual notion, we consider the proposition in extension; if we turn our attention to the specific notion we consider the proposition in intention: in the one case referring to the individuals composing the class, in the other to the attributes composing the class-type. The first corresponds to induction, the second to deduction. When we study individuals we study physics; when we study the attributes composing the class-type, we study metaphysics. The Law of Thinking as educed from a study of the proposition is the law of classification. The proposition, considered affirmatively, asserts explicitly agreement between certain attributes of two terms; that is, it asserts a classification. The aim of science is to reach this proposition, to discover and assert the principle of classification—in other words, to formulate metaphysically what nature has presented physically. We must find, then, the first or fundamental law of thinking in this *integration* or classification. This fundamental law may be subdivided into two species, according to the two terms of the proposition; of which the first may be stated thus: "Every possible object of thought is to a certain extent identical with every other"; and as the proposition implicitly states disagreement, the second may be stated thus:

"Every possible object of thought is to a certain extent diverse from every other." The first gives the positive (subjective) condition of the proposition, the second the negative (objective) condition: both together constitute the conditions of thinking. The proposition is thus the assertion of the same in the different. The proposition also asserts, implicitly, the *tertium quid*, or the basis of classification—the class-type, to which both terms are referred—that is, the proposition secondarily asserts an analysis. According to the first condition we have the inductive process; according to the second we have the deductive process. A complete movement of idea from its purely physical symbolization to its metaphysical interpretation, must involve both these processes.

The mind possesses the power of analysis; it can watch its own operations and retrace its steps, until it arrives at the original data of consciousness; but analysis cannot comprise the whole of the logical process. Before there can be analysis there must be something to be analyzed; before steps can be retraced, they must be taken. We must not confound a condition with a Law—the one is a conception antecedent to all action, a genus to which the particular activity may be referred; the other is coincident with action. The one is the medium of the other. We may illustrate this idea by science itself, which is reached only by an analysis of Art. Matter is the condition of the expression of an idea; hence to all but the artist, Art must precede Science, but this cannot be in the case of the artist; in his mind the Idea is first conceived, and there it is given expression in the forms of Art. Here, as uniformly in Nature, the whole absolutely precedes the part—the universal exists before the particular—God before man. Truth absolute thus exists before truth conditioned. Science before Art. Remove conditions and the conditioned becomes the absolute; art and science coincide. But truth which is assumed to be out of all relations, cannot be comprehended by man, and practically is not. Even the universal propositions

of deduction express universality under conditions—that is universality of relation; just as infinity in mathematics means that which passes measurement, while in fact between infinity and measurement there is no relation, and the infinite is thus incomprehensible as an object of thought, although by no means unrecognizable as a necessary condition antecedent to all intellectual action. It is of vital importance that we note this distinction, because reasoning, i. e. classification, is possible only so long as we deal with what is admitted to be under relation: if we assume a term to be out of all relation, it ceases to be an object of thought—it can neither be classified nor unclassified; it is beyond reason. Mathematics can proceed with its investigations only so long as it treats all quantities as measurable; it must wholly cease its calculations if an infinite term be introduced. To claim that analysis represents the complete normal action of the intellect in reasoning, is ultimately to claim that the initial point of thinking is the *summum genus* of thought—God. Now God is undoubtedly the initial point of absolute thought, but he is not the beginning of human thought. Intellectually speaking, God is the final generalization; every movement possible to him must be one of analysis—a differentiation of Himself, so to speak, by negatives. Thus the course of absolute Thought, beginning with God, must be first towards a complete differentiation into ultimate individualization; and lastly a complete integration again of individuals into an infinite whole. This dual action completes the circle of intellectual activity. We have dropped attribute after attribute until we have reached the last possible analysis; but we do not stop here, but by the assumption of attributes we again reach the highest possible synthesis. This must be the method of the divine activity, successive differentiation and integration, the closing in of a mighty circle of infinity, embracing all the finite, but never losing the essential characteristic of the infinite.

Now, if this also represent the exact movement of the finite

mind in action—that is, in reasoning, man must be God. Man is finite. Even his infinite is only the immeasurable—not that which is without the category of measure. He cannot begin where the Infinite begins, at the highest possible generalization,—but he must begin with the finite. If what we have shown above be true, man must begin with the individual, and the first mental act of the positive character of thinking, is the reference of this individual notion to a class. Now the *class-notion* is the same as the individual notion, less certain attributes as *individual* attributes, but gathered into a larger whole. This process is plainly integration; we are rejecting from the new conception whatever prevents enlarging the class. Each higher generalization involves all the attributes of the lower, not individually, but specifically or generically. In the final generalization, extension and intension coalesce. Just as we reach the individual by differentiating a universal through successive negations, we reach the universal again, by integration, by successively denying the negations through which we just now differentiated. The movement of the finite mind in reasoning is thus from the individual through the universal to the individual again.

Science thus parts into two great branches — one seeking to establish principles by what we have called integration, and the other the elucidation of facts by *a priori* reasoning instead of observation. That is, the aim of true science is to free man from the restrictions of the finite, and to place him in possession of the infinite — the closing in of a lesser circle of infinite truth, yet never losing hold upon the finite. In accordance with this view we see science pursuing its integrations until it has identified as composing an essential unity all the various manifestations of force. This is the finite becoming the infinite, for unity is, in so far, infinity — God is one, a unity, not a unit. But we also see science going beyond this point, and by a new series of differentiations reaching truths new to experience, if indeed not impossible to experience.

Between these two limits all knowledge is forever moving. It can never rest. The tide of thought sweeps onward towards the infinite—God following it to its final absorption into the *I Am*, simple being,—while finite man, because of his finiteness, can only reach those universals which are infinite only to human thought. Like men on a journey we leave the train when we have reached our journey's end, but the train passes on out of sight in the distance, sending back, now and then, tokens of its progress, as it thunders over a bridge, or whistles shrill as it nears some further stopping place, until at last all is still, not because the train has stopped, but because we can follow it no further with our senses. Even after science has reached the utmost limit possible to it, it is not satisfied to rest there, but starts at once upon its return trip, to bring to notice undiscovered facts hidden in these mighty generalizations. Thus the pendulum of intellectual activity unceasingly vibrates between the infinite and the finite, never resting, because Idea and Matter, the force of Man and the force of Nature can never be completely identified.

VEXED QUESTIONS IN ETHICS.

BY REV. F. M. HOLLAND, A. M., BARABOO, WISCONSIN.

The best and wisest people differ widely about what is right. John Brown, Stonewall Jackson and Abraham Lincoln, were equally conscientious in their ideas of the duty of Americans towards slavery and the Union. Ardent friends of morality take opposite sides about liquor laws, taxation of church property, Sunday amusements and the use of the bible in the public schools. Similar differences of opinion exist about the duty of dealers to mention defects in their wares, the propriety of giving to strangers who appear needy, and the obligation of speaking the truth when it seems likely to do harm. We need some general rule for solving all such problems, some acknowledged test of right and wrong, some practical moral standard. Two honest men might easily quarrel about the length of a plank, if they had no rule to measure it by; and we quarrel continually about moral dimensions, because we have no established system of measurement.

About a dozen different systems are advocated by moralists, but the fact that there are so many proves that no one has been made sufficiently accurate to take the proper place. This diversity of opinion, about the moral standard, arises from the general disagreement about the essential peculiarity of right, distinguishing it from wrong. Corresponding questions are—what is conscience, and what is the ground of moral obligation?

We may find great assistance in solving these almost identical problems, by turning our attention to another one, which was thought fundamental in ancient ethics, but has received too little attention from modern thinkers, namely, what is our

supreme end, highest good, or rightful ultimate aim? The question once asked by classic philosophy, concerning the Summum Bonum, has been reiterated by Christian theologians in the form of "What is the chief end of man," but modern moralists have not agreed upon an answer. If they had, they could easily have been unanimous about the true moral standard. Given the supreme end, this standard is found in the fact that whatever tends towards the supreme end is right, and everything else wrong in proportion to the degree of obliquity. The true moral test is that of direction towards the highest good. We must locate this pole in ethics before we make a compass. Modern philosophers generally make the compass first, and try to find a pole afterwards, so that we have some dozen compasses pointing all sorts of ways.

One of the oldest and most popular ethical systems, however, owes its commanding influence to its persistent attempt to identify the moral standard with the supreme end. This peculiarity has won the co-operation of such keen philosophers as Epicurus, Pliny, Gassendi, Hume, Locke, Bentham, Mackintosh and Mill, to which great names might be added those of Lucretius, Horace, Lucian, Moliere, Rochefoucauld, Voltaire, Franklin and Lincoln. Rapid progress is being made in this country, as well as in Europe, by this system, which, asserting the supreme end to be Universal Happiness, pronounces all actions right or wrong, according to their tendency to increase or diminish the greatest good of the greatest number. Such at least is the utilitarian formula, which, however, takes an unfair advantage of the fact that the word "good" has two senses, sufficiently distinguished in common use, and means sometimes pleasant or productive of happiness, and sometimes obligatory or obedient to the moral law. The term good may denote either that a dinner is well cooked or that an action is moral. We are practically so well aware of the different significations of goodness as applied to cooking or to conduct, that a system, which founds itself on an attempt to confound together

such radically distinct ideas, is self-condemned. We all know that the least pleasant duties are commonly the most obligatory. The great mystery of life is that true happiness never comes to those who seek nothing higher. The attempt to make happiness the supreme end defeats itself.

Still another objection to utilitarianism has been powerfully stated by Lecky and Herbert Spencer, namely, that there is so great difference of opinion about the real nature and conditions of happiness, that no firm standard of morality can be erected on such an unstable foundation.

Serious as are the defects of the greatest happiness theory, however, no moralist can hope to displace it, unless he succeeds as least as well in recognizing the supreme end in his moral standard. Most anti-utilitarians and semi-utilitarians make no attempt to reconcile these two ideas, but separate them so plainly as to make their systems self-contradictory. This is especially the case with the intuitionalists, or believers in the supreme authority, if not infallibility, of conscience, which theory is further proved to be defective by the existence, not only of such great differences of opinion among its followers about many practical questions, like non-resistance, prohibition and free-love, as to demonstrate its inability to supply a moral standard which can be used with sufficiently uniform results to make it valuable, but also of so irreconcilable a controversy between leading philosophers, about the very fact of our possessing any independent and original intuitions, that to assert them as the foundation of a moral system is too much like building a house on a lot of land, about the title to which there is a law suit. The true system of morality must recognize supreme good higher than happiness, and plain enough to be its own self-evident authority, independent of all metaphysical and theological disputes, so that the moral standard shall be fully demonstrated by its connection with the supreme end. It is also necessary that the true moral standard should not be liable to be disturbed by individual

differences of inclination and interest, and should be applicable to all the relations of life and capable of supplying all needed moral precepts. The true statement of the ethical end and standard must be its own definition and demonstration and need no help from any other theory.

THE PHILOSOPHY OF EVOLUTION.

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The intellectual processes of a rational being must proceed according to some law. They cannot succeed each other at hap-hazard. The notion of rationality is conditioned upon this regular procedure; if this be wanting, the essential character of rational action is wanting. But to say that rational processes are determined by law, and conditioned upon a regular procedure, is simply to assert that the steps in ratiocination are so related to each other that the relation of each to every other may be determined by the application of the law—the difference between any two steps being analogous to the difference between any other two. The astronomer determines the orbit of a planet from three observations, because he thereby determines the law of variation between these points; from which he assumes that this law will be constant, presenting a series of terms each differentiated according the series of differences already determined.

Applying the same principle to mental phenomena, we may determine the law of intellectual action. Thoughts are discriminated by the presence or absence of certain attributes. At one extreme we find the *summum genus*, comprising the fewest possible attributes distinguishing an idea; at the other extreme we find the individual, comprising any number of attributes. Between these two extremes we find a regular series of intermediate terms. The movement of an idea from the general to the individual is like the motion of a planet through one-half of its orbit; while the return movement from the individual to the general, corresponds to the motion of the planet over the remaining half of its orbit The same law governs both movements and unites the two halves of the orbit into a

single whole; and a series of observations taken at equal distances, will, by the uniformity of differences presented, reveal the operation of the same law in this dual manifestation. Upon examining the processes of deduction and induction, we find in each the same series of terms, differing only in the fact that they are in inverse order, and this correspondence reveals the operation of one and the same law. An inductive series is only a deductive series read backward. Any two terms in a series whether inductive or deductive, differ only in the degree of generality, and differ similarly from a third term, so that two being known the third can be therefrom determined. In a deductive series the terms differ by a constant increase in the number of individualizing attributes—a concept being expanded into a deductive series by such regular additions. Having two terms we can proceed to the third—that is, from two propositions expressing this relation, we can proceed to a conclusion. In an inductive series the terms differ by a constant diminution in the number of individualizing attributes—an individual term being expanded into an inductive series, by successively dropping the attributes which compose the individual term, until we reach the required degree of generalization.

Thought must proceed in one of these two directions. The object-matter of thought being composed wholly of attributes can differ only in the presence or absence of certain attributes. A combination, then, of these two movements must complete the intellectual orbit. The direction of the movement of the mind will be determined by the end proposed. When we possess the knowledge of phenomena and wish to discover law—that is, when we seek information—we proceed by induction, from the individual to the general. When possessed of knowledge, we wish to discover its applications, when knowing the law, we wish to determine the phenomena necessarily resulting therefrom, we proceed by deduction—from the general to the individual. Complete knowledge, then, consists in the highest

possible generalization, and the expansion of this term into a series, ending only with the last possible individualization. The aim of physical science is to determine that half of the intellectual orbit which lies between the individual and the general—the aim of metaphysical science is to trace the other half which lies between the general and the individual. When we seek to know what is, we proceed by induction—the method of the phenomenal. When, knowing what is, we proceed to determine what hence must be, we procced by deduction—the method of the Necessary. Thus Science, at first seeking principles, proceeds by induction to establish them; but after these fundamental principles have been established, it proceeds deductively to determine what must result from them, without waiting to discover these truths by observation.

Knowledge is thus complete just in proportion to the extension of its scope through generalization. The higher the generalization, the more inclusive will it be, and the *summum genus*, or the final generalization, will be the highest attainable reach of knowledge. When man can make no further generalization, his knowledge will be, in so far, absolute and complete, and all that remains possible to him will be the practical application of what he already knows. Perfect knowledge is nothing but perfect generalization. The Supreme Intelligence being hypothetically possessed of all knowledge, that is, having discriminated the absolute *summum genus*, can proceed no further in this direction; his intellectual activity must be exerted in a descending series, or from the general towards the individual, and this process must be, as we have seen above, by a determinate series of steps, fixed by the operation of a definite law, which law proceeds by the successive addition of attributes to the general.

Complete knowledge, being complete generalization, the lines of all science will necessarily converge, as they approach this generalization, until all sciences coalesce in one science, and all truth is reduced to a single expression in the utterance

of the final conception. In accordance with the laws of thinking, this general term is reached by successive omissions of particularizing attributes, until at last we reach Being — the absolute *summum genus*, wholly free from individual attributes, and thereby embracing everything possible to thought, whether material or immaterial. But this *summum genus* must be predicable of this whole. Matter and mind may thus be reduced to a single category, and the physical and the intellectual finally coalesce in this last generalization. Materialism and idealism thus differ merely in the degree of generalization reached — or rather they both agree in avoiding the final generalization which identifies both matter and mind. Materialism must always deal with the individual, for matter can appear under no other form. Idealism must always rest upon the general, for thought, to be thought, must state a generalization. Each, however, finds its explanation in the other, and both are harmonized by the application of the law of intellectual action above given. Matter and Mind are complementary, not incompatible. They differ with each other, but they agree in being similarly related to a third term. Matter is objective; it is thought taking form, becoming individual, manifesting itself in space. Mind is subjective. The one appeals to the senses; the other is known only to the consciousness.

Science reaches its full development only when it includes both physical and intellectual phenomena within its scope. Every step which it takes carries it further from the purely physical, and brings it nearer the purely intellectual — that is the development of physical science is from the individual towards the general, and it reaches its end, its completion, only when the last distinction, that of subjective and objective, has disappeared in the last possible generalization. When the objective has been identified with the subjective, the distinction between Mind and Matter has been obliterated, and we have reached the Supreme Intelligence — the "I Am" of Scripture — simple Being.

Matter is the formal expression of thought, or the necessary condition of such expression, and in this condition is found the link that connects the subjective and objective manifestations of *being*. Subjectivity is ideality, as objectivity is materiality. The consciousness can take cognizance only of what is within itself, and therefore without every other. Consciousness is therefore wholly personal. To communicate an idea it must be placed within the consciousness of another. To reach this result it must cease to be personal, must pass out of the subjective consciousness into objective form, so as to be placed in the same relation to the speaker and the hearer. Thought, out of the consciousness of the thinker, is objective to him, and to render thought objective is to give it material form. Thought to be communicated, must pass out of the consciousness of the thinker into a material representation. The assumption of material form individualizes the idea. The artist's mind may be filled with splendid conceptions, but no one but he can look within his consciousness and see them. Before others can have any knowledge of his thoughts, he must give them form, or embody them in statues or paintings. The soul of the musician may be thrilled by the harmonies that his imagination creates, but no other soul can join him in this ecstasy until he has given form to his conceptions. So the thinker must embody his thoughts in language before he can communicate them to another. Matter, then, is the vehicle by which thought is communicated, and, so far as we are concerned, the necessary condition of such communication, so that the conception of thought apart from the thinker involves the intervention of material forms, and it is by the interpretation of these symbolical forms that we discover the idea.

Now, let us suppose a Supreme Intelligence. The intellectual processes of such a Being, to be conceived as rational by us, must be identical with ours, or at least analogous to ours. The possession of infinite attributes may in fact free him from the control of any law, but it is impossible for us to conceive

an intelligence acting otherwise than in accordance with law. So that if the Supreme Intelligence is to communicate with man, it must be in obedience to the laws which control our mental activities. The Divine thought must, then, like human conceptions, be communicated by means of physical symbols.

The Supreme Intelligence, being the final generalization, must possess all knowledge, and the only intelligent action possible to him from our point of view, is from this absolute generalization towards the concrete and individual. The absolute general is purely subjective, which, to become cognizable, must be rendered objective. This can be secured to us only through the intervention of material forms. From this point of view, matter is only the symbol of thought—thought apart from the thinker. The first result of the divine activity in self-manifestation would be the analysis of *being* into subjective and objective—that is the discrimination of mind and matter, which terms are severally the final generalizations of the two fundamental divisions of science. Matter, then, mere formless, chaotic matter, would be the first result of creative activity. Following the development of this idea in its continually increasing individuality, as new attributes are severally added, matter assumes determinate form and becomes related in systems, as the various so-called elementary substances are discriminated, until finally all truth, capable of being revealed by inorganic matter, is presented to us.

Add the idea of organism and we have the two great divisions of phenomena—material and vital. The higher the generalization, the fewer will be the attributes composing the concept, and thus the simpler will be the form symbolizing its expression. As in the case of matter, the first result of the divine activity was mere matter, undiscriminated by any further attribute; so here, we have, as the first organic creation, a concrete expression of the highest possible generalization comprising the fewest possible attributes—that is, forms of

life involving the fewest individual characteristics. To matter add the simplest organic attribute—that is, the one lying nearest the genus—and we have mere organized matter, the simple cell, the foundation of all life, no matter how great its future complexity, equally the origin of animal and vegetable growth, which are as yet entirely undiscriminated. This would be the first appearance of life.* Differentiating again by the addition of a new attribute, and organic being is subdivided into the two species, vegetable and animal. Beginning with these typical forms, adding single attributes in a continuous series, we at last reach the highest types of animals and plants. Finally, add rationality to the animal, and we reach man, the highest and therefore the most complex type of life, and who, so far as we are concerned, must be the end of creation. We cannot conceive of any higher creation, because we cannot add an attribute to those we already possess, any more than we can conceive of an additional sense by which to cognize such new attribute.

This process has been determined from the very outset by those intellectual laws which we cannot disobey, and which we cannot conceive disobeyed by an intelligent creator. If the law of intellectual action require this process from the simple to the complex, the concrete representation of the steps of this process must indicate the operation of this law, and must also proceed from the simple and rudimentary to the complex and highly developed. An intelligent Creator in revealing his thought must follow the method which our minds must follow in interpreting this revelation. When we know and seek to communicate our knowledge, we proceed from the general to the specific.† The Creator assumed to be infinite in knowledge would therefore follow this process instead of the method peculiar to investigation. The law of intellectual action de-

*This, of course, does not absolutely determine the order of organic creation; as in the case of the syllogism the conclusion or either premise may be the proposition first enunciated, the order of expression being determined by circumstances.

†Compare the demonstrations of Geometry.

termines this method, and the conditions of intellectual communication determine the representation of this method in the material expression of the ideas communicated. Considering the operation of this law under these conditions, we find that the thought communicating only, as nearly as may be, the generic idea, will be distinguished from it by the addition of but a single attribute as the generic by itself is incapable of being represented in concrete form, the expression of this thought in form will present us matter distinguished from matter in general by but a single attribute. The least possible individualizing attribute added to the highest possible generalization gives us the simplest expression of an idea, and the form or the organism symbolizing this thought will be the simplest form and the simplest organism possible. For instance: in organic life the highest generalization barely individualized will give us the simple cell; and no matter what degree of complexity we subsequently reach by the addition of an almost infinite number of attributes, we nevertheless begin in every case with the same starting point.

Each higher type is reached by adding to a lower. The higher thus embraces all that can be found in the lower, and something besides. This method is invariable, and can never be departed from. The genus must always be predicable of every individual component of every species contained under it. Translating this law into the forms of material expression, and it requires each higher species to physically include all lower species, and to differ from them only by addition. Man, the highest type, must thus include all the attributes of the cell as physically expressed, and without them he would not be man. The differences between no two terms in a series can be total. If the successive steps in a train of thought must be related, so that no two notions will be wholly distinct from each other, these notions will constitute a series, each term of which will, in a measure, determine the next, so soon as the law of the series is discovered; and if this train of

thought be objectively presented, it will afford a corresponding series of physical terms, each one of which will in like manner determine the next. But thought is impossible unless by a train of ideas so related. Its physical expression will therefore be equally impossible except by a series of physical terms similarly related, each one of which in some manner determines the next. There must then be a perfect continuity in the line that reaches from the simplest form of matter through all grades of organic life up to man, the highest expression of the divine idea. There can be no break in the chain of thought, because the law of the logical process forbids it: there can be no break in the series of material symbols for the conditions of concrete expression equally forbid it. A symbol is nothing except as it represents that which is to be symbolized. So the symbols form a physical series, because the thoughts symbolized form a logical series.

If the creator has fully revealed his thought, it must be by a series of physical terms arranged in such a manner as to indicate the logical series of ideas symbolized. Every form of matter is a symbol of thought, and challenges interpretation. Every change in form corresponds to an antecedent change in idea, and must be intended to reveal it. As thought, then, begins its evolution with the general and proceeds to the individual by a series of terms each of which is similarly related to both extremes, we must find the material enunciation of this process assuming the form of a series of terms, beginning with mere nebulous matter, grading into organic life, and organic life presenting us with a similar series beginning with the mere cell and ending with man. So rigid and invariable must this serial arrangement be that if a term in either series be wanting, we are authorized to hypothetically interpolate it.

"Nature never makes a leap" says the scientific investigator, as he studies the material symbols of thought. "Thought never makes a leap," says the metaphysician, as he studies the necessary laws of rational action: and both have uttered the

same truth. We prove a proposition by determining the steps by which it was educed from a more generic statement. Science must proceed in the same manner, for science only discovers the track of mind—it does not make the track, it only follows it. If then we find the chain of evolution broken at any point, science must either stop there, or assume the wanting term in the series. We have the right to interpolate these missing terms, for we must assume that the thoughts of God communicated to us in material forms constitute a continuous revelation, beginning with Himself, the final generalization, and ending with man the highest individualization. These limits are fixed—the one by the nature of God, and the other by the nature of man. Between these two extremes we must find a series of intermediate terms. Any other conception of their relation than that of a determinate series is impossible and irrational; and a series, so far as it means anything, means evolution of some sort. Finding the relation between these terms—distinguishing the *same* which reproduces itself, and the *different* which introduces a new term—that is, determining the law of apparent evolution—is the problem presented to science.

The astronomer found Bode's law to all appearance violated by the omission of a planet between Mars and Jupiter. He could see no reason for the law, but if the planets had been placed by an intelligent Creator, some order of arrangement must be discoverable according to which their position was determined. The Creator being intelligent, it is impossible to conceive them placed fortuitously. There must then be a link between Mars and Jupiter, because the law once established cannot be broken. The same law may be observed in the arrangement of leaves around the axis of a plant. If intelligence arranged them they must be arranged in some order, for intelligence never performs the least act without a purpose. Each leaf or pair of leaves is not a mere duplication of the previous leaf or pair of leaves. The relation which subsists

between any two sets in the series expresses the idea of the Creator, and this must be constant. Completing the series as indicated by different plants, we may assume that if any term is apparently wanting, it is only because it has not been discovered. In neither of these cases would it be asserted that any physical evolution had taken place—the terms form a series of which each term is equally determined by the operation of a fixed law; and yet it is an operation precisely analogous to that which in the case of animals presents every appearance of a real evolution. Take, for instance, a series of animals, presenting at one period of time the simplest and most rudimentary forms, and at another the most complex and highly organized; we cannot do otherwise than conceive these two extremes as related by intermediate terms, through the operation of some law which holds good throughout the series. The relation subsisting between any two, must be the same as that subsisting between any other two similarly situated, or a departure from that relation which is itself governed by a definite law discoverable from a comparison of two sets of terms. The application of this law is so universal and so rigid that we need not hesitate to interpolate a missing term, and confidently assert that it either does exist or has existed. To deny this principle is to deny the necessity of continuity in reasoning. This continuity of thought is represented in matter by the persistence of generic forms under specific differences. But just as the specific is the generic with certain additions, so the individual is this same generic with still further additions; and these additions, whether considered solely in space, as given in the symbols of physical science, or in time as in the conceptions of intellectual science, must be determined by the same unvarying law. The persistence of the same form furnishes us the means of identifying this relation, while the differences reveal to us the successive steps by which the generic was differentiated into the individual.

If the creative thought has been expressed by the forms of

matter, the laws of thought must be thus expressed in the relative forms of matter. Anything less than this, while it might interpret isolated ideas, would not communicate the method of the creative process, and science is nothing but the discovery of this method. If the terms of the logical process must be arranged in a series, the physical symbols rendering this logical process cognizable, must be arranged in a similar series, for science becomes impossible when the logical process becomes undiscoverable.

The differences between the terms in this series must be cognizable. Two terms which are indistinguishable are practically identical; and two terms which are not identical vary by a difference which is cognizable by itself apart from either term. The steps in the logical evolution of the final term *Being* must be separable to be cognizable, and the material forms interpreting these steps to the senses must also be distinguishable. A species differs from the genus by the addition of at least one attribute. Now, if the species is distinguishable from the genus, the attribute which differentiates it, must be separately cognizable—so also the individual differs from the species by the addition of attributes, which must in like manner be separately cognizable, or the species will never be conceived independently of the individuals. A thought cannot proceed by insensible steps, nor can its material expression vary otherwise than by determinate and distinguishable differences. The distinction of species is thus a logical necessity. The addition of distinct attributes to the genus gives origin to distinct species; variation in attributes not affecting their substantial identity gives rise to varieties. One species, then, cannot become another, except by the assumption of a new specific attribute, so that one species passes into another precisely as the genus passes into the species, and that is just as, and not otherwise, than one thought passes into another.

The fundamental law of the logical process is that we pass from the generic towards the individual; from the simple to

the complex. Induction can proceed only by assuming a genus at the outset—that is, by assuming certain attributes in the individual to be generic. Translate this law into material forms, and we have each higher—that is more complex—species evolved from the lower by the addition of some new characteristic. This new attribute cannot be added by the functional activity of the lower organism; that can only reproduce itself. A thought does not change merely through repeated expression. We pass to the conclusion of a syllogism, not from each term, but from a comparison of the premises—and this requires an intellectual operation entirely distinct from a mere apprehension of the terms. It is one thing to comprehend the premises; it is quite another to deduce a conclusion from them. It may necessarily follow, but it requires a separate act of the mind to reach it. Premises will not of themselves reach a conclusion.

Reading this same truth in the forms of matter, we may say that species will not pass into higher species without the intervention of a force distinct from either. The impulse which adds a new attribute must be intellectually separable from all those pre-existing, and its material representation must be physically distinct from pre-existing forms. This complete separability precludes the possibility of mere physical genesis. The added attribute is presented by a new form of matter, revealing the presence of a new thought—a new effect, requiring the agency of a new cause. In accordance with the usual economy of nature, who never duplicates her forces, change will be made only so far as may be necessary to communicate the additional idea. Organisms representing previous thoughts will be added to, in order to express the expansion of the thought, instead of a creation *de novo* in each instance. Thus an indentical cellular structure will be found in all organic beings, from the lowest to the highest, each higher type carrying forward the idea and its physical expression found in the lower. The differences between no two terms in the series can

be total, nor can any two terms be identical, as each higher species will embrace all the attributes of the lower, differing only by the addition of others. This is simply the physical expression of the logical truth that whatever can be predicated of the genus can be predicated of every individual contained under it. As the individual is only the expansion of the genus, so higher physical types must also be similar expansions of lower.

Here, then, is evolution, or development: primarily an evolution of the generic into the individual, the continued differtiation of a generic idea through successive individualizations, each adding to the previous group of attributes, thus rendering the idea increasingly complex; and, secondly, an apparent physical evolution or development, interpreting this logical process by a series of physical forms so related as to reveal the relation existing between the thoughts thus interpreted. In the physical representation of the ideas so related, there must be an apparent physical evolution—that is, the process of evolution logically must, like the ideas thus evolved, have a physical expression, and the successive steps in this logical evolution must be revealed by material forms bearing an analogous relation, and thereby expressing the logical process. Matter is nothing, so far as we are now concerned, but the condition necessary to the objective expression of thought. Every phase of matter is simply an objective formulation of a corresponding phase of thought. Every addition to form implies an antecedent increase of thought, as there can be no formal expression until there is something to be expressed. There can, then, be no such thing as mere material evolution, for whatever is material is only symbolical.

Matter being thus wholly inert, the origin of the impulse towards greater complexity must be sought for outside of that which undergoes the change. The movement by which one species becomes a higher is not an elaboration, an extension or a differentiation of existing attributes, but involves the posi-

tive addition of a new attribute, different and distinct from any or all previously existing. One species cannot pass into another by an innate impulse, for a species is an entity composed of a determinate number of attributes, and all attributes potentially present must be considered as actually present. We cannot say that the child is a different species from the man, and that one passes into the other by a process of evolution, because all the essential attributes of the man are potentially present in the child. If the polyp, by the action of innate forces, operating through a series of ages, however extended, can, without any impulse from without, develop itself into a man, then the polyp is as much a man as a boy is, differing only in the time required for development: and the data for the final deduction of the highest types of creation must be furnished in the most elementary forms of life.

The force manifesting itself in organic life is readily distinguishable from the organism by which it is manifested. Life and organization are not synonyms; one is the condition of the other, but a condition is not a cause. We can consider force apart from organism, and this possible separation in thought proves that the same form may not represent both, but that life can absolutely exist apart from organs which serve to give it a physical manifestation.* Physical life being conditioned upon organization, whenever the organism varies, the vital force thus manifested must also vary, such variation being necessarily antecedent to its manifestation. The organism varies, because it must, in order to express the added thought. Change in organism, therefore, is not induced by simple organic action, because the organs and the force acting through them can be distinguished. Assuming that matter is the objective or formal representation of thought, there can be no change in the material expression without a corresponding change in the antecedent conception. There can, then, be physical evolution, only as there is antecedent logical evolu-

*As in the case of man after the death of the body.

tion, and then only because of this logical evolution and not because of the operation of an innate organic force. Force, whatever may be its genesis, is only the exertion of power, not the increase of it. Exertion limits the view to the force immediately in operation. We may replace one manifestation by another, but the quantity is neither increased nor diminished by this change. Change in form implies the operation of force: and apart from such manifestation in matter, it escapes the tests of science, and passes into the purely metaphysical notion of cause. And unless the operation of force be constant, or, if different forces are blended, variable according to some determinate law, the action of which is constant and discoverable, so that the different units of force are separately measurable, the force thus irregular in its action can never be placed in any scientific category. Evolution, then, cannot proceed from any innate organic impulse, unless the force that tends to exact reproduction, and the force that induces a change be equally and separately cognizable. Change must proceed according to some law which accounts for the change, and distinguishes between the normal exertion of power and that exertion which causes a deviation. Science, to be science, must explain apparent exceptions as fully as the regular operation of forces, and that which causes the irregularity must be as distinctly cognizably by itself as the force which acts regularly. Anything less than this is not science. The discovery of Neptune was the result of the application of this principle; it was a successful attempt to discriminate the force which caused variation from the force which operated regularly.

Each species represents the operation of certain vital forces, and one cannot physically pass into another except by the increase of this force, or at least by a change in the manner of its manifestation; and this increase in amount or this change in direction must separately be accounted for. Nor does it matter, for the purposes of this discussion, as to the genesis of this added increment, further than to show that its origin must

be exterior to the organism by which its presence is manifested; for vital energy acting through an organism is a unit, and cannot, even in thought, be separated into distinguishable portions. Change in the direction of vital energy indicates that the original impulse has been modified in its action by encountering another force, for nothing but force can change the direction of force. It does not fall within the range of this paper to determine the nature of this exterior force which is thus distinguishable from that acting through the vital organization, and therefore capable of separate objective representation. Metaphysically we may say that force is resolvable into will, but will being purely personal is incapable of material representation, and thus cannot enter into the determinations of physical science, which does not seek to discover the origin of force, but deals solely with its presence.

As the logician must assume his premises, and, as a logician, cannot question their truth, so the physicist must assume a force in operation, and, as a physicist, cannot examine its genesis. The physical or the metaphysical method of inquiry is valid only so long as restricted to physical or metaphysical processes: a mixture of the two methods will give results satisfactory neither to science nor to philosophy. As logic furnishes no criterion by which to test the absolute truth of propositions, but deals wholly with conclusions drawn from given premises, so science furnishes no data by which to determine the absolute genesis of force, but restricts its enquiries to the phenomena resulting from a force given. For the student of physical science cause and effect is only the transference of a given and determined force from one material form to another. If this idea is to be traced further, it must be studied outside the limits of physics. This study belongs to metaphysics.

Now, if physical science does not deal with the origin of the initial force, but assumes at the outset its presence, no more does it fall within its province to examine into the origin of the increments which give to physical forms that variety which

renders science possible. Science deals with results, not antecedents; and after having determined results, it is not authorized to affirm that one species has produced another by evolution, or has produced it at all. If there are agreements between different organisms by which they are brought into relation, there are also differences by which they are discriminated, and these differences imply increments of force; and to assert that one organism has evolved another is to determine not merely the presence of this new increment, but also to determine its origin. Scientific investigation deals with phenomena which give evidence to the senses of a *transference* of force from one form or from one manifestation to another. Transference is not increase—an effect can be no more than the evolution of what was potentially present in the cause; it cannot add to it. The origin of the force must be investigated according to intellectual laws.

It has been argued that a Supreme Intelligence in manifesting his thought will, according to the necessary laws of rational activity, pass from the universal and general to the particular and individual, or from concepts involving few attributes to those involving these and others; and that these steps in the rational process must be represented in a corresponding physical series; and that the communication of thought is conditioned upon this physical representation. If the logical series comprises one thousand terms, each related to the preceding according to logical law the physical series must comprise one thousand terms, each physically related in such a manner as to reveal this law. As the highest generalization comprises the fewest attributes, the concrete expression of this idea will present the simplest possible physical form and the least complexity of organization, and thus will present the lowest types of life; and as the individual comprises the greatest number of attributes, its concrete expression will present the greatest complexity, and consequently the highest type of life.

We have seen that the logical process begins with the general and ends with the individual; its material expression must therefore begin with the lowest orders and end with the highest. But the individual cannot be immediately derived from the general without the intervention of intermediate generalizations. No more in the concrete expression of this deduction can we pass from the lowest types to the highest without the intervention of an intermediate series. These intermediate terms are not capable of independent interpretation; they find their full explanation only in the extremes of the series—God and Man.

If, then, in the intellectual process from the abstract and universal towards the concrete and individual, we find a constant evolution of idea, each advance being an addition to the previous conception, each new term in the series embracing all the attributes of the preceding, and differing only by addition; and if thought is possible only on this condition; it necessarily follows that the material representation of this thought must present physical forms similarly related, so that, leaving out of view the intellectual genesis of this relation, the observer might conclude that these forms compose a series evolved from a primordial cell in accordance with an organic law. But such we find to be the universal law of intellectual procedure: this apparent development or evolution must, therefore, be the condition of the communication of such intellectual process, and the physical terms are brought into this relation by the fact that they symbolize the logical process. If the material symbols of thought were unrelated physically, the thoughts thus expressed would also be unrelated and independent. But such a supposition renders Science impossible, for its one aim is to find the *same* in the *different*. If there be no *same*, there can be no science: if there be no *different*, there can be no science. Thought proceeds by adding the *different* to the *same* in an endless series, and this addition of the *different* to the *same* expressed in concrete forms is

what is called evolution. If no evolution were apparent in Nature, there could be no Science; for those steps which to the naturalist indicate evolution, being only the physical expression—the formulation — of the logical process, afford the means by which the student reaches the highest generalization. If these steps be wanting, he cannot proceed.

Admitting then to its fullest extent the fact that, judged from a purely physical point of view, all organic forms seem to have been derived each from its immediate predecessor, by a mere functional impulse; and admitting that science is possible upon no other condition, we claim that these material forms are brought into such relation by intellectual evolution, and not by physical genesis; they represent an evolution of Thought and not an evolution of Matter. We know from consciousness that this process of evolution is the method of our thinking. We know also that the divine thought can be rendered intelligible to us upon no other hypothesis than that which supposes it to be governed by the laws which control human thought. Translating the physical symbols which we see about us, and which present this appearance of evolution, we infer that this is the method according to which the Divine Mind proceeded. Science will not materially err in its physical results, if it adopt the hypothesis of physical evolution, but it must confine its attention to physics; it is only as we attempt higher generalizations that the insufficiency of the hypothesis becomes manifest in its failure to satisfy the conditions of the problem as presented to philosophy.

DEPARTMENT OF SOCIAL SCIENCE.

POPULATION AND SUSTENANCE.

BY DR. G. W. STEELE, LL.D.,
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The question of the increase of population and its relation to sustenance is one of the most interesting with which social science has to do. The subject, it is true, does not affect us so directly and imperatively here in the United States as it does the more crowded communities of the old world. We have as yet thousands of unoccupied acres, where for centuries to come additional millions may gather subsistence; while in Europe there are millions who are in continual danger of pauperism if not of starvation. There are supposed to be too many people for the territory they occupy, and the question is how to cure the evil or rectify their social irregularity. This question becomes a serious one in view of the doctrine largely prevalent in certain circles that by a natural law population increases by a ratio ever becoming greater than that of the increase of sustenance.

The remedies proposed for this state of things are mainly two, viz., emigration, and the restraint implied in abstinence from marriage. So far as the former is concerned it is a fortunate fact that there are countries to which the surplus of over-populated communities can emigrate. Yet this resource is unavailable to multitudes of those who need it most; and at best, it is only a temporary relief. Sooner or later the

habitable portions of the earth must be filled to their utmost capacity, so that not another human being could find subsistence, if nature takes its own course without artificial obstruction.

The second remedy, which is yet a precaution rather than a remedy, has two forms. The one is that of restriction by public law; the other, that of self restraint. The former has been tried in several countries, but with different success. The fact that it has been abandoned in some of them which are now still more populous, though less over-populous, than before the remedy was applied and abandoned, would seem to militate against it. A project so unnatural and fanatical is not likely to be largely accepted among men of practical wisdom. Nor is the other form of the remedy more promising. The influence to be exercised by self-restraint in relation to a course of action to which both nature and inclination powerfully prompt, must depend upon such a degree of moral and spiritual development as seldom exists among the classes which are chiefly to be benefited. Even so it must be in the line of motives which nature itself furnishes and not in antagonism therewith.

If, then, the law of the increase of population referred to really exists, it would seem that no humane or prudential provision to prevent or remedy the evil is practicable. These only remain frightful "checks of war, famine and pestilence," which by destroying a portion of the human surplusage, will temporarily relieve the remainder.

This prospect is indeed still more appalling in view of another law announced by an eminent economist. Says Mr. Mill:

"After a certain and not very advanced stage in the progress of agriculture; as soon, in fact, as mankind have applied themselves to cultivation with any energy, and have brought to it any tolerable tools; from that time it is the law of production from the land, that in any given state of agricultural skill and knowledge, by increasing the labor the produce is not increased in an equal degree; doubling the labor does not double the produce; or, to express the same thing in other words, every

increase of produce is obtained by a more than proportional increase in the application of labor."* "This general law of agricultural industry," says Mr. Mill, "is the most important proposition in political economy."

Now if there be a law in accordance with which the human race must go on multiplying till there shall not even be standing room for them upon the earth, unless checked by famine, pestilence or war, or by such restraints as are both unnatural and impracticable; and if there be another law by which the same amount of labor gives less and less means of sustenance, the prospect for humanity is indeed deplorable. These two laws combine to form the doctrine "that there is in the constitution of earthly things a positive, natural and ever-increasing disparity between the production of human life and the capability of the earth to support it." They agree with each other in this respect, if in no other, that they are as discordant as possible with all the other managements of Providence of which we know anything. Such an hypothesis needs to be carefully examined before it takes its place as an admitted principle of social science.

It becomes us to be suspicious of any proposition which is out of harmony with the general order of nature. The doctrine under consideration is certainly adapted to excite such a suspicion.

It is, no doubt, to be admitted that during considerable periods of history, and in many portions of the earth, the increase of population has been very rapid. It may also be admitted that in many of these times and places the mortality has been frightfully large. In some of these instances the population has increased faster than the means of sustenance. But it does not necessarily follow that the vast number of births was the cause of the extraordinary number of deaths, or that the diminished proportion of sustenance was owing to the too great number of births. It is clearly possible that the increased number of births was an effort of nature to supply the

*Political Economy, Bk. I, Chap. xii, § 2.

demand made by the fearful mortality; for this is what nature is perpetually doing elsewhere; depletion at any point being the occasion of a grand rally of forces to supply whatever loss has been sustained, and so restore the equilibrium. It is also quite possible that the lack of sustenance, instead of being a natural co-operating cause of the mortality, may itself be the effect of the same unnatural cause to which the other derangements are due; the predominance of the animal over the spiritual elements in man. For in some of the same countries in subsequent times has sustenance been produced for a much larger population where the mortality has been less; and in no country have the capabilities of the soil for production ever yet been exhausted.

These possibilities become more obvious and tend more strongly in the direction of probabilities in view of certain analogies which themselves hint, at least, at a natural law capable of universal application. It is well known that the insects whose term of life is but a few days are produced by myriads; animals whose term is half a dozen years, are reduced as to the number of their offspring from thousands to only hundreds; while those which live a score or mere of years, are proportionately less prolific. The principle here unquestionably is that the power of reproducing life is in the inverse ratio to the power of maintaining it. May we not suppose this law to extend not merely to all the various *species*, but also to the varied conditions of the *several* species, including that of man? The facts of history would seem to warrant an affirmative answer.

That there is no such thing as a natural law of uniform increase of population can be made tolerably evident to any ordinary observer. Providence works here as everywhere else, according to the conditions and requirements of the case. Hitherto, while there has sometimes been a rapid increase, at other times this increase has been slow or has entirely ceased. In many instances where, according to the natural order of

things, there would have been a steady growth of numbers, owing to the operation of unnatural causes, whole continents have been rendered less populous at the close of a century than at its beginning. The number of births may have been two-fold greater in one generation than in the preceding, yet because of devastating wars, or cruel oppressions of the lower classes, or an unjust and unnatural economical system by which the fruits of industry were unequally distributed, resulting in famines, pestilences, and other various sufferings among the masses, there has been a diminution of the population rather than an augmentation.

Again, nature, as already stated, works here, as everywhere else, not stiffly and inflexibly, but according to the demand made upon her. Just as when a bone is broken, or there is a lesion of muscle or membrane, she concentrates extra forces at the point where repairs are needed, producing in unusual quantities what is requisite to supply the need; so after destructive wars or other seasons of extraordinary mortality, the births are more numerous than before. It is so, also, where from any cause there has been a disproportionate diminution of either sex; nature hastens to restore the equilbrium. We might doubtless gather from these few simple observations, the general principle that nature, in relation to the increase of the race, would vary according to the means of support she herself would furnish; and that if any portion of the population lacked sustenance, it would be not because the increase of population was greater than that of sustenance, nor because of the lack of artificial and unnatural restraints, but because of unnatural and unequal distribution of the natural means of sustenance.

The rate of the increase of population in the different communities of the world is so variable as at first to seem to defy any attempt to infer a general law, and certainly such as to render obvious the impossibility of a law of uniform increase. It is a well known fact that the Aborigines of this continent

have always been noted for the slowness of their increase, and that, too, while occupying a soil and climate capable of affording sustenance many hundred fold greater than their demands. The tribes of the Pacific and South Sea islands are conspicuously prolific. In Great Britain and Ireland the population doubless in about sixty-five years. In Great Britain alone it doubles in about fifty years. In France not very dissimilarly situated on the whole, at the present rate of increase, it would require two hundred and seventy-seven years to double the population. In the United States, deducting the increase from immigration, the population doubles in about thirty years. The variation would be found doubtless quite as great if we should compare other countries.

But while we can deduce no law of increase, nature is by no means lawless or capricious either here or elsewhere. There is unquestionably a grand general principle governing this whole matter and beautiful in its adaptations; a law which is self-adjusting and to which men may readily adapt themselves without arbitrary artificial restraints. It is that *the increase of populatton is inversely as the advance of civilization;* or that the fecundity diminishes as the mental and moral development increases. There are some apparent exceptions, as among the hunter and, to a less extent, the pastoral tribes; but, as a whole, we shall find that it holds good. It is doubtless involved in the great law before alluded to, which evinces itself in the fact that the lower the order of animal life, the more prolific.

Manifestations of this law are obvious in the fact that the greatest fecundity in our times is found among the drudges of civilization — the former slaves of our Southern States and the lower classes of tailors in Europe and among the immigrants to America. Here the animal prevails over the rational nearly to its utmost; matter almost entirely subordinates mind. There is little of self-respect and little of hope. To talk of self-restraint to persons so conditioned, yet where such a remedy

is needed if anywhere, would be preposterous. It would be urging a duty for which they have almost no motive. The question of over-population and its alarming consequences, can only arise in a community where by vicious and unequal laws, the class of mere laborers, uneducated and unsagacious, is kept unduly large, where there is a constant effort by capitalists to keep labor cheap, and where, as in England,* small properties are discouraged, and agriculture, mechanical pursuits and direct commerce are made subordinate to the trade which keeps the producer and consumer at the greatest practicable distance.

It is thus, nearly everywhere in modern civilized society, that where man is at the lowest grade of mental development, where the animal subordinates the rational, there fecundity is greatest. The cause is not gross sensuality; for that is antagonistic to increase of population; but one involved in the very constitution of things and proceeding after a natural order. As men rise above their lower grade and mind asserts larger relative power, individuality becomes developed, self-respect is generated and self-direction assumed, the number of births diminishes. We may see some exemplification of it in our own country. A few years ago some of us were startled by the statistical reports concerning the relative number of births among the immigrants and the native population in Massachusetts. It was found that the former were greatly outnumbering the latter, and some fears were excited lest the old Puritan stock should soon wholly disappear. Yet this is only an illustration of what is taking place everywhere in the world under the general law just stated, that fecundity is inversely as the social and intellectual development of man. As education increases and the mental and moral predominate over the animal, the fecundity decreases. It is doubtless

*In Great Britan we are informed that the number of land owners has diminished within a little more than a century from two hundred thousand to seventy thousand as some authorities say, or according to others to less than forty thousand.

in accord with this law that we find the most eminent men leaving few or no children; for instance Alexander, Julius Cæsar, Napoleon, Gœthe, Shakespeare, Washington, etc. The British peerage affords further illustration. "Twenty years ago," says Carly in 1858, "the number of peers was three hundred and ninety-four, of whom no less than two hundred and seventy-two were the result of creations subsequent to 1760. From 1611 to 1819 no less than seven hundred and fifty-three baronetcies had become extinct; and yet the total number created had been less than fourteen hundred." The same tendency is observable among the aristocracies of other nations, ancient and modern.

Dr. William Elder forcibly sets forth some of the reasons of this tendency as founded on physiological principles.* The discussion is interesting and instructive, and altogether plausible, covering the whole grounds of, and making provisions for, the apparent exceptions noted above in the hunter and pastoral tribes. But it is not necessary to seek all the philosophical grounds of the law in question. We should certainly be warranted *a priori* in presuming that a wise Providence would so adjust the relations of sustenance and population that the increase of the latter would gradually diminish as it approximated the possible limits of the former, and that when these limits were reached, it would wholly cease. That there are so many facts which go to corroborate this presumption and so few making against it, which cannot be otherwise accounted for, ought to give some force of conviction of its truth. Clearly enough, nature intended that men and women should marry and multiply and replenish the earth, and that for all who follow this Divine ordering there should be sustenance provided, and that she will adjust the relations of the two without any artificial intermeddling of man. If there is at any point a derangement in these relations, such as to work destruction or distress to any portion of the population, it is

* QUESTIONS OF THE DAY: Economic and Social. Philadelphia, 1871.

because nature's laws have been broken, not because they have been obeyed.

The question of the diminishing ratio of sustenance to population demands particular consideration. It is difficult to apprehend the grounds upon which this principle is based. Mr. Mill, who strenuously insists upon the law of decreasing ratio between the agricultural product and the amount of labor, to which he has perhaps been the first to give a clear and comprehensive statement, himself admits the existence of an agency in habitual antagonism to it; namely, the progress of civilization, or the improvements by which the products of labor are so greatly multiplied. This, if I understand him correctly, operates more effectually in the mechanical industry than in agricultural, and thus makes up a part of the lack which relative diminution of produce from the soil creates; but not so much as to make the means of subsistence keep pace with the natural increase of population.

Now it may be true that of a certain portion of land, say ten acres, or as much as one man can cultivate successfully, if two men should labor, the product would not double, though this would not always be the case. At any rate, the limit would some time or other be reached beyond which doubling the labor would not double the return. But this would, contrary to Mr. Mills' supposition, indicate "a very advanced stage in the progress of agriculture," at least, it would imply a cultivation of the soil such as no country, as a whole, has ever yet nearly attained. I suppose that few would doubt that more than double the present amount of produce might be effected on the soil of Wisconsin already under cultivation, and that, too, with less than double the present amount of labor bestowed. But then the most fertile soils have not yet been brought under cultivation; they are such as require for their subjugation a very considerable advance in society and in the art of agriculture. Probably the state of Wisconsin is not to-day yielding one-twentieth part of the returns of which it is

capable with no more than ten times the labor now bestowed upon it.

But there is another condition of productiveness left out of sight by Mr. Mill. Purely agricultural communities the world over are almost certain to exhibit not only a diminishing ratio between the agricultural product and the labor bestowed, but an actual diminution of products of the soil. In our own country, on lands formerly yielding thirty bushels of wheat to the acre, the returns at present are less than that, as in Western New York and Ohio. In our own State of Wisconsin the same deterioration is observable. The reason of this is that the wealth of the soil is exhausted by the exportation of raw products, and however true it may be theoretically that the fertility of the soil may be kept up by proper appliances, these appliances are almost certain never to be made. It is only where there is considerable proportion of the population engaged in other occupations besides that of agriculture that the soil is kept up to its original productive power or can duplicate and reduplicate that indefinitely.

In Massachusetts there are hundreds of farms which now produce several times their former capability, and, so far as we can judge, with far less than the proportional outlay of labor. The same is more conspicuously the case in England and France and Belgium, in the communities where, by reason of the vast diversity of employments, a large proportion of what is taken from the soil is returned almost immediately to it. It is not perfectly clear whether those who talk of the pressure of population on sustenance mean by the latter only *food*, or whether they mean to embrace, also, clothing, shelter and some other materials of human well-being. If the latter, then it is evident that the increase of sustenance in very many of the most populous communities of the world greatly outstrips that of population, even after a considerable advance in the art of agriculture. It is certain, moreover, that, up to the present time, in no country where a wise industrial and eco-

nomical system has prevailed has the increase of population outrun the increasing capability of the soil to support it. In Belgium, where the density of the population is probably greater than anywhere else in the civilized world—four hundred and thirty-three to a square mile, or more than one to every arable acre in the kingdom—with a very defective social system, sufficient food is produced from the soil to supply all its own habitants and afford a surplus for exportation—this, too, in what was originally one of the most sterile countries in Europe. France, with a density of one hundred and seventy-nine to a square mile, feeds all her own people and has food to spare. The agricultural productions of France have more than doubled within the last forty years, while, as we have seen, at her present rate of increase, it takes two hundred and seventy-seven years for her population to double. This does not appear as though population were pressing very closely upon subsistence in France. Great Britain seems to be almost the only country in which there is any alarm concerning the relations of population to subsistence, yet Great Britain is capable of producing far more than food enough to supply her present population but for the system of economy encouraged by her, which subordinates agriculture to trade. Mr. Mill himself shows, with great conclusiveness, how greatly superior is the French system of peasant proprietors, by which the land is divided up into small farms. It was claimed by some British economists, that this measure, which, I believe, began to be adopted before the revolution, and was more fully carried out subsequently, would result in a vast increase of the population, because as it would at first render sustenance more abundant for the lower classes, it would thus remove the motive to self-restraint, leaving them to multiply, as it was forcibly expressed, "like rabbits in a warren." He shows that after half a century of experiment the effect is of a directly contrary character. We have seen above that the increase of population in France is insignificantly small in

comparison with the increase of food supplied from its own soil.

A source of error which has helped to support the doctrine here combatted exists in the assumption that the most productive lands are first occupied, and then those that are poorer, and so on down to those whose cultivation will barely sustain life. If this were so it would almost inevitably follow that the increased labor necessary to secure a given amount of product from the inferior soils would imply the truth of the doctrine. But it is evident that in the infancy of society when the numbers are small and the facilities for cultivation few, only the lands easily cultivated can be occupied, and there must necessarily be the lighter and less productive soils. Up to their time even in the oldest civilized communities, some of the most productive lands have not yet been brought under cultivation, while as in Great Britain, within the last twenty years perhaps the most beautiful crops in the whole country have been taken from lands which previously were considered almost valueless.

The statistics of the most advanced nations do not at all indicate this disparity between increase of population and the means of subsistence. In the United States the increase of population from 1850 to 1860 was 35.5 per cent., while the wealth of the country, real and personal, excluding that in the slaves, increased 86 per cent.; or the capital wealth of the country grew at the rate of 8½ per cent., and the population at that of a fraction over 3 per cent. per annum; the average share of each individual in the whole wealth of the country, were it equally divided, being in 1850, $266, and in 1860, $449; being an increase in ten years of 69 per cent. to each person. The siatistics of the last census present still more astonishing results. The "true value" of the real and personal property of this country in 1860 was in round numbers $16,000,000,000. In this was included the value of slaves who in 1870 owned themselves, and so were not reckoned as property. Aside

from these the "true value" may be put at $13,000,000,000. In 1870 it was as given by our census tables $30,000,000,000, giving an increase greater in the last decade by 30 per cent. than the total previous accumulations since the first settlement of the country by Europeans; this, too, in a decade of unparalleled public and private expenditure, of immense waste and destruction of both laborers and their products. This would give nearly $1,000 a piece to every man, woman and child in the whole country, an increase of more then 100 per cent. over the average portion of each at the beginning of the decade.*

In France in the decade ending in 1860, the increase of population was 2.6 per cent.; the increase of annual product 44 per cent., and the average share of each inhabitant in the annual products was 40 per cent. greater than in 1850. The increased value of each acre's share in the total wealth is supposed to have been considerably greater than this, but the statistics are not at hand.

In Great Britain the average of the total values of the property of the kingdom to each person were in 1851, $827; in 1861, $1,074; and in 1866, $1,239, being an increase of 50 per cent. in fifteen years. So that in Great Britain it is not because there is less increase of means of subsistence than of population that there is danger of starvation and need of preventive checks, but because there is somehow an inequitable distribution of the products of labor.

The following proposition will answer for a brief summation:

*Exceptions have been taken to the above statistics and to the inferences likely to be drawn from them, on the score of the decrease in the "purchasing power" of money. Probably some modification should be made on that account, but not nearly so much as has been thought by many. The vast increase of gold and silver within the last twenty-five years, and the inflation by means of paper currency in the last ten, while changing the money price of many articles of ordinary traffic, has not left the values of some of the more permanent kinds of property as measured by money, nearly unaltered except as due to other causes, as the latter are many times greater than the former, the probability is that the variation to be made in the estimate is comparatively moderate.

1. In regard to population and sustenance, nature works as everywhere else, in harmony with herself and for and not against the increasing prosperity of the race.

2. Up to the present time, in every healthily ordered community, all increase of population has been accompanied by still larger increase in the productiveness of labor in agriculture, in the mechanical arts and in the emancipation of mind from the dominion of matter.

3. Whatever remote limit there may be to the capability of the earth to afford subsistence, and whatever may have been the rate of increase of population, it is evident that the increase of sustenance hitherto has been greater than that of population; and that in the order of nature they will adjust themrelves to each other without artificial restriction or destructive checks.

4. Notwithstanding the crowded condition of some localities and the vast population of the globe, only a comparatively small fraction of the earth's capabilities of support for man have yet been exhausted, and if humanity is anywhere a drag or a nuisance, it is because the animal in it prevails over the rational and the spiritual.

5. The increase of individuality and of association is the one essential instrument to the upward and forward movement of the race. This depends upon the largest practicable diversity of industry, the bringing of men into the most intimate commerce with each other, rapid societary circulation, and all possible facilities of education and development.

RECORDS OF MARRIAGES.

BY REV. F. M. HOLLAND, A. M., BARABOO.

Records of marriages are primarily designed to furnish proofs of the fact, but they might also be adapted to giving valuable statistical information. The present method of making such records in Wisconsin seems capable of improvement in both respects.

Whoever solemnizes marriage in this state is required to deposit with the county register of deeds, a certificate stating the time and place of marriage, the full names of both parties and of their parents, and also the occupation and place of birth and residence of the man, though not of the woman. Probably the legislators thought that women did not have any occupations, but it rather looks as if they were beginning to have some, to say the least. Women certainly have places of residence, and also of birth, the record of which latter might much assist the student of statistics by informing him which portion of the marriages are between foreigners, what between native-born Americans, and what between an American and a foreigner. Such a record would also become much more valuable as legal proof.

Both objects would be yet more promoted by inserting what has been wholly overlooked, but is peculiarly needed for both legal and statistical investigations, namely a record of *age.* This would plainly assist identification. Social science, also, needs to know whether our people marry earlier or later in seasons of unusual prosperity or adversity, and also what occupations and nationalities are most prone to early matrimony. The question whether the American, or rather Anglo-American, race is dying out would be much enlightened.

It might, also, be worth while, in view of the presence of negroes and Indians, to make some record of race, though this would probably not be done with sufficient accuracy, until a change, described below, is made in the parties making such records.

The present law makes a poor apology for records of race and nationality, in requiring that of *color*. This provision is merely a relic of wicked prejudices, which the blood shed in our great war should have washed away. In the name of Abraham Lincoln, John Brown, and the countless other martyrs for universal liberty, let us cleanse our records of such stains. Social science recognizes the distinction between negro or Indian, and Anglo-American, as she does that between Anglo-American, German, Celtic and Scandinavian. The distinction between white and black is not scientific but barbaric.

The word "color" should therefore be exchanged for the word "race," or entirely omitted. Indeed the mere substitution of the word "age" for the word "color," would be a great practical benefit, and should, in the opinion of this writer, be secured during the present session of the legislature by a committee appointed for the purpose by this Academy.

Such a committee might consider what record should be made of nationality, and whether some record should not be made of the wife's birth-place, residence and occupation.

The attention of such a committee, as well as of this association, may also profitably be directed to the fact that ministers are now required to certify that a marriage has been *consummated* by them. The statute, indeed, uses invariably the proper word "*solemnize*," but the printed form substitutes the word "*consummate*," which could not be properly applied to any act of the minister, and has a special usage in reference to acts of the parties married.

The writer has been accustomed to correct this error in his own certificate, and now asks that this correction be made in all the authorized forms. It is unworthy of the state of Wis-

consin to require clergymen to make out certificates in bad English.

It is further worth considering whether it is the proper business of clergymen and justices of the peace to make out such certificates for record in any form, and whether it would not be better for Wisconsin to do like other states and require all parties desirous of committing matrimony to obtain a license from the county clerk, who shall biennially make a record of the full names of parties and parents, as well as of age, occupation, residence, birthplace, and nationality of both bride and bridegroom. The clerk might then, if satisfied that the parties were legally entitled to marry each other, give them a license, which would be returned by the minister, who would simply note down the time and place of the ceremony. The clergymen of Wisconsin would be much indebted to this association for relieving them of the present necessity of acting as police magistrates and detectives. At present, ministers have practically to marry almost anybody that applies to them, a custom greatly favoring runaway matches. Indeed, Wisconsin marriages are becoming a proverb in adjoining states. This is made still worse by the conduct of ministers themselves, in occasionally omitting to make proper returns, when so requested by the parties. The writer was twice invited to solemnize marriage without making the returns required by law. In both cases he refused. In one case the parties finally gave consent, but in the other a more accommodating parson was easily found. But if both bridegroom and clergyman were liable to be fined heavily for lack of a license, they would certainly have one, as the minister would insist upon it for the bridegroom's sake as well as for his own, and before it could be obtained all needed opportunity for making full records would be given to the most competent person, the county clerk or register of deeds.

These officers might then be required not only to keep a general record, setting down the ages of parties married, in

parallel columns with their occupations and nationalities, but also annually to return abstracts to the secretary of state, who might then issue condensed statements which would be highly useful to students of social science.

Whether this Academy should take any steps toward so materially altering our whole system of matrimonial records is one question. It is quite another whether its members should at once agitate the omission of the word "*color*," the insertion of the word "*age*," and the exchange of the phrase "*consummated*," for "*solemnized*," in the existing forms of record, and whether these forms should not mention the occupation, birthplace and residence of the wife as well as of the husband. Possibly a statement whether previously married or unmarried, might also be required with advantage.

THE EFFECT OF DUTIES ON IMPORTS UPON THE VALUE OF GOLD.

BY JOHN Y. SMITH, ESQ., MADISON.

That the paper currency of the United States is depreciated below the common money of the world—gold and silver—is universally admitted, and the cause generally recognized, viz; the excessive quantity of paper in circulation. It is also a fact well understood by every careful student of economic science, though not so generally understood by others, that the nominal premium of gold over paper, as it has existed for several years past, does not mark the true depreciation of the paper. A careful comparison of present general prices with those of ante-war times, fourteen or fifteen years ago, demonstrates that gold itself, in this country, is depreciated even farther below its value in other countries than our paper is below our gold.

Thus far economists see their way clear, and are substantially agreed. But what is the cause and what the extent of this depreciation of gold, are problems which they have not yet been able satisfactorily to solve. Prof. Perry and others have attributed this depreciation to the demonetization of gold in this country. It is true that if we impair the utility of an object we depreciate its value; and as gold derives most of its value from its use as money, if gold were universally demonetized, the greater part of its value would be destroyed. If a small portion only of the general stock of the world is demonetized, only a correspondingly small portion of its value will be destroyed. The little gold which we have demonetized has long since been exported and distributed itself throughout the commercial world, adding a trifle to the specie volume of all other countries. In accordance with the law of money, that as its total quantity

is increased (other things remaining the same) the value of a given quantity declines, the entire stock of gold in the world has thus been slightly depreciated. From this cause, therefore, it has been depreciated as much in other countries as in this. The rule for determining the general depreciation from this influence is very simple. Assuming that gold derives seventy-five per cent. of its value from its use as money, and that we have demonetized one twenty-fifth part of the entire stock of the world, the depreciation from this cause will be four per cent. of seventy-five per cent., or three per cent. of the whole. Considering the large amount of gold still held in partial circulation by the demands of the government, it is not probable that the amount actually demonetized exceeds the fiftieth part of the world's stock, and that the consequent depreciation does not exceed one and a half per cent. But the relative depreciation in this country, as compared with other countries, is nothing at all, and it is the relative depreciation which we wish to account for.

Some economists think that the duties on imports have *something* to do with this relative depreciation, but how much and in what way the effect is produced, they are unable to determine. I think it is susceptible of scientific demonstation that the depreciation is wholly the result of these duties, and that the extent of the depreciation is just equal to the average rise of prices on all importables and exportables added together.

As we proceed with this demonstration, we must endeavor to gain and keep in mind a clear and accurate conception of the nature of *value*, which is often confounded with other things or qualities which are quite distinct from it. Some confound the value of a thing with its *quality*, and as the quality of pure gold, wherever found, is always the same, they conclude its value must be equally immutable. Others confound value with *utility*, while utility is only one of the *elements* of value, always present, but rarely determining the

value of anything; *that* being determined, almost always, by the other element of its existence, namely, *resistance*, or the difficulty to be overcome in obtaining it. The brilliant Bastiat defines value as "*accumulated service.*" This is much like calling a snow-drift accumulated wind, and is quite too great a stretch of poetic license to answer the severe demands of scientific accuracy. A large class, including some able writers on political economy, regard value and *wealth* as synonymous and convertible terms. But *wealth* consists of the aggregate of exchangeable objects, while *value* is simply the *ratio* in which those objects exchange, or are exchangeable for each other, and is not necessarily dependent upon their aggregate quantity. Let us bear in mind, then, as we proceed, that *value is the ratio of exchange between different objects, money included.*

To avoid unnecessary complications we will, for the present, entirely ignore the existence of paper currency and deal only with the money of commerce, consisting chiefly of gold. Under the natural conditions of commerce—free trade—each country will retain, with slight oscillations, just that proportion of gold which will hold the average prices of its importables and exportables aggregated, at very nearly a uniform level throughout the commercial world. If any one country has even a slight excess over this proportion, prices there will become relatively cheaper than domestic products, and more goods will be imported than its exports of goods will pay for, and the balance will be paid in gold, until, through the contraction of the gold volume thus effected, prices of domestic products are again brought down to the common level in other countries, and then the *efflux* of gold will cease. If the country has *less* than this proportion, domestic prices will fall and foreign goods will become relatively dearer than domestic goods, and the demand for the former will decline until the imports (other than gold) will no longer balance the exports and the balance will be brought home in gold until the vol-

ume of gold and, consequently, domestic prices are again brought up to the common level in other countries, and then the *influx* of gold will cease. This point where the exports and imports just balance each other, is what Mr. Mill happily calls "*the equation of supply and demand.*" This law of trade is just as immutable and invariable in its operation as any law of chemistry, as every economist knows. Owing to the complicated transactions of commerce, it is impossible for commercial sagacity to adjust those transactions to the exact line of this equation. They are constantly oscillating across it, like a pendulum across the center of gravity, but never varying very widely from it, on either side; for the moment the slightest deviation is detected, commercial self-interest is prompt to apply the corrective by importing more goods and less gold, or more gold and less goods, as either one becomes more profitable than the other—the one which is most profitable being always the right one to restore the equation of supply and demand. Wherever gold will buy less than it will elsewhere, there it is depreciated just to the extent of the difference, and if unobstructed by artificial barriers, elsewhere it will go till the difference no longer exists.

Now suppose a country places obstructions in the way of commerce in the form of heavy duties on imports, as our country has done. What will be the consequence? Undoubtedly the price of all importables, that is, commodities imported and all domestic products of the same descriptions, will be forcibly raised to the extent, or very nearly to the extent of the duties imposed, except where the duties are so high as to become prohibitive; while the prices of exportables, that is, all domestic products of which we raise a surplus for exportation, whether exported or consumed at home, will still be governed by the foreign market and remain the same as before. The consequence will be a rise of average prices above the average prices in other countries where these obstructions to commerce do not exist, and the advance of average prices will continue

as long as the obstructions which raised them above the common level continue. Average prices being thus raised and held there by arbitrary means, as water is held by a dam across a stream, more money than before will be required to effect the exchanges of the country; for it is a very plain proposition that it requires more money to buy and sell a given quantity of products at a higher range of prices than it would to buy and sell the same quantity at a lower range of prices. One of two things, then, must be done—either average prices must come down to the former level, or the volume of money must be increased. The price of exportables will not yield, to restore the former level, for that is governed by the foreign market. The price of importables will not yield, for that, both in respect to actual imports and domestic products of like descriptions, is governed by the foreign cost and the duties added. There is but one remedy left—the volume of money must be increased. How can it be done? It will be effected in this wise.

The cost of imports being largely increased, the demand for them will as certainly be diminished—not always in the ratio of the increased cost, but very sensibly diminished. The demand for exports will remain the same, because the cost remains the same, and the imports will no longer pay for them, and the balance must be returned in gold. This process must go on, and very rapidly too, until the volume of money has been raised the same per cent. that average prices have been increased, and then the equation of supply and demand will be restored upon a new and artificial basis of prices, and the influx of gold will cease. But the ratio of exchange between gold and other things will be changed. We shall then pay just that much more gold for the same things, in the aggregate, which we before bought for so much less, and so much more than we could again buy for under the natural equation of supply and demand; and keeping in mind our definition of value—that it is the ratio of exchange

between different objects, money included, our gold is depreciated by the duties on imports just that much below its natural value. In exchange for importables, the gold will be depreciated to the extent of the average per cent. of the duties upon them; but in exchange for exportables it will not be depreciated at all, so that for general purposes it will be depreciated only to the same per cent. that the average per cent. of duties bears to the total *natural* value of both exportables and importables added together. Thus: if the two classes of commodities be each represented by 100, and 45 be added by the duties, the per cent. advance on importables will be 45, but the advance on the two aggregated will be but 22½ per cent.

To determine what the advance is in average prices and the resulting depreciation of gold, is a difficult problem only because of the difficulty in ascertaining the exact value of importables and exportables, respectively, the extent to which they are respectively subjects of exchange, and the extent to which exchanges of real estate, which is neither exportable nor importable, may modify the result. By reference to accredited statistics we may, however, arrive approximately at least, at the true depreciation of gold from the cause stated; the object of this paper being rather to develope a principle than to arrive at exact results from its operation.

The average per cent. of duties on imports, as determined by dividing the total amount of revenue derived from them by the total amount of imports, is about 45 per cent. This per cent. (with slight modifications) is added to the price of all importables, whether foreign or domestic. Now what we wish to know is, what per cent. this adds to the average price of importables and exportables aggregated.

According to the census returns for 1870, the total valuation of manufactured products, deducting $90,000,000, the product of mines, and adding $462,277,587 of actual imports is	$4,604,703,029
Deduct from this the tariff element in the valuation (45 per cent.	2,072,116,363

Leaves as the natural value	2,532,586,666
Value of farm products (exportables)	2,447,538,668
Natural value of both	$4,980,125,324

Divide the tariff element in the valuation of importables by the total natural value of importables and exportables added together as above, gives about 41 per cent. as the average advance in prices and the true depreciation of our gold. Lest this result should appear too startling, it should be remarked that this is the true depreciation from the absolute free trade standard, or, normal state of commerce. By this rule, the present depreciation is about 33 per cent. below what it would be under a strictly revenue tariff, averaging say 15 per cent.

This explains how it is that the country has been able, for the last four or five years, to float such an enormous amount of paper so nearly at par with gold ; when, in 1857, only about twelve years before the gold premium settled down to about its present figure, two hundred and fourteen millions of paper was sufficient to drive all the gold out of the country and produce a general supension of specie payments. Now, the paper volume is seven hundred and fifty millions, and has been for years past, and at an average discount of only about twelve per cent. Many of our statesmen, or rather I should say politicians, pretend to believe that this is the result of the national growth and developement of the country. But no rational man can believe that the country, in twelve years, has advanced three hundred per cent. in population, wealth and exchanges, with four of those years devoted to the most destructive war of modern times, when about twenty per cent. has been the usual advance in a decade, in peaceful and prosperous times.

I am aware that this law by which gold is depreciated by duties on imports, seems to conflict with the general law which causes gold to flow from where it is worth *less* to where it is worth *more ;* for, we have seen that, pending the adjustment of the volume of money to the forced increase of average

prices, gold actually flows from where it is worth *more* to where it is worth *less*. In a correspondence on this subject, which I had with Prof. Perry of Williams College, this apparent conflict with a well established law, was what staggered him as to the soundness of the principle I have endeavored to develop. But this conflict is only in appearance; for, although the gold imported to raise the volume of money to the new volume of prices, is actually depreciated below its general commercial value, still it is worth more to *us* than the foreign goods we would get instead, clear of the custom house. The demand for our exports, we have seen, is not diminished by the duties on imposts, and we must import *something* in exchange for them, or give them away. Give them away we will not, and in importing gold in preference to goods, we only choose the better of two bargains, either of which is bad enough.

The elements of this calculation are liable to some modifications, both in the direction of a greater and of a less depreciation; the *greater* from the vastly larger proportion of farm products which are consumed by the agricultural population and never become the subjects of exchange at all, than can be predicated of manufactured products; which will considerably reduce the agricultural element in the total of exchanges and make the average rise in prices and the depreciation greater; and then the *less*, as money used in the transfer of real estate will add to the volume of non-importables and tend to *diminish* the average per cent. of prices and depreciation. But it is probable that these opposite tendencies will nearly balance each other, and leave the results I have arrived at not very wide of the practical truth.

Thus far we have reasoned upon the assumption of a purely metallic medium of exchange. Will the introduction of paper currency change the result? Not in the least. If a local currency exists in the meantime, equal in volume to the gold which would otherwise have been imported and held in the

country, the same results will be arrived at without any influx of gold at all, and the little gold remaining in the country will be depreciated in the same degree as if the circulation had been all coin—the high duties acting as a strong inducement to import gold, and the paper currency acting as an equally strong inducement to export it—the two antagonistic forces just balancing each other. If the paper volume, in the mean time, is *greater* than the gold volume would have been, with no paper, the tendency to import gold, produced by the duties, will not only be balanced, but *overpowered* by it, and gold will flow out just so long as there is any in the country not held back by arbitrary means. This latter state of things has existed in the United States ever since the commencement of the civil war. The paper volume has all the while been in excess of what the gold volume would have been without any paper, and, of course, gold has all the while been flowing out of, instead of into the country. Our gold, then, as compared with its value in other countries, is depreciated a little more than forty-one per cent., estimated upon a free trade basis, or a little less than thirty-four per cent. estimated upon the basis of a strictly revenue tariff, and our paper currency, by its enormous volume, is depreciated ten to twelve per cent. below that, making the total depreciation of our currency, upon the one basis, about forty-five per cent., and upon the other, about fifty-three or four per cent.

The foregoing facts and principles have an important bearing upon the financial and commercial policy of the country, if it is ever again to have a policy. The country is now suffering both from a depreciated, irredeemable currency, and from an exorbitant monopoly tariff, and the signs of the times indicate a determination on the part of the people to rid themselves of both as speedily as possible. But can we with safety get rid of both at once and *all* at once? Let us see. The depreciation of the currency, as we have seen, is *compound*. The paper is depreciated eleven or twelve per cent. below the

gold in the country, which is itself depreciated say thirty per cent. below what its value would be under a strictly revenue tariff. So long as the present high duties are maintained, the depreciation of the gold will continue, and we will only have to overcome the present premium on gold by contraction of the paper volume to that extent, in order to maintain specie payments. But, repeal the tariff entirely, and gold in this country would immediately resume its normal value and shoot up to about fifty-three per cent. premium, and we would see just how far, between tariff and paper inflation, we have drifted with our currency, from a normal specie basis. Reduce the duties to a revenue standard, and the premium on gold would at once rise to fully forty-four per cent., and we would be compelled to overcome that by a like contraction of the currency before specie payments could be maintained. It should also be noted that, in returning to specie payments, the gold which we have demonetized must be drawn from the general stock of the world to resume its functions as money in this country, and thus the whole stock of gold will be appreciated in value as much as it was depreciated in the process of demonetization, and will add one, two or three per cent., whatever it is, to the depreciation of our currency, and which must be overcome by contraction. Such a contraction, even if extended through a whole year, would doubtless be seriously felt by the business interests of the country, though it would be trifling compared with those which used to occur under the old bank suspensions, when the currency was contracted, sometimes to the extent of fifty or sixty per cent. in sixty days. I am satisfied that much of the dread of contraction results from the memory of the violent and sudden contractions of 1837 and 1857, which sprung like a steel trap upon its unsuspecting victims. But contraction is an absolute necessity if we are ever to return to a specie basis. True, some politicians, who pass for statesmen, talk of resumption without contraction of the paper volume; but a tyro in eco-

nomic science knows that this is as impossible as for a man to walk across the Atlantic with a crowbar for a walking stick. Any attempt of the kind would result in another suspension in less than sixty days. It would at once add 11½ per cent. to the profit on the exportation of gold, and the gold would disappear as fast as it could be counted out. To resume without contraction and at the same time reduce the tariff to a revenue standard, would add forty-four per cent. to that profit, and how long would resumption last then? And yet the country is beginning to demand a return to a specie basis and reduction of duties on imports to a revenue basis, and that demand will become more and more imperative. Both can be accomplished without serious disaster; but, in order to do that, the currency must be contracted and the duties reduced by *regular installments*, in pursuance of a steady and persevering policy, regardless of the clamor of bankers and speculators. A contraction of ten per cent. a year would bring us to a specie basis, under a revenue tariff, in about four years; and if business men could know that such a policy would be inexorably carried out, they would regulate their business accordingly and steer clear of disaster. A contraction of five per cent. a year, steadily pursued, would accomplish the same objects in eight years, and scarcely be felt at all. The latter policy would perhaps be the better one, if we could depend upon our government to maintain any definite policy for that length of time. The danger is that it would be reversed before the end could be accomplished. Inflation is easy and contraction is hard. It is easy to jump down from the top of a tower, but not so easy to jump back again. The misfortune is that many of our statesmen (?) propose, as the shortest way to get back, to jump down a precipice at its base—to arrive at resumption by way of further inflation! Many others of them propose to *drift* back—to wait for the country to *grow* to the present paper volume; while the very few who have taken the pains to qualify themselves for their business, and

know what the difficulty is and how to remedy it, are either dragged down by the jumpers or overwhelmed by the drifters, who persistently refuse to learn anything from the laws and history of finance, the experience of other countries, or even of our own country. They will grant that two and two make four in the old countries of Europe, but insist that this great republic is so different from all other countries in the world, that, here, two and two will make five, or seven or nine—anything you please, except four! And thus they drift on in complacent imbecility, without chart or compass or rudder, they know not whither.

REQUISITES TO A REFORM OF THE CIVIL SERVICE.

BY DR. J. W. HOYT, PRESIDENT OF THE ACADEMY.

If it be true, as asserted by the civil service commission of the United States, that the present system of the civil service "violates the fundamental principles of thrift and economy; fosters personal and political corruption; paralyzes legislative honor and vigilance; weakens and degrades official conduct; tempts dangerous ambition; and, by poisoning the springs of moral action, vitiates the character of the people and endangers the national prosperity and permanence," then is it a matter of the most vital importance to the nation, and to the republican principles upon which the government is based, that we accept it as truth and devote our best thoughts and energies to the reformation of that service.

Unhappily, there is nothing in the results of inquiries instituted by the civil service commission, nor yet in the facts recently brought to light by the investigations of committees formed by the state and national legislatures, that is calculated to disprove these grave charges. It is true that the civil war, through which the nation has so recently passed, may be held responsible, in large measure, for the corrupting influences which have so infected the body politic and tainted the political atmosphere of the country. This is one of the legitimate fruits of all wars, one of the terrible penalties a people must suffer for yielding to the impulse of passion instead of holding themselves bravely to the demands of reason. But far more of this political demoralization is chargeable against our system of the civil service. And if, on the one hand, we are filled with alarm at the revelations made from time to time of the extent to which these corrupting agencies have done

their fearful work, we have just cause, on the other, to congratulate the country and the friends of republican institutions everywhere, that the patriotism and morality of the country, acting through the thoughtful, earnest and pure men of all sections and all political parties, have already begun the great work of purification.

A further ground of encouragement is found in the fact that this reform did not have to wait for its inauguration until universally demanded by an indignant people, but originated in an appeal from the chief magistrate of the nation, clothed in these words:

"Always favoring practical reforms, I respectfully call your attention to one abuse of long standing, which I would like to see remedied by this Congress. It is a reform in the civil service of the country. I would have it go beyond the mere fixing of the tenure of office of clerks and employees who do not require the advice and consent of the Senate to make their appointments complete. I would have it govern, not the tenure, but the manner of making all appointments. * * * * The present system does not secure the best men, and often not fit men, for public places. The elevation and purification of the civil service of the government will be hailed with approval by the whole people of the United States." [Message of 1870.]

The promptness with which congress seconded these views of the president and gave him authority to appoint a commission charged with the duty of devising a plan under which the needed reform should be inaugurated, and the readiness with which he adopted the recommendations of that commission and sought to give them efficiency,—these circumstances have so enlisted the sympathy and support of good men throughout the country as to have warranted the hope that the reformation will steadily go on to its completion.

It matters not so much that many friends of the object sought to be accomplished criticise and condemn some of the details of the plan adopted by the commission; much less that selfish demagogues, who see in it a curtailment of their prerogatives, hold up its weak points to public ridicule. The plan

recognizes and embodies important principles, which cannot be contemptuously treated, which are sustained by reason and have stood the test of long-continued and faithful trials in other countries.

It is no longer the rule that the clerkships in all the departments at Washington are filled by favorites of senators and members of congress, with little regard to fitness, as had been the case almost since the foundation of the government. Under the present regulations, requiring notice of vacancies and impartial competitive examination of all candidates, it is manifest: first, that merit, and not mere party and personal subserviency, is to be the prime consideration in the selection of persons to do the work of the departments; and secondly, that in proportion as these regulations are perfected and faithfully enforced, we have a guaranty that this work will be *well* done.

But the civil service commissioners have been charged with only a small part of the work of reform, which, viewed in its totality, is as comprehensive as it is important, involving a necessity not only for legislative action, but also for modifications of state and federal constitutions.

As the subject presents itself to my mind, the requisites to a thorough reform of the civil service of the country are these:

I. A judicious and faithful application of qualification tests in the case of all offices filled by appointment.

The work of the United States civil service commissioners, as already observed, is limited to a few subordinate places in the executive departments; whereas, the principle should have a much wider, indeed a general application.

Objections may with propriety be urged against filling some of the higher government offices by open competitive examinations; the chief of such objections being, that the duties performed by the incumbents of them are not routine and largely mechanical, as in the case of a majority of clerk-

ships, but largely administrative, and hence demanding such high natural qualifications as must be personally known, either to the officer having the appointing power, or to persons of his acquaintance whose recommendation is a guaranty of capacity and trustworthinss. But no objection can be urged against the right of the people to demand that all appointments, even the highest, shall be made on the principle that ability, integrity, special adaptation, and special attainments wherever essential to a proper discharge of the duties devolving on the appointee, are absolutely essential, and hence paramount to all considerations of mere party relationship or partizan service. Such right is undeniable, and the only reason it is not exercised is, that, on the one hand, there is a lack of appreciation of it, and, on the other, the potent influence of party prejudice and party interest. As a consiquence, most unfit men are found in all branches of the civil service. United States judges, unsited to the responsibilities of the bench; foreign ministers, without the slightest knowledge of diplomacy, scientifically or historically considered; consular agents, without any idea of consular duties or even of the language of the country to which they are accredited; and even heads of executive departments, sometimes chosen with less reference to special fitness than to influential standing in the political party of the administration.

Here is a vast and immensely important field for civil service reform, in which the executive is supreme, one in which, practicing on the principle, "country first and party afterwards," we may do a great deal to promote the welfare of the country and establish the world's confidence in the wisdom and economy of republican institutions.

II. A second requisite is the making the tenure of all such offices as require special preparation and considerable experience for the proper discharge of their duties, conditional, not on party affiliations merely, but on demonstrated ability and fidelity.

The theory long practiced by successive administrations, but first sanctioned, if not formulated, by President Jackson, this, namely, "To the victor belongs the spoils," is demoralizing and dangerous. It places party before country, discourages laboriousness of preparation for, as well as faithfulness in, office, and puts a premium upon trickery and rascality in the conduct of every political canvass. Contending under this banner for the mastery, the citizen is lost in the partizan, and the idea of sacred trusts gives place to the idea of public plunder. It is the very system to breed a race of thieves, as is shown by both reason and experience. And yet it is a most difficult system to overthrow, for it is rooted in human selfishness, and has been so long nourished, that it is now of rank and giant growth. But its overthrow is possible, and great will be the reward of that party or administration which shall bravely and resolutely enter upon this patriotic work.

III. There should also be adopted some equitable system of promotions and other rewards wherever practicable.

In the army, we have a career for the soldier; he knows that although he should enter the service as an obscure private, there is before him a line of promotion, which, if he can but once enter upon it, is as sure as life and good behavior to lead him upward, and may eventually place him in the supreme command. But in the civil service, upon whose skilful and faithful administration the welfare and security of the country no less depend, we have as yet no career. The man whom pecuniary circumstances may have constrained to secure for himself a subordinate position in one of the departments, but who possesses rare qualifications for that or even a superior position, and who, by long experience and close attention to his duties, has fairly entitled himself to the grateful recognition of his chief, has hitherto been doomed,—unless able to bring powerful party influence to bear for his advancement,—to see inexperienced and possibly totally unfit persons

appointed to positions above him and directly in what ought to be the line of his own promotion. That such a course of injustice—injustice to both the individual and the government—must be highly injurious to the public service is plainly manifest. Something has been done towards remedying the evil by the civil service commission. It has at least done good service in calling public attention to the principle, and in securing for it some degree of practical recognition.

It may also be well to inquire whether there could not be adopted yet other methods of rewarding services of extraordinary merit. In the military service, we have brevets, bounties, pensions, etc. Is there any good reason why corresponding rewards should not be provided for specially meritorious services in civil departments of the government?

IV. There should be an increase in the legal or constitutional term of many offices.

This would—

1. Encourage able and good men to accept office who now stand aloof because they are unwilling to break up present business relations for the questionable advantage of a very brief term of public service.

2. Discourage mere adventurers and worthless politicians in the same proportion, since it would have the effect to make all conscientious and intelligent voters more scrupulous and exacting.

3. By diminishing the frequency of elections, tend to cure the present thirst for political excitement and the mania for political office, now become a most prominent evil of the times.

4. As a consequence, correct that absurd practice of frequent *rotation*, which is based on the false theory that office is a perquisite of citizenship, a thing for the individual, and not for the government and the common good of the whole people to be affected by it.

This requisite to a reform of the civil service deserves there-

fore to be urged upon the country with great force and persistency. We are already a nation of politicians—politicians, too, in the most objectionable sense; by which is meant a great body, a mighty host, of place-hunters, hungering, panting, scrambling, fighting, each for his share of the spoils of office. With an alarmingly large and increasing proportion of the people, an ordinary legitimate businees, yielding a comfortable living, is unsatisfying, and to be escaped if possible; and as for downright labor, that is contemptible!

Of those who are politicians in the better sense, the great majority are almost totally ignorant of political science, while the number is by no means small of those who openly scout the idea of there being any such science. As to statesmanship, that is a thing of which we hear much talk but see few illustrations. What wonder that so much of our legislation is botch work, requiring to be torn to pieces and done over again and again, in the vain attempt to accomplish the desired object. How can it be otherwise, when each successive legislature or congress is composed, for the greater part, of men who have neither knowledge of the principles of political science, nor the advantage of legislative experience—composed, in a word, of raw recruits, whisked off, with short warning and no preparation, from the field, the workshop, the factory, the counting-room, or the professional office, and required to devote themselves, for the space of a few months at the most, to the settlemnt of a thousand and one questions, a majority of them entirely new, and some of them gravely important, requiring years of the most careful research for their solution?

The same is true of offices other than legislative. The term, as a rule, is too short, and changes are too frequent. In most of the states the governor and other state officers are chosen once in two years; and although re-eligible, it is quite as often as otherwise that they remain in office but one term. Not because of neglect of duty or malfeasance of any sort, but because some one not in office is bent on having his turn! And

so it is, that, with annual local elections, biennial state elections, and quadrennial national elections, we manage to have nine-tenths of the most important offices filled with inexperienced men, and to keep the whole body of the people in a fever of excitement and under the play of demoralizing influences from the beginning to the end of their lives.

But for this state of things, or in other words, if the people were always capable of acting wisely and calmly in the selection and support of men to represent them in official positions, so that the selection of an officer conspicuous alike for ability and fidelity would depend more upon his willingness to continue in service than upon the manoeuvering of ambitious scramblers for his place, then, in that case, the necessity for an increase in the term of office would not be so urgent. But the people are not universally capable of so acting, and it is next to impossible that they should ever become so under the short-term system.

In connection with the presidency, there has been much discussion within a few years past, of the one-term principle. Able senators have urged congress to take preliminary steps looking to a change to that effect in the constitution; and at least one candidate for the presidency has inscribed the one-term proposition on his banners.

The strong argument, if not indeed the only one, employed by the advocates of this change is, that, as the provision now stands, the tremendous power of the public patronage, so much of it in the hands of the president, is liable to be used to secure his re-election, regardless of the wishes of the people of the whole country. This is indeed a matter worthy of thoughtful consideration. It seems to me, however, that the proper order of the discussion is: first, to inquire whether re-eligibility is in itself desirable; secondly, whether the objections thereto are of sufficient weight to overbalance the reasons for the present provision; and, thirdly, whether in such event, it is not possible to remove the objections without the sacrifice of any other important interest.

To the first of these questions there can be but one answer. The wisdom of the founders of the republic, the experience of our past history, and the unbiased judgment of the present time, all agree that, in a matter of so great moment, as in other matters of moment, it is best to leave the hands of the people untied, the popular will free to act in accord with the popular judgment.

The second question cannot be so easily disposed of, since it is impossible to determine the extent to which the power of patronage is ever used by the executive for the purpose of securing a renomination and re-election. As a rule, to which there have been but few exceptions in the history of the government, the high character of the chief magistrate is a good guaranty against the corrupt exercise of power for personal advantage; and as it may be assumed that an exceptional president will very certainly have favored his first supporters, by way of reward for their services in securing his first election, and hence, in large measure, have exhausted the resources of his patronage, there is reason to believe that the danger from this source is very much overrated. It is also to be borne in mind that the unfortunate experience of such of the presidents as have ventured to disregard the wishes of ther constituents has already pretty well impressed it as a conviction upon the public mind that no amount of corrupt use of patronage will be sufficient to override the popular will, when it has once declared itself with the voice of condemnation. While, on the other hand, it is worthy of mention that, of the presidents who have been re-elected, not one has disappointed the public.

The advocates of the one-term rule admit the force of the reasons that sustain the constitutional provision as it stands,— namely, the great value of experience on the part of the executive, and of steadiness in the administration of the government,— for, with one accord, they propose to couple an *extension of the term* with their limitation of the number of elections. But they appear to overlook this important consideration, that,

in order to meet the argument based on experience and steadiness by any considerable extension of the one term, they subject the country to the liability of serious injury from the prolongation of a most faulty administration. But granting, for the sake of the argument, the full force of the arguments urged by the advocates of the one-term proposition, let us see, in the third place, whether there cannot be found remedies for them less open to the serious objections above alluded to. The following suggest themselves at once:

1. The proposed general increase in the term of most offices, as a means of correcting the present tendency of the whole people to make politics a *trade;* thus, in a great measure rescuing them from the dangers of political corruption.

2. The cutting down of the presidential patronage, by providing suitable conditions on which many of the appointments shall of necessity be made,—a work already commenced by the civil service commission under the inspiration and support of the present chief magistrate,—and, possibly, by transferring the right of choice, in some other cases, from the president to the people themselves.

3. The choice of our presidents by a direct free vote of the people, or by some other method worthy to succeed the present fraud-engendering electoral-college system.

I confidently believe that, if these several remedies were applied, the evils now attending the re-eligibility of the president would be so nearly cured that the heroic and very questionable measures proposed by the limitationists would cease to be urged.

V. A fifth requisite is the re-adjustment of salaries on the basis of equity and public policy. At present, there is a great, and often very unjust, inequality. The head of an important bureau or department perhaps receives less compensation than a second class insurance or dry goods clerk, while the collector of a port, with but little to do personally, except

to "set up the pins" for his party, enjoys an income of ten times as much.

So, likewise in the states, salaries are often a very inadequate compensation for the service required. So recently as five years ago, the constitutional salary of the governor of Wisconsin was twelve hundred and fifty dollars; and it is not long since the salary of the chief justice of the state was but twenty-five hundred dollars, while certain officers of the county government were receiving twice as much for services of a much lower grade.

It is not a sufficient answer to the objection, that a given salary is not a sufficient compensation for the duties of the office to say, as is usually said, "There are a plenty of competent men willing to accept of the salary and perform the service;" for, as a rule, it is not true. Competent men, in the fullest sense, willing to perform any sort of service for less than a fair living price, are not plenty. You may find here and there one who will make the sacrifice for a short time, for the purpose of accomplishing some worthy public object, or for the gratification of a private taste, or from the hope that the loss may be made up to him by some future advantage—motives, of which the public should be too just and honorable to take advantage. But such places are always liable to be filled by ambitious persons not competent, or who, being intellectually so, merely seek them for the illegitimate profits it is supposed they may be made to yield.

To state the whole case in the fewest words, in determining the salary to be attached to any office, the question should be, not, For how small a sum is it possible to have the work done? but rather, What would be an adequate and liberal compensation for the quality of service demanded? For the fixing a compensation less than reasonable must have the effect to discourage competent and honorable men from accepting public office, and hence to open the door to incompetency and fraud, greatly to the injury of the public service and the demoralization of the community.

For similar reasons, the method of providing compensation in the form of fees, moieties and the like, is injudicious, unjust to those who bear the burdens of the government, and demoralizing in its influence.

VI. A sixth and very important requisite is a change in the method of electing persons to office, so as to diminish the power of the *caucus* and guarantee the true *sovereignty of the people.*

It is manifest that he who owes his position, not to the people who are theoretically his constituents, but to a small clique of political wire-pullers, who have their own ends to accomplish, is in danger of holding himself, consciously or unconsciously, amenable to them, first of all, and of neglecting his duty to the people in the same proportion. The clique elected him once, and they can do it again. Why then trouble himself too much about the will of the multitude, who can practically neither help nor hinder?

As this is not a pure democracy, and cannot be, the system of representation is unavoidable and must be used alike in the making and in the execution of the laws. The question is, therefore, not, how to do away with representation, but, how to limit it and rid it of objectionable features, so as to give practical effect to every individual elector's ballot, and, as a consequence, to make every representative, in whatever capacity, directly responsible to his constituents. Every intelligent citizen must see, on reflection, the vital importance of this object, if we would save our republican system of government from passing irrecoverably into a practical and intolerable oligarchy of the majority, nay worse than this, a tyrannical and ruinous oligarchy of the caucus.

This object can only be accomplished by the adoption of *some system of personal representation*, to the maturing and introduction of which the attention of thoughtful and patriotic citizens throughout the country should be directed. A system

so planned that it would secure the elector from the present necessity to support one of two candidates, dictated to him by a clique of political managers, or to throw his vote away, and give to him a free choioe of candidates from the whole body of his fellow citizens; that would give to every ballot a definite and an equal political value; that would give to each constituency its due proportion of political power; that would insure to each claes of citizens and each public interest their just share of representation in the government; such a system would certainly guarantee a great improvement in the quality of the civil service, in the manner already pointed out—by increasing the conscious weight of every official's responsibility to those who gave him their suffrages. It would accomplish still more, in an indirect way, by putting an end to the trickery and tyranny of the nominating caucus and convention; by insuring in many instances the election of a class of superior men, who under present conditions are neither able nor willing to take part in politics; by diminishing the temptations to bribery and other forms of corruption in elections; by increasing the elector's sense of the responsibility of citizenship, and stimulating him to the acquirement and exercise of an intelligent judgment in governmental affairs; and, finally, in general terms, by improving the intellectual standard and elevating the moral tone of the whole body of the people.

VII. Still another requisite is the infliction of the most summary and condign punishment upon all who are found guilty of corruption in securing, or of malfeasance in, office.

It is not enough to provide every safeguard against the appointment and election of bad men to office. In spite of all that can be done to prevent it, there will be cases in which men will work themselves into power by dishonest means; in which, likewise, persons fairly entitled will prove traitors to the public interests they were chosen to protect. The purchase of place by ambitious charlatans and unscrupulous dem-

agogues; the bartering of legislative power and privilege, for influence or pecuniary gain; the corrupt letting of contracts; embezzlement of public funds, and rascality in many other forms, have their root in human nature and are incidental to all governments. But they would certainly occur less often, even under the best possible system, if their perpetrators when detected, were made to feel the full rigor of the law and the withering condemnation of the people.

VIII. But it were unphilosophical to expect official virtue to outmeasure public virtue. It is only in exceptional cases that a representative of the intelligence of a community will not also be a fair representative of its morality. Hence it is requisite, above all, that the community, the state, and the nation should adopt and vigorously enforce measures calculated to increase the intelligence and to strengthen and refine the moral sense of the people.

This is a trite statement. But that it sadly fails of universal recognition, even among those who rank as intelligent leaders and guides in social and political affairs, will appear from the action of great numbers of town boards, municipal councils, and legislative assemblies.

We are a great nation, aiming at self government — the only great republic so fortunate in its conditions of social and political life as to have gained the world's confidence. Confident of the ability of the republican system, under these favorable conditions, to successfully resist the disturbing or deteriorating influences consequent on the immigration of the multitudes destined to come, first from the oppressed populations of Europe, and later from the semi-barbarous lands of the Orient, the founders of the government made easy provision for their absorption into the body politic. Then, to make the system of government more fully consistent with the principle of equality, which lies at its very foundation, we have ourselves extended the privileges of citizenship to the millions of

our black population who were, but recently, in the chains of slavery, and are of necessity still in the fetters and clogs of the grossest ignorance. And soon, as a logical necessity, the same privileges and immunities that we enjoy will be accorded to the whole body of women. But with all this recent and prospective multiplication of voters unaccustomed to the responsibilities of freemen, it is only with the utmost difficulty, and after a struggle of many years, that the American congress has been induced to concede that the government owes anything further to the cause of popular education, after having granted for its encouragement a small portion of the unsold public lands. Even at this hour we present the spectacle of a mighty nation of forty millions resting our only rational hope of a great and glorious future on the intelligence of the masses, and yet showing a most alarming proportion of illiteracy, hesitating over the proposition to consecrate the net proceeds of the public lands, hereafter sold, to the education of the people, and denying to the cramped and crippled, though nobly officered, Educational Bureau of the Interior Department the few thousand dollars essential to its greater efficiency. In such schools as we have, but little instruction is given in the elementary principles of our government, and in too many of even the best of them there is recognized a much more important defect bearing upon the question of good government, namely, the want of a judicious and systematic culture of the moral nature, such as is calculated to insure to the country virtuous and noble men, in all respects fitted to meet the responibilities of citizenship, and to save the republic from the increasing dangers which already threaten its destruction.

To my mind, nothing is more manifest than that this requisite, although mentioned last, lies at the foundation of all. In a country governed by an autocracy or a monarchy, it is possible to have an efficient and economical civil service without universal intelligence, with intelligence of the governing

class merely. But in a republic, the way to whose highest places of power and trust is open to any citizen who has the intellectual energy or the mere self-assurance to enter, and who furthermore possesses the tact essential to political management, or only the means to command the tact of others, there is no security short of universal education.

Nor is this enough, if understood in the ordinary sense. The rudimentary education of the whole people is not sufficient. The elementary principles of government and of a sound social and political economy must also be widely understood and appreciated; and in every community the number must not be few of them who have made statesmanship a profound study.

Stopping short of the most ample provision for all these guaranties, we have left our free institutions in peril, and are justly obnoxious to the censure of mankind.

NATURAL HISTORY AS A BRANCH OF ELEMENTARY EDUCATION.

BY DR. P. R. HOY, RACINE.

I am persuaded that great good would result from making the study of natural history one of the most elementary branches of education. Children should be taught to see carefully and minutely, and thus early learn to observe and compare, a most important part of education. Their attention should be directed to the more common objects by which they are surrounded.

The chipping bird that pecks at crumbs in the yard, and nests in the currant bush, what a warm, light and beautiful feather-coat it wears, its wings are only a variety of hands which enable it to fly where we cannot follow. See how it hops, with one foot a little in advance of the other, in place of running, or walking like the chickens. All birds that perch on trees move by hops, when on the ground.

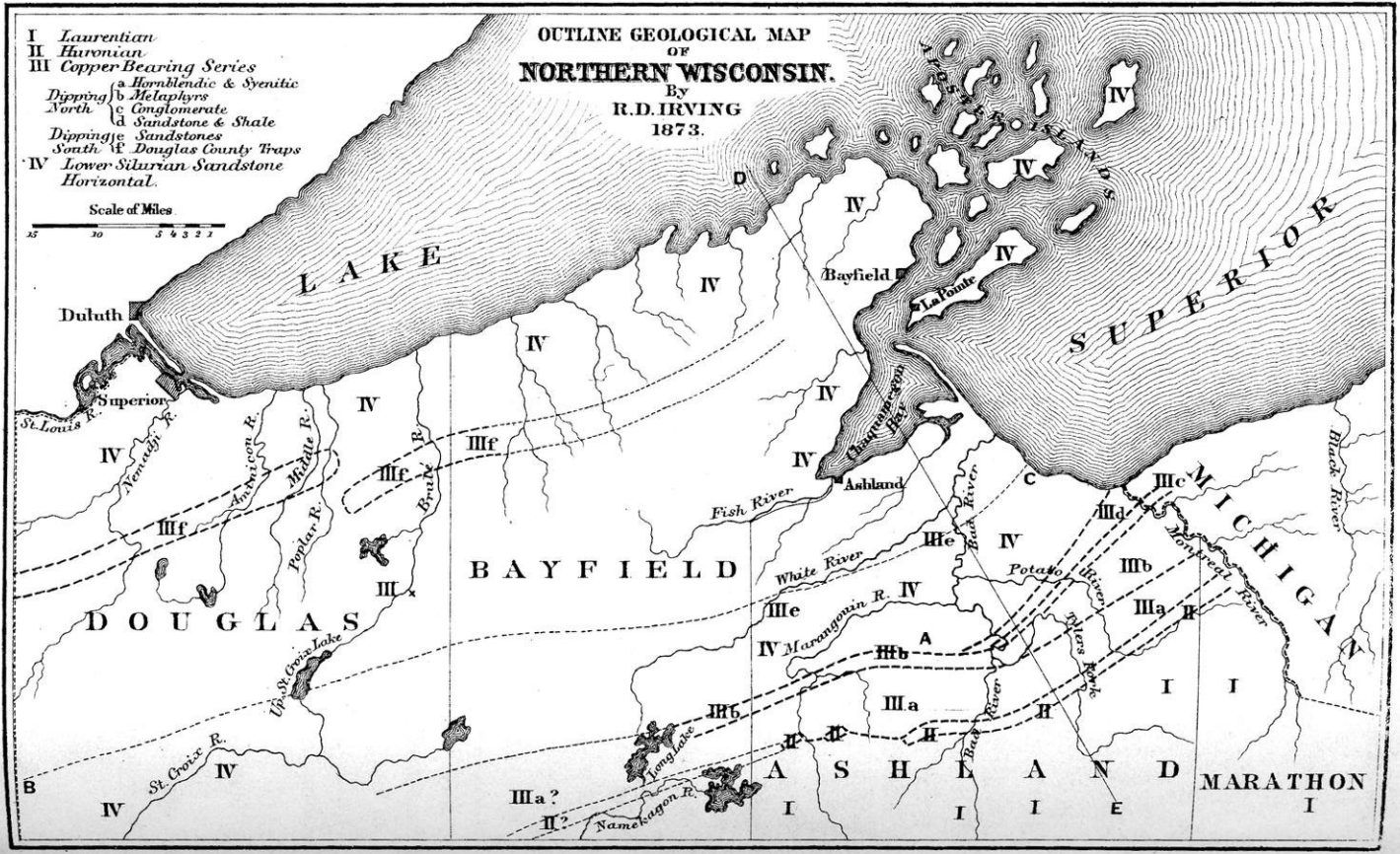
The ant that labors so diligently in the garden—observe its six feet, its pinchers to clip and cut its food, its antennæ, by means of which it makes its wants known to other ants. How busily they are running up and down that tree. Watch and we shall find that they have discovered the locality of their cows (plant lice), and are in haste to sip the sweet fluid secreted by these curious insects.

See the "pinch bug," that comes stumbling in at the open window, attracted by the light. Observe its antennae; how curious its eyes, how large. All beetles have a beautiful box fastened on their backs, in which are neatly packed their delicate, transparent wings They elevate the two lids (wing cases), and unfold the glacy wings, then they prepare to fly.

What curious claws, like forks, this fellow has to enable him to hold on securely. What stout jaws. You see they open sidewise, instead of up and down, like all the large animals. There too is the butterfly that flutters on the garden flowers, sucking with its long tongue, the sweets of the blossoms. It has no pincers; like the ant and bee it cannot bite. What large beautiful wings, four in number. See the long "feeler," with a nob on the end. The spider, that spreads its lace trap, to catch heedless flies, the grasshopper that springs up from the grass. All, these thing should be a subject of thought, observation, and comparison; for it is by *comparison* that we form ideas of the differences which exist between things; by comparison alone that we reach conclusions the most valuable for the developement of mind and the acquisition of knowledge.

How common the mistake parents and, I am sorry to say, teachers often make, in impressing the young and sensitive mind with horror and alarm, at the sight of the more harmless, and in all cases, beautiful works of God. Impressions thus made in youth, are very permanent and should be carefully avoided. We should be ever watchful that nothing prejudicial finds a lodgment in the minds of our children.

There is nothing farther from the truth, than that "any one is qualified to teach primary schools." It is far more difficult to teach the rudiments with profit than the more advanced branch of any subject. Especially is this true of Natural History. I am aware of the difficulty, the lack of qualified teachers; but let the demand be made with sufficient *emphasis* and the supply will be furnished. The law of demand and supply is as good in education as in commerce.


OUTLINE GEOLOGICAL MAP
OF
NORTHERN WISCONSIN.
By
R.D. IRVING
1873.
I Laurentian
II Huronian
III Copper Bearing Series
Dipping North
a Hornblendic & Syenitic
b Metaphyres
c Conglomerate
d Sandstone & Shale
Dipping South
e Sandstones
f Douglas County Traps
IV Lower Silurian Sandstone Horizontal.
Scale of Miles
LAKE SUPERIOR
Duluth
Superior
St. Louis R.
Nemadji R.
Amnicon R.
Middle R.
Poplar R.
Brule R.
Bayfield
La Pointe
Apostle Islands
Chequamegon Bay
Ashland
Fish River
White River
Marengoun R.
Potato Rivers
Tylers Fork
Bad River
Montreal River
Black River
MICHIGAN
DOUGLAS
BAYFIELD
ASHLAND
MARATHON
Upr St. Croix Lake
St. Croix R.
Long Lake
Namekagon R.
A
B
C
D
E

DEPARTMENT OF NATURAL SCIENCES.

ON SOME POINTS IN THE GEOLOGY OF NORTHERN WISCONSIN.

BY ROLAND IRVING, A. M. E. M.,
Assistant State Geologist of Wisconsin.

When the title of my paper was sent to the secretary, in answer to his request, I had intended to give in detail all the facts I could collect bearing on the question of the age of the copper bearing rocks of Lake Superior—the subject proposed in the title then sent—including also the observations made by myself and my assistants in northern Wisconsin; and to elaborate a subject which is briefly stated without theoretical discussion in my report on the geology of that region, now before the legislature. My double professional duties have however, rendered it impossible for me to do this at all satisfactorily, so that I have been obliged to give up presenting an exhaustive paper to the Academy. It has seemed to me, however, that the very interesting discoveries made by my party, bearing on the relations of the copper bearing series of rocks, and the Silurian sandstones of the west end of Lake Superior, should be presented to the Academy in some way. I had supposed also that the members of the geological corps would be expected to give some account of the results of their work,—I propose, then, to give briefly an outline of the geology of the district which has been under my charge, including a bare statement of the discoveries alluded to. This I am

the more able and willing to do since no special preparation is required, the subjects being those upon which my thoughts have constantly dwelt for many months past.

I. There are four distinct groups of rocks in northern Wisconsin, the *Laurentian* granites, gneiss, and schists; the *Huronian* schists, quartzites, iron ores and diorites; the melaphyrs, porphyries, greenstones, conglomerates, sandstones and shales of the series known now as the "copper bearing rocks;" and the lower silurian sandstones. In addition to these are enormous thicknesses of quarternary clays and of boulder drift.

The Laurentian (I on the map and section) rocks, are always furthest removed from the lake, never coming nearer to it than eighteen miles, and being usually much more distant than this.

So far as observed these Laurentian rocks are altogether granitic, gneissoid or syenitic in character, though undoubtedly various schistose beds must be present, since they are found just east of the eastern limit of the district, within the area of the upper peninsula of Michigan. In Wisconsin the rocks of this group are almost everywhere overlaid by enormous accumulations of drift material, showing through this covering in but very few places. This overlying drift is heaped up in masses which sometimes attain the altitude of from 1,100 to 1,200 feet above lake Superior. Amidst these drift heaps, and amidst the swamps which everywhere cover the country between them, the northward and southward flowing streams interlock in an intricate manner, the former in a distance often not more than thirty miles from their sources to their mouths, falling as much as 700 or 800 feet. It can readily be seen from this that their courses must be a series of chutes and falls, which is the fact, the single falls reaching in many instances a height of from 60 to 70 feet, and in one instance at least, that of Black river in Douglas county, a height of 160 feet.

The completeness with which this drift covering conceals the Laurentian rocks, may be understood, when I say that in all that portion of Ashland county underlaid by them, an area of not less than 800 square miles, only four localities are known where outcrops are to be seen, all of which are very near to the junction of the overlying Huronian, and two of which are caused by the action of rivers, the main Bad river and its Marangouin branch,—where they leave finally the Laurentian rocks and pass on to the Huronian. At each of these places the exposures are bold, and give rise to falls of some size. Those on the Marangouin have a height of sixty feet in three leaps, the river curving as it falls, so that the last leap faces in a direction at right angles to the first, the curve being around a bold face of syenitic rock.

The *Huronian* (II on map and section) rocks, which directly overlie the Laurentian and *unconformably*,—as shown by Brooks and Pumpelly, from observations made by them just east of the Montreal river in Michigan—constitute in Ashland county a continuous narrow belt, whose central portion is the well known Penokie Range, and whose width never exceeds two miles, being generally much less than this. These rocks extend without break into Michigan, almost as far as lake Gogebic, when they become lost, being covered by accumulations of drift, and finally by newer rocks, until, one hundred miles east of lake Gogebic, the Marquette Iron Region is reached, where they are again found, but covering a much wider extent of country than in Wisconsin. Towards the west, the Huronian belt comes to an abrupt ending, the underlying Laurentian, and overlying Copper Bearing series closing in on one another. Still further west, however, just on the west side of Ashland county, are two isolated belts of Huronian rocks, in every way similar to the main area, having each also its central ridge rising abruptly above the level of the country. Further west still, we know nothing of its continuance. In an old congressional document I find an

account of a trip made from the interior of Wisconsin to Lake Superior, by way of Long Lake and White river, by Dr. Randall, one of the assistants under Dr. D. D. Owen, then in charge of the geological survey of Wisconsin, Iowa and Minnesota. He gives a detailed description of all the rocks seen, but says nothing of any that could possibly be Huronian. I infer their absence, or entire concealment by drift material.

This question of a western continuation of the iron belt of Penokie range opens an interesting field for further investigation the question being one of economic importance, quite as much as of scientific interest. We have absolutely no *facts* going to show the entire absence ot the Huronian in the southern ends of Bayfield and Douglas counties. The wonderful quantities of iron which the strata of this series carry everywhere on the south shore of Lake Superior, makes this investigation of such importance that it should be undertaken at an early day by the geological survey. The dip needle will soon tell the story, even if the rocks are entirely concealed by drift.

The rocks of the Huronian group in northern Wisconsin are siliceous schists, talco-siliceous schists, white quartz rock, very peculiar black slates of unknown lithological affinities, magnetic and specular schists and slates, banded magnetic schists (alternating bands of magnetite and jasper or quartz), metamorphic diorites, and diorite schists. In Ashland county the whole series divides naturally into three portions. The *southernmost, lowest or oldest* portion is composed mostly of simple siliceous schists with some granular white quartz, grey quartzite and black slate. The *central portion*, consists of magnetic and specular slates and schists, whose content of the oxyds of iron varies from a fraction of one per cent. to sixty and even eighty per cent., in which latter case the schists are iron ores. In this portion of the group occur all the famous ores of the Penokie Range—and indeed *all* the ores whose existence is yet known—these ores being never intercalated lenticular masses, independent of the enclosing rocks, but simply portions of the

great group—five hundred feet thick—of magnetic and specular schists, carrying a larger portion of the oxyds than the general run. *The northernmost, highest, or newest portion of the group*, consists, so far as known, almost entirely of diorites, diorite slates and diorite schists, one locality, however, of quartz slate is known, and no doubt more occurs, since this portion of the group is much concealed by drift, and, indeed, has not been examined with the thoroughness devoted to the lower members. Between the exposures of this uppermost member and the next one beneath, there is always a gap without exposures, at least a thousand feet in width, on the southern side of which rises the Penokie Ridge, whose mass is chiefly made up, at least on its western portion, of the middle member of the group. It is evident that some general cause gives rise to the lack of exposures in this interval, which cause I take to be greater softness of material; and, inasmuch as in the Huronian of the Marquette region, the soft portions are chiefly the soft hematites, which are never found outcropping, for this reason, and for others, I have recommended in my report, that this part of the county be thoroughly searched by test-pitting.

The total thickness of the Huronian series at Penokie Gap, as calculated from actual measurement, is about 4,000 feet, as follows:

		Feet.
Lowest member	not exp.,	900
	in sight,	700
Central member		600
Space without exposure		1400
Upper member		400
		4000

About fifty miles east of Penokie Gap, Messrs. Pumpelly and Brooks estimate the thickness of the same belt at 4,000 feet, a remarkable uniformity of its structure is thus shown.

Copper Bearing Series.—Next north of, and immediately overlying the Huronian, are the enormously thick beds of the copper-bearing series, which have, in all, an apparent thick-

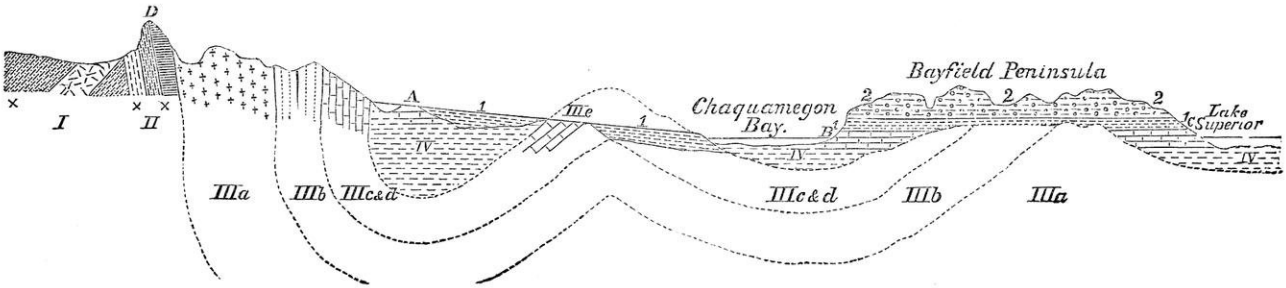
ness never less than four miles, and in places on the east much more than this. This enormous thickness may be due to some extent to folding and faulting, although no evidences of this have been seen. Of course, if portions of the group are of igneous origin, as they are supposed to be, the great thickness may be readily explained by the rapid formation of molten masses. Still, the upper portions of this series are, beyond all doubt, the results of sedimentation exclusively, and in one portion of Ashland county, one can walk over the edges of upturned sandstones, which show no sign of fault or fold whose actual thickness, after making the trigonometrical correction for dip, falls but little short of 10,000 feet.

The rocks of this copper-bearing series, form in Ashland county a broad belt, which is widest at its eastern end, where the rocks reach the shore of the lake, and narrows toward the west, at the same time receding toward the southward. The most westerly known portion of this belt is at Long Lake, in the southern end of Bayfield county. East of the Montreal river the series continues without break to the end of Keweenau Point. The Wisconsin belt, however, is the result of the fusion of two distinct belts in Michigan, which come together just east of the Montreal river, and which, eastward of the point of junction, are separated by an area underlaid by horizontal Silurian sandstones.

Northward of the belt of copper-bearing rocks in Ashland county, and removed from it as much as eight or ten miles, are two or three isolated outcrops of sandstones and traps, along a line some twenty-five or thirty miles in length, which I have regarded as forming the northeasterly edge of a synclinal of which those already mentioned, to the southward, form the southerly edge.

In Douglas county, the Copper Bearing Series is largely represented, and forms a broad belt curving southwestward across the county from one side to the other, and extending on the east into Bayfield county, whose peninsular form is doubtless due to this continuance, as indicated further on.

SECTION ALONG LINE D E OF MAP.



1. Red Marly Clay. 2. Boulder Drift. A, Penokie Iron Range. B, C, G, Horizontal Lower Silurian Sand Stone. Full line portions from observation, dotted line ideal. For further explanation see Map.

The Copper Bearing Series in Ashland county divides naturally into three members.

The lowermost member, designated A, in my report [II. a], covers the broadest surface of country of any of the three divisions. The rocks are always highly crystalline, generally very coarsely so, and present such a variation in lithological characters that I have not yet attempted to describe all the varieties, or even a small portion of them. The prevailing kinds, which themselves, however, include many varieties, are: 1st, a dark colored, coarsely crystalline rock, breaking with jagged edges, and showing broad, crystalline faces, with often a high lustre, varying in color from a light gray, through green, to dead black, and composed apparently of either hornblende or pyroxene, and a triclinic feldspar, probably in most cases Labradorite, although this last ingredient does not seem always to be present; that portion of Ashland county just north of English and Bladder lakes, presents on all outcrops, which are very numerous indeed, rock of this character: 2d, peculiar varieties whose aspect is usually pinkish, from the presence of orthoclase feldspar, and a black mineral probably, hornblende, with a varying amount of quartz: 3d, finer grained hornblendic and pyroxenic rocks.

The indications of stratification in this portion of the group are seldom seen—the whole mass being apparently without it—still, in the few places where they are seen, they are marked, and point towards entire conformability with the underlying Huronian.

Next north of and overlying the rocks just described, are the beds of that portion of the group designated B in my report [III.b.] This division, like the preceding, occupies a belt of country stretching entirely across the county, and having a much greater width on the eastern side. It includes a series of alternating beds of trap of many different kinds, both amygdaloidal and compact, always cryptocrystalline, and, in the upper portions, beds of a very remarkable conglomerate, (III.c.)

together with great thicknesses of sandstone (III.d.) and shale. These sandstone, shale and conglomerate beds do not altogether overlie the trappean beds, *but are, near the junction, directly and unmistakeably interstratified with them.* The whole series, traps, conglomerates, shales and sandstones, have a very high dip to the north, seldom less than 85 degrees, the beds having often a true vertical position. The sandstone, conglomerates and shales have not as yet been seen west of Bad river, in the central part of Ashland county, but the trappean members can be traced uninterruptedly as far west as Long Lake.

The outcrops of traps and southward dipping sandstones (III. e), already alluded to, I have regarded as being really the same as those just described, forming the opposite edge of a synclinal.* These rocks are exposed only in isolated patches, those thus far seen in Ashland county, being sandstones only, of great thickness; but on the same line further west, in Bayfield county, trap occurs.

Silurian.—Over all that portion of Ashland county north of division "B" of the copper bearing series, there is an immensely thick mass of a peculiar red marly clay, almost every where concealing the underlying rocks, which are exposed in but very few places. In the interval between "B" and the line of southward dipping sandstones, are found horizontal sandstones and shales in every way similar to those on the Apostle Islands, which last constitute the fourth great group of northern Wisconsin. These sandstones are, without doubt either the exact equivalents—or, which is more probable the downward continuation—of the light-colored primordial sandstones of the Mississippi valley. They form every where the basement rock of the Apostle Islands, and of the adjoining coast of Bayfield county. Following them westward into Douglas county they can be traced, with the same horizontality, to exact junction with the copper bearing traps of that part of the state, (III.f.) Farther south,

*See section.

again, these sandstones reappear (at points marked IV), on the head waters of the St. Croix, from where they can be traced uninteruptedly until they disappear beneath the light-colored sandstones of the Mississippi valley. From these latter the horizontal red sandstones of the west end of lake Superior differ much in appearance and composition, being always of a dark red or reddish brown color, and always carrying a large percentage of sesquioxide of iron, and of alumina. These peculiarities have led many geologists to assign these red sandstones to a much later date than the Lower Silurian, and it has always been wondered why they should so differ from the light colored sandstones of the Mississippi, if they are of the same age. The explanation is, however, very simple, as shown further on.

On the east side of Keweenau Point there are horizontal reddish sandstones which are, without doubt, the exact equivalents of those just described, because: 1st. they bear the same relation to the associated copper bearing and Huronian rocks; 2d. They graduate upward into light-colored sandstones, which themselves pass underneath limestones of Trenton age; and, 3d. They extend westward nearly as far as the Montreal river, being thus separated from the sandstones of the west end of the lake by only a few miles.

Having given thus briefly an outline sketch of the geology of northern Wisconsin, with the main features of its four great groups of rocks, it remains for me to draw your attention especially to those points bearing on the age of the copper-bearing series. The age of this series, as well as that of the accompanying horizontal sandstones, now proved to be Lower Silurian, has for years given rise to discussion, the earlier geologists calling them all Triassic, Foster and Whitney making them the equivalents of the Potsdam sandstones of New York, whilst the Canada geologists have regarded them as the equivalents of the Quebec group of Canada East. Still more lately Mr. Bell of the Canada Geological Survey, has revived the

half forgotten theory of their Triassic age. All of these geologists have however considered these two groups, i. e., the copper-bearing, and the horizontal sandstones as of the same class. It is only within the last year that Messrs. Pumpelly and Brooks have recorded observations, going to show an entire difference in age between the two groups, and proving that the former is much the older of the two.[1]

[2] In Michigan the highly tilted beds of the Copper Bearing series, which dip northward, and which form the back bone of Keweenaw Point, are flanked on the south and east by horizontal Silurian sandstones, which abut directly against their upturned edges. These sandstones continue westward nearly to the Montreal river, having the tilted beds of trap always on the north. They come to an end where the belt of Copper Bearing rocks on their north unites with one on the south. This more southerly belt is composed like the northern one of a series of traps with interstratified sandstones and conglomerates, all inclined at a very high angle. *The horizontal undisturbed beds of the Silurian sandstones, occupies then a trough between two lines af highly tilted beds of the Copper Bearing series.*

In Ashland county, on Silver creek, *occur horizontal sandstone, and shaly sandstone, within a few hundred feet of Copper Bearing Trap, and within two miles of vertical sandstones of the same group.*

In Douglas county the horizontal sandstones are traceable to within a short distance of the trap—and sometimes to actual contact, the traps here dipping, wherever dip is observable always to the southward, and having no tilted sandstones and conglomerates associated with them.

The interstratification of the trap with sandstones, and their mutual conformability—as observable everywhere on the south shore of Lake Superior—proves that the trappean beds, if ever thrown out in a molten condition, must have been

[1] Am. Jor. Sci. June, 1872. T. B. Brooks—"Iron Bearing Rocks." Michigan geological survey, 1873.

[2] Brooks and Pumpelly.

spread out in horizontal layers on the bottom of the sea, whilst the sedimentation of the sandstones was still in progress. Hence the present tilted position of these sandstones and traps was produced by a movement entirely subsequent to the solidification of the latter; *and, therefore, the tilted position of the sandstones of the Montreal and Bad rivers, those of the former reaching a thickness of nearly ten thousand feet, is not due to the protrusion of igneous rock, but to an ordinary regional dislocation, in which the trappean beds themselves partook. Moreover the strong indications of conformability between the whole of the copper bearing series, and underlying Huronian, goes to show that this disturbance was due in part, at least, to the same causes that elevated and folded the beds of the latter series.* We have then in this case horizontal sandstones found in immediate proximity to sandstones which have undergone regional disturbance. *The vertical sandstones, then, belong to a period far antecedent to that of the horizontal sandstone.*

The conclusions, then, that I would draw are these:

1. The Copper Bearing and Huronian Series were once spread out horizontally one over the other and owe their present highly tilted position to one and the same disturbance.

2. That subsequently—after a long period of erosion—the horizontal Silurian sandstones were laid down over, and against the upturned edges of the Copper Bearing Series, filling also the synclinal, in Ashland county, which lies between the northward and southward dipping sandstones.

3. That hence the Copper Bearing Series is more nearly allied to the Archaean, than to the Silurian rocks.

One fact observed, however, seems at first difficult of explanation on this hypothesis. In Douglas county, as already said, the horizontal sandstones can be traced to their exact junction with the southward-dipping traps. But, in several places, these sandstones present a very remarkable change as the trap is approached. On passing up the gorge of Black River, whose sides are perpendicular exposures of rock over one hundred

and fifty feet in height, towards the south, the horizontal layers of sandstone are suddenly seen to change from their ordinary position to a confused mass of broken layers, dipping in every conceivable direction, and increasing in confusion as the trap is approached, until, finally, the whole changes to a confused breccia of mingled trap and sandstone fragments. This appearance is presented along both sides of the gorge, for a distance of 300 feet, and I am assured by my assistant, Mr. E. T. Sweet, by whom all observations in Douglas county were made, that it is certainly due to no mere surface displacement. The same appearance is presented on one of the other northward flowing streams in Douglas county, on a much diminished scale however, the undisturbed sandstones reaching within twenty feet of the trap. On all other of these streams, the sandstones are undisturbed. The explanation which first suggests itself to account for these disturbances is naturally, that they were caused by the ejection of the traps through the already formed sandstones. In answer to this it may be said that it is very difficult to see how just such a disturbance as this could have been caused in this way, the sandstones presenting no appearance of baking or other indication of heat, but seeming rather to have been *crushed* by a pressure from the south. Next the trap it is crushed to a confused mass, a little further a few layers of sandstone become distinguishable, still further these are all distinct but broken and pitching in every direction, and finally they grade into regular unbroken horizontal layers. It may also be said that the proofs already given of the greater age of the copper bearing rocks, as compared with the horizontal sandstones are so strong as to necessitate some explanation of these disturbances other than the one just mentioned. The only one that I can offer, is this; the traps being deep seated are, as it were, independent of the more superficial sandstones, and would, if impelled to move by any force, move independently of them. Now a very slight movement of the traps northward against the sandstones would

produce all the phenomena observed. Such a movement is not at all difficult to explain.

II. *Westward continuation of the Lake Superior synclinal.*

Foster and Whitney long since pointed out that the rocks of Isle Royale and those of Keweenaw Point formed the opposite edges of a synclinal in whose depression lie the waters of Lake Superior. The rocks of Keweenaw Point continue westward uninterruptedly as far as Long Lake in Wisconsin. Do those of Isle Royale extend westward in a similar manner? I have obtained facts going to show that they do, and that the peninsula of Bayfield owes its existence to this extension. The facts alluded to are these: 1st. The known existence of a synclinal in Ashland county. 2d. The southward dip of traps of Douglas county. 3d. The known existence of an extension of the Douglas county traps into Bayfield county.* 4th. The vertical position of the beds of traps and sandstone in the westward continuation of the Keweenaw Point belt, as compared with the much lower dip at its eastern end;—since towards the west the two sides of the supposed synclinal approach more nearly to one another, it would be expected that the dip would be much greater, on one side at least, than where they are far apart. 5th. A westward continuation of the Isle Royale rocks is nowhere else found. 6th. The Douglas county traps are very similar to those of Isle Royale. The accompanying section shows at once what is actually known of the geology of the country along its line (D. E. on accompanying maps), and the probable structure of the concealed portions.

The views thus set forth at once explain, and are confirmed by, the ferruginous and aluminous character of the Lower silurian sandstones of Lake Superior, as compared with the quartzose character of their equivalents in the Mississippi valley; *the former have been derived from the wear of the feldspathic and magnetite bearing traps of the Copper-bearing series, whilst the latter owe their material to the wear of quartzose Laurentian granites and of Huronean quartzites and schists.*

*These traps disappear under the drift as they are traced eastward.

SOME OF THE PECULARITIES OF THE FAUNA NEAR RACINE.

BY P. R. HOY, M. D., RACINE.

With few exceptions, the facts recorded in this paper were obtained by personal observation within fifteen miles of Racine, Wisconsin, lat 42° 49′ north; Long. 87° 40′ west. This city is situated on the western shore of Lake Michigan, at the extreme southern point of the heavy-timbered district the base of which rests on Lake Superior. At this point the great prairies approach near the lake from the west.

The mercury rises in summer from 90 to 100° Fah., while in winter it sinks from 12° to 20°. The average daily temperature for the four warm months, June, July August and September, is within a fraction of 70° Fah.

The isothermal line curves farther north in summer and retires farther south in winter, than it does east of the great lakes; which physical conditions will sufficiently explain the remarkable peculiarities of its animal life the overlapping, as it were, of two distinct fauna. More especially is this true of birds, which are enabled to change their locality with the greatest facility.

Of summer birds I will enumerate only a few of the many that belong to a more southern latitude in the Atlantic states:

Yellow-breasted Chat, *Icteria Virideis.*
Mocking Bird, *Mimus Polyglottus.*
Great Carolina Wren, *Thriothorus Virginicus.*
Summer Redbird, *Pyrangia Æstiva.*
Carolina Parrot, *Conurus Carolinensis.*
Whooping Crane, *Grus Americana.*
Wood Ibis, *Tantalus Loculator.*
Royal Tern, etc., *Sterna Regia.*

Among Arctic birds that visit us in winter are:

The Great Grey Owl, *Syrnum Cinereum.*
Hawk Owl, *Surnia Ulula.*
Arctic Three-toed Woodpecker, *Picoides Arcticus.*
Banded Three-toed Woodpecker, *Picoides Hirsutus.*
Magpie, *Pica Hudsonica.*
Canada Jay, *Perisoreus Canadenses.*
Evening Grosbeak, *Hesperiphona Vespertinus.*
King Eder, *Somateria Spectabilis.*
Black Throated Diver, *Colymbus Arcticus.*
Glaucus Gull, *Laurus Glaucus.*

Of mammals I will instance:

The Opossum, *Didelphys Virginica.*
Silvery Mole, *Scolaps Argentatus.*

As belonging farther south.

Of northern mammals found here are:

Pine Marten, *Mustela Americana.*
Canada Lynx, *Lynx Canadensis.*

Reptiles, southern forms:

Glass Snake, *Ophisaurus Ventralis.*
Blue Tailed Lizard, *Sincus Faciata*; (as far north as Lake Winnebago.

Insects furnish many interesting examples of Southern species found here, some of which are abundant, as: *Leucanus elephas, Copris Carolina, (Phanaeun) carnifex, Terias nicippe, Colydryas ebula, Paphia glycerium, apatura Celtis*, etc., etc.

These examples are sufficient to indicate the rich fauna of this locality. It is doubtful if there is another locality where the *Canada Jay* and its associates visit in winter, where the *Mocking Bird* nests in summer, or where the *Hawk Owl* flits silently over the spot occupied during the warmer days by the

Summer Red-bird and the *Yellow-breasted Chat.* Within the last twenty-five years in the narrow bounds of Racine county there have been collected over *three hundred* species of birds; more than have as yet been noticed in any single state—nearly one half of all birds known to naturalists within the entire territory belonging to the United States.

But the axe has already leveled much of the "great woods," so that there is now a great falling off on the part of our old familiar feathered friends. It is extremely doubtful if such a collection can ever again be made within the limits of the state.

ON THE RELATION OF THE SANDSTONE, CONGLOMERATES AND LIMESTONE OF THE BARABOO VALLEY TO EACH OTHER AND TO THE AZOIC QUARTZITES.

BY JAMES H. EATON, PH. D.

Professor of Chemistry and Mineralogy, Beloit College.

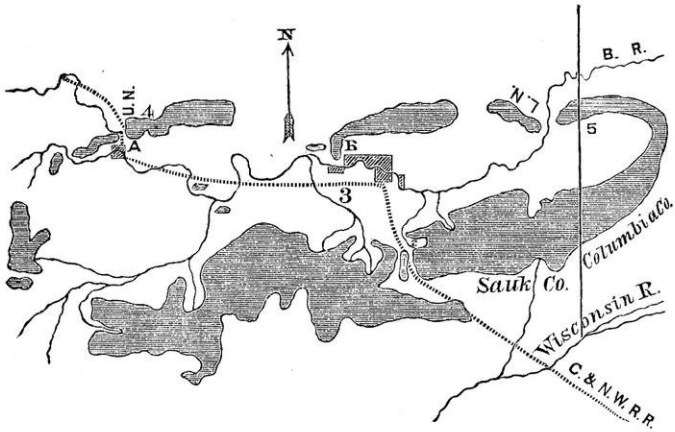
The age of the quartzite hills and ridges of Sauk county has been satisfactorily determined by Mr. Roland Irving[1] to be pre-silurian. Mr. James Hall[2] in his report of the State Survey, calls them Huronian. Their relation to the great central area of azoic rocks in Wisconsin may, perhaps, be determined by finding their junction with the latter. On Dr. Lapham's map a small region on the Eau Claire river, adjacent to the great central area of granitic rocks, is colored as quartzite. An examination of this locality, to determine whether the quartzite rests unconformably upon the granite rocks, would doubtless determine their age.

The accompanying map is by Mr. Wm. H. Canfield, of Baraboo, who for many years has been the official surveyor of Sauk county. It is taken from surveys made by him with the especial purpose of marking the quartzite outcrop.

In regard to it I would only remark, that it does not present so much the appearance of two parallel ridges, terms generally used in describing the elevations on either side of the Baraboo river, as of a group of islands, with a common east and west trend at right angles to the dip of the rocks. These elevations formed islands in the Potsdam sea. The point marked (2) on the map is the locality from which the fossils were obtained,

[1] Trans. of the Wis. Acad'y, 1871-72, p. 129.
[2] Survey of Wis., p. 11.

which were described by Mr. Alexander Winchell* in 1864. I was assured that there is a quarry of the rock in place near by, but a subsequent visit has shown that the sandstone only exists at this point as loose pieces. In a short time a larger number of Potsdam fossils were obtained. They were *Scolithus Linearis*, Hall, *Orthis Baraboensis*, Winchell, *Straparollus primordialis*, Winchell, *Dicellocephalus Minnesotensis*,



A, Abelman; B, Baraboo; B R, Baraboo River; L N, Lower Narrows; U N, Upper Narrows. 1, Devil's Lake; 2, 3, Potsdam Sandstone; 4, Section; 5, Limestone. Scale, three-twentieths of an inch equal to a mile.

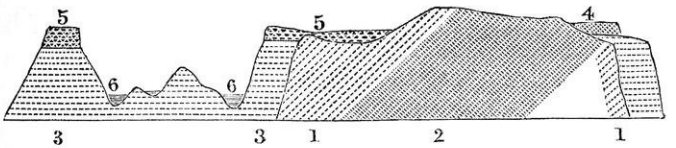
Owen. At the locality marked (4), however, is a section (fig. 2), which is truly magnificent in its exposure of all the rocks, which belong to this region, in their stratigraphical relations, except the limestone. It is at the railroad station, Abelman. The Baraboo river, in forming the upper narrows, has left upon the east side a nearly vertical section, about half a mile long and 300 feet high at the highest point. This section is of a core of tilted rock, flanked on *both* sides by horizontal Potsdam sandstone and conglomerates. No doubt can therefore remain that the tilted rock is Pre-silurian.

The dip of the entire section of Azoic rock is to the north or slightly west of north. Its face is cut by numerous vertical

†Am. Jour. Sci. and Art, II, vol. XXXVII, p. 226.

joints in the same manner as the cliffs at Devil's lake. At the extreme southern end, the rock varies from a compact, dark-colored, homogenous quartzite to a much less compact and lighter quartzite. One large detached block of the hard, dark quartzite was seen beautifully covered with ripple-marks. Passing along the face of the cliff toward the north, it becomes covered with large blocks of quartzite, sandstone and conglomerate, which have fallen from above. Coming to the exposed rock again, it changes to a metamorphic conglomerate. This makes up more than half the section. It consists of *angular* pieces of the compact, dark quartzite, firmly imbedded in a cement of white crystalline quartz. The former vary in size from small fragments to masses several tons in weight. Numerous cavities are lined with quartz crystals. The dip here is from 75–80 ° N.

Fig. 2.



1, Quartzite. 2, Metamorphic Conglomerate. 3, Potsdam Sandstone. 4, 5, Conglomerates. 6, Drift.

The remainder of the section consists of the homogeneous, dark, compact quartzite, bedded in the same manner. We have indications then of these successive sets of circumstances in Azoic times; those in which were formed respectively the underlying quartzite, the conglomerate and the overlying quartzite. The lower quartzite must have been already hardened from the moving sands before it was broken into fragments for its conglomerate. And then its cement was crystallized. Finally layers of sand spread over this were hardened. As has been said, upon the southern flank of this Azoic core, horizontal beds of Potsdam sandstone lie unconformably. They extend a short distance over the edges of the upturned beds of quartzite. The relations of this sandstone to the underly-

ing quartzite show most unmistakably the effects of shore action. The quartzite is generally in place, but the large blocks, formed by the crossing of the planes of bedding and the joints, are somewhat isolated, as if they had formed crags on an old coast, where the wearing of the waves had enlarged the cracks. Into these fissures and crevices the sand is forced. There are also blocks of quartzite, that have been displaced somewhat, which are enveloped in sandstone. In the sandstone itself is an occasional rounded pebble of quartzite. The sandstone which rests upon the northern flank is irregularly bedded, having the ebb and flow structure. Further north are these isolated hills of sandstone.

Resting on the sandstone at the south, and stretching also over the quartzite, is a conglomerate made up of a friable sandstone, like that below, containing numerous rounded pebbles of the quartzite of obvious sizes. The cement makes up a considerable part of the rock. This coglomerate, as I have assured myself by careful examination, is exactly like that mentioned by Mr. Irving, as occurring on the quartzite just northeast of Devil's Lake, and containing Potsdam fossils. The finding of this conglomerate, therefore, in its true relation, verifies Mr. Irving's supposition in opposition to Mr. Winchell, that neither the conglomerate nor the quartzite is the *base* of the Potsdam system, for here the true base comes in between, as sandstone.

In the same manner there is a conglomerate at the north, resting conformably on the sandstone and unconformably on the quartzite. One of the isolated hills of sandstone is also capped by the same. Though on the same level as the conglomerate at the south, its character is different. It is made up almost entirely of small rounded pebbles of quartzite of a pretty uniform size. The cement is quite hard, but true sandstone.

This section, then, represents an old Azoic reef of tilted rock, running east and west, washed upon either side by the

waves of the Potsdam sea. On the south the action appears to have been gentler than on the north, for the quartzite has been triturated to a fine sand, containing, to be sure, larger or smaller pieces of quartzite well rounded. The northern shore must have been exposed to the breakers, which washed out the fine sand and left pebbles of a uniform size. It may be that within the circle of these islands was a sheltered bay.

At the point marked (5) on the map is a limestone quarry. The limestone is horizontally bedded and rests on the southern flank of one of the ridges, but all points of junction with the underlying rock are concealed. About half a mile distant is sandstone on the same level, and in another direction is sandstone at least 100 feet higher. I am inclined to regard this limestone as a local deposit of the Potsdam epoch rather than of the Lower Magnesian epoch. The latter supposition would require an enormous erosion between the putting down of the Potsdam sandstone and the Lower Magnesian limestone. The fossils, also, a number of which were secured, although undetermined, have more the aspect of Potsdam fossils than of those of the following epoch. A number of cephalic shields of a trilobite, with other fossils, were obtained.

Another feature of interest in this region is the evidence of glacial action aside from the dift. At the point (3) on the map is an isolated hill of sandstone. On my visit the earth had just been removed from a large surface in order to quarry the rock. It was entirely smoothed and covered with glacial striae. Their direction is N. 66° E. On the surface of the limestone previously mentioned, the polishing is even more perfect, and the striae have the same direction. Polished surfaces have also been observed three quarters of the way up the quartzite hills. The most reasonable explanation of the deflection of the striae from the usual direction seems to be, that they were produced by ice masses small enough to be influenced in their motion by the east and west trend of the ridges.

NOTE ON THE RAPIDITY OF THE ABSORPTION OF ARSENIC BY THE HUMAN LIVER.

BY W. W. DANIELLS, M. S.,
Professor of Analytic Chemistry, University of Wisconsin.

In June, 1873, August Mansard died suddenly. In December following the body was exhumed, the stomach, bowels, and a portion of the liver were brought to me to be examined for poisons. The stomach and duodenum were examined at once, and found to contain eight grains of arsenious acid. The liver and remaining portions of the viscera were put in a glass jar, covered with dilute alcohol, and sealed December 25th.

On the 9th of February, 1874, that portion of the liver brought to me, weighing thirty-one ounces, was taken from the alcohol, decomposed by Fresenius and Babo's method, and the arsenic weighed as arsenious sulphide. The weight of arsenious sulphide thus found was 1.864 grains, which is equivlent to 1.5 grains arsenious acid.

The subject died three hours after eating dinner, and it is supposed that the poison was given in the food at this time.

As death is seldom caused by arsenic in so short a time as three hours, this case is of interest on account of its showing the rapidity of the absorption of this poison by the liver. The weight of an adult liver is about four pounds. Supposing the weight of this liver to have been sixty-two ounces, the amount of arsenious acid contained in it would have been three grains.

SOME EVIDENCES BEARING UPON THE METHOD OF THE UPHEAVAL OF THE QUARTZITES OF SAUK AND COLUMBIA COUNTIES.*

BY T. C. CHAMBERLIN, M. A.,
Professor of Natural History, Beloit College.

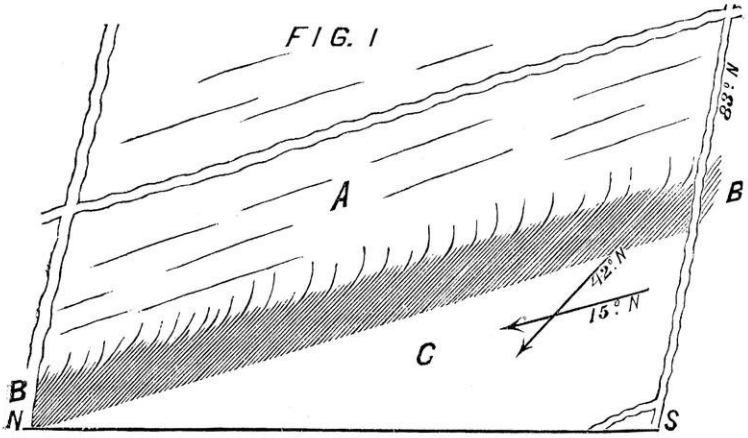
Next to the age of these quartzites, perhaps no question in Wisconsin geology has been more prolific in speculation and discussion, if not in investigation, than the method of their upheaval. The former question has been discussed with much success by Prof. Irving. Evidence bearing upon the latter question cannot then fail to be interesting in itself, while it must also strengthen or otherwise the conclusions that have been reached concerning the former. The evidence which will be adduced in this paper rests chiefly on the peculiarities of certain bands of talco-silicious schist interstratified between heavy beds of quartzite. The best observed exposure of this is to be found on the east side of Devil's lake, and is represented in the accompanying figure.

The dip of the quartzite beds, as well as of the included stratum of schist is 15° to the northward. The determination of this does not rest alone upon the inclination of the beds, but is rendered certain by that of the laminæ and layers of pebbles included in the quartzite, as well as by ripple-marked surfaces. Another similar band, but less conveniently exposed, occurs in the north range near Ableman, standing nearly vertically, corresponding to the higher dip of that range.

The material of these bands is not sufficiently defined by

*It is proper here to state that the observations on which this and the following paper are based, were made in connection with a party organized at Whitewater for the purpose of studying this region, and some credit at least is due to the remaining members though I have made use of my own observations exclusively. The party consisted of T. G. Vincent, S. R. Alden, A. L. Arey, F. H. King, L. C. Wooster, L. W. Winslow and H. D. Bell.

the term talco-silicious schist, although, perhaps, no better single term can be used. It consists of thin laminations of talcose material, separated by somewhat thicker layers of quartzite, presenting a structure quite peculiar. It is neither a typical schist nor a true slate. It lacks the cleavage of the former and the homogeneity of the latter. It cleaves readily along the laminæ of talcose material, which, however, are not entirely parallel, nor always continuous across the band. If an oblique direction is found, it follows the talcose layer as far as possible, when it passes by an abrupt transverse fracture across the intervening quartzite layer to the next tolcose lami-



A, Quartzite; BB, Talco-silicious schist; C, unexposed.

næ, and so continues by alternate cleavage and fracture, resulting in a step-like face. In this sharp distinction between cleavage and fracture, the rock shows its relationship to the true slates. Were it demonstrably a true slate, the suggestions of this paper, now advanced with deference, would be stated as a demonstration. It is the "foliated" structure of some authors, but the foliations are not parallel to the bedding lines.

In the formation on the east side of the lake, the laminations cross the band at an average angle of 27°, having thus a dip of 42° to the north. (See figure.) On reaching the quart-

zite bed above many of the talcose laminae disappear, while a few of the more prominent curve as they enter it until they take a direction more nearly perpendicular to the laminations of the quartzite. Their behavior with the underlying bed was not observed, it being obscured by a projecting shelf of rock, from the surface of which, however, it was inferred that it was the same, the curvature being probably in the opposite direction.

That the material forming this schist and the quartzite beds above and below was originally deposited in an essentially horizontal position, does not admit of doubt. That the material of these talcose laminae was deposited in its present remarkable position and relationship, is not to be supposed. To what then do they owe their origin?

That the lamination and cleavage of true slate are due to pressure is now considered as demonstrated. That pressure is competent to produce such cleavage and lamination has been verified by direct experiment, with homogeneous as well as heterogeneous material. That some of the so-called schists owe their structure to a similar cause, has been conceded by high authority. Mr. Sorby has shown* that cleavage may even be produced in sandy layers included in slaty material, by the pressure which gave rise to the slate. Bearing these facts in mind, let us go back to a time previous to the metamorphism of these rocks. The quartzites were then sandstones and the schist would have been classed as the same with magnesian impurities. The metamorphism of these implies either heat or pressure, or both. But there are no evidences of any source of heat, unconnected with pressure to be found in the region. There are no volcanic or trappean rocks, no deposits of thermal springs. Any source of heat of this character must have been considerable, and should have left its traces, for the area includes more than 150 square miles, about 75 of which are occupied by the quartzite ridges.

*On the Origin of Slaty Cleavage, by H. C. Sorby, Edinburg. New Phil. Jour., 1853, vol. iv. p. 137.

But the fact of upheaval bears its own evidences of pressure. Over all this area, the rocks have been tilted northwards till they dip at angles varying from 15° to 90°. Similar outcrops elsewhere in the state present like phenomena. The common cause of tilting throughout the globe is lateral pressure, and no other cause seems competent in the present case. The same is true of metamorphism, though in a somewhat less degree. The two are usually synchronous events having a common cause. The lateral force usually acts from the direction of the neighboring ocean. This would require, in the present case, a force acting from the south. Let such be assumed to be the case. While the beds were horizontal, the force would tend to produce compression, heat and metamorphism, and as the strata offer the greatest resistance in this position, these results must be supposed to be greatest at this stage. The result of compression would be cleavage in such portions of its rock as were capable of taking it in a direction transverse to that of the force, according to the law of slate formation. The more resisting quartzite would prevent the complete compression of the more yielding schistose material. This is substantiated by the observations of Mr. Sorby. But as the strata yielded, the force would take a new direction relative to the layers and expose the schistose material to farther compression, producing new foliations in a new direction, and those previously existing would be modifed. And so for every change in the strata till the force ceased to act. This is precisely the phenomena presented by the case in hand. Some of the features of what is known as "drag" in slate are unmistakable.

A line drawn perpendicular to the laminae should, if this reasoning be true, represent the direction of the upheaving force. A line so drawn would be transverse to the shore of the Eozoic island to the northward, and precisely in the direction demanded by theoretical considerations.

The fact that the foregoing explanation is so fully in harmony with the usual phenomena of upheaval and metamorphism is at least an element in its favor.

ON FLUCTUATIONS IN LEVEL OF THE QUARTZITES OF SAUK AND COLUMBIA COUNTIES.

BY T. C. CHAMBERLIN, M. A.
Professor of Natural History, Beloit College.

In this paper, the level of the ocean will be assumed as a fixed standard, and all changes will be supposed to take place in the quartzite. This, though not a strictly accurate method, is, I believe, tacitly assumed in the literature of geology.

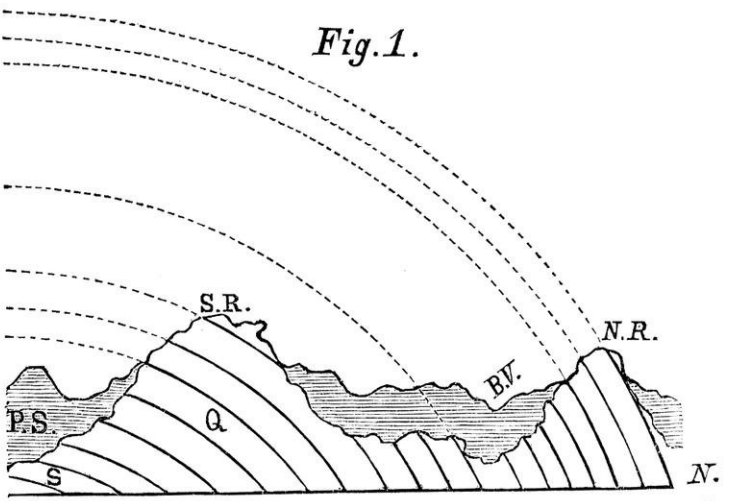
1. Their original position was submarine and essentially horizontal. This is abundantly demonstrated by ripple marks, lines of rounded, water-worn pebbles, and the phenomena of bedding and lamination, and may be dismissed with the mere statement.

2. The position assumed was the result of the tilting and metamorphosis of the strata. That this was one of considerable elevation above the ocean level is more than probable. The sea was shallow during their deposition, as is shown by the mere fact that they were sandstones, and by the evidence quoted above. The sea was also shallow during the Primordial period following, as is shown by precisely similar evidence. So that, unless great depression accompanied the tilting and metamorphosis, an idea that has never, I think, found a place in geology, a very considerable elevation above the ocean must be supposed. This much at least is certain, a vast amount of denudation took place before it assumed the position next to be noticed. To understand this fully the two ranges must not be considered as separate and distinct, but as portions of one grand group of strata, by estimate, 15,000 or 20,000 feet in thickness. The disassociation of the two ranges seems to have resulted from the fact that previous observa-

tions have been confined chiefly to the region of Baraboo, where the ranges are most separated. Their more intimate association, if not direct connection, both at the east and west, was shown in my paper on the geographical distribution of these rocks, and may be seen by reference to the paper of Prof. Eaton, of this volume.

The dip increases from south to north and indicates an arrangement such as is represented in the following ideal section, which also shows the nature and amount of denudation:

Fig. 1.



S. R., South Range. N. R., North Range. B. V., Baraboo Valley. Q., Quartzite. P. S., Potsdam Sandstone.

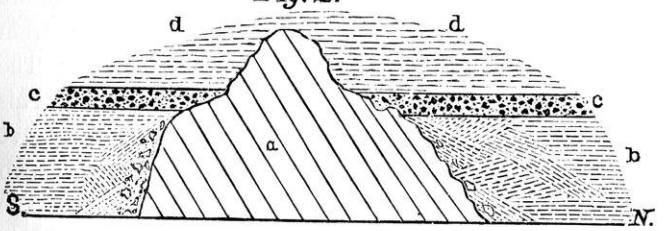
That a portion at least of this erosion was sub-aerial is necessitated by the nature of the case, for in that way only can we explain the deep excavations between and on the outside of the ranges. Preceding the Potsdam period all of these rocks that are now exposed, must have stood above the ocean level, and were doubtless portions of the Eozoic continent.

3. In the earlier part of the Potsdam period, these ridges of quartzites stood as islands in the seas. This is evident when we consider that they exceed, in places, 500 feet in height, while at the base, sandstone, showing cross lamination and

containing *Scolithus linearis* is found, and that a complete submergence would have been incompatible with such a deposit. The greater mass however, of what we are now acquainted with was beneath the surface of the water at some time during that period, though probably not at its commencement, for it is highly probable that a slow subsidence was in progress during this time, and this may have been but a continuance of the depression that constituted the change from the elevated position just described to the present one.

That the shores were precipitous is a matter of observation. That the water along shore, was of moderate depth, is inferred from the nature of the deposit. The following section will render this more clear:

Fig. 2.



a, Quartzite. b b, Potsdam sandstone, showing beach structure and included quartzite fragments. d, Potsdam sandstone. c, Conglomorate.

This is an ideal section, but no feature is introduced that has not been verified by personal observation, and no violence has been done to nature in the combination. It is here used as a convenient substitute for the seven natural sections accompaning the original presentation. I beg leave also to refer to the five natural sections accompanying the paper of Prof. Eaton on the relations of these rocks, to be found on page 125 of this volume. The sandstone formed at this time is marked b b. Near its junction with the quartzite, well defined cross lamination occurs. This is beautifully shown near Ableman. Near the vertical junction there also occur, imbedded in the sandstone, large and chiefly *angular* masses

of quartzite, lying in such positions as to leave no doubt that they fell from above and buried themselves in the soft sands and were thus not subjected to erosion. This may be seen at Ableman, near the western extremity of the outcrop, and in the town of Caledonia, near the eastern extremity, and more than twenty miles distant. It occurs on both the inner and outer side of the range.

From these facts it appears that the deposit was not, on the one hand, beneath the limit of wave action on the shifting sands, nor, on the other, so near the surface as to be subject to the more violent assorting and eroding action of the breakers.

4. There came a time, however, when this last became true and resulted in the formation of a conglomerate marked *cc*, in fig. 2. The well rounded pebbles of this conglomerate are evidently from the adjacent quartzite and vary in size from the fraction of an inch to three or four inches in diameter. The matrix is similar to the under and over-lying sandstones. This is not a mere local formation, as might be supposed. I have observed it at Ableman, at the canon of Narrows creek, two miles further west, where one of the finest sections in the whole region occurs, at two or three points south of this in the towns of Freedom and Westfield, at Devil's lake, at the mill about four miles east of the lake, at the chapel three miles east of the last point, in section 35, town of Caledonia, near the eastern extremity of the outcrop, and again on the north range in section 22 of the same town; in other words, at every point where an opportunity for observation presented itself. As near as could be judged, the elevation at all these points was about the same.

The conglomerate was not observed to exceed 30 feet in thickness, and was usually much less. Its definition both above and below is sharp, and would seem to indicate a sudden elevation which caused the shallow beach necessary to its formation.

In the figure the conglomerate is represented as joining the quartzite on a shelf or terrace such as is often formed by the breakers on a rocky coast. This was observed to be true in some cases, but may not be a general fact, though I suspect it is.

5. Following the period of the formation of the conglomerate, which previous investigations have identified as the Middle Potsdam, there occurred another subsidence indicated by the formation of the sandstone marked *dd*, Fig. 2. This subsidence seems to have continued until the entire formation was submerged beneath the ocean level, and buried beneath its sediment. This, however, I am not able to positively demonstrate in respect to certain portions of the south range. East of the Lower Narrows, resting upon and rising high above the north range, is a high bluff, which presented at a distance the appearance of sandstone, and which I was assured by Mr. Canfield it was. The elevation of this seemed about equal to that of the higher portions of the south range, but I had no means of measurement. Even should its elevation be found to be considerably less, its approximation to the height of the quartzite can scarcely be regarded as less than a demonstration of the fact in question, when it is remembered that at least 400 or 500 feet of sandstone in the vicinity have been swept away by eroding agencies, and that this bluff must have suffered much more denudation proportionally than the quartzite. I conjecture, however, that the quartzite rose into the horizon of the lower magnesian limestone.

On the high bluff just east of the lake, in excavating for a cistern, Trenton fossils in a silicified condition were thrown out. This portion of the bluff does not seem to have been visited by the glacial agencies, although northern drift occurs a short distance east. This will not seem strange when it is known that the drift, even on the lower lands, extends but a short distance west of this. There was no foreign drift discernable in the material excavated or in the vicinity, and the quartzite bottom did not indicate glacial erosion. These facts

whatever may be thought of their force or conclusiveness, are at least interesting.

6. Subsequently the whole was elevated above the ocean, and, whatever fluctuations may have intervened, stands there to-day, testimony to which this academy has received, perhaps, *ad nauseam.*

ON A HAND SPECIMEN, SHOWING THE EXACT JUNCTION OF THE PRIMORDIAL SANDSTONES, AND HURONIAN SCHISTS.

BY ROLAND IRVING, A. M., E. M.,
Professor of Geology in the University of Wisconsin.

On Black River, in Jackson county, this state, in the vicinity of the town of Black River Falls, the Primordial sandstones are found overlying Huronian and Laurentian rocks. About a mile or two above the town the banks of the river are formed of abruptly rising and as abruptly sinking mounds of tilted Huronian schists,—chloritic, talcose, talco siliceous, siliceous and ferruginous. Between these mounds, the depressions are filled with the light colored quartzose Primordial sandstones of the region, and these often form the bank of the stream. So close is the association of these formations, that in following the bank of the stream, one is constantly stepping from the Primordial sandstones, on to the Huronian schists, and then as abruptly back again. In many cases the sandstones form the upper part of a high bank, whilst below, immediately at the water's edge the schists are visible. In these cases the exact junction of the sandstone and schists is nearly always concealed by debris, soil and undergrowth. In one place, however, Mr. T. B. Bowman, assistant on the geological survey, found a long exposure showing the exact line of junction, the horizontal sandstones above, and the ferruginous schists below. From this place he obtained specimens, of which I exhibit one. It will be noticed that even the hand specimen shows the horizontal position of the sandstones and the inclined position of the schist, or "iron ore" the lamination being marked. (See sketch.)

ON THE OCCURRENCE OF GOLD AND SILVER IN MINUTE QUANTITIES IN QUARTZ FROM CLARK COUNTY.

BY R. D. IRVING, A. M., M. E.

Professor of Geology in the University of Wisconsin.

In the fall of 1871, some samples of quartz from Clark county, Wis., were handed me by Mr. Geo. W. Brown, with a request for an assay for Gold and Silver. The samples were barren looking, tough, white quartz, presenting none of the reddish or rotten appearance common to surface Gold ores of any value. Scattered throughout the quartz, were small quantities of Magnetite in scales, Pyrite and Arsenopyrite; this association being a usual one in Gold quartz. Mr. Brown pointed out the locality from which the samples came in Clark County just north of the junction of the Potsdam Sandstone with the Eozoic rocks. He represented the prevailing rocks in that section as Chloritic and Talcose Schists; and of the former he brought me fine specimens. The quartz he represented as occurring in veins; though his samples seemed to have been selected from loose masses. I need hardly say that these associations are the common ones in Gold regions. On taking the usual amount, four (4) Assay Tuns., or about 120 grns., the resulting button of bullion weighed just enough in excess of the Silver in the Litharge used, to make me suspect the presence of Gold in the quartz. On dissolving the button in Nitric Acid, one or two small flakes remained, but not enough to weigh. I then took for a second Assay, four times the usual quantity and obtained a weighable amount of gold, corresponding to about 20 cts per 2,000 lbs of ore.

Mr. Brown subsequently, at my advice, sent me samples, showing the reddish and rotten appearance already alluded to.

The result of the assay on these samples, however, was the same as before, save that in this case, the difference between the weight of the button obtained and the silver in the lithurge used, was not fully made up by the weight of the gold; the presence of silver was thus indicated. In making a further assay some time afterwards, I obtained an unmistakable amount of silver. And during the fall just past, Mr. Theodore Bowman, of the University, made two assays, in which he obtained the following results:

PER 2,000 LBS. OF ORE.

1st Assay.		*2d Assay.*	
Gold	A trace.	Gold	A trace.
Silver	0.407 oz.	Silver	0.37 oz.
Total	0.407 oz.	Total	0.37 oz.
Gold	A trace.	Gold	A trace.
Silver	$0.52	Silver	$0.47
Total	$.52	Total	$0.47

DEPARTMENT OF THE ARTS.

ON THE WISCONSIN RIVER IMPROVEMENT.

BY W. J. NICODEMUS, A. M. C. E.,
Professor of Engineering, in the University of Wisconsin.

Before speaking of the physical features of the Wisconsin river, we will offer some general remarks applicable to the whole of North America. Recent surveys show that Lake Winnebago formerly had its outlet southward to the Wisconsin river, and since changed to the north through the lower Fox river into Green Bay. It has long been known that Lake Michigan once had its outlet southward through the Illinois river, and that Chicago stands in the old bed of the lake, the southern shore of which is twelve miles south of the city. All the small lakes examined show the same condition, an elevation south of a line drawn from Cape Hatteras on the Atlantic to Cape Mendocino on the Pacific, and a depression north of that line. If this supposition be correct, going back in time, the lake outlets would all be southward, and not northward as at present. Hence we would infer that the Niagara and probably the St. Lawrence rivers (though there are signs of greater antiquity connected with the last), are of comparatively modern origin, which is confirmed by the fact of their abounding in waterfalls and rapids. There is no doubt that Lake Winnipeg was once continuous southward, covering the central portion of the valley of the Red River of the North, and having its outlet down the Minnesota River, and not as now, down the Nelson river to Hudson's bay. The river bank near the old out-

let show that this change took place since the glacial period. The ancient Lake Winnipeg was larger than the present Lakes Superior and Michigan combined. The northern depression is known to be going on along the Atlantic coast from New Jersey to Greenland. Any one can test the matter of north ern depression and southern elevation for himself by examining the published maps, and remembering that the effect of bodies of water on the shore is to abrade it and spread the material smoothly over the bottom, while the effect of the atmosphere is to cut the land up in ridges and to wash the soil from the rocks; so that the land rising from the water will have comparatively smooth outlines, and successive lagoons parallel to the shore, while the land going under the water will show jagged and sharp outlines, with deep indentations and numerous islands. We know that during the cretaceous period, an ocean extended from the present Gulf of Mexico to the Arctic Ocean, covering a large portion of the space between the Missouri River and the Rocky Mountains. At that time the country through which the Upper Mississippi now flows was dry land, and its slopes must have sent its water westward to that cretaceous ocean. As the continent rose this ocean disappeared, and the tertiary period began with great fresh water lakes along the Rocky Mountains. Into these lakes the waters of the upper Mississippi region continued to drain westward. The gradual southwestern elevation of the continent throughout the testiary period is distinctly proved by the deposits of the testiary lakes. The earliest deposits were of the least area, and as they become more recent they expand northeastward, and this action continued apparently to the time preceding the glacial epoch. Preceding the glacial period, then all the water-courses westward of the upper Mississippi region were westward and not southward, as now. Not only the slope of the land but the great folds of the Silurian strata compelled the water to this course. Over a great deal of the region thus drained, no rocks more recent than the Silurian are found, so

that it must have been dry land since the Silurian period. In the immense ages succeeding the time of the Silurian oceans, the rocks being exposed to the destructive atmospheric influences must have been cut up by the ravines and valleys encroaching on each other in endless confusiou. The pre-glacial erosions of even the hard Azoic rocks which formed the dry land of the Silurian period can still be distinguished from those made since. When the glaciers came they planed down the whole region of the upper Mississippi river, removing silurian strata 500 feet in thickness over hundreds of miles. The southwestern limit of the glacial drift action is the Missouri river from the 48th down to the 43d parallel of latitude. From the Missouri river to the Rocky Mountains, over a space varying from 300 to 500 miles in width, there is no drift. The motion of the glacial mass must have been along the line of least resistance; and towards this limiting line, the glacial scratchings in the northwest show that the glacial motion was southwest. There, then, on that limit, a river must have been formed to carry away the melting water from the glacier, and this limit was the Missouri river, and that was the river so formed. As the glaciers began to retire to the northeast, as long as the general slope of the plain was towards the glacial mass, successive rivers were marked out by it along the western face; and all have a parallism and are close to each other, and have short tributaries or parallel branches, if any. There are, besides minor streams, the James, Big Sioux, Des Moines, Iowa and Cedar rivers; and finally the Minnesota and Mississippi the last of the parallel rivers. After the lowest line of the continental valley was passed, the glacier would retire, so that the melting water would run directly from it, and thus we see the origin of the tributaries of the Mississippi on the east side.

This direction corresponds with that of the pre-glacial rivers, and it is probable that many of them were washed out and regained their old beds; such as the St. Croix, Chippewa and

Wisconsin rivers, and is confirmed by their appearance. From the foregoing we infer that the Wisconsin River was in the trough of what was formerly a far mightier stream; that the ancient river was not only greater in volume, but cut deeper into the bed through which it flowed; that this ancient bed is composed of the silurian or older rocks and is silted up many feet deep. Such are a few of the facts which geology lays before the scientific engineer to guide him in making his plans for water improvements. A knowledge of the old channels of our rivers would have prevented the folly of making a canal through the solid rock in order to avoid the falls of the Ohio at Louisville, instead of digging through the drift of the old channel of the river. Instead of probing with an iron rod every inch of the bed of the Mississippi before we can determine the practical depth at which firm rock may be reached, geology steps in and tells us it will be found at a depth of at least 60 to 100 feet through the sand, with two remarkable exceptions at the rapids, one at Keokuk, the other at Rock Island. These exceptions are readily accounted for, when we know that the whole valley of the Mississippi was covered with an extension of the Gulf since the glacial period as high up as Savannah or Dubuque. That the silt brought in by the Des Moines river in the one case, and the Iowa and Rock rivers in the other, during this period, filled up entirely the valley cut out by the great glacial river, and that when the land rose again the Mississippi could not at these points regain its old bed, so it had to cut a new one, which is not yet completed. There is no doubt that Lake Erie had formerly an outlet past Fort Wayne, Indiana, and down the Wabash valley, which indicates the natural course for water communication between the lake and the Ohio river.

From these general remarks which will be recognized as germane to my subject, I will now turn to its special consideration. The main features of the Wisconsin river are common to northwestern rivers. First, there is a high bluff on

each side of the river valley, from one to ten miles apart, and from 100 to 400 feet high, composed mainly of horizontally stratified rocks; and in the case of the Wisconsin, of Magnesian Limestone of the Silurian formation. The slopes, however, are often covered with earth and green grass. The sand feature is a level or nearly level terrace mainly composed of sand, though occasionally having a rich surface soil. This terrace is from 20 to 60 feet above the level of the water. It is never continuous throughout the valley on either side, and rarely of much extent but on one side at a time. It is probably the shallow part of an ancient water-course which once occupied the valley from bluff to bluff. It is now generally above overflow. The third feature is the bottom land of the river, generally overflowed at highest stages, and having the high bluff or terrace for its margin. This bottom contains many lakes and marshes, and is cut up by sloughs forming islands. These islands sometimes divide the main stream into nearly equal parts. The margins of these bottom lands are, in the natural state, generally wooded, and form the banks of the streams at moderate stages when the sand bars are covered. The fourth feature is the bed of the stream, which includes the part covered at medium stages, but large portions of which become dry sand or gravel bars at very low ones. There are thus four different prominent branches or levels in the river valley: 1. The level forming the main bluff. 2. The sand terrace generally above overflow. 3. The bottom land generally overflowed at highest water. 4. The bed of the stream. In 1867, a careful survey under direction of Gen. Warren was made of the Wisconsin river from Kilbourn City to its junction with the Mississippi river. A continuous transit line was carefully measured and staked off on one bank or the other of the main river, as was found most easy and all the topography sketched along it. The opposite shore was located by triangulation across. A careful line of levels was run, noting frequently the height of the bottom lands, or sand terrace when

near, the height of the water at the time, that of the last high water, and the most noted high or low water mark ascertained. Besides the parties who ran these main lines there were two subordinate compass parties who surveyed the minor channels making connections with the main line as often as possible, a cross section level party and a sounding party. The object of this survey was to determine the practicability of improving the river so as to form part of a line of communication by steamer from the Mississippi River by way of the Wisconsin River, Upper Fox, Lake Winnebago and Lower Fox River to Green Bay, and thence with the lakes. For this improvement Gen. Warren submitted three plans. 1. By means of a series of wing dams. etc., and the use of Long's scraper, so as to make it navigable for boats drawing three feet water. Estimate $428,000. 2. By use of natural channels in connection with side-canals of sufficient width and depth for steamboats drawing four feet water. Estimate, $3,207,000. 3. By means of a canal designed for steamboats drawing five feet water, built along the valley, alternating from one side of the river to the other, as circumstances demand, and using the natural bed of the river for crossings. Estimate, $4,164,000.

In 1871, Col. Houston, U. S. Engineer, was directed in accordance with these plans to improve the navigation of the river at those points where the proposed canal was to cross the river, and in doing so to determine the practicability of improving the river itself. The proposed canal starts from a point on the canal now connecting the Wisconsin and Fox rivers, near Portage City, where it connects by a lock with the river. The canal then commences on the opposite bank of the river and proceeds on the right bank to a point about 56½ miles below Portage, when it again connects with the river by a lock. Commencing again on the left bank opposite it proceeds to a point 88⅝ miles below Portage, when a similar crossing becomes necessary, and then proceeds on the right bank to Prairie du Chien, when it connects with the Missis-

sippi river. The depth of the proposed canal is for vessels drawing five feet, and the lengths of the river to be improved to enable boats navigating the canal to cross the river, are, at the upper crossing, 2,300 feet; at the middle crossing, 7,000 feet; and at the lower crossing, two and a half miles. There are two classes of obstructions. Those arising from causes not now operating and which once removed will not return, and those arising from causes now operating and which must be constantly recurring until the cause is removed. In this latter class we find sand the chief obstruction to the improvement of the Wisconsin river. What shall be done with it? This problem, John Nader, Assistant U. S. Engineer, under direction of the U. S. officer above named, has been endeavoring to solve, since July, 1871. He finds the sandbanks of the upper river the cause of the sandbars below Portage. That wherever the river is contracted between narrow banks, the sandbars will form only behind projections or obstructions, and in this case tend to improve rather than obstruct the channel; also occasionally, where the river is moderately wide, sandbars are found to have lodged on one side or the other (probably caused by some obstruction) and preserve a good channel; but where the stream is straight for some distance, and of considerable width, there will be formed a middle ground, with but little water over the same, and sometimes a dry bar; in either case the channel is on one side or the other, never on both. Where the middle ground is flattened out, and extends across the whole width of the river, one side of the bar advances more rapidly than the other, and the crest of the bar is formed obliquely across the river; the current generally flows at right angles with the line of the crest, and the width of the river is virtually nearly doubled in some cases; in nearly every case, deep water is found along the crest of the bar. The motion of the sandbars is quite regular, and depends not so much on the stage of the water as upon the rapidity of change from high to low, and upon the velocity of

the current. During a continuous stage of water, the movement is slow and regular, and the bars are moved along as an obstruction by the pressure rather than by the velocity of the water, rolling slowly and steadily along the bottom with no floating sand, until the equilibrium is disturbed. When moved by the velocity of the water, they move quite rapidly, and the sand is found floating in the water in quantities. He gives an instance of a bar above Steamboat Slough, containing a uniform depth of water of twenty-two inches at a certain stage of water. After the water had fallen twelve inches, the same amount was found; also subsequently when the river had risen again a little above its former stage, still the same amount of water covered the bar, clearly indicating the existence of equilibrium between the current and weight of sand. In order to determine the most favorable condition of equilibrium to preserve a good channel, a section was measured near Lone Rock, where the channel is quite uniform for several hundred feet, and the stream at low water is confined to one channel of 325 feet between banks; the greatest depth was 7.4 feet, and the mean depth six feet, giving the cross-section of 1,950 square feet; a series of floats gave a mean velocity of 1.95 miles per hour; the channel in question always preserves a uniform depth, and is free from sand-bars. As there are many similar places on the river, it will be safe to assume from these the necessary section for any required depth of water.

Aside from the sand bars, the only other obstruction to navigation are the railroad bridges and the principal difficulty with these is that they are built obliquely across the stream; the water is thereby inclined to flow to the bank at the down-stream end; whereas the draws of both the Spring Green and Lone Rock bridges are at the opposite or up-stream end; in addition to this the draw spans are very narrow; and still more contracted by the piles and protection of the pier-foundations, making the entire available width at low water about

36 feet only. The experimental improvement was made by building wing-dams at suitable points along the line to be improved. The plan adopted required only the use of brush, with sufficient stone to retain the same in places and the addition of gravel to prevent leaks under the brush. The brush was made in fascines of 11 feet long and 13 to 15 inches in diameter, securely bound. The fascines were then formed into mats of about 9 feet wide, by placing a number of fascines side by side, and placing light poles on top and bottom, and tying the ends of the poles with twine. Having determined the position of the dam with stakes driven into the sand, a sufficient number of mats were prepared as above stated, and a quantity of stone and sand bags being in readiness, the work was commenced. The mates were floated into position and sunk by placing stone and sand bags upon them. They were placed side by side in the line of the draw, and the bottom row carried to the entire required distance; the brush ends or tops were placed up stream, and after the first course was laid the tops were covered with a layer of gravel, to prevent undermining; and the remaining courses were carried up in the same manner; each course was brought forward from 2 to 4 feet in order to break the fall of the water. After the dam rose a little above low water, a substantial layer of loose brush was placed along the entire face of the dam, and covered with a layer of stone, and then with sufficient gravel to stop all leaks. The general effect of these dams was the usual effect of contractions; the water was elevated above the contracted part in some cases as much as six inches, but subsided again as the channel accomodated itself to the change. In the case of cross dams, a general movement of sand took place for some distance above, and to a considerable distance below the work; and as soon as the current was checked there was a deposit of sand in front of the dam in its whole length. As soon as the dams were brought to the surface, there was a rapid deposit of sand and below the same; that above was concave, and that

below convex to the axis of the stream. In connection with the work, observations were made of the movements of sand bars, and the effect of the work upon them. The movement at Portage was from 3 to 5 feet per day which seemed to be the average upon the river unless disturbances occured. At Dekorra the effect of dams caused a movement of from 7 to 14 feet in twenty-four hours, and at Lone Rock from 6 to 20 feet in twenty-fours hours. The bars moved along at this rate until reaching the dams, and then receded as rapidly and disappeared, the sand being deposited behind the dams. From the result of the work it would appear that it is only necessary to contract the stream proportionate to the required depth, everything else depending upon the stability of the dams, of which he has not the slightest doubt, as he considers the test which they withstood, when in an early stage of progress, the water poured over the same in an entire sheet, as much severer than any resulting from high water. Concerning the stability of the channel produced, the question arose as to whether high water with increased pressure and velocity would not continue excavating the same until banks and dams would slide in, and the channel become useless; this gave rise to an examination of the river where the same is confined to a narrow channel, so that its depth is from 6 to 8 feet at low water; at such places the bottom is found to be composed of coarser material and gives considerable resistance to the thrust of a pike; the bottom always remains the same excepting during the passage of a sand bar during a freshet.

For my own part I think the canal project by far the mos preferable. As the work will be principally excavation in sand and loam it can be done with proper machinery at a comparative small cost. When once completed it can be maintained at small cost. The banks as proposed will be above high-water mark in the river and consequently not be liable to damage from floods. No estimate need be made for feeders. The Wisconsin river will constitute a natural

feeder. The daily discharge of water in the Wisconsin at Portage City is 259,000,000 cubic feet; not less than 3,000 cubic feet per second. The total daily supply of water for the Erie canal of Pensylvania, enlarged with a prism greater in area than the one here proposed, is less than 20,000,000 cubic feet—about 231 cubic feet per second—not one-twelfth of the amount available in the Wisconsin, and yet the Erie canal, which is 136 1-2 miles in length, and has a lockage of 926 feet, has sufficient water to pass through the locks 144 boats per day, or to carry through the boating season 5,400,000 tons of freight. The Dalles, which is a gorge in the rock about 23 miles above Portage, reduces the river at one place 54 feet, so that the extreme of fluctuations from low to high water below the Dalles does not exceed 10 feet, and arrangements could be made, besides supplying the proposed canal, to turn only the desired quantity into the Portage canal and Fox river. Freight could be carried by this line for about one-fourth of what they can by railroad. In view of the great and increasing amount of grain annually shipped to the east from the west of the Mississippi, it should be constructed at the earliest practicable day.

THE STRENGTH OF MATERIALS AS APPLIED TO ENGINEERING.

BY JOHN NADER,
Assistant United States Engineer.

The subject herewith presented deserves, and in fact requires, particular attention.

It is not the intention to give tables and formulæ on the subject in question, but only to discuss the obscure, uncertain, and therefore unreliable, manner in which information is placed before the public, and, in such a manner as to call the attention of this and other scientific societies to this subject, in order that at sometime, and I hope not a distant day, something reliable may be obtained on the subject, either from existing data or from those obtained from special researches. Barlow and Hodgkinson appear to be the favorite authorities; but, if these authors have experimented on wood of which we have no knowledge, or if we have, cannot obtain or make use of, of what use is repetition of the record of their experiments?

In examining a set of tables on the strength of timber, what a useless lot of materials do we meet with, for instance, crab, elder, plum, willow and the like; and in passing to the useful, how are we not mistified by the simple word deal. This in its real sense means nothing more or less than the wood of the fir or pine, yet we find in most of these copied tables no less than four kinds of deal, the same number of firs, and also the same number of pines. The question now is, how is all this to be reduced to common sense or practice?

So far as other timbers are concerned, the matter is not quite but nearly as obscure as deal. This dealing out of spurious

matter cannot be too severely criticised, and the time must and will come, when such information will be accepted only from scientific organizations, where the same will have been thoroughly discussed before passing to the public.

In iron, the matter is not quite so bad. Iron being a valuable material, and a saving in weight of importance, so that an excess in any structure over and above that which was actually necessary, would be a very expensive as well as worse than useless application. This simple fact brought about a number of experiments by able and reliable men, some of whom made a specialty of the subject and deduced formulæ which are now in general use.

Some valuable and carefully calculated tables on the strength of columns were published in 1860, by Mr. G. P. Randall, in the Architects and Mechanics' Journal, and by Mr. Wm. Bryson, in the Journal of the Franklin Institute. Both were calculated from the formulæ of Prof. E. Hodgkinson. Mr. Randall assumes one-third of the breaking weight as the weight of perfect safety, and thereby makes no allowance for a misfit; and since a pillar imperfectly set is less than one-third the strength of one properly fitted, this fact should have been taken into account. Mr. Bryson, on the other hand, adopted one-tenth of the breaking weight as the weight of perfect safety, and carefully computes the minimum quantity of metal which will support the weight under the assumed conditions, and at the same time he is on the safe side in case of imperfect workmanship.

Quite recently an article comes from England which is not only at variance with previous data, but contrary to all accepted laws. The following is the article:

"STRENGTH OF IRON INCREASED BY STRAIN.—Some experiments recently made in England to ascertain the effects of strain on wrought iron, give results quite at variance with the supposed data of previous experiments, and are therefore worthy of attention. It is usually supposed that the effect of strain is to diminish the strength of iron, but if

these experiments are to be trusted, the contrary appears to be the case, and that very heavy strains, even to the extent of the breaking strain, and this even several times repeated, actually increases the strength of iron by every application. The result of several experiments are stated as follows on 'Iron':

"1st fracture, mean breaking strain of 33¼ tons; 2d fracture, 35¾ tons; 3d fracture, 37¼ tons; 4th fracture, 40⅙ tons; diff. 6$\frac{11}{12}$ 20 per cent.

"'These facts,' says the official report, 'appeared so important, and were so much opposed to the opinion of the best informed persons upon the subject, that in order to prove beyond all question that the increased strength was due to the repeated previous strains, and not to the diminished length of the bar, we considered it proper to make experiments upon this point.

"'We therefore took several bars of the same kind of iron, of the same diameter, but varying in length from ten inches to ten feet, and found they were all equally strong. It may be proper to state the circumstances which usually attend the fracture of iron bars, namely, that considerable heat is evolved at the breaking place, and that the diameter of the bar is everywhere reduced, but particularly so at the place of fracture; but it is worthy of remark that at the second and subsequent fractures of the bars, it generally happened that little or no heat was given out at the place of fracture, and that the general diameter of the bar was not again sensibly reduced, except in some instances, at the place of fracture.' The publication of these results in a government blue book is sure to attract general attention to this important question."

I should say it would.

All experimenters, without any exception, men who have made this problem their particular study report results in contradiction to the foregoing article. In reading the above, the question would occur to some, Who would think of testing a bar after the same was once broken or injured? But it seems that experimenters did think of it, and they did also faithfully report the results, and furthermore, they all agreed exactly upon this point, more so than upon many others. Their uniform reported results were: that the strain exceeding the limits of elasticity and producing permanent elongation, could not be borne for any considerable length of time. Yet it might be argued that the relaxation of the strain would have had some influence on the results. This, however, was also thought of by

Fairbairn, who made tests a little beyond the elastic limits, removed and reapplied the same weight a number of times, and ultimately produced fracture with a strain much less than that which would have done so if the first strain had been carefully and gradually increased.

From a common sense point of view alone, it would appear as though a bar of iron of uniform section would be permanently injured by a breaking strain, since at the moment of rupture the particles would be all uniformly strained and ruptured until the break occurred at some point of mechanical or other imperfection, the remaining portions would remain in their almost entirely ruptured condition. In my experiments on timber I found that the strain which produced a permanent set would break the same, and that a less weight applied for a longer time would also produce rupture if the specimen had been injured previously.

The heat evolved by tearing asunder a bar of iron is common to violence, and is the result of friction produced by the excursion of the molecules, simply denoting work done. The almost entire absence of heat in the subsequent fractures in the aforementioned experiments would go to show that the work had already been done. I have purposely dwelt upon this subject to invite inquiry, and have based my arguments not upon my own, but upon the knowledge of men who have been the leaders of special branches of science and industry. Another case more serious than the former frequently makes its appearance in lengthy articles; it is the effect of frost upon the strength of iron and steel. The subject is a comparatively new one, and has but very recently been seriously considered by scientific men.

Railway companies have been in the habit of attributing every accident in winter by broken rails or axles to the effect of the frost upon the metal. In some manner this led to investigations, and several have appeared who have attempted to refute the idea entirely, and who endeavor to prove that

frost, instead of weakening iron, on the contrary strengthens it. That this should be so, in respect to axles and rails in *extreme* cold, remains yet to be proven.

Papers on the subject have been read before several societies and associations, one of which I will here introduce and then discuss its merits.

"EFFECT OF FROST UPON IRON AND STEEL—(From 'Nature,').—From papers read before the Manchester Philosophical Society, Dr. Joule made experiments with iron and steel wires stretched through a freezing mixture, so as to be part within and part without. In every case tried the wire broke outside of the mixture, "showing that it was weaker at 50° Fah. than at 12°." Also further experiments on darning needles, supported on steel props 2½ inches apart and weights suspended from the middle. The average breaking weight of six needles at 55° Fah. was 58⅜ oz., and that of six at 12 degrees was 59⅝ oz. The next experiment was with cast iron "garden nails," 1¼ inches long and ⅛ inches thick; they were supported on props $1\frac{1}{16}$ asunder and a blunt-edged steel chisel weighted to 4 lbs. 2 oz. was let fall from a given height upon the middle of the nail. Twenty-one cold nails broke and twenty warm ones. "The general conclusion," says Dr. Joule is this: Frost does *not* make either iron (cast or wrought) or steel brittle, and accidents arise from the neglect of the companies to submit wheels, axles and all other parts of their rolling stock to a practical and sufficient test before using them. Mr. Spence also made experiments on cast iron bars of ½ inch square, supported on knife edges nine inches apart and suspended weights from the centre by means of a knife-edged hook to which was attached a scale pan. The average breaking weight of six bars at 60° Fah. was 4 cwt. 4 lbs. and of six bars at 0° Fah. was 4 cwt. 20 lbs." being an increase of 3½ per cent."

Further evidence to the same effect has been furnished by M. Caron of Paris, the result of whose observations on the fracture of car axles, have lately been laid before the Paris Academy of Sciences. He finds, in every case, that the break is due to the bad form of the pieces or the faulty nature of the iron; and denies that bar iron becomes crystalline and brittle under the influence of winter cold. This denial is based on the following experiments: Several pieces of good bar iron were exposed for four months in an ice factory, to temperature

varying from 0 to 19°. Others were allowed to remain throughout the cold of last winter, 1872 and 1873, exposed to a temperature of about 20° in the open air. The bars were broken, both in their cold state and after raising the temperature above 0. In no case was there any appearance of crystallization. Mr. Caron attributes the breaking of rails in winter to the greater shock to which they are subjected on the frozen ground and to inferior qualities of iron.

Should the publication from which I took my information be correct, neither Doctor Joule nor Mr. Spence have proven anything which I did not consider a fact, viz: that the specimens tested by the former were stronger at 12° Fah., than at 50°, or that the difference were uncertain, and that those tested by the latter showed as great, or a still greater difference than 3½ per cent. existed in bars of cast iron of 1-2 inch square. There is no doubt that a great many fractures of rails and axles occur from the faulty nature of the iron, but these occur at all seasons, and, as a general thing, it is difficult after a railway accident to say what broke first. All that I could discern in several cases was an indescribable wreck.

From my experience with various kinds of implements and machinery, I have every reason to believe that iron and steel become stronger under a moderate degree of frost to a steady strain, but that from a very moderate to an extreme degree of frost they are exceedingly more susceptible of fracture from impact than when not frozen. The latter is well known to every mechanic who endeavors in every way to guard against the results. I had hoped to make some experiments, and made some preparation for the purpose, but found that I would not be able to produce the same in time for the present meeting of the Academy. I will conclude by noticing a few special cases of application. The entire weight of a structure, such as a bridge or roof, together with its passive or accidental load, is borne by the points resting upon the walls or abutments, and the plates and bolsters, if of wood, receive the en-

tire strain in a direction perpendicular to their fibre; I have found that American white pine will not bear a strain greater than five hundred pounds per square inch under these conditions, and that even less than this will leave a permanent impression; no regard is however paid to this fact, and it is very common to find premature rot produced in wall plates, bolsters and chords of bridges, by a partial crushing of the timber. The same is also true with regard to the bearing of brace-blocks in bridges.

A similar fact came to my notice. It was that of an ice house. The ice, to the amount 200 tons, being packed on the second story, the entire floor was constructed to bear its proportional weight per square foot of the entire mass. The ice was packed and supported safely until towards the close of the first season, when the mass, by use and thawing, was reduced to less than one-half, when suddenly the center portion of the floor began to bend and finally to break, requiring a number of props for safety. Before the packing of the second season, additional joists were placed between the broken ones and a straining beam under all, and suspended at intervals of nine feet from trusses above; still, at about the same time as in the previous season, the centre interval broke. I was called into consultation and examined the case carefully. I found that, after admitting a loss of one-third the strength of the timber from moisture, the original floor should have safely supported the entire weight desired, provided the same had been uniformly distributed. This led me to re-examine the matter. I found that the ice, which was a solid mass, had melted beneath from the heat conducted by the zinc-covered floor and assumed a convex form, so that the center joist, which would break at sixteen tons, broke when overloaded, and its companions in turn, until the spherical segment in contact rested upon a sufficient number of joist to support it. This is not by any means a singular occurrence, but I doubt if the same has been taken into consideration by builders.

I would add a word with regard to obtaining coefficients and formulæ for computing the strength of materials. As a general thing, experiments are continued until fracture takes place, and a fractional part of the breaking weight is taken as the coefficient of safety. The specimens must also be of limited size in order that they may be broken by ordinary means. Hence the results would be doubtful in two respects: 1st. There would be a flexure not admissible in practice with even a fraction of the breaking weight. And, 2d. The specimens must necessarily be selected, and would differ from material used in practice. (These remarks are in reference to wooden beams.) Mr. Wm. Hearding in making experiments on the retaining power of large bolts in wood, found that the resistance to a transverse strain in very strong beams was materially different from accepted data. I would hence suggest, that in experiments the strain producing the extreme flexure admissible in practice be taken as the safe strain; it would then be possible to use specimens of large dimensions, even those used in practice, and also for comparison to subject some to a breaking strain. Parallel with the strength of materials is an accurate knowledge of the weight of all materials used in construction and especially in their applied form. Considering the subject in question one of great importance, I have determined to make the same a specialty and will convey the result of my investigations to the Academy as occasion may permit.

RAILWAY GAUGES.

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The great need of this country is cheap transportation. All sections would have railway facilities if they had the money or could borrow it at a reasonable rate of interest. As the narrow-gauge will do all the business of any section of the country with a much less bonded debt, it tends to give a better security to the bonds and stock of the roads, making a better sale for the same, and in that way furnishing many feeders to our present through lines which would not otherwise be constructed, and soon connecting lines so as to make new through lines of the three-feet gauge, north and south as well as east and west. Experience has shown that in very rough mountainous countries the narrow-gauge can be built for the transportation of ores, such as gold, silver, iron, copper and other minerals in bulk, before reduced, so as to collect the same at the various smelting works, with the coal, wood and fluxes used in their reduction and manufacture for about one-fifth the cost of such roads as the Erie, Pennsylvania Central, and Baltimore and Ohio; that in the broken rolling country, where most of our roads are located, the cost will be about one-half as much as that of present broad-gauge roads; and in the slightly undulating prairie country the cost will be about three fifths. As it is easier to raise $10,000 per mile than it is $30,000, in the same ratio is it easier to construct the narrow gauge than the broad gauge. Where the light business of a road would not justify the construction of a broad-gauge, or if one were constructed, the

high rates would rather retard than stimulate development, the construction of the narrow-gauge would offer good inducements to capitalists for investment and furnish cheap transportation for the people. Comparing the cost of operating the two gauges we find that the narrow-gauge coach, weight 12,000 pounds, carries, when full, 36 passengers, with a dead weight of 12,000 divided by 36=333 pounds per passenger, while the broad gauge coach, capacity 56 passengers, weighs an average of 19 tons, giving a dead weight of 38,000 divided by 56= 678 pounds, a difference of 345 pounds per head in favor of the narrow-gauge. But these coaches seldom run full, in which case the advantage will be still greater in favor of the latter. Suppose we have 38 passengers, two more than the small coach will accommodate, making it necessary to put on a second one. Here we will have two narrow-gauge coaches weighing 24,000 pounds, or 24,000 divided by 38=634 pounds per passenger, while by the broad-gauge we have 38,000 divided by 38=1,000 pounds dead weight per passenger or a difference of 366 pounds per head in favor of the narrow-gauge. Again, let us suppose that we have two narrow-gauge car loads, 72 passengers, or 16 more than can be accommodated by one broad-gauge coach, necessitating the use of a second one. The account will then stand as follows: two narrow-gauge coaches, 72 passengers, 24,000 divided by 72= 333 pounds per passenger; while by the broad-gauge it will be, two coaches 76,000 divided by 72=1,055 pounds per passenger, a difference of 722 pounds per passenger, or a total of 52,000 pounds, or over 26 tons' saving in dead weight in favor of the narrow-gauge in only two cars. The dead weight per passenger on roads in Massachusetts in 1870 was 1,250 to 2,782 in New York. In New York this was exclusive of baggage, with an average of 13 passengers per car. On a large majority of roads the average dead weight is much greater. The passenger coaches, then, on the New York roads, run about one-fourth full. Assuming that our broad-gauge rail-

ways average the same number (13) per car, we have the following table:

Kind of Traffic.	Gauge.	No. of Passengers per car.	Weight of car in pounds.	Total paying load in lbs.	Dead weight of passengers in pounds.	Gross load in pounds.
Passenger	Broad	13	38,000	1,950	2,923	39,950
	Narrow ...	13	12,009	1,950	923	13,950
			26,000		2,000	26,000

A difference of 26,000 lbs. or 13 tons, in favor of the narrow gauge, or 2,000 lbs. per head per passenger. Assuming the weight of the broad-gauge car to be only 15 tons, or 30,000 lbs., the difference in favor of the narrow-gauge cars will still be 18,000 lbs. or 1,384 lbs. per head for each passenger, as against 923 lbs. per head by the narrow-gauge. So much for passenger traffic; now let us see how the account stands with regard to freight. The average weight of the most recently constructed broad gauge cars is 20,000 lbs., capacity 20,000 lbs. The average weight of the southern broad-gauge cars is 18,500 lbs., capacity 16,000 lbs. But to make it as favorable as possible we will consider their weight to be 18,500 lbs., capacity 20,000.

Gauge.	Freight of box cars in lbs.	Capacity of box cars in lbs.
Broad	18,500	20,000
Narrow	8,000	16,000
		4,000

The average pounds of dead weight to one ton of paying freight carried on railways in Massachusetts and New York in 1870 was:

Massachusetts ..... 3,136 New York..... 3,109

By this we see that the railways of Massachusetts and New York average only about one-sixth of their capacity. The general average of our railways will fall far short of this, especially in the agricultural districts of the South, West and Northwest.

In transporting way-freight the narrow-gauge cars have still greater advantages as is shown by the following table:

Gauge.	No. of cars to carry Shipment.	TONS.										
		1	2	3	4	5	6	7	8	9	10	11
		DEAD WEIGHTS.										
Br'd	1	18,500	9,250	6,166	4,625	3,700	3,083	2,642	2,312	2,055	1,850	.....
"	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3,363
Narr.	1	8,000	4,000	2,666	2,000	1,600	1,333	1,142	1,000	.....	.....	.....
"	2	.....	.....	.....	.....	.....	.....	.....	.....	1,777	1,600	1,454
*	...	10,500	5,250	3,500	2,625	2,100	1,750	1,500	1,312	278	250	1,909

This table shows that if it is necessary to drop cars with 9 tons of freight, at a way-station—this being an amount which is one ton over a car load for the narrow guage, and which renders necessary the use of two cars at the utmost disadvantage—the dead weight is even then only 1,777 lbs. per ton, and still 278 lbs. less than the broad-gauge. As to wear and tear, if we assume that the repairs of machinery and rolling stock are in direct ratio to their cost, the reduction for the narrow-gauge would be about 50 per cent., which is the difference in the first cost. Narrow-gauge locomotives weigh from 6 to 18 tons, depending upon the nature of the service they have to perform. The following table gives the principal dimensions and weights of various patterns and sizes of narrow-gauge locomotives, together with the loads they will haul on a straight track in good condition:

*Difference in favor of narrow-guage.

DIMENSIONS, WEIGHTS AND LOADS OF NARROW-GAUGE LOCOMOTIVES.

Kind of Locomotive.	Cylinders.		Diameter of Driving Wheel.	Weight in Working Order.			Load in Gross, Cars and Lading.			
	Diameter.	Stroke.		Total.	On Drivers.	On each pair of Drivers.	On a Level.	On a 40 ft. grade.	On an 80 ft. grade.	On a 100 ft. grade.
Class 1. Four wheels, connected tank locomotive.	9	12	30	18,000	18,000	9,000	390	120	70	55
	9	16	36	22,000	22,000	11,000	490	150	85	70
	10	16	36 to 40	26,000	26,000	13,000	590	180	105	85
Class 2. Four wheels, connected with separate tender.	9	12	30	16,000	16,000	8,000	385	115	65	50
	9	16	36	20,000	20,000	10,000	480	140	75	60
	10	16	36 to 40	24,000	24,000	12,000	580	170	95	75
Class 3. Six wheels, connected tank locomotive.	10	16	36	28,000	28,000	9,333	615	185	105	85
	11	16	36	33,000	33,000	11,000	740	225	130	105
	12	16	36 to 40	38,000	38,000	12,666	860	265	150	125
Class 4. Six wheels, connected with separate tender.	10	16	36	25,000	25,000	8,333	505	175	95	75
	11	16	36	30,000	30,000	10,000	730	215	120	95
	12	16	36 to 40	35,000	35,000	11,666	850	255	140	115

As the weight on each wheel and the momentum with which the wheels strike irregularities in the track affect the "wear and tear," we give the following data for the two gauges:

WEIGHT ON WHEELS—THEIR MOMENTUM.

[Passenger trains—Speed 25 miles per hour.]

	Five Feet Gauge.		Three Feet Gauge.	
	Weight on single wheel Pounds.	Momentum. Pounds.	Weight on single wheel Pounds.	Momemtum. Pounds.
Engine driver.....	8,000	288,000	6,250	225,000
Engine truck.....	5,000	180,000	2,500	90,000
Tender	7,650	174,000	3,500	126,000
Baggage car	4,000	144,000	3,000	108,000
Passenger car	4,760	171,360	1,780	64,080

The ends of the rails are beaten to pieces, the surface abraded, the ties splintered, the fibre of the wood cut under the iron, weak joints rapidly made worse, so that each succeeding wheel falls with an increasing force upon the ends of the yielding rails by the tremendous forces developed by the passage of these enormous weights at high speed. The lightest broad-gauge coach weighs about 16 tons, or 32,000 lbs. empty, and hammers the rail joints with 4,000 lbs. on each wheel. When loaded and driven over the rails at 25 or 30 miles per hour, the weight of the blow is enormous and terribly destructive to the superstructure, crushing out the best rail in five or six years. The passenger car of a three-feet gauge would only hammer the rail with 1,500 lbs. per wheel. The same applies to locomotives. A 30-ton locomotive, and its loaded tender, weighing about 14 tons, or a total of 57 tons, will exert a pressure of nearly six tons on each driving wheel. When driven at a high speed, the strain upon the track is terribly destructive. The "Fairlie" engine, constructed for narrow-gauge lines, bears its whole load, including wood and water, on the driving

wheels, thus utilizing the whole weight in the work of hauling the train. Instead of an engine carrying 57 to 50 tons to obtain the power of 20 tons, we have an engine weighing 20 tons and no more; and this load distributed over eight wheels, with a pressure of 2 1-2 tons per wheel, instead of 6 tons, as with the broad-gauge. The action upon the rolling stock is the same as upon the track. The wheel receives a blow of precisely the same weight as that administered to the rail at a low joint, and the shock is transmitted to the axles except what is taken up by the springs and the yielding of the parts of the whole structure of the engine or car. The saving of dead weight is so much saved from the grand total of this destructive agency; and by the reduced weight upon each wheel, no single blow of such enormous forces can be given on the narrow gauge.

Can narrow-gauge locomotives be constructed of sufficient power and speed to answer the general requirements? They can, as daily experience testifies. The locomotives of the Denver and Rio Grande Railway, freight and passenger, are giving entire satisfaction both as to speed and power. By adopting the proper form of construction, the engines can have sufficient power to handle any number of cars that can be prudently and economically run together in one train, and such a train can be handled with as much safety as on the broad-gauge; while the proportion of dead weight being much less, the same number of train men will handle more tons of paying freight, when worked up to the same tonnage. There is no difficulty in making as fast time as the great majority of the broad-gauge roads make, which is all the public demands.

The first class narrow-gauge coaches on the Denver and Rio Grande Railway are 40 ft. long over all, 7 ft. wide inside, 7 ft. 6 in. high, with two 4-wheel trucks, wheels 24 in. in diameter, weight 12,000 lbs. and carry 36 passengers. The sills are only 27 in. above the rails, making the center of gravity very low; hence the cars ride exceedingly steady and with less lateral or oscillating motion than is usually observable upon the broad-

gauge. The seats are arranged, double on one side and single on the other, one-half the length of the car having the double seat on the right, and the other half having them on the left, so as to distribute the weight equally. The single seats are 19 in. wide or long; the double, 36 in.; the aisle 17 in. If found desirable the width of the car can be increased to 8 ft., making the single seat 22 in., the double, 39 in., and the aisle 23 in. These cars, finished in the best style, furnish every comfort of a first-class coach. Sleeping coaches with a single berth on each side, can be constructed so as to be as comfortable as those now in use.

The freight cars of the Denver and Rio Grande Railway carry 9 of the largest cattle in a car weighing less than 8,000 lbs., while the broad-gauge cars carry only 14 of the same class in a car weighing from 18,000 lbs. to 20,000 lbs. The stock cars have 4-wheeled trucks, are 24 feet long, the door being at the side, but near the end instead of the center, and on the opposite side of the other end. For heavy and valuable cattle, they have two gates in the car (which when not in use are folded back against the side of the car), which makes three rooms 6x8ft., into which they put three head of stock, each, giving a space of 2x8ft. to each head. The broad-gauge puts 14 head of the same cattle into a 28ft. car, which gives the Denver and Rio Grande and other narrow-gauge cars the same floor room that the broad-gauge cars, have and with much less dead weight.

COMPARATIVE DEAD WEIGHT IN THE TRANSPORTATION OF CATTLE BY THE TWO GAUGES.

Gauge.	Weight of cars in lbs.	No. cattle per car.	Weight of cattle in lbs.	Gross weight of loaded cars.	Total weight per head.
Broad	18,000	14	19,600	37,600	1,285
Narrow	8,000	9	12,600	20,600	888
Dead weight in favor of narrow gauge					397

A difference of 397 lbs. per head, 3,573 lbs. per car load of 9 head, and, in a train of 20 cars, 71,460 lbs. or 35 tons in favor of the narrow-gauge. As so many are not put together in the latter, the danger of the cattle getting down is much less, while they can be fed and attended to much better.

COMPARATIVE COST OF TRANSPORTATION.

The average cost of transporting freight by the broad-gauge may be estimated at 1 1-2 cents per ton per mile, and on the narrow-gauge one cent. Estimating the cotton crop of the south at 4,000,000 bales, transported on an average 200 miles, the narrow-gauge would effect a saving of $4,000,000 per annum to the producers; a sum sufficient to build 400 miles of narrow-gauge railway at $10,000 per mile. The East India Company, looking to the extension of the cotton culture in their territory, have projected 10,000 miles of narrow-gauge railway, and that, too, in a country far more densely populated than ours, and offering a large general business. They are, besides, changing their broad to narrow-gauge. Break of gauge is an evil, but not so great as generally supposed. The time of transferring freight need be very little, if any, greater than is now necessarily consumed in the inspection and repair of cars at intermediate points, which are sent over long lines. In Great Britain the cost of transferring freight is about 2 pence per ton. In Canada 5 cents per ton. The cost will be heaviest upon through freight, which has to be changed at each end of a line, at a cost of 5 cents per ton, or a charge of 10 cents per ton total. As the average cost of transporting freight by the broad-gauge is 1 1-2 cents, one ton transported 200 miles would cost $3.00. But, as is seen by the following table, there is a saving of 25 per cent. in actual working expenses. A saving of 25 per cent. on $3.00 would be 75 cents, so that an expense of 10 cents per ton may be incurred in transferring freight, and still leave a balance in favor of the narrow-gauge, or shipper, of 65 cents per ton, $6.50 per car load of 10 tons, or $162.50 for a train of 25 cars.

CLASSIFICATION OF EXPENSES.

	Per-centage of whole operating expenses.	Per-centage saved by Nar. Gauge.
MAINTENANCE OF ROADWAY—		
Repairs road-beds	.166	.055
Cost of iron for renewals	.129	.065
Repairs, building fences, etc.	.037	.....
Taxes	.038	.....
Repairs of machinery and cars	.20	.070
OPERATING—		
Office expenses, agencies and employes on trains and at stations	.123	.....
Fuel, oil and waste	.125	.041
Loss and damages to goods and persons	.....	.....
General superintendence, etc.	.030	.....
Contingencies	.052	.017
Total	.....	.248

In Norway, railways of the 4 ft. 8½ in. and of the 3 ft. 6 in. gauges have been constructed by the same engineers, and worked by the same manager for the government, and the following is the result of six years' experience:

	Gauge, 4 ft. 8½in.	Gauge, 3 ft. 6 in.	Difference in favor of Narrow Gauge.
Cost of construction per mile	$26,343	$17,143	$9,200
Receipts per mile (alike)	27,600	27,600	.....
Maintenance per mile	7,173	6,555	608
Locomotive expenses per mile	9,426	5,760	3,666

Mr. Millington, Chief Engineer of the Memphis and Knoxville Railroad, has made a careful estimate of the comparative cost of building 30 miles of the track extending from Memphis to Macon, with 3 feet and 5 feet gauges. The surface of the country is undulating,—in places rolling and bro-

ken, but with no serious obstacle to the construction of a first-class road at the average cost per mile of Southern roads. No gradients steeper than 66 feet per mile, and this only for short distances. No curves less than 1,146 feet radius, and none of this radius on steeper grades than 46 feet per mile. Grading all earthwork and easy to handle. The average haul about 400 feet. One girder-bridge of three 50 feet spans. The piers, piling. In consequence of the soil being very liable to wash during heavy rains, piling is used in preference to trestling, for which safe foundations would in some places be difficult to obtain. Weight of rail, 30 lbs. per yard for narrow-gauge, and 60 lbs. for broad-gauge.

GAUGE, FIVE FEET.

COST OF ROADBED.

664	stations, clearing and grubbing, at $9.00 per station		$5,976 00	.....
461,150	cubic yards earth excavation, at 30 cents per cubic yard		138,345 00	.....
150	lineal feet girder bridge, $12.00 per lineal foot		1,800 00	.....
5,665	lineal feet piling and trestling, at $7.50 per lineal foot		42,412 50	.....
41,520	cubic feet timber, log culverts, 3½ cents per cubic foot		1,453 20	.....
36,950	cubic feet timber in cattle-guards, roads, etc, at 3 cents per cubic foot		1,108 50	.....
9,860	feet, board measure, plank in ditto, at 3 cents per foot, board measure		295 80	.....
	Laying 30 miles of track, at $500 per mile		15,000 00	.....
			$206,391 00	
79,200	cross-ties, at 40 cents each	$31,680 00	.....	.....
	Engineering, right of way, salaries, office expenses, stationery, incidentals..	10,000 00	.....	.....
			41,680 00	.....
				$248,071 00

COST OF SUPERSTRUCTURE.

3,168	tons of rails (60 lbs. per yard), at $90.00 per ton	$285,120 00	.....
12,000	joint fastenings, at $1.00 each	12,000 00	.....
165,000	pounds spikes, at 5 cents per pound	8,250 00	.....
			$305,370 00
	Total for roadbed and superstructure	.....	$553,441 00

Cost per mile for road-bed	$8,269 00
Cost per mile for superstructure	10,179 00
Cost per mile for roadbed and superstructure	$18,448 00

THREE-FEET GAUGE.

COST OF ROADBED.

589	stations, clearing and grubbing, at $9.00 per station	$5,361 00	.....
244,200	cubic yards earth excavation, at 30 cts. per cubic yard	73,260 00	.....
150	lineal feet girder bridge, at $12 per lineal foot	1,800 00	.....
5,655	lineal feet piling and trestling at $6 per lineal foot	33,930 00	.....
29,580	cubic feet timber, in log culverts, at 33 cents per cubic foot	887 40	.....
23,400	cubic feet timber in cattle-yards and road-crossings at 3 cts per cubic foot	702 00	.....
6,020	feet, board measure, planks in ditto, at 3 cents per foot, board measure	198 00	.....
	laying thirty miles of track at $375 per mile	11,250 00	.....
		$127,329 00	
79,200	cross-ties at 30 cents each... $23,760	.....	.....
	engineering, right of way, salaries, office expenses, stationery and incidentals 10,000		
		33,760 00	.....
			$161,089 00

COST OE SUPERSTRUCTURE.

1,584	tons of rails (30 lbs per yard), at $95 per ton	$150,480 00	.....
10,500	joints fastenings at 80 cents each	8,400 00	.....
105,609	pounds spikes at 6 cents per lb	6,336 00	.....
			$165,216 00
	Total for roadbed and superstructure		$326,305 00
	Cost per mile for road-bed		$5,369 63
	Cost per mile for superstructure		5,507 20
	Total cost per mile for road-bed and superstructure.		$10,876 83

RECAPITULATION.

Distance.	Gauge.	Cost of preparing road-bed for rails	Cost of superstructure.	Cost of road-bed and superstructure.	Cost per Mile.		
					Road-bed.	Superstructure.	Total.
M	F.						
30	5	$248,071 00	$305,370 00	$553,441 00	$8,269 00	$10,179 00	$18,448 00
30	3	161,089 00	165,216 00	326,305 00	5,369 63	5,507 20	10,876 83
*	..	$86,982 00	$140,154 00	$227,136 00	$2,899 37	$4,671 80	$7,571 17

Making a saving in favor of the narrow-gauge on the cost of preparing the road bed, 35 per cent.; on the cost of superstructure, 46 per cent.; on the roadbed and superstructure, 41 per cent. We have the following estimates of cost of two Canada roads, guage 3 ft. 6 in.:

TORONTO, GRAY AND BOUCE.

Western Junction to Orangeville, 41 Miles.

	Total.	Per mile.
Grading, fencing, ties, bridges and culverts	$196,595	$4,795
Rails and fastenings	181,015	4,415
Track-laying and ballasting	67,770	1,653
Station buildings	24,407	595
Right of way	24,600	600
Telegraph	1,640	40
Engineering	23,370	570
Commissions, officers, directors' fees, etc	15,469	377
Law expenses	3,936	96
Sundries	2,000	49
	$540,802	$13,190
Rolling stock	105,960	2,560
Total cost	$646,762	$15,750

* Difference in favor of narrow-gauge.

TORONTO AND NEPISSING.

Scarboro Junction to Uxbridge, 32 Miles.

	Total.	Per mile.
Grading, fencing, ties, bridges and culverts	$151,307	$4,725
Rails and fastenings	139,041	4,345
Track-laying and ballasting	46,696	1,460
Station building	15,012	470
Right of way	22,092	690
Telegraph	1,500	47
Engineering	14,110	441
Commissions, officers and directors' fees	10,292	321
Law expenses	936	30
Sundries	615	20
	$401,601	$12,549
Rolling stock	101,588	3,175
Total cost	$503,189	$15,724

By which we see that the Toronto, Gray and Bouce Railway has cost $13,190 per mile, exclusive of rolling-stock; and including rolling-stock $15,750 per mile. The earthwork averages 10,500 cubic yards per mile. The line is fenced throughout, at a cost of $800 per mile. The grubbing amounts to an average of one-half an acre per mile; the clearing to three acres per mile; slashing on each side of the railway to the entent of four acres per mile has also been done, the grubbing, clearing and slashing having together cost $140 per mile. The ties have cost an average of 25 cents or $500.

The Toronto and Nepissing Railway has cost $12,549 per mile, exclusive of rolling stock, or including rolling-stock, $15,724 per mile. The earth-work has averaged 9,750 cubic yards per mile. The line is fenced throughout at a cost of $700 per mile. The ties have cost $480 per mile on this section, and the grubbing, clearing and slashing, $140 per mile.

Upon the authority of Col. W. W. Nevin, who is connected with the management of the Mexico National Railway

Company, I give the following statistics in regard to Narrow-Gauge.

IN THE UNITED STATES.

Name.	Miles Built.	Total Length.
Denver and Rio Grande	156	870
Cairo and St. Louis	92	150
Utah Northern	70	160
Kansas Central	65	560
Arkansas Central	64	150
Colorado Central (N. G. Division)	42	237
North and South of Georgia	35	130
Montrose	27	27
Ripley	26	36
At Johnston (private)	25	25
Cherokee, Alabama	23	45
Iowa, Eastern	20	183
Milwaukee and Des Moines	20	380
American Fork (Utah)	18	22
Peoche (Nevada	18	18
Central Valley	12	12
East Broadtop	12	30
Mineral Range, Michigan	12½	100
Wasatch and Jordan Valley	12	16
Pittsburgh and Cattle Shannon	8	8
Bell's Gap	8½	40
Peekskill Valley	7	7
Summit County, Utah	8½	30
Tuskegee	5½	30
Louisville, Harrod's Creek and Westport	5	28
Painesville and Youngstown	12	65
Baltimore, Swan Lake and Lowsontown	6½	6½
Peachbottom	5	60
Bingham Cannon and Salt Lake	20	20
Ceredo Mineral, W. Va	12	20
Cheraw and Salisbury	11	80
Lawrence and Evergreen	5	5
Echo and Coalville, Utah	9	9
Natchez, Jackson and Columbus	6	260
Galena and Southern Wisconsin	30	150
	908½	3,889½
The following were to have completed additional mileage by January, 1874:		
Cairo and St. Louis	52	.....
Des Moines and Minnesota	17	.....
Parker's Landing and Kansas City	18	.....
	1,007½	

IN THE CANADAS.

Name.	Miles. built.	Total length
Toronto, Gray and Bouce	199	200
Toronto and Mississippi	87	218
New Brunswick	70	170
Prince Edward's Island	90	203
	446	791

The following list is given of

ROADS ACTUALLY UNDER CONSTRUCTION.

Name.	Under construction.	Total. length.
Florida, Memphis and Columbia	120	260
Lexington, Lake and Gulf	170	170
Wyandotte, Kansas City and Northwestern	50	250
Cairo and Tennessee River (under construction in Duck River Valley, Ala.)	75	100
South Branch (W. Va.)	26	51
Cheraw and Salisbury	15	80
Nashville and Vicksburg	26	470
Bambridge, Cuthbert and Columbus	20	140
California Central	150	465
Des Moines and Sioux City	20	180
Salt Lake, Sevier Valley and Pioche	25	300
Alameda, Oakland and Piedmont	60	60
St. Louis and Manchester	8½	30
Juan, San Pete and Sevier	10	75
Washington, St. Louis and Cincinnati	65	950
Greenville and Paint Rock	5	22
Stockton and Ione (California)	36	36
St. Louis and Western	100	315
Denver and Rio Grande ..... miles graded.	50	.....
Utah Northern ..... do	90	.....
Arkansas Central ..... do	86	.....
North and South of Georgia ..... do	60	.....
Summit County (Utah) ..... do	3½	.....
Peachbottom ..... do	45	.....
Ceredo Mineral (W. Virginia) ..... do	6	.....
Natchez, Jackson and Columbus ..... do	14	.....

The following

PROJECTED ROADS

Are organized and more or less under way:

North Pacific Coast	250
Big Sandy Valley	137
People's Narrow Gauge, of Iowa	170
Minneapolis, Rochester and La Crescent	140
St. Louis and St. Charles	14
Holly Springs, Brownsville and Ohio (being graded)	..
Long Island Narrow Gauge	..
Toledo and Maumee	..
Northern and Southern Narrow Gauge, N. C.	..
St. Louis and Florissant	16
The South Park Railway, Col	260
Tennessee Central	..
Memphis and Raleigh	..

From which we see that the total length of projected narrow-gauge roads in the United States is 3,889 1-2 miles, and in the Canadas 791, making a total of 4,680 1-2. Of this there are completed 1,354 1-2 miles; 908 1-2 in the United States, and 446 in Canada.

Wherever the narrow-gauge has been adopted it has proven a success—in Norway, Sweden, Denmark, Russia, India, Great Britain, Canada, United States and other places. Costing about one-half as much as the broad-gauge, many sections of the country now waiting for railway facilities for development can afford to build them at once, and thus prepare a market for their produce. Their first cost being small, their operating expenses and maintenance light, they will prove paying investments in almost any part of this country. For the reasons enumerated, I would recommend the narrow-gauge of three feet for general adoption.

DEPARTMENT OF LETTERS.

ON SEVERAL POINTS IN THE PRONUNCIATION OF LATIN AND GREEK.

BY S. S. HALDEMAN,

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Modern facilities for travel have had the effect of bringing the people of different countries together to such an extent that an opinion has been developed in favor of pronouncing names and quotations in the native mode, in some cases even when they contain sounds which do not occur in English, and the study of philology is gradually showing that language is amenable to the laws of speech, and not to the conventionalities of spelling.

Loose views about "English analogies" have resulted in much false science. By a true English "analogy," that is, by a law of English speech, pure or hard *gay* cannot occur before "soft" *dzhee* or *jay;* in genuine English speech, therefore, there can be no lug-jer for *lugger*, no beg-jar for *beggar*, nor words like *exag-jerate* and *sug-jest.* When we introduce a foreign word which corresponds with an English syllable, it is consistent with analogy to preserve the sound, as the syllable *key* in *musquito* and *quinine* (kee-neen—which is by some supposed to have the initial syllable of *quiet*), *lee* in *Liebig* and *rin* in *rinderpest.* A Latin analogy appears in the initial of *wine*, *wind*, *wit*, *worm*, and a French one in *veal*, *vile*, *victual*, *vagrant*, and even in *vacuum*, whose initial we pronounce with *vee* and

not with Latin *way*. Some Latin words or parts of words occur in English, as *ŏbēy, core, marine, genteel*—which is an older word than *gentile*, having preserved the Latin vowel which *gentile* has lost.

Most of our grammarians being grammatolaters or letter-worshippers, who determine vowels by the eye and not by the ear, they have given currency to several important errors. They tell us that 'the vowel of *not* is long in *note*,' when in fact *naught* is the lengthened form of *not*, and it requires more time to pronounce *know* with its single consonant than *note* or *not* with two consonants, for *note* and *obey* have a short *o*, which is long in *owe, lo*, and *own*. The long vowel of *may* shortens in *mate*, which is neither *met* nor *mat*. *Feet* and *fit* are equally short, with distinct vowels, and the rare vowel of *fat*, which is unknown to normal German, French and Italian, has no relation to that of *far*, but is akin to that of *met*.

Overlooking such facts, some who reject the English pronunciation of Latin fall into the error of giving the vowels of *hat, hit, hot, hut*, as Latin and Greek sounds. An English scholar once objected to a speaker for saying λόγος, because he supposed the vowels to be pronounced long, but the speaker made them very short—as short as in *o-mit*. When a Latin or Greek vowel varies in length, it does not change in quality, that is, it does not become a different vowel. Independently of its final, *lōcūsta* must be pronounced like *lŏcŭs*, except that it must occupy twice the time in utterance, and the *ŏ* of *lŏcŭs* must be placed in *hŏnŏr*, *hŏmo* (genitive *hŏminis*,) chŏrus, Greek χορός, which rhymes with mŏrŏse (Latin mōrōsŭs.)

The erroneous assertion has been made that in syllables termed long by position, the quantity is short. Latin, like Italian and Arabic, has doubled consonants, as in *pēnna, stēlla*, in which each consonant must be pronounced as in *un-natural*, which gives length, whether the vowel is naturally short or long. The principal vowel is naturally long in *lūx, lūcĕo, lūcĭfĕr, lūnă; fĕrōx, fĕrōcĭtās; frīgĕo, frīxī*. The short

vowel of *vĕho* may continue short in *vēxī*, *vēcto*; but this is difficult to determine, because *ĕ*, of *rĕgo*, *rĕgĭmĕn* is long in *rēgālĭs*, *rēgīnă*, and perhaps in *rēx*. In Greek ὤχρα (ochre) we have length by nature and position, and in ὄχλος (a crowd) the syllable is lengthened by two continuous consonants.

Those who pronounce the first syllable of the Greek υἱός (son) like English *hwee*, convert υ into a consonant, instead of keeping it strictly to its vowel power of French or German ü, and subjecting the ι to modification, for as two vowels cannot make a single syllable, one (usually the latter) must become a liquid consonant of the lip or throat series. A German cannot pronounce such an English form as hwee-ós, although he can pronounce every letter of the Greek word, which in his alphabet is hüjós. To sap *hwee-os* instead of this, is like saying *why* for *high*.

The initial vowel of Greek and Latin diphthongs does not vary from its ordinary sound, so that if Latin *o* is German and English *o*, the dipthong œ is nearer to English *oi* in *going* than to that of *loiter*; and Greek αι (with ε of *end*) should not be confounded with *ai*. Greek ου became the Latin vowel u (in *fool*) at an early period, but it is properly a diphthong beginning with *o*, which shows the relation between βοῦς and the Latin genitive *bŏvĭs* where the middle consonant is English *w*. Compare the double forms *sīlvă and sīlŭă*, *mīlvŭs and mīlŭŭs*.

As the Latin angular letter v is now rounded when it stands for the vowel u (oo), and as the letter q (coo) was introduced to show the consonant nature of the next element, qv should be printed instead of qu, the power being that of English *kw*. Some words in the derived modern languages have lost the liquid sound, leaving such forms as French *qui*, Italian *chi*, and Spanish *quien*, which have led some to believe that the Romans said 'aca' for *aqva*, and 'cando' for *qvando*. Even granting that some Romans may have pronounced thus, the liquid must have had an existence in normal Latin, because

such originals as 'cando' could not have produced the Spanish words *cuando*, *cuantidad*, *cuarta*, *cuestion* (formerly '*question*'; nor could 'aca' have produced Italian *acqua*, Spanish *agua*, Rhætian *aua*, *ava*, and Wallachian *apĕ*.

In conclusion, an opinion may be given, that as *di*-phthong means *two* sounds, it is possible to separate such, as in οἴω and ὀΐω (to suppose), and we find the monosyllable κλείς beside its cognate dissyllable κλῄς. But if the power of ει or οι is that of ι, as in Ellenic (modern Greek), no division can be made, because a vowel cannot be separated into two sounds, and diæresis has not the power to "separate" the English word *be* into *by*, *boy*, or *bo-i*.

THE ETYMOLOGY OF "CHURCH."

BY J. B. FEULING, PH. D.

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It is commonly assumed that *κυριακόν* is the orignal of "Church," but not universally admitted. Before considering the etymology of our word, let us first note some of its forms in English and the more important cognate dialects. In O. E. we have *chirche*, *chireche*, *churiche*, chiric-(lond), etc.; in A. S. (Low German), *cyrice*, *cirice*, *circe*. The *a* of *cyriac*, which I remember of seeing, but where I saw it I cannot now recall, crept in to connect it with kyriakon. The O. H. G. form is *chirihha*, *chilihha*. It is probable that *chiriihha=chirjihha*, found in Isidor, arose for a similar reason as *cyriac*. The *Old Danish* or *Old Northern* form is *kirkia*, which was introduced along with the gospel by missionaries, especially from England, from the IX to the beginning of the XI century. The first impulse had been given by the Frieslander Liudger, and the real "Apostle of the North," Anskar, had acted as the head of a school at Corvey, in Westphalia, on the banks of the Weser, and preached among the natives before he set out for the Scandinavian kingdoms. Among the *Slavonian* races we should expect to find a word directly derived from the Greek, as the first lasting success was gained by Cyril and Methodius, who were monks of the Greek communion and in intercourse with Rome. In the documents referring to their missionary labours "*ecclesia*" alone occurs. But the Slavonian words for church (*Cyrkew*, *Cerkiew*, *etc.*), are evidently connected with the parent of *chirihha*, which indicates the far reaching influence of the Teutonic spirit. Lipsius was the first who rejected the derivation from *κυριακόν*: "Credo

et a circo kirck nostrum esse, quia veterum templa instar circi rotunda." He was followed by J. Grimm who, in his G. Gr., proposed likewise *circus* (circulus), which is found very early under the form of *chirih* and *chirch;* in his preface to E. Schulze's Goth. Glossar (p. XI), he proposed the Gothic *kelikn*=ἀνώγαιον, the upper floor of a house (πύργος), in which he sees the Alemannic *chilicha*=templum, "as the oldest churches were not without spires." The *kelikn*, he says, would be an allied word to the Albanian κουλλε, Lith. *Koras* or *Koryczia*, which come very near the Anglo-Saxon and Old High German words. But in the German Dictionary, edited by Hildebrand, Vol. V, he abandons these etymologies and returns to κυριακόν, still not without objections. First he mentions the change in the grammatical gender; but it has been shown that Latin (Greek) neutra become feminine, not only in the Romanic, but also in the Germanic dialects. Another, more important difficulty lies in the loss of *a*, which could not be accounted for. Still the difficulty of which the derivation from κυριακόν presents, is little compared with the difficulty of wanting historical probability. We must be able to answer, how did the Germanic nations receive the word, or how did it happen, that they agree in this one word with the Greek church, but differ from the Latin church, which held sway among them in all other respects? From Rome they ought to have received *ecclesia*, perhaps *basilica*, as the Latin nations: French, *église* (iglise, esglise); Prov., *gleisa;* Italian, *chiesa;* Spanish, *iglesia;* Port., *igreja;* only in Roumansch, *baselgia* and Wall., *biseric* i. e. basilica. But *chilihha*, *cyrice*, etc., must have been rooted so deeply among the Germanic nations, when they came under the influence of the Latin church-language, that it could no longer be supplanted by the word *ecclesia*. It must have become a national word, which, like the Germanic *Ostara*, could not be dispossessed by *pascha* of the Latin church. Now if we stop at the etymology of *church* as is generally adopted, Philology cannot inform us, how the

Germanic nations came into possession of this word, but Ecclesiastical History alone. Of the attempts to account for the introduction of "*church*," if derived from *κυριακόν*, I mention the most important. Cf. Grimm's German Dictionary, Vol. V., 791 seqq., and Smith's Bible Dict. I, 452.

Jacobson, in his Church History, is of the opinion that this word had been introduced into Germany by British missionaries, either by the Anglo-Saxon Winfrith, or by the missionaries who had come before him from Brittany, who were however *Celts*. The Anglo-Saxons never came in direct contact with the Greek church; only an indirect contact may have taken place through the Celts of Brittany, who must have received their first missionaries from Asia Minor or from Gaul, where the churches at Lugdunum and Vienna had been planted by missionaries from Asia Minor. But this theory is not supported by the fact, that the Celts themselves have only Latin words: Ir. *teampall, domhnach;* Kymr. *teml;* Gael. *eaglais, eglwys*, Bret *ilis, llis*, i. e. ecclesia. In the Kymr. law of the 10. century we find *ecluys*, Old Cornish, *eglos.** The introduction of the word into Germany by Winfrith, as mentioned above, is impossible, since we find, before his appearance in Germany, names of places compounded with it, e. g. in Alsace (a. 718) *Chiricunvillare*, a. o. For similar names of places in England see Taylor's "Words and Places."

The Greek influence can have made its way only from the south, and a considerable time before the mastery of the Latin church. But Ecclesiastical History is silent about such a far reaching Greek influence. Still it might have come from the lower Danube, where some Goths had been brought to the knowledge of Christ by Greek missionaries from Constantinople, since the 3d century; or from the river Rhone, across the upper Rhine. The Bishop of Lyons, Irenaeus, a Greek of the

*Roman influence, however, had entered into England, even before the landing of Roman missionaries, for Ninias, the apostle of the southern Picts, had been educated at Rome, and died early in the fifth century.

2d century, speaks already of "*αἱ ἐν Γερμανίαις ἱδρυμέναι ἐκκλησίαι.*" Mark here the term *ἐκκλησίαι*, as also the fact that in Gothic we find only *aikklesjo* and *gudhus* (*ἱερόν*).

Max Müller's theory that our word "*church*" was brought "by the Christian missionaries and priests, from the time of St. Augustine's landing in 597 to the time of Alfred," remains unproved. The passage in which *Κυριακόν* is used in the sense of church, according to M. Müller, is found in the canon of the Sixth Council, which prescribes: "*ὅτι οὐ δεῖ ἐν τοῖς Κυριακοῖς, ἢ ἐν ταῖς ἐκκλησίαις τὰς λεγομένας ἀγαπὰς ποιεῖν.*" Zonaras, of the 12th century, in commenting on the passage, says that the name of *Κυριακόν* is frequently found in the sense of a church, although only this canon directly distinguishes *ἐκκλησία* and *Κυριακόν*, "but I think," he adds, that the *ἤ* is not there used disjunctively, but by way of explanation." See Wedgwood's Etymol. Dict. The fact, however, that in the canons of the first four councils *Κυριακόν* is never used, but *ἐκκλησία* (the same word occurs in all the other documents, both Greek and Latin, which I had the opportunity to consult), and that Modern Greek has no word for church derived from *Κυριακόν*, seems to indicate that *ἤ* in the passage quoted by M. Müller is used disjunctively. On considering again this passage of the 6th council, I think that *ἐν τοῖς Κυριακοῖς* refers to the Lord's Supper and *ἀγαπάς* to the entertainment in which the poorer members of the church partook, furnished by the richer members. This canon would prescribe, therefore, that such entertainments should not take place either in connection with the Lord's Supper, or in the church. I venture further to conclude, although I had not the opportunity to examine the passages where it is said to occur, that wherever in the Canons *Κυριακόν* (sc. *δεῖπνον*) is found, it refers to the Eucharist.

Trench ('On the Study of Words' p. 101) says: The passage most illustrative of the parentage of the word is from Walafrid Strabo, abbot of Reichenau 842–849, who writes

thus: "Sicut domus Dei Basilica, i. e., Regia a Rege, sic etiam Kyrica, i. e., Dominica, a Domino nuncapatur."* But this assertion of the 9th centuary does not prove more than the same assertion of the 19th century. In Fitzedward Hall's "Recent Exemplifications, etc." I noticed that he tried to derive 'church' from 'ecclesia'; but I could not procure his article to see how he has succeeded. Nor have I been able to consult the dictionaries of Du Cange and Weigand.

History tells us that Roman legions and colonists had come in contact with Teutonic nations both north and south, long before the Christian religion had made its way among them, at the time when they established themselves in Gaul, along the line of the Rhine and later in other parts of Germany, under Drusus and others. Wherever it was convenient, they founded military camps and colonies; and it is well known that the neighboring tribes were not always in a hostile contact, but came by way of trade, etc. into a peaceful intercourse with the Roman soldiery.† Many Teutonic barbarians entered the Roman service and whole tribes accepted Roman protection. The Roman fleet visited the shores of Slesvig and Iutland. The consequence was that Germanic words crept into the lingua vulgaris (a few of which were adopted into the lingua urbana), as Roman words into the language of the bar-

*Es ist bekannt, wie wenig sich die alten Geschichtschreiber sowohl als die Urkundensteller in die Rechtschreibung der Namen zu finden wussten, die sie bald nach der Aussprache des gemeinen Lebens auszudrücken, bald in mancherlei, ihrer Meinung nach lateinischen (griechischen) Formen einzuschmelzen suchten. Wenck, Hess. Landesgesch, I 670, Anm, a.

†Les Romains avaient tonjours été un peuple d'esprit pratique. Le pays barbare qúil n'avaient pu dompter par les armes, ils s'appliquèrent à l'exploiter au profit de leur commerce. Geffroy, Rome et les Barbares. (Paris 1874 p. 45.—Dès l'époque où la rive gauche était devenue romaine, les marchands et négociants de l'empire avaient pénétré dans ces nouveaux pays, et bientôt traversé le fleuve. Id. p. 257; cf. also pp. 262 and 348 sqq. and Tacitus' Annal., in regard to the jus commercii, established under Marbod.

barians; and principally such words which were most commonly used in their mutual intercourse or whose import was new to either of them. But which terms could have been more often used by the Roman invaders or be more novel to the barbarous nations, than those relating to the command of the legions, to the charge or oversight of the military and other works necessary for the establishment of colonies? Such terms were "*cura*," "*curatio*" rerum, frumenti, legionis armandae, operum publicorum, viarum, aquarum, etc. G. superioris Germaniae legiones *curabat*, Tacit. Annal. VI, 30. That the word "*cura*" or one of its congeners has been the parent of "*church*," we shall endeavor to show. If we adopt *cura*, the c, hh, etc. of the Germanic dialects would be excrescent consonants or formative elements (cf. O. H. G. chranih; Slav. zeravi, zoraw; L. grus; Gr. γέρανος), and the name of the English *kirby*-churchtown, as also the German *kirweih*, *kirmes*, (i. e. originally the mass celebrated on the anniversary of the consecration of a church), a. o. would remind us of *cura*, unless the prefix *kir* is the phonetic decay of *curatio*. It is well known that only an educated ear is able to catch a foreign word and its stress and to observe this stress in the pronunciation. Now the barbarian in mouthing over *curatio* threw the accent of the antepenult back on the stem-syllable.

This shifting of the accent we observe in all Latin words which were introduced into the Germanic dialects at such an early period. E. g., L. *cupella*, O. H. G. *chubili*, G. *Kübel*; L. *cellarium*, O. H. G. *chellari*, G. *Keller*; L. *coquina* (cokina), O. H. G. *chuhhina* G. *küche*, A. S. *cycene*, E. *kitchen*. In consequence of the changed accent there followed *Gravitation*, i. e. the tendency of sounds to accentual centers. It is seen in the lengthening of accented syllables, the lightening and final disappearance of unaccented syllables. According to this law of gravitation the *o* of curatio was dropped, from *i* developed *e*, as it generally does among the North European nations, *a* sunk into *e* and after passing through intermediate *i* fell out alto-

gether. Thus we arrive at *curite* (curte). The Anglo-Saxon *î* or *ŷ* corresponds to Old High German *î*, which develops from *œ* of Latin words, e, g. pîna=*pœna*. As *cura* appears under an older form *coira*, *cœra*, which *œ* (whose sound in Latin we do not know) easily passed into *u* or *i*; cf. *fœdus* and *fidus*; *mœnia* and *munire*; it is possible that in the lingua vulgaris the pronunciation of *cura* fluctuated between *cœra* and *cira*. Any one acquainted with the vowel scale in the dialects of a modern language will not be surprised at such a supposition. For the change of the dental *t* into the guttural *c* we would account by the shifting of one consonant to another of the same class, which was favored here by the initial *c* (assimilation). A similar assimilation we find in *χόλικες* for the older *χολάδες*; cf. also panca, *πέμπε* (*πέντε*), quinque, fimf. etc. This change has been explained physiologically and occurs quite frequently; it is probable that in the Roman folk speech *c* and *t* were hardly distinguished* (cf. Aeol. *κῆνος* and Dor. *τῆνος*=*κεῖνος*), so that the ear of the Teutonic barbarian was more liable to mistake the one for the other.†

The Anglo-Saxon guttural appears usually as *c* (rarely as *k*),

* See M. Müller, Science of Language, 2 Series, p. 182. Grimm, W. B. v, 5, K 6.

† Other words in which we find c (k) and t (d) interchanged, are: Wilperaht, Wilpert, Wilperc; O. H. G. hart, harc and harug; Tuisco, Tuisto; schlenkern, schlendern; schlank, slender; Hekenstal, Hetenstal; Schalkjar, Schaltjar; Mikwoch, Mitwoch; Schwäbisch-Augsburg, Woerterb. von Birlinger, (München 1864). In a dialect of Modern Greek we find a peculiar change from *τ* to *κ* in the nom. and acc. neuter, of *ἐκεῖνος*. See Geldart, Modern Greek, p. 121; (Oxford, 1870). In the *Cantilène de Sainte Eulalie* of the IX century, as also in the *Vie de Saint Léger* of the X cent., we find *veintre* for *veincre* (*vencre*)=*vaincre*. In the latter poem we find *cartres* (castres) Lat. *carceres*. "Le c de carcer paraît plutôt s'être changé en t par un simple adoucissement euphonique" (Dissimilation). G. Paris, *Romania*, Vol. I, p. 313. It seems to me that the forms *didrai* and *ditrai* of which G. Paris (Romania, Vol. I, p. 290) says: "Je ne sais pas comment expliquer ces formes"—arose from *dic'rai* by assimilation.

which through the influence of Norman French is aspirated in the Southern dialect: *chirche* for *cir* (*i*) *c—e*. To *c* (k) corresponds in Old High German *ch*, which appears usually as *hh* in the middle of a word: *chirihh—a*. If we remember that from about 200 A. D., words with *ti* began to be spelt with *ci*, it will be easy to derive the Teutonic *cyrice* and *chilihha* from *curacio*, on the condition of the vowel changes in consequence of the shifted accent, as above mentioned. See *A. Fuchs, Die Romanischen Sprachen* (Halle 1849), p. 304.

The reason why the Latin word *cura* (*curatio*) had found such an easy access into the Teutonic speech and held its ground so tenaciously, until it was appropriated by Christian missionaries, perhaps already in the second century, who followed in the wake of the Roman soldiers and merchants—may be found in the fact that it has a similar meaning as the Gothic *kara*, O. H. G. *chara*, A. S. *cearu*, *caru*, E. *care*, though Grimm's Law does not allow to connect the Teutonic words with the Latin *cura*. Compare with these words the A. S. *carc*, *cark*, in which *c* is an excrescent consonant, as k in hear-ken, etc.

Those changes, through which we have accompanied our word, we may call its history anterior to the period, when it was taken into Christian usage. It had lived on in the mouth of the common people, which prepared it for casting it into the declensional mould of the Teutonic dialects. It was undoubtedly familiar to and perhaps permanently appropriated by *Columbanus* (590–615) who worked in Switzerland, in the neighborhood of Zürich, by his fellow-worker and countryman, *Gallus* (690–640) who, with a perfect knowledge of the native dialects, promoted the conversion of the Swiss and Swabians, and later by *Kilian* (650-689), the center of whose labors was at Würzburg, in Franconia. As these missionaries came from Ireland, it is probable, that the Gadhelic word *Kil* which we find in a large number of local names in Ireland and which is said to denote originally a hermit's "cell," and afterwards "church," may have caused the change of r into l in the

South German dialects: *chilihha chirihha*;—although we find this interchange in many other words of the South German dialects, in which we can not assume such an influence. The consonant l being a weakening of r, may not the Gadhelic Kil stand for kir, and kir be a reminiscence of the Roman *cur·a*? but it remains to be proven, whether kil as prefix in Irish village—names points indeed to "local centers from which proceeded the evangelization of the half-savage Celts." As *kil* means also *inclosure* in general, may it not have entered into the naming of villages long before the appearance of Christianity in Ireland? And if it really had the distinct meaning of "church" in the 1,400 local names in Ireland, according to I. Taylor (Words and Places, p. 227), it seems very strange, that the Celtic dialects did not retain it as the common name of 'church,' as the Teutonic dialects.

The theoretical middle steps through which we have followed "church," of course have passed away without a trace of them being left; they were perhaps only momentarily taken, but surely unconsciously. Foreign words taken by the uneducated into a language obey apparently no rule; they seem to enter into a chrysalis state, till they emerge fully fashioned from the depth of the folkspeech and take their rank in the literary language, no further mutable. But the external or phonetic change of a word is frequently accompanied by an internal or ideal change. The spirit of Christianity filled our word with a nobler meaning. From the oversight or charge of worldly affairs, implying responsibility for safety and prosperity it passed to the charge and oversight of that which concerns mankind so much—*cura* or *curatio animarum*. Thus we easily perceive the later development of its meanings, to that of the edifice, for instance, in which the *cura animarum* took place.

In conclusion, it will be of interest to consider briefly the history of *cura* in the Romance languages, whose ideal development in these languages seems to support our etymology of

"church." We have seen above, the Latin *cura* is used both of military commands and of civil administration. From this meaning the French *cure* (Saintongeois, *chure;* Wallon, *Keure;*) passed into the meaning of *'charge ecclesiastique*, cure d'âme (Seelsorge). In Old French it is still found in the meaning of *soin, souci.* Then it passed into the meaning of the "house of the priest," but not of the "house of the Lord," for *ecclesia* had already been firmly established.*

In Low Latin we find *curatus*, (celui qui est chargé d'un soin, du soin des âmes), whence French, *curé;* Italian, *curato;* while the Spanish employs the abstract *cura.* D'Arnis' Lexicon ad Scriptores Mediæ et Infimae Latinitatis mentions, besides *curatus*, *curator*=custos ecclesiae; and also the following suggestive phrases: CURATA *ecclesia*, parochialis, cui præest curio; *curatum beneficium*, sacerdotale, ad quod pertinet cura animarum. Of special interest is the form *curita*=curatura, which exhibits the trace of a phonetic decay, as postulated above.

In the preceeding we have endeavored to follow the two fundamental rules of etymological research: 1. "No etymology is admissible which refuses to account for all the letters of the word it proposes to explain, without a single exception;

*In the documents of the Merovingian epoch we find *ecclesia* or *basilica* used for the sacred edifice, but never *templum.* Also *Monasterium* and *coenobium* signify *church*, while a monastery was called "casa Dei." From monasterium we have in A. S. *minster*, G. münster, in O. F. *mouster, mushter*, which were lost in Modern French. It is strange that the forms *mouster* and *iglise* or *esglise* which were brought to England by the Norman-French, and were employed in the middle of the XIII century (Cf. Romanz de un chivaler e de sa dame e de un clerk, ed. by P. Meyer, Romania, Vol. I), did not supplant the A. S. *cirice*, for we owe to the Normans most of the terms pertaining to the church. See R. M. Morris, Historical Outlines of English Accidence, p. 30. This shows, that the word from which developed *cirice*, must be older than the ecclesiastical terms which entered the Anglo-Saxon in the 6th century, so that the words of Robert of Gloucester apply to it: Ac lowe men holdeth to Engliss and to hor owe speche yute.

and 2, every etymology which assumes a change of letters ought to have in its favor at least one example of a change quite identical with that which it assumes." If thus the phonetic growth alone of our word out of the Latin *curatio* (cura), is more organic than out of the Greek *κυριακόν*, and therefore preferable,—it becomes still more so through historical probability and through the beauty of its import.

HISTORY OF THE SCIENCE OF HYDRAULICS.

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Although some of the fundamental principles of the science of hydraulics were discovered and applied by Archimedes, the progress of this science was almost imperceptible until about the fourteenth century. And this, notwithstanding we read that Rome in A. D. 98 was supplied with water by nine aqueducts, whose discharge was 27,000,000 cubic feet per day, and whose aggregate length was 250 miles. About the beginning of the fourteenth century, great damage was experienced by the overflowing of the mountain streams of Italy, which resulted in disastrous litigations, arising from the stringent laws enacted for the protection of property. This called the attention of practical and scientific men to the necessity of inventing some means of preventing these inundations and rendering the streams more navigable. This resulted in the invention of the canal lock, which was first applied to the canal between the Ticino and Milan, which is at the present day in a perfect state of preservation. From this date hydraulic engineering was ranked as a science, and has steadily progressed to the present time. The successive stages of this progress it is now proposed to follow.

Towards the last of the fifteenth, or the beginning of the sixteenth century, Leonardo da Vinci, one of the architects engaged upon the construction of the cathedral at Milan, first applied his invention of the mitre-sill gate to the lock above mentioned. Canals were now rapidly constructed throughout all parts of Italy. In 1628, Castelli first introduced the meth-

od of estimating the discharge of a river by the velocity of the water. In 1643, Torricelli discovered the general theory of hydraulics that neglecting resistances, the velocities of fluids in motion are in the sub-duplicate ratio of the pressures. He also argued that the acceleration of the currents of rivers was due to the slope of their surfaces, basing his conclusions upon the supposed analogy between spouting fluids and rivers. Pascal made valuable contributions to the science in his works published between 1646 and 1663. A dispute having arisen in 1665, among the inhabitants of the Chiana valley as to the disposition of the water of a certain stream, Rome and Florence assembled a scientific congress to report upon the best plan of accomplishing this task. Many theoretical essays upon river improvements were submitted, but these added very little to what was previously known upon the subject.

Near the close of the seventeenth century appeared the work of Mariotte and Guglielmini. These authors adopting the parabolic theory of rivers, of the celebrated Torricelli, perfected it. According to this theory the velocity of any particle of water in a river will be the same as that of a body falling from a state of rest through a distance equal to that of the particle below the plane of the surface of its source produced. As this theory is contrary to observation and was adopted by so many writers it shows how theoretical was the science at this period of its history. The principal writers upon it being philosophers whose lives were passed in inventing theories and deducing therefrom practical laws instead of making practical observations and building upon this foundation their theories.

Newton in his Principia, published in 1714, discusses the friction of fluids on solids and the discharge through orifices, and though some of his conclusions are erroneous his contributions to the science are valuable.

The Marquis Poleni first discovered that by adapting a small cylindrical tube to an orifice in a thin plate the discharge

could be increased. His work upon the discharge of fluids through orifices was published in 1718. Varignon in 1725 published his work on hydraulics in which he reduced the parabolic theory of rivers to algebraic formulæ.

M. Pitot, between the years 1730 and 1738, made a series of experiments upon the velocities at different depths by means of the tube which bears his name. These experiments proved the fallacy of the parabolic theory of flowing water. In 1732, were published the results of the experiments by Couplet upon the discharge of water-pipes at Versailles. At the same time appeared the works of many Italian writers, such as Grandi, Manfredi, Zendrini, Frisi, Zanotti, Gennette. In 1798 was published the work of Daniel Bernouilli, who applied the principle of living force to the motion of fluids, which forms one of the schools of hydraulics.

Between the years 1742 and 1752 appeared the works of John Bernouilli and d'Alembert, upon the theoretical science of hydraulics. Valuable theoretical papers upon the motion of fluids by the celebrated engineer, Lecchi, and by Euler, appeared between 1765 and 1771. Professor Michelotti of Turin, and the Abbé Bossuet of Paris, first established it as a fundamental principle, that formulae must be deduced from experiment and not from theory. The former conducted an extensive series of experiments under the patronage of the king of Sardinia, the results of which were published in 1774; the latter conducted a series of experiments under the patronage of the French government, the results of which were published from 1771 to 1778. Both of these furnish important data, particularly the latter, and have been of great value to succeeding writers in deducing constants and testing the accuracy of formulae. We consider that the origin of the modern school of hydraulics is due to the last two named authors. The works of the earlier writers are now of but little importance to the practical engineer.

In 1775, M. Chezy, an eminent French engineer, deduced

the first formula for mean velocity in terms of the slope and dimension of cross-section.

In 1782 was published a voluminous work of Belidor, Architecture Hydraulique, Paris. In 1874, M. l'Espinasse published in the Memoirs of the Academy of Science, at Toulouse, two papers on the expenditure of water through large orifices, and on the junction and separation of rivers.

In 1786 was published the celebrated work of M. Dubuat, which is still a standard authority in the science. He produced a formula which is applicable to most problems respecting the uniform motion of water. He fully illustrates its practical application and touches upon all the general questions of interest to the hydraulic engineer. Valuable works on hydraulics were published by Bernard in 1787, by Brünings in 1790, by Woltmam between the years 1791 and 1799. Fabre published a work on torrents in 1797. Venturi published a memoir in 1798, giving the result of a series of experiments upon the contraction of the fluid vein, in which he discusses, among other things, the effect of eddies in rivers and shows that they retard the current.

In 1800 Coulomb published a paper in which he enunciated the principle that the resistance arising from the friction between fluids and solids may be represented by a function consisting only of two terms, being the first and second powers of the velocity. This is called Coulomb's law. In 1801, M. Eytelweine published a large work on hydraulics, following the methods of Dubuat, which has been translated by Nicholson, and has received a very flattering notice from Dr. Young in the Journal of the Royal Institute. In 1803, M. Girard first applied the law of Coulomb to flowing water in open channels, producing a much more simple and practical formula than that of Dubuat. Some of his other articles, particularly those on canals are of special importance. M. de Prony published his first work on hydraulics between 1790 and 1796, his second work in 1802, and his third in 1804. These works

have placed him in the foremost rank of writers on this subject. He shows in his third volume, by discussing experiments, that the resistances of fluids in uniform motion may be represented, as indicated by Coulomb, by an expression involving only two terms, one containing the first, and the other the second, power of the mean velocity; but that these terms should be affected by independent coefficients, and not by a common one, as advocated by Coulomb and Girard. He then deduces the value of these coefficients for pipes and canals by employing two methods given by La Place in his Mécanique Céleste, and by a general equalization of disturbing causes; he gives a new formula of his own for obtaining the mean velocity, etc., from that of the surface.

He published an additional paper in 1825, giving methods of simplifying the application of his formulæ. In 1804, Lecreulx published his Recherches sur la Formation et l'Existence des Ruisseaux, Rivières et Torrents.

In 1808–9 appeared the work of Fünk, a celebrated German scientist, upon hydraulic architecture. M. Krayenhoff published in 1835, his "Recuil des Observations Hydrauliques et Topographiques faites en Hollande," containing a full collection of tables of observations upon the hydrography and topography of Holland, a standard work of great value. He made detailed measurements of discharge, slope of surface, etc., determining the velocity by means of observing the time of transit past a base line of vertical poles reaching from the surface nearly to the bottom. In the Memoirs of the Academy of Berlin, 1814, 1815, appeared the celebrated articles of M. Eytelwein, giving new values to the constants in de Bouy's formulæ, etc. In 1816, Girard read before the French Academy his valuable work upon the Nile; his graphic representation of the daily gauges kept for the years 1799, 1800 and 1801, is the first diagram of the kind on record. In 1820 appeared Fünk's second work on hydraulics. Escherde la Linth, in 1821, read a paper before the Helvetic Society of

Natural Sciences in Basle, upon the upper Rhine. By modification of Eytelwein's formulæ from a few measurements of surface velocity, he deduced by a daily gauge-record the annual discharge from 1809 to 1821 at Basle. De Prony published 1822, his noted work on the Pontine Marshes. In this year was published the result of a reconoissance of the Ohio and Mississippi rivers by General Bernard and Lieut. Colonel Tot ten, of the United States Engineers. This contains valuable information, especially upon the Ohio river.

In 1823 was published a valuable collection of Italian papers which made the collection complete from the fourteenth century. In 1824–26, M. Rancourt made his well-known experiments upon the Neva when frozen and when open. Mr. Poncelet published in 1828 his theory of permanent motion, that is, the permanent motion of water moving through a channel of variable area and slope. In the same year M. Belanger published his noted work on the same subject containing an original formula which gave more accurate results than any which had preceded it. In 1829, M. Genieys published a practical treatise upon water-works. In 1827 experiments were begun at Hetz upon a large scale to establish the principles of, and fix the constants in, the formulæ for water flowing through orifices. The results were published in 1842, by order of the French government and are known as the Poncelet and Lesbros experiments. In 1833 were published the results of observations upon the Rhine and its tributaries. This is the most important contribution to river improvement of modern times. The works used were both temporary and permanent. The temporary works were built for the purpose of inducing deposits of sediment, etc., which being of service but for a short period, were made of perishable materials. The permanent works consisted of levees and either solid revetments or breakwaters, to prevent the banks caving. These improvements were under of charge Defontaine. He advocates two general plans for improving the Rhine, first by closing all

chutes to confine the river to a single channel; and second, converting all straight lines to curved in the river's course. His reason for the latter plan is that in a bend the caving is limited to one bank, and can be more easily prevented than in a double line of defensive works on a straight line. The dimensions of the levees are far greater than those of the Mississippi. They are 10 feet thick at top, with a slope of one upon two towards the river and one upon one and a half toward the land. The height is calculated to be a foot and a half above the highest floods. Even the large levees are not considered sufficient. Strips of grass-land are left on both sides 6 1-2 feet wide on the exterior and 3 1-2 feet on the interior, measuring from the foot of the slope of the levee. On the outer edges of these strips are planted willows and poplars. To guard against filtration when the levees are more than 7 feet high a banquette is added. Here and there when the current of the river would be liable to act upon the levees, large and strong traverses at distances of 600 to 1000 feet apart are placed and protected, if need be, by fascines, to break the force of the current.

In 1834 appeared the first edition, and in 1840 the second edition of a general treatise on hydraulics by D'Aubuisson de Voisins. In 1835, M. Destrem published the result of a carefully conducted gauging of the Neva and its various branches, under his immediate supervision. In the same year appeared a historical sketch of the progress of hydraulics by Charles S. Storrow, Boston, giving the demonstrations and practical applications of various formulæ proposed by different writers on hydraulics. In 1836, Tredgold published Smeaton's experimental papers on the power of water and wind to turn mills; Venturi's experiments on the motion of fluids (1798); and Dr. Young's summary of practical hydraulics, chiefly from the German of Eytelwein, In 1840, M. Dausse obtained a premium for a paper upon the best methods of improving the navigation of the principal rivers of France. Between 1843

and 1853, the celebrated hydraulic engineer Lombardini, published a number of papers upon the hydraulic condition of the river Po, in which he demonstrates that levees have not elevated the bed of the river, although they have increased the height of floods by retaining between the banks the waters which before escaped through crevasses; and this height has been further increased by the more rapid flow caused by clearing the mountain sides of their forests. In 1841, M. Surell published a paper upon the torrents of the Alps, showing that forests exercise an important moderating effect, and advises their cultivation for that purpose. In 1843, M. de Buffon published his theoretical and practical treatise upon irrigation. He adopts de Prony's formula for the mean velocity with Eytelwein's co-efficients. He thinks the float, from its simplicity, is superior to all other instruments for measuring the velocity. M. Weisbach in his mechanics, published at Freiberg in 1846, treats very fully of hydraulics, for which task the special study of many years had peculiarly fitted him.

M. Surrell, in 1847, published an elaborate work upon the improvement of the river Rhone. In 1848 appeared Dupuit's work on hydraulics, which is a valuable contribution to the science. This same year was published a memoir by M. Baumgarten upon a portion of the Garonne, giving the various works used in the improvement and discussing their effects. He reports some very interesting experiments, among others that of measurements upon the transverse section of the water-surface at a nearly straight portion of the river (width about 600 feet), both when the water was rising and falling. When rising, at the rate of about 5 feet in twenty-four hours, with a maximum velocity of about 7 feet per second, he found the water in the middle to be about 0.4 of a foot above that on the right bank, and 0.1 above that on the left. When falling at the rate of about 8 feet in twenty-four hours, with a maximum velocity of about 7.5 feet per second, the water-surface was sensibly a plane, being at the right

bank a little less than 0.1 of a foot above its level at the opposite side of the river. In the proceedings of the American Association for the Advancement of science for 1848 and 1849, are valuable papers, which contain the results of experiments made at Natchez and Memphis upon the Mississippi river. The daily discharge at Memphis was determined by making a cross-section of the river, and subdividing it into three partial areas. The surface velocity in each of these areas was measured by anchoring the boat and using a chip and line. During calm weather the relative velocity near the bottom was also measured by comparing the velocity of a surface float and a double float whose lower portion, composed of a tin vessel, was sunk nearly to the bottom. The discharge was equal to the sum of the products of the partial areas by the average velocities in them. The temperature of the water at the bottom was found to be the same as at the surface. The velocity near the bottom was to that at the surface in the ratio of 268 to 300. The average downfall was 0.11 inches, and the average evaporation from the surface of the water of considerable depth, was 0.13 inches daily.

Mr. Ellet, in a memoir to the Smithsonian Institution in 1849, advocated the reservoir system for the improvement of the Ohio and other rivers. M. Boileau made a very extended series of hydraulic experiments by order of the French government between the years 1844 and 1854, which were published in the last mentioned year. It is a work of great value to the science.

In 1851 Mr. Ellet submitted a report to the War Department upon a survey made by him under its direction to determine the best method of preventing the overflows of the delta of the Mississippi. In the same year appeared a work on hydraulics by M. de Saint Venant, which contains much original and valuable matter. In 1855, Herman Haupt published a pamphlet advocating the improvement of the Ohio river, by a low dam and chute plan. Lombardini, in 1858,

published a memoir upon the recent inundations in France and the means of remedying the evils thereof. During this same year Dupuit in France, David Stevenson in England and Ellet in this country, made valuable contributions to the science.

The annual reports to the Chief Engineer of the Army furnish valuable information upon the improvement of rivers and harbors. Time at present will not permit my tracing farther the progress of this science, and I will merely add that the governments of all civilized nations have fully awakened to its importance, and by authorized experiments are daily aiding in its advancement.

THE NAMING OF AMERICA.

BY PROFESSOR J. D. BUTLER, LL. D.

The name America has been called a monument of ingratitude. It is said to be a misnomer, and worse than that, to owe its origin to fraud.

Our continent owes its name to Americus, the baptismal name of the Florentine navigator, Vesputius. Concerning him some specimens of popular opinion are these.

It is charged that, "after returning from Brazil, he made a chart in which he gave his name to that part of the main land. The date of his first voyage, as he gives it, is unquestionably false." So says Appleton's Cyclopedia. The whole narrative of that voyage Irving pronounces a "fabrication." Morse, father of the telegraphic inventor, says, "Americus had so insinuated that the glory of discovering the new world belonged to him, that the bold pretensions of a fortunate impostor robbed Columbus." Morse quotes the Scotch Robertson as authority. A thousand others have done likewise. Robertson accuses Americus "with premeditated usurpation of rights," etc. One of the most elaborate of British encyclopedias says, that "as the employment of Americus afforded him opportunity, so while drawing charts he distinguished the new discoveries by the name of America, as if it were Amerigo's land, so that the true discoverer, notwithstanding the complaints of the Spaniards, was defrauded of the honor that belonged to him." Delaplaine of Philadelphia — father of our Madisonian pioneer, charges Americus with imposing his name on the continent by stratagem, and says he gained his end by waiting till after the death of Columbus before putting forward his own pretensions.

Such, during three centuries, were the ideas prevalent regarding the naming of America.

Within the last generation, however, the researches of Humboldt in his *Examen critique* of the Geography of the Fifteenth Century, 1835–9; of Henry Harries in his *Bibliotheca Americana Vetustissima*, (New York, 1866); of Varnhagen in his monograph on *Amerigo Vespucci*, (Lima, 1865), and of others, have vindicated the character of Americus, demonstrated that he discovered more of America than any other man, and even rendered it probable that he set foot on this continent (June 17, 1497,) before either Columbus (August 1, 1498,) or Cabot (June 24, 1497,) while his name was bestowed on his discoveries not only without his instigation but without his knowledge.

It ought to be here said, in passing, that but for aids ministered by the Library of our State Historical Society, the following paper could not have been prepared in Wisconsin. There is no possibility of finding elsewhere, within the limits of our state, the documents to which every original investigator of my theme must betake himself.

The earliest charge against Americus, and that the mother of a myriad others,—*fons et origo malorum*,—originated twenty-one years after his death, and a thousand miles from his home. These circumstances stamp it with suspicion, and the more since no contemporary trace of similar aspersions can be detected in Spain, where he lived and labored.

It was in 1533, and in Nuremberg, that John Schöner remarked in a geography he issued then and there (*Opusculum Geographicum*), that "Americus sailing westward from Spain and coasting Asia, believed a region which belongs to *upper India* to be an island, which he appointed to be called by his own name."

Schöner's words were: "Americus Vesputius maritima loca Indiæ superioris, ex Hispaniis navigio ad occidentem perlustrans, eam partem quae superioris Indiæ est, credidit esse insu-

lam quam a suo nomine vocari instituit. (H. Harries, p. 304.) This passage affords no proof that Schöner *blamed* Americus for thus baptizing his finding with his own name. But there is no doubt that he did. Yet the first name which Schöner himself gave to the southern half of our continent on a globe he had made thirteen years before, and which we may see today in the city library at Nuremberg, is *America.* Besides, eighteen years before,—or in 1515, the same Schöner had published a geography in which we read, "America or Amerigen a *novus mundus*,—and fourth part of the globe, named after its discoverer Americus Vesputius, a man of sagacious mind, who found it in the year 1497." (H. Harries, p. 142.) As Schöner subsequently censured Americus, he must have changed his mind after 1515. It was after that time perhaps, that he first learned about the abuse of Columbus by Spaniards, and indignant at his wrongs naturally attributed the defrauding him of fame to the man who had gained most by that fraud. Yet the truth is, there is no proof that Americus ever gave his own name either on maps or otherwise to any portion of his findings,—though most other voyagers in all ages have thus perpetuated their fame.

The slur cast on Americus by Schöner was repeated and exaggerated, especially by Las Casas in his *Historia de las Indias*, a work not completed for forty-seven years after the death of Americus, till it reached the pitch indicated at the commencement of this article.

But no map with the name "America" on it of an earlier date than 1520, is known to exist, or to have ever existed any where. This first map appeared in Vienna, and long before any bearing the name America was issued in Spain, although its own date was eight years after the death of Americus. If any suggestions of his led to its issue, they must have been those fabulous, or at least thaumaturgic, "poisons given to work a long while after."

But the maker of this Vienna map had no thought of doing

injustice to Columbus. It is true he printed "America" in capitals on the southerly portion of the new found region which extends no further north than the equator, but he intended to call only a portion of that region by that name, for beneath the word America the word *province*, "Provincia," is subjoined. America, as then and thus designated, was a smaller part of the West Indies than the West Indies now are of America.

Thus much of honor may have been deserved by Americus, who possibly first discovered the American main land, and at all events was the first explorer of more of it than even Columbus.

Moreover, on the Vienna map, above the name America so that it may well apply to the north shore of South America and the West Indies, we read this epigraph: "In the year 1497 this land with the islands adjacent was discovered by Columbus, a Genoese by order of the King of Castile."

The original text is, Anno, 1497, hæc terra cum adjacentibus insulis inventa est per Columbum, Januensem ex mandato regis Castellae. AMERICA, provincia.

On this map, as on all before it and on legions afterward, the two portions of America are widely sea-severed. The truth is they were long regarded by no means as Siamese twins, but as belonging to different continents.

Men find what they seek. Columbus voyaged for India, thought his first landing was there, and forced his crew to swear they thought so too by threatening to cut out their tongues. (H. Stevens, "Historical and Geographical Notes.") Like too many others, he forgot that voting asses to be horses never made long ears short.

Columbus called his finding the main land or islands of India beyond the Ganges (*Insulæ Indiæ supra Gangem.*) Manifold memorials of his mistake we see to this day. Witness our aborigines from pole to pole called "Indians;" witness the archipelago between the Americas now as in the beginning,

"West Indies;" witness *Las Indias*, the Spanish official name including even now all our continent; witness the words, "King of the Indies," *Indiarum rex*, stamped on every Spanish dollar we, ever saw.

Show Agassiz one bone, and he would reconstruct any animal; so when Columbus beheld one corner of trans-Gangetic India, that is of Eastern Asia, he could map the whole of it, for that eastern coast line was known to him from the relations of overland travelers. The configuration of that Asiatic line is not without resemblances to that of eastern North America. Hence the delusion lasted longer, and each new finding pieced out the Asiatic map, like a new patch sewed on an old garment. A quarter of a century after the death of Columbus, the prince of German geographers still maintained that Mexico conquered by Cortez ten years before, was the Chinese city Quinsay, so excessively extolled by Marco Polo. So Humboldt tells us in his Cosmos.

Syllacius, the first Italian who described the first voyage of Columbus, in his "*opusculum de insulis nuper repertis*," assured both that that navigator had pushed through to trans-Gangetic India, and perhaps also satisfied that a ship sailing westward must slip off from the world, represents Columbus as circumnavigating Africa. *Ultra Æquatoris metas, usque ad Arabiae beatas insulas.* Persistence in mistaking North America for Asia was one among countless illustrations that false knowledge is worse than ignorance; a truth so well understood by Isocrates, who always exacted double fees from students who came from another teacher, one for unteaching as well as one for teaching.

Among the results of Columbus's error, the Pacific was called the *South* Sea, being supposed to lie almost altogether south of the equator, and the better half of the western hemisphere was reckoned by many an appendix of Asia, even until Behring passed through his Straits only four years before the birth of George Washington.

Faith in the connection of North America with Asia outlived many a proof to the contrary. It was scarcely less credulous than the "hard shell" citizens of the Egyptian section of Illinois, who are reported to continue deaf to all reports concerning the death of "Old Hickory," and so still cast their Presidential votes for Jackson.

But this Asiatic mania, if I may so call it, was much less lasting in reference to *South* than to North America. That portion of our hemisphere in fact approaches the old world nearer than the northern half of it does, and its actual distance from Africa was under-rated. On some early maps its eastern-most cape was set down as no more than ten degrees west of the Cape Verd group. Its outline was also ascertained by nautical survey, while the corresponding coast of North America was still mapped after the model of Asia.

As neither the position nor the coast-line of South America had anything in common with European ideas respecting Asia or the globe southeast of it, it was at once regarded as a discovery veritably new. Accordingly, while the West Indies were viewed as only an extension of the Canaries, and Columbus was thought to have discovered only some other islands further toward the Indies of the East (*Insulas alias incognitas versus Indos*), and North America was drawn after an Asiatic pattern, or held at most for a thin barrier on the road to Asia and cut through by straits if not by seas,—men were already satisfied that South America was nothing less than a continent, and so sought for it a name. No man did more to make South America thus known to the old world than Americus. He was first to trace its shore line through fifty degrees of latitude even down to Patagonia.

"As early as 1501, Vespuccius proposed to double the extremity of the Southern Hemisphere." H. Harries, p. 226. Would it have been surprising if he had appeared in the earliest maps and books honored with a name in the world of wonder he had revealed? But he does not?

The oldest map containing engraved delineations of the new countries was published at Rome in 1508. On this we see the southern portion of our hemisphere which stretches through more than fifty degrees of latitude and sixty of longitude, inscribed, "Land of the *Holy Cross*, or New World." No America was yet dreamed of. Says Roselly de Lorgues, "The discovery having been made under the auspices of the cross, and for the triumph of the cross, the new land was usually designated on maps by the sign and name of the cross. (*Terra sanctae Crucis.*") Nor yet was there any other western continent in existence, according to the notions of the Roman mapmaker. His nearest land west of Cuba is Bengal. North of it the nearest land is that explored by the Cabots, which is mapped as a part of Asia, and conterminous with Gog and Magog. This map (11½x16 inches) was drawn by Ruysch, a German navigator, who is believed to have sailed with Americus.

It was forbidden to infringe its copyright or that of the geography which contained it, on pain of excommunication, but the price of the work was to be fixed by the Pope's librarian. Such a defense of the public from booksellers, and of authors from pirates is now, alas! one of the Lost Arts.

Humboldt arguing that Americus never knew that he had discovered a continent, holds that the words *Mundus Novus* (new world), in the fifteenth century, meant no more than any region new found, no matter though of small extent. Admitting the phrase to have been often thus used, it clearly was not as to the case in hand. The title of the first German edition (1505) of the third voyage of Americus is, "Concerning a new found region which may well be named a world." *Von der neu gefundenen Region die wohl eine Welt genennt mag werden.* Again the Mundus Novus on Ruysch's Roman map was well-nigh as extensive as we now know South America to be, and larger than Europe. But this map appeared four years before the death of Americus. Can we believe that he

himself knew less concerning the greatness of his own discoveries than was manifest on maps to all the world?

It is further worth notice that while the words *mundus novus* head the very first publication of the voyages of Americus, they never occur in the title of any one among the twenty-one works which were issued in the fifteenth century in relation to Columbus.

One reason may be that the islands—or at least the main land which Columbus brought to light needed in his opinion no name. According to his foregone conclusion they had been named already with appellations time-honored and in part sacred.

A principal reason then why our continent does not bear the name of Columbus, was that he and his contemporaries supposed there was no continent in existence which still remained without a name. Bombastes cut off only the hand of his slain enemy, because the head had been cut off already. Janus was never struck on the back of the head because he was all face, and time cannot be seized by the hind-lock for he is bald behind.

The first landing of Columbus on the American main was at the mouth of the Orinoco. He thought it the paradisaical Gihon. He died assured that he had there bathed in one of the rivers of Eden. According to his faith, "the airs of Paradise did fan its shores, and angels officed all." Small thanks would he have rendered anyone who had proved that his landing was not in Paradisaical Asia, but that it was of the earth earthy. His celestial dream he would have scorned to exchange for stamping his name on any continent. If forced to give up his beau ideal for a continental reality, his must have been the feelings of Lessing's hero in Nathan the Wise, who at the denouement found out that the lady whom he had adored with the love of forty thousand brothers, and who loved him as much, was after all only his own sister.

Should a less sentimental image be demanded, Columbus, if

disenchanted of his golden delusion, may be compared to a Californian pioneer bringing to the mint a load of glittering specimens from far off *placers*, and there convinced that they were one and all iron pyrites,—fool's gold and nothing more.

Columbus fancying America to be Asia lay under a mistake analogous to that of the Northmen in the tenth century. They sought no collective name for their great discovery, because they were convinced the America they had found was no more than an outlying fragment of Europe.

But how was greatness thrust upon Americus? How did his name, at first too plebeian to appear on title-pages, or to indicate a cape or bay, make its way into books and maps, and, supplanting all other appellations of the New World, gain a glory eclipsing whatever is reflected from all such names as New Spain, New England, New France, etc.?

Americus wrote several private letters, about his voyages, to friends in Italy and France, perhaps in 1502, but made no claims to give his name to any locality. These accounts of his discoveries were soon published, and were sometimes headed with his name, as *Nouo Mondo da Alberico Vesputio, Milan* 1508. More commonly their titles were complimentary to some sovereign, for that servility was then ubiquitous, which, to-day, in British army bulletins forbids naming any non-commissioned officer, even though a victory should be altogether due to him.

Thus the title-page of the earliest German edition of the letters of Americus (1509) is: "This little book relates how the two most illustrious Lords, Ferdinand King of Castile, and Emanuel King of Portugal, have searched through the vast seas,—discovered many islands, and a new world," etc. (Dies Büchlein saget wie die zwei durchlüchtigsten Herren Fernandus, K. zü Castilien und Herr Emanuel, K. zu Portugal haben das weyte mör erzüchet und funden vil Insulen, und ein Neüwe welt von wilden nackenden Leüten, vormals un bekannt.)

Another edition in Latin, was entitled, "concerning the Antarctic region formerly discovered by the King of Portugal. (*De ora antarctica per regem Portugallice pridem inventa.*) The earliest Italian edition was styled, "All the navigations of the King of Spain." (*Libretto de tutta le Navigazione del Re di Spagna Isole trovate novamente per el Re di Spagna*, 1495.) That monarch voyaged as easily as Solomon built the temple without lifting a finger, and no one has profited more by the law-maxim: *quod facit per alium facit per se.*

Perhaps it was his wife who, accustomed to do all drudgery by proxy, when urged by her confessor to do penance, said: "O yes, I will. I will make my maids of honor fast all through Lent!"

In many editions the motto was:

> "Cum Deus astra regat et terræ climata Cæsar,
> Nec tellus nec iis sidera majus habent."
>
> As God in heaven, so kings on earth bear sway;
> Above, below, no greater names than they.

The voyages of Americus were published separately many times, but, so far as can be ascertained, never together till the year 1507, and then in Lorraine at Saint-Díe. A professor in the gymnasium there, born in the neighboring Freiburg, was then publishing a Latin cosmography. While thus engaged, he fell in with the letters of Americus in French, translated them into Latin, dedicated them to René the local potentate, and added them to his other geographical chapters. His work was entitled, "*Cosmographiæ introductio.* * * * Insuper, quatuor Americi Vespucii navigationes."

On the title-page he mentioned this addition as "things unknown to Ptolemy and discovered by moderns." The professor's name was Waldzeemüller. After the fashion of his time he latinograecised it as Hylacomylus. In a note treating of the progress of discovery in the old continents, he adds: "but now another fourth part has been found by Americus, as

will be seen in the sequel. I see not why any one can rightfully forbid it to be called Amerige, or *America* as if the land of Americus after Americus, its discoverer, a man of sagacious mind, since both Europe and Asia have derived their names from women." So long ago were men fearful that women were getting more than their rights! In the margin of this note he printed the word *America.*

The exact words of the St. Die cosmographer are as follows:

"Nunc vero et hæ partes sunt latius lustratæ, et alia quarta pars per Americum Vesputium (ut in sequentibus audietur) inventa est, quam non video cur quis jure vetet ab Americo inventore, sagacis ingenii viro, Amerigen, quasi Americi terram, sive Americam dicendam: cum et Europa et Asia a mulieribus sua sortitæ sint nomina. Ejus situm et gentium mores et binis Americi navigationibus quæ sequuntur liquide intelligi dant."

This suggestion, according to our best knowledge, was the first ever made for giving honor to Americus and a collective name to his findings. It was published in 1507, on the 25th of April, which is accordingly the birth-day of the American name. But it never has been pretended that Americus knew Hylacomylus or could by possibility have incited him to bring forward his name.

It is not to be forgotten that the name America was thus proposed in 1507. This date refutes and renders ridiculous the pretense that Americus first foisted the name into maps when he was head of the Spanish cartological bureau, for he was not appointed to that position till a year afterward. Could he be guilty of a sin that was committed before he was born? No more than he could be guilty of Adam's sin. No more than a preacher can be called to account for his hearers' naps if they begin before he stands up for sermonizing.

Besides, as already stated, the earliest map on which the word *America* is inscribed, was made eight years after the death of Americus, and that name was introduced on Spanish maps later than any where else.

If any further vindication of Americus from the stain of stealing the laurels of Columbus could be needed we should see it in the fact that Columbus, to the very close of his life and his son after him, though very jealous for his father's glory, remained the fast friends of Americus. The charges of Las Casas, Humboldt considers refuted by the life-long friendship of the Columbus family with Americus. He also remarks that those charges are very mild near the beginning of his book, which was written soon after the death of Americus, but very harsh near the end of it which was written thirty years afterward. We may, therefore, appeal from Philip drunk to Philip sober—from Las Casas in his dotage to Las Casas in his best years.

Again, Cuba was believed to be the continent till after the death of Columbus, and he discovered that island in 1492. Americus sharing in this belief had no motive to date his first voyage 1497, unless it then took place. Why forge and falsify only for the name of discovering what, as was firmly believed, had already been five years discovered?

It was once my fortune to visit Freiburg—the native town of the namer of America. My journey thither in 1868 was repaid by its mountain scenery, its streets irrigated with living water after the manner of Salt Lake,—its cathedral unsurpassed in Germany till Strasburg was captured, and its associations with the inventor of gunpowder. But I was not then aware that it had given birth to the god-father of our western hemisphere. Had I been, its charms would for me have been tenfold. I also passed near Saint Dïe where the name "America" was first printed, and perhaps first written. Had this fact been known to me how gladly would I have turned aside to gaze upon that cradle of our name. However small to the eye it would have been great to the mind. Still greater would have been my interest in it, had I not been ignorant that a head-master of the school there, Pierre D'Ailly, had written the picture of the world—*Imago mundi*, which stimulated

Columbus to his great voyage, and which is still to be seen in Seville with marginalia penned by the hand of Columbus himself. Americans will ere long pilgrim to Saint Dïe, as the mother of their name, and so the source of a stream flowing further than the Mississippi, yes from pole to pole.

From the peaks of the Vosges, towering above the college of Hylacomylus, you can almost espy Strasburg, which claims the invention of printing, Freiburg where gunpowder was first compounded in Christendom, and Spires where Protestantism first assumed its name.

The new name for the new continent, proposed by Hylacomylus in 1507, was employed about five years after by Vadianus of Vienna, who indeed, until recent researches, was mistaken for its author. But three years sooner, or in 1509, it was adopted by an anonymous writer, who then published, in the neighboring Strasburg, his "*Globus Mundi*, or a description of the world as a round globe, whereby every man, even if he do not know much, can see with his own eyes that there are antipodes whose feet are opposite ours, together with many other things concerning the fourth part of the earth recently discovered by Americus."

Here, in this title, is one secret of the special importance attached to discoveries in *South* America, and hence to the exploits of Americus. His logic of facts rooted up two dogmas which had been viewed as essential to orthodoxy, one that there could not be antipodes, and the other that the equatorial zone was too hot to be inhabited. A commentator on Albertus Magnus soon detecting in him the same heretical taint, exclaimed in 1514, as if at the fulfillment of prophecy, "Lo! Albertus, two centuries ago, conceived that the earth might be inhabited beyond the equator, as Americus has found and described it"—things not in heaven and on earth but *under* the earth.

Interest in occidental exploration turned mainly southward for another reason, namely, that the first adventurers to the

West Indies and northward, reported much codfish, but no gold. Where the carcase is there the eagles gather. *Ubi mel, ibi apes.*

Onward from 1511 the name America appears in most geographies, and from 1520 in most maps But it long denoted no more than a portion of our southern hemisphere which was itself up to the year 1548 reckoned rather an island in the West Indies than a continent. The earliest known MS. map bearing the name America, is supposed to date from 1514. It was drawn by Leonardo da Vinci, and is among the treasures of the British museum. (R. H. Major, p. 388.) The extension of the name is worth tracing, yet not easy to trace.

On the Nuremberg globe of 1520 the southern part of the new continent is inscribed, *America vel Brasilia sive papagalli terra*, and the name for some decades after seems no more than commensurate with Brazil.

The name "America" in English cannot be traced back of 1520, and then it appears in an anonymous work "touching dyvers straunge regyons and the new found landys." It is thus introduced:

> "But this new lands founde lately
> Been called America by cause only
> Americus dyd first them fynde."

A year or two later was issued the first English book descriptive of this America. In this book the new region is spelled "Armenica." A century later Lord Bacon (vol. xiii. p. 196), speaks of "Mexico, Peru, Chili and other parts of *the West Indies.*"

The Landshut cosmography of 1524 calls America *now* a fourth part of the world—but adds that it is an island. "*Quoniam mari undique clauditur insula merito appellatur.*"

Copernicus, in 1543, writes that his theory was confirmed anew by taking into account the islands brought to light in his time, and especially America, which, owing to its magnitude still unascertained, men thought to be another world, *alter*

orbis terrarum. The great astronomer was before his age in geography also. So potent is a name that men still called geographies "Ptolemies," as we now call a dictionary Webster, though so metamorphosed that Webster would not recognize it. But the Ptolemy of 1540, only three years before the death of Copernicus, inscribes the map of the western hemisphere *Novæ Insulæ*, and its southern portion *Insula Atlantica quam vocant Brasilii et Americam.* In the Ptolemy two years later there is still no collective name for the north half of our continent, but a strait runs through it labeled *per hoc fretum iter patet ad Molucas.*

The rapids at Montreal were named La Chine (China) because the pioneers there thought they could ascend the St. Lawrence even into the Celestial Empire.

Nor were these Frenchmen so far wrong as were their more learned compatriots, for in "the Mirror of the World," issued at Lyons in 1546, three years after the death of Copernicus, we read: "Since Ptolemy no land called a continent has been discovered except one called America, about which we are not well assured, and several islands. As to America (which the writer also calls *L'Améque,*) I place little reliance on those who have been there, but speak of it so obscurely that one cannot guess what their dreams mean." Two years before, the Brazil map is inscribed *America seu Insula Brazilii.* The Antwerp cosmography of 1545 inscribes the map of the Western World on the southern part *America*, and on the northern, which is a narrow, elongated prolongation, *Baccalearum*, a word which means land of cod fish.

At length, in the Venice Ptolemy of 1548, forty-seven years after the discovery of Brazil, the southern half of the New World is mapped as a continent. *A partir de* 1548 *toutes les cartes que j'ai examinées représentent l'Amérique meridionale comme un continent.* So says Santarem, but his meaning is not clear, for he seems also to say that the map of South America is inscribed *Castill del Oro*, Golden Castile.

The new name America, having mastered the Southern, that is the largest, richest and best known half of the Western world, naturally spread over its outlying peninsulas, and the Northern portion was still either viewed as nothing more than one of them, or most of it was deemed more likely to be joined to Asia than to South America.

At some date, however, between 1548 and 1570, North America had also grown in men's minds to the dimensions of a continent, or at least to half that size, for on a map of 1570, the entire new world is inscribed *America.* This map of 1570 is the most ancient of all the goodly number in the library of our Wisconsin Historical Society. Its imprint is Antwerp. This map of the new world is inscribed near the Arctic circle, *America,* sive *India Nova.* The northern and southern portions are described as the northern and southern peninsulas, but neither of them is inscribed with any general name. It is added that the southern peninsula was called Terra Firma by Spaniards.

This map also shows a southern continent encircling the whole globe and at certain points almost touching the equator.

There is a wide channel from Baffin's Bay to the Pacific, although our portion of the northern peninsula stretches so far westward that its western shore is almost in sight of Japan.

When the name America was extended from pole to pole it lost its hold on Brazil, and it would seem for a time on the two grand divisions of the New World.

In Heylin's "Cosmographie," long in great repute, published in 1652, we read that "the fourth and last part of the world is called by some and most aptly the New World, but the most usual and yet somewhat the more improper name is America." "The whole is naturally divided into two great peninsulas, whereof that towards the north is called Mexicana, and that towards the south hath the name Peruana." On Heylin's map, however, the northern peninsula is inscribed "America Mexicana," the southern "Peruana America."

One question remains, and that too important to be now considered.

It is whether Americus really landed on the American main before Columbus and Cabot. Varnhagen claims that he did, and so that America is no misnomer after all.

He must have so landed if his date is correct, and Humboldt has demonstrated that his voyages are no where willfully falsified.

But however this may be, thus much seems clear, that Americus next to Columbus best deserved to have the New World named for him, that he never sought that honor by any means fair or foul, that the name originated without his knowledge, never appeared on a map until after his death, and then was long confined to a region smaller than that he had himself discovered.

It is pleasant to see clouds of suspicion rolled away from any character. Thereafter we think better of our race, and learn to believe Satan himself not so black as he is painted. What a good time was that when men ceased to burn geometries, on perceiving that the sign plus might not be popish, and that circles might not be conjurer's rings. It was a still better day when men saw a sovereign die and yet suspected neither poison nor foul play. It is especially pleasant to be assured that the American name which is our own, and which will be in the mouths of millions forever, is neither a monument of ingratitude, nor yet owes its origin to fraud. The word America, according to etymologists, means *rich in work.* May the American continent, in all its parts, forever deserve its name!

THE RURAL CLASSES OF ENGLAND IN THE THIRTEENTH CENTURY.

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At the last annual meeting of the Academy, I had the honor to read a paper upon the rural population of England in the eleventh century, a part of which has been printed in the Transactions of the Academy. I propose, to-day, to follow up the line of inquiry there suggested, and examine the changes in the social relations of the English peasantry during the two centuries that followed. I take two centuries rather than one, simply for the reason that the materials within my reach for the twelfth century are so meagre as, by themselves, to afford no certain results; while for the thirteenth century the materials are relatively abundant and instructive. On the other hand, I go down no later than the thirteenth century, because at this epoch the social institutions of the Middle Age had reached their complete development, while after this they were subjected to rapid and fundamental changes. In the thirteenth century, the abuses of feudalism had reached their height, and remedies began to be provided. In the thirteenth century jurisprudence began to be studied; and usages that had grown up in the confusion of the preceding century, were reduced to a system, formulated, and, so to speak, codified. The thirteenth century was the century of Magna Charta, of the "Establishments" of St. Louis, of the "Customs of Beauvoisis," of the treatises of Bracton and Britton, of the legislation of Edward I., the "English Justinian." In the fourteenth century, on the other hand, the feudal ties were loosened, and the system essentially under-

mined; commerce and industry began to assume a leading place in society; in the fourteenth century serfdom was abolished. At the accession of Edward I., in 1272, English villenage was at its height; at the death of Edward III., in 1377, (just about a century later,) villenage no longer existed. The commencement of the reign of Edward I. is therefore the time which one would choose, of all others, to study the full development of feudal institutions.

It so happens that this is precisely the time at which our materials are most abundant; those materials, at all events, to which I have had access. If any thing is lacking to the full understanding of them, it is not so much in the actual existence and workings of the institutions, as in their history and formation.

Edward I., the greatest king who sat upon the throne of England between William I. and William III., has left the marks of his legislative activity in every department of English law; from him, as is natural, we derive our first clue to the solution of the problem before us. In the fourth year of his reign, 1276, a document was issued, entitled *Extenta Manerii*, which prescribes the several points to be reported upon, in what we may call the census of the manors—their extent, population and value. In this document we find three classes of tenantry specified; the *liberi tenentes* (free tenants), *custumarii* (customary tenants), and *coterelli* (cottagers)—the free tenants being again divided into those who held by military service, those who held by socage, and those held in any other manner (*alio modo*). There is no mention, by name, of *villeins*, which we know from other sources to have been at this time the appellation of the great mass of the tenantry. Here we have a general classification of the English peasantry, to which we may expect the census of the several manors to conform.

The Cartulary of the Abbey of St. Peter of Gloucester,[1] contains the register of twenty-seven manors, belonging to

[1] Historia et Cartularium Monasterii Gloucestriae, Vol. iii.

this Abbey, dating from the years 1265 and 6. This was a few years before the statute Extenta Manerii; and, as would be expected, the reports do not precisely follow the rules laid down in that instrument. They follow them, however, in the main; that is to say, they contain most of the points of information there specified, although sometimes in a different order, and with some variation in names. For example, for the second class, instead of *Custumarii*, they give *Consuetudirarii*—an equivalent Latin form in place of the latinized form of an English word. In like manner, for the third class, besides *Coterelli*,[1] we find *Coterii*,[2] *Cottagii*[3] and *Cotlandarii*,[4] forms which are obviously the same at bottom, and which appear precisely equivalent in meaning. We have thus the three classes defined in the Extenta Manerii; but besides these, we find other classes, not there mentioned—*Honilond*, *Ferendelli* and *Lundinarii*, besides a few occasional ones, described by terms which appear to be a variety of expression for one of these others. It is obvious that, however many shades of servile tenure there may have been, and however many local usages and expressions, all these must have been reducible, in the judgment of the authors of the statute *Extenta Manerii*, to three general classes—free tenants, customary tenants, and cottagers.

On examination of the documents, we find it possible to assign at least two of these additional classes to one of these principal ones. In order to do this, let us take up the several classes in their order.

The Register of each manor begins with the names of the tenants and estates of the first class. These differ very widely from each other in the amount of land held, varying from a *hide* of 160 acres (or even larger estate), down to a mere messuage and lot of land. They differ also in the terms on which these estates are held; some by military service, some by the

[1] Extenta de Churchehamme, p, 139.

[2] Extenta Berthonae Abbatis, p. 164.

[3] Extenta de Broctrope. The obligations of these are somewhat higher than the rest.

[4] Extenta de Hynehamme, p. 119.

payment of a fixed sum of money, some by a personal service of an honorable nature, as, for instance, holding[1] the towel while the Lord Abbot is washing on the day of St. Peter and Paul. These three forms of tenure would appear to be respectively Knight service, free socage and the "*alio modo*" referred to in the statute. In a few cases there is agricultural labor in addition to the money payment, but this labor is of the highest class of agricultural operations, and is always moderate and fixed in amount: as, "he shall gather and carry hay for four days."[2] The tenure likewise varies in form and degree; some hold by deed, some by ancient tenure, some for life, some at the will of the lord. What they all agree in, is in the services being free and honorable in character, and, except the military, fixed in amount and time. The number of this class differs widely in the different manors—in some there are only one or two, in others a considerable number.

In a few manors there come next to the free tenants, the tenants of *Honilond*, that is "Honey-land;" whose estates are small, and whose rent is a certain amount of honey, e. g., one gallon to each acre.[3] This is of course an equally free and certain service—equally *socage*—with those before described; the tenants of Honilond fall, therefore, in the class of free tenants—as their position in the register would indicate.

Next come the *Consuetudinarii*, the largest, and, in a sense, the most important class. In this class, instead of the irregularity of the free tenants, we find the greatest possible regularity and uniformity; all (with very slight exceptions) hold an equal amount of land (or at least an amount proportionate in quantity), and are subject to the same services. The customary land, *terra consuetudinaria*, is invariably given by *virgates*, and the *virgata* varies very widely in extent.[4] I find ten differ-

[1] Extenta de Hynetone, p. 55.

[2] Extenta de Clifforde, p. 51.

[3] Extenta de Ledene, p. 128.

[4] It is always one-fourth of a hide. The hide being a variable quantity.

ent values given to it, ranging from eighteen to eighty acres, but almost without exception the same is all estates of the same manor. The customary tenants hold either a virgate apiece, or half a virgate apiece, or a virgate in common between two. For this they render a very great variety of services, prescribed with the greatest minuteness, hardly varying at all in the same manor, and not varying much in different manors. The enumeration of these occupies in each case from a page to a page and a half in the book; and when they have been enumerated for one tenant, the Register goes on merely to give a list of the names of those holding the same estate, adding to each *et facit in omnibus sicut praedictus Robertus*, or whatever the name may be.

The *consuetudinarii* are the one class, besides the free tenants, who are found in every manor; the classes that follow are quite variable. The *Ferendelli* come next, when they are mentioned at all, and their tenures and services are precisely analogous to those of the *Consuetudinarii*, and are given in the same uniform style. Their estate is always one-fourth of the virgate, that is twelve acres where the virgate is forty-eight, sixteen acres where the virgate is sixty-four. The *Ferendellus* is the latinized form of *ferding*, a form equivalent to *farthing*, and meaning a fourth part. As the farthing is one-fourth of the penny, the ferding is one-fourth of the virgate. The name *ferdingi* occurs in some documents of the twelfth century.[1] In one manor[2] we find this estate called *quarterium*, and the tenants have no special name. The services also vary in about the same proportion to those of the *virgatarii*, as the holders of a full virgate are sometimes called. It is clear that the *Ferendelli* are properly classed with the *Consuetudiniarii*, as holding one-fourth of a virgate; indeed, sometimes they are enumerated under the same head with them,[3] just as the holders of a half-virgate are regularly.

[1] Leges Henrici Primi, XXIX.

[2] Extenta de Berthona Regis, p. 69.

[3] c. g. Manor of Bertonestret, p. 160.

The *Coterii*, *Coterelli*, *Cotlandarii* and *Cotagii*, all agree in holding *Cottagium* or "*messuagium cum curtilagio*," that is, a cottage with a small lot of ground, for which they pay in services, similar to those before described, but less in amount. They are the lowest class of laborers, and have no farms—nothing but cottage lots.

The *Lundinarii*, *Monday men*, are less easy to classify. Their place in the list is after the *Ferendelli*, and before the *Coterii*; but they occur oftener than either of these classes. Their estates vary in different manors, but do not appear to have any relation to the virgate. The "*lundinarius*," or estate of this class, is defined as "*messuagium cum curtilagio*"—thus associating them with the cottagers—and, in addition, so many acres of land, generally two, four or six: that is, small farms besides their cottage lots. The distinguishing characteristic of their tenure, implied in their name, is that of laboring one day in the week throughout the year: but this does not exclude other services. It would seem likely therefore that they were a specially privileged class of cottagers; and I feel inclined, although with some hesitation, to place them with this third category of the *Extenta Manerii*. It is true we meet the expression "*lundinaria consuetudinaria*,"[1] and the introduction to the Cartulary[2] quotes an expression, "*duo crofta, cum duabus lundinariis terrae, vocata* Mundais land *de custumariis terris manerii*;" still, in the strict sense of the word, all below the free tenants hold by customary services, that is, defined amounts of agricultural labor; and in one case, in fact, we find all of them grouped as *Consuetudinarii majores* and *minores*;[3] several times as *Consuetudinarii* simply. I am inclined, therefore, in spite of this expression, to consider these as cottagers who had received additional allotments of land, on the tenure of certain customary services, rather than as customary tenants

[1] Extenta de Culne Rogeri, p. 207.

[2] p. cvi.

[3] Extenta de Culne Sancti Alywini, p. 203.

proper, of an inferior grade,—as privileged cottagers, rather than as inferior customary tenants. In one case[1] they are in fact classed with the *Coterelli.* It may be remarked that the services of the *lundinarii* agree very nearly with those of the *Cotsetlan*, the second, or intermediate, class of peasants of the *Rectitudines.* The importance of this distinction will appear further on.

It will be observed that in this Cartulary, as in the statute *Extenta Manerii*, we hear nothing of *villeins* as a class. I have met in it with the word *villani* once and *villenagium* twice, as will be shown presently.

The result of an examination of these registers, is fully to confirm the classification of the statute *Extenta Manerii.* We find that the three classes there enumerated are distinctly mentioned here, under names essentially the same; and we find that every other class can be easily reduced to one of these three, with the single exception of the *Lundinarii*, who agree in certain points with one class, and in certain point, with another; probably what puzzles us now, was perfectly plain to the men of that time. Further, the result of this examination is to develop the fact that the class of *consuetudinarii*, or customary tenants, ranking between the other two, was distinguished by a remarkable regularity and uniformity, both of estate and of services; while the free tenants, the class highest in rank, are exceedingly variable and irregular, and the cottagers, the third in the list, are uniform, it is true, but wholly insignificant. The customary tenants enjoy a relatively very respectable standing, and their estate—the virgate, usually of 36 to 60 acres,—is a very comfortable farm, especially when it is considered that this was exclusively arable land, and that they had besides the use of the common pasture, wood-land, etc. For this farm they paid in a great multiplicity of prædial services, burdensome no doubt, but determined in amount and time. Including the *ferendelli*, this class

[1] Extenta de Ledene, p. 131.

far outnumbers all the others taken together; the *consuetudinarii* may therefore be pronounced the main body of the peasantry, and the uniformity of their estate and services shows them to have been a compact, organized body.

It remains to trace, so far as possible, the origin of these three classes. In this, our starting point must be Domesday Book. According to this, there existed throughout England, in the eleventh century, (besides certain local and occasional classes), two great classes of peasantry—the *villani*, or villagers, and the *bordarii*, or cottagers. Both these classes are found in every county, and in nearly every manor.

In the paper that I read last year, I attempted to prove that the *villani*, who are generally recognized to have been the Anglo-Saxon *ceorls*, were the representatives of the primative Village Commmunities, which recent investigations of Nasse, Maine and others, have shown to have existed in early times in England, as in other Germanic countries. The argument may be briefly summed up as follows: 1. The word *villanus* means villager etymologically; and we find no trace in the eleventh century of the servitude or degradation which are associated with the *villeins* of the thirteenth century. 2. The *villani* are, in the document entitled "*Rectitudines Singularum Personarum*," identified with the Anglo-Saxon *Geneat*, as the highest class of the peasantry; and their services are described as more moderate and of a higher order than those of the other classes. 3. In the "Exeter Domesday" the *villani* are regularly spoken of as land-holders, as distinguished from the *bordarii* on the other hand, and from the lord's demesne on the other. 5. The laws of King Edgar[1] contrast the thegn's "inland" or demesne, with the "geneat-land;" and we have just seen that the *geneat* were the *villani*.

Thus far we have proved only that the *villani* were the occupants of the "*utland*" or "tenement lands" of the manor, that the land held by them was of a very considerable amount, and

[1] I. 1.

that they held these lands on the tenure of a moderate and determinate amount of agricultural labor. But nothing so far shows in what manner these lands were distributed among these tenants. So many *villani* hold so many *hides* or *bovatae* of land, but, from all that appears, their estates may have been variable, like those of the *liberi tenentes* of the Gloucester Cartulary, or uniform, like those of the *consuetudinarii*. Fortunately we are able to supply the required proof, and to show that the *villani* held their lands in equal estates; from which we may infer with certainty that they were identical with the *consuetudinarii*, only with changed name.

The first link in the argument is supplied by the Boldon Book, a register of the property of the see of Durham, A. D. 1183, just about 100 years after Domesday Book, and 100 years before the Gloucester Cartulary. This document describes the services of the *villani*, very much as those of the *consuetudinarii* are described a century later; and what is of more importance, the *villani* are described as holding uniform estates of two *bovatae* each, amounting to 32 acres. Below the *villani* is a class of *cotmanni*, or cottagers, and there are also a number of *firmarii*, who hold similar estates to those of the *villani*, but on a privileged tenure. Here the *villani*, from the description of the services, appear to have sunk below the position which they enjoyed when the "Rectitudines" was compiled, although the services are less burdensome than those of the *consuetudinarii* of the following century.

Nearly contemporary with the Boldon Book, we have the rent-roll of a few manors of the Abbey of Abingdon in Berkshire.[1] This gives three classes of tenants precisely corresponding to the three classes of the *Extenta Manerii*, except in name. First come a few free tenants, holding estates of various sizes, by very varying tenures. Next follow the *neti*, the most numerous class, who hold equal estates of one or two virgates, and pay for them in an equal amount of specified

[1] Chronicon Monasterii de Abingdon, ii, p. 302.

services, similar to those of the *consuetudinarii*, but far less burdensome. Lastly the the *cotsetel*, who appear to correspond with the *coterii* of the thirteenth century. Now the word *neti* is evidently the Latinized form of *geneat*, which we have found to be the Anglo Saxon equivalent for *villani*. This class therefore forms another link between the *villani* and the *consuetudinarii*.

We have now seen: 1. That the *villani* of the eleventh century are identified with Anglo-Saxon *geneat;* and that the term is applied to the highest class of peasantry, the body of the Anglo-Saxon *ceorls*, who held considerable amounts of land by the tenure of predial services of a respectable character, moderate and fixed in amount. There is nothing to show the size of their individual estates at this period. 2. That in the twelfth century the *villani*, and in the south of England the *neti*,—whose name is obviously the Latinized form of *geneat* (*villanus*), held equal estates of a very respectable size on the tenure of predial services of a respectable character, moderate and fixed in amount. But they are no longer the highest class of peasantry. There is, above the *neti*, body of free tenants, whose estates are irregular in amount, often quite inconsiderable, although under a privileged tenure. 3. In the thirteenth century, that there was a class of *consuetudinarii*, who in like manner held equal amounts of land in respectable quantities, but on the tenure of predial services of a very multitudinous and burdensome character. There is above these two a body of free tenants, precisely corresponding to those of the twelfth century. Each of these classes appears to embrace the main body of the peasantry at their respective epochs; and to have been a compact and organized body.

We find then that the class which makes up the substance of the peasantry, is called by different names at these three epochs,—*villani*, *neti* and *consuetudinarii*. Further, we find that its position has deteriorated in two respects; first, by the

development of another class above them; second, by the increase in number and degradation in character, of the services by which they hold their lands. In other respects the classes are identical in character, and we may fairly infer that the *neti* of the twelfth century, and the *consuetudinarii* of the thirteenth, are the same as the *villani* of Domesday Book. This view is supported by the fact that the term *villenargium* is twice applied, in the Cartulary of Gloucester,[1] to the tenure of these *consuetudinarii*.

The question next arises, what was the origin of the *liberi tenentes*—a class that has come into existence since the time of Domesday Book; for the *liberi homines* of Domesday Book are almost exclusively confined to two or three counties (Norfolk, Suffolk and Essex); and that document gives only *villani* and *bordarii* in manors where, two centuries later, we find *liberi tenentes*. An examination of the lists of *liberi tenentes* will show, as has been already remarked, that there was a very great disparity in their condition; the Extenta Manerii distinguishes those who hold by Knight's service and those who hold by socage. Those who hold by Knight's service need no explanation; they were members of the aristocracy, who had received grants of land in the manors, but were broadly separated from the other tenants. The tenants in socage, on the other hand, appear to have been specially privileged *villani*. In the manor of Ledene, for example, nearly all the free tenants appear also as customary tenants—that is, they held two estates at a time (not at all an uncommon thing), and these two estates were of different rank,—the one free, the other servile. In some cases, again, the freehold is precisely the virgate or half-virgate of the customary estate; and the freeholder would appear to have received the special privilege of setting apart his strip of land from the strips of the rest of the villagers, fencing it off, cultivating it after his own system, and paying for it in money instead of in services. In other cases,

[1] Extenta de Lutlethone, p. 37; Linkeholte, p. 42.

the freehold is nothing but a cottage or a messuage with a garden lot. It is testified by Britton[1] that a villain may be enfeoffed by his lord, "et par tel feffement est le vileyn fraunc." It is a strong confirmation of this view, that in the only place in which the word villani occurs in this Gloucester castulary, it is used of the tenants in free socage.[2]

The free tenants in socage appear, therefore, to have been members of the class of *villani*, and to have been either advanced by way of privilege to a more favored condition, or were exempted from the burdens gradually imposed upon the rest of the class, and thus remained more nearly in their original freedom; for there seems no doubt that the villagers as a class had sunk between the eleventh century and the thirteenth —the *villani* had become *villeins*, serfs. Probably the correct view is between the two. The *villani* held by praedial services in the eleventh century, as is shown by the *Rectitudines;* the free tenants were therefore actually privileged by having these services commuted for money payments, while at the same time the services of the class from which they were raised were made more base and burdensome. This view agrees with that of Mr. Finlason, editor of Reeve's History of English Law,[3] that "our common freehold estates arose out of villenage." It is also supported by the rent roll of the manor of Addington in Kent, dating 1257–71, where we find a similar irregular and quite insignificant class of freeholders, while the mass of the tenants hold by praedial services.[4]

As regards the position of this class which I have called the body of the peasantry,—the *villani* of the eleventh century, and the *consuetudinarii* of the thirteenth,—I have attempted above to identify them with the members of the primitive village communities, which have lately been shown to have continued in existence down through the Middle Ages, and even

[1] Book II. 7, 2.

[2] Extenta de Mayesmore, p. 171.

[3] Vol. I, p. 70, note.

[4] Larking's Domesday Book of Kent, App. p. XXI.

in some cases to the present day. There are many indications that the land held by the *Consuetudinarii* of these manors were subject to certain of the obligations of the community. The equal size of the estates—the virgate, or half or quarter virgate —is a proof of something organized and regular in the assignment of the estates. In one case the estate is a virgate, "in utroque campo"[1]—another indication of regularity and organization, and undoubtedly a reference to the custom of having the arable lands in two or three fields, which were alternately cultivated and fallow. There are still clearer indications of this "three-field culture" in other manors.[2]

In saying that the *Consuetudinarii* were the representatives of the village communities, I would not be understood to imply that they all had their origin in such communities, or that all such communities had kept up their compact organization down to the thirteenth century. As Mr. Maine says:[3] "it cannot be supposed that each of the new Manorial groups takes the place of a village group which at some time or other consisted of free allodial proprietors. Still, we may accept the belief of the best authorities, that over a great part of England there has been a true succession of one group to the other." And at any rate, the "compact and organically complete assemblage of men, occupying a definite area of land,"[4] can be identified with nothing but the *villani* of the eleventh century, and the *consuetudinarii* of the thirteenth.

My object in this paper, has been to trace one of the steps in the social history of the English peasantry. Several questions have presented themselves, in the course of this enquiry, which I have not been able to answer; I think, however, that the facts and arguments here brought forward, are sufficient to establish the essential identity of the most important class of the peasantry during the period between the Norman Con-

[1] Extenta de Duntesburne, p. 194.
[2] Extenta de Lutlethone, p. 26. Linkholte, p. 42.
[3] Village Communities, p. 135.
[4] id., p. 133.

quest and the accession of Edward I. At this time the process of deterioration in their social condition had reached its lowest point, and the free villager had become a servile villein, bound to the soil, and almost a slave. After this time the history of the class is one of progress and amelioration, no longer of degradation.

NOTE.—Since writing the above paper, I have succeeded in procuring a copy of Nasse's important work, "The Agricultural Community of the Middle Ages," which I tried in vain to secure while preparing it. Prof. Nasse's attention is given rather to the organization of the community, than to the classification of the peasantry; he gives a few pages, however, to the latter, and his views are in the main the same as those here presented. Especially he takes the same ground as to the identity of the *consuetudinarii* with the *villani* (p. 39), and as to the lundinarii being "a peculiar kind of 'cotarii'" (p. 42). It may be remarked that his authorities, for the thirteenth century, are entirely different from mine. He makes no reference to the Gloucester Cartulury, and on the other hand I have not had access to the documents to which he refers. I need not say that I have been on my guard against drawing conclusions broader than the facts will warrant. I have made use—for this period—of only a small group of manors in the west of England, and, what is of more importance, the property of an ecclesiastical corporation, where we might expect to find peculiar usages, and perhaps a more liberal order of things. It is gratifying, therefore, to find my conclusions supported by researches based upon such a mass of evidence as that used by Prof. Nasse.

RANKS AND CLASSES AMONG THE ANGLO-SAXONS.

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[Only that portion of this paper is here printed, which treats of the Eorls.]

The accepted doctrine as to the original classification among the Anglo-Saxons, is that the entire population fell into two distinct classes, *eorls* and *ceorls*, terms which have been corrupted into the modern *earl* and *churl*, but which originally implied nothing more than a certain ill-defined hereditary distinction in rank, hardly so strong as that of *noble* and *freeman*. This view, which is held by Lingard, Palgrave, Kemble, Hallam and Stubbs, is nowhere better expressed than by Mr. Freeman.[1] "In the primary meaning of the words, *eorl* and *ceorl*—words whose happy jingle causes them to be constantly opposed to each other—form an exhaustive division of the free members of the state. The distinction in modern language is most nearly expressed by the words *Gentle* and *Simple*. The ceorl is the simple freeman, the mere unit in the army and the assembly, whom no distinction of birth or office marks out from his fellows." This is, as I have said, the prevailing view at present; and, so far as the word *ceorl* is concerned, there is no question as to its correctness; but with regard to *eorl*, I am inclined to go back to the earlier opinion, held by Thorpe[2] and Lappenberg,[3] and to take the ground that it never designates

[1] Norman Conquest, i. p. 37.

[2] Glossary to "Ancient Laws and Institutes of England."

[3] Vol. ii. p. 313.—Compare also Waitz, Deutsche Verfassungsgeschichte, i. p. 76. Waitz remarks, as a matter of course, that the Anglo-Saxons, like the Franks, had no hereditary nobility. To explain this departure from the prevailing institutions of the Germanic nations, we must consider, in the first place, that the German nobility was

an hereditary rank, but always a personal office or relation. It is admitted that this was the case in the eleventh, and partially in the tenth century; it appears to me that the weight of evidence is as to having always been so—that it never essentially changed its meaning until after the Norman Conquest, when, in its modern form *earl*, it became an hereditary title of nobility.

The passages in which the word *Eorl* occurs, may, for our purposes, be classified into three groups:—the early Kentish laws of the seventh century; the laws of Alfred and his successors; and the Saxon Chronicle and other works of literature. Between the two groups of laws there is an interval of about 200 years; and it is to be noticed that the arguments for "the distributive character of the words" *eorl* and *ceorl*, i. e., as, with the meanings "Nobleman" and "freeman," making up the entire free population, are derived wholly from two or three passages in the later laws. Taken by themselves, neither the early laws nor the scattered passages in the Saxon Chronicle and other documents, would suggest any such meaning. Now it may fairly be urged that the use of the words in the seventh century, if explicit enough, is sufficient by itself to establish their original signification.

First, however, it will be proper to compare the English *Eorl* with the Danish *Jarl*, which is of course the same word, and may fairly be presumed to have the same original meaning. The settlers of Kent, it will be remembered, in which kingdom we first meet the term as a legal one, were neither Angles nor Saxons, but Jutes, or natives of the peninsula of Denmark. That is, while the English as a whole are more nearly related to the Scandinavians than to the Germans, the Kentishmen stand in a peculiarly near relation to the Scandi-

very limited in numbers—among all the Saxons, there were only about twenty-five noble families; and in the next place, that they migrated, not under kings, but chiefs—*heretoga*—and that these chiefs und ubtedly included whatever nobles chose to join in the enterprise. It is hard to see, therefore, what can have been the origin of the eorls as an hereditary class.

navians. It may be assumed therefore, that the Eorls of Kent were identical with the Jarls of Denmark and Norway. Now the Scandinavian Jarls were not an hereditary class of noblemen, but were officers or magistrates appointed for life or pleasure.[1] It is significant too, that the late well-established use of Earl, as the governor of a province, is attributed to Danish influence.

In the laws of Kent its use is never inconsistent with this. *Ceorl* is used, as it always is, for the common freemen—"peasant," if we choose to employ this term, but not by any means a low order of peasant; the *ceorls* are represented as landowners and even slave-owners, and may perhaps be best described by the term "yeoman." The legal standing of the *Eorl*, as represented by the *bot* or composition, is double or triple that of the *Ceorl;* but this is by no means a proof of difference in hereditary rank, but may equally well indicate a personal authority or a special relation to the king.

Turning to the Saxon Chronicle for this early period, we find this conclusion strengthened. In a speech of King Wihtred of Kent, A. D. 692, we read: "Kings shall appoint Earls and Ealdormen, Shire-reeves and Judges" (eorlas and ealdermen, scire-revan and domesmenn.) From this it appears clearly that the *Eorls* were not an hereditary, but an appointed class. In the same document, A. D. 657, we read (of the King of Mercia): "to all his thegns, to the archbishop, to the bishops, to his earls." Note the word "his," showing a personal rather than an hereditary relation. Again, A. D. 675 (in Mercia): "neither king, nor bishop nor earl nor no man." This, although not so explicit as the others, certainly implies no hereditary rank. The above are all the instances of the use of the word *eorl* which I have been able to find before the time Alfred except in works of poetry. I think it will be

[1] Dahlmann, Gesch, Danemarcks, ii. pp. 88 and 305. The same view is taken by the latest Norwegian historians, Munch and Keyser, as I am informed (being myself ignorant of Norwegian) by Mr. R. B. Anderson, Instructor in the Scandinavian languages in the University of Wisconsin.

admitted that they clearly support the view that the English *eorls* were, like the Danish *jarls*, appointed officers or magistrates, not hereditary noblemen.

Let us now pass to the later group of laws, those of Alfred and his successors. Here we find four passages in which the words *Earl* and *Ceorl* are coupled in what appears to be a distributive use: these are, Laws of Alfred, 4, "all degrees, whether earl or ceorl"; Judicia Civitatis Lundoniæ: Intr.: "as well eorlish as ceorlish"; Laws of Ethelred, VII. 21: "we know that through God's grace a thrall has become a thane, and a ceorl has become an eorl." Of Peoples' Ranks and Laws: "each according to his condition, eorl and ceorl, thegen and theoden." These four are, I believe, all the instances of the so-called distributive use of the terms Eorl and Ceorl; upon these, therefore, the prevailing theory is exclusively founded.

It may be observed, in the first place, that in the Latin translation of these documents, dating probably from the twelfth century, Earl is uniformly rendered by *comes*, a word which has more than one use, but which certainly never has the general meaning of gentlemen or noblemen, but always that of some special rank or office, as follower, magistrate, or, in later times, count or earl. I do not rest much upon this argument, for the reason that this translation was made at a time when *earl* had a fixed meaning in English, as designating particular grades of nobility, so that it is very easy to suppose that the translator confounded the meaning of the word in his own day with that which it had in the original document. It is more to the purpose to remark that we have an equal number of cases, in genuine Latin laws of the tenth century,[1] in which *comes* and *villanus* are used precisely as these same words are used in the translation just referred to, and as *earl* and *ceorl* are used in their originals. If therefore *earl* and *ceorl* are distributive, we have a right to infer that *comes* and *villanus* were

[1] Aeth. Decr. Episc. 6.—Decr. Sap. Ang. 3 and 6.—Eadm. Conc. Cul., vii.

so; that is, that all persons who were not ceorls or peasants (the accepted meaning of *villanus*) were *comites*—a use of *comes* which is certainly inconsistent with any accepted meaning of this word. It is still more to the purpose to note that *thegn* is joined with *ceorl* in precisely this same way (Ord. resp. the Dun-saetas, 5); and the inadequacy of the argument is proved by noticing that in Ethelred's Law *thrall* and *thegn* are joined, exactly as *ceorl* and *earl* are. Now a thrall was a slave; and it certainly was not true that all who were not slaves were thegns. The coupling of *earl* and *ceorl* is easiest explained by the jingle, as that of *thrall* and *thegn* is by the alliteration. It may be noticed too that the Norsemen made use of precisely the same jingle—*jarlar ok karlar*. As to the explicit statement (Eth. vii, 2) that a ceorl might become an earl, Mr. Freeman is obliged, in consistency with his view of the strictly hereditary rank of the earl, to question the correctness of the statement. "I may remark that the jingle of beginnings and endings has carried the lawgiver a little too far. In strictness the Ceorl could not become an Earl (in the older sense of the word.)[1]

When we leave these four passages, we find that the use of the word *Earl* in the ninth and tenth centuries is perfectly consistent with what we find in the sixth. It is usually assumed that the later use of *Earl* as a governor of several counties was introduced by Cnut; and it is certain that Cnut did reorganize the kingdom and establish a new grade of governor with this title. It is no less certain, however, that even before his time the word was frequently used to designate magistrates, as equivalent to *ealdorman*, (see Bosworth, Anglo-Saxon Dictionary, s. v.), and that this use occurs even in legal documents. In the Laws of Edward and Guthram (12) we find: "If any man wrong an ecclesiastic or a foreigner, then shall the king, or the earl there in the land, and the bishop of the people, be unto him in the place of a kinsman and of a pro-

[1] Norm. Conq. i. p. 95, n. 1.

tector." Again, in the Saxon Chronicle (A. D. 963); "neither king, nor bishop, nor earl, nor shire-reeve." In these two passages the earls are certainly not an hereditary class, but persons invested with power and authority. This view is supported by the fact that in the Saxon Chronicle this word is regularly used for the Danish jarls.[1]

The use of the word in poetry is not inconsistent with the view here presented. In Beowulf,[2] for example, the earliest Anglo-Saxon poem, it is translated by Mr. Thorpe, 20 times by *warrior*, 13 times by *earl*, 7 times by *man*, *hero* once, and *noble* once: where it is translated *noble*, (v. 4488) either of the other terms would have made equally good sense. Indeed, if one always rendered it "man," using the word with the same latitude that we do in English (e. g., as in the expressions, "This was a man," "a company of so many men," "he was such a one's man") it would answer fairly enough; in several verses (3458, 4272 and 6327) we find *eorlscipe* translated "bravery"—*virtus*. (Noble is regularly *aetheling;* see vv. 1968, 2592). This is consistent likewise with the song of the Battle of Brunanburh (Sax. Chron. A. D. 937), where Athelstan is called "Eorla Dryhten," (lord of earls); again, (A. D. 957), we read of Edgar "thaet cyningas and eorlas georne to him bugon" (that kings and earls willingly submitted to him). In Christian poetry Christ is called "Eorla hleo," refuge of men.

There is, however, one poem of very great antiquity, the Rigsmal, which certainly appears to support the view that the Danish jarls were originally an hereditary class; it is cited by Munch and Keyser to show that this was the mythical or praehistoric meaning, although they hold without any question that its historical meaning was that here presented. In this poem the three classes, of nobles, commons and slaves are represented as descended from three brothers, Jarl, Karl and

[1] e. g., A. D. 871, 915.

[2] Most of these references to Beowulf were furnished to me by my friend, Mr. Thos. Davidson, of St. Louis.

Thrall. Inasmuch as my concern is simply with the historical value of the term eorl, as applied to the Anglo-Saxon classes, its mythical or prae-historic value makes no difference to my argument. I will only mention, to show how little consistency there is in this mythical genealogy, that among the sons, not of Jarl, but of Karl are, besides Smidr (Smith) and Bondi (peasent); Thegn, which is the title of the later nobility in England, and which even as early as Beowulf (v. 3293, eald-or Thegna, *prince of Thegns*) indicated a vassal of rank; and Hauldr, the designation, according to Dahlmann,[1] of "a genuine primitive nobility," and which we find also among the Danish invaders of England,[2] and afterwards as the highest nobility in the Danish parts of England.[3]

We are warranted, therefore, in the conclusion that, although there are a few expressions a little hard to explain, there is nothing really inconsistent with the view supported by the great weight of evidence—that *Earl* originally designated some purely personal rank or position—one to which even a peasant, *ceorl*, could rise. It must have been the title either of a class of officers or magistrates, or of the personal followers of the king.

[1] ii., p. 304.
[2] Sax. Chr., A. D. 905, 911, 915.
[3] Of Wergild's, North County Laws, 4.

PROCEEDINGS.

EIGHTH MEETING OF THE ACADEMY.

JULY 15, 1872.

The Academy met, pursuant to requirement of By-Laws, in the capitol, this evening at 7½ o'clock.

Present, Dr. J. W. Hoyt, President; Dr. A. L. Chapin, Vice-Presdent; Prof. T. C. Chamberlin; Geo. P. Delaplaine, Treasurer; W. Dudley, Esq., Director of the Museum, and Dr. John E. Davies, acting Secretary; President Hoyt in the chair.

The minutes of the preceding meeting having been read and approved, the secretary read letters from some ten of the members, regretting their inability to attend on account of anticipated absence from this state at date of meeting, and suggested whether it might not be better, under the circumstances, to confine the present meeting to the transaction of necessary business; which suggestion, on motion of Dr. Chapin, was approved.

Some matters pertaining to the printing and publication of the Academy's next volume of Transactions, and of the Bulletin, were considered, but without action.

The President called attention to the deficiences of the Museum, and urged the necessity for additional cases for specimens already here and for others soon expected.

On motion, Prof. Chamberlin was appointed a committee to draft plans for cases and to submit the same to the President, Secretary and Director of the Museum, for their approval and presentation to His Excellency the Governor of the State.

The names of Prof. Joseph E. Emerson, of Beloit College, J. B. Reade, C. E., of Milwaukee, and Prof. Alexander Kerr of the State University, were presented for annual membership and referred to the standing committee on Nominations.

On motion, the Academy adjourned *sine die*.

JOHN E. DAVIES,
Acting Secretary.

NINTH MEETING OF THE ACADEMY.

CITY HALL, Milwaukee, September 24, 1872.

The Academy met pursuant to requirement of By-Laws, and notification of the press, at the old City Hall in Milwaukee, on the evening of September 24, 1872, being Thursday of the week of the annual exhibition of the Wisconsin State Agricultural Society.

Attendance small, on account of the distractions incident to the exhibition; the President, Dr. J. W. Hoyt, in the chair.

Dr. I. A. Lapham, General Secretary, read the minutes of the last meeting, which were formally approved.

The Secretary also submitted some remarks touching the difficulty, if not impracticability, of holding successful meetings of the Academy during the progress of the state industrial exhibitions, and proposed amendment to sec. 2 of the by-laws, providing that

> Hereafter there shall be but *two* regular meetings of the Academy annually, to-wit: the Annual Meeting, to be held, as now, on the 2d Tuesday of February, and a summer meeting, to be held at such time and place as shall be determined by the General Council.

Which amendment was put upon file and record, for action at the next regular meeting.

On motion, the thanks of the Academy were tendered to His Honor the Mayor of Milwaukee, the City Clerk and other officers of the municipality, for the use of the City Hall and its preparation for this meeting.

Ajourned *sine die*.

I. A. LAPHAM,
General Secretary.

THIRD ANNUAL MEETING.

First Session.

ACADEMY MUSEUM, Feb. 11, 1873.

The Academy met at their room in the State Capitol, in the evening of this day, at 7½ o'clock; attendance of members and citizens large.

The President, Dr. J. W. Hoyt, in the chair.

The acting Secretary, Dr. John E. Davies, read the minutes of the last two meetings, which were approved.

The President gave an account of the work of the year.

Report of Treasurer deferred until a subsequent session.

The following named gentlemen were put in nomination for membership, and unanimously elected under a suspension of the rule requiring reference to the standing Committee on Nominations:

R. M. Bashford, Esq., Madison.
Prof Joseph Emerson, Beloit College.
Prof. Alexander Falk, Racine College.
Rev. F. M. Holland, Baraboo.
Prof. Alexander Kerr, State University.
Capt. John Nader, U. S. Corps of Engineers, Madison.
A. C. Parkinson, Esq., Madison.
S. F. Perkins, Esq., Burlington.
E. D. Reade, C. E., Milwaukee.

Prof. John E. Davies submitted the following as amendments to the Constitution and By-Laws:

(1) That the titles of the Departments of the Academy be changed so as to read, "Department of Science," "Department of Philosophy," "Department of Art," "Department of Letters."
(2) That the initiation fee of annual members be hereafter five dollars in place of ten; the annual fee two instead of five.
(3) That there be a perminent publishing committee, to consist of the President, the Vice Presidents—one of whom shall be a resident of Madison—and the General Secretary.

On motion, a committee consisting of Prof. W. F. Allen, Dr. I. A. Lapham and Dr. A. L. Chapin, was appointed to nominate officers of the Academy for the ensuing three years.

The reading of papers being now in order, the following were read and discussed, to wit:

Population and Sustenance, by Dr. G. M. Steele, President of Lawrence University.
On the Rural Classes of England in the Thirteenth Century, by Prof. Wm. F. Allen, of the State University.
Vexed Questions in Ethics, by Rev. F. M. Holland, of Baraboo.
On the Requisites Reform of the Civil Service of the United States, by the President, Dr. J. W. Hoyt.

The following papers by Dr. P. R. Hoy, of Racine, owing to his detention at home by sickness, were read by title only, to wit:

On the place of Natural History in Primary Education:
On some Pecularities of the Fauna of Wisconsin: and
On the Classification of Animals.

The Academy adjourned to meet at 9 o'clock, A. M., to morrow.

Second Session.

FEBRUARY, 12—9 O'CLOCK, A. M.

The Academy met pursuant to adjournment; President Hoyt in the chair.

The Treasurer submitted his annual report for the fiscal year just closed, of which the following is a copy:

WISCONSIN ACADEMY OF SCIENCES, ARTS AND LETTERS,
OFFICE OF THE TREASURER,
MADISON, FEBRUARY 13, 1873.

Hon. J. W. HOYT, *President of the Wisconsin Academy of Sciences, Arts and Letters:*

SIR: I have the honor to report the financial condition of the Academy, as follows:

RECEIPTS.

Total amount fees received from 49 members	$542 25
To fees received from ten life members	1,000 00
To interest on loan of same	100 00
	$1,642 25

DISBURSEMENTS.

Disbursed in payment of warrants as per vouchers heretofore and herewith furnished	$509 00
Balance in treasury	$1,133 25
Placed to credit of Life Members' Permanent Fund	$1,000 00
Total credit of general fund	133 25
	$1,133 25

[Signed] GEO. P. DELAPLAINE,
Treasurer.

In the absence of the members of the Standing Committee on Finance, the Treasurer's report was referred to a special committee, consisting of Prof. T. C. Chamberlin, Gen. John Lawler and Prof. James H. Eaton, who subsequently reported as follows:

We have this day examined the above report and account of the Treasurer, and compared the same with the vouchers, and find the same in all respects correct.

[Signed] T. C. CHAMBERLIN,
JAMES H. EATON,
Committee.
(General Lawler being absent.)

MADISON, February 12, 1873.

On motion, the President, Dr. Hoyt, and Messrs. Chamberlin, Steele, Lapham and Irving, were appointed a committee to examine the several bills now pending before the Legislature for a Geological Survey of the State, and to make such suggestions in regard to the same as said committee may deem advisable.

The following papers were then read and discussed:

On the Relation of the Sandstone, Conglomerates and the Limestone to the Azoic of Baraboo Valley, by Prof. J. H. Eaton, of Beloit College.
On the Geographical Distribution of the Quartzite of Sauk and Columbia counties, by Prof. T. C. Chamberlin, of State Normal School, Whitewater.
On the Metamorphic Rocks of Portland, Dodge county, with remarks on the occurrence of similar rocks in other parts of the state, by Prof. R Irving, State University.
Results of Analysis of certain Ores and Minerals, by Prof. W. W. Daniells, State University.
Analysis of Madison Building Stone, by T. E. Bowman, of State University.
Results of Analysis of Black River Falls Iron Ore, by Prof. R. Irving.

The Academy then adjourned until 2 o'clock P. M.

Third Session.

FEBRUARY 12, 2 o'CLOCK P. M.

The Academy met pursuant to adjournment, the President in the chair.

The committee appointed to nominate officers, made the following report, which was unanimously adopted:

FOR PRESIDENT—Dr J. W. Hoyt, Madison.

FOR VICE PRESIDENTS—
Department of Natural Sciences—Dr. P. R. Hoy, Racine.
" *of Social Science*- Rt. Rev. Wm. E. Armitage, Milwaukee.
" *of Arts*—Dr. I. A. Lapham.
" *of Letters*—President A. L. Chapin, Beloit.
FOR GENERAL SECRETARY—Prof. John E. Davies, Madison.
FOR TREASURER—Gen. Geo. P. Delaplaine, Madison.
FOR DIRECTOR OF MUSEUM—Prof. R. Irving, University.
FOR LIBRARIAN—D. S. Durrie, Esq., Madison.

FOR SECRETARIES OF THE DEPARTMENTS—
Natural Sciences—Prof. J. H. Eaton, Beloit.
Social and Political Sciences—Rev. F. M. Holland, Baraboo.
Arts—Prof. W. J. L. Nicodemus, State University.
Letters—Prof. J. B. Feuling, State University.

FOR COUNSELORS—
Department of Natural Sciences—Prof. P. Englemann, Milwaukee; Prof. T. C. Chamberlin, Whitewater; Prof. J. C. Foye, Appleton.
" *of Social and Political Sciences*—Pres. G. M. Steele, Appleton; Rev. Charles Caverno, Amboy, Ill.; Hon. S. D. Hastings, Madison.
" *of Arts*—Wm. Dudley, Esq., Madison; Capt. John Nadir, U. S. A.; Hon. J. I. Case, Racine.
" *of Letters*—Prof. Jos. Emerson, Beloit; Hon. Lyman C. Draper, Madison; Prof. W. F. Allen, State University.

Prof. W. W. Daniels submitted an amendment to the by-laws, providing that the officers of the Academy shall hereafter be elected *by ballot.*

The following amendment to the by-laws, submitted by Dr. I. A. Lapham at the ninth regular meeting of the Academy, was taken from the file and adopted, *nem con.*, to-wit:

Instead of three meetings annually, as heretofore, there shall hereafter be but *two* namely: The Annual Meeting, to be held at Madison, on the 2d Tuesday of February, and a Summer Meeting, to be held at such time and place as shall be determined by the General Council.

The following papers were then read and discussed, to-wit:

On the Occurrence of Gold and Silver in Minute Quantities in Quartz, in Clark County, by Prof. R. Irving, State University.

Evidence bearing on the Methods of Upheaval and Fluctuations of the Quartzite of Sauk and Columbia Counties, by Prof. T. C. Chamberlin, Whitewater.

Potentials and their Application to Physical Science, by Prof. John E. Davies, State University.

On Kerosene Oil, by E. T. Sweet, of the State University.

On the Improvement of the Wisconsin River, by Prof. W. J. L. Nicodemus, State University.

On the Correlation of Forces, by E. D. Reade, C. E., Milwaukee.

Adjourned to 7½ o'clock P. M.

Fourth Session.

FEBRUARY 12, 7 o'clock P. M.

Academy met pursuant to adjournment.
Reading and discussion of papers resumed:

On Railway Gauges, by Prof. W. J. L. Nicodemus, State University.
Fish Culture in Wisconsin: its Claims upon the State, by the President, Dr. J. W. Hoyt.
On Several Points in the Pronunciation of Latin and Greek, by Prof. S. S. Haldeman, of Philadelphia, Corresponding Member.
The Metaphysics of Science, by Prof. S. H. Carpenter, State University.
On the Relative Import of Language, by Prof. J. B. Feuling, State University.

The reading of the papers prepared for this meeting having been concluded,

President Hoyt, from the committee on Geological Survey, reported a bill, which had the approval of the Academy, and was authorized to be laid before the proper committee of the legislature.

On motion, it was

Resolved, That papers intended for publication in the Transactions be examined by the Vice President and Secretary of the department to which they belong, and then by the President and General Secretary.

The following named persons were nominated and duly chosen corresponding members of the Academy:

Dr. Edmund Andrews, M. D., Chicago.
Dr. Theodore Gill, M. D., Washington.
F. V. Hopkins, M. D., Baton Rouge, La.
Prof. W. B. Porter, St. Louis, Mo.

On motion, it was

Resolved, That the next meeting be held at Appleton, at such time in the month of July, as shall be determined by the President and General Secretary.

The Academy then adjourned *sine die*.

[Signed] I. A. LAPHAM,
General Secretary.

Tenth Meeting—Memorandum.

Owing to the absence of the President of the Academy in Europe, and the inability of many other officers and members to be present, the July meeting of the Academy was not held.

J. E. DAVIES,
General Secretary.

MADISON, July, 1873.

ELEVENTH MEETING OF THE ACADEMY.

ACADEMY ROOMS, December 12, 1872.

Pursuant to a call of the Secretary—the President being still absent in Europe—a special meeting of the Academy was held at their rooms, December 12, 1873, at 4½ o'clock P. M.

Prof. J. B. Parkinson of the State University was called to chair.

Prof. W. F. Allen announced the sudden death, in New York city, on the 6th inst., of the Rt. Rev. Bishop W. E. Armitage, S. T. D., Vice President of the Academy, and spoke of the great interest manifested by the deceased in all that concerns true progress, and particularly of his special interest in the work of the Academy, contributing to its success, as he did, not merely by the influence of his name and position, but also as an active member in all its meetings.

Remarks were also made by Profs. Parkinson and Davies, and by Hon. W. W. Field and Daniel S. Durrie, Esq.

Letters were read from President A. L. Chapin, of Beloit College, and Dr. I. A. Lapham, of Milwaukee, expressing their regret at not being able to attend the meeting, and uniting in the tribute of respect to their deceased associate.

On motion, a committee was appointed, consisting of Professors W. F. Allen and J. E. Davies, of the State University, and Daniel S. Durrie, Esq., Librarian to the State Historical Society, to draft resolutions expressive of the sense of the meeting.

The committee, through their chairman, reported the following resolutions, which were adopted:

Resolved, That the Academy has learned, with deep regret, of the death of its late Vice President, the Right Reverend Bishop Wm. E. Armitage, S. T. D.; and that it recognizes that in him it has lost an active and useful member, who has been identified with its interests from the beginning, and to whom a large share of its success is due.

Resolved, That these resolutions be published in each of the daily papers of this city, and that a copy of them be transmitted to the family of the deceased.

The Academy then adjourned *sine die*.

J. E. DAVIES,
General Secretary.

FOURTH ANNUAL MEETING.

First Session.

ACADEMY ROOMS, Feb. 10, 1874.

The fourth annual meeting of the Academy was commenced in these rooms on Tuesday evening, February 10, 1874, at

7½ o'clock; their being a large attendance of members and citizens; the President, Dr. J. W. Hoyt, in the chair.

The minutes of last previous meetings, regular and special, were read by the Secretary and approved.

The Librarian presented his report and tendered his resignation. Report approved; resignation subsequently withdrawn at the request of the President and many members.

The President of the Academy made appropriate and feeling remarks upon the death of the late Rt. Rev. Bishop Armitage, Vice President for the Department of the Social and Political Sciences and expressed a desire that some member of the Academy should be chosen to prepare a carefully written biographical sketch of his life and labors.

Being obliged to retire from the meeting on account of severe indisposition the President then called Dr. E. B. Wolcott, of Milwaukee to the chair, who presided during the remainder of the evening's session.

Prof. Davies next read a "Preliminary Paper on the Magnetic Rotatory Polarization of Light," illustrated by diagrams and electro-magnets.

A committee of arrangements, consisting of Professors Irving, Chamberlin and Eaton, was appoited to provide for the public evening lecture by Dr. Edmund Andrews, of Chicago, Corresponding member; also to assist in the discharge of other duties preparatory to the meeting.

On motion, the rules were suspended and the following named persons were elected annual members of the Academy to wit:

Prof. J. D. Butler, LL. D., Madison;
Prof. Edward Searing, Milton;
H. E. Copeland, Esq.;
John Bascom, President elect of the State Uuiversity;
J. W. Bashford, Esq., Madison;
Thos. L. Cale, Esq., La Crosse;
W. G. Ballentine, Esq., Ripon.

Adjourned till to-morrow at 2 o'clock P. M.

Second Session.

FEBRUARY 11,—2 o'clock P. M.

The Academy met pursuant to adjournment; the President, Dr. J. W. Hoyt, in the chair.

Reading and discussion of papers resumed.

The first paper was by Rev. F. M. Holland, of Baraboo, on "Records of Marriages," after which, on motion of Prof. J. D. Butler, a committee, consisting of Dr. Hoyt and Professors Kerr and Feuling, was appointed to wait on the proper legislative

committee and to urge such changes relating to marriage certificates as are recommended in Mr. Holland's paper.

The remainder of the afternoon was occupied with the reading and discussion of the following papers :

On the Naming of America, by Prof. J. D. Butler, LL. D., Madison.
On Ranks and Classes among the Anglo-Saxons, by Prof. W. F. Allen, A. M.
On the Derivation of the Word *Church*, by Prof. J. B. Feuling, Ph. D., State University.
On some Azoic Outcrops in Wisconsin not previously noticed, by Prof. T. C. Chamberlin, A. M., Beloit College.
On some Stone Implements in the Cabinet of Beloit College, by Prof. James H. Eaton, Ph. D., Beloit.

Adjourned till 7½ P. M.

Third Session.

FEBRUARY 11—7½ O'CLOCK, P. M.

Pursuant to adjournment and to published notice, the Academy met in the Assembly Chamber to receive a paper in the form of a lecture, from Dr. Edmund Andrews, A. M., M. D., of Chicago, Corresponding Member, on the views of Lyell and Lubbock on the antiquity of the human remains found near Abbeville, France; also on the age of the remains in the cave of the Fieriere, at the head of Lake Geneva, Switzerland, and on the rate of the land deposits, etc., around Lake Michigan.

The President, Dr. J. W. Hoyt, in the chair.

The paper was well illustrated with diagrams and charts, and was listened to with great attention. The authors, conclusions were, that, from all the sources examined by him, there was no sufficient ground for claiming an antiquity of more than 5,000 to 7,500 years for the oldest human remains heretofore discovered.

At the conclusion of the paper, which occupied one hour and a quarter, a vote of thanks to Dr. Andrews was moved by Dr. E. B. Wolcott, and unanimously carried; whereupon the Academy, on motion, adjourned to meet in the rooms of the Academy the following day at 2 o'clock P. M.

Fourth Session.

THURSDAY, February 12, 9 o'clock A. M.

The Academy met pursuant to adjournment.

President Hoyt in the chair.

The following papers were read by title only, to wit:

"On some peculiar Terminal Moraines," and "On the Relation of the Magnesian Limestone of Wisconsin to the Manufacture of Lime," both by Prof. T. C Chamberlin.

Prof. W. F. Allen offered the following substitute for the constitutional amendment placed on file by Prof. John E. Davies at a former meeting, to wit:

"With a view to the convenience of holding meetings, the Departments of the Academy shall be arranged in two classes, to be denominated respectively, the Class of Science and the Arts, and the Class of Philosophy and Letters, which latter shall include the Department of the Social and Political Sciences. This amendment to be an addition to section four of the constitution."

Which was laid over for one year.

The law requiring an initiation fee of $10, and an annual fee of $5, was changed so as to read, "an initiation fee of $5, and an annual fee of $2."

On motion, the transaction of further business was postponed until the evening session.

Adjourned till 2 P. M.

Fifth Session.

THURSDAY, 2 o'clock, P. M.

The Academy met pursuant to adjournment; the attendance of members and citizens being unusually large.

President Hoyt in the chair.

The following papers were read and discussed:

On the Fauna of Wisconsin—certain peculiarities thereof, by Dr. P. R. Hoy, Vice President for the Department of the Natural Sciences, read by Prof. J. D. Butler.

History of the Science of Hydraulics, by Col. W. J. L. Nicodemus, Professor in the University of Wisconsin.

On the Influence of Duties on Imports on the Value of Gold, by John Y. Smith, Esq., Madison.

On the strength of Materials, by John Nader, U. S. Asst. Engineer.

The Academy adjourned till 7½ o'clock.

Sixth Session.

THURSDAY, 7½ P. M.

The Academy met pursuant to adjournment, with a full attendance.

The President in the chair.

Papers were read as follows:

On the Philosophy of Evolution, by Prof. S. H. Carpenter, State University; and

On the Amount of Arsenic absorbed by the Human Liver, by Prof. W. W. Daniells, State University.

Remarks on the latter paper were made by Drs. Joseph Hobbins and E. B. Wolcott; after which, on motion, the Academy went into a business session.

Dr. Wolcott reported favorably on the nomination of Dr. Ely Van De Warker, of Syracuse, N. Y., who was thereupon elected a Corresponding Member.

The following persons were also nominated for corresponding membership, and elected under a suspension of the rules:

Lewis H. Morgan, LL.D., Rochester, N. Y.
T. W. Harris, LL.D., St. Louis, Mo.;
Herbert P. Hubbell, Esq., Winona, Minn.;
John A. McAllister, Esq., Philadelphia, Pa.

Prof. O. M. Conover, Madison, and Prof. Thure Kumlein, of Albion College, were elected Annual Members.

The Treasurer of the Academy presented his annual report, as follows:

WISCONSIN ACADEMY OF SCIENCES, ARTS AND LETTERS,
Office of the Treasurer,
MADISON, February 10, 1874.

Hon. J. W. HOYT, *President:*

SIR: I have the honor to report the financial condition of the Academy as follows:

Total amount of fees and dues received from 51 members	$592 25
Fees received from 10 Life members	1,000 00
Interest on loan of same	100 00
	$1,692 25
Amount disbursed in payment of warrants to date	555 55
Balance in treasury	$1,136 70
Placed to credit of Life Members' Fund	$1,000 00
Placed to credit of General Fund	136 70

G. P. DELAPLAINE, *Treasurer.*

The report was read and referred to a committee consisting of members Nicodemus, Wolcott and Durrie, who, after a careful examination, reported the same back with an endorsement of its correctness.

Prof. Daniells called up his amendment to the constitution, providing that hereafter the election of officers shall be by ballot, which was adopted, *nem con.*

On motion, a committee consisting of Dr. J. W. Hoyt, Dr. E. B. Wolcott, Ex-Gov. Nelson Dewey, and Rev. J. W. Bashford, was appointed to procure the printing of the Academy's Transactions.

President Hoyt submitted a proposition that the constitution be so amended as to make the President and Secretary of the Wisconsin State Horticultural Society members *ex-officio* of the General Council of the Academy; also the following motion:

That the Treasurer be instructed to omit the collection of further dues from the Secretary of the State Historical Society.

The proposition was put on file and the motion was adopted.

Secretary Davies offered the following, which was unanimously adopted:

Resolved, That the President is hereby requested to designate some member of the Academy to prepare a suitable sketch of the life and labors of the late Rt. Rev. Bishop Armitage, Vice President for the Department of the Social and Political Sciences, for publication in the next volume of Transactions.

On motion, a ballot was taken for a Vice President of the Department of the Social and Political Sciences, to fill the vacancy caused by the death of Bishop Armitage, which resulted in the election of Rev. Dr. G. M. Steele, D. D., President of Lawrence University, Appleton.

Dr. E. B. Wolcott, of Milwaukee, was chosen to succeed Dr. Steele as Counselor for said Department.

In pursuance of a proposition submitted at the third annual meeting, there was created the new Department of Speculative Philosophy; and on motion a ballot was taken for the two principal officers thereof, with the follow result:

Vice President—Prof. S. H. Carpenter, LL.D., State University.
Secretary—Rev. F. M. Holland, Baraboo.

The following resolutions were adopted:

Resolved, That hereafter there shall be held a meeting of one or more departments of Academy on the second Tuesday of each month.

Resolved, That the next regular meeting of the Academy be held in the city of Milwaukee on the 1st Tuesday in July.

The President and Secretary to have authority to change time and place if it shall be best to do so.

Resolved, That the thanks of the Academy are hereby tendered to the Assembly for the use of their chamber for the Wednesday evening's session, and to the Madison *Democrat* and the *State Journal* for their valuable reports of the proceedings of the Academy.

The President designated the Rev. J. B. Pradt as the member who should prepare a biographical notice of the lamented Bishop Armitage, [which notice will be found on the following page.]

The Academy adjourned *sine die*.

JOHN E. DAVIES,
General Secretary.

IN MEMORIAM.

BY REV. J. B. PRADT, MADISON.

Entered into rest, December 7, 1873, the Rt. Rev. WILLIAM EDMOND ARMITAGE, S. T. D., Bishop of Wisconsin, and Vice President of this Academy.

William Edmond Armitage was born in the city of New York, September 6, 1830. Educated under the influences of the Episcopal Church, he entered Columbia College, in the same city, at the earliest age the statutes of that institution allowed, and graduated with honor in 1849, at the age of 19.

Having, from early youth, determined to devote himself to the sacred ministry, after graduation he immediately entered the General Theological Seminary of the Episcopal Church, in New York, and after finishing the usual three years' course of study, was ordained deacon early in the summer of 1852, and to the priesthood in 1854.

His first ministry was as assistant to the venerable Dr. Burroughs, rector of St. John's Church, Portsmouth, N. H. His first parish was St. Mark's Church, Augusta, Me., where, in 1858, he married Louisa, daughter of Mr. Allan Lombard.

His next parish was St. John's Church, in the city of Detroit, of which he was the first rector, and which he built up to a very remarkable degree of strength and prosperity.

From this post of usefulness he was called, in 1866, to become the Assistant of the venerable Bishop Kemper, of Wisconsin, his consecration taking place in his own parish church, December 6, and his funeral in the same church seven years later, December 11.

It is in keeping with the beautiful symmetry of his character, that he thus spent seven years in scholarly preparation for his life-work, seven years in its more youthful prosecution at the east, seven more of matured labor at the west, and seven as a Christian Bishop in Wisconsin. For Dr. Armitage was indeed a man of singularly beautiful and symmetrical life and character. Of sweet and serene temper, of methodical habits, of orderly and untiring industry and devotion, these traits ex-

tended to every part of his life, and gave character to his thought, his speech, his chirography and to his manners.

As might be expected from such a man, his mind was singularly free from dogmatism and illiberality, While firm in his own convictions, he was courteous and charitable towards those who thought differently. In this respect he was a model as a man as well as an ecclesiastic. Nor was he so absorbed in his peculiar calling as to disregard or underrate secular things. On the contrary, he took a lively interest in the promotion, not only of the arts and sciences, but of the general business of life.

In the department of the Academy entrusted to his charge as a Vice President, namely, that of Social Science, he took especial interest, and was anxious that its management and labors might be attended with beneficent results. He made, himself, a valuable contribution to the labors of the Academy in this department, in a paper on the Sunday Question.* In the discussion of this delicate subject he showed himself equally free from bigotry and weakness.

Though much pressed with the burden of his Episcopal duties, and suffering from a disease which shortened his life, he found time to attend several meetings of the Academy, and evinced, by frequent letters, his interest in its affairs.

His memory will be cherished by his associates in the Academy with respectful and affectionate regret, and his character revered, not only for its higher qualities, but as one eminently befitting all who would promote the cause of truth, of science and of human progress.

* Published in Vol. I of the Transactions, page 62.