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OF THE

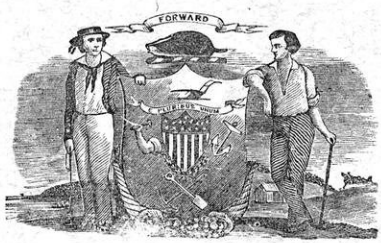
WISCONSIN ACADEMY

OF

SCIENCES, ARTS, AND LETTERS.

VOL. III. 1875—76.

Published by Authority of Law.



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Department of Natural Sciences.

ON KAOLIN IN WISCONSIN.

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

I.—NATURE, ORIGIN, AND OCCURRENCE OF KAOLIN.

Origin of the word "kaolin."—The word *kaolin* is a corruption of the Chinese *kao-ling** or *kau-ling*,† meaning "high-ridge," the name of a place near Jauchau Fu, in China, where for many centuries the Chinese have obtained the material for the manufacture of their famous porcelain. According to Von Richthofen,‡ however, the Chinese material is not the same as that to which the term *kaolin* is applied in Europe and America, but is on the contrary a solid rock, which is exported in a pulverized condition under the name of *kao-ling*. The application of this name to the European porcelain-clay by Berzelius, was, according to Von Richthofen, made on the erroneous supposition that the white powder which he received from China occurred naturally in that state.

What is kaolin?—However this may be, since Berzelius, the word has been applied in Europe to a white clay-like substance which, from its peculiar composition and freedom from any ingredients tending to lessen the whiteness of the wares burnt from it, or its refractoriness to heat, is especially adapted to form the base of the finer kinds of pottery known as porcelain, whence its name of

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* Baron Von Richthofen, American Journal Science, "On the Porcelain Rocks of China," III i 179. Comp. also Percy's Metallurgy, volume on Fuels, p. 92.

†Dana's "System of Mineralogy," p. 75—S. W. Williams' "Middle Kingdom," vol. II, p. 116.

‡ Loc. cit.

"porcelain-clay." An exact statement of the geological and chemical application of the term is not so easily given. Geologists have commonly designated as kaolins only those clays resulting directly from the disintegration of felspar-bearing rocks in place, as distinguished from the bedded or sedimentary clays. It is true that most all of the kaolins used for porcelain making are obtained from deposits of the former nature, but it is equally true that beds, or patches in beds, of sedimentary clays have the same composition and properties as the ordinary kaolins. It has long been noticed that clays possessing these properties tend to approach a type composition, and that they are frequently separable by a process of levigation into a fine white scaly clay, and a sand composed of particles of quartz and undecomposed felspar. The white clay thus separable has always a definite composition, and, as shown by Messrs. Johnson and Blake,* is seen under the microscope to consist of translucent or transparent, rhomboidal or hexagonal plates, which are flexible and inelastic, isolated or aggregated in prismatic, curved, or fan-shaped bundles, and referable to the orthorhombic system. The bases of these scales are marked with lines arising from the edges of super-imposed laminae. The hardness varies from that of talc to about midway between that of selenite and calcite. The mineral whose existence is thus rendered certain, has been designated as *kaolinite* by these gentlemen, from the *kaolin* in which it is most commonly found. These crystalline scales are however found to occur, not only in the real kaolins, which they chiefly make up, but also in small quantities in many ordinary sedimentary fire-clays, or even in common brick-clays. In these, however, they appear to be associated with other silicates of alumina, or at least with an excess of silica over the amount necessary to form kaolinite, which cannot be proved to exist in the free state. The ordinary clays cannot therefore as yet be regarded as having a base of kaolinite. The composition of kaolinite, Messrs. Johnson and Blake showed to be as follows:

	P. cent.
Silica	46.3
Alumina	39.8
Water	13.9
	100.0

*"On Kaolinite and Pholerite." Am. Jour. Sci. II. xliii. p. 351 et seq, as quoted in Percy, p. 92 volume on Fuels etc.

These figures correspond to the formula $Al_2 O_3, 2 Si O_2 + 2 H_2 O$, one deduced by Forchhammer for kaolin as long ago as 1830, from a comparison of a series of analyses of crude and washed articles.

We may then designate as kaolin any native hydrated silicate of alumina having the above percentage composition, or any native material composed of a mixture of such a silicate with quartz fragments, and fragments of undecomposed rock. Some of the raw kaolins are almost pure kaolinite, whilst others contain as much as fifty to sixty per cent. of foreign matter.

Origin of Kaolinite.—The mineral kaolinite, when considered as the base of large clay masses, appears always to have resulted from the decomposition of minerals of the felspar group. In very small quantities, it is true, the same substance is known to be an alteration product of other minerals than the felspars, e.g. beryl, staurolite, leucite; still all of the large kaolinite masses have originated by the alteration of some of the felspars. This alteration may have been caused by several agents, by far the most important of which has, however, been carbonated water, or water carrying carbonic acid in solution. The felspars are silicates of alumina with an alkaline ingredient, which may be either potash, soda, or lime. Obtaining carbonic acid from the atmosphere, and to some slight extent from direct organic decay, the surface waters, thus reinforced, infiltrating through the seams of the felspar-bearing rocks, (granite, gneiss, porphyry,) act gradually upon the alkaline silicates, forming first carbonate of lime, if lime be present in the rock, which dissolving as bicarbonate in the carbonated water, is carried away. More slowly are taken up and leeched out the alkalies as carbonates, or as silicates, if the amount of carbonic acid is only small, which will be the more usual case. Part of the silica thus set free always remains as colloid or hydrated silica, and may be detected in samples by its solubility in alkali. The amount of colloid silica† remaining will depend directly on the supply of carbonic acid, being greater as the carbonic acid is more plenty. Still remaining after the leeching process are now certain proportions of alumina and silica, to which is added a certain proportion of water. These three combining and crystallizing, form the hydrated silicate of alumina, kaolinite. The theoretical change from orthoclase felspar

* Dana's Mineralogy—under orthoclase, p. 361.
† Bischof Chem. Geol. Vol. II, p. 183.

to kaolinite is well shown by the following figures, which are percentages by weight, calculated on the original orthoclase:

Constituents.	Orthoclase.	Removed.	Remain.	Added.	Kaolinite.
Silica	64.6	43.1	21.5	....	21.5
Alumina..............	18.5	....	18.5	....	18.5
Potash...............	16.9	16.9	....	....	....
Water................	....	....	....	7.4	7.4
Total.............	100.0	60	40	7.4	47.4

The last column corresponds to the composition already given for kaolinite, viz., silica, 43.3; alumina, 39.8; water, 13.9. The change may also be conveniently indicated from the formulae as follows:

Orthoclase - - - - - -	$6K_2O+6Al_2O_3+36SiO_2$
Removed - - - - - - -	$6K_2O+ \quad 24SiO_2$
Left - - - - - -	$6Al_2O_3+12SiO_2$
Which corresponds to - - -	$Al_2O_22SiO_2$
Added - - - - - -	$2H_2O$
Resulting Kaolinite - - - -	$Al_2O_3,2SiO_2+2H_2O$

These calculations are made on the assumption that the alumina is not removed. It appears however in some cases to be partially removed.* The soluble substances resulting from this decomposition, the carbonates and silicates of potash and soda, and the bicarbonate of lime, pass off with the infiltrating waters, and reaching the surface again, give rise to mineral springs, or add to the solid contents of the drainage waters of the region. The felspar may alter so as to produce certain zeolites when all of the protoxyd bases are not removed,† and if the infiltrating waters carry magnesia in traces a steatitic change may result. These are however much rarer changes, and do not affect the object of the present paper.

Should the felspathic rock be contaminated with iron pyrites, its decay may be much hastened.‡ This may be in part due to a direct action upon the silicate by the acid waters resulting from

* Dana, loc. cit.
† Bischof. Chem. Geol., p. 211—Dana, loc. cit.
‡ Dana's Mineralogy, p. 360. Geology of New Jersey, p. 68.

oxydation of the sulphid, but is rather due chiefly to the disintegration of the rock produced by this oxydation, which leaves it more easily permeable to the carbonated waters.

The felspars which appear especially to have given rise to kaolin masses are orthoclase and albite, the potash and soda felspars. This must be attributed rather to their greater abundance as compared with oligoclase and andesite—the soda-lime felspars—since these latter change much more easily to kaolin, whilst orthoclase changes with the least readiness of any of the felspars, being found often unaltered, when oligoclase occurring in the same rock is completely kaolinized.* Labradorite does not commonly alter to kaolinite.†

Origin of clay deposits in general.—All clays and indeed most shales (clay shales) may be said to have resulted primarily from the alteration more or less completely carried out, of the felspar of felspar bearing rocks. The disintegrated material resulting from this alteration may either have remained where formed, still occupying the position and retaining the lamination of the original unchanged rock, or may have been subsequently removed by the ordinary eroding forces and deposited elsewhere as a bedded clay. This removal, if merely for a short distance, may have been unaccompanied by any assorting of the clay and rocky materials; as for instance is observed in the "kaolin" of the Cretaceous beds of eastern New Jersey. Such an assorting appears however most commonly to have taken place, the clay having been washed out from the quartz and undecomposed rock fragments accompanying it, having had more or less of foreign material mingled with it during the process of sedimentation, and having thus resulted in a bed of ordinary clay. Again in other cases the action of eroding forces on the unaltered felspathic rocks may have resulted in a sediment of powdered felspathic material which by subsequent alteration has become a clay. In some one of these ways all true clays would seem to have been formed. Fragments of felspar still remaining in many of them, and the alkaline ingredients shown by analyses, testifiy to this general origin. Of course bedded clays may have been again and again removed and redeposited, mingled with various impurities, or introduced as impurity into other sedi-

* Dana, p. 348. † Dana, p. 361.

ments—*e. g.* limestone—by whose subsequent solution and removal the clay may be left alone and pure.

Whatever the exact origin, we may then group all clays conveniently into the *bedded clays*, and the clays accurring as *disintegrated rocks in place.* In both of these ways kaolin occurs. A brief consideration of each mode of occurrence will be of interest in the present connection.

Kaolin as a disintegrated rock in place.—Most kaolin of commerce comes from this kind of a deposit. Gneissic and other felspathic rocks, frequently placed with their bedding planes vertical, admit of deep penetration by the surface carbonated waters. Their felspathic ingredient being thus decomposed, the whole rock is converted into a soft admixture of kaolinite, quartz fragments, particles of partly decomposed, and entirely undecomposed felspar, and more or less altered particles of mica. This alteration has been noticed to as great a depth as seventy feet and over. The gneissic rocks of the Blue Ridge in Virginia, North Carolina, and Georgia, are found altered to this depth over considerable areas, retaining still their original lamination and highly inclined position.* Similar changes and to much greater depth are reported from Brazil.† In such cases the once quartz veins are often seen occupying their original position as great sheets in the soft clay.

Should now the felspar be a largely predominating constituent of the rock, or should the mica be present in inconsiderable quantities only, there will result on decomposition a mixture of a very pure white kaolinite with more or less quartz sand and undecomposed felspar fragments, which can readily be removed by levigation, and a valuable article obtained. Should, on the other hand, the mica be largely present, or should there be any quantity of hornblende or pyrite in the rock, the resulting clay will be largely contaminated with non-separable alkalies from the mica, or oxyd of iron from the mica, hornblende or pyrite, and will be a mere red brick-clay of no value. Thus it happens that whilst many localities of disintegrating granite are known, but few of them yield good kaolin. In the case of much pyrite or other ferruginous constituent in the rock, the weathering and leeching by the carbonated waters, may result in the formation of deposits of the hydrated sesquioxyd of iron, in the shape of "bog iron ore." Such Dr.

* Am. Jour. Sci. III. vii p. 60.

† Hartt as quoted by Hunt, Loc. cit.

T. S. Hunt* regards as having been the origin of some of the bog-ore deposits in the vicinity of the disintegrating gneissic rocks of the Southern States. I allude to this here since it is a fact that bog-ores of considerable value occurs in the Wisconsin kaolin district and may be supposed to have had a similar origin.

In as much as the decomposition of the felspar in such a process is hardly ever so completely carried out as to leave none of it unaltered, it results that the kaolins used in the arts show either in their crude or washed state almost always a certain amount of alkali on analysis. This alkali may be present partly as entirely undecomposed felspar fragments, in which state it can be completely removed by levigation, and partly as felspar in different degrees of change. All of the latter cannot be separated.

Many of the best kaolins aspear to have resulted from the decomposition of a rock consisting chiefly of felspar with as small admixture of quartz and no mica, known as *pegmatite*.† These, from their great richness in felspar, tend to produced an especially pure kaolin. The ordinary gneisses and granites on the other hand, by their decay yield a very coarse sandy clay, which may be quite impure from foreign admixtures, or if free from any hurtful impurity, so largely mingled with quartz, as to be very lean in pure kaolinite. In some regions it is noticed that those granitic or gneissic layers more largely composed of felspar than the adjoining beds, tend to alter whilst the rest stand firm. Since these alternating beds are always inclined at high angles, their outcropping edges strike across the country in groups of narrow parallel bands. Thus it comes that kaolin is sometimes found following long straight lines, having a constant bearing. This fact may be made use of in "prospecting" for kaolin.

Examples of the occurrence of kaolinized rock.—Most of the authorities that I have been able to consult agree in describing the Chinese kaolin. used many centuries before porcelain-making was introduced into Europe, as a result of the disintegration of a granitoid rock, though I have not seen any detailed account. A recent paper‡ by Baron Von Richthrofen, as already said, gives a different account of the nature of the Chinese article. He says: "I visited * * * * the famous King-te-chin, where the Chinese have made nearly all their porcelain for almost three thousand years. I

* Loc. cit. † Von Cotta's Lithology p. 206, English Ed. ‡ Am. Jour. Sci., cit.

examined the places from which they take the material. * * * I have to record the unexpected fact that the material from which the porcelain of King-te-chin is made, is taken from certain strata intercalated between these slates, and occurring at several places, separated from each other laterally, i. e., at right angles] with the strike of the rocks. It is a rock of the hardness of felspar (inferior kinds are not so hard) and of a green color, which gives it to some extent, the appearence of *jade* to which the Chinese too, compare it. The rock is reduced by stamping to a white powder, of which the finest portion is ingeniously and repeatedly separated. This is then moulded into small bricks. The Chinese distinguish chiefly two kinds of this material. Either of them is sold in King-te-chin in the shape of bricks, and as either is a white earth, they offer no visible differences. They are made in different places by pounding hard rock, but the aspect of the rock is alike in both cases. For one of these two kinds of material, the place "Kaoling" was in ancient times in high repute, * * * * and the Chinese still designate by the name "kaoling" the kind of earth which was formerly derived from there. * * * * The second kind of material bears the name pe-tun-tse, ("white clay.") S. W Williams, in his "Middle Kingdom," speaks* of the kaolin as a disintegrated granite, which is almost all felspar—and of the "pe-tun-tse" as nearly pure quartz—but his account does not appear to be based on personal inspection.

One of the most famous kaolin localities of Europe is that at St. Yrieix-la-perche, near Limoges, in France. Here is obtained the material for the famous Sevres porcelain manufactory.† The kaolin occurs as a result of the disintegration of masses of pegmatite partly interstratified with the gneiss and partly intersecting it in cross veins. The gneiss is also decomposed, but to a red clayey mass of no value. The pegmatite, consisting chiefly of felspar, wherever decomposed has given rise to an excellent kaolin, moderately free from quartz and rocky particles, these forming only about ten per cent. of the whole.

Another famous European occurrence of kaolin is that of the vicinity of St. Austle in Cornwall. This is a weathered mixture of orthoclase and quartz, chiefly on Tregoning hill near Helstone,‡ in

* Vol. II, pp. 116, 117.
† Dana's Mineralogy, p. 475; Knapp's "Chemis'y Applied to Arts," vol. ii, p. 230.
‡ Wagner's Chem. Technol. Eng. Ed.

various stages of decomposition. The kaolinite portion is removed from the weathered rock by allowing streams of water to run over it. The clay thus washed out settles in a series of large catch-pools. The weathered rock itself is used to a considerable extent in the ceramic arts in England, under the name of *Cornish stone.*

At Aue in Saxony the source of the kaolin was a rounded mass of granite very much decomposed on the surface and surrounded by the kaolin as by a cap.* The deposit is exhausted. At Mionia in Saxony, the kaolin is decomposed porphyry, and is used in the Dresden manufactories.† At the Einigheit mine near Freiberg, Saxony, it is in nests in gneiss.‡ The kaolin of La Bresse, France, is an altered andesite.‖ That of Bayonne, France, is a graphic granite in every stage of decomposition.¶ At Passau the occurrence is exactly like that of St. Yrieix in France.§

The following are analyses of crude European kaolins:**

Place.	Rock residue.	Silica.	Alumina.	Water.
St. Yrieix	9.7	41.9	34.6	12.2
Cornwall	19.6	46.5	24.0	8.7
Devonshire	4.3	44.1	36.8	12.7
Aue	18.0	35.9	34.1	11.0
Passau	4.5	46.4	37.0	12.8
Mort near Halle	43.8	26.0	22.5	7.5

A few occurrences of kaolinized rock are known in the United States, of such a nature as to supply a good article. An excellent material is found in the graphic granite of Brunswick, Maine, and also at Haddam, Connecticut. At each place the rock is a coarse mixture of very pure quartz and felspar. At the latter locality it has been of late mined and broken up for making kaolin for white ware at Williamsburg, N. Y.†† Near Trenton in New Jersey the gneissic rocks are more felspathic than usual in the region, and the felspar is entirely changed to kaolin, which is dug to be used in making fire-brick.‡‡ This clay contains zirconia.

Kaolin as a bedded clay.—As a bedded clay kaolin is known in

* Knapp, vol. II, p. 230.
† Wagner Chem. Technol, p. 230.
‡ Percy's Metallurgy, Vol. on Fuels, p. 96.
‖ Ure's Dictionary, Vol. 1, p. 427.
¶ Knapp, Loc. cit.
§ Dana's Mineralogy, p. 348.
** Wagner, Loc. cit.
†† Appleton's Encyclopedia, Art. Clay.
‡‡ Geology of New Jersey, p. 323.

two occurrences: (1) as a coarse admixture of felspar, kaolinite etc. removed but a short distance from where it resulted by disintegration; and (2) as a fine-grained clay washed from its coarse material, and not directly traceable to its origin. In New Jersey the great thicknesses of plastic clays, forming the lowest member of the Cretaceous series, stretch in a wide band south westward across the state from Staten Island Sound to the Delaware River. In places these clays come into contact with the gneisses of the Archaean belt crossing the state from northeast to southwest, and have evidently derived their material from the wear of the previously disintegrated gneissic rocks. In these clay beds kaolin-like clays occur both in the assorted and unassorted conditions. The coarse or unassorted kaolin * is dug at several places on both the main land and island sides of Staten Island Sound. The bed is from two to twelve feet thick, and is composed of coarse angular fragments of quartz mingled with decomposed felspar and mica scales. It is interstratified with other clay and sand layers, and lignite. The finer New Jersey clays of the same series are largely used for making fire-brick and the rougher kinds of pottery. Some of them appear to be sufficiently pure for the manufacture of porcelain.† Ordinary stoneware, porcelain knobs etc. are extensively manufactured at Trenton.‡ The purity of these bedded clays as compared with most others would appear to be directly due to their derivation from the disintegration of the gneissic rocks of the region, and deposition near by where first formed.

A recent discovery in Indiana has brought to light what appears to be a valuable bedded clay, occurring under peculiar circumstances. The kaolin bed lies at the base of the coal measure conglomerate, in Lawrence county, Indiana, having a thickness of five to six feet, one of which is pure white kaolin, the remainder being more or less stained with iron and manganese oxides. Immediately beneath the clay is a bed of limonite iron ore. This clay appears to replace a bed of limestone which has been dissolved away by the action of carbonated waters. It has almost exactly the composition of kaolinite. With it are found lumps of the mineral allophane, another hydrated silicate of alumina, with a larger percentage of water than kaolinite.

* Geology of New Jersey p. 249. † Geology of New Jersey loc. cit.
‡ Geology of New Jersey p. 685.

A similar occurrence to the one just described is mentioned by Jukes* as existing in the tilted bottom-beds of the Carboniferous Limestone, on Cork Harbor, Ireland. Here, over a small area, the limestone has been almost entirely removed, leaving the clay-like substance behind. This clay has been used considerably in the English potteries. The following are analyses of those of the Indiana and New Jersey bedded clays, which approach to kaolinite in composition:

Constituents.	I.	II.	III.	IV.
Silica	43.20	45.30	45.90	47.05
Alumina	39.71	37.10	40.34	37.14
Water	14.25	13.40	13.26	15.55
Oxide of Manganese	....	....	....	0.03
Sesquioxyd of Iron	0.74	1.30	....	.. ....
Potash	.37	1.30	....	....
Magnesia	....	0.22	....	0.03
Lime	....	0.17	....	
Zirconia	1.40	1.40	....	....
Total	99.67	100.19	99.50	99.80

I. is a fine white clay from Burts Creek, near South Amboy, New Jersey, analysed just as it came from the pit. II. is a kaolin-like clay analyzed after washing to free from particles of quartz, mica, and feldspar. It is from Trenton, New Jersey. III. and IV. are the Lawrence county, Indiana, kaolin, analyzed without washing.

II.—KAOLIN IN WISCONSIN.

Geographical position of the kaolin district.—The fact of the existence of kaolin in Wisconsin has been known for many years. The material has however only very recently attracted much attention and become the object of actual exploitation. The first published mention I find of it is in the report of Dr. J. G. Norwood in Owen's Geological Survey of Minesota, Iowa, and Wisconsin.† He says, in describing the last Archaean exposure seen in descending the Wisconsin River: "Above the granite at the old mill-dam,‡ is a bed of ferruginous argillite four feet thick, succeeded by five feet of decomposed felspar, above which is a bed two feet thick of well digested kaolin, or porcelain clay, with * * * * quartz disseminated through it in veins and containing a notable quantity of

*Jukes and Geikie's Manual of Geology, p. 130.

† P. 289.

‡ Near Point Bass, Wood county.

pyrites. Then succeeds a variegated white and yellow sand-stone * * * *." In this account Dr. Norwood conveys the erroneous impression that the kaolin of the Wisconsin occurs as a bedded clay, which it does not do.

The various localities at which kaolin has been noticed in the state, so far as my knowledge extends, all occur in a belt of country about fifty miles in length and fifteen in breadth, stretching eastward from Black river in Jackson county to the Wisconsin, in the vicinity of the city of Grand Rapids, in Wood county. This district includes more or less of townships 21, 22, and 23 north, and ranges 1, 2, 3, 4 west, and 1, 2, 3, 4, 5, 6, 7 east, of the meridian. It is crossed from north to south by three streams of considerable size; Black River on the west, the Wisconsin on the east, and Yellow River towards the centre. The kaolin discoveries have, I believe been made almost entirely in the vicinity of these streams.

Geology of the kaolin district.—The district thus described, lies for most of its extent just south of the main boundary-line between the Potsdam sandstone, which underlies so large an area to the south, east, and west, and the Archaean rocks, which form the sub-structure of all the region to the northward. In places the boundary, which is a very irregular one, lies within this district. The country in this part of the state is generally level, with a gradual rise to the northward. In the more southern portion of the belt, the sandstone is nearly everywhere the surface rock, except along the beds of the rivers, where the strata of Archaean gneiss granite and diorite are laid bare. The sandstone is therefore, where it occurs, only a very thin covering over the crystalline rocks, and indeed these occasionally rise through it in bold isolated bluffs of granite and quartzite, which, though sometimes as much as two hundred feet in height, cover but a small area. Interspersed with these are other bluffs of similar height and dimensions, of horizontal sandstone, bearing witness to the great thickness of that rock which has suffered denudation. Further north, the gradual rise of the country seems to be due in some measure to the shape of the surface of the underlying Archaean rocks, which finally rise from beneath the sandstone and become the surface formation. The boundary between the two terranes is traced with great difficulty. Barometrical elevations are no guide at all, for the sandstone having once covered the region so deeply may be found at the very highest levels, whilst the irregular upper surface of the gneissic rocks is apt to bring them up through the sandstone at any place. A geological map, including Portage, Wood, Clark, and Jackson counties, would show on the south the sandstone as the surface formation, on the north the crystalline rocks, whilst where the two meet they would be shown dovetailing into each other, the Archaean extending many miles south in the stream beds, the sandstone penetrating as far north on the divides. As we trace the rivers southward towards where the last crystalline rocks are seen, these are found confining themselves more and more closely to the vicinity of the streams until they are finally restricted to their beds, the sandstone forming the banks. Thus the Wisconsin River, for ten miles above Point Bass, and the Black for a greater distance above the falls, present strips of crystalline rocks only as wide as their own currents.

Another feature in the geology of the kaolin district seems worthy of notice in the present connection. I refer to the fact that the boundary line between the "driftless" area of the south western quarter of the State, and the "drift-bearing" area to the north and east, crosses the district in a nearly east and west line from Grand Rapids to Black River Station, on Black river.

Nature and mode of occurrence of the Wisconsin kaolin.—The Wisconsin kaolin occurs entirely as "kaolinized" rock. As already stated it has been noticed only in the vicinity of the large streams. This is so because elsewhere the crystalline rocks are for the most part covered by the sandstone. Nearly always it occupies exactly the original position, retaining sometimes even the minute structure, of the unaltered rock. A few cases were noticed immediately on the river banks, where the structure of the clay seemed to have been modified slightly by water action. The rocks from which the kaolin has been formed, and into which it can frequently be traced throush every degree of alteration, are beds interstratified with the series of Archæan strata which have over wide areas a common strike. Only the out-cropping edges of these beds are decomposed, and as a consequence it follows that the resulting kaolin forms narrow bands crossing the country in straight lines parallel to the general strike. It is exceedingly common to find overlying the kaolin a few layers of sandstone, sometimes a few inches only, at others, a score or so of feet. In such cases the purer kaolin is found immediately below the sandstone, next below a partially kaolinized rock, and next below again the entirely unaltered rock. Such sections are common in the district.

The kaolin localities appear to be almost entirely within the driftless area, or at least where the drift is very thin and the glacial action has been insignificant. This fact becomes a significant one, when we consider that over all the great Archaean region of the north half of the state, which is drift covered, no occurrence of kaolin is known; all the known occurrences being confined to that comparatively small district where the Archaean rocks are found within the driftless area. I am inclined to attribute this absence of kaolinized rock in the northern portion of the state to the denuding agency of the drift forces, following Dr. T. S. Hunt, who has made the same suggestion* in explanation of the non-disintegrated condition of the gneissic rocks of the Blue Ridge in the northern Atlantic States, the same rocks further south being constantly found decomposed to considerable depths.

Where and how to search for kaolin in Wisconsin.—If it be a fact that the drift forces have removed all kaolinized rock they have encountered, then at once we may conclude that search at any considerable distance north of the drift limit is not likely to be rewarded with success. An exception to this might be where the kaolin has been formed underneath protecting masses of sandstone. Within the thus restricted district, moreover, the labor of the search may be much lessened by the recognition of a few simple guiding facts. The explorer should visit the known outcrops of kaolin, note the rock from which it has decomposed, measure carefully its strike and then follow the line thus obtained until other patches are found. Having once noted the kind of rock tending to produce the kaolin, (in this region usually a pinkish felspathic gneiss or granite,) by following the strike of any similar bed kaolin will probably sooner or later be found. The search would be best made with a boring-tool of some simple kind. Should sandstone be struck in the boring the kaolin may yet underlie it. The explorer should at the outset divest himself of the idea that the kaolin occurs in a continuous horizontal bed.

Kaolin on the Wisconsin River.—The best known kaolin deposits in Wisconsin are those that occur on and near the Wisconsin Riv-

* Loc. cit.

er, in the vicinity of the city of Grand Rapids, in Wood county. The Archaean gneissic rocks here occur chiefly in the bed of the stream, which for many miles makes bold rapids over their upturned edges. Elsewhere they are mostly covered with sandstone. The predominating gneissic rocks have associated with them both interbedded, and clearly intrusive granite and diorite. Of the gneiss and granite there are many varieties, according to the predominance of one or other mineral ingredient, both rocks being formed sometimes of a largely predominating pinkish felspar. These beds are the ones most commonly weathered, though some of the dark micaceous kinds show the same tendency. All of the beds strike between N. 50° E. and N. 80° E. with a dip of about 50° either S. E. or N. W.

On the southwest quarter of section 5, town 22, range 6 east, on the land of Mr. Garrison, considerable digging has been done in borrowing for the road-bed of the railroad near by. The removal of about two feet of earth has exposed the kaolin in a number of places extending along the railroad for some rods. The clay is here in some places quite white, in others much stained with iron sesquixoyd, the stained portions being those nearest the surface. Much of it appears to have lost all sign of the original rock structure, whilst in many places the spade turned up masses as distinctly laminated as any of the gneiss in the vicinity. All of the kaolin here is quite gritty from the presence of quartz and undecomposed felspar fragments, a statement which will apply to all of the Wisconsin kaolins that have come under my notice. Scales of silvery mica appear to be largely present. Average samples of the whiter clay, selected by the writer, yielded Mr. Sweet, of the State Geological Survey, by whom all the analyses of Wisconsin kaolins quoted in this paper were made, the following results:

Constituents.	I.	II.	III.
Silica	78.83	49.94	92.86
Alumina	13.43	36.80	2.08
Sesquioxyd of Iron	0.74	.72	.74
Lime	0.64	trace	.96
Magnesia	0.07	......	.10
Potash	.37	.51	.28
Soda	.07	.08	.05
Carbonic Acid	.01	......	......
Water	5.45	11.62	2.53
Total	99.60	99.67	99.60
Specific Gravity	2.52	2.522	2.749

I. is the clay just as it came from the pit, after drying at 100° C. II. is the fine or kaolinite portion of I. washed from the coarse matter by repeated decantation and stirring. The separation is not perfect, but imitates what would be done in washing on a large scale. III. is the coarse residue from this washing, its composition being calculated from the two preceding analyses after finding that it constituted 67.1 per cent. of the whole clay. The carbonic acid remains as a silent witness of the agency by which the clay was formed. The following show II. and III., calculated in percentages on the original unwashed clay, and indicate how the various ingredients distribute themselves between the fine clay and coarse residue:

	II.		III.		I.
Silica	16.33	+	62.50	=	78.83
Alumina	12.03	+	1.40	=	13.43
Sesquiox. Iron	.24	+	.50	=	.74
Lime	.00	+	.64	=	.64
Magnesia	.00	+	.07	=	.07
Potash	.12	+	.25	=	.37
Soda	.03	+	.04	=	.07
Water	3.75	+	17.0	=	5.45
Total	32.50	+	67.10	=	99.60

The fluxing ingredients, iron oxide, lime, magnesia, potash, soda, very small in the original clay, have thus been removed largely (five-sixths) by washing. The following are other determinations made on samples from the same locality, all in the raw state:

Constituents.	IV.	V.	VI.	VII.
Sesquioxyd of Iron	1.69	2.3	....	....
Potash	....	....	.78	2.14
Soda	....	....	.03	3.21
Water	....	....	....	.56

IV. is the bright yellowish clay from near the surface; V. is somewhat less yellow but apparently more ferruginous. It is the most abundant kind. VI. is white clay, still retaining, to a marked degree, the lamination of the original rock. It would appear, however, to be much more thoroughly decomposed than much of the more homogeneous clay of the region. VII. is a highly micaceous weathering granite from the river bank near by the kaolin pits.

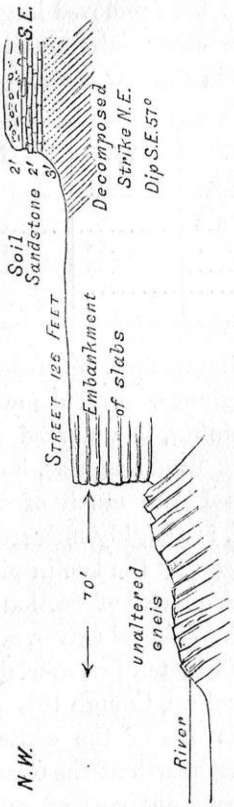
On the northwest quarter of the southwest qnarter of section 4, town 22, range 6 east, on the east side of the Wisconsin river, near the centre of the section, kaolin occurs overlaid by ten feet of friable sandstone. Most of it has lost the rock structure, though this appears very distinctly in places. This clay is one of the whitest looking noticed. It has been used for making hearth at the Grand Rapids foundry. The following are Mr. Sweet's analyses of samples from this place:

Constituents.	VIII.	IX.	X.	XI.
Rocky residue	42.59	....	....	....
Fine portion	57.41	....	....	....
Potash	....	0.38	1.21	.87
Soda	....	0.08	0.46	.00

VIII. is the raw clay; IX. the same washed. X. is raw clay taken from the box at the foundry, and said to come from the same place; XI is the fine portion of X. The removal of alkalies by washing is here evident.

In digging for the turn-table at the Green Bay and Minnesota depot, at Grand Rapids, a few layers of compact sandstone were first penetrated, this giving place suddenly to a white kaolin through which piles had to be driven five or six feet (?) before becoming firmly placed.

Fig. 1



Immediately north of the Rablin House, at Grand Rapids, kaolin is exposed in the cut made for grading the street, which here runs immediately along the river bank. The following section was obtained at this point—Fig. 1—:*

The decomposed rock is in most places quite firm, though often a soft clay. It is all whitish, and without any appearance of the unaltered rock except the lamination. A specimen of the former kind yielded:

	XII
Potash	7.56
Soda	5.03
Water	3.55

The decomposition had not yet removed much of the alkalies, although the rock was quite white.

On lot 5, section 24, town 22, range 5 east, on the west side of the river, on the land of Mr. L. P. Powers, kaolin occurs in the river bank.

The clay has been dug here to a considerable extent. It shows here as elsewhere every degree of decomposition. The pure white is of inconsiderable thickness before a firmer rocky kind is reached. At the waters edge below are seen ledges of unchanged rock. At the time of my examination the locality had been less developed than since that time; but the several outcrops along the river bank indicated a considerable quantity. From this place all of the clay that has been shipped away from Grand Rapids has been taken. Places were noticed here where bunches of highly ferruginous clay

* The engraver has omitted the word "kaolin," in Fig. 1, underneath "sandstone," and also the word "gneiss" after "decomposed." "Unaltered gneis" should read, "unaltered gneiss."

occurred in the midst of the whiter kind. The following are analyses of samples from this place:

Constituents.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.
Silica	70.83	....	....	....	70.25	....	69.34
Alumina	18.98	....	....	....	17.68	....	19.19
Sesquiox. Iron .	1.24	....	2.30	....	2.32	....	1.75
Lime	0.24	....	....	....	0.33	....	0.44
Magnesia......	0.02	....	....	....	1.49	....	0.31
Potash	2.49	1.22	2.30	1.96	1.69	2.33	3.30
Soda	0.10	trace	trace	0.05	0.39	.10	2.43
Carbonic acid ..	0.02	....	....	....	trace	....	....
Water.........	5.45	8.84	....	....	5.61	....	2.67
Total......	99.31	10.06	4.60	2.01	99.76	2.43	99.43

XIII. is the raw clay from the exposure furthest down stream. It was averaged from an apparent thickness of three feet. XIV. is the fine portion of XIII. XV. is the raw clay from the next exposure above along the river bank. It represents an approximate thickness of two and a half feet. XVI. is the fine portion of XV. XVII. and XVIII. are the raw and washed clay from the exposure furthest up stream, still showing the rock structure. XIX. is only partly kaolinized rock from the same place. These analyses nearly all indicate the material lessening in percentage of the alkalies effected by levigation.

On the west side of the northeast quarter of section 26, town 22, range 5 east, on Mr. Canning's land, several pits and a well have been sunk into kaolinized rock. The decomposition did not appear to extend to any great depth. The following are analyses:

Constituents.	XX.	XXI.	XXII.	XXIII.
Silica	....	....	....	54.87
Alumina	....	....	....	28.87
Sesquioxyd of Iron	1.95	....	....	1.54
Protoxyd of Iron	....	....	....	.95
Lime	....	....	....	1.62
Magnesia	....	....	....	.99
Potash........	1.84	2.65	2.95	2.57
Soda........	0.27	.21	.83	.07
Water	....	7.29	....	9.48
Total........	4.06	10.15	3.78	100.56

XX. and XXI. are crude and washed clay from Mr. Canning's well. XXII. and XXIII. are both washed samples, from different pits. XXIII. was 43.39 per cent. of the unwashed clay. All of these clays are very white, but appear to be much charged with alkali even after washing.

On the northwest quarter of section 10, town 21, range 5 east, on the land of Mr. Moses M. Strong, on the west bank of the river, kaolin occurs underlying sandstone. The clay shows at a number of places at different levels above the water, but these do not probably indicate a continuous mass. Two samples were taken from the opening at this place, one at a higher level than the other. The following are analyses:

Constituents.	XXIV.	XXV.	XXVI.	XXVII.
Potash	1.25	2.18	1.51	1.54
Soda	0.08	trace.	0.81	0.22

XXIV. and XXV. are the same clay, before and after washing, taken from the upper portion of the opening. XXVI. and XXVII. are crude and washed clay from a lower level. The percentage of alkalies does not appear to be lessened by washing.

About half a mile below this place the last Archaean rocks are seen in the bed of the stream, and resting directly upon them the sandstone. Sections showing the exact junction of the two terranes are common in this vicinity. A detaiied section across the river was taken at one place, the water being very low. It is an interesting one, and I have condensed it in Fig. 2.

Kaolin on Yellow River.—Kaolin is reported in quantity on Yellow River. The localities are above Dexterville in Wood county. The Archaean rocks are exposed finely for many miles along the bed of the stream. They show everywhere a tendency to weather, consisting largely of a pinkish felspar. In places I noticed the weathering carried to the condition of clay, but did not see any of the white clay that is said to exist.

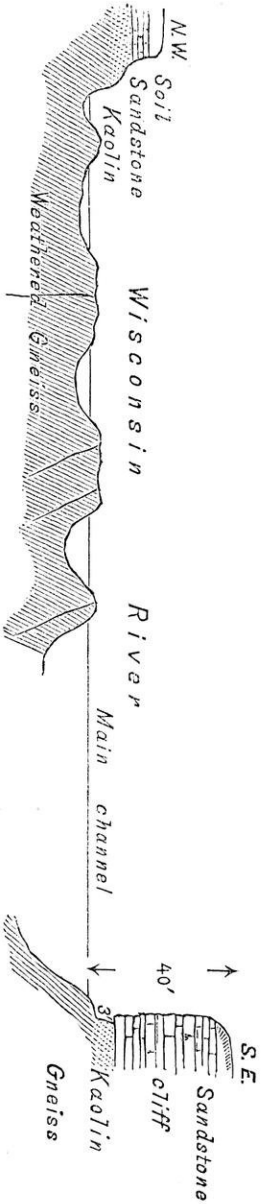
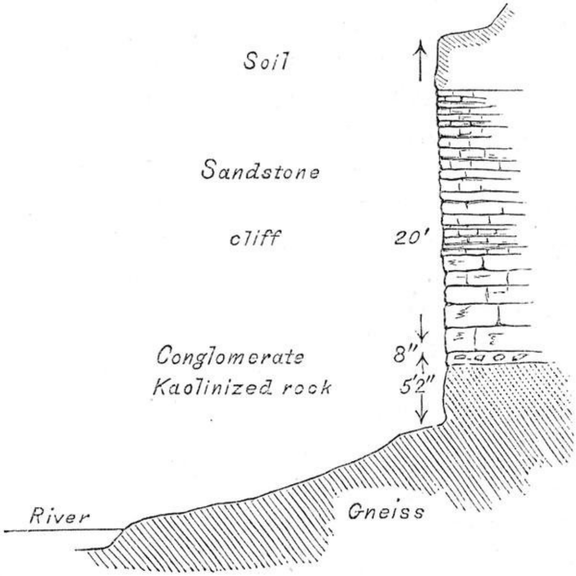


FIG. 2

Kaolin on Black River.—On this stream, in Jackson county, kaolin occurs between Black River Falls and Black River Station. As on the Wisconsin, the Archaean rocks are found here forming the bed of the stream, the sandstone overlying them in the banks. In many places the gneissic rocks are decomposed. At the lower end of the rapids at the town of Black River Falls, the gneisses disappear beneath the sandstone. A section very like that on the Wisconsin, at Point Bas, occurs here; and exhibits the mode of formation of the kaolin handsomely.

On the west bank of the river at Ledyard's old mill, is a high cliff of sandstone overlying gneiss, (Fig. 3.,) the exposures of both rocks extending several hundred feet. The surface of the gneiss is irregular, its depressions being filled by the overlying sandstone. The gneiss is very distinctly seamed—the seams striking north 37 degrees west, (magnetic,) and dipping southwest about sixty degrees—is moderately coarse, micaceous, and has much pinkish orthoclase felspar, which occurs sometimes in nests of some size. Near the water-level the gneiss is but little changed, but as as it is traced up to the sandstone it is found getting more and more decomposed, until it becomes a soft, greyish kaolin, retaining most markedly the laminated structure of the gneiss.

Fig. 3



Quantity of kaolin obtainable in Wisconsin.—Taking the whole district together, a very large amount of kaolin undoubtedly exists. There is no reason why what has been seen should be all there is. It must always however be expected that any one deposit will vary much in character, both as to purity, and as to thickness. Numbers of instances came to my notice where boring showed two feet of kaolin, and no kaolin at all, within a few feet of one another. The fact that the kaolin is apt to occur in continuous lines will however counter-balance the disadvantage of its lack of uniformity, since it can be searched for with assurance of success. In my opinion the indications are such as would warrant the outlay of money in exploitation.

III.—USES OF KAOLIN.

Having thus shown the existence of kaolin in Wisconsin in quantity, it becomes pertinent to ask what it is good for. Its chief use has always been in the ceramic arts. It is also used to make fire-brick and refractory vessels, and to some extent in making alum. The two former of these uses are the important ones.

Use of kaolin in the ceramic arts.—For making the finer kinds of pottery the important qualities of the kaolin are its color after burning; plasticity; and capacity of hardening well under heat without fusion. The plasticity is necessary for the moulding, the last named property for the perfect retention of the moulded form. Pure kaolinite is almost absolutely infusible under heat, simply losing its water and becoming an anhydrous silicate of alumina. This refractory property is lessened by the addition of any other bases; least by magnesia, more by lime, still more by iron oxyds, and most by the alkalies. The table of analyses of foreign clays given below, will serve to indicate how the Wisconsin clays rank in this regard.

The many kinds of clay-ware may be grouped conveniently into the *dense* and *porous* kinds,* according to the internal texture of the mass. Certain kinds of the dense wares are the ones for which kaolin is chiefly used. The ordinary "true" or "hard" porcelain consists of (1) a body of previously washed kaolin, and (2) a fusible binding material, which by its fusion fills the pores of the baked clay and thus renders the ware homogeneous and translucent. This binding material, or "flux," is composed chiefly of felspar, to which are added other ingredients, such as quartz, gypsum, etc. In general, the three ingredients of porcelain are kaolin, felspar and quartz. True porcelain has usually no external glaze placed upon it, its glaze being imparted by the flux which renders it translucent. To give an idea of the amount of kaolin needed in making porcelain, I select the following admixtures used at some of the famous European manufactories:†

* Wagner's Chemical Technology. † Knapp. Chem. app. to Arts p. 229.

Constituents.	Berlin ornamental.	Berlin common.	Dresden common.	Dresden ornamental	Vienna.	Sevres.	St. Petersburg.	Munich.	Copenhagen.
Kaolin	75	76	72	37	72	48	50	65	40
Felspar	15	24	26	....	12	....	25	....	27
Quartz	10	....	....	37	12	....	25	21	33
Lime	....	....	....	17½	....	....	....	....	....
Gypsum	....	....	....	....	4	....	....	5	....
Chalk	....	....	....	....	....	4	....	....	....
Broken ware	....	....	2	8½	....	....	....	5	....
Sand separated from kaolin	....	....	....	....	....	48	....	4	....
Total	100	100	100	100	100	100	100	100	100

Kaolin is used to a considerable extent also for other dense wares than true porcelain. In the manufacture of the so called English or "tender" porcelain are used kaolin, plastic clay, "Cornish stone," burnt bones, and steatite. The "Cornish stone" is the partially weathered granite, which by its complete kaolinization affords the famous kaolin of Cornwall.

Preparation of kaolin for porcelain making.—The crude kaolin is always first washed to free it from quartz and felspar fragments. This is effected by simply breaking up the clay, stirring in water, and decanting the suspended matter. The coarse residue from this washing is frequently of value, since it contains two essential ingredients of the porcelain, viz. felspar and quartz.

Use of kaolin as a refractory material.—As a fire clay or for making fire-clay articles, I cannot find that kaolinized rock has been much used. The chief difficulties in the way of such use appear to lie in the lack of uniformity so characteristic of this kind of deposit, and in the fact that where of fine quality the material is too valuable for other purposes. The use of kaolinized rock from near Trenton, New Jersey, as an ingredient of fire-bricks, has already been alluded to. The only other instance I find recorded is that of the so-called "Lee Moor Porcelain Brick," made in Devonshire, England, by mixing a small quantity of inferior kaolin with an excess of the coarse residue obtained from washing the same kaolin. This residue consists chiefly of angular fragments of quartz. The bricks are reported as of extraordinary refractoriness, and are even compared with the famous Dinas silica bricks.

Practical suggestions as to the use of the Wisconsin kaolin to make fire-brick.—There appears to be every reason why a kaolin brick, if properly made, should be of unusual value. A few suggestions are given here as to its manufacture. First, then, the clay must be *selected* in the pit, the red and bluish portions being rejected. The pure white are the best kinds, whilst some of the yellowish kinds are much better than they appear at first sight. After selecting, the kaolin should always be *washed*, to free it from felspathic particles, which contain a large amount of fluxing alkalies. The raw clay will never prove uniform in its capacity of withstanding heat. This is what theory would teach, and, as I am informed by Mr. J. J. Hagerman, of the Milwaukee Iron Works, is found in practice to be the chief obstacle in the way of using the Wisconsin clay. The fine clay obtained by washing should next be mixed with a large excess of tolerably coarse angular quartz, for which might be substituted in part, fragments of fire-brick. The mass should now be moulded or baked carefully. In this way I am persuaded that an unusually good quality of biick might be prepared. It will not do to make brick from this clay as the ordinary fire-brick are made, on account of its extraordinary shrinkage on heating. Prepared in the manner I have suggested the kaolin brick would far excel ordinary fire-brick for all purposes, save where contact with a highly basic slag is necessary, when it would be inapplicahle on account of its high content of free silica. I might say in this connection that a number of places exist in Wisconsin where the quartz for mixing with the kaolin might be obtained. I am informed that since my examination of the Grand Rapids localities, a number of fire-brick have been made without great success, the clay being used raw and mixed with wood-ashes as a counter-shrinkage ingredient. No worse admixture, of course, could be imagined, since the ingredient most desirable to avoid is thus directly introduced into the clay.

IV.—TABLES OF ANALYSES OF WISCONSIN AND FOREIGN KAOLINS AND FIRE CLAYS.

These tables are given so that a comparison between the Wisconsin clays and the already well known clays of Europe and the

United States may be readily made. The analyses in Table I of Wisconsin kaolins are those already given, and have the same numbers as before.

In Table II., analyses I., II., III., IV., V., VI., and VII., are taken from the "Geology of New Jersey, pp 683–688. I. is the average composition of the best white clay of the Cretaceous, near South Amboy, analyzed just as taken from the pit. II. is the clay from Trenton, New Jersey, analyzed after washing to free from quartz sand, also Cretaceous. III. and IV. are clays imported from Coblentz, Germany, for making glass-pots. V. and VI. are the St. Louis, Mo., glass-pot clay, raw and prepared. VII. and VIII. are New Jersey potters-clays (Cretaceous), and undergo some vitrification on burning. Analyses IX. to XIX. are taken are taken from Percy's Metallurgy, Volume on Fuels, p. 99. IX. is a true kaolin from Pool, Dorsetshire, used in making Cornish crucibles. X. is also a true kaolin, from Ireland. Small crucibles made from it were kept for hours with melted steel in them, without changing form. XI. is also an Irish kaolin. XII. and XIII. are the finest Cornish kaolin, analyzed by different chemists—washed before analyzing. XIV, is the best Stourbridge fire-clay; XV. a poorer kind of Stourbridge clay. XVI. is the best Dowlais clay; XVII. a poorer Dowlais clay. XVIII. is a greenish kaolin, with red spots, from Newcastle, Delaware; used for making glass-pots and porcelain saggars. Analyses XIX. to XXV. are from the Indiana Geological Report for 1874. XIX., XX., and XXI. are the Lawrence county, Indiana, porcelain clay, analyzed raw. XXII. is from Golconda, Illinois; occurs in pockets in the Carboniferous rocks. XXIII, is washed Chinese kaolin. XXIV. is washed kaolin from St. Yrieix, France. XXV. is Missouri "ball clay." XXVI. and XXVII. are kaolins from Saarau, Silesia, analysed raw and washed; quoted from the second supplement to Watt's Chemical Dictionary p. 354. In comparing the Wisconsin clay with these foreign clays it should be borne in mind that for porcelain making the qualities desired are whiteness after burning and refractoriness to heat; and for making firebrick refractoriness only. The coloration will increase directly with the content of oxyds of iron. The refractoriness will decrease* with the increase of the ratio of fluxes (iron protoxyd, lime, magnesia, pot-

* Watt's Chem. Dictionary, Second Supplament, p. 354.

ash, and soda) to the silica and alumina together, and with the decrease of the proportion of the alumina to the silica. Of the fluxes the alkalies are the most, the alkaline earths the least harmful.

TABLE I.—*Wisconsin kaolins.*

(Analysed by E. T. Sweet, M. S.)

Constituents.	I.	II.	IV.	V.	VI.	VIII.	IX.	X.
Silica	78.83	49.94						
Alumina	13.43	36.80						
Sesquioxyd of Iron	0.74	.72	1.69	2.30				
Lime	0.64	Trace						
Magnesia	0.07							
Potash	.37	.51			.78		0.38	1.21
Soda	.07	.08			.03		0.08	0.46
Water	5.45	11.62						
Protoxyd of Iron								
Carbonic acid	.01							
Total	99.60	99.67						
Coarse sand	67.30					42.59		
Fine-clay	32.70					57.41		
Total	100.00					100.00		

Constituents.	XI.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.
Silica		70.83				70.25		69.34
Alumina		18.98				17.68		19.19
Sesquioxyd of Iron		1.24		2.30		2.32		1.75
Lime		0.24				0.33		0.44
Magnesia		0.02				1.49		0.31
Potash	.87	2.49	1.22	2.30	1.96	1.69	2.33	3.30
Soda	.00	0.10	Trace	Trace	0.05	0.39	0.10	2.43
Water		5.45	8.84			5.61		2.67
Protoxyd of Iron								
Carbonic acid		0.02				Trace		
Total		99.37				99.76		99.43
Coarse sand								
Fine-clay								
Total								

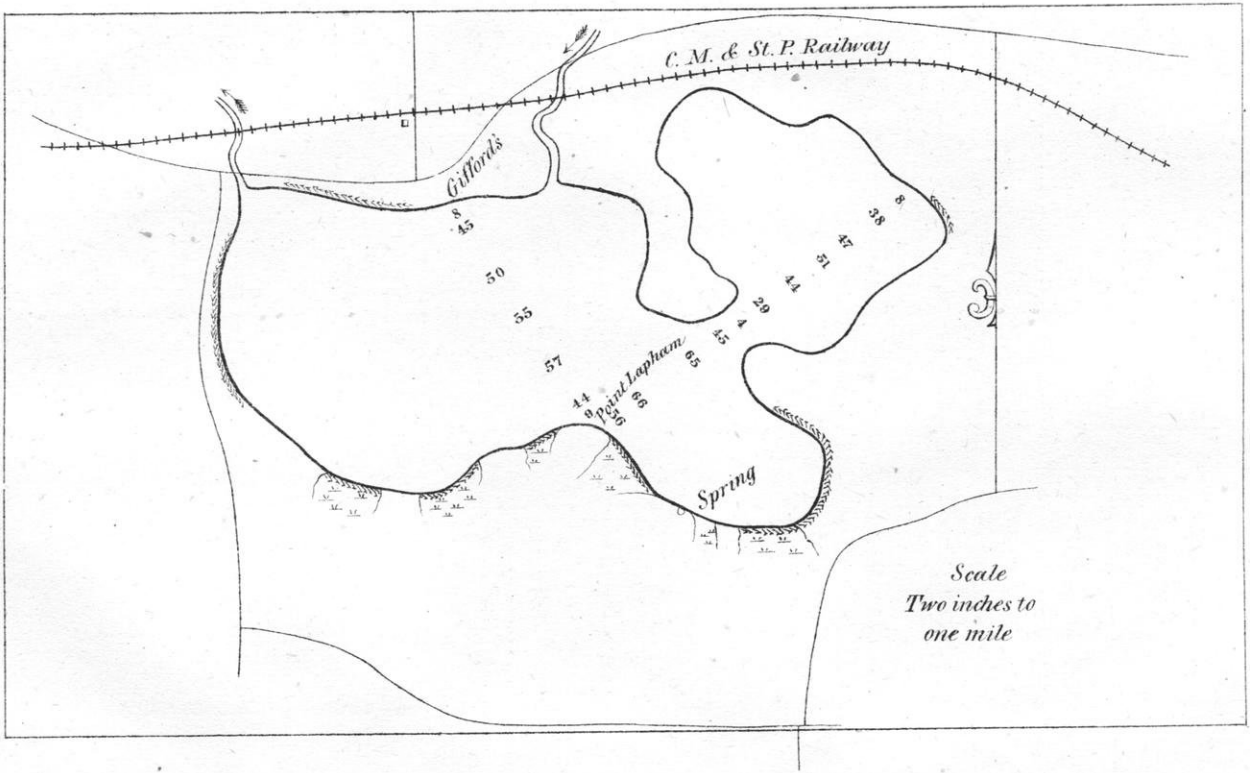
Constituents.	XX.	XXI.	XXII.	XXIII	XXIV.	XXV.	XXVI.	XXVII
Silica				54.87				
Alumina				28.87				
Sesquioxyd of Iron	1.95			1.54				
Lime				1.62				
Magnesia				.99				
Potash	1.84	2.65	2.95	2.57	1.25	2.18	1.51	1.54
Soda	0.27	.21	.83	.07	0.08		0.81	0.22
Water		7.29		9.48				8.69
Protoxyd of Iron				.95				
Carbonic acid								
Total				100.56				
Coarse sand			56.61					
Fine-clay			43.39					
Total			100.00					

TABLE II.—*Fire-clays and kaolins from various localities.*

Constituents.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.
Silica	43.20	45.30	50.20	51.20	61.02	59.60	71.80	65.62	48.99
Alumina	39.71	37.10	34.13	30.03	25.64	26.41	19.95	20,88	32.11
Sesquiox. Iron	9.74	1.30	......	1.50	1.70	1.61	1.31	1.23	2.34
Lime	......	0.17	0.30	1.60	0.70	1.00	0.31	......	0.34
Magnesia	......	0.22	......	0.18	0.08	0.07	0.79	0.30	0.22
Potash	0.37	1.30	0.39	0.89	0.48	0,29	0.61	1.95	3.31
Soda	......	......	......	......	0.25	0.19	......	......	......
Water	14.25	13.30	13.70	13.90	10.00	10.36	6.08	8.10	......
Protox. Iron	......	......	0.87	......	......	......	......	......	......
Zirconia	1.40	1.40	......	......	......	......	......	......	......
Sulphur	......	......	......	0.45	0.38	......	......	......	......
Phosphoricacid	......	......	......	......	......	......	......	......	......
Sand	......	......	......	......	......	......	......	......	......
Combin'd water	......	......	......	......	......	......	......	......	9.63
Hygros'pic wa'r	......	......	......	......	......	......	......	......	2.33
Organic matter	......	......	......	......	......	......	......	......	......
Total	99.67	100.19	99.59	100.00	100.32	99.88	99.95	98.08	99.36

Constituents.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.
Silica	78 40	74.44	46.32	46.29	65.10	50.20	67.12	44.25	72.23
Alumina	12.25	19.04	39.74	40.09	22.22	32.59	21,18	34.75	16.75
Sesquiox. Iron	1.30	0.61	......	......	......	3.52	1.85	3.41	1.29
Lime	0.50	0.45	0.36	0.50	0.14	0.36	0.32	0.34	2.00
Magnesia	......	0.27	0.44	......	0.18	0.44	0.84	1,18	0.07
Potash	......	2.07	......	......	0.18	2.32	2.02	1.58 }	......
Soda	......	......	......	......	......	......	......	...... }	......
Water	......	......	......	......	......	......	......	......	......
Protox. Iron	......	......	0.27	0.27	1.92	......	......	......	......
Zirconia	......	......	......	......	......	......	......	......	......
Sulphur	......	......	......	......	......	......	......	......	......
Phosphoricacid	......	......	......	......	0.06	......	......	......	......
Sand	......	......	......	......	......	......	......	......	......
Combin'd water	5.20	5.71	12.67	12.67	7.10	9.69	4.82	8.56	6.34
Hygros'pic wa'r	......	......	......	......	2.18	......	1.39	2.89	1.14
Organic matter	......	......	......	......	0.58	......	0.90	3.17	......
Total	98.65	100.59	99.80	99.82	99.66	99.12	100.44	100.13	100.32

Constituents.	XIX.	XX.	XXI.	XXII.	XXIII.	XXIV.	XXV.	XXVI.	XXVII
Silica	45.90	47.05	47.13	42.28	50.50	48.37	65.69	19.99	45.39
Alumina	40.34	37.14	36.76	43.05	33.70	34.95	24.87	17.31	39.34
Sesquiox. Iron	......	trace	trace	......	1.80	1.26	2.54	0.56	1.28
Lime / Magnesia	trace } ...... }	0.03	0,04	trace	0.80	......	......	......	......
Potash / Soda	......	......	......	......	1.90	2.40	......	0.46	1.04
Water	13.26	15.55	15.13	14.66	11.22	12.62	16.60	5.70	12.95
Protox. Iron	......	......	......	......	......	......	......	......	......
Zircouia	......	......	......	......	......	......	......	......	......
Sulphur	......	......	......	......	......	......	......	......	......
Phosph'ric acid	......	......	......	......	......	......	......	......	......
Sand	......	......	......	......	......	......	......	55.89	......
Combin'd water	......	......	......	......	......	......	......	......	......
Hygros'pic wa'r	......	......	......	......	......	......	......	......	......
Organic matter	......	......	......	......	......	......	......	......	......
Total	99.50	99.77	99.07	99.99	99.92	99.60	99.70	99.91	100.00


C. M. & St. P. Railway
Gifford's
Point Lapham
Spring
8
45
50
55
57
44
9
56
66
65
45
4
29
44
51
47
38
8
Scale
Two inches to
one mile

OCONOMOWOC LAKE, AND OTHER SMALL LAKES OF WISCONSIN, CONSIDERED WITH REFERENCE TO THEIR CAPACITY FOR FISH-PRODUCTION.

BY I. A. LAPHAM.

The Oconomowoc Lake in Waukesha county, on the line of the Chicago, Milwaukee and St. Paul Railway, is one of those beautiful sheets of clear, cold water that may be taken as a type or representative of hundreds of others within the State of Wisconsin. A few facts and observations in regard to this lake may therefore be of interest to the Fish Commissioners, and to all who desire to encourage the increase of fish-production.

As shown upon the plats of the government land surveys, it has a length of two miles; breadth, three-fourths of a mile; a shore line of six and a half miles; covering an area of 830 acres, or one and three-tenths square miles.

Its elevation above Lake Michigan, as ascertained many years ago, in making the survey of the Milwaukee and Rock River Canal, is two hundred and eighty-two feet. Its irregular form can best be seen by reference to the accompanying chart.

The Oconomowoc River, a small stream which is the outlet of several other lakes, enters it on the north shore and leaves it at the northwest corner. So irregular is the shape of this lake that it might be taken to illustrate geographical terms, as gulf, bay, point, cape, promontory, peninsula; it has also straits, channels, bars, shoals and its coast-line.

The banks of the lake consist mostly of high grounds which are selected as sites of beautiful, often costly residences, which, especially when duplicated by reflection from the smooth surface of the water, form landscapes worthy of the pencil of the painter.

The lines of figures on the accompanying chart show the depth of the water as measured in 1875. They indicate three principal depressions, the deepest being 66 feet,* the mean of all the soundings is 39 feet.

* The greatest depths measured in other lakes in the vicinity were:

	Feet.		Feet.
Nagowicka	100	La Belle	45
Upper Nashotah	55	Silver Lake	40
Lower Nashotah	50	Upper Genesee	39
Pewaukee	50	Lower Namahbin	34

There are several shoals with from two to six feet depth of water.

There is no deposit of mud or sand brought into the lake by the river; the water-supply both from the river and from the numerous springs on the shore, being always clean and pure. One of these springs on the south shore, known by its Indian name Minnewoc, (place of waters,) has been analyzed by Mr. G. Bode, of Milwaukee, Chemist of the Wisconsin Geological Survey, with the following result:

Chloride of sodium	0.129
Sulphate of soda	0.627
Bicarbonate of soda	1.041
Bicarbonate of lime	9.638
Bicarbonate of magnesia	6.138
Bicarbonate of iron	0.129
Alumina	0.067
Silica	0.879
Total (grains in one gallon)	18.648

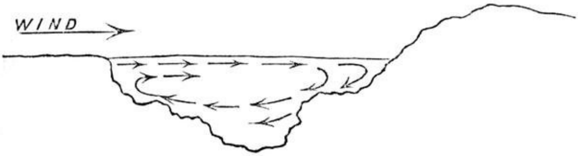
It will be seen that the chief ingredients, as in most Wisconsin waters, are lime or magnesia, derived doubtless directly from the magnesian limestone rocks and pebbles buried beneath the soil. This analysis also shows that the water does not differ essentially from those having great reputation for their medicinal virtues.

The lime from the springs is deposited, under favorable circumstances, upon the bottom of the lake forming beds of pure white marl; a process which is materially assisted by the secretions of mollusks aud aquatic plants, especially the chara and algæ.

The temperature of the water, being an important item in fish culture, was taken at different times near the surface, where it had considerable depth, with the followiug result:

In May	41°	Fahr.
In June	63	"
In July	72	"
In August	72	"
In September	72	"
In October, 1874	53	"

An attempt was made to find the temperature at the bottom in deep water and resulted in showing at some times no differences, at other times one or two degrees warmer or colder; though the deep water is popularly believed to be much colder than that at the surface.



The strong wind blowing over the lake causes a surface current which must be balanced by a counter current below, and thus by a constant interchange of water equalizes the temperature. If the day is warm with but little wind, the surface water will become the warmest; at night the surface cools down so that in the early morning it is colder than at the bottom.

The deep-water fishes do not, therefore, seek that locality on account of diminished temperature.

One lake is said to have remained open nearly all winter; the cold weather having been accompanied by high wind, which prevented the water from freezing.

When the surface is once covered with ice the currents cease, and ice is formed of great depth and of crystal transparency and purity.

The temperature of the spring-water along the shores remain nearly uniform throughout the year, varying from 47 to 49 degrees, which is not far from the mean temperature of this locality.

The currents caused by the wind blowing over the surface of the lake, act upon the bottom and shores, causing abrasious at some places and accumulations at others, very much as by the larger currents of the ocean. This is quite apparent at two points on the channel between the lake and the large bay at the northeast angle. The current flowing into the bay from the lake causes an eddy at these points from which are deposited long narrow bars projecting from the shore. This channel it will be seen is quite narrow and the water in it shallow.

These currents also cause accumulations of beach sand and gravel at certain points along the shore; separating and assorting the material upon a small scale, precisely as is done on a larger scale by the currents in the great lakes, and in the ocean.

While white shell marl is accumulating in some portions of the lake, soft muck resulting from the annual decay of aquatic vegetation is accumulating in others. Some of the lakes, especially those not connected with a stream of running water, are thus becoming rapidly filled with marl and peat, causing changes that become apparent after long intervals of time. Some small shallow lakes have thus been changed to meadows within the recollection of the first settlers of the county only 38 years ago.

The government plats represent some lakes in 1835, which are now only known as marshes or wet meadows. One called "Soft Water Lake," was a clean sheet of water only four years ago, but is now nearly covered with the leaves of the yellow pond lily (Nuphar) and other water plants. Soon it will cease to be known as a lake.

There are also some changes of the level of some of these lakes, indicating a less amount of water than formerly. Sand bars formerly covered with water are now dry, and in one case the bar extends quite across the lake, thus dividing it into two. Another proof of a diminished supply of water is afforded by the occurrence of ancient beaver dams in places where no pond could be formed at the present time, for want of running water.

The time may come when by the use of some simple, easily worked dredge, the marl, and muck may be removed from the bottom of some of the more important of these lakes, to be used as a fertilizer of the neighboring farms; especially as the beauty of the lakes would be increased by deepening the water, and by the consequent removal of the unsightly vegetable growth along their shallow margins.

Ice ridges are formed at certain places around the shore, some of them double, or triple, and varying in height up to ten feet. These ridges are formed by the expansion of the ice during the winter, pushing the materials of the beach in-land. They consist of sand, gravel, or boulders; in the latter case they constitute the so-called "walled lakes." If the banks are high and steep at the edge of the water, no ridge can be formed, but wherever low grounds or marshes approach the lake, they may be looked for. Where springs enter the lake, no ridges are formed, the water remaining above the freezing point all winter. Trees are often found with their roots crowded inland by the ice-expansion; their tops leaning over the water. These ridges make excellent road-beds, and are often used for that purpose.

The ancient mound-builders, that mysterious people who preceded the present Indian races, once occupied the banks of these lakes as is clearly shown by their numerous works; and they probably derived no inconsiderable portion of their subsistence from fish. No shell-heaps have been found to indicate their use of the abundance of Unio and Anodons found in these lakes. The works of the mound-builders are rapidly disappearing, being levelled by the plow of the farmer.

Besides the Unios, these lakes abound in other bivalve and univalve mollusks; crustaceans and worms, and the larvæ of insects appear in wonderful numbers. These, with the innumerable minnows found in shallow waters, afford at all times an abundant supply of food for the larger fishes. Loons, geese, ducks, gulls, plover, and many other birds swim upon the waters or wade along the margin.

Among the fishes to be found are the following:

PERCH, Perca flayescens, Cuvier.

WALL-EYED PIKE, Lucoperca americana.

STRIPED BASS, Roccus chrysops, Girary.

ROCK BASS.

STONE-ROLLER, Etheostonia.

BLACK BASS, Micropluas nigricans, Agassiz.

SUN-FISH, Pomotis.

PUMPKINSEED.

SHINER.

SHEEPHEAD, Haploidonotus grunnieus.

STICKLE-BACK, Applissinconstans, Kirtland.

PICKEREL, Esox, Lesueur.

SISCO, Argysosomus sisco, Jordan Am. Nat., 1875, p. 135, Ind. Geol. rep. 1875, p. 190.

SUCKER, Catastomus.

RED-HORSE, Plychostonus.

CAT-FISH, Amiurus catus, Cuvier.

BULL-HEAD.

BILL-FISH, Lepidosteus oxyurus, Rafinesque.

The Salmon and Brook-trout are reared artifically, and have been introduced into some of the lakes.

Young salmon (Salmo salar) and the brook-trout (S. fontinalis,) have been introduced into this lake, but so far as known they have not increased.

From the data given above one will be able to decide whether it would be advisable for the State to attempt to stock this lake with fish; and if so, the kinds best adapted to the conditions named.

The natural supply of fish has been drawn upon so heavily that the present yield is quite small, compared with what it was a dozen or more years ago; and hence the necessity of some effort for the restoration of the supply of the better kinds.

FISH-CULTURE.

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

It is of the first importance to ascertain the nature of the water which we desire to stock with fish, its depth, temperature and chemical character; also, the nature of the bottom, and of the shore, how supplied, and what becomes of the surplus water; what species of fish, crustacea, mollusks, annelida, and insect larvae are found in the water and in the mud of the bottom; what aquatic plants are found growing in the water, and on the margin of the lake, pond or stream. An intelligent answer to these several interrogatives would furnish data, that will enable us to escape the danger of certain failure. For it is evident to the most careless, that these conditions should agree with the iustincts, habits, and way of life of the animals to be developed there. The neglect to observe, or properly appreciate these natural conditions has, in many instances, been the cause of total failure of fish culture, even when in other respects, the men have been skillful pisciculturists. All our lakes should be surveyed in the most careful manner, under the supervision of men fitted for such investigations. The paper prepared by the lamented Dr. Lapham, on Lake Oconomowoc, is a model in almost all points. It only remains for us to dredge the bottom in order to secure the lower forms of life, to ascertain their species and abundance, so that in all future time it can be known to a scientific certainty what valuable species of fish will thrive in its waters.

What species of fish are best to cultivate in order to stock our hundreds of small inland lakes? This is a question of great moment, and one that should be answered with caution in any given case. I will however in a general way state a few of the species that will be suitable for many of these charming sheets of water.

White-fish.—The genus Coregonus includes the true white-fish of the great lakes. They may be known by their blunt nose and short underjaw. These fish are, undoubtedly, superior as an article of diet to any other fresh-water fish. They feed on small crustacea and occasionally on the larvæ of insects. Whether this fish will thrive in any of these smaller lakes is still doubtful. However, it is worth the trial surely. The genus Argyrosomus includes those smaller species of whitefish, having a sharp nose and projecting underjaw. There are at least four species known, three of them are found only in the largest lakes. The fourth, the Sisco, inhabits several of the smaller lakes. There is at least one species, the Lake-herring, *a. cluperiformis*, that can be transferred to all of those lakes where the Sisco is now found. All of these small whitefish take the baited hook at certain seasons of the year. The other two species inhabit the profound depths of Lakes Michigan and Superior, and will not flourish if taken from these waters. The Salmon trout--*Salmo namaycush* is one of the largest and best of the fresh water salmon; a species that is one of the easiest to propagate artificially, the egg being large and hardy. We have many lakes, undoubtedly, where this great gamefish would multiply and be at home. Why should we be running after strange gods, when we have such a treasure at home? At Racine and Milwaukee the egg can be procured in any numbers desired.

The so-called brook-trout *(Salmo fontinalis)* are just the thing for ponds supplied by free flowing springs of pure cold water. For this purpose they have no equal, bnt it is probable that it would be hardly expedient to use this species for stocking public waters. There is a species of salmon that has lost the instincts of its distant relation, the *salmo salor*, so that it has no longer a desire to visit the ocean. The " land-locked salmon" *(Salmo sebago)* is not quite one half as large as the salmon trout, but is an excellent game fish; one that will thrive in a number of the lakes. We have quite a number now in the State of Wisconsin, and hope soon to be able to stock some of the lakes with this fish. The black bass *(Micropterus nigricans and M. Salmoides)*, are excellent fish, but difficult to propagate in consequence of their eggs having a mucous coat that causes them to adhere in packets. There is an interesting paper published in the U. S. Fish Commissioners Report, for 1872 and 1873, on page 567, by Rudolph Hessel, of Germany, " On methods of treating adhesive eggs of certain fishes in artificial propagation." Hessel, it is hoped, has struck the right method, and we hope that in a short time we shall be able to propagate bass, and especially the European Carp, *(Cyprinus carpio and other species)* which deposits her eggs on the underside of submerged aquatic plants, only an inch or two under the surface of the water. The Carp is extremely tenacious of life, but flourishes in shallow lakes with muddy bottom and partly filled with vegetation. We have numerous lakes of this discription where the bass will not thrive, but where all the conditions are favorable for the healthy development of the Carp. I look with great hope in that direction. Prof. Baird will secure abundance of Carp spawn as soon as it is proven that we can manage them artificially. When you can go with hook and line and bag ten pound specimens of that most desirable fish, the carp, then you will feel like thanking the men who have so persistently persevered in investigating every condition that can secure benefits so great. These waters that now produce so slender a supply of ordinary fish, then will teem with the best; such as but few men can now afford to eat.

NOTES ON THE GEOLOGY OF NORTHERN WISCONSIN.

BY E. T. SWEET, M. S.
Assistant on the Geological Survey of Wisconsin.

During the summer months of 1873 and 1875, I was occupied, mainly in northern and northwestern Wisconsin, assisting in the prosecution of the field-work of the State Geological Survey. The greater part of the season of 1873 was devoted to an examination of the Penokie Iron Range, including incidental observations upon the geology of Ashland county, under the direction of Professor Irving. Late in the season I received instructions from our lamented chief geologist, Dr. Lapham, to examine and report upon the "Copper Ranges" of Douglas county. My visit to the northern part of the State during the season of 1875 consisted of a reconnoisance of northern Wisconsin, under the direction of Dr. Wight, the State Geologist. Canoe-trips were made from St. Croix Falls, nearly to the source of the St. Croix river; from the head of the Chippewa river to Chippewa Falls; from Jenny up the Wisconsin and Pelican Rivers, and from Post Lake down the Wolf River to Shawano. The total distance traveled by the party, during two months, mainly upon these streams, was about 700 miles.

The main results obtained in Ashland and Douglas counties the first season, have already been made public by Professor Irving, through the second volume of the Transactions of the Academy. I wish to call particular attention to the Professor's paper on "Some Points in the Geology of Northern Wisconsin," and to the conclusions reached by him; for, in many respects, this paper may be considered merely a supplement to that. His general conclusions will be accepted and quoted without reiterating the proof upon which they are based. Several points alluded to in his paper, I wish to still further elaborate in connection with the presentation of facts which were observed for the first time during the reconnoissance. In this paper I shall especially discuss the main features in the geology of the region immediately bordering the St. Croix river from St. Croix Falls to the head of that stream, and shall also frequently refer to other localities in northern Wisconsin and Michigan, in order to present new facts, or to quote those already known, which bear upon points in the geology of the above mentioned district.

Four great geological formations are represented in northern Wisconsin.

1. Granitic and gneissic rocks supposed to be the equivalents of the Canadian *Laurentian.*

2. The *Huronian* magnetic schists, quartzites slates and diorites·

3. A great variety of rocks lithologically distinct, among which are diabase, melaphyres, porphyries, conglomerates, shales and sandstones, known as the *Copper Bearing Series.*

4. The *Lower Silurian Sandstones.*

Of these formations, the Laurentian and Huronian are not known to occur in the vicinity of the St. Croix River. The first probably will not be found nearer than twenty-five or thirty miles to the St. Croix, while the existence ot the second, as shown below, may be proven much closer to that stream.

1. *Laurentian.*—The rocks of this, the most ancient geological age of which we have any knowledge, although very interesting to the geologist, are in northern Wisconsin of comparatively little importance. In this state we have no evidence of the occurrence of useful minerals in these rocks, in anything like workable quantities. Gold, however, has been reported in very small quantities from Oconto county. Professor Irving reports traces of gold and silver in quartz from Clark county, which is probably of this age. The Laurentian rocks are usually granites, passing tnrough the fine and medium grained to very coarse grained varieties. Rocks of this age, with a single exception, were found to occur the entire distance passed over in the reconnaissance of the Chippewa, Wisconsin, Pelican and Wolf Rivers. Upon the Chippewa and and Wisconsin Rivers, numerous exposures of syenitic and hornblende rocks occur interstratified with granite aud gneiss rocks. The bedding of the strata along these streams can usually be determined with a great degree of certainty. A remarkable uniformity in the strike of the rocks of this region has been proven to exist. There is scarcely an exposure along the banks of the Chippewa or Wisconsin upon which the strike can be made out, that does not fall within the arc included between north sixty degrees east and

east and west. The dip is always at a high angle either to the north or south.

The Laurentian rocks of Wolf River are very uniform in character. From Post Lake to Keshena, a distance of about seventy-five miles, the rocks are all exceedingly coarse grained feldspathic granite. The crystals of orthoclase are often several inches across. Biotite, a variety of black mica, appears to be a characteristic of these rocks. At localities it is the exclusive variety of mica found. At Post Lake dam, on section 9, town 33, range 12 east, a ledge of hornblendic schist gives a strike of north, fifty degrees east. With this exception no undoubted strike or dip was observed in the rocks in the vicinity of Wolf River. A few miles above Keshena the surface of the granitic fields has been worn by glacial action into knolls and knobs which present the characteristic appearance of "Roches Montonnees." Large boulders of uniform, coarse grained granite are of frequent occurrence in the channel of Wolf river from Post Lake dam to Keshena. Many boulders also, of immense size have been transported from this region, far to the southward, aud deposited in Waushara and adjoining counties.

Huronian.—Several new and interesting points showing the relationship between the Laurentian and Huronian formations were observed at Penokie Gap, by Mr. C. E. Wright, of Marquette, Michigan, and myself, during the season of 1875. We spent nearly three days at the "Gap" and succeeded in making several important additions to the geological section of the "Range," taken two years before at that point, by Professor Irving and myself. The section referred to accompanies Professor Irving's manuscript report on the Penokie Range now in the office of the Secretary of State. It extends from the fine grained white quartz and siliceous slates on the south to the massive diorites on the north, a distance across the formation, at right angles to the dip, of about four thousand feet. Mr. Wright and myself extended this southward a short distance to the Laurentian gneiss and granite, and northward over two thousand feet, probably to the lowest member of the Copper-Bearing Series.

The juuction between the Laurentian and Huronian is in the southern part of section 14, town 44, range 3 west. At this point Bad River passes through a narrow gorge having nearly vertical walls on either side. In the left or northern wall of the gorge, fine grained white quartz with a vitreous coating and slaty siliceous schist occur, showing a strike nearly east and west, and dip of sixty-six degrees to the north. The quartz represents the lowest member of the Penokie system examined by the party in 1873. Upon examining the opposite wall of the gorge siliceous marble was discovered for the first time to be one of the beds of the Penokie system, lying below the iron bearing beds.* A similar arrangement has long been known to exist in the Huronian of the Marquette district, which has led to the suspicion of its existence in Wisconsin. The thickness of the siliceous marble is about fifty feet. It is usually fine grained and grayish in color. Small crystals of calcite and dolomite however can be observed irregularly disseminated. An analysis of a specimen taken from the ledge afforded me the following result:

	Per cent.
Carbonate ot Lime	50.52
Carbonate of Magnesia	33.41
Insoluble Matter	13.85
Oxide of Iron	1.70
Undetermined	.52
Total	100.00

The analysis shows that the proper name for the rock is siliceous dolomitic marble. In the Marquette region the Morgan furnace limestone but very little purer than this has been extensively used as a flux. One hundred feet southeast from the exposure of siliceous marble, there is a large ledge of gneissoid granite showing a well defined dip ot seventy-seven degrees to the south, and strike of north, seventy-five degrees west. In following the strike west, one passes within twenty-five feet of the outcrop of siliceous marble which has a northerly dip. Between one and two hundred feet south, on the line of the railroad, other large exposures of gneissoid granite are found having essentially the same bedding as that mentioned above. When the railroad cut is completed at this locality, the absolute junction of the Laurentian and oyerlying Huronian will doubtless be exposed. There can be no doubt of the unconformability of these formations, approaching each other as

* I will say in this connection that the facility for making observations at this locality have been greatly increased since Professor Irving's examination of the "Gap." Excavations have been made at the gorge for a railroad bridge and the earth and roots which formerly overhung the face of the wall removed. The rocks are now plainly exposed and are easily accessible.

they do with a persistent opposite dip and somewhat different strike. Unconformability has been shown to exist between the Laurentian and Huronian in Michigan, but this is the first time that it has been proven in Wisconsin. Northward from the granites the section has been completed for over sixteen hundred feet. In this space are included two "magnetic ore" beds, the southern one hundred and thirty and the northern over five hundred feet thick. Directly above or north from the northern "ore" bed there is a space of fourteen hundred feet upon which exposures have not been found. Above this blank, recent railroad excavations enabled Mr. Wright and myself to subdivide and extend the belt of four hundred feet, supposed to be the uppermost member of the Penokie system, into: a. siliceous schists, one hundred feet; b. blank, (Bad River,) seventy-five feet; c. contorted black slate, two hundred and fifty feet; d. diorites, seventy-five feet; and e. black porphyritic slates, fifty feet.

Owing to the heavy deposits of drift we were unable to find exposures for thirteen hundred feet north from the black porphyritic slates.

We then found what are probably the latest beds of the Huronian formation, g. black slate, forty feet, h. quartzite, about two hundred and fifty feet, i. slaty amygdaloid seventy-five feet.

The thickness of the formation, I estimate at something over five-thousand feet. The dip is about sixty-six degrees to the north showing entire conformability throughout.

It will be observed from this brief outline of the geological section at Penokie Gap, that there are two important belts left blank. There is no attraction of the needle upon either, which would lead one to suspect the presence of magnetic deposits. But the red or hematite ores have no influence on the magnetic needle, they are soft and easily worn away, and never outcrop naturally in the Marquette region. Consequently although not exposed on the Penokie range they may yet be found in one of these blank spaces. Representatives of most of the beds of the Marquette system occur at Penokie gap. This is a strong argument in favor of the existence of the soft or hematite ores in the unexplored belts of the Wisconsin Huronian.

An accurate geological section ought to be constructed entirely across the Penokie Range at some point from the granites on the south to the undoubted Copper-Bearing Series on the north, even should it be found necessary to do a little testpitting in order to expose representatives of each member of the system.

A new quartzite locality was discovered on section 6, town 32, range 6, west, during the descent of the Chippewa. It forms a hill about three hundred feet in height, and three or four miles in circumference. The lowest stratum of the formation is reddish metamorphic conglomerate, having a thickness of three hundred feet. The pebbles are seldom over an inch in diameter and are either jasper or amorphous quartz. The matrix consists of reddish grains of quartz. Above the conglomerate is a bed of reddish quartzite four hundred feet thick. The grains of quartz of which the layers are composed are much more distinct than in specimens of quartzite from the Baraboo Hills of Sauk county. Also the rock has a much deeper red color than most of the Sauk county quartz. A depression in the side hill one thousand feet across, comes in above this quartzite upon which exposures were not found. The space is probably occupied by some softer rock than quartzite. Above this arises the main hill of quartzite. In every respect the rock is similar to that mentioned above. The entire thickness of the formation is not far from five thousand feet. Both the conglomerate and quartzite are distinctly and heavily bedded. The strike is north twelve degrees, west, and the dip sixty degrees to the west. Careful observations were taken with the dip compass, and also with the magnetic needle, with a view to discovering magnetic ore deposits. No undue attraction, however, was observed.

One and three-quarters miles from the exposures of quartzite, syenitic granites which may be assumed Laurentian in age, were found in the banks of the Chippewa striking north, fifty degrees east, and dipping high to the north. From the persistency of the strike here and at Little Falls, two miles below, it may be assumed that the quartzites and conglomerates unconformably overlie the Laurentian granites and syenites.

No evidences were observed along the Wolf River, of the crossing of that stream by the Huronian.

3. *Copper-bearing series.*—The only examinations upon the Copper-Bearing Series during the reconnaissance, were made in the ascent of the St. Croix River. At St. Croix Falls there are several well defined ridges of Copper-Bearing rocks trending east north east. It is not known, however how far to the eastward they ex-

tend. Neither has their relationship to the Lake Superior Copper-Bearing System yet been made out. The bedding, if it exists, is very indistinct. Across the formation at right angles to the apparent strike, the distance is between four and five miles. In lithological character the rock differs from any I have noticed in the Lake Superior region. It is usually very fine grained, dark gray in color, and is apparently made up of feldspar, hornblende and quartz. Some varieties are porphyritic, other amygdaloidal. At the falls and dalles of the St. Croix these rocks are largely exposed. A mine at Taylor's Falls, near the dalles, has been worked to a considerable extent in this rock for metallic copper. It is said encouraging results have been obtained.

After leaving the St. Croix Falls range, nothing more is seen of the copper-bearing rocks along the river to a point thirty miles north from the Falls. A short distance north of the mouth of Snake River Cupriferous rocks again come in. They are mainly melaphyrs and amygdaloids, and are overlaid by horizontal beds of light colored Potsdam sandstone. A few miles to the north, conglomerates and reddish shales conformably overlie the Cupriferous strata. The dip, so far as can be made out, is slight, and to the northwest. The conglomerate is heavily bedded, but does not cover the melaphyrs and amygdaloids at all points. It appears rather to fill pockets and depressions in the underlying rocks than to be intrstratified with them. The pebbles of the conglomerate are usually very large, some of them being over a foot in diametor. They have all evidently been derived from the underlying Cupriferous rocks. The matrix consists of reddish grains of quartz, similar to the Lake Superior sandstone. A short distance above the mouth of Kettle River, the most northern exposure of the Kettle Riyer range is found. Across the formation at right angles to its trend, the distance is four and one half miles. Copper has been discovered and locations have been marked upon this range near the St. Croix River. The conglomerates and shales associated with the melaphyrs and amygdaloids of the Kettle River range occupy the same stratigrapical position, and are in every respect, except in the degree of inclination, similar to those of the copper range of Ashland county, exposed on Bad River at the mouth of Tylers' Fork. On Bad River the dip is nearly vertical to the northwest, while on the St. Croix it is but a few degrees in the same direction. Between these localities the upper conglomerates and sandstones accompanying the Copper-Bearing series have not been seen. For asserting that they are the representatives of each other—I have among others, the following reasons:

1. Cupriferous strata have been traced uninterruptedly from the extreme end of Keweenaw Point to Long Lake in Bayfield county, a distance of over 200 miles. The apparent thickness of the formation is never less than 20,000 feet, and is often even 60,000 feet. Fifteen miles west from Long Lake, Dr. Wight found the Cupriferous series represented at the Eau Claire Lakes. From here, in the same general southwesterly direction, the distance to the out-crops on the St. Croix is about 60 miles. Exposures of "trap-rocks," have been reported by explorers at numerous localities between the two points. There can be no doubt then, that the Kettle River Range is merely a westward prolongation of, and is directly connected with, the "mineral range" of Keweenaw Point, upon which the most famous copper mines of the world are located. From facts which have been obtained mainly from explorers, and also from Dr. Owen's report, I am satisfied that the range extends forty or fifty miles into Minnesota before it is covered by later strata.

2. The region has been very little examined, and the conglomerates might escape observation.

3. There is probably a gradual thinning out of the conglomerates towards the west. At the mouth of the Montreal River, the conglomerates and interstratified sandstones and shales have a thickness of 10,000 feet, while on Bad River, but eighteen miles to the west, the exposed thickness is but a few hundred feet. On the St. Croix River the thickness is still less. Owing to this thinning out they have been largely removed by erosion.

Northeast from the Kettle River range there is a space of forty miles along the St. Croix River, although only about four miles at right angles to the trend of the formations, upon which rocks in place were not observed. At Sawyer's dam, on section 16, town 42, range 14, west, southward dipping sandstones and shales were found. For fourteen miles along the stream, in a southeast direction, the strike and dip are very persistent. The strike corrected for variation is north sixty degrees east, and the dip fourteen degrees to the southeast. The greatest horizontal distance across the formation is three miles. A trigonometrical calculation therefore gives 3,949 feet for the thickness of the bed. The sandstone is reddish, fine grained and argillaceous. Flakes and concretions of indurated reddish clay are of frequent occurrence in the layers. The most northern exposure is near Chase's dam on section 36, town 44, range 13, west. Above here, on the St. Croix, no rock in place has been found. Two localities of southward dipping sandstone are known in Ashland county —the first at Lehigh's, on Bad River, where the thickness is 2,000 feet, and the second twelve miles southwest from Lehigh's—at Welton's, on White River—where only a few huudred feet are exposed. Owen, in an old executive document, reports southward dipping sandstone, at the head of White River, twenty miles still farther southwest. From here it is only 32 miles in the direction of the general trend of the formation to the southward dipping sandstones of the St. Croix, at Chase's dam. It is therefore probable that the bed extends entirely across the State from the St. Croix River to Lake Superior, entering the Lake at the mouth of the Montreal River. Owen reports southward dipping sandstones in Minnesota, on Kettle River, six miles above the falls of that stream. These exposures may be a westward continuation of the same bed.

The southward dipping sandstones and shales, form with the northward dipping sandstones, shales and conglomerates, a synclinal extending entirely across the State, the opposite edges of which approach on the west within four miles of each other, but on the east are separated by eight or nine miles. From this fact and others to be given, the conclusion may be assumed that the northward and southward dipping beds are the equivalents of each other. As both are largely represented on Bad River, and, moreover, as it was upon that stream that the southward dipping bed was first observed, I propose the name of *Bad River sandstone* for these, the upper beds of the copper-bearing series.

4. *Lake Superior sandstone.*—This term is generally employed to designate the reddish aluminous sandstones which nearly everywhere border the south shore of Lake Superior. They also form the basement rock of the Apostle Islands. They have never been found in a tilted condition. The interesting question of their age has been ably discussed by numerous writers upon the geology of Lake Superior. Without commenting upon the opinions which have been advocated upon this subject, some referring them to the

Triassic, others to the Potsdam, we may regard the question as definitely settled by the investigations of Dr. Rominger, of the Michigan Geological Survey, and others, that they are the downward continuation of the light colored Potsdam sandstones of the Mississippi valley. No fossils have ever been obtained from these sandstones. In the eastern part of the upper peninsula of Michigan they are found directly underlying light colored sandstones and Calciferous strata. A large area of Lake Superior sandstone extends southwesterly from Keweenaw Bay nearly to the Montreal River. The distance from the western end of this area to the exposures of horizontal red sandstone on the Wisconsin shore of Lake Superior is about 30 miles. From their proximity to each other, and also from a similarity in lithological characters, and in stratigraphical relations to the underlying formations, it may be asserted that the red sandstones skirting the lake shore from near Ashland to the St. Louis River, at the western end of the lake, and those of the Apostle Islands, are of the same age as those east of Keweenaw Point.

Upon the St. Croix River the Lake Superior sanestone does not occur. Only the light colored Potsdam and Bad River sandstones are represented upon that stream. It has been shown by Professor Irving that the dipping sandstones, shales, and conglomerates, associated with the Cupriferous rocks, very much ante-date the horizontal sandstones of Lake Superior in age. This being the case no satisfactory evidence can be drawn of the age of the horizontal sandstones from the stratigraphical relations which occur in the vicinity of the St. Croix River. The conclusions of Dr. Owen upon the "Age of the Lake Superior Sandstones," are based mainly upon the fact that the Bad River sandstones dip beneath, and are overlaid by light colored Potsdam sandstones. He did not realize that there is a vast difference in age between these and the true Lake Superior sandstone. There is no known locality west of Keweenaw Point, where the Lake Superior sandstone and Potsdam of the Mississippi valley are not separated by many miles.

The Lake Superior sandstones usually contain a large per cent., of alumina and sesquioxide of iron, which it has been observed were derived from the wearing down of the highly aluminous and ferruginous Copper-Bearing rocks.

The following analyses, made by me for the State Geological Survey, show at a glance, the change in chemical composition which has taken place in the process of the formation of the sandstones from the Cupriferous rocks:

	No. 1.	No. 2.	No. 3.	No. 4.
Gravity	2.92	2.69	2.43	2.18
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Silica	48.28	53.69	69.78	87.02
Alumina	17.35	22.10	15.43	7.17
Peroxyd of Iron	11.43	8.53	7.93	3.91
Protoxyd of Iron	4.02	3.65	....	....
Lime	6.27	4.31	.49	.11
Magnesia	6.58	2.09	1.17	.06
Potassa	1.14	1.39	2.64	1.43
Soda	1.83	1.99	2.42	.22
Water	2.66	2.61	Trace	Trace
Total	99.56	100.36	99.86	99.92

No. 1. (239, of the survey collection) is a fine-grained greenish gray diabase, from the Fond du Lac copper mine, Douglas county. It contains a trace of metallic copper. No. 2, (40 of the collection), is brownish-black melaphyre from the Ashland copper mine, near the mouth of Tyler's Fork, Ashland county. No. 3, (44) is coarse grained, reddish, Bad River sandstone, from Lehighs, Bad River. Crystals of feldspar can easily be distinguished in the specimen. No. 4. Typical Lake Superior sandstone from a large quarry on Basswood Island, Lake Superior. It is extensively used as a building stone. The material for the walls of the Milwaukee courthouse was obtained from this quarry.

5. *Potsdam sandstone.*—At St. Croix Falls, Potsdam sandstones, characteristic of the light-colored Primordial sandstones of the Mississippi valley, come in contact with the Cupriferous rocks at numerous localities. At the Falls they are usually fine-grained, and are also of ten aluminous and somewhat shaly. The shaly beds are often highly fossiliferous. Dr. Owen states that at St. Croix Falls, "the oldest Palaeozoic fossils of this continent, if not of the world, are found." At the western end of the old St. Croix dam about one half mile above the village of Taylor's Falls any number of shaly slabs may be obtained almost entirely made up of

large Lingulas. Fossils are also numerous at other localities. At Osceola, six miles from the Falls, trilobite fragments are especially abundant. Among others, I was able to detect the following: *Conocephalites binodosus. C. diadematus*, *Illaenurus quadratus*, *Agnostus disparilis*, and *Dikelocephalites osceola*. Associated with them is a very large gasteropod, believed to be new to science.

Dr. Owen, whose observations only have been published upon the geology of the St. Croix, considered the crystalline rocks at the Falls and Dalles of the St. Croix, of igneous origin, and of more recent age than the contiguous sandstones. I submit the following reasons for differing with him upon the question of age:

1. So far as can be determined, the sandstones are perfectly horizontal, and show no signs whatever of ever having been subjected to igneous or metamorphic action, or even of ever having been in contact with highly heated rocks.

2. Horizontal layers of fossiliferous sandstone occur a few feet from Cupriferous rocks, and in two instances perfect specimens of *Obolella polita* and *Lingulepis pinnaeformis* were found in a film of sandstone, not over one eighth of an inch from the absolute base of the formation at those points. In other instances shells were obtained from sandstone largely made up from the unaltered grains of the underlying formation. These shells certainly would have been destroyed, thus near highly-heated rocks.

3. Depressions and pockets in the surface of the Copper-Bearing rocks are often found filled or partially filled with horizontal layers of sandstone.

4. Grains from the crystalline rocks appear in the layers of sandstone at a distance of several rods from ledges of the former, thus showing that part of their material at least was derived from the Copper-Bearing rocks. The layers of sandstone were deposited therefore after the Cupriferous strata had assumed nearly their present condition.

Occasional outcrops of the Potsdam occur along the banks of the St. Croix for nearly forty miles above the Falls. A short distance below the mouth of Kettle River, on section 16, town 39, range 19 west, the most northern exposures of light colored sandstone were found. The outcrops are in the banks of the stream from ten to forty feet above the surface of the water. They are underlaid by melaphyrs, amygdaloids, conglomerates and fragments of aluminous red sandstone. Owing to the haste with which the expedition moved, the actual junction was not observed.

The Lake Superior Synclinal.—Foster and Whitney first painted out the existence of a synclinal between Keweenaw Point and Isle Royale. Professor Irving has suggested that this extends into Ashland and Bayfield counties. I think it has been pretty satisfactorially shown in this paper that it extends uninterruptedly westward, entirely across the state of Wisconsin, and enters the state of Minnesota. A general geological section across the formations represented upon the upper St. Croix, is very similar to one from Lehigh's, on Bad River, extending southeasterly across the formations to the Penokie Range. Starting from Chase's dam on the St. Croix, and from Lehigh's, on Bad River, the formations to the south are as follows:

1. A bed of southward dipping sandstones. About four thousand feet are exposed on the St. Croix, and two thousand on Bad River.

2. Trough of the synclinal; four miles across at the St. Croix, and about nine, in the vicinity of Bad River. Lake Superior sandstone may fill the trough of the syuclinal. At present only one small exposure of horizontal red sandstone is known to occur in it.

3. Northward dipping sandstones, shales and conglomerates. On the St, Croix they are but a few feet thick; on Bad River probably 1,000 feet are exposed; at the mouth of the Montreal the thickness is fully 10,000 feet.

4. Amygdaloids, melaphyrs, porphyries, etc. On the St. Croix the dip is slight to the northwest. Across the belt, the distance is four and one half miles. At the Montreal River the distance across the formation is about ten miles, and as the dip is nearly vertical, the apparent thickness is, in round numbers, 50,000 feet. If the rocks are of igneous origin, it is not difficult to account for this seemingly enormous thickness.

In Douglas and Bayfield counties, the Copper-Bearing strata have a dip to the south, and probably conformably underlie the southward dipping Bad river sandstone. If this is the case they are the representatives, in the northern edge of the synclinal of the Ashland and Burnett county copper series. The distance across the formation in Douglas county is about 30 miles; allowing a dip of fourteen degrees, which is that of the sandstones on the St. Croix, the thickness is not far from 40,000 feet.

The dimensions of the Lake Superior Synclinal, as thus made out, are simply enormous. It is over 300 miles in length, and from 30 to 50 miles in width. Over 4,000 square miles of territory are occupied in Wisconsin alone, by rocks belonging to its northern or southern edge. It can only be compared to an extensive, inverted range of mountains.

Westward extension of the Penokie range.—The Penokie system lies directly below, or geographically, south, from the Copper-Bearing series. The two formations are intimately connected, the strike and dip conforming throughout. The eastern end of the Penokie Range is near Lake Gogebic, in Michigan, nearly 100 miles from the famous Marquette iron region. It extends westerly without break to a point seven miles west from Penokie Gap. In Ashland county it forms a bold, high ridge, over thirty miles in length, and never more than two miles in width. In the western part of the county the range appears to break down and become lost for a distance of ten miles, when it appears again at two localities near Atkins Lake. The question of its westward extension from Atkins Lake, is one of great economic as well as of scientific importance. The country between the supposed end of the range and the St. Croix River has never been visited by a geologist. On account of its poverty in pine, it is comparatively unknown to woodsmen and explorers. That the formation does extend westward, probably to the vicinity of the St. Croix, I have strong presumptive evidence, but of course not absolute proof. I do not intend to assert that the Huronian belt extends uninterruptedly from the Penokie Range to the St. Croix. On the contrary, it has doubtless been subjected to extensive denudation, and large portions of it may no longer remain. Large sections of it are probably buried deep beneath accumulations of drift. The space of ten miles between the western end of the main range and the outcrops near Atkins' Lake, has been largely removed by erosion. but it is more than probable that below the deposits of drift the downward extension of the members of the system may still be found. The arguments in favor of the westward continuation of the Huronian schists in a more or less interrupted belt, are the following:

1. The westward extension, to the St. Croix River, of all the formations found north of the Penokie Range to Lake Superior.

2. If the iron bearing belt extends westward, it doubtless follows the southern boundary of the Cupriferous formation. It would therefore cross the St. Croix River some distance below the mouth of Snake River. Then, in the neighborhood of a line drawn from the mouth of Snake River to Penokie Gap, one would expect to find indications of the Huronian magnetic schists. Iron ore is reported in place, at several localities in the vicinity of this line. Explorers report its occurrence near the southern end of Long Lake, also on section 18, town 43, range 19 west, and from the northern part of Burnett county. On the original survey plat of town 38, range 19 west, I find on section 19, topographical lines indicating a ledge, and the words "iron ore." The locality has not been examined by members of the Geological Survey.

3. The non-occurrence of ranges or marked ridges in the St. Croix country may be cited in this connection, and reasons given why they should not be expected. In the eastern part of Ashland county the high ridge formed by the Penokie range is due to the nearly vertical dip of the strata. As the formation of northern Wisconsin extend westward the dip gradually decreases and they more nearly approach horizontality. Brooks reports the dip of the Huronian schists in the vicinity of Black River in Michigan, sometimes as great as 90°. At the gorge of Tyler's Fork I found the dip 75° to the northwest. At Penokie Gap the dip is 66° while at Atkins Lake the inclination is only 45° to the northwest. The upper members of the Copper-Bearing series, which have an almost vertical dip on the Montreal River and at the mouth of Tyler's Fork, have only a slight dip to the northwest on the St. Croix River. At Lehigh's, on Bad River, the southward dipping sandstones incline 38° to the southeast. At Welton's the dip is 25°, while on the St. Croix it is but 14° to the southeast. *As the formations approach the St. Croix they do not form bold ridges, but cover a much wider extent of territory than in the eastern part of the State*, and consequently the opposite edges of the synclinal are found much closer to each other than farther eastward.

4. The occurrence of small angular boulders of magnetic rock and iron ore in the drift at numerous localities in Polk and Burnett counties.

In Michigan, and in all regions where magnetic ore is found much reliance in exploring is placed upon magnetic surveys. Valuable mines have been discovered by noting the abnormal deflection of a delicate magnetic needle in crossing the formation at right angles to its trend. This method often succeeds when the dip compass fails. Although magnetic surveys have not been made in the region under consideration, linear surveys have, and the variation at several points upon each section recorded upon the township plats. In the township through which the Huronian belt is supposed to pass, the difference between the maximum and mimi, mum deflection of the needle from the magnetic meridian is much greater than in townships known to be distant from local magnetic influences. For instance, in township 37, range 20 west, the difference is 5 degrees, 30 minutes. Numerous other examples might be mentioned. The fluctuations of the needle from a fixed point under ordinary circumstances, and in ordinary townships, is not usually over one or two degrees. Investigations with a dip compass, and with an instrument for making accurate magnetic surveys, will certainly settle the question of the western prolongation of the magnetic schists. It will be necessary to go over a considerable portion of Burnett county, the southwest of Ashland, and southeast of Bayfield, and possibly the northern part of Polk very carefully. It is an important question, worthy of thorough investigation, and one which should be definitely decided as soon as possible by the Geological Corps.

ON THE RAPID DISAPPEARANCE OF WISCONSIN WILD FLOWERS; A CONTRAST OF THE PRESENT TIME WITH THIRTY YEARS AGO.

BY THURE KUMLEIN.

For the last thirty-two years I have resided in the vicinity of Lake Koshkonong, in Jefferson county, Wisconsin, and have during that time paid some attention to the Fauna and Flora of that locality, and have collected somewhat extensively in nearly all the branches of Natural History, particularly Ornithology and Botany.

When first I came here in 1843, a young and enthusiastic naturalist, fresh from the university at Upsala, Sweden, the great abundance of wild plants, most of them new to me, made a deep impression on my mind, but during these thirty-two years a large number of our plants have gradually became rare and some even completely eradicated.

When first I visited the place where I now live, the grass in the adjoining low-lands was five and six feet high, and now in the same locality, the ground is nearly bare, having only a thin sprinkling of June grass, Juncus tenuis and J. bufonius, Cyperus Castaneus, here and there a thistle or a patch of mullein and in the lowest with parts some Carices. As the land gradually became settled, each settler fencing in his field and his stock increased, some plants became less common, and some few rare ones disappeared; Lupinus perennis, among the first. But when all the land was taken up by actual settlers, and each one fenced in all his land and used it as fields or as pastures for as many cattle, horses, sheep, and hogs as could live on it without actual starvation, botanizing in this vicinity became comparatively poor.

In the oak openings, besides grasses of several species there were an abundance of other plants of which I will mention only some Orchids from a small piece of opening-land near my residence: Pogonia, pendula, Goodyeara pubescens, Corallorhiza odontorhiza, Aplectrum hyemale, Liparis lilifolia, Orchis spectabilis and Plalanthera bracteata, of these only one or two can be found in the same locality now.

In the thick timber along the Koshkonong Creek, there is now but one lot of about 40 acres where the plants can yet be found nearly as abundant as formerly. There can yet be had Phlox divaricata, Laphami. Allium tricoccum, Erythronium albidum, Dentaria laciniata, Asarum canadense and many other interesting plants. A Tamarack marsh held out the longest; it was not visited by cattle till, for want of pasture elswhere they were obliged to cross its miry borders. In this marsh, or on its borders, were formerly growing, Microstylis ophioglossoides, Liparis lœselii, Gymnadenia tridenta, Platanthera leucophoea, lacera and orbiculata, Arethusa bulbosa, Pogonia ophioglossoides, Calopogon pulchellus, Cypripedium pubescens, Parviflorum candidum and spectabile, Tofieldia glutinosa, Drosera linearis, Lobelia kalimi, Ophioglossum vulgatum, Schoenus albus, Schenchzeria palustris, Triglochin palustre, and many Carices among which Carex oligosporma. Now of all these and many other interesting plants formerly growing in this marsh or near it some have become very rare and some are totally eradicated.

On a small prairie, too stoney and gravelly for cultivation, there can yet be found Geum triflorum, Aster obtusifolius and ptarmicoides, Lithospermum hirtum and longiflorum, Castileja sessiiflora, Linum boothi, Gentiana puberula, Ranunculus rhomboideus, Hieracium longipilum, Draba caroliniana, Arubis lyrata, Arenaria, stricta, Mich. and Diplopappus which on gravel hills grows only two to three inches high, with leaves very stiff and narrow, but the flower large, having somewhat the aspect of an Alpine plant. A list of the plants of this vicinity, giving the plants of to-day, would be a comparatively meagre one and nearly useless, as their number is lessening every year, and a list of the plants of thirty years ago would perhaps have no other than a small historical value.

These observations, though made in only this locality, do probably apply to all the settled portions of the State.

ON THE ANCIENT CIVILIZATION OF AMERICA.

BY PROF. W. J. L. NICODEMUS, A. M., C. E.

The ancient works divide themselves into three great geographical divisions, viz., South America on the west coast between Chili, and the second degree of north latitude; Central America and Mexico, and the valleys of the Mississippi and Ohio.

The ruins of ancient Peru, which form the first division, are found chiefly on the elevated table-lands of the Andes, between Quito and Lake Titacaca, but they can be traced five hundred miles further south to Chili and throughout the region connecting these high plateaus with the Pacific coast. The entire district extends north and south about two thousand miles.

Before the Spanish conquest the whole country was the seat of a populous and prosperous empire, rich in its industries and far advanced in civilization. It is now accepted that the Peruvian antiquities represent two distinct periods in their ancient history, one being much older than the other, one before and the other after the first Inca. Among the ruins which belong to the older civilization are those of Lake Titicaca, old Huanaco, Tiahuanaco, and Gran-Chimu, and probably the roads and aqueducts were originated by it. On Titicaca Island are the ruins of an edifice supposed to be a palace or temple. It was built of hewn stone, and had doors and windows, with posts, sills, and thresholds of stone. At Tiahuanaco, a few miles from Lake Titicaca are what are supposed to be the oldest ruins in Peru. They are described by Cieca de Leon, who accompanied Pizarro. He mentions great edifices "that were in ruins," two stone idols resembling the human figure, and apparently made by skillful artificers." These idols were great statues, ten or twelve feet high. He describes large gateways with hinges, platforms, and porches, each made of a single stone, some of which were thirty feet long, fifteen high, and six thick. Along the whole length of some above the stone ran a cornice covered with sculptured figures. "The whole neighborhood," says Mr. Squier, "is strewn with immense blocks of stone, elaborately wrought, equalling, if not surpassing in size, any known to exist in Egypt or India."

At Cusco, about two degrees north of Lake Titicaca, are the ruins of buildings that were occupied until the rule of the Incas was overthrown. The Temple of the Sun was surrounded by a great wall built of cut-stone. Near by this is the extensive ruins of the palace of the Incas. The objective points to notice about both these periods of ancient civilization are, the absence of inscription; little or no decoration; method of building peculiar; their constructions including cities, temples, palaces, other edifices of various kinds; fortresses, aqueducts, (one, four hundred and fifty miles long,) great roads, (extending the whole length of the empire,) and terraces on the sides of mountains, built of cut-stone laid in mortar or cement, sometimes ornamented, but generally plain in style and always massive.

The Peruvians were highly skilled in agriculture and in some kinds of manufactures. They excelled in the arts of spinning, weaving, and dyeing. They had great skill in working metals; especially gold and silver. They excelled in the manufacture of articles of pottery. They had some knowledge of engineering as evidenced by their roads and aqueducts. They had some idea of astronomy. They divided the year into twelve months; and are supposed to have had something in the form of a telescope for studying the heavens, as a silver figure of a man holding a tube to his eye, has been discovered in one of the old tombs.

MEXICO AND CENTRAL AMERICA.

We now come to our second geological division, Mexico and Central America. Here we trace four distinct eras of civilization, which we will mark by describing a ruin belonging to each era. In the order of antiquity comes Quirigua. It is situated on the right bank of the River Motagna, in the State of Guatemala. It covers a large area of ground. We have described a pyramidal structure with flights of steps, and monoliths larger and higher than those at Copan. Though the sculptures are in the same general style, they are in lower relief and hardly so rich in design. One of the obelisks is twenty feet high, five feet six inches wide, and two feet eight inches thick. The chief figures carved on it are a man and woman on the front and back, while the sides are covered with inscriptions similar to those at Copan. Other obelisks are higher than this. The ruins of Copan that mark the second era are situated in the extreme western end of Honduras. Owing to the hostility of natives these ruins have not been very carefully explored. A stone wall from sixty to ninety feet high is described as running along the River Copan six hundred and twenty-four feet, in some places fallen and in others entire, which supported the rear side of the elevated foundation of a great edifice. It was made of blocks of cut stone six feet long, well laid in mortar or cement. The chief peculiarity of Copan was the number of sculptured inscribed pillars. In speaking of these, Mr. Squier says the ruins of Copan are distinguished by singular and elaborately carved monoliths, which seem to have been replaced at Pelenque by equally elaborate basso relievos, belonging, it would seem, to a later and more advanced period of art. Palacios, who described these ruins three hundred years ago, speaks of an enormous eagle carved in stone which bore a square shield on its breast carved with undecipherable characters; of a stone giant; a stone cross; a plaza circular in form surrounded by ranges of steps or seats, as many as eighty ranges remaining in some places. This plaza was paved with beautiful stones, all square and well worked.

The next era is represented by the ruins of Palenque situated in the northern part of the Mexican State of Chiapa. The largest known building is called the "Palace." It stands near the River Chacamas on a terraced pyrmidal foundation, forty feet high and three hundred and ten feet long, by two hundred and sixty broad at the base. The edifice itself is two hundred and twenty- eight feet long, one hundred and eighty wide, and twenty-five feet high. It faces the east, and has fourteen doorways on each side, with eleven at the ends. It is built of hewn stone laid in mortar of the best quality. It has four interior courts, the largest being seventy by eighty feet in extent. These are surrounded by corridors, and the architectural work facing them is richly decorated. Within the building were many rooms. The piers around the courts are covered with figures in stucco, or plaster. There is evidence of painting being used for decoration, but the architectural effect of the stone-work and the beautifully executed sculptures, particularly strike attention. The walls and piers are covered with ornamentation. Mr. Stephens thinks that the sculptured human figures, fragments of which are found, must have approached in justuess of proportien and symmetry, the Greek models.

The ruins of Uxmal represent the fourth and last era of the ancient civilization of Mexico and Central America. This brings us down to the time of the Spanish conquest. At that time it had begun to be a ruin which was complete in 1673.

The most important edifice was named by the Spaniards "Casa del Gobernador." It is 320 feet long, and was built of hewn stone, laid in mortar or cement. The faces of the walls are smooth up to the cornice. There follows on all four sides, one solid mass of rich, complicated, and elaborately sculptured ornaments, forming a sort of arabesque.

Before leaving this geological division, mention should be made of the astronomical monument, described by Captain Dupaix. In the Mexican State of Oaxaca, near the village of Mecamecan, is an isolated granite rock, which was artificially formed into a kind of pyramid, with six hewn steps facing the east. The summit of this structure is a platform, well adapted to observation of the stars on every side. It is supposed that this very ancient monument was devoted to astronomical observations. On the south side of the rock are sculptured several hieroglyphical figures, having relation to astronomy. The most striking figure in the group is a man in profile, standing erect, and directing his view to the rising stars in the sky. He holds to his eye a tube or optical instrument. Below his feet is a frieze divided into six compartments, with as many celestial signs carved on its surface.

Our third geographical division, the valleys of the Mississippi and Ohio Rivers, includes the remains of the ancient people called the Mound-Builders. Their ruins are the most numerous in the south, extending from the Gulf of Mexico, to West Virginia, Ohio, Michigan, Wisconsin, Nebraska, and probably further west. They consist of mounds and inclosures. In these mounds have been found ornaments and implements made of copper, silver, obsidean, porphy, and greenstone, finely wrought. Also, axes, single and double; adzes, chisels, drills, or gravers, lance-heads, knives, bracelets, pendants, beads, and the like, made of copper; articles of pottery, elegantly designed and finished; ornaments of bone, mica from the Alleghanies, and shells from the Gulf of Mexico. Porphyry is a very hard stone and could only have been worked with tools made of the hardest material. Obsidean is of volcanic origin and much used by the Peruvians and Mexicans for arms and cutting instruments. It is found in its natural state no nearer the Mississippi Valley than the Mexican mountains of Cerro Gordo. The art of spinning and weaving was known to them as evidenced by the cloth found in the mounds.

Before any evidence of ancient mining was discovered in the Lake Superior copper region, pieces of copper with blotches of silver appearing to be welded to it but not alloyed with it, had been dug from mounds. As this condition is peculiar to the Lake Superior copper, it was supposed that the Mound-Builders were acquainted with the art of mining. This was proven to be so in 1848. The modern mining works are mostly confined to that part of the copper region known as Keeweenaw Point. This is a projection of land extending into Lake Superior. It is about eighty miles in length, and at the point where it joins the main-land, about forty-five miles in width. All through this district, where-ever modern miners have worked, remains of ancient mining works are abundant; and they are extensive on the adjacent island, known as Isle Royale.

The area covered by the ancient works is greater than that which includes the modern mines, as they are known to exist in the dense forests of other district where modern mining has not as yet extended. Their mining was chiefly surface work; that is, they worked the surface of the veins in open pits and trenches. The mounds differ greatly in size. At Grave Creek, West Virginia, there is one 70 feet high and 1,000 feet in circumference. One at Miamisburg, Ohio, 68 feet high and 852 feet in circumference. Another at Cahokia, Illinois, is 700 feet long, 500 wide, and 90 feet high. They range generally from 5 to 30 feet in height. It is supposed that the lower mounds were used for the same purposes as the mounds in Mexico and Central America, for the foundation of their principle buildings. But these buildings, having been built of wood, soon perished, leaving no trace behind them save this earthen base. The high mounds are pyramidal in shape and have level summits of considerable extent, which were reached by stairways on the outside as those at Miamisburg, Ohio, and Grave Creek, West Virginia, which resemble the great mounds at Chichen, Itza, and Mayapan, in Yucatan, the first 75 feet high and the last two each 60 feet high. These Yucatan mounds were evidently constructed for religious uses as upon the summits of the first two are the ruins of stone temples. On the third the edifice has disappeared, as in all probability those upon the high mounds in this division, being built of the same material, wood.

In one of the mounds of the Ohio Valley there were found the timber-walls of two chambers and arched ceilings, with overlapping stones, precisely like those in Central America.

The Natchez Indians, on the lower Mississippi, had temples and sacred buildings, in which the "perpetual fire" was maintained. They were sun-worshipers, their chief claiming descent from the sun. Their traditions connected them with Mexico. By some they are classed as the Nahuatl, or Toltee race.

According to the Central American books, the Toltees came from "Huehue Tlapalan," a distant country in the northeast, long previous to the Christian era. Here they dwelt in a high state of civilization for a long period, were overthrowu by the Aztecs, who in turn were conquered by the Spaniards.

All indications aeem to warrant the conclusion that the mound-builders and the palace-builders, if we may be permitted to use this term, of Mexico and Central America, belonged to the same race. They must have left the United States on or before the advent of the wild Indians. This emigration south may have been voluntary to seek a more congenial clime, or may have been forced by the savages from the north. Fragments would seem to have been incorporated with the Indians, as for instance the Mandan Indians, a supposed branch of the Dacotahs. They differed in many respects from the other Indians, being of lighter color and peculiar in manners and customs. We suppose the mound-builders came to the United States from the south, entering the country near the Gulf of Mexico, where they were the most populous, and then gradually throwing out colonies, extended their sway, with sparser population to the northward.

They were eminently an agricultural people. Maize is supposed to have been their chief grain. Having fulfilled their mission here, they returned to Mexico and Central America.

The time of their disappearance is estimated to be about two thousand years ago. The appearance of the wild Indian is located at or after this time. In him we find an original barbarian with no signs of ever being connected with civilization. Besides, his traditions connect him with the northwest, from which direction he is supposed to have entered North America.

A strong fact in support of this view is that there are several tribes, the nomadic Koraks and Chookchees, found in Eastern Siberia, throughout the region that extends to Behring's Strait, who have a strong resemblauce to the wild Indian, and may well represent the common parent stock.

A few words in regard to the points relied upon to establish the antiquity of the mound-builders.

1. As no mounds are built upon the lowest formed of the river-terraces, it is presumed the mounds were built prior to their formation. These rivers show four successive terraces in their subsidence to their present channels. It is not possible to say what antiquity this would indicate, but at least a great one.

2. Sound and well preserved skeletons known to be two thousand years old have been taken from burial places in England and other European countries, less favorable to their preservation than the burial places of the mound-builders. Hence, it is supposed that the decayed skeletons taken from the mounds are more than two thousand years old.

I. The great age of the mounds are shown by their relation to the forests which must have sprung up after the disappearance of this eminently agricultural people. In conclusion, I will merely add that many theories, some plausible and others very absurd, have been invented as to the origin of the ancient civilization of Central America, and Peru. Authorities differ as to whether these two are distinct and if not which is the oldest. The weight of authority inclines to the opinion that they were originated by the same people and that of Central America is the most ancient.

Mr. Baldwin, an eminent writer on Archæology, after reviewing the principal theories as to the origin of this ancient civilzation, arrives at the conclusion that it was an original civilization. This is certainly a very safe theory and till more light is thrown upon this subject, seems to have as much to be said in its favor as any other hypothesis.

ON THE EXTENT OF THE WISCONSIN FISHERIES.

(An abstract of notes sent by Dr. P. R. Hoy to the President of the Acadamy.)

There are thirty-six locations on Lake Michigan, and two or three on Lake Superior, which are merely headquarters for the fishermen for a large extent of shore, in the vicinity of the Apostle Islands, and the shore immediately east of Duluth.

In these regions there are employed about 148 pound-nets, 48 bearing gill-net stocks, and 212 lighting gill-net stocks, valued, at a low estimate, at $200,000.

To carry on fishing, there are proprietors and men, but a small proportion of the number of men on wages—about 800 men.

The production of the Wisconsin nets, it would be difficult for me to separate from the total Michigan, Wisconsin, and Illinois fisheries; *Chicago sales of lake fish amount to over a half million of dollars,* of which, of course, a large quantity come from Wisconsin, as they recover into Milwaukee dealers, the whole of the Lake Superior catch, on the Wisconsin shores. Milwaukee inspection reports have reached about 17,500 half-barrels of lake-fish, worth $87,500. Other points in Wisconsin, placing salt-fish on the eastern market, would swell the amount to about $40,000 more. The interest of the fisheries, probably brings into the State every year about $350,000. These estimates are made with the figures in my possession of statistics of the lake receipts of fish, for 1872, including the handling of fish in the markets, which has never been compiled before.

The evidences are very apparent, and universally acknowledged by fishermen, that the food fishes of the lakes are decreasing to an alarming extent.

The purpose of the United States Commission was first to investigate the decrease, its causes, and the remedies to be applied to arrest the decrease, and restore the fishes to their former numbers; in other words, to increase the product of the fisheries of the United States.

From careful investigation, it is evident that the first and principal means is artificial propagation, with judicious protective laws as an auxiliary.

The State commissions have given special attention to propagation, with the most encouraging results. The shad, in the Connecticut River, where they had been nearly exterminated, are now more plentiful than in the period of 70 previous years. Last season there was a large increase in the Hudson River, the result of the successful work of Seth Green, three years ago. In Canada, Samuel Wilmot, the government breeder, has restored the salmon in large numbers. Experiments have been made by three prominent fish culturists in the propagation of the white-fish, and their efforts are now crowned with complete success. Mr. N. W. Clark, of Clarkston, has carried three-quarters of a million of eggs beyond the stage of danger, and Seth Green has a large quantity hatched and is distributing them to inland lakes in large numbers. Seth Green has been equally successful with lake-trout.

The advantage of artificial culture is in the fact, that almost the entire number of eggs are hatched, while in a state of nature, but a very small proportion are hatched. This is especiallly true in the lakes, where there are so many species of fish who make the ova of fishes their food, and where the continual stormy weather, at certain seasons, carries the sediment from the clay-banks, outward, and deposits it on the spawning beds.

A bill has passed in the State of Michigan, providing for a fish commission and making an appropriation for the expenses of their work.

The State of Michigan has enacted that:

"It shall be the duty of the governor, to appoint three commissioners of fisheries, whose terms of office shall be, respectively, two four, and six years, and their successors appointed, two years thereafter."

(As I cannot follow the detail of the bill, from memory, I will give the character of the different sections.)

The duties of the commissions were provided for in the second section *i. e.*, to propagate white-fish, and such other food-fishes as they saw fit,providing for two breeding-establishments, one in the eastern and one in the western portion of the State.

The third section provides that they should have the privilege of taking in any manner any fish they choose, for the purposes of propagation or scientific purposes.

Another section provides that the pay should be three dollars per day and necessary traveling expenses, for expenses actually incurred, and for time actually employed. The pay should be drawn on a properly sworn voucher, from the auditor of the State. A clause gives the governor authority for directing concurrent action with other States. It has been drawn as conciosly as possible, and embraces nothing but the provision for commissioners work, as it was deemed best to let the bill stand on its own merits, and not involve protective legislation or anything else.

LEVELING, AND USE OF THE BAROMETER.

BY JOHN NADER, C. E.

The term leveling is used to denote the art of determining the difference of level between two objects or of one object with reference to some fixed or known object.

Leveling is one of the most difficult branches of surveying, in as much as it is impossible to detect or correct an error as may be done in some other branches without again repeating the whole work.

The term level is also applied to the position of an apparent horizontal plane. The object desired may be attained in various ways depending upon the purpose of the work and the amount of accuracy required, and also upon the instruments which may be available.

The art of leveling is based upon invariable natural laws, *i. e.*, the horizontality of a body which yields to the fullest extent to the force of gravity, such as a liquid under favorable circumstances, or a body freely suspended and submitted to the action of gravity.

It would hence be an easy matter to assume a horizontal plane and refer objects to the same were it not that a number of influences come to bear upon the results which often differ widely from the truth.

The principal influences are the following: Mechanical imperfections; errors of observation; effects of temperature; curvature of the earth and atmospheric refraction.

I will here notice the latter. When an object is viewed obliquely through a transparent medium of any nature whatever, it does not occupy the position in which it appears, the rays being bent by refraction. If the medium be of a uniform density throughout the ray will pass through in a straight line, but if the density of the medium is variable, the line will be irregular, and as in the case of the atmosphere, whose density is as its height, the line of refraction will be a curve, and since the denser medium will have the greater refractive power the rays become bent more and more as they approach the earth, and the curve as a rule will be concave towards the earth.

It would appear an easy matter to determine this curve, but in attempting to do so we at once find a complication and uncertainty arising from accidental causes; a variation of temperature and of the amount of moisture held in suspension, will both separately and combined, cause a variation in the density of the atmosphere, and especially affect Barometric Leveling and often render the results uncertain and unreliable.

According to "Bessel" the atmospheric refraction amounts to nearly thirty-five minutes of arc at the horizon and diminishes towards and becomes nil at the zenith.

Cases may occur where the refraction is negative, *i. e.*, when the curve is convex towards the earth. This happens when the higher strata are condensed, while the lower recieve the heat previously absorbed by the earth or ocean. I have had the opportunity of observing some remarkable cases of negative refraction. In the one case the exhaust of the high-pressure engine of a tug-boat, distant about two miles, stood up distinctly like a row of columns from forty to sixty feet high apparently, at the same time the scraggy cedars four or five miles off appeared like great poplars. In another case the full moon, rising from the horizon of the ocean, presented a remarkable phenomenon; it came up depressed on its upper edge, and continued to rise with its sides perpendicular until the whole disc should have been above the horizon, then it began to assume the form of a balloon until the disc should have been about one-fourth its diameter above the horizon at which time the lower edge left the water, and the disc assumed its usual circular form. This occurred in August, 1867, after a very hot day, the atmosphere, from some cause or another was very much reduced in temperature in the evening, while at the same time the sea was giving out the heat absorbed during the day.

A singular case occurred to one of the assistants of the Lake Survey. While engaged in taking soundings with two boats within speaking distance, his second boat, seen and spoken but shortly before, suddenly disappeared; upon arising, the boat was plainly visible, whilst sitting it could not be seen. I will not attempt to explain this phenomenon, but I have it from a gentleman of veracity

In leveling operations where great accuracy is required, there is occasional need of correcting for curvature of the earth and atmospheric refraction. The curvature amounts to about eight inches per mile, and increases as the square of the distance; the refraction is dependent on the distance, and, as will appear from previous remarks, will vary with different conditions of the atmosphere. Since refraction as a rule makes objects appear higher than they really are, it serves to reduce the errors due to curvature, and according to Bessel's coefficient of 0,0685, it amounts to a little more than one-seventh of the curvature.

As the earth is not a true sphere its diameter cannot be equal in all places, yet this will make no practical difference in most operations, but it would be well in all cases to give the basis upon which tables are computed. I give the following tables for corrections for curvature and refraction for a mean diameter of 7925,646 statute miles, or 41,847,247 feet. The quantities are computed to six and seven places of decimals and corrected for second differences:

$$\text{Formula } C = 0,4315 \frac{e^2}{r}$$

Distance *e*.	Curvature *h*.	Refraction *f*.	*h*—*f*=*C*.
	Feet.	*Feet.*	*Feet.*
100 yards	0.0021	0.0003	0.0019
200 yards	0.0086	0.0012	0.0074
300 yards	0.0194	0.0026	0.0167
400 yards	0.0344	0.0047	0.0297
500 yards	0.0538	0.0074	0.0464
600 yards	0.0774	0.0106	0.0668
700 yards	0.1054	0.0144	0.0909
800 yards	0.1376	0.0188	0.1188
900 yards	0.1742	0.0238	0.1503
1,000 yasds	0.2151	0.0295	0.1856
1.100 yards	0.2602	0.0356	0.2146
1,200 yards	0.3097	0.0424	0.2673
1,300 yards	0.3635	0.0498	0.3137
1,400 yards	0.4215	0.0577	..3638
1,500 yards	0.4839	0.0663	0.4176
1,600 yards	0.5506	0.0754	0.4752
1,700 yards	0.6215	0.0851	0.5364
1 mile	0.6662	0.0913	0.5749
1¼ miles	1.0409	0.1426	0.8983
1½ miles	1.4989	0.2053	1.2936
1¾ miles	2.0402	0.2795	1.7607
2...miles	2.6648	0.3650	2.2997
3...miles	5.9957	0.8213	5.1744
4...miles	10.6591	1.4601	9.1989
5...miles	16.6548	2.2815	14.3734
6...miles	24.9829	3.2853	20.6976

The object sought viz: The difference of altitude of objects may be attained in various ways depending upon the degree of accuracy required and the instruments at hand.

The masons level, the builders level, and the surveyors level all serve their purpose in their respective places. The construction and value of these instruments varies with their real worth as compared with their requirements.

The Theodolite and Sextant are sometimes used in leveling, in such case it is nothing more or less than a vertical triangulation and is treated and computed as such.

In connection with the sextant there is used an artificial horizon. This is simply a reflecting liquid by means of which the direct and reflected images of an object are brought in contact in the horizon glass of the sextant and the angular distance measured, the angle as a matter of course is double the angle of elevation above the apparant horizon. Mercury is most generally used, but oxidises rapidly when in contact with air, and although a very dense substance is most easily disturbed by the slightes breeze. Oil, colored with lamp-black or molasses, are about as convenient and reliable as anything for the purpose, and being inexpensive can be renewed whenever desirable.

In measuring great differences of altitude recourse is had to the barometer. It is not reliable for small differences as its motion is but one-tenth of an inch for altitudes of from 96 to 110 feet and is moreover affected by every change of temperature and the consequent change of density of the atmosphere.

Operations with the barometer are based upon the principle of the Torricellian vacuum which is simply a measure of the weight of the atmosphere. If now according to Marriot's law "the den sity of one and the same quantity of air is proportional to its tension." we have at once a means of measuring the difference of heights by the tension of the atmosphere, for as we ascend, the density decreases as the column.

This motion as before stated is so gradual (one inch for 1,000 feet) and affected by so many contingencies that the barometer has always, and now is, looked upon as a very uncertain and unreliable leveling instrument.

This, however, will vanish with experience, and with proper care and application the barometer will be found very useful and quite reliable. The distrust generally arises from an insufficient acquaintance with the instrument and its defects. For instance, a mercurial barometer may be taken from one temperature to a higher, and instead of rising as it should do the mercury may fall; everything else being correct, the vacuum cannot be perfect, a small quantity of air is above the mercury which expands according to Gay Lussac's law with the increase of temperature and hence instead of rising, as the mercury should from expansion, it falls.

The barometer consists of two parts; a tube and a basin. The tube is first filled with mercury and then the open end is inserted into the basin of mercury, the other, or upper end, being closed in the manufacture. The mercury in the tube will now descend until the height of the column measured from one surface to the other, is just in equilibrium with the weight of the atmosphere. It makes no difference how long the tube may be, whether three feet or three hundred, the difference of level will measure the weight of the atmosphere. If the tube is inserted deeper into the basin a corresponding rise will take place in the tube. Such being the case, how does the expansion of the mercury have an influence on the height of the column as we have seen that the quantity has nothing whatever to do with the same; this will be accounted for from the fact that the mercury has lost in specific weight, in other words, has brcome lighter and the atmosphere is consequently enabled to support a correspondingly greater column of equal weight. I would here remark that the greatest distrust to the barometer may probably arise from too many observations being made indoors, for although the detached thermometer would indicate a dilation of the atmosphere, yet this local dilation does not affect the tension but acts merely as a cushion. Cases may occur, however, where the atmosphere of a room may be in an abnormal condition, that is when the heat currents are such as to carry small objects as though supported by a denser medium.

I have under such circumstances found a difference of temperature between the upper and lower ends of the instrument amounting sometimes to as much as ten degrees. At such times the barometer is very seriously affected and is entirely unreliable.

In making observations for heights, the same should be made simultaneously at both stations, as the density sometimes changes as much as 200 feet in a few hours; the instruments should be carefully compared before starting, one remaining at the lower station while the other should receive sufficient time to reach the upper, the observations to begin at a certain time and repeated at intervals previously agreed upon, and continued until it is certain that the distant party may have had time to make the necessary repetitions. When not too distant a gunshot may answer for signal, if beyond hearing distance the smoke from a fire may answer the purpose, the signals applicable will generally depend upon the situation.

Repetitions are necessary for several reasons. An imperfect contact of the vernier scale or local and wave-like disturbances may all tend to make the observation doubtful unless repeated, or the apparatus may not yet have partaken entirely of the local temperature. After carefully adjusting the index of the vernier to the top of the column, the scale should be read, recorded, and the vernier displaced, a second or third reading may verify the first, or one another. The barometer requires two thermometers, one attached to show the temperature of the mercury, (it being impossibe to insert the attached thermometer into the mercury, it is only necessary to place the same under as nearly as possible the same conditions,) and one detached which should be moved about to give the temperature of the atmosphere. Above all it appears necessary to be well supplied with instruments when starting for a different altitude. Assistant Edwards, of the coast survey, started for the top of a mountain in California with six barometers and arrived at his station with one, one of the original syphons of which he carried the mercury in a flask in his pocket.

It may be observed that valleys and abrupt inclinations should be avoided, and isolated stations chosen where the atmosphere appears undisturbed.

For reducing the observations the formula published in the United States Coast Survey reports is most convenient in ordinary cases, this is arranged for a mean temperature of fifty-five degrees Fah., and is the product of the constant 55,000 multiplied by the quotient of the difference of the Barometer readings divided by their sum, $\left(55000\ \frac{B-b}{B+b}\right)$ and differs but little from the truth.

When we desire to make more accurate measurements, we find the matter proportionately complicated. If we assume that the atmosphere is of a uniform temperature, we may take the difference of level of any two stations according to the equilibrium of elastic fluids equal to a constant 60200 (at 32°) multiplied by the difference of the logarithms of the readings in inches, thus:

$$(x = k\ (\text{Log. B.} - \text{Log. b});)$$

Since the height of the mercury is affected by temperature, it is necessary to reduce the observations to a common temperature.

Mercury expands at 32° Fahr., about .0001 of its bulk for every degree of heat, the rate of expansion varies, but this will not be sensibly felt under ordinary circumstances. It is most easy, and hence most proper to reduce the temperature of one reading to that of the other, rather than to reduce both to a normal, and it will be most convenient to reduce that which has the lowest temperature, which, as a rule, is at the highest station.

The difference of temperature which will affect the height of the mercury by expansion, will also affect it further by affecting the density of the atmosphere.

Air expands about .0021 of its bulk for every degree from 32° Fahr., and although this rate is not regular, it is safe to assume it as such when applying to mean temperature.

Where the distance between stations is great, or that the latiude differs much from 45°, a correction must be made on account of the difference of the force of gravity. Taking one practical example and applying the two formulæ before mentioned, the first gives an altitude of 6143.50 feet, and the second 5960.1622 feet, both of which are fair approximations.

Example.

Stations.	Barometer.	THERMOMETERS.		Latitude.
		Detached.	Attached.	
N. lower......	B.=28,94 in.	T=76°	T′=68	44°-40′
V. upper......	b=23,12 in.	t=47°	t′=53	45°-10′

$$\frac{T+t}{2} - 32° = 29.5°;\quad T' - t' = 15°;\quad 2\ \text{Lat.} = 89°.50'$$

$$\text{1st. } 55{,}000\ \left(\frac{B-b}{B+b}\right) = 6143{,}50.$$

$$\text{2d. } 60200\ (\text{Log. B} - \text{log. b}) = 5960,\ 1622.$$

Taking the 2d formula and correcting b the upper reading for difference of temperature of mercury by $(1 + 0,0001.\overline{T'-t'},)$ gives 5831.014 feet, here we have lost, as we have reduced by the difference of temperature of mercury which was lower at the upper station, and consequently indicated a greater altitude.

If now a correction for dilation of atmosphere is made by

$$1 + 0,0021\left(\frac{T+t}{2}-32.\right);$$

we obtain 6192.21 feet, this correction necessarily increases the difference of the readings and consequently the altitude. The third correction of 1—(0.0028 Cos. 2 Lat.) reduces the result only one hundreth of a foot. This example gives 106.5 feet for every one-tenth of an inch of difference of barometers, and it will be observed that the result differs by but 0.78 feet in one hundred from the first formula, which is arranged for a mean of 55° Fah. and by 3.70 in one hundred from the second, which is for a mean of 32° Fah.

The complete formula with three corrections reads:

$$x = k \log \frac{B}{b(1+0,0001.(T'-t'))} \times 1 + (0,0021(\frac{T+t}{2}-32)) \times$$
1—(0,0028 Cos. 2 Lat.),

The following form is convenient:

B=28,94		log.=1,461499
b=23,13	log.=1,363988	
1+(0,0001×15°)=1,0015	log.=0,000650	
	Sum=	1,364638
	Difference=	0,0096861
Difference=0,096861 log=		$\bar{2}$,986148
k=60200 log.=		4,779596
1+(0,0021×29,5°)=1,06195 log.=		0,026102
1—(0,0028×Cos. 89° 50′)=0,99999 log=		$\bar{1}$,999999
x=6196,20 feet from sum of logs.=		3,791844

The aneroid barometer is coming into general favor perhaps more from convenience than any other reason, as it is imposible to read as small fraction from the index as from the vernier of the mercurial barometer.

From observations made in two different rooms at temperatures of 54° and 65° respectively, a difference was found amounting to ten feet, but since this was eqnal to the probable error of observation of the scale of the instrument used, the result might be taken as a test of the accuracy of the formula.

Whenever observations are made in a room of moderate temperature, the detached thermometer should be placed in the open air in a sheltered place, and from the temperature obtained the corrections for dilation may be made with accuracy, for expansion of mercury, the temperature as shown by the attached thermometer must necessarily be taken for corrections of the same.

The barometer is subject to regular periodical oscillations in consequence of variable temperature of the earth and the consequent air currents. A very small diurnal barometric wave exists which may be traced with great accuracy. The laws which control the regular motions will soon be thoroughly understood from the results of a recording apparatus in use for the several years by which a diagram is photographed which gives an accurate continuous record day or night.

The thermo-barometer and other useful and interesting matter is omitted for want of the time necessary to prepare the same.

ON KEROSENE OIL.

BY E. T. SWEET, M. S.

The introduction of kerosene as an illuminating agent has became so general, that the leading charicteristics of a safe and valuable oil, should be well understood by consumers. It was with this idea in mind that I commenced the preparation of the following paper. As the sources of information in regard to the methods of detecting dangerous burning fluids, are exceedingly limited, I shall, after briefly referring to the manufacture of kerosene, and summing up the results of a number of evperiments made at the University of Wisconsin, in January, 1878, upon different samples of commercial kerosene, particularly refer to the proper manner of testing oils. Whiie nothing original is claimed for this article it is thought that its perusal will give general knowledge of the principles of testing burning fluids, and may awaken an interest in the subject, and indirectly lead to the consumption of a higher grade and safer kerosene than is at present in use.

The fire-test is the only efficient method of distinguishing between a safe and a dangerous hydro-carbon oil. Experiment shows that but very few samples of commercial kerosene will stand the tests required by law. Consequently instead of perfectly safe burning fluids, as dealers nearly always represent, immense quantities of inferior oil are sold, which are liable to become ignited at any moment, when heated a few degrees above the temperature of an ordinary room.

Crude petroleum as it comes from the earth is a dark colored fluid, consisting of many hydro-carbons, compoundsof hydrogen and carbon. It has a density of about .880, water being 1,000.

The raw or crude material is placed in immense iron retorts, holding from fifteent to twenty thousand gallons each, and distilled. The distillation is eminently destructive, for it "cracks' or breaks up the oil into lighter hydro-carbons, which have different boiling points, and consequently pass off in vapor at different temperatures. The vapors are condensed in an iron coil passing through water and collected in separate reservoirs. The products of the distillation taken in order, as they are driven off, are as follows:

Name.	Gravity.	Boiling point.
		° F.
Gasolene	.665	120
Naptha	.709	180
Benzene	.721	216
Kerosene	.804	350
Mineral sperm oil	.857	425
Lubricating oil	.883	575

Rhigolene is a very volatile hydro-carbon, produced by the repeated distillation of gasolene. In consequence of its rapid evaporation, its boiling point being but 65° F., it is used in surgery for producing "local anæsthesia." Paraffine, another product of petroleum, is a solid. It is used principally in the manufacture of candles, chewing gum, and water-proof cloth.

About ten per cent. of the native petroleum consists of gasolene, naptha, and benzene. They pass from the still first, and are nearly valueless, being sold for from five to ten cents per gallon. All readily ignite at ordinary atmospheric temperature, therefore are highly dangerous for illuminating purposes. After the light hydro-carbons have been driven off, the remaining fluid in the still is generally transferred to smaller retorts, the temperature raised, and safe kerosene distilled. A heavy black residue remains, which is principally manufactured into paraffine and lubricating oil. On account of the poor market for the light oils, and as they afford even a more brilliant flame than safe kerosene, there is a strong tendency on the part of unscrupulous manufacturers to commence the collection of burning fluid before the less dense oils have entirely passed off. This is the primary cause of the many fatal accidents that yearly occur from the use of kerosene.

Kerosene oil has no constant composition. Like petroleum, it consists of a great number of liquid hydro-carbons. Most of the higher combinations of these elements found in kerosene, have a low specific gravity, and are very volatile. They pass off in vapors at comparatively low temperatures. As a burning fluid contains a large or a small proportion of these volatile compounds, it is said to be a light or a dense oil; those known as light being regarded dangerous, while the heavy oils are called safe. But the specific gravity of kerosene, as shown below, is not an invariable indication of its purity.

Soon after the introduction of kerosene as a burning fluid, a method called the "fire-test" was devised for the detection of dangerous oils. It consists in determining the temperature at which an inflamable vapor is evolved, or the "flashing point;" and also the temperature at which the fluid becomes ignited from the flash of the vapor and continues to burn, or the "burning point." The flashing point is determined by inserting the bulb of a thermometer half an inch below the surface of the fluid to be tested, and gradually raising the temperature from sixty or seventy degrees, to the point at which a pale blue flicker is observed to pass across the surface upon the approach of a small flame or lighted match. The burning point is usually from ten to fifteen degrees above the flashing point.

If an oil gives off a combustible vapor, or flashes, at a low temperature, there is danger of forming a very explosive mixture with about four volumes of atmospheric air, especially in a confined space. This mixture is often formed in a kerosene lamp, containing a small quantity of oil, in attempting to refill it while still burning. It is also formed if the temperature of a partially filled lamp is suddenly lowered by changing it from a warm to a cool room, or by allowing a cold draught of air to come in contact with it. In these cases a part of the vapor above the oil condenses, air rushes in to fill the partial vacuum, the flame has a tendency to descend and an explosion is apt to take place. The oil itself never explodes, it is a mixture of vapor and atmospheric air that bursts the lamp and kindles the flame, hence the necessity of keeping lamps well filled and uniform temperatures.

Laws have been enacted by several State legislatures, and a special act was passed by congress March 2, 1867, which however, has since been declared unconstitutional, fixing the temperature at which hydro-carbon oil may be deemed safe and merchantable, at not less than one hundred degrees Fahrenheit, for the flashing point, nor below one hundred and ten degrees Fahrenheit for the burning point. An oil which will stand these tests may be regarded as perfectly safe. The results of my observations show that such a burning fluid in the ordinary market is of rare occurrence. Of twenty-seven samples of kerosene collected in this city, and examined, but two were found to stand the test required by law. The following are the results of the examinations referred to:

No.	Brand.	Flashing point.	Burning point.	Specific gravity.
		Deg. F.	*Deg.* F.	
1	Kerosene	71	92	.797
2	....do	83	100	.799
3	....do	84	94	.798
4	....do	85	94	.797
5	....do	85	100	.797
6	....do	86	98	.796
7	....do	86	102	.799
8	....do	86	102	.739
9	....do	88	94	.800
10	....do	89	100	.798
11	....do	90	96	.798
12	....do	90	102	.788
13	....do	90	102	.799
14	....do	88	98	.799
15	....do	90	106	.799
16	....do	92	107	.800
17	....do	92	106	.796
18	....do	92	107	.800
19	....do	92	109	.802
20	....do	92	109	.800
21	....do	94	104	.801
22	....do	97	106	.799
23	....do	97	106	.799
24	....do	98	106	.793
25	....do	99	107	.800
26	....do	100	118	.810
27	....do	103	127	.806
28	Head-light oil	156	158	.802
29	....do	158	172	.800
30	Mineral sperm	258	296	.841

In order to determine the proportion of contaminating fluids contained in the oils, several samples were subjected to a fractional distillation, which gave the following important results:

Number.	Brand.	Gasolene, naptha, and benzene.	Burning fluid
		P. Ct.	*P. Ct.*
1	Kerosene	12	88
9	....do	5	97
15	....do	4	96
52	....do	3	97
30	Mineral Sperm	0	100

It will be observed from these results that but two of the twenty seven samples of kerosene may be regarded as safe burning fluids. Of seventeen samples of kerosene tested in the city of La Crosse, by myself, in December, 1873, but one was found to answer the requirements of law.

Headlight-oil was originally manufactured for lanterns used on locomotives.

Mineral Sperm oil owes its name to the odor and color of the fluid. The process of manufacturing it was discovered in 1872, by Mr. Joshua Merrill, at the Downer Oil-Works, in Boston, Massachusetts. In the notice of its discovery Mr. Merrill says: "Flames of considerable size, such as a large ball of wicking yarn saturated with oil and ignited, when plunged beneath the surface of this oil, previously heated to the temperature of boiling water are extinguished at once."

It is estimated that about one-fourth of the production of petroleum may be manufactured into this beautiful and safe illuminating agent. No danger, whatever, need be anticipated from mineral sperm or headlight oil, even though a lamp containing either should be accidentally broken while in use. The flame at the end of the wick would probably be extinguished, but if circumstances the most favorable should happen for igniting the oil, fire could not possibly be communicated to it until the temperature of the surrounding fluid became raised to its vaporizing point. The flame would then gradually spread over the surface of the oil in an enlarging circle, and no sudden flash would be observed, as in the case when a lamp is broken containing oil heated above the temperature at which it evolyes a combustible vapor. It is certainly to be hoped that these perfectly safe oils will soon come into general use. The lamp in which kerosene is burned, often has an important bearing upon the temperature of the oil which is contained in it. I can not better convey an idea of the effect of the lamp upon the temperature of the oil, than to quote from a report upon the subject, submitted to the Metropolitan Board of Health, in 1870, by Professor C. F. Chandler, of Columbia College, and chemist to the board. He says, "in continuing the investigation with regard to dangerous kerosene, it was thought a matter of importance to ascertain the temperature to which the oil is heated in lamps while they are burning, as a knowledge of this point is obviously a preliminary to the establishment of a proper standard for safe oil. To this end twenty-three ordinary lamps were purchased. Eleven were of metal, mostly brass; twelve were of glass. They were filled with the same oil and allowed to burn for seven hours; the temperature of the room during the experiment was nearly constant, varying from 73° to 74° Fah. The temperature in the eleven metal lamps varied from 76° to 100°, the average being 86° Fah. The temperature in the twelve glass lamps varied form 76° to 86°, the average being 81° Fah. The average temperature of all the observations on all the lamps was 83° Fah.

These experiments show, that an oil which does not give off an inflammable vapor below 100 ° F., may be regarded as perfectly safe. They also show that the average temperature of the oil in the lamp is about 8 ° above the temperature of the room in which it is burning, hence if the temperature of a room in which an oil is burning is 74 °, and the flashing point of the oil is 80 °, a vapor is constantly passing off, and there is danger, upon suddenly cooling the lamp, of an explosion.

Testing the oil is a very simple operation. A rough method of detecting dangerous kerosene is to pour out a small quantity of the oil into a saucer, and attempt to ignite it with a lighted match. If the flame is not at once extinguished, on being plunged beneath the surface of the fluid, the oil is highly dangerous, and should at once be consumed. By this means cheap burning fluids, usually bearing fancy names, as "Eureka," "Sunlight Oil," "Danforth's Fluid," "Non-explosive Chemical Spirit," etc., may easily be detected. When a thermometer is at hand the temperature of the oil may be raised by cautiously heating the saucer over a stove, and for every two or three degrees rise, a lighted match may be passed rapidly across the saucer, one-fourth of an inch above the surface of the fluid. If the oil becomes ignited, a slight puff of the breath will extinguish the flame. Of all the methods devised for testing kerosene, the most approved is that used by the British government in applying the "fire-test" to hydro-carbon oil. The only apparatus required, is a tester, thermometer and spirit lamp or candle.

The tester consists of a tin vessel four and one-half inches deep, with the same diameter. A cover fits this, which supports another small vessel of tin, two inches in depth and two inches in diameter. When the cover is placed in position, the small vessel descends into the larger vessel. The cover also has an elevated rim about the circumference, one-fourth of an inch in height. Stretching across the top of the rim is a wire, which passes over the center of the small vessel containing the fluid to be tested. Water at 60° or 70° is placed in the large vessel and slowly warmed from underneath by the flame of a lamp or candle. The cover, containing the small vessel filled with oil, is put on, and the bulb of a thermometer is introduced one-half inch below the surface of the fluid. For every rise of two or three degrees in the mercury, a minute gas-flame, or lighted match, is passed along the wire a quarter of an inch above the surface of the oil, which is repeated until a pale blue flicker is observed to pass across the surface of the fluid, when the flashing point is reached. The temperature is then increased until the oil will take fire from the flash and continue to burn. The temperature of this is the burning point.

IMPROVEMENT OF THE MOUTH OF THE MISSISSIPPI RIVER.

BY JOHN NADER, C. E.

The improvement of the mouth of the Mississippi, the free and unobstructed outlet of a great national highway equal in extent to that which forms the subject of this paper, can certainly not be over-estimated. A number of important producing States depend mainly upon this highway to dispose of their productions, and also to obtain through the same those imports which are necessary for manufactures, arts, and comforts of life. The river, very properly denominated the father of rivers, flows in a north and south line through a fertile tract of country, partaking of varieties of climate and embracing the extremes of latitude of the United States. Its tributaries are numerous, and some are of considerable magnitude; its productions embrace the extremes, its commerce concerns the world at large, and the national character of this great highway demands free and unobstructed passage for the largest ships sailing the ocean.

Before entering upon any plan of improvement, we will first examine the physical and hydrological conditions of the river in question.

The Mississippi River is one of the great working-rivers of the world, and compares with the "Nile," the "Po," the "Rhone," the "Danube," and others. By working-rivers, we understand those rivers which deposit large quantities of alluvium in deltas at their outlets to the ocean or seas.

The working of rivers is due only to natural forces, and in order to remedy any resulting difficulties it is necessary to amend these forces, but in order to master the forces of nature and to use them to our advantage, the first condition is that we should well understand them.

In examining a map of portions of the Mississippi valley, we can conclude, by observing the form of sloughs, bayous and annular lakes, that the river which occupies a very inconsiderable portion of the valley, has at some time occupied in turn nearly every portion of the same. The matter is very plain when we observe the present working of the river; an abrasion takes place on one side, while a corresponding accretion takes place on the other, and in this manner a constant lateral motion takes place which may continue in one direction for an indefinite period, until from some cause or other the motion is changed.

It is not difficult to comprehend the movement of an island down stream, or the shifting of the point of bifurcation. The upper end of the island is worn away by the current, while at the same time the lower end grows by deposits which take place in the still water. The movement of bends, on the other hand, partakes of an entirely different nature; these must be destroyed before they can reform. The peninsula like portion of land projecting into the bend is abraded on both the upper and lower side, until it is finally cut off, the old river bed is abandoned and a new one is formed; the regimen of the river thus disturbed, at once seeks to readjust itself and hence the fearful inroads consequent upon a natural or artificial cut-off. The causes are plain, the absolute slope, and consequently the velocity is increased, while at the same time the reciprocity of curves is broken, and a new bend must result. The remedy in this case is plainly the preservation of the natural bends.

My object in dwelling upon the foregoing, although foreign to the subject, was simply to illustrate the source of the material requisite to form the delta. The material which is carried along by the action of the current, will be found to differ very materially along the course of the stream, on the upper portions it is composed of sand and gravel, this will be found reduced by attrition as we descend the river, until it is finally reduced to impalpable mud; decomposed vegetation is added by the draining of the forests, and of this composition the delta is formed. I can give no better illustration of the delta than the following from a translation of a work by "Reclus." He says:

"These narrow embankments of mud, brought down into the open sea by the fresh water, present a striking spectacle. In several places these banks are only a few yards thick, and during storms the waves of the sea curl over the narrow belt of shore, and mingle with the river. The soil of the banks becomes perfectly spongy; it is not firm enough to allow even willows to take root, and the only vegetation is a species of tall reed, the fibrous roots of which give a little cohesion to the ooze, and prevent its being dissolved and washed away by the succession of tides. Farther down the reeds disappear, and the banks of mud form, are washed away and form again, wandering, so to speak, between the river and the sea, at the will of the winds and tide. On the left bank of the southwest passage, which is used for the largest ships, the plank built huts of a small pilots village have been fixed as delicately as possible. These constructions are so light, and the ground that carries them is so unstable, that they have been compelled to anchor them like ships, fearing that a hurricane might blow them away; still, the force of the wind often makes them drag on their anchors. Below, the banks of the Mississippi are reduced to a mere belt of reddish mud, cut through at intervals by wide cross streams; still farther down even this narrow belt comes to an end, and the banks of the river are indicated by nothing but islets, which rise at increasing distances from one another, like the crests of submarine dunes. Soon the summits of these islets assume the appearance of a thin, yellow palm floating on the surface of the water. Then all is mud; the land is so inundated with water that it resembles the sea, and the sea is so saturated with mud that it resembles the land. Finally, all trace of the banks disappears, and the thick water spreads freely over the ocean. After getting clear of the bar, the sheet of water which was the Mississippi preserves, during floods, the yellowish color by which it can be distinguished for about twenty miles, but it loses in depth all that it gains in extent, and, gradually depositing the earthy matter which it holds in suspension, becomes ultimately mingled with the sea."

This beautiful illustration gives one at once an idea of the difficulties of navigating the Delta, which in storms and dark weather becomes uncertain and dangerous even with the assistance of expert pilots. Now, in connection with the above, if we consider the insufficient depth of channel, our problem at once becomes manifest. Before however entering upon the solution of the problem, we will examine the working of rivers, and the means applied to remove the resulting obstruction in the deltas and mouths of rivers.

The amount of alluvion brought down and deposited in the gulf annually is estimated equal to a mass one mile square and 268 feet high. The "Hoangho," which probably carries more alluvium than any river in the old world, has formed a deta which extends over a space of over 90,000 square miles, and constitutes one of the most important provinces of China. It is estimated that the alluvion of this river would in the course of sixty days, form an island a mile square and over 100 feet in depth. According to Rennell, the Ganges conveys from five to six cubic yards per second, or from forty to fifty thousand cubic yards per day. The Nile, scarcely comparing with rivers of an inferior class, advances but slowly, yet its Delta measures nearly 200 miles on its front and increases over seventy acres in a year.

The "Po" is considered one of the most remarkable working-rivers in the world, although a constant subsidence is taking place; the river is nevertheless continually encroaching upon the Adriatic, its deposits being estimated at over 15 million cubic yards every year.

The Rhone deposits an estimated mass of 22 million cubic yards every year.

I have here given a fair idea of the enormous amount of work done by rivers, in order to show what we have to deal with.

Considering the enormous masses which form the obstructions which we wish to remedy, it may be well to examine the manner in which they are disposed of by nature, and how these obstructions, are formed. I will here return directly to the river in question—the Mississippi.

It will be observed that two parallel banks, confining the river, stretch out into the gulf over 60 miles; these finally become irregular, and the stream is divided into numerous branches and outlets. It is asserted that the Delta proper commences only at the head of the *passes*. I would, however, consider the entire projection as belonging to the same. The first formation was on the shallow coast of the gulf, removed from the destructive force of the ocean waves; the river here asserted its rights and pushed boldly on, every freshet increasing and fortifying the narrow causeways forming its banks, which the waves would, in my estimation, only tend to solidify by impact and by incorporating denser substances eroded from the gulf-shores.

The west side of these advancing banks is by some considered part of the gulf shore, whereas it appears to me to be an accretion, formed by the littoral current, such as would occur in the case of a jettee'. In fact it appears that at one time the Delta was being forced to the east, as may be observed at Bird Island, where the motion must at some time have been decidedly east. As soon, however, as the delta had advanced far enough to stop the erasion of the shores, the accretion ceased, and the shoals produced by the previous easterly motion gave a tendency to a contrary motion. During freshets the alluvion is precipitated on the banks which thereby continue to rise and to assume a more substantial consistance.

In building a dyke, or causeway of earth, the same is self-snstaining to a considerable height; even in shallow water the same can be formed, but when the saturated portion becomes considerable, it finally loses the cohesion necessary to support the superincumbent weight and partakes of a lateral motion, or in other words, spreads out, until the submerged portion attains sufficient resistance to produce an equilibrium.

The alluvion of the delta after reaching deep water, and not being fortified by any material denser than its own impalpable mud, must necessarily spread out until the lateral resistance would prevent motion. The river also would become wider, and lose in depth what gains in extent. Now, considering the foregoing facts, it is not at all surprising that the delta of the Mississippi encroaches on the gulf and presents the difficulties with which we are already familiar.

The estimated discharge of alluvion of the South Pass is about 22,000,000 cubic yards per annum, and the advance of the delta is put at 100 feet.

As the delta advances, its progress will decrease in proportion as the depth of the gulf increases; the difficulties of navigation would increase in the same ratio in this wide-spread bed of alluvion. In order to estimate the result of this progressive motion, we must consider that the discharge of a stream is the product of two quantities, viz., the cross-section and mean velocity, $(Q = F. V_o)$ and that the latter depends principally upon the absolute slope;

$$\left(h = \frac{v^2}{2g}\right)$$

hence the lengthening of the river would diminish the slope, and since the natural supply must of necessity be discharged, the slope must of necessity adjust itself for the performance of the work.

It is for this reason that we find that the Mississippi, which at first most naturally flowed in the lowest portion of the valley, is now at places over fifteen feet above the abjacent flood plains. On the improvement of the Rhine, the entire river has been lowered as much as six feet in places by increasing the slope by means of cut-offs, and large tracts of land have been reclaimed which had become entirely worthless.

On the majority of "working-rivers," we find very little difference in the ultimate result, unless they are interfered with by artificial contrivances, or that the natural forces find a new field of operations. After what has been observed, I will endeavor to review what has been done up to the present time to remedy the difficulties arising from the detritus deposited at the mouths of rivers.

The first, and most natural conception, was to endeavor to improve the natural outlets of the rivers, but this plan has been attended with varied results, and in some cases the very action of nature suggested the contrary.

In the case of the Vistula, every attempt to improve the mouth failed; a new outlet was formed and the old channel was converted into a canal which gives the necessary water to Dantzic. At the mouth of the Danube the Jetties gave success, but they were applied to the "Soulina Pass," a comparatively new branch of the river, far removed from the actual delta. The Jetties were carried out into the sea to a point where a current passes from north to south in the Black Sea; this current receives and carries all the alluvium brought down by the river, and prevents the formation of a bar. The channel has been deepened from nine feet, to sixteen and one-half feet by this means, since the works were constructed. It is very properly presumed that the encroachment of the whole delta will have the effect of crowding the current farther into the sea, and finally a bar will form as heretofore.

The improvement of the mouth of the "Adour" was accomplished by means of Jetties, but this river differs very materially from what we consider "working-rivers." The difficulty in this case was, that the obstructions cast up by the Atlantic forced the river in a direction parallel to the shore until its banks were no longer able to contain it; at such times the river would break out and form a new mouth. The mouth below "Bayonne" was improved precisely upon the plan of our own lake shore harbors. Parallel dykes are carried out to a depth where the action of the waves cease to disturb the bottom, which is in about eighteen feet, the channel is cleared by dredging and the natural current of the river maintains the same, the detsitus moved down by the river is carried off by the littorral current into deep water. The question as to how long these artificial structures will serve their purpose, is a matter not yet determined. Operations were carried on for many years at the mouth of the Rhone by dykes and jetties, which plan had finally to be abandoned. It was hoped that by closing the lateral outlets, and by confining the channel between contracted banks that a sufficient depth might be obtained, but the works were not carried out to a sufficient depth, and the mass of alluvium carried down, left the outlet in about the same condition as it was before the improvement. Finally, a canal was constructed to the "Gulf de Fos" so called from a former canal constructed by Marius. This canal (St. Louis) is entirely sufficient for the requirements of commerce. In connection with this canal there is a very extensive basin to serve the purpose of trans-shipment to the steamers navagating the shallow portions of the river.

It appears that a system of jettees is the plan that has most generally been resorted to by engineers for the improvement of the mouths of rivers. In some cases they have been attended with partial success, and in others the enormous expense involved did not warrant the completion of the experiment.

An attempt was made about 1857 to improve the Southwest Pass of the Mississippi, but a tempest swept away a jettee of over a mile in length.

In reviewing the subject, we may safely conclude that the jetty system would give but temporary relief in working rivers, although the plan has succeeded admirably in the majority of our inland harbors where the same was applied.

Returning directly to our own subject, we find the Mississippi one of the most active working-rivers in the world. The South Pass increases at the rate of one hundred feet annually, and the other principal passes even more.

From the manner in which it is brought before the public we know that it is obstructed to a great degree and requires a remedy. For years the government has been engaged, and with considerable success, in improving the Delta. The method applied has been a peculiar kind of dredging. Boats of considerable power were provided with a movable propeller, which could be lowered to the required depth. The boat was run down stream into the bar, the excavator was agitated, and the alluvion was given to the current. This process most naturally required constant repetition, but on the whole was not of sufficient capacity to satisfy commerce. I am reliably informed that the depth of water maintained in the Southwest Pass at present varies from fourteen to eighteen feet, rarely, however, less than sixteen feet. But that, on account of this lack of sufficient water, many of the larger sailing vessels and steamboats have been withdrawn from the trade, and my informant says: "I believe that one German line has been discontinued on account of the difficulties, dangers, and delays at the mouth of the Mississippi."

Now, when we consider the foregoing, together with the fact that for the past twelve months the port of New Orleans reports a total export in cotton, tobacco, grain in bulk, sugar, and sundries of $100,000,000, and total imports, foreign and coastwise, of $60,000,000, notwithstanding the many drawbacks, we no longer wonder that the nation calls for improvements.

Now, the question arises, as to the kind and extent of improvement to satisfy the requirements of commerce. Although the Government, with an annual expenditure of about $100,000, has failed to maintain a reliable 18-feet channel, while commerce demands at least 24 feet, still the problem is one that must and can be solved. There are however other difficulties of a local nature which I would wish to exhibit. Captain C. H. Howell, of the Corps of Engineers, makes the following statement in his report for the fiscal year ending June 30, 1873:

"Even the popular prejudice against dredging has been overcome, and the people of New Orleans most interested to-day acknowledge the good done. So far, so well; but there is a powerful monopoly, known as the Tow-boat Association, domiciled in New Orleans, controlling its commerce, opposed to the improvement of the channels across the bars at the mouth of the Mississippi, and having in its power at any time to render valueless any improvement attempted. This association has, time and again, willfully and maliciously retarded my work, and damaged and destroyed its fruits."

This monopoly really forced the dredges from the Southwest Pass to Pass a l'Outre, in April of 1873, according to the engineer's report. Science may overcome the natural difficulties, but those just mentioned can only be overcome by prompt and positive legislation.

From what we know of this matter, it appears that the nation is prepared to do the work; the only question has been as to the plan which would, with the greatest certainty of success, and at a warrantable cost, satisfy the wants of commerce, and which could be maintained with a reasonable expense.

A board of engineers was appointed in compliance with an act of Congress of June, 1874, to examine and report a plan with estimates for obtaining and maintaining sufficient depth of water to tne Mississippi for purposes of commerce. The plan to be either a canal, or the improvement of one or more natural outlets.

The board has completed its labors and has reported in favor of the Jetty-system, according to the idea of Captain Eads, (of St. Louis bridge fame,) with this difference, that they reccommend the South instead of the Southwest Pass. In this connection I agree with the committee, as the South Pass is several miles the shortest and debouches, into deeper water than the others, although some work will he required at the head of the passes to make a sufficient depth to the entry of the pass. The committee discussed several canal plans, the Fort St. Philip plan receiving the preference, but on account of the greater cost was rejected, and the improvement of the south pass by means of Jettees and dredging was finally recommended.

The estimated cost of construction and maintenance of this plan is $7,942,110, and the estimate for the Southwest Pass is $16,053,124, and that of the Ft. St. Philip Canal $11,514,200. Now as to the relative merits of the different plans without regard to cost of construction or maintenance, the improvement of the South Pass would open the Delta in the middle and vessels going either way would not be obliged to make a detour, while at the same time it is the shortest and most direct route to the river; on the other hand Capt. Eads may have counted on the more stable bottom of the Southwest Pass to support the Jettees. In either case it would require a large annual expenditure to lengthen the Jettees as the delta advanced, and to dredge out the bars.

If we should now consider the Jetty-system to succeed, the danger of entering is still not removed. It will be necessary, in a storm, to find an entrance to a gap of only 300 yards among mud-lumps and mud-banks, none of which are more than three feet above still water, and although the channel may be boyed and marked and lighted, still more than ordinary skill would be required, while at the same time the entry would be subjected to the severest storms and waves of the ocean.

As reported, one member of the board concurred only in so far as the selection of the south pass for the *trial* of the Jetty-system if that be adopted, as the chances of success of the improvement of the natural outlets do not in his judgment justify recommendation; and since the canal plan offers reasonable chances of success, he gives this his preference.

New Orleans being the second city for value of her exports and sixth in the value of her imports in the United States and promises fair to improve with sufficient navigation, it is important that the plan offering the greatest chances of success should by all means be the one to be adopted.

From the quotation which I have used to give a general idea of the appearance and consistence of the delta, and by examining a map of the same, the difficulties to be encountered are very apparent. Placed, I might say, in an open sea, a hundred feet deep of mud, of insufficient consistence to sustain itself, ever seeking an equilibrium, some sinking, some rising, moving, oozing, never at rest; volumes at times lashed into foam by the fury of the ocean waves.

Considering the unstable foundation upon which we would have to construct, and the fact, that the Jetty-plan has been attended with success in only a few and special cases, it is but proper that we should adopt some other and more certain method to obtain the end in view.

The plan known as the Fort St. Philip Canal, has always appeared to me to be most reliable method of opening the Miss. The river at this point is deep and safe; the banks, although not more than a few feet above the level of the river, have assumed sufficient stability to admit of constructions; the whole length between extremes of excavtion will be about six miles; the river at this point never rises more than seven feet above the level of the gulf, and is seldom lower than the same. The gulf-end is sheltered by the arms of the delta, and by a number of islands, and will give a safe outlet of 26 feet, which is sufficient to admit the largest class of sea-going vessels. Several locations of canals have been advanced, but all seem to be encumbered with the same objections excepting the Fort St. Philip Canal.

One plan has been to leave the Pass a l'Outre six miles inside of its bar and reach deep water to the north; another, of leaving the Southeast Pass about six miles above its bar and make deep water towards the east. Both these plans have this disadvantage; although the slope is inconsiderate, yet without locks, there is a possibility of the canals becoming a branch of the Delta; on the other hand, it may be that the stability of the banks is insufficient to support the construction of locks, or resist the pressure during freshets.

Another plan has been considered, which is the closing of the head of the South Pass by means of a dam, and entering the Pass through a channel from the Southwest Pass. In this case the difficulty would be the keeping open of the mouth of the pass by dredging away the bar which would be thrown up by the ocean waves. It appears to me, that the plan of the Fort St. Philip Canal is the most reliable plan of producing uninterrupted navigation to the Mississippi, and the only plan which promises positive success. This canal would be in the extreme six and one-half miles long and should be 300 feet wide at the bottom, with sloping banks of not less than two horizontal to one perpendicular. The lift to be overcome would never exceed seven feet; the locks should be of the greatest capacity, say 500 feet long and 80 feet wide, so as to enable the largest class of vessels to enter without difficulty, or to pass a fleet of small vessels at the same time. I would recommend at least two locks, in order not to impede navigation in the least degree; at the same time if one lock should in any manner be impaired, commerce would not be impeded.

I have not the slightest doubt that such a canal could be constructed at a cost not to exceed that estimated for the improvement of the South Pass, say $8,000,000 in round numbers with a certainty of success which no other plan promises. An annual expenditure of $25,000 or $30,000 may be required to maintain the work, still this is no comparison to the $100,000 or $300,000 required to extend the jetties per annum, provided that science and determination should exist in sufficient abundance to produce the same on the ground which would have to be occupied, and of sufficient stability to escape the fate of the jettee of 1857.

ON THE CATOCALÆ OF RACINE COUNTY.

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

There is an interesting group of large showy Lepidoptera, belonging to the great family of Nocturnidac, included in which is the genus Catocala. The larvæ feed on the leaves of various shrubs and trees. In the United States this genus is largely represented. The accomplished entomologist Augustus B. Grote, has catalogued sixty-four species. Many more undoubtedly remain to be caught and described. There has not yet been a locality discovered where Catocalas are so numerous as they are in the vicinity of Racine. During the summer and fall of 1874, there were taken within a space, bounded on the north by Ninth street, on the south by Evergreen Cemetery, on the east by the Lake shore, and west by College Avenue, being one and a half miles long by forty rods wide, no less than six hundred specimens, belonging to forty species. The abundance of insects found in the vicinity of Racine College, may be accounted for by the numerous and great variety of plants, shrubs, and trees cultivated, as well as the scarcity of summer birds.

The birds have been driven off by the boys belonging to the college, who for several years past robbed, indiscriminately, every birds' nest found, and their sharp lookout leaves very few undiscovered.

The consequence of this egging mania has directly diminished the number of birds, and indirectly vastly multiplied insects.

The following catalogue includes only those taken at Racine, all captured with two exceptions within the past year, (1874.)

CATOCALÆ, Epion, *Drury.*
" insolabilis, *Guen.*
" residna, *Grote.*
" obscura, *Streck.*
" viduata, *Guen.*
" desperata, *Guen.*
" retecta, *Grote.*
" Flebilis, *Grote.*

CATACOLÆ, relicta, *Walker.*
" unijuga, *Walker.*
" Meskei, *Grote.*
" Briseis, *Edw.*
" parta, *Guen.*
" coccinata, *Grote.*
" ultronia, *Hubn.*
" concubens, *Walker.*
" amatrix, *Hubn.*
" nurus, *Walker.*
" cara, *Guen.*
" ilia, *Cramer.*
" inubens, *Guen.*
" Var. scintillans, *Grote and Robison.*
" cereogama, *Guen.*
" neogame, *Guen.*
" subnata, *Grote.*
" piatrix, *Grote.*
" palaeogama, *Guen.*
" Var. phatanga, *Grote.*
" habilis, *Grote.*
" consors, *Abb. and Smith.*
" ponderosa, *Grote and Robison.*
" badia, *Grote and Robison.*
" antinymptha, *Hub.*
" levettei, *Grote.*
" serena, *Edwards.*
" nuptialis, *Walker.*
" polygama, *Guen.*
" grynea, *Cramer.*
" nuptula, *Walker.*
" fratercula, *Grote and Robison.*
" androphila, *Guen.*

ON A MASTODON FOUND IN RACINE COUNTY.

Everything relating to those great animals that in the distant past inhabited this country, is of interest. This paper is presented for the purpose of recording the facts and conditions under which the bones of a mastodon were found on the farm of H. Hoffman, southwest quarter of section 68, in the town of Dover, Racine county, Wis., on the 12th day of November, 1874. These remains were exhumed by F. Wells and F. S. Perkins, of Burlington. I am indebted to Mr. Perkins for a minute account of the soil and condition in which the bones were found. They excavated a piece of ground 15x20 feet, to the depth of four feet from the surface. They passed through first fifteen inches of peat, then through a bed of yellowish sand quite compact and hard, of a uniform thickness of six inches. Below this stratum of sand is a bed of light-colored deposit, of sticky clay, intermingled with fine sand, all of which was of the consistency of soft putty. The depth of this deposit was not ascertained, as they could not reach bottom with an iron rod ten feet in length.

The most superficial of these bones was found only six inches below the sand—twenty-seven inches from the top af the peat.

The greatest depth at which any were found was four feet from the surface. They procured many fragments of broken ribs, several vertebræ, the right scapula, a fibula and two tusks. All the bones were much decayed, and of little value. However, by the exercise of great care and skill, one of the tusks was taken out and so prepared, that it is now the most perfect specimen I ever saw. There is not a fraction wanting. Even the sharp edge of that portion entering the socket in the jaw is complete.

This tusk is four feet eight inches in length and fifteen inches in circumference. No teeth were found. All the lower bones were found in great disorder; the tusks were separated ten feet apart, and each resting on fragments of ribs.

The peat-swamp, in which the bones were found, is 200 feet wide, by 800 long, surrounded by high ground with the exception of a narrow outlet. This marsh was undoubtedly once a small lake, now filled with the wash from the adjacent elevated grounds.

The scattered condition in which the bones were found may be accounted for by the agency of ice. The water freezing to the bottom would include the skeleton. Then when the ice broke up it would transport the bones to various parts of the lake. Possibly, however, animals, or even man, have had to do with separating the various parts of the skeleton.

COPPER TOOLS FOUND IN THE STATE OF WISCONSIN.

BY PROF. J. D. BUTLER, LL. D.

Implements of unalloyed copper are among the most rare and curious of archæological findings. The exhibit of these articles now made at the Philadelphia Centennial comprises the largest collection ever brought together. The copper age proper, in distinction from the age of bronze, forms a link in the chain of human development which according to Sir John Lubbock, "is scarcely traceable in Europe." The only European museum known to that distinguished archæologist which contains any copper tools is the Royal Academy at Dublin. The number there was thirty till within a year or two, when five were received from Gunjera—a province in India north of Bombay.

The articles now on view at the Centennial are as follows: In the Government building, from the Smithsonian Institution, seventeen real tools, besides casts of several others, and various copper trinkets. In the same building two articles, much corroded, owned in the State of Vermont.

In the mineral annex. From Ohio eight implements; from Michigan nineteen, and from Wisconsin, *one hundred and sixty four*. The whole number from all quarters is two hundred and ten.

I made notes regarding all the exhibits, but having lost them; can only describe the show from Wisconsin. But the coppers from that State are nearly four times as many as all the rest of the world has sent to Philadelphia, and they surpass others in size, variety, and perfection of preservation, as much as in number. The only instrument from any other source, not represented among Wisconsin Coppers, is a crescent about six inches long—perhaps intended for a knife, though it has no handle.

Among the varieties in the Wisconsin exhibit—which is made by the State Historical Society—are the following:

Ninety-five spear-heads. Of these the larger number are what some antiquarians called "winged," that is the sides of the base are rolled up towards each other so as to form a socket to receive a shaft. Some of these sockets are quite perfect, and all are ingeniously swaged. Sixteen of them are punched each with a hole, round, square, or oblong, for a pin to fasten the shaft, and one of the copper pins still sticks fast in its place. Twenty-three of the spear-blades swell on one side something like bayonets, the rest are flat. Three are marked with seven dents apiece, and one with nine; indentatious which have been fancied to indicate the number of beasts, or men, the weapons had killed. Nine spear-heads have round tangs which are so long, smooth and sharp, that they may well have been used as awls and gimlets. The blades of these nine spears swell in the middle of each side. Their shape is a beautiful oval. The largest specimen of this class is about a foot in length. In the middle of its blade there is a hole as large as a pipe-stem, which may have been drilled for putting in a cord to recover the spear when it had been thrown into the water. One spear has a unilateral barb. This, meeting with unequal resistence, will not go straight in water, so we think it of an absurd pattern. But the truth is that if aimed at a fish where he looks to be, it will hit him where he is—though, owing to the refraction of light in water, he is not where he looks to be. One barb is then better than two, and we are the fools after all. Spears of a similar pattern, though of other material have been exhumed in France and California, and are still used in Terra del Fuego. Specimens in bone from Santa Barbara may be seen in the Smithsonian exhibit. Thirteen spears have flat tangs to thrust into shafts. Six of these tangs are serrated or notched like the necks of flint weapons for binding about with sinews. They seem to mark the very point of transition from one material to another—from mineral to metal.

There are fifteen knives. Most of these were intended to be stuck in handles, but one of them has a handle rolled out of the same piece of copper with its blade. Another has its copper handle bent into a hook. There are several gads, or wedges, to be driven. There are three adzes—tools beveled only on one side of their edges, and with broad sockets for handles. There are eleven chisels, some as heavy as those we now use. There are twelve axes, one weighing three and three-quarter pounds is exactly the weight of those common among Wisconsin lumbermen to-day. Another, which is a pound heavier, is the largest specimen of wrought copper that has ever been brought to light. There is one hook, and a square rod. There are more than half a dozen borers of various sizes. One may be called an auger, being sixteen inches long and three in circumference. There is a dagger ten inches long with a blade an inch wide. These, with various anomalous articles, complete the catalogue.

For the conservation and display of this unique copper treasure the State of Wisconsin has set apart one of the towers of the Capitol in Madison. There they will be daily open for inspection, and will no doubt be a magnet attracting to themselves other curiosities of like nature.

The question is always asked, "Where did these coppers come from?" It cannot be so definitely answered as is to be desired. Nevertheless something is known in respect to the finding of them. They were all discovered within the limits of Wisconsin—while the Smithsonian specimens—less than one eighth as many, were gleaned from eight different States. Nearly all of them have come to light in eleven southeastern counties of Wisconsin. Only in those counties has much search been made.

Most of the Wisconsin coppers were brought together into one collection by the zeal and perseverance of one single man, Frederick S. Perkins of Racine county. Five years ago this gentleman, though he had long been forming a museum of stone implements, had never seen one of copper. On the 25th of November, 1871, he was first shown such an antique. It was a large spear-head that had been exhumed three miles north of his residence in Burlington, Wisconsin. That November date marks the birthday of his interest in copper—or his transition from the stone to the copper age. His enthusiasm which had been great for the former became greater for the the latter. He had leisure—or he made it, to ride over county after county on every road, waylaying every pedlar, calling at every school, every store, at almost every house. He advertised in newspapers, he threw tempting baits abroad on all waters. He found what he sought, where no one else would have looked for such a prize, and where many proved to him that it could not be found. He has recorded the name and residence, by county and town, of one hundred and twenty-one persons from whom he obtained pre-historic coppers, as well as of three hundred and twenty-five others who furnished him stone antiques, but had no coppers to furnish. This record shows how thorough and wide-spread were his researches. Indeed, although the Wisconsin Historical Society has bought the bulk of his findings, some of them are scattered far and wide. Five of them are in the Central Park museum, others in the Metropolitan in New York, others I think have enriched the Smithsonian. A further question which must occur to every investigator, is, where were these implements obtained by those from whom Mr. Perkins obtained them? On this point my information is more scanty than it would be were not Mr. Perkins now in Europe, and than it will be on his return. Large numbers of the tools were turned up in plowing or hoeing. Others at greater depth in digging foundations of houses or sinking wells. Not a few have come to light in burial mounds close by skeletons. In one such mound at Prairie du Chien an axe weighing two and seven-sixteenths pounds and eight inches long was discovered lying on a large flint spade, fourteen feet below the top of the mound, and seven feet below the level of the earth around, and among human bones. Another axe, with other coppers, was taken from a similar mound in Barron county. The only socket spear-head which shows its rivet still in its place, was found on a knoll in plowed land by James Driscoll in May, 1874, at Lake Five, Waukesha county. One knife was dug out of a mound by a dog while hunting, in 1860, in Troy, Waukesha county. One chisel was met with ten feet below the surface in cutting a road through a bluff at Cedarburg, Ozaukee county, in 1871. One of the most remarkable articles, a sort of copper pike, was dug up three feet under ground on the bank of Pike Lake, Hartford, Washington county, by Samuel Mowry in 1865. One massive celt, at first turned up in Merton, Waukesha county, a pedlar had preserved for twenty years. Several knives and other implements found near lakes and rivers appear to have been washed out of their banks. A lance-head found at Rubicon, Dodge county, in 1869, has a lump or stud of silver on one side of it.

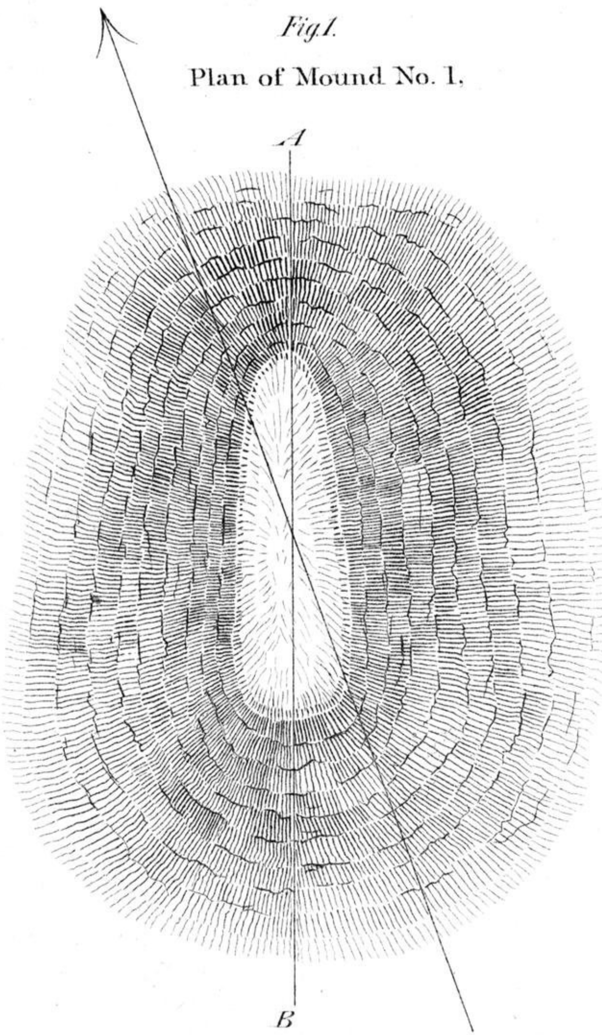
But we cannot fail to ask, " who made these copper instruments? was it Indians or some pre-Indian race?" It has been argued that they are of pre-Indian origin because the skeletons with which they are discovered in burial mounds are not of the Indian type, but of a very different cranial development. Again, as the mounds, multitudinous and often of vast size, are beyond Indian industry, so the tools seem beyond Indian ingenuity. Most of them indeed, are hammered, and so show copper used rather as a mineral than as a metal. Others of the coppers betray no marks of hammering, no laminations or flaws. Practical foundrymen detect on them mould-marks where the halves of a flask united, and so declare them smelted. Others they hold were run in a sand-mold. These indications of casting are plainest on the largest piercer and on one of the chisels, except perhaps on certain implements which Mr. Perkins has carried abroad for the conversion to his views of trans-Atlantic skeptics regarding our pre-historic metallurgy. All proofs that our coppers were cast, tend to show that they are not the handiwork of Indians.

Our early annals indicate that our copper implements were a pre-Indian mauufacture. They testify that the earliest travelers in Wisconsin found the Indians using copper, if at all, only for trinkets and totems, but not for implements either of war or of peace. Thus La Salle on his last expedition through this region, well nigh two centuries ago, says of the Indians: "The extremity of their arrows is armed, instead of iron, with a sharp stone or the tooth of some animal. Their buffalo-arrow is nothing else but a stone or bone, or sometimes a piece of very hard wood." Charlevoix, writing about 1720, mentions Indian "hatchets of flint which take a great deal of time to sharpen, as the only mode of cutting down trees." "To fix them in the handle," says he, "they cut off the head of a young tree, and make a notch in it in which they thrust the head of the hatchet. After some time the tree by growing together keeps the hatchet so fixed that it cannot come out. They then cut the tree to such a length as they would have the handle." "Both their arrows and javelins," he adds, "are armed with a point of bone wrought in different shapes." According to Hennepin about 1680, (2.103) "the Indians, instead of hatchets and knives, made use of sharp stones which they fastened in a cleft piece of wood with leather thongs, and instead of awls they made a certain sharp bone to serve." The Jesuit Father Allouez, writing about 1660, says: I have seen in the hands of the savages, pieces of copper weighing from ten to twenty pounds. They esteem them as divinities or as presents made them by the gods. For this reason they preserve them wrapped up with the most precious things, and have sometimes kept them time out of mind." In none of these or other early chronicles do I find any mention of any copper tool whatever. Pre-historic mines about Lake Superior are a proof that our copper implements are not Indian work. No tradition of such mines was brought to light by early adventurers among Indians. But if excavated by them to such an extent as we see them, and for ages, how could they have been given up and even forgotten? On the whole the evidence now before us tends to show that our copper tools are the work of some pre-Indian race. The success of Mr. Perkins in unearthing coppers in unlooked for numbers should raise up a legion of copper-hunters. For encouraging such investigators still more, my last words shall be regarding the greater harvest than has crowned his labors which seems to me ripe for their sickles.

Indications are not wanting that our past prizes in copper-hunts, are all as nothing to what is in store for us. Pre-historic mining-pits honeycomb Isle Royal all over. Along the south shore of Lake Superior they are frequent for a hundred miles. They were every one rich pockets. Their yield of copper must have been many times enough for sheathing the British navy. What has become of this copper? It cannot have vanished like iron in oxidizing rust. It must still exist, and lurk all around us. At Assouan the quarries prove to a stranger that Egypt must be rich in granitic monoliths, for there we see the rock whence they were hewn. Spanish treasure-ships sunk in the Carribbean ages ago, still teach divers where to ply their sub-marine machinery for richest spoils. In Greece, the Styx, and other catabothra, or lost rivers—emptying into subterranean abysses, suggested to the ancients streams that girdled the whole under world. So our mining shafts sunk time out of mind are a prophecy and an assurance of copper bonanzas for explorers in the future so vast as will make us utterly forget whatever has been discovered. All hail such a ressurrection of the copper age. The longer it has been lost the more welcome will it be when found again.

Fig.1.

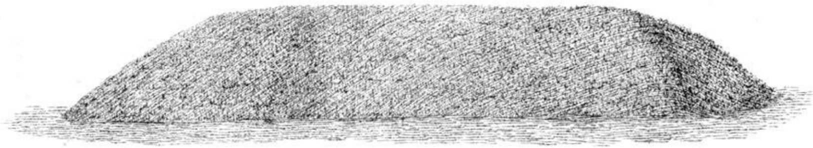
Plan of Mound No. 1,



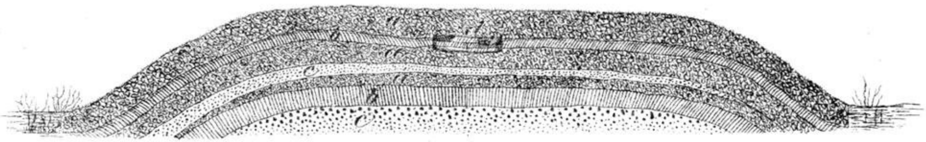
Scale 20 ft to 1 inch

Fig. 2.

Elevation and Section of Mound No. 1,



on line A.B.



Scale 20 ft. to 1 inch

Surveyed by W. I. L. Nicodemus C. E. 1874

REPORT OF COMMITTEE ON EXPLORATION OF INDIAN MOUNDS.

The committee, on exploration of Indian mounds in the vicinity of Madison, Wisconsin, have the honor to report, that they have explored three mounds.

These mounds are situated upon the crest of the peculiar ridge of glacial drift, which separates Lakes Monona and Wingra, known as Dead Lake Ridge.

Mound No. 1 is pear-shaped, and runs east 30 degrees north, by west 30 degrees south, being in this direction 78 feet long and in a line through center, perpendicular to this, 55 feet.

Beginning at center and proceeding inward, alternate layers of

mould and clay, very dry and compact, were penetrated to a depth of six feet, then a layer of gravel, a foot thick in center, gradually reducing to four inches in thickness at the base, having the natural slope of gravel thrown down at center. To this succeeded alternate layers of clay and mould to a depth of nine and one-half feet from the surface to the natural surface, (see Figs. 1 and 2;) a. represents mould, b. clay, and c. gravel. The penetration was carried three feet below the natural surface through layers of boulders and coarse gravel. A fire-place, 2x2½ feet, with a layer of charcoal and ashes four inches in thickness, was found at a depth of five feet. In this was a piece of cloth partially burnt, which for the most part crumbled to powder on exposure to the air. A small piece was preserved. Both on the north and south sides, fragments of bones occurred at three to five feet from surface in an advanced stage of decomposition. A chert arrow-head was found three feet below surface opposite the center on the north side. In the center at two feet above natural surface were obtained, nearly broken down by decomposition,

the femurs, tibiæ and fibulæ of a single skeleton corresponding to a height of six and one-half feet in the living subject.

Mound No. 2, (see Figs. 3 and 4,) is a round mound 40 feet in diameter, and sloping to the base of No. 1. The line joining their centers runs east 30 degrees south, by west 30 degrees north, and is 64 feet long. In opening this mound obscure alternations of mould and clay were pierced to a depth of 8½ feet.

Two fire-places were found, one at 3 feet, and the other at 5 feet below surface. Dimensions the same in each, 3 by 6 feet. In the lower one was partially burnt bone in the ashes. At 6 feet were found some pieces of pottery and a bundle of bones, consisting of fragments of four or more skeletons in a tolerably good state of preservation, corresponding to heights from 5 feet 8 inches to 6 feet 6 inches in the living subject. Photographs are transmitted herewith, which give forms of two crania secured.

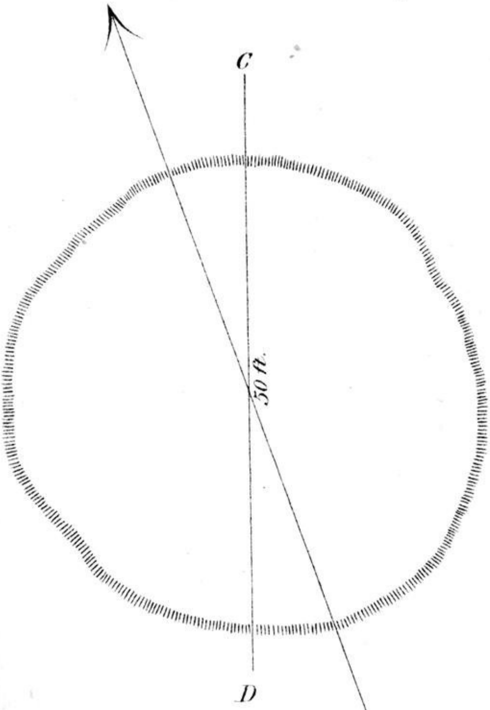
Mound No. 3 is a low mound about 200 yards south of No. 2, on the same ridge, forming a mere swell upon the surface. About 2 feet below the surface, in the center, occurred partially decomposed bones of a single skeleton. Below that the mould and clay of natural surface.

Comparative measurement of crania, above referred to, as being found in Mound No. 2.

Description.	No. 1.	No. 2.
Longitudinal diameter	6.4	6.5
Inter-parietal	5.2	5.4
Vertical	5.5	6.0
Frontal	4.2	4.5
Inte-mastoid arch	14.9	15.0
Inter-mastoid line	4.1	4.2
Occipito-frontal arch	12.0	12.5
Horizontal periphery	19 6	20.2
Facial angle	70°	75°
Internal capacity	81	85

Fig. 3.

Plan of Mound No. 2,

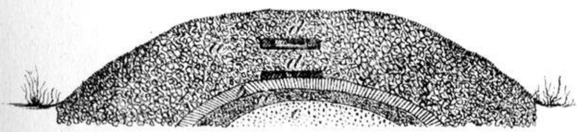


Scale 20 ft to 1 inch

Fig. 4.

Section of Mound No. 2,

on line C.D.



Scale 20 ft. to 1 inch

Surveyed by W. J. L. Nicodemus C. E. 1874

(Crania No. 1.)

(Crania No. 1.)

(Crania No. 2.)

The committee have not thought it advisable to do more in this report than to state the mere facts of the exploration, leaving to individual members of the academy the opportunity of pointing out the bearing of these facts.

The thanks of the committee are due Messrs. Delaplaine and Burdick, on whose lands the explored mounds are located, for permission to open them, to Mr. James R. Stuart, artist, for assistance in superintending the exploration, and to Mr. N. B. Van Slyke, chairman of the executive committee of the Board of Regents of the State University, for furnishing tools and workmen from the university farm.

Photographs of the arrow-head, cloth, pottery, and crania, two of the pottery and three of the others, with four drawings of mounds Nos. 1 and 2, and an account of expenditures are herewith transmitted, as also the specimens of the first three articles named.

Respectfully submitted.

W. J. L. NICODEMUS,
J. B. FEULING,
ROLAND D. IRVING,
I. A. LAPHAM,
G. P. DELAPLAINE.

MADISON, WIS., Nov. 18, 1874.

THE LAW OF EMBRYONIC DEVELOPMENT—THE SAME IN PLANTS AS IN ANIMALS.

BY I. A. LAPHAM, LL.D.

It is now generally admitted that there is a law in the animal kingdom, that the young or embryonic state of the higher orders, of animals resemble the full grown animals of the lower orders.

As examples of this law we have the tadpole, which is a young frog with gills and a tail, resembling the fishes which stand lower in the scale than the reptiles; and the caterpillar, which has the characteristics of a worm, but which is the immature state of the higher class butterflies.

The discovery of this important law, and its application to particular cases, has been one of the causes of the recent rapid progress in the study of the animal kingdom; it has enabled naturalists to determine the proper place of certain species in the grand scale of beings, and thus to correct their systems of classification; it has enabled geologists to decide upon the relative age of rocks in some otherwise doubtful cases. It has also given occasion for much speculation, which may have its use in directing the attention of men to the wonderous works of the Creator.

It is the purpose of this letter to show, as briefly as possible, that the same law of resemblance between the immature of one order, and the mature of a lower order of animals, is equally true in the vegetable kingdom, where its study may hereafter lead to results of equal importance.

To understand what follows it will be necessary to recall certain facts respecting the growth, development, organs, etc., of plants of the higher orders.

They grow from seed planted in the ground, have roots, stem, branches, leaves; they produce flowers with calyx and corolla, and the more essential organs—stamens and pistils; they bear fruit with seed after their kind, which, when planted, swell and become other plants.

The stamens have, at the top, a sack, (the anther,) completely filled with grains, (Fig. 2,) nicely packed; each of which proves on examination to be a smaller sack, (the pollen,) filled with a viscous fluid matter, in which is floating exceedingly small grains, called fovilla.

These are all essential organs in the re-production of plants, and must perform their functions before the seed can be matured. We may increase and multiply plants by layers, cuttings, budding, etc., but to re-produce a new plant, the agency of the stamens, pollen, and fovilla, as well as of the seed, is needed.

Under a good microscope this fovilla may be seen in any ripe pollen-grains, but the particles are among the most minute things we are called upon to examine, requiring the higher powers of the instrument even to see them; and what seems truly wonderful, these minute particles are found to have a proper motion of their own. They move forward, backward, or side-ways, but never make much progress in any direction; the motion appears to be objectless, like that of an animal seeking food.

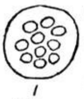
The cause of this motion is not known; it is called molecular motion, and may be the effect of some chemical action, but is more probably due to the mysterious vital force.

From the bottom of ponds of stagnant water, and from springy places, we may bring up plants so minute that no unaided human eye has ever seen them; they consist of a single cell; they are the smallest and the very lowest grade of plant-life, the Desmideœ, and yet they are full-grown plants. They never grow to be anything else; they are only Desmideœ, and nothing more. They are true plants, and not animals, as was once supposed.

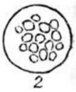
These minute, though full-grown plants, will be found actually moving forward and backward and sidewise; making no progress; appearing to have no aim, no object; precisely like the little particle of fovilla from the pollen-grains of the highest orders of plants.

Here, then, we have the first proof of the existence of the law in the vegetable kingdom; the wonderful motion, both of the full-grown plant of the lowest vegetable race, and of the particles, which may be regarded as one of the first steps toward the reproduction of the plants of the highest type.

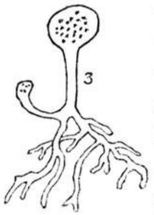
Arctic and Alpine travelers report the snow as sometimes red, and we know that our stagnant waters are sometimes green. These colors are found, upon close examination, to be owing to other minute one-celled plants, called Protococcus.



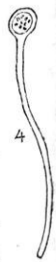
They are little sacks or cells, containing particles of a brilliant carmine red, or a beautiful green color. Each particle within the cell is destined to become a new plant, and then again to give origin to others.



The analogy between these full-grown plants of an exceedingly low grade and the pollen-grains of a rose, standing at or near the head of the plant-kingdom, is at once apparent. They contain particles (fovilla) destined to the same office of reproduction. One wood-cut serves to represent both.



The Botrydium (Fig. 3) may be deemed a plant only a little higher than the Protococcus. It consists like that of a single cell; but this cell sends down a tube which is often branched, extending off in various directions, very much like roots in search of vegetable food. The cell proper is filled as usual with the reproductive particles, and some of the branches become enlarged, (as shown in the figure,) develop other particles, and soon separate to form new plants of the same kind.



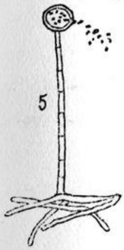
In this, and in many similar full-grown plants of the lower orders, there is a very striking correspondence with the pollen-grains after they have fallen upon the stigma, and developed the pollen-tubes, (Fig. 4.) In both cases we have a cell with a tube extending downwards from one side, with the vegetable particles and fovilla; and in both, these minute bodies are supposed to pass down the tube to perform their office of originating a new plant.

Here, again, the full grown Botrydium corresponds with the embryonic pollen-tubes of higher plants, and we have a third proof of the existence of the law.

Fungi are plants of a higher grade than the Algæ, the Protococcus, and Botrydium. Instead of a single cell, they consist of an aggregation of cells; and they produce a number of little cases or sacks, filled with grains called spores.

Fig. 1. Protococcus. Fig. 2. Pollen-grain.
Fig. 3. Botrydium. Fig. 4. Pollen-tube.

Here (Fig. 5) is a figure of the mould that grows upon bread in a damp cellar. It consists of a single stem, made up of cells placed one upon another, and a single globular spore-case at the top.* The spores are liberated when ripe, and blown to the four quarters of the world, by the wind. Wherever they alight, (circumstances being favorable, as bread in a damp cellar,) they grow and become mould again.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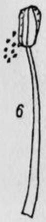
Compare this, which is one of the lowest of the fungi, with a stamen (Fig. 6) growing in one of the most perfect of flowers. It has its filament (stem) supporting a case or sack (the anther) filled with pollen-grains, (which I compare with the spores of the fungi,) and which, when fully mature, are liberated and scattered about by the wind, or are carried by insects. Under favorable circumstances (falling upon the stigma) they also grow and become new plants.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These examples are sufficient for the present purpose; they show clearly the existence of this important law in the vegetable as well as in the animal kingdom.

Many similar analogies might be found throughout the whole course of vegetable life, had we time to pursue the subject.

We have here one more connecting link between the two great kingdoms of organized nature; and another proof of the unity of design of the Creator.

Fig. 5. Mucor, (mould.)

DEPARTMENT OF

LETTERS.

TITLES OF PAPERS READ BEFORE THIS DEPARTMENT

Studies in Comparative Grammar, by J. B. FEULING, PH. D., Professor of Comparative Philology, in the University of Wisconsin.

Department of Letters.

STUDIES IN COMPARATIVE GRAMMAR.

BY J. B. FEULING, Ph. D.,

Professor of Modern Languages and Comparative Philology, in the University of Wisconsin.

1.—SOME WEAK VERBS IN THE GERMANIC DIALECTS.

A few weak verbs in the 1st class in *ia (j)* present some peculiarities due to euphonic changes, on account of which most grammarians class them with the "irregular" verbs, or place them with the modal auxiliaries (praeterito-praesentia) in the *mixed conjugation*, because "they unite in themselves something of the features of the *strong* and *weak* verbs." See Earle, Philology of the English Tongue, p. 246. Dr. F. A. March classifies correctly those of the Anglo-Saxon dialect in his A. S. Grammar (209), though following tradition he mentions them again among the so-called irregular verbs, (216). They are also correctly classified by Dr. S. H. Carpenter, in his "Introduction to the Study of the Anglo-Saxon Language." In the "Transactions of the American Philological Association, 1872, (Article IX, 'Some irregular verbs in Anglo-Saxon") Dr. March has given an explanation of these verbs. A comparison with the other dialects shows not only the correctness of Dr. March's views, but also the fact that there is nothing anomalous in the conjugation of these verbs. All dialects have in common the syncope of the derivative *j* (*i*, *e*) in the preterite, and the letter-changes incident to this syncope are in harmony with the euphonic laws of the respective dialects.

In *Gothic* these verbs are: *briggan* for *braggjan,* to bring; *brŭkjan*, to use, want; *bugjan*, to buy; *kaŭpatjan* for *kaŭlpatjan;*

vaúrkjan, to work; *thagkjan*, to think; *thuggkjan* or *thugkjan*, videri. The *d* of the preterite-suffix *da* can only stand after *n*, *r*, *l* and *z*, (the only exceptions are: *gahugds*, *ajukduths*); it changes to *t* after *t* which becomes *s*, and after *k*, *g* which become *h*, hence *gd* and *kd*=*ht*, *td*=*st*. The nasal *g* (*n*) disappears before *h*, which causes the lengthening of the preceding vowel. The preterite of these verbs is, therefore, as follows: *brâhta* <*braghta* <*braggda* <*braggida; brûhta* <*brûkta* <*brûkda* <*brûkida; baúhta* <*bugta* <*bugda* <*bugida*, short *u* before *h* (*r*) has the breaking *aú; kaúpasta* <*kaúpatta* <*kaúpatda* <*kaúpatida; vaúrhta; thâhta* <*thâkta* <*thâkda* <*thag(n)kda* <*thagkida; thûhta* for *thugkida*> *thugkda*, etc. The consonant-changes are due partly to assimilation, partly to dissimilation. In *briggan* (root *brag*, cf. fra-n-go), the *i* is a weakening of the original *a*. In the other dialects the derivative *j* (*i*) caused *Umlaut* in the present which remained after the *j* had disappeared (after stems long by nature or position) by syncope as in Old High German, or by assimilation as in the Anglo-Saxon. But in the preterite *Rück-umlaut* takes place on account of the syncopated *j*, which vowel-change, in addition to the consonant-changes, forms the peculiar characteristic of these verbs. This vowel-change is not the *Ablaut*, as some grammarians teach.

Old High German—prenkan (prinkan), pret. *prâhta*, p. p. *prâht*. This verb belonged originally to the strong conjugation, (Class XII, Grimm), for we find the following forms: *prank, prunkumês, prunkan;* in the Gothic documents strong forms do not occur. Its present stem was formed with the infix -*na*-, shortened -*n*-, which was originally a suffix. This verb is an example of a primitive verb in the transition-period to the weak conjugation, and Language remained conscious of its primitive character in retaining the strong form which occurs for the pret. participle in the dialects of New High German. *Denchan (thenkan)*, pret. *dâhta*, p. p *dâht* and *denchit; dunchan*, *dûhta*, *dûht; furhtan* or *forhtan*, *forhta*, *forht* and *furhtit; wurchan (wirchan)*, *worhta*, *worht* and *wurchit (wurht)*. Old High German rejects the Umlaut of *u; forhta* and *worhta* have weakened *u* into *o* on account of the following *a*, but when the succeeding syllable has *i*, the original *u* reappears in the root, hence *furhtit* and *wurchit*.

In *Middle High German* the vowels *i* and *u* are sheltered by the liquids *m* and *n*, followed by another consonant. While the Umlaut *ü* is unknown in Old High German, it appears in Middle High German without excluding entirely *u* (*o*); we observe therefore a fluctuation between *u* (*o*) and *ü*. *Bringen*, *brâhte*, *brâht;* the strong forms *brang*, *brungen* are occasionally found in documents of the twelfth century. The strong pret. participle *ge-brunge(n)* by the side of *gebrocht* for *gebracht* is found in dialects of New High German. *Denken*, *dâhte*, *ge-dâht (gedenkt*, New High German patois); *dunken*, *dûhte (dunkte)*, *gedûht (gedunket); vürhten*, *vurhten*, *vorhten*, pret. *vorhte*, p. p. *gevorht*, *gevürhtet*, *gevorhten;* the *o* flattened into *ä* (*ö*), continues in New High German patois. *Würken*, *wurken*, *wirken*, pret. *worhte*, *(warhte) wurhte*, p. p. *geworht*, *gewurht*, *gewürket*.

In *Anglo-Saxon* the *a* has weakened into *i*, as in *Gothic*, e. g. *bringan*. The *i*, not only original, but also weakened, passes into *e*, hence the form *brengan*, by the side of *bringan;* the *e* in *brengan* might be considered as the Umlaut of the original *a*, on account of the syncopated derivative *i*. I prefer, however, to take *e* as a weakening of *i*, because this verb does not seem to have established itself entirely as a weak verb, as indicated by the existence of the strong forms *brang*, *brungon*. It forms the preterite *brôhte*, not *brohte*, as the comparison with other dialects shows. Although the *Anglo-Saxon ô* is identical with the Gothic *ô*, it corresponds here to the Gothic *â;* an interchange between *ô* and *â* is peculiar to Anglo-Saxon (Low German.) In *bycgan* the *y* is Umlaut of the original *u*, which passes into *o* in the preterite. The consonant combination *cg* represents the gemination of *g*, which takes place before a syncopated *j* according to *Holtzmann*, *Altdeutsche Grammatik*, p. 212, 5. But it is preferable to assume an assimilation of the derivated *j* to the preceding *g: bygjan*> *byggan*> *bycgan*. This derivative *g* (assimilated *j*) is dropped before the suffix of the preterite, which causes the reappearance of the original *u*=weakened *o*: *boc(g)-de*> *boc-te*>*boh-te;* the sonant *d* is assimilated to the surd *c*, and "when two mutes come together, one of them often becomes continuous for more easy utterance." Of *hycgan* <*hygjan* we should expect, after the analogy of *bohte*, the preterite *hohte*, but we find *hygde* or *hogde*. It formed the preterite from the unassimilated *hyg-jan* either *without* Rück-umlaut *hygde*, or *with* Rück-umlaut *hogde (hugde);* in either case it dropped the derivative *j*, being treated as a stem long by position. If it had formed the preterite from the assimilated *hycgan*, we would have *hycde*> *hycte*> *hyhte*, which could not have been distinguished from *hyhte*, the preterite of *hyhtan*, to hope. It is evident that *hogde* with the Rück-umlaut is a later form than *hygde*, if not, there is no reason why we should not have *hohte*. The cognate *hogjan* (Class II.), pret. *hogôde*, may have been the cause, that *hygde* adopted Rück-umlaut. In *thyncan* the *y* is Umlaut of *u*; in the preterite Rück-umlaut takes place; *thûhte* <*thûcte* <*thuncte*. In *wyrcan* the *y* is Umlaut of *o*, weakened from *u*; as *y* and *i* are interchanged, we find sometimes *wircan*, which has the breaking *weorcan*, but *wircan* and *weorcan* are bad spelling, for while *y* might always replace *i*, the reverse could happen only after it had been forgotten that *y* was the Umlaut of *u* (*o*). In the preterite the original vowel reappears regularly, as *worcte*>*worhte;* the *o* is therefore not the effect of the *h*, as Dr. March assumes in the article above mentioned, (p. 112, 3); for the original *y*=*i* would have the breaking *eo*. The *lecgan* and *secgan* arise through assimilation and umlaut from *lagjan* and *sagjan*. As the derivative *j* (*g*), Anglo-Saxon *e*, disappears in the preterite of stems long by nature or position, which causes Rück-umlaut,—the preterite of these verbs is **lagede*,**sagede* >*laegde*, *saegde*, contra., *laēde*, *saēde; ae* is the regular weakening of *a*. The *e* in *segede*, *legde* is bad spelling for *ae*.

In *Old Norse* we observe similar euphonic changes, e. g. *soekja* from *sôkja*, *oe* (*ae*) being umlaut of *ó*, forms the preterite with Rück-umlaut *sôtta*. We should expect *sôkta*, for *kt* never assimilates into *tt*, as Helfenstein says; but as *k* represents an original *h*, which with *t* assimilates into *tt*, the form *sôtta* is entirely regular. In *Old Swedish* we find *sôkt* by the side of *sott*. In *yrkja y* is the umlaut of *o* (*a*); its preterite is *orta* and *orkta (varkta)*. Of three consonants one is sometimes dropped, cf. *mart* for *margt; morni* for *morgni*, *apni* for *aptni; thykkja* or *thykja*, *kk*=*nk*, pret. *thôtta* from *thôhta*< *tkok(n)hta*; *thekkja*, *e* is the umlaut of *a*, pret. *thâtta* from *thâhta*<*thok(n)hta*.

2.—THE USE OF THE INFINITIVE OF MODAL VERBS INSTEAD OF THE PRETERITE PARTICIPLE IN NEW HIGH GERMAN.

Fred. Münch, a well known German-American writer, advanced lately the opinion that it was a blunder to say, "ich habe es tun können," instead of "ich habe es tun gekonnt." In reference to this construction I found in Professor Whitney's German Grammar, p. 109, the following note: "This is a simple grammatical anomaly, an original blunder of construction, though now sanctioned by universal use; it was apparently caused by the influence of the other neighboring infinitive, which attracted the auxiliary into a correspondence of form with itself." It will appear from the following remarks, that the *infinitive* is *not* an "original blunder of construction," but represents the ancient *preterite participle.*

1. The prefix *ge* was originally not a necessary element in the formation of the Germanic preterite participle. Afterwards some dialects used or omitted it as special prefix to the pret. part. It is a characteristic feature of the German and English languages, that Middle German developed the tendency to adopt this prefix, and Middle English (1100 to about 1250) to drop it, after it had been weakened to *i* (*y*); yet it continued to hold its ground for some time; cf. Corson's Note to "The Legende of Goode Women," Prol. v. 6. In the Nibelungenlied the participles *brâht*, *komen*, *laszen* (*lân*) never take *ge*, so that in M. H. German the context decides, whether *komen*, etc., stand in the infinitive or in the pret. participle.

2. The verbs *dürfen*, *können*, *mögen*, *müszen*, *sollen*, *wollen* are originally strong preterites, but later used as presents, after their own present had been lost (praeterito-praesentia). The strong pret. participle took the place of the infinitive and was replaced by the formation of a weak participle. It is probable, that the dialects, those faithful wardens of ancient forms of speech, retained the original participle with the former freedom to omit the prefix *ge*, as often as an infinitive preceded it, so that in the sentence, "ich habe es tun können," *können* is *not* the *infinitive*, but the old participle. Cf. Grimm, D. W, vol. v., p. 74.

3. Owing to a false analogy the verbs *hören*, *lehren*, *lernen*, *laszen*, *heiszen*, *sehen*, employ the infinitive instead of the participle, when preceded by another infinitive. The last three verbs could easily be "attracted" by the neighboring infinitive, because their participle, the prefix *ge* being omitted, is identical with the infinitive. It is, however, a better usage, to employ the participle of the verbs *lehren* and *lernen* in such a construction.

DEPARTMENT OF

Social & Political Sciences.

TITLES OF PAPERS READ BEFORE THIS DEPARTMENT.

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1. United States Sovereignty; whence derived and where vested. By W. F. ALLEN, A. M., Professor of History and Latin in the University of Wisconsin.
2. Formal Commendation of Government Officials. By J. W. HOYT, M. D.
3. Industrial Education. By Rev. F. M. HOLLAND, Baraboo.
4. The People and the Rail Roads. By Rev. C. CAVERNO, Lombard, Illinois.
5. The Boa Constrictor of Politics. By Rev. F. M. HOLLAND.
6. The Revolutionary Movement among Women. By Dr. J. W. HOYT, President of the Academy.

Department of Social and Political Science.

UNITED STATES SOVEREIGNTY—WHENCE DERIVED, AND WHERE VESTED.

BY W. F. ALLEN, A. M.,

Professor of History and Latin in the University of Wisconsin.

The late war brought to an end the long and fierce controversy as to the nature of the Federal Union. What argumeut had not been able to decide, was decided by arms; and the United States are recognized as a Nation, possessed of sovereignty. With the determination of this controversy, however, another question has come into prominence, as to the origin of this sovereignty. Before the war it was commonly held that the act which severed the colonies from the mother country had as its effect the creation of thirteen independent and sovereign States; and that it was not until the formation of the Federal Constitution that sovereignty was conferred upon the central government. This doctrine, however, of the original sovereignty of the States, has been thought to afford some foundation for the doctrine of Secession. Some of the most ardent advocates, therefore, of the national and sovereign character of our Union, have, since the war, brought into great prominence the theory that the Nation was not created by the States, but the States by the Nation; that the States were never, in any true sense of the term, sovereign, but that the act of independence created at once a sovereign Nation. This view has been most fully elaborated in a series of articles in the first volume (1865) of the *Nation*, by Hon. Geo. P. Marsh, United States minister to Italy; it is presented also by Professor Pomeroy in his "Introduction to Constitutional Law." In this work the authority of Hamilton, Jay, Marshall, Story and Webster is claimed for this theory. I do not think, however, that Marshall and Webster can fairly be cited as its adherents. Mr. Pomeroy has given no citations in support of his view, and on the other hand both these jurists have expressed themselves unequivocally in favor of the original sovereignty of the States. Webster says, of the Confederation: "it was a league, and nothing but a league."* Chief Justice Marshalls' language is: "it has been said, that they [the States under the Confederation] were sovereign, were completely independent, and were connected with each other only by a league. This is true."†

Admitting, therefore, that the one theory has in its behalf the authority of Jay, Hamilton, Story and Kent, the other has the equally high authority of Marshall, Madison and Webster. We may, therefore, where authorities disagree, proceed to examine the arguments with perfect freedom from bias. The question is eminently an historical one—that is, a question of facts, not of theory. Sovereignty being the supreme power to command, it is simply a question of fact what organization was found in possession of this power, when it ceased to be exercised by Great Britain.

It requires no argument to show that before the Revolution the colonies were absolutely dependent upon Great Britain; whatever powers of government they severally possessed was in virtue purely of sufferance or explicit grant, on the part of the mother country. It is equally clear that the colonies were connected with one another by no organic bond. There was no government of the united colonies; each colony had its own government; and if sometimes, for the convenience of administration, two or more colonies were united under the same royal governor, this was simply an administrative union—one official managing two independent governments at a time, not a single government resulting from the fusion or union of two individual ones. There were thirteen organized communities, standing in a condition of coequal dependence upon the government of Great Britain. This tie of dependence was severed by the Declaration of Independence, July 4, 1776, sustained, as this act was, by armed force.

Two points fall here under consideration: first, the power which severed the tie; second, the logical effects of the act of severance.

*Speech on "The Constitution not a Compact," Works, iii. 454.
†Ogden vs. Gibbons, 9 Wheaton, 187.

First, the power that performed the act of severance was the Continental Congress. But by what authority, and in virtue of what delegation of power did the Continental Congress act? Was the Congress the organ of the several States, or of the "people at large" (to use Mr. Marsh's expression)?* To answer this question, which rests at the bottom of the argument, we must trace briefly the history of this Congress.

In the year 1764, upon motion of James Otis, the General Court of Massachusetts passed a resolution proposing to the other colonies to form a union for the purpose of resisting the acts of the British government. This proposition was accepted, first by Virginia, then by the other colonies. The Congress met the next year (1765), and shortly afterward, as a result of the spirit thus manifested, the Stamp Act was repealed. The Second Continental Congress met in 1774, called in a precisely similar manner. In both cases the members of the Congress were elected by the several colonies, and in both cases it was only a portion of the colonies—nine the first time, twelve the second—that were represented. Now so long as Georgia staid away, it is clear that not "the people at large of the United States," but only the people of twelve colonies, were engaged in formal acts of resistance. In the assembly thus composed of delegates from the several colonies, the colonies voted *as such*; no measure was adopted by a majority of votes, as would have been the case if they had been considered to represent the people at large; a majority of the *colonies* must always decide. It was by colonies that the Declaration of Independence was passed, and in this document the several colonies are declared to be "free and independent States."

Let us pause a moment upon this word "State," which thus makes its appearance in our political vocabulary. The great convenience of having a different term to denote the units which compose our federal government from that which designates the federal government itself, has established, in American constitutional law, a fundamental difference in the meaning of the respective terms. By *State* we understand a political organization inferior to the *Nation*. But this distinction is peculiar to American public law. The two terms are originally identical in meaning, or rather in application; being applied indifferently to the same object, but from different

* The Nation, No. 23.

points of view. A State is, in public law, a Nation, regarded from the point of view of its organization; a Nation is a State, regarded from the point of view of its individuality. We must not, therefore, suppose that when the colonies, in 1876, declared themselves to be free and independent States, they attributed to the word State the same inferiority which we now associate with the word. They understood by it, a sovereign political organization. That they selected this term, rather than Nation, is no doubt partly due to its expressing more distinctly the idea of organization; partly, I am ready to admit, to the feeling that *Nation* was a larger term, and that a higher organization, which should embrace all these individuals in one whole, was destined to result. Nay, we meet the term Nation very early, as applied to the united body.

That the Congress considered itself as acting as the organ of the colonies or States, and not of the people at large, appears manifest from the language habitually used. On the tenth of May, 1776 Congress resolved to "recommend" to the "respective assemblies and conventions of the United Colonies," to form permanent governments. August 21, of the same year, it made use of the expression: "All persons not members of, nor owing allegiance to any of the United States of America,"—showing that allegiance was regarded as due to the several States. Its constant title for itself was "the United States in Congress assembled"—a term which plainly recognizes that the United States, as an organized body, has no existence except in the Congress, which Congress, as we have seen, acted purely as the organ of the several States.

I pass now to the nature and effect of the act of severance. This act was in the first place purely negative in its intrinsic character. It simply put an end to a certain previously existing relation—that by which the colonies individually depended upon the British sovereignty. The relations of the several colonies to one another could not be affected by it. If before the act they formed a united, organized body, this united body, in virtue of the act of independence, succeeded to the sovereignty surrendered by the mother country; if they were individual and disconnected before, they remained so after the act, and each individual passed into the full enjoyment of sovereignty.

Now I have shown first, that before the revolution the colonies had no organic connection with one another, but only with the mother country; second, that the union which they formed for purposes of resistance professed to be nothing but a voluntary, incomplete and temporary association, with only limited and temporary aims, possessing none of the essentials of a permanent government, capable, it is true, of developing into a complete sovereignty, but in all its acts and words appearing as not itself an organic body, but the representative of certain organic bodies. "The United States in Congress assembled," made no claim to individual or independent existence, but acted avowedly as a mere intermediary or instrument of joint action for organisms which did possess individual existence. And this practical independence accrued to the several colonies simply from the fact that, upon the severance of the tie which connected them severally to the mother country, each was left standing legally alone; and, standing alone, having no legal superior, but possessing a complete and adequate organization of its own, each colony passed into the undisputed enjoyment of sovereignty.

Neither before nor after the commencement of the revolution, therefore, did there exist any united organic body which could supersede the several colonies, and assert a claim to the lapsed sovereignty of Great Britain. And if this is true for the period of inchoate nationality which intervened between the first acts of resistance and the practical establishment of independence, still more is it true for the ensuing period of the Confederation. It needs no argument to show that the States were at this time recognized as fully and exclusively sovereign; its Articles explicitly provide "that each state retains its sovereignty and power which is not by this Confederation expressly delegated to the United States in Congress assembled." All that can be said in opposition to this view is that this was a "palpable usurpation,*" set on foot during this "embryonic or inchoate period†"; and their arguments plainly imply that they understand the Articles of Confederation to represent a different phase of national life from the Declaration of Independence, and as requiring therefore to be construed from a different point of view; they were adopted by Congress sixteen months later than the other act, (Nov. 15, 1777.) and in this period of time, it is hinted, the "flow of enthusiasm," under which the united act of independence had

*Pomeroy, p. 48. †Mr. Marsh, in the Nation, No. 1.

been accomplished, "receded," and selfish and local prejudices took its place. Now, if the Articles of Confederation were really drawn up a year and a half after the Declaration of Independence, this reasoning would have much weight. But the date here given is only that of the *adoption* of the articles by Congress. They were reported to Congress July 12, 1776, just a week after the Declaration—the preliminary steps, indeed, were taken in June, before the passage of the act of independence. It is therefore perfectly legitimate to interpret the act of independence in the light of the government which was established after it. The two acts were to all intents and purposes parts of one and the same act. In the very act of declaring their independence, the States formed themselves into a Federal Union; and in this Union the several States were explicitly declared to be independent and sovereign; from which it necessarily follows that the Union thus formed, was, in Webster's words, "a league and nothing but a league."

It will be seen that the whole controversy turns upon the period between the suspension of the royal authority and the establishment of the confederation. While the royal authority continued to be recognized, sovereignty of course belonged to Great Britain; after the establishment of the Confederation, it as manifestly belonged to the several States. Was there an interval during which it was possessed by the United Colonies? Mr. Marsh says:* "it was not for a moment imagined that the sovereignty was in the interim lodged anywhere except in the whole people of the United Colonies." But he brings no facts to prove this assertion.

At the beginning of this discussion it was remarked that the question was essentially an historical one, and must find its decision in historical facts—that is, in the series of events by which the sovereignty was transferred from Great Britain to the United States; and I think I have shown that, as a matter of fact, this transfer was not made at one stroke, but that the sovereignty was actually possesed for a while by the several States, before it was transferred by a deliberate act to the nation. There remain, however, some theoretical objections to this view, which it will be necessary to consider.

Mr. Pomeroy states these theoretical objections in the following strong terms: "Grant that in the beginning the several states

* The Nation. No. 21.

were, in any true sense independent sovereignties, and I see no escape from the extreme positions reached by Mr. Calhoun."* No arguments are presented in support of this startling assertion, except the doctrine that among the attributes of sovereignty, "the one which underlies all others, and is, in fact, necessarily implied in the very conception of separate nationality, is that of supreme continued self-existence. This inherent right can only be destroyed by overwhelming opposing force; it cannot be permanently parted with by any constitution, treaty, league, or bargain, which shall forever completely resign or essentially limit their sovereignty, and restrain the people from asserting it." There is no attempt made to prove this doctrine; it rests simply npon Mr. Pomeroy's assertion, backed by references to the works of half a dozen European publicsts. According to this doctrine Texas was never annexed; if the United States had conquered her, and forced her into the Union, her status would have been a legal one; but as she came in voluntarily, surrendering her sovereignty and individual existence, the act was null and void. According to this doctrine the act of union by which, in 1706, England and Scotland surrendered their individual sovereignty, and united into the new sovereignty of Great Britain, was an impossible act; and Scotland might now, if she chose, re-establish her Parliament at Edinburgh, and crown a Presbyterian King at Scone. Again; on this theory, what are we to do with Rhode Island and North Carolina in the interval between the establishment of the Federal Government, and their accession to it? They were certainly not members of the new Union; which made no claim to extend its power over them. The Confederation of which they had been members, no longer existed. There is but one answer to the this question. They were independent, sovereign States, as independent and as sovereign as Costa Rica, or San Marino, or the Free City of Hamburg.

In arguing for the original sovereignty of the States, I would not be understood to advocate the modern doctrine of State Rights. I hold with Marshall, Webster and Story, with Mr. Marsh and Mr. Pomeroy, that the United States form a nation, and possess full powors of sovereignty. But I hold that this sovereignty was formally and voluntarily conferred upon them by the States in the act of forming the Federal Constitution. The doctrine advanced by Mr.

*p. 39

Pomeroy* as to the relation of the States to the United States, which is essentially that of Mr. Austin, I fully accept. "The people of the United States, as a nation, is the ultimate source of all power, both that conferred upon the General Government, that conferred upon each State as a separate political society, and that retained by themselves." Only, by "ultimate source," I do not understand historical filiation, but legal authority, under the constitution; the States—meaning by that the people of the several States—formed themselves, by this act, into "the People of the United States;" and this sovereign people, as organised in States, exercises its sovereign powers by the two-fold instrumentality of the National Government and the States' Governments, distributing these powers between these two instrumentalities as seems most expedient. Thus the States are as much sovereign as the Nation; but *in* truth neither is sovereign, but each is an organization for the exercise of a certain definite portion of the powers of government. The sovereignty is not divided between States and Nation, because sovereignty is indivisible and absolute; but the functions of government, in which consists the exercise of the powers of sovereignty, can be divided, and are divided between these two organizations.

* Page 23.

ON THE FORMAL COMMENDATION OF GOVERNMENT OFFICIALS.

J. W. HOYT, M. D.

It has been customary in all countries, and in all ages, for both people and government, in extraordinary cases, to take formal notice of distinguished services in the public interest. Sometimes by statue or monument, after death, as a means of perpetuating the memory of noble deeds through succeeding generations; sometimes by commendation of him who rendered the service, through decree of sovereign or vote of parliament, congress, or legislature, while yet living.

There has been, of course, no prescribed rule of action in any time or country, for the guidance of sovereign or people in such matters. In general, however, the distinctions have been conferred for cause so patent and so sufficient that the thing done amounted to a demand that left no room for question.

Commendation of the kinds mentioned have perhaps been more common under monarchies, where the sovereign is not always free from the motive of strengthening himself by the accession of faithful supporters, than in a republic, where titles of nobility are forbidden and decorations are unknown. But even there, they are usually confined to cases where the recipient has, in matters of public moment, transcended the line of mere official duty, doing more than could of right have been expected, or has made voluntary contributions of an important character to the welfare of his country or the general progress of mankind.

In the early days of American history, there was a severity of practice in these regards that comported well with the stern virtues and high moral standards of the heroic people who planted the colonies, defended them so grandly against foreign encroachments, and finally founded the Republic, now closing its first century.

In the light of more recent times, and at the distance we now stand from the leading actors in those great events of American history, one is even ready to wish there had been a less exacting standard for our early heroes. For, if ever men deserved the formal and cordial commendation of a people by resolutions or otherwise, it was they who, in the face of so great a personal and common peril, pledged "their lives, their fortunes, and their sacred honor" to the establishment and maintenance of American Independence. Nobly in the great drama of the Revolution, and no less nobly in the founding of the Federal Government, they played their part. Yet, where are recorded the thanks of the Federal Congress, or of legislative assemblies in the States whereon they shed the lustre of their names?

What, then, does it mean that to-day, in face of this example of the Fathers, ere the close of the first hundred years of our national existence, and ere the completion of the only national monument to the Father of his country, we hear of legislative resolutions thanking the Chief Magistrate of a nation, second in resources and power to none other on the face of the earth, and his Secretary of the Treasury, with others of lower official rank, for that, in the fulness of time—when all honest patriots are alarmed, if not appalled at the corruption seen and suspected on every hand; when venality, theft, and robbery stalk abroad and threaten a universal disgrace as well as national ruin;—they, the President and a high cabinet officer of his appointment, have shown a disposition to bring the villains to justice? It means a demoralization of the public sentiment, the cause of which, and the remedy *for* which demand a most serious consideration.

A people may very properly, even in the most formal manner, as by legislative resolution or enactment, express their grateful appreciation of an important public service, when such service illustrates a superior wisdom supported by an exalted virtue. An occasion for such expression is furnished when, in the time of public danger or national trial, an officer charged with discretionary authority, steadily holds his intellectual powers to the forming of just judgments and lofty purposes, uninfluenced by personal prejudice or popular clamor, and bravely leads his countrymen and kind to take new steps on the road to a higher civilization. But surely an occasion is *not* furnished when a public officer merely fulfills his sworn duty as the executor of a plainly written statute of the land, whether it be a law against frauds on the ballot-box or on the public revenues. A vote of thanks by the representatives of the people for such a cause proves one of two things: that the popular idea of duty has become wofully debased, so that not to wink at crimes against the general weal is evidence of superior virtue on the part of the highest officers of the government; or, that the political parties of the country have grown so corrupt and reckless that for mere short-lived partisan advantage they are willing to at once poison the fountains of virtue for the youth of the land, and put a tarnish upon the national honor.

Accepting either alternative, there is ground of anxiety for the future. There is need of a resolute purpose among honest citizens everywhere to stem the swift current of immorality and to raise up the old, or yet better, standards of both public and private virtue.

It should be settled at once and forever that no public officer, be his rank as low as the lowest, should be formally commended by the people or their representatives for doing, however thoroughly and well, what was a manifest duty, what not to have done would have justly subjected him to condemnation and punishment.

And it should also be settled as a principle, and deeply engraven on the hearts of the people both young and old, that such commendation of an officer whose duties are of so grave a character that *honor* is the only secnrity demanded for their fulfillment, is a reflection upon those who offer it, and an imputation upon that integrity and high sense of honor which, in the public mind, should be inseparable from every public trust.

INDUSTRIAL EDUCATION.

BY F. M. HOLLAND, BARABOO.

This is a topic peculiarly appropriate here, in an association which is the pinnacle of the State temple of public instruction, Our public school system is enlarging its field of force so rapidly, that it is well to enquire if the improvement in quality keeps pace with that in quantity.

We shall probably soon imitate the example of the States that have established compulsory, or as it might better be called, guaranteed education, a measure for which there need be given no other argument than Professor Huxleys, "If my neighbor brings up his children untaught and untrained, to earn their living, he is doing his best to destroy my freedom by increasing the burden of taxation for the support of jails and work-houses for which I have to pay."

The force of this argument, however, depends on the extent to which the children are really trained to earn their living in the public schools. And so does much of the force of all arguments for public schools at which attendance is voluntary. The fact that we are taxed to keep up these schools gives us a right to require that the instruction be made as practically useful and generally valuable as possible.

Of course, the whole aim of the public school should not be to teach children to earn their living, but this is certainly a part of the legitimate aim and might be largely developed in harmony with other parts, as is actually the practice in Europe.

No knowledge of any kind can be acquired without increasing all the powers of usefulness, but some kinds of knowledge do immensely more than others to develop particular powers. A law student would learn more in a theological seminary than in a factory, but not so much in a year as he would in a law school in a single month. Neither law school nor theological seminary would particularly increase the skill of the mechanic. These seem truisms, but just consider how much better fitted our public schools are to prepare men to be law and theological students than to be farmers or mechanics. It is these branches of manual labor that most of the boys are to go into, but their schooling does not teach them how to use their hands and muscles. but rather their brains.

Our public school system would be practically perfect, provided all the pupils were going to be clergymen, lawyers, doctors, or teachers. Indeed, the village schools under my own observation seem to aim mainly at turning out school teachers. Every girl, at least, who graduates, tries immediately to get a school, for her training has exactly fitted her to earn her living in just that and no other way. No wonder teachers wages are low, when the number of teachers is thus continually increased.

In view of this lowness of wages, as well as the pressing demand for skilled workers in many other fields, it seems to me that something might be done in our public schools to fit pupils to earn their living in other ways. If our schools are merely going to educate teachers, and these to educate still other teachers, the whole system might be compared to a grist mill, of which the wheel is so large and the stones so heavy that the force of the stream is spent in turning them around, without grinding any grist.

Even if the aims of the public school are legitimate enough, there seems to me much room for improvement in the choice of means. Let me quote from Dr. Bartol, who says; " He that can sketch an object with a pencil understands it better than he who recites all its titles in the epoch of every tribe under the sun.

Possibly we have yet to learn what education is beyond a series of tasks in sentences and mathematical figures. Was Horatio Greenough educated, when glued to the bench for a Latin recitation, or loath to demonstrate the sum of degrees in a triangle, and not when he picked up a piece of plaster in the streets to carve the head of a Roman Emperor?

Michelet says a man always clears his mind by doing something with his hands. The poor girl goes to school with the rich, and learns to scorn her mother who cannot read, to envy her mates' costlier dress. and to steer for means of like adornment into temptation in the course of study. The education is a curse that puts notions into her head but no skill into her hand. Taught to create value, she would disown the tempter." (Rising Faith, p. 177.)

The possibility of making Wisconsin a great manufacturing State gives peculiar importance to the immense results achieved in Europe by Industrial or as it is sometimes called, "Technical Education." For instance the great iron works of Creuzat. France, which in 1867 employed 10.000 workmen and turned out $3,000,000 worth of products annually, rose from small beginnings through the systematic training of laborers in schools opened for this purpose more than thirty years ago.

When the first International Exposition was held in London, in 1851, English workmen excelled in ninety departments out of one hundred; but, in the Paris Exposition of 1867, England carried off 10 per cent. instead of 90 per cent. of the honors. The introduction of drawing into the public schools, with the opening of special schools in all the great centres of industry in France, Germany, Switzerland and Austria. had made these countries equal to Great Britain where she had hitherto reigned supreme. The British Government took the alarm, and made general inquiries, to which the Birmingham Chamber of Commerce replied that every trade in Birmingham suffered from lack of technical education. Similar answers came from Sheffield, Kendall and Staffordshire, except that the potteries in the last district were found to be kept up by the importation of properly educated foreigners.

Active exertions have since been made in Great Britain to recover the lost sceptre by imitating the course adopted on the continent, but the Swiss, French and German workman are still superior in training, not only to the British but to the American ones, according to the report of the Massachusetts Commissioners of Education for 1873. These Commissioners report that in Pennsylvania the great body of skilled artisans are foreigners. Mr. Stetson, in a work on Technical Education, published during the year 1874, declares "it is not the pauper labor but the educated labor of Europe which America has good reason to fear." A country, nineteen twentieths of whose artisans are unable to work from drawings, has good reason to dread the rivalry of countries where a mechanic who cannot draw is a rare exception.

When we consider, further, that as good a judge as Mr. Russell, the builder of the Great Eastern, declares that if in Great Britain, one-half the laborers were as highly skilled as one-quarter of them are at present, the change would be worth 50,000,000 pounds sterling, or onr quarter of a billion dollars a year, as it would enable the mechanical power of the kingdom to be used to three or four times as great advantage as at present, we can imagine what a mine of wealth lies almost unbroken at our feet. And again from the fact that in this conntry the highly skilled worker earns $3 where the utterly unskilled laborer earns $1, we can see how immensely the condition of our laboring classes is capable of being improved at little cost.

One of the principal means has been already mentioned; this is drawing, knowledge of which helps a mechanic to work from plans, and trains eye and hand to act in union. Four or five years ago this branch was introduced into the public schools of Massachusetts, New York and Connecticut, and the example is being generally followed all over the country. The lack, however, not only of properly qualified teachers, but of sufficient public interest, often prevents the instruction from being much better than nominal. We are very far behind the French practice of teaching every scholar seven years old, to draw and write simultaneously, so that each of the two acquirements may help the other. The Swiss and German primary schools also give to drawing a prominent place. So small a part of the primary school session in this country is spent in actual study, that not only drawing but object lessons and Kindergarten exercises, as well as needle work for the girls, might be introduced for two or three hours a day without hindrance to the present instruction, and with immense gain not only to the discipline but to the intellectual spirit of the school.

Enough free hand drawing should be taught in the primary schools to enable the pupils in the grammar schools to use drawing instruments, draft plans, and copy geometrical solids, and it is very important that they should be restricted to these and similar branches of purely industrial drawing; otherwise the desire to make a show at exhibitions, to get something pretty to hang up in the parlor, and to amuse oneself with little efforts, will tempt both pupils and teachers into giving their attention almost exclusively to fancy drawing of too little industrial value to be paid for justly out of the school fund. And in the grammar schools might also be given some knowledge of the practical teachings of chemistry, such as would be of assistance not only to the bleacher, dyer, founder, miner, and machinist, but to every farmer and housekeeper. The high school should continue the instruction in chemistry and drawing, and add the study of perspective, descriptive geometry and mechanical proportion. Of course these high school studies should be electives, alternatives with Latin and Greek perhaps.

It would also be possible for instruction in one or two trades to be given to a few of the most skillful pupils in every high school. One teacher in the girls' high school of Boston has introduced the study of photography, mainly at her one expense. Other trades which might be taught with advantage, are telegraphing, wood-carving, engraving, stenography, dress-making, watch-making, pharmacy, designing and painting. I mean of course not artistic but industrial painting; not painting pictures, but furniture and signs, and I speak particularly of this branch because it might be taught with advantage to the community in most of the village high schools.

The industrial course in our public schools would then be: Primary School, drawing, sewing, and kindergarten lessons; Grammar School, mechanical drawing and chemistry; High School, chemistry, drawing, perspective, geometry, and some special trade.

The pupils, who need this teaching most, would not, however, be able to go through the high school course, and special trade schools should be opened to allow them to pass through the whole course in two or three years after leaving the primary school.

The same teachers could carry on the instruction in drawing and other industrial studies in the common schools and also in the trade schools, where the training could be made extremely practical. One of the highest class of trade schools, which might well be imitated in America, is that for the French watchmakers at Besancon. The course is three years; first year mechanical drawing and general principles of the trade; the second year adds geometry, designing various parts of the watch and modelling the tools used; the third year adds the study of mechanics and practice in modelling various parts of the watch, mechanical drawing and designing being continued. Among the industrial schools especially worthy of note, are those for carpenters and builders held in the large cities of Germany for four or five months, beginning with the first of November, and giving instructions in "elements of physics and knowledge of materials, details of the art of building, plotting, geometrical and ornamental drawing and modelling" and other practical studies, described at length on page 124 of the report on education made in 1870 by Dr. Hoyt, who wisely recommends the opening of such schools in all the cities of the United States. Similar schools might be opened at the same season for the improvement of farmers. There are also many laborers who cannot attend any day school, even an industrial one, but who would go to an evening school gladly. The workman who is too tired to study anything else has been found able to learn drawing in such a school with great advantage.

A State which has so many German and Scandinavian inhabitants as Wisconsin really seems to me also bound to give the men and women some such facilities for perfecting their knowledge of the English language. Allow me to suggest further, that in a great railroad centre, like Madison, evening schools should be opened to teach railroad hands, and workers in machine shops, mechanical drawing, modelling, the use of every part of the steam engine and all the scientific principles involved in the running of railway trains and the manufacturing of cars and locomotives. The gain merely to the morals of the pupils, by removing them from temptation, would fully justify all the outlay necessary. I am glad to hear that twenty-nine evening schools for adults are in successful operation in Philadelphia, and hope the time will come when similar statistics can be furnished by Chicago, Milwaukee and Madison.

In one point we are already wiser in America than they are in Great Britain, or on the continent of Europe. Scarcely any industrial schools for women have been opened there, or seem likely to be. Of what little has been done in the United States, woman has had her full share. A prominent place in the Boston public school system is occupied by what are called the "designing young ladies;" and the philanthropic women in that city are attempting to follow the example of their sisters in New York, who have for the last two years been giving instruction in running sewing machines, housework, sewing of all kinds, laundry work, cooking, book-keeping, proof-reading and other useful employments with great success.

Of the many female colleges springing up all over the land, none deserve more praise than that already founded by John Simmons, of Boston, who bequeathed $1,400,000 "to provide for the teaching of medicine, music, drawing, designing, telegraphing and other branches of art, science and industry best calculated to enable the scholars to acquire an independent livelihood."

Among the branches in which women might engage with advantage are those pursued by decorators of glass, porcelain, and china, artificial flower makers, feather colorers, retouchers of photographs, wood carvers, fan and toy makers, watchmakers, jewelers, lapidaries and cameo cutters, workers in wax, plaster and ivory, glass cutters and grinders, piano tuners, designers, engravers, telegraph operators, compositors, druggists, photographers, florists, dentists and journalists. Indeed all the arts in which a good eye for color is needed, seem to be especially suited for women.

And let me here suggest that our State University, having shown its enterprise in establishing departments of law, military science, agriculture, civil engineering and mining and metallurgy, should give similar attention to the industrial education of the "better half" of its pupils, by opening one or more departments especially adapted for training women in some of the occupations just mentioned. In closing I would say that no industrial training is complete without artistic culture, which, though never its equivalent, should always be its inspiration.

THE PEOPLE AND THE RAILROADS.

BY REV. C. CAVERNO, LOMBARD, ILL.

The following are *some* views connected with the railway question. It is not pretended that there are not other views, but these lie near the base of the subject, and cannot be disregarded.

The transportation question is one to which we must in the future give close attention, if we would properly discharge our duties as American citizens. Whether we are to exist as a united nation or not, may depend upon our views and practice respecting rights and rates of transportation.

Macaulay says that of all modern inventions, those which abridge distance are of first civil and social import. The South failed to detach the West from the East in the rebellion because the men of the West had come from the East. But generations are to come after us who were not born at the East. Whether the sympathies of the various sections of our country are to flow together in time to come will depend upon the amount of communication there is between them. That will depend upon facilities and rates of transit. We shall be a united people if we are a *traveling* people.

It is a patriot's duty to see that the conditions are supplied which will create mutual interest and sympathy between all sections of the Republic. Once there was but one name for stranger and enemy. The fact is of deep significance. Given no strangers under the government flags, and there will be no enemies. Among isolated people springs up the tendency to rebel.

The question then before us touches not alone the pocket; it touches the heart as well. It is a question not merely of rates on exchange of *produce*, but one of rates on *social* exchange—an exchange of ideas.

Just now the item of *freight* is the one uppermost in the public attention. But if we look deep enough we shall see that the matter of *passenger* rates is one of tremendous import.

Just where we are in the whole matter can best be brought out by the statement of a single fact. A few weeks ago the telegraph informed us that the Freight and Passenger Agents of the various main lines of railroad running across the country, were in Pittsburg in consultation upon the rates of freight and passenger transit over those lines. It was stated that they were sitting with closed doors.

That is something which happens once or twice a year. Considered as a telegraph report that makes but a small item. But think what it means. Think of all the vast interests that centre around the matter of freight and passenger communication between the Mississippi valley and tide water. It is a matter of as much concern to the people of the nation as the question of the currency, or the right to declare war and make peace. In fact the currency question is one *subordinate* to the transportation question.

We are interested in the currency only as a subsidiary agent in transportation. Currency is of value only as it helps persons and property to change place. Yet the subsidiary question goes to an open congress of the nation—the main question to irresponsible corporation clerks who sit with closed doors.

We convulse the nation in our politics on some issue of tithing mint, anise and cumin, while we neglect the weightier matters of the law.

It would seem fair that the public should have some voice in fixing rates since they are the one factor out of whom rates are to be raised. A matter of such importance ought to be open for discussion and settlement before representative men of the nation.

The men who actually sit upon it are not even the representative men in their various corporations. They are the mere mandataries of the few capitalists who control the corporations. No questions of public right or interest are ever submitted to them. As mathematicians, they cipher in aid of the schemes of the stock operators who control the roads.

Rates of transportation are a tax upon the people.

Unquestionably the people ought to pay some tax—a righteous tax for transportation. But that a body of irresponsible and unknown men, the mere agents of a few private capitalists, should have the right, in secret session, to levy this tax on the whole American people is an anomaly in the practice of this nation, before which, one may well stand in blank astonishment.

This nation declared its independence and fought to its liberty on the foundation. "No taxation without representation." But here is taxation, and that too without representative voice in it before which, that against which the patriots of the Revolution fought, pales into nothingness.

We never could have come where we are in respect to the matter of transportation, had we not practically lost sight of one of the most fundamental principles of common law.

The right of the people to transit was a right that the common law always asserted and protected. It said the rivers should be the people's free highways. It has kept them open up to to-day.

The common law was always a jealous protector of the right of private property in land. But beyond any right which a man might have in his acres, it asserted the right of the people somehow and somewhere to find transit over them as their needs might require.

Behind every individual right lay the public right of eminent domain for the purposes of transit. The river was open to the people; any man might put his boat thereon and go up or down the stream at his pleasure. The road was open to the people; any man might put his carriage thereon and go whither he would.

In the development of human industry and art a new method of transit has come into use which supercedes both the old methods.

The simple question at issue is, *whether the people are to preserve any of their old rights of transit in this new mode of transportation, or whether they are all to be swallowed up in the private interests of the capital that built and manages the roads.*

Have the masses at large any rights in the new inventions which revolutionize modes of communication and commerce? Did Watt think out the steam engine in the interests of capital only? Did the old vegetation of the coal measures "suck the fire of forgotten suns" only to lodge in the hands of a fortunate few the power to obliterate one of the most cherished rights of the people.

It is no answer to this inquiry to say that the river and the road are still open to the people, and they can travel on them as of old. The new mode of transit has rendered the old compartively useless. The humblest living cannot be earned without making use of the new system of communication. The right of the people to transit it a right inhering in them as to all modes of transit.

If the river and the road were theirs they have the right to the new method of accomplishing the ends they executed on river and road.

The practical point is to find a way of asserting the rights of the people—to put into practical shape the old right of eminent domain for transit under the new method of locomotion. So long as private corporations are concerned with the business of transportation as they now are, it is hard to see how the public can realize any of its ancient right except it have some voice in the determination of *rates* of transportation.

From the nature of the new mode of locomotion a man must travel or put his freight in such vehicles as the companies may provide and at such times as they may designate. He may not put his own conveyance upon railway track as he formerly might put his boat on the stream or his carriage on the road.

Now if the officers of the corporation may say, "you may have transportation but only at such rates as we choose to fix" the old right of eminent domain which was maintained to secure free communication among the people is annihilated.

The people travel no longer on any right of their own but simply on the mercy of the corporation. The selfishness of corporations may be enlightened enough not to fix rates that will prohibit travel. That does not alter the fact that it is by their will alone, practically, that travel by the new mode of transportation exists.

If a private corporation makes a railway bed, and puts upon it rolling stock, it is but just that the people using the method of conveyance provided should pay proper charges therefor. *But it is unjust that in or about the rates collected there should not be some element which should represent the old right of the people to locomotion.* The right of transit is of as high order as any right of property in road-bed or vehicles of transit. *The right of the public to a voice in respect to the rates of transportation is at least equal to the right of the corporation for moneys expended.*

The recent legislation of the Western States may, in fact, be unjust. If so, it must and it will be made just. It would be strange if the first attempts at regulation in a matter so immense and so novel, had hit the exact line of justice. *But this legislation is correct in theory.* In attempting to regulate *rates* of transportation, it asserts, in the only practical way, the people's right to transportation—the right to it in the freest way—in the cheapest way consistent with justice to the capital invested in transportation enterprise.

We are in our present imbroglio, in respect to railroads, because we have lost sight of the fact that there are two distinct interests vested in them.

The people have not heretofore asserted their rights; and, of the people's rights, the railroad corporations have been willingly ignorant.

The railroad position, at least in the northwest to-day, is that of denial of all public right in the railways and of defiance of all control over them.

The open contempt exhibited by the railway companies for the recent legislation of the people, and the tone and import of the latest reports of the presidents of the leading railroad companies is the sufficient evidence of this fact. The issue is joined on this plain question—*whether railroads are a private concern entirely.* The people maintain that the railroad corporations stand in a relation of trust to themselves to whom they must give account of the deeds done in their corporate body, as well as the operators who manipulate their stocks. The people maintain that railroad property is not private property, like a farm or a stock of goods in a store. Whatever of private property there is in them *is property laid down on the foundation of a public use as no other property is.* It is property laid down over an old time right of the people—a right that permeates it everywhere.

De Witt Clinton's idea was that transportation was wholly a public business. It would be instructive to have the history of our unfortunate departure from the principles and practices of De Witt Clinton. Our recent legislation is charged in certain quarters with being an unjustifiable attack on the rights of private property.

The Hon. David A. Wells says that objection to that legislation is founded ultimately on the command "thou shalt not steal." It ill becomes those who are attempting to convert an old time common law right of the people to their own especial use and behoof, to talk about theft.

As between the obliteration of a right and the regulation of a rate it does not require much ability to decide where the most wanton meddlesomeness lies.

The people mean no injustice to property invested in railroads. It is that which is *not* invested that they desire to make some inquiries about. They want to know what the fictitious elements are which they sustain by taxation levied in the shape of rates. In Illinois there are roads that cost but $16,000 per mile on which rates are collected on a basis of cost at $32,000 per mile.

When we want to get to tide water if we go over the New York Central, or Erie, or the Pennsylvania Central, we have to pay rates to support stocks that represent an average cost of $107,000 per mile on those roads. It is well enough known that not one-half of that amount per mile was paid to build and equip those roads.

The people have no desire to convert private property into a public use, but they do not want to be taxed from year to year to make that property which is no property.

It is "watered stock," stock, that represents no money advanced, that the people are at war with. If a farmer had the privilege of taxing the community to make up to himself any sum which he might name, he would only be doing as the railroads have had the privilege to do in "watering" their stocks and in issuing stock dividends. No wonder that railroad operators have become rich men.

It may be difficult even impossible at this date to eliminate this no property element. But that is no reason why we should not look steadily at it till we know what it is, and till we find out where it came from. It is an element, that beginning with credit mobilier contracts in the construction of roads, has by various modes of "watering" and mortgage "loading" increased, till it may be roundly stated as constituting half of the burden against which the people lift, in the payment of rates of transportation. If the past cannot be rectified the future can be secured. If it cannot, then, farewell to the prospects of honest industry.

Everything cannot be swallowed up by the men who do not earn but invent property.

Besides being property laid down on the foundation of a public right as no other property is, railroads should be subject to the public control for the reason that they are supported by public taxation as no other property is.

The President of one of our railway companies in a recent report maintains, that the railway companies should have a right to the increased value of their property. Certainly, if they want to sell it. But certainly not if they want to make that increased value a basis for levying rates upon the people. No farmer has the right to tax the community to make good to him a dividend on the increased value of his farm. When holders of other property can have this right it will be time enough to grant it to the railroad corporations.

If new property appears on a railroad it got there either by the earnings of the road which have been raised out of rates assessed upon the people, or it is there because loaned money has put it there, the interest upon which, and ultimately the principle of which, is paid by rates assessed upon the people. It is not right that the people should be again taxed upon property which they have already paid for. The owners of no other species of property have yet found out a way to derive an increased value of their property while they themselves retained possession of it.

We cannot build new railroads all over the country to compete with those which already exist. The people are not driven to that resort. They have their rights and they should prosecute them in those roads which already exist.

The farmers movement will not rectify the situation. The Grange may be of value to the farmer in many directions. Possibly it may be an element helpful in the solution of this problem, but it can only be subsidiary at best.

New times and new conditions demand new measures. Courts and legislatures, as now constituted, are inadeqnate to the solution of the railroad problem. We need commissioners, State and National, with legislative and law powers ample enough to meet the demands of the situation. The constant increase of the transportation business will make such commission a permanent necessity.

Those who control the private interests invested in railroads are at all times alert to their interests. The people should have what would be equivalent to an always open court and ever sitting legislature to attend to their interests in the roads. These commissions should have full powers of instant action. We have not exhausted the resources of society in the establishment of a Circuit Court and a State Legislature. When a new business attains to such gigantic dimensions as the transportation business has reached, there ought to spring up a new tribunal to attend to it—a tribunal that should stand on its own basis, not being the mere creature of some other department.

Our Commissioners ought to be the courts of last resort in railroad matters, and no more amenable to the State Legislature than the judiciary is now. Mr. Windom's proposition for a Railroad Bureau is in the right direction, but it is not radical enough as he has up to this time developed it. The first work of such a commission would be an investigation of all the elements which figure in the sums on which it is claimed dividends should be paid out of the rates assessed, and the remorseless rejection of all the no-property which is now confounded with property, when such rejection can with justice be done. Then a proper basis will be laid for a just assessment of rates. We have long been running a reckless race, careless how we lost our rights, or who picked them up. It will be a long way back to the correct position. But courage, persistence and honesty will take us there.

THE BOA CONSTRICTOR OF POLITICS.

BY REV. F. M. HOLLAND, BARABOO.

Recent elections show how generally our politics are believed to be corrupt. But merely changing the party in power will not purify them. Great as is the need of civil service reform, we can no more expect either party to be the first to refuse to favor its followers, than we can expect an army to spike its cannon before it goes into battle.

We may blame the practice of passing by wisdom and purity to nominate popular mediocrity or unprincipled brilliancy, but it is plain that the policy of nominating only the most popular candidate would have the same advantage over that of preferring men, whose height of principle and intellect excited enmity, which the Prussian needle-gun had over the Austrian musket. And for any party to dismiss an able and popular leader on account of private immorality would, to borrow President Grant's comparison, be like relieving a general under the fire of the enemy. And so will a party that forbids any severe criticism on its leaders within the ranks, meet one that permits it, just as an army meets a mob. Popular enthusiasm may give the mob the victory, but only exceptionally. On the whole, the more a party is like an army, the stronger it will be, and therefore party success requires that the management be centralized in a few men of experience, enough to set up the platform, and candidates most likely to catch votes. "The ring" has a terrible sound, but a party without a "ring" would be pretty apt to be beaten by any party with one. Indeed a party without a "ring" is like a barrel without a hoop.

These facts are not pleasant ones, but we need to keep them in mind in order to see that to purify politics we must change our system so deeply as to lessen the power of parties, and no longer enable the one, which happens to gain even the smallest majority, from sweeping all the presidential electors, members of congress, state legislatures, judges, and county officers into its jaws and swallowing them as completely as a boa-constrictor engulphs a rabbit. And, as a rabbit, shut up with two such monsters, can simply flee from one to the other until it is taken, so third parties have to choose by which of the two stronger ones they will be devoured, before the larger one shall swallow up the other, or, in other words, carry the state.

There is only too much evidence to show how far we fall short of Lincoln's ideal of a government of the people, by the people, and for the people. In both the Forty-second and Forty-third Congresses, whose successive sessions extend over the four years closing March 4, 1875, the Republicans have had more than two-thirds of the representatives, though they polled but little more than one-half the votes, so that a majority of 35 or 36 per cent. in the House has been gained by one of 7 or 8 per cent. at the polls; and this injustice is not lessened by the fact that no delegates to the Forty-third Congress were sent by the supporters of the administration in Kentucky or Texas, but it is much increased by the allotment of not a single delegate to its opponents in Iowa, Kansas, Louisiana, Maine, Massachusetts, Michigan, Minnesota, South Carolina and Vermont. This disproportionate strength of the Republican party increases the apparent magnitude of the change in 1874, when no Republicans were elected to the Forty-fourth Congress, either by the Republicans of Arkansas, Georgia, Maryland, Missouri, Texas or Western Virginia, who cast 351,764 votes, or by the Democrats of Maine, Rhode Island, Florida and Minnesota, who cast 104,510; and when of the 265 delegates from 28 states, all then voting except Louisiana and the four one-member states, 97 represent 2, 30,300 supporters of the administration, and 168 represent 3,410,535 of its opponents, whereas the former are really entitled to 122, and the latter to but 143. The democrats have thus obtained nearly two-thirds of the House by little more than one-half the votes, or more exactly, 64 per cent. of these 265 members by 59 per cent. of the votes, a majority of 28 per cent. in the House representing one of 8 per cent at the polls. These estimates are from the Tribune Almanac for 1875, and in some cases only approximative, though it is sufficiently plain that the members of one party or the other in sixteen of these twenty-eight states will be virtually unrepresented in this Congress, since the Republicans have three members less than their share in Tennessee and Virginia, two less in Kentucky, North Carolina and Alabama, besides being wholly unrepresented in the six states above mentioned; and their opponents three members less than their share in Iowa, besides being unrepresented in four states as mentioned. In a seventeenth state, Wisconsin, the party actually in the majority was able to elect but one third of the State Assembly and but three out of the eight Congressmen, while the republican minority claims to have carried the state and may yet succeed in getting a sixth Congressmen. In Florida, where the parties are almost balanced, the majority gets both the Congressmen, but has a minority in the state legislature, a double injustice. In New York, Massachusetts and Kansas the assembly men are unfairly distributed, so there are but two states among the twenty-eight where the elections did justice to both parties, Vermont and Illinois, in the latter of which a new system has been introduced as we shall soon see.

Three presidents, Taylor in 1848, Buchanan in 1856, and Lincoln in 1860, secured large majorities in the electoral college, though none of them had one half of the popular vote. In 1864, indeed, Lincoln got a little more than half the votes and this gave him ten-elevenths of the electors, but if McClellan had received 35,000 of the votes given to Lincoln he might have gained the majority of the electors and become president, though he would still have been in the minority at the polls.

It is plain that the people are very imperfectly represented and that neither party gets its fair share of the power. It is also plain that corruption is much facilitated by the extreme difficulty of setting aside the nominations of either party except in favor of those of the other, perhaps equally bad. Parties would be slow to nominate men who oppose civil service reform or lack character and ability, or are mere tools of the ring, if such candidates could be defeated easily. This can now be done only when the bolters form the majority of the district, and many a patriotic statesman, who has friends enough to send him to Washington if they could act together, stays at home because he cannot carry the district where he resides. What we want is a system of voting which will give a fair share of power not only to each party but to every combination of independent voters, so that, for instance, of the one hundred members of the assembly, in Wisconsin, forty, fifty, or sixty would come from each party according as it polls forty, fifty or sixty per cent. of the votes, and any independent candidate would be elected who gets his one per cent.—more indeed than is now requisite, so that the voting districts must be enlarged greatly to enable any one to obtain it. This system is meant to give no special favor to individuals or minorities, but only such justice to all the candidates, that its proper name is not Personal or Minority, but Proportional Representation.

There are several plans for doing this, the best known being the cumulative, advocated by Horace Greeley twenty years ago, and now in use in Illinois, as well as in England, where, as the London *Times* says, "it has made its way by its inherent justice." In Illinois it was enacted in 1870 that the 153 legislative districts, formerly sending each a representative to the legislature, should be consolidated into 51, with three members each. Each voter casts three votes, which he can concentrate on one candidate or distribute among two or three, as he prefers. This plan was first tried in 1872, when, as Mr. Medill stated in the *Cincinnati Commercial*, of December 2, 1872, "for the first time each party is represented from every part of the State, and the aggregate representation is exactly in preportion to the numerical strength of each party. For the first time since the Republican party was organized in Illinois (1854), have the Democrats secured a representation from Northern, or the Republicans from Southern, Illinois, with rare exceptions. The bitterest Democratic districts down in Egypt now, for the first time in the history of existing parties, elected Republicans." The *Chicago Tribune* adds: "On the whole, it has worked admirably; it has secured the great end sought, and has enabled the people, in many instances, to defeat the objectionable candidate," which is a fulfillment of the prediction of John Stuart Mill, that "those who would be favored by the cumulative vote would generally be the persons of the greatest real or reputed virtue or talents." (Thoughts on Parliamentary Reform.)

It was further noticed that in thirty-three of these fifty-one districts, the republicans were in the majority, so that by the usual, or as the Chicago Times aptly called it, the "jug handle" method, there would have been ninety-nine of one party to fifty-four of the other, whereas the estimated proportion was eighty-five to sixty-eight, and the actual result nearly the same, eighty-six to sixty-seven. At the last election in 1874, when the old plan would have elected fifty-four republicans to ninety-nine of their opponents, the new one gave seventy of the former to eighty-three of the latter, of whom indeed there were twenty-seven independents and fifty-six democrats, almost exactly the allotment justified by the vote.

Seven of the districts, however failed to get their exact share, most of these discrepancies being due to the voters scattering their ballots among too many candidates. In England, however, at an election of the Birmingham school board. the Liberals, though slightly in the minority, tried to elect all the fifteen members and so got in only six, while really entitled to seven. Such failures of this method can be prevented only by strict party discipline, though they would be much less frequent if no voter were allowed to vote for more than the majority of the candidates, or indeed, where their number is even, for more than one half of them. Thus no voter in Illinois should be allowed to vote for more than two of his three representatives, and the one hundred assembly districts in Wisconsin might well be consolidated into ten, in each of which there would be ten candidates to be elected, and five votes to be distributby each citizen.

All the essential advantages of the cumulative plan would thus be preserved, and it would become still better fitted for electing members of congress than the form recommended by Senator Buckalew in 1869, which, for instance, would give each New Yorker thirty-three votes for representative, whereas he would have exactly as much power if he had but seventeen, and any independent candidate getting above three per cent. of the vote would be equally sure of election under either arrangement. It would, however, be better still to have three districts, each sending eleven delegates and allowing six votes.

This restriction of the number of votes would lessen immensely the difficulty of counting them, and the distribution bv the individual would be much easier when the parties were equally balanced, while the labor of marshalling the voters of a party largely in the majority, so as to get all the benefit of them, would not be increased.

Neither form of cumulative vote would be likely to abolish the caucus, which indeed can scarcely be spared, but either form would restrain its abuse, by the facility it would offer for defeating its candidates, and electing those nominated by boards of trade or mass meetings called by leading newspapers. This is most easily done when the districts are the largest, hence the advantage of the proposed restriction, which makes the distribution and counting of votes but one-half as laborious as would be the case where the same number of voters were to choose the same number of representatives by the ordinary form or the cumulative vote.

A further restriction of each voter to one vote would indeed make counting them still easier, but render the distribution, when the number of candidates is large, extremely difficult and precarious. Either of these plans might, however, be used in choosing directors of corporations and stock companies, and thus enable the holders of a comparatively small quantity of stock to have their own representative to protect their interests. In such elections comparatively few votes would probably be thrown away; but at the polls there is great risk, not only of the votes being too much scattered, but of their being too much concentrated.

Thus the Democrats, in two of the Illinois districts in 1874, gave all their votes to one man when they might have elected two, and at an election of the Marylebone school board, in England, Miss Garrett got more than twice as many votes as she needed, and more than half of them were thrown away. Now if Miss Garrett's friends could have placed her on a ticket with several other of their candidates, and could have had every vote not needed by her transferred to her associates, they would have been much more fairly represented.

A plan which would have done this, and which is known as the preferential method, has actually been in use for twenty years in Denmark, and was several times employed in the nomination of overseers of Harvard University. Many English liberals favor it, and John Stuart Mill places it among the very greatest improvements yet made in the theory and practice of government, "and therefore of civilization." Mr. Thomas Hare, after whom this plan is often named, says: "In framing this system I have always looked forward to its reception by the American people with an anxious hope. Surpassing all other people in the arts of peace as they minister to the universal comfort and well being. attaining a not less distinguished though unhappy eminence in the arts of war, a nobler work remains to them * * * that they become the leaders of mankind in the far greater art of government."

This plan is sometimes called too difficult, but Mr. Mill declared that it is as easy as the multiplication table. The voting is easy enough. Miss Garrett's friends would have deposited ballots on which her name was marked, "First choice," while those candidates would be named as second or third choice, etc., to whom that vote should be transferred if not needed for her election. The votes are first counted so as to show the full number, which divided by the number of candidates to be elected, gives the quota required for the election. Then the ballots are recounted for the first choice. As soon as Miss Garrett had reached her quota, her name would have been cancelled on all the other ballots of her friends, and these votes would be counted for the second choice, and if that candidate also gained the quota, for the third. The same process being applied to all the ballots, it would have happened in this case as in most others, that there would be a vacancy or two left to be filled from among candidates, none of whom had the quota. Mr. Hare's last decision seems to be, that in such cases the name having least votes be cancelled, and these ballots redistributed until the quota is reached. Other authorities are in favor of giving the preference in such cases to the plurality, or of getting a smaller quota by methods, of which it is enought to say that they would much prolong the labor of counting the votes, a task already so difficult as to give great opportunity for fraud.

Indeed there is one case in which dishonesty would be peculiarly easy and justice almost impossible.

Suppose these Illinois Democrats and Liberals, who elected one representative when they might have got two, had used Hare's plan, and all of them made Brown their first choice, while, for the second choice, the ballots were divided between Jones and Robinson. Now if Jones' votes were counted first, Brown would be elected and his name cancelled on all other ballots, which would thus elect Robinson also, whereas if the Robinson ballots were counted first the choice would be Brown and Jones. Either Jones or Robinson could secure the seat by persuading the inspectors of the votes to shuffle them, so that his name would be counted last while if these officers were too honest for this, their decision would be merely a matter of chance, and either chance or fraud might elect Jones, when he had less than half as many votes as Robinson. The Hare plan should not therefore be adopted, if we can find any other which could not be so perverted, but which would be equally likely to prevent any vote from being lost.

The true plan should always make as exact an apportionment as Hare's can ever do, work as simply as the cumulative method, and have the additional advantage over both these plans of always appointing in advance, for every vacancy during the term of office, a substitute representing the same constituency. Such a plan was actually invented in 1866, by M. Morin, of Switzerland, in which country it is termed the the "free list," though American writers call it the independent or list system. It is really Hare's plan simplified. The ballots are very similar, namely, lists of names arranged in order of preference, but marked list number one, two, *i e*, according to the order in which they have been recorded. The quota is obtained in the same way, but there is only one counting of the vote, of which the number cast for each list is ascertained, at the same time as the whole numbers of votes polled. It is then only necessary to divide the number cast foi each list by the quota, to know how many of the candidates on that list are elected, the names being taken in order as they stand.

By this system, if the list containing three names headed by Miss Garrett had obtained three times the quota, all three would have been elected. In the States of Kentucky and Tennessee, each of which now has ten representatives in Congress, the quota would be ten per cent. of the vote polled. Any party would have three, four or five representatives according as it had thirty, forty or fifty per cent. of the vote, and any independent candidate would be elected who got his ten per cent. This way of reckoning would give the Republicans three from the former and four from the latter State, instead of one member in each actually elected to the forty-fourth Congress.

This method favors independent candidates even more than the cumulative, for there is much less danger of votes being thrown away. There is the same probability as under Hare's plan, that every ballot will count, but not the same possibility of the interference of chance or fraud. The imaginary votes for Brown, Jones and Robinson would be classed as so many for list one, Brown and Jones, and so many for list two, Brown and Robinson, and the second man would be taken from the list best supported, while the few cases of an exact tie could safely be referred to the legislature.

With this slight exception. the results would be quickly made known and easily verified. If a member of Congress dies in office his successor would be the first man left on the list from which he was taken constituents would continue to be represented by a candidate of their own choice.

Under the list system the nominating power of the caucus would be the same as with the cumulative or preferential plan, except that its advocates have proposed a restriction which might well be incorporated with any method of election, even the boa-constrictor one, namely, the condition that all the nominations should be recorded and published long enough beforehand. to give the citizens time for independent action. There is some difference of opinion as to how long the time should be, and how great should be the possibility of offering and altering lists by individuals. It seems to me that it would be best to provide that any list, signed by the secretary of any convention of delegates or any mass-meeting. or by one hundred voters individually, and sent at least thirty days before the election, should be numbered, registered, and published at once; that lists signed by any citizen and wholly made up of names already presented should be received, numbered and published as above, until fifteen days before the election; and that all ballots should be counted according to the registered number; alterations being disregarded and unregistered lists treated as blanks. I think such restrictions would simply exclude scattering votes and chances of mistake in the count. But these details are of little importance and may easily be adjusted.

It will be seen that this method is peculiarly adopted to the choice of members of Congress and presidential electors, while the cumulative plan works best in districts where the number of candidates and of votes is small.

Still more complete representation of the whole people than at present, would be attained, if either system were employed in electing committees who should take the place of the President's Cabinet, and form, with him, a national council; whose unanimous vote should be necessary for the appointment of judges, ministers and heads of departments, while other high officials might be appointed by a two-thirds vote, which should also be requisite for vetoes, suspension of the *habeas corpus* act, etc. It would be easy to change our civil service from a partisan to a national bulwark, if all minor officials were under the control of supervisors appointed and retained in office by such a council, while not only the leaders of both parties, but the great men outside of party lines could thus take their rightful places beside the President. It will easily be seen that State and city councils might be formed on the same plan.

Some may think these changes too radical; but every reader will see the advantages, in other respects, of the list system over any other method of proportional representation, though any of these methods would be an immeasurable improvement over the present plan, by which a party but slightly in the majority, or perhaps not having a majority of votes, but only one of districts, can crush and swallow up its opponents in true boa-constrictor fashion.

NOTE.—A member of the last Constitutional Convention of Missouri, to whom I sent a copy of this essay, informs me that its main principles have been "adopted n private corporation elections."

ON THE REVOLUTIONARY MOVEMENT AMONG WOMEN.

BY JOHN W. HOYT, A. M., M. D., LL. D., PRESIDENT OF THE ACADEMY.

I.

The work of civilization is the work of individualization. The problem of the ages in the interest of mankind is the problem of the soul at work in its own consciousness. Man's service to man in attempt to harmonize universal need is not greater, nor is it other than this—the attempt of the individual to find himself his proper place. The accomplishment of this by the few is that which makes any advancement possible, and it is the accomplishment of it by all that must merge the mission in the fulfilment of civilization.

But the unit man is able to open the eyes of his fellow men to this greatening of power and privilege only as he is able to help them to a like experience of it. Soon it is found that thought-level and class-level coincide—that one cannot at once get beyond the charter or the decree, and that progress is chronicled by caste and special end.

This parcelling out the rights of the individual has had the effect to make advances slow and partial; for in the same breath that makes the declaration, "thus far will we come!" there is heard the limitation, "we and no others!"

There are two thoughts that run along so parallel to any retrospect made of the progress of the race that they seem a part of all other thought upon this subject. They are distinctly these: that whatever has been gained has been wrung from those withholding as long as it was possible to do so, and that these gains have been so generally in the interest of man, that woman has remained outside of any considerable advantage. And yet, after all these generations of steady advancement for man, the burden-bearer of the world, how little he is advanced, at the best of his aspirations and means! The marvel that he has not been goaded to a fuller conquest of all barring the way to his rights of manhood and possible achievement stands face to face with that of woman, now moving in her own interest to the most complete and far-reaching revolution the world has yet seen.

That man, with his constitutional aggressiveness, his aptness for organization, the clear field with nothing but himself to oppose, should up to this hour have missed so much, is not more surpris- than that woman, unaggressive by nature, unsuited to organization and with universal history, precedent, and prevailing philosophy against her, should have undertaken at one move, the sum of all revolutions. And yet there it stands, the most conspicuous fact of the times touching either a moral or a political future for society.

A demand for rights of one kind and another—in the home, in the schools, in the occupations and professions, with a more equal control of property, and lastly, use of the ballot, as covering all these—has characterized this movement from the beginning. The wholeness of this demand makes the requisite reconstruction easy. Could anything be more simple? The half of society claiming to speak for the whole population, and hitherto exercising that prerogative have but to draw a pen across a few prescribing words in statute and constitution, and there is freedom for the whole people to be and do, each according to capacity and power. To the thoughtful and just man, it is strange that in the countries most enlightened, especially in our own the very essence of whose institutions is freedom without partiality, this sublimest act of emancipation that history can ever record should be so long delayed. For what can be more profoundly moving to the justice and sympathy of the universal mind than the spectacle of one-half of the great people, through sheer force of muscle and ruder force of brain, withholding from the other its dearly purchased and most sacred immunities?

All things considered, the success of the movement, at last begun, is next to the fact of it noticeable. It has acquired a respectable, not to say remarkable frontage in literature, on the rostrum, and in the halls of legislation. For thirty years, from pulpit, press and platform, in club and in social circle, it has had the benefit and hindrance of approval, protest and discussion; enlisting the dignity of conversation, the brilliancy of wit, the contempt of sarcasm, the repartee of humor, and all the vicissitudes of a question so much at home among the people as to be equally everybody's and nobody's business. And yet, should the history of this movement be attempted, the details would be found unsatisfactory, its methods unattractive and its results vaguely defined.

II.

Of the causes moving to this unrest and protest among women, the difficulty of finding suitable and remunerative employment is conspicuous. Here, as in the beginning of human effort, the question for woman is first one of shelter and sustenance, and without the world before her, as it has ever been before man; for the great highways of occupation are either positively or practically closed to feminine industry; and in those open to women it is the almost universal rule that they are met with less wages for the same work.

The best argument for this inequality of compensation is based upon the usual responsibility of man for the family maintenance. This leads to the question, How, then, when a woman receives from one-fourth to one-half of that paid a man for the same service, is she to maintain a family left to her care? It seems very unsatisfactory to be told that such persons are exceptions to the rule of generally provided-for married women, and the case must be met in some other way than that of labor and compensation for it;"* or that, "women left without natural protectors, must take upon themselves the pursuits of men in order to live at all," and that "for these aberrations from general law special arrangements must be made." So far from staying this revolt, women are not even pausing to press the old question, "Gentlemen, what is this other way, and when are those special arrangements to take effect?" but are moving upon results with the apparent purpose of making their own arrangements.

*"Social Science and Women Suffrage." By Rev. C. Caverno, Academy Transactions, Vol. I.

There is not a more pitiful proposition in the list of social impracticabilities than that of a mother turning to the occupations of men and asking bread and education for her children. So far as I am aware, the consideration of this struggle for existence among dependent women has not advanced much beyond the admission that it is a case to be considered. And I would here suggest, as a step toward something known, if not done, in this regard, that through this organization for the advancement of knowledge and social amelioration the Government be asked at the taking of the next census, to inquire how many women there are in the United States dependent upon themselves for support; and how many, in addition to their own support, are charged with the maintenance of children, aged parents or family relations dependent upon their labor, with the occupations followed and the means accruing therefrom. This, with the number, sex, and age of children and other statistics relating to the family, and a statement of such partial means as have been left by deceased or are furnished by incompetent natural providers, would throw much light upon related questions, while bringing this one of compensation for labor with a new significance before the social philosopher who answers the inquiry, "Ought not the compensation of one person to be equal to that of another for the same work?" by asking, "Ought not families to be supported?"*

The question before us is not a divided one, but inseparable by virtue of a higher law no political economy can permanently resist. That "the laborer is worthy of his hire," stands denied by Christian, as by Pagan communities, to the multiplication of poorhouses and jails under sound of the Sabbath bells of all Christendom. This is no mere figure of speech; the logic of statistics proving that in the so-called most Christian nation upon which the sun shines, the pauper list, because of unremunerated employment, is greater than that of any other country in the world. And what is pauperism? Pauperism is the result of uncompensated labor; and labor uncompensated is that the wages of which do not furnish the means of keeping in repair the instruments of it. Science and experience show that man, as a laborer, must receive wages in advance of keeping himself in repair, or the instrument he leaves to take his place must be a deteriorated one. This, be-

* Social Science and Woman Suffrage, by Rev. C. Caverno. Vol. I. Academy Transactions.

cause, while he labors he also becomes the father of children. This deterioration, going on with each generation, at last reaches the point where pauperism becomes a settled condition rather than an occasional and temporary result.

This monstrous evil, this unconvicted crime, of labor without adequate wages, it is plain to be seen, falls most heavily upon the laboring woman who, least of all, is responsible for it. The interests of industry and the instincts of virtue unite in the condemnation of such barbarism.

This question of family maintenance rests upon an arrangement far below the righteous or unrighteous usages of society. In the nature of things, the duty of maintenance belongs to that parent, be it father or mother, best fitted for the fulfilment of it. Shall the little one of any household in the Kingdom of Christ go less suitably fed, clothed and educated because the burden of this providing falls upon the mother, whose more brooding care and greater tenderness more fully symbolize those of the All-Father for the child Humanity? Not always. Nor need the majority-man, upon whose shoulders this burden usually falls, fail of courage because of this concession. He will find the problem most easily solved by the rule of equal compensation. Women do not go into the occupations of men, competing for wages, save from necessity; remaining there the shortest possible time, and finding themselves, when there, at disadvantage of natural and acquired unfitness. Nevertheless, it is true that women, thus thrust out of their own into new and distasteful occupations, often accomplish as much and as good work as men trained to its pursuit. This putting of themselves so completely into their work, to secure this result, must be exhausting beyond that of masculine services of the same sort. For this reason, and for other very good reasons, when women do go into the occupations of men for wages, they ought to have at least as much, since in respect of need they have the same—that of having others to support—and, in addition, this: the care of the household, in cooking, sewing, nursing, and the general responsibility of administering the affairs of the home. This is so much extra burden laid upon the average laboring woman beyond that performed by the average laboring man.

But the great reason, covering all classes and all conditions of each class is this—*that women are not able to labor so continuously* *as men.* The disabilities that cut a man off from compensation for labor he is not able to perform are possible and occasional; while those thus hindering a woman are inevitable and periodical. And this, most certainly, at that period of life when family maintenance, if left to her, would, from the youth of her children, be the heaviest. That physiology which stands with its protest at the ballot-box may well take the initiative of protection for woman against this iniquity of more work for the same wages. For a woman to do as much, and as good work as a man, at any continuous employment, involves the using of her life-forces at the rate of self-destruction. And for society to compel, or even permit, this is to legalize by stronger than statutory provision the abrogation of that law of self-preservation, and that duty of equal protection, for the enforcement of which society was formed.

Another and most prolific source of discontent is the want of appreciation which everywhere meets women in the performance of the ordinary and ever-recurring duties of domestic life.

This want of appreciation is apparently grounded, not so much upon a depreciation of woman, herself, as of her occupation. It is as wide-spread as domestic life, and a source of bitterness among all classes not exempted from personal care in affairs of the house by exceptional exaltation of rank. It is found equally among the intelligent and the illiterate—a prevailing low estimate of home duties. Strange as it may seem, this estimate steadily lowers as the intelligence and pursuits of class advance; finding its ultimate in the disdain of gentlemen of the best circles.

The fact that women do not complain of this very much, or that, to many, it is not distinctly formulated in thought, is all the more to the argument of its being a great wrong and working serious injury. Indeed, next to the fact itself, that it finds so little expression is the worst of it. It is a skeleton with a shadow for every homely joy, dragging the body of its death, through the weary round of woman's life.

The depreciation of whatever industry, art, or gift belongs to the furtherance of purely domestic ends, such as thrift, organization, and device in the household, has gone so steadily on since the days of King Lemuel, that, taking it up as a cause of revolution among women is, as if in obedience to the command, "Open thy mouth for the dumb, in the cause of all such as are appointed to destruction."

I am not unaware of the speculative nature of the theory that measures the decay of woman's interest in home by that of man's estimate of business, but I appeal to both to say whether as the world enlarges to the one the home is not belittled to the other. The house increases in dimensions, for there must be room for the conveniences of art and a retinue for the service of means. But the home atmosphere is dying out. In the language of one whose celestial philosophy often touches practical life, "it is not known any more what it is, or even that it is." What is there in the well-furnished modern home? Everything to make it comfortable but comfort. Man, with his energy and skill, brings everything there but an appreciation of what woman does to convert material into beauty and use. Ignoring that the home contains in microcosm every element of power with which he wrested from the world the right to call it his own, with additional force of finesse and spirituality of which he has little conception, he seats himself so in the midst as to leave her pretty much out. How to organize the forces, that there may be ordered without restraint; to harmonize the restlessness of the child with the rest of the adult; to adjust the duties and privileges of servants, the entertainment of friends, the courtesies of society, the calls of religion and charity, maintaining through all her own individuality, and things, if possible, more precious,—the saving from themselves of dearer ones by the conservation of all the powers through which the thoughtful woman knows how to build with stones that need no smiting,—she knows through what an incarnation of soul and sense these have come. He does not. So far from this, he really thinks they have cost him so much money. Are not these the receipts?

There is nothing more common than for the wife to discover that her husband wonders what has become of her time. The masculine judgment that money and hired service are sufficient to the results a woman knows have commanded, not her time and freshness only, but as high an order of talent as was ever employed in money-making or in State administration, is driving the wife of price beyond rubies out of the home and out of the world.

There is no mistaking either the fact or the effect of this. In regard to the highest of these home duties, the care and training of children, notwithstanding the theoretical value placed thereon, they fall into the rut of a uniformly low estimate of what is properly considered a woman's work. Evidence of this is found in the fact of no provision made for the development of any practical efficiency for their performance in the home, and in the placing of children under charge of the most incompetent and poorly paid teachers in the schools.

Not until the best institutions that can be established make ready the devoutly impressed and richly furnished young women to become mothers will women believe there is any honest conviction behind the complimentary speech with which this branch of home service is taken out of the category of contempt. From the gridiron and clothes line to the best possible administration of the home, it is against this grinding sense of undervaluation of her employments that woman makes her way through life.

Of education, as a cause of the present revolutionary movement, it is more difficult to speak. I refer now to that wrong and inadequate education, of which girls get so much that women find themselves practically without any. It commences early and continues long, in that indirect tutelage found in the home, in institutions, laws, literature and society, and which, between repression and stimulation, becomes an almost systematic procedure for baffling nature and substituting the standards of art. And what do we see? Hearty, happy little girls? We see very little, any more, of that phase of female loveliness. Preferences and tendencies are no longer tolerated unless of clear becomingness, according to estimates as changing as the unreliable qualities they foster. To atone for this ever present repression in regard to food, frolic and devices of taste, an enervation of indulgence sets in, with corresponding results to body and mind.

The law of nature, which is development and not hindrance, is thus stimulated to over-activity among boys by the constant assault upon its application to the girls of the household. Thus the hard and aggressive nature of boys becomes harder and more aggressive than nature intended, resulting in injury to the female organism. Reference is had to that sort of injury upon which the discovered relations of physiology and psychology begin to throw some light, and which is due to the more complete wholeness of woman's structural development at any given time, and at the earliest time, making the endurance of repression or the excess of stimulation more hurtful to the childhood of girls than of boys.

The pernicious doctrine that women are made for sacrifice, with the stimulus of making this sacrifice wholly acceptable has been the root and front of all falsity in relations between the sexes. It begins in the family, teaching to the least of them that brothers are to become whatever they can make themselves through their gifts and opportunities, and that sisters are to become what is neither in the way of nor unacceptable to their brothers. This subordination of one sex to the other teaches inferiority and breeds the pride of some sort of rivalry. The field of this is soon found, there being much help to it; and the aim is fixed to be a pleasure to the brother, as he is a power to her. If this were all, little harm would come of it; since, at its height of art and purpose, it is the gift of God—*this art of a woman wholly pleasing a man.* But the end being presented, with no incentive beyond it, the aim soon touches its depth of demoralization, through the notion that methods are of less consequence than results, and forgetting the purpose of appearing to be what she is not.

There is little room to doubt that this is a legitimate result of early indirect training, and a fountain of that insincerity which is so dark a shadow on female character. The affectation, instead of the cultivation of gracious quality in the plastic years of childhood often remains but an affectation, to the wormwoodand gall of other lives and latest years. It is because of exceptional nurturing of truth and womanly quality, that society is saved from the full penalty of the teaching that women are bound to please; and, pleasing, it matters but little how. Grave as this charge seems, it is as true as when made a quarter of a century ago by that illustrious friend of man, Horace Mann, that, "Through all time women have been assiduously taught that the garniture of the body was more precious than the vesture of the spirit; and in no age nor portion of an age, in no country nor segment of a country, has woman ever been elevated for her reflex power of elevating others."

Under the conditions, it is not surprising that woman should seize upon material ornamentation as accessory to the purpose of making the most of herself; or that, as the sense of her moral responsibility is lowered, she should rely more and more upon these allies of personal attractiveness. The surprise is, that, with any moral sense left, she should not repudiate the putting of things beautiful and appropriate, as aiding the expression of intrinsic beauty and worth, in the place of these. Nevertheless, this is done, and to such an extent that, just as the connection between taste and morals disappears in modern feminine apparel, it reappears in the spectacle of a very low standard of personal appreciation, expressing itself in the deformities of fashion. It is not merely the empty head of the votary of conventional extremes that measures the folly and wickedness of training up childhood to such maidenhood; it is in the exhibition of moral unfitness superinduced upon womanhood itself, and finding its moral expression in her attire, where the womanly art of decoration becomes artifice.

As life advances, the position and language of institutions reaffirm to woman the humiliating proposition of her youth. At the threshold of all higher power and privilege, she is met with the denial of right, or the denial of capacity. There is not an institution, of the highest grade of its kind, in the world where a woman can go for instruction, upon an equality with man; and in those approximating this rank, where she finds admission, it is also to find the atmosphere and hindrance of his supercilious toleration.

In the language of the law, she finds herself ranking first in the list of natural and convicted incapables—"women, children, criminals, idiots and slaves." Moses placed her in the category of substance—property—and there she remains. Not long since I saw in an American newspaper an advertisement of the escape of a wife who had been left as security for the payment of money, with notice of penalties for harboring her. The property and the husband are one, and not the husband and wife; for does not their relation terminate upon the death of either, while the husband and his horse go on together beyond the solemn event?

In regard to the ownership of children, not the slave-mother alone, but Cæsar's wife may miss the infant from her side and Cæsar make no answer. Moses inaugurated this also, and time has meddled but little with the policy.

In literature it is the same, and yet worse of the kind. The voice of institutions and of law can be somewhat escaped, invading the home but occasionally. But literature, which is a woman's refuge, with its treasures of new and old, its enchanting fabrications in story and verse, and its record of all that has been done, and hoped, and failed,—it is here that woman finds herself in the full habiliment of her subordination. It is not the bold avowal of her inferiority and the scorn of her sphere, of which there is no lack; it is not the meaningless paraded recognition of her charms and gifts, as the decorator and subserver of his leisure, nor yet the vows and homage accorded her as ministering angel of the house and purifier of society; it is that inexpressible tone and spirit pervading the whole, as she turns its pages, announcing everywhere to woman the measure of her esteem among men. Out of literature proper she is eased down into society—where the virus of all takes most fatal effect—by the newspaper press. There is nothing more offensive, and nothing more damaging to the moral sense of the average reader, of either sex, than the manner in which woman is distorted and bemeaned by the newspaper craft. Woman, the scandal of the double-leaded column, the gist of every well-told tale, the butt of the best joke, the glint of sarcasm, the ridicule of domestic discontent and diabolism, and the unknown quantity of all innuendo and suspicion. And woman not at her best, or half best of admitted worth, but at her worst of disadvantage.

In society, the attitude and the speech of man to woman is most decorous; for it is here, in the presence of her physical charms, that the fascinations of her intellectual and spiritual beauty unite in appeal from the decrees of his calculating intellect. And yet it is here that woman brings the largess of an unreserved sacrifice—her time, labor, means, capability, her health, herself.

As a last cause distinctively considered, we have the direct education furnished in schools for girls. And it may be that here will be found the chief cause of the attempt of women to revolutionize public sentiment in their interest, since the language of positive education is the plainest possible statement to woman of the inferiority of her duties and of herself.

The rule of less compensation for labor may come in part from a mistaken judgment as to the number of dependent women; the depreciation of home duties from an imperfect knowledge of domestic economy; and much of indirect teaching may be the half unconscious growth of a belief that, things being as they are, it is best to make the most of conditions found. Even the injustice of her legal status may be glossed over by the assumption that the responsibilities of equality would overbalance its additional security. Such conclusions are compatible with a rather fair estimate of women taken out of the intricacies of relations which it is difficult to estimate. But that direct education, which is neither for public nor professional service, comes to woman with a denial of the right to it or capacity for it. If one could lay upon the page, or place before the eye, a picture representing the hemispheres of time occupied by men and women respectively, and touch them with light and shade, according to the measure of education that has been furnished each, the eye might help the mind in gaining a conception of the extent to which woman has been denied a knowledge of herself and of the world in which she lives. But Art has not the gift, as eloquence has been in vain, to arouse man to the wrong of denying to woman an equal share in whatever education can give as a preparation for life. Because there is a difference between the present and the practice of earliest times, it is not to be lost sight of that the difference in the opportunities afforded young men and women respectively, has not been diminished in proportion to general educational advancement; so that it remains, to the dishonor of all time and countries. Using again the language of Horace Mann, "In estimating the number of heroic souls who have languished out their lives in dungeon cells, or fallen beneath the axe of the oppressor, we count by hundreds and by thousands; in summing up the multitudes whom conquerors have subjugated and enslaved, we count by nations and races of men; but, in enumerating the women whom man has visited with injustice and persistent wrong in the rights of education, we express ourselves by a unit, but that unit is the world. And this, notwithstanding that human reason seeks in vain for a reason why there should be this difference of education and no education between the sexes."

It is incredible that women have not been taking note of these things through much time of both experience and retrospect; and that they are not more moved to protest and revolution to-day, in the flush of modern enlightment, than when abiding in the thicker darkness of the past. Nor is it wonderful that this revolution, having its root and furtherance in the English-speaking countries, where progress has done the most for men, should find just here, where their education has most advanced, most bitter cause of complaint.

III.

Of the aims and methods there is but time for the most general mention.

The aim is to take woman out of the condition of subordination to one of equality with man. As an aim it is all that it could be —a whole, a wise, and a just one.

Of the methods, it must be said, they have often been mistaken ones, hindering the cause. But they are explained as being the only ones furnished as models—the means used by man in furtherance of similar objects.

IV.

The supposed results being the hydra-headed confusion and desolation of the social scheme, it is well to look a little carefully at what they would probably be. And, first, they must appear in woman herself more than in man. The mere fact of equality before the law would vitalize her intellectual being, through an added sense of power, not likely to awaken at once a corresponding sense of responsibility. This has been the history of all class advancement, and especially when advancing upon privileges long withheld, and it cannot be doubted that the entire body of women, I mean all classes of them, would be thus affected—first by the privileges, rather than by the duties, of the new position. Nor could this fail to bring about great social injury, involving the neglect of children and homes, domestic industries and charities, differences between husbands and wives, and disaster to private and public business. As the direct result of the independence of woman, this would be bad enough; but it would undoubtedly be followed by the darker shades of increased licentiousness among both women and men. Political power, and political power alone, as furnishing the means of protecting himself against the inflictions which may come of it, has been the bulwark of man's prerogative and practice of vice. It has done more and worse than this; it has compelled, whenever his interests were subserved thereby, a participation by woman in his vice, while meeting out direst penalties for the same when it did not so subserve his purposes.

The revulsion from all this, with co-ordinate power and privilege, will most assuredly work to the debasement of female character, checked only by her natural superiority of instinctive virtue, and by the increased security against temptation found in her enlarged material independence. The tendency to this growth of vice among men would also find restraint in their increased respect for women, *because* of their independence, and in the elevation of sentiment inspired by them through better culture and the consequent ability to turn the excess of masculine passion into virtuous and useful channels.

Another powerful, and, it may be, more immediate check to either the ordinary or increased licentiousness of men would be the alarm seizing upon all but the most depraved circles of society, at the spectacle of woman becoming the instrument of so appalling a measure of retributive justice. Nor can it be doubted that this spectacle would become a measure of extraordinary enlightenment to him concerning the whole nature of the sexual passion and of the non-sexual character of morality *in extenso*.

An increase of divorce legitimate to this state of things would ere long be corrected by enabling women to enter upon marriage more considerately than now; while marriage itself would be steadily gaining in dignity and security, as the elevation and responsibility of enfranchised women began to take effect upon the general quality of men, as well.

This movement, would, however, beyond all question, show itself to have been a great and just movement in the result of better educated women. Through the independence of equality in education, better women; and after that a better race of men, better rearing, better society, better government, and a nobler civilizaotin.

That women desire an equality with men to the end of entrance upon public life, or of competing with them in the affairs of business, is as far as possible from the truth. There is much apprehension as to the subversion of social order, while insisting upon obedience to the law of nature in the parcelling out of duties and relations between men and women; and yet the entire proceeding of the civil structure of man in this regard is as if nature had furnished no law not in need of the sanction of his enforcement. But if there is one law of the intellectual constitution of sex more clearly defined than another, it is this: That man is intended for massing himself with his fellows in organization, and woman for abiding in the unity of self-hood. Man for openly aggressive, and woman for silent, power is the *law* of power; each after its fitness and its destiny. Since the world was, man has appeared best in activity, woman in repose. Instance the testimony of all marble and canvas, as well as of literature, and observe it in the daily round where the self-blinded eyes of men begin to see this open secret of the social disorder.

Women do not crave a public career, nor would they remain long in public life if its paths were fully open to them. They do not seek the ballot to this end. Even the majority of the leaders of this movement desire nothing so much as the protection a domestic sphere and home-life theory promise them. As before the Magi of the old, a woman stands to-day before the law maker of this new time questioned as to what most pleases woman. And thus has she always stood, answering in the language of the myth, "To be loved, to be studied by her husband, and to be mistress of the house."

The difference between the women of that and this time is in the manner of the response. The Persian representative of her sex stood in the twilight of the world, asking for a veil behind which to hide from even the gods, who held in their keeping such precious gifts, her sacred joy in anticipation of their bestowal; while the representative-movement woman of to-day stands on platform and in press in the emphasis of her determination to have something better than the *promise* of these good things.

To be loved, to be studied, and to be mistress of the home where strength and honor are her clothing, this has always been and always will be the joy and crown of woman. By the laws of her physical and spiritual being, as well as by intellectual preferences, she is wedded to her motherhood. But she never has been, and never can be, true to it under the imposition of conditions dependent upon the will of man.

Ideal freedom, which is the birthright of every human soul, is more necessary and more possible to woman than to man, if any comparison can be made. Alone with herself, in the unity of that mysterious bond which binds a finite to an infinite being, woman becomes a power for baffling evil and furthering good. But under the ban and surveillance of her master, she is not able to realize, much less to find, her place.

V.

The final cause of this movement is that of all real progress, and in the nature of things it cannot fail. That women will accept less than the obliteration of the last jot and title of man's ungraciousness to her is not possible, as it is not possible for a law to be and not to be at the same moment. Ways and means are nothing, as condition and precedent are nothing. Through folly and through wisdom, through strength and through weakness, moves on the perfect plan to perfect ends.

DEPARTMENT OF

Speculative Philosophy.

TITLES OF PAPERS READ BEFORE THIS DEPARTMENT.

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1. Were the Stoics Utilitarians? By Rev. F. M. HOLLAND, Baraboo.
2. An Examination of Prof. S. H. Carpenter's Position in regard to Evolution. By HERBERT P. HUBBELL, Winona, Minn.

12——W A S

WERE THE STOICS UTILITARIANS?

BY F. M. HOLLAND, BARABOO.

The practical value of Stoicism was long ago fully demonstrated in the energy, justice and philanthropy with which, for more than eighty years after the death of its worst enemy, Domitian, five of its pupils successively ruled the Roman Empire. It is well to ask if the philosophy, for which Nerva went into exile at the same time as Epictetus, in which the latter, with Dion Chrysostom and Arrian, instructed Trajan, Hadrian and Antoninus Pius, and of which Marcus Aurelius made himself the grandest embodiment, has still a place among living systems of ethics.

The few writers who have tried to find such a place for the Stoics differ widely. Mr. Lecky and Miss Cobbe labor to array them among the transcendentalists, the History of European Morals asserting that of "the two rival theories, one is generally described as the stoical, the intuitive, the independent or the sentimental—the other as the epicurean, the inductive, the utilitarian, the selfish," (vol. i. p. 3,) while the Essay on Intuitive Morals frequently appeals to the authority of the Stoics, in quotations, for the most part mistranslated, as is especially that from Lucan, ix., 573, (Am. Ed., page 120,) which owes its significance wholly to the words, "inborn precepts," which are rightly italicized by Miss Cobbe, for they are not contained in the original Latin printed beneath them. This liberty, like the similar ones with Marcus Aurelius, I. 13; and V. 27, was undoubtedly taken in the firm belief, that the real views of the authors were thus fully manifested. Even J. S. Mill so far agrees with his two antagonists, as to speak of "every writer, from Epicurus to Bentham, who maintained the theory of utility," and to say "let utilitarians never cease to claim the morality of self-devotion as a possession which belongs by as good a right to them, as either to the Stoic or to the Transcendentalist." (Utilitarianism, Ch. II.) Everybody knows Jeremy Bentham's hatred of "the sort of trash which a set of people used to amuse themselves with talking, while parading backward and forward in colonnades called porches," but everybody does not know that Alexander Bain, who is, except Herbert Spencer, the ablest living advocate of utilitarianism, declares that "Stoicism and Epicureanism are both included in its compass." (Moral Science, Am. Ed., p. 16.) Mr. Bain, however, gives no evidence for this statement, and takes little pains to show the proper place of the Stoics among the happiness moralists.

These differences of opinion make it necessary to examine carefully the statements of Stoicism, made by its principal teachers, Seneca, Epictetus and Marcus Aurelius, as well as the accounts of the opinions of still earlier authors by Diogenes Laertius and Cicero. Such an examination will show that the Stoics never were led by their belief, that every soul is a part of the Supreme and All-pervading Intelligence, to suppose themselves thus endowed with an infallible moral guide, and raised above the necessity of learning what is right and wrong by observation and experience.

Seneca, in his 120th letter, says: "Nature could not teach us the first ideas of goodness and virtue. She gave us the germs of knowledge, but not knowledge itself. Our philosophy holds that these ideas come by observation and comparison of our daily deeds, and that goodness and virtue are known by analogy."

Epictetus devotes the eleventh chapter of the second book of his Discourses to proving that we are not so well provided with innate ideas of good and evil, as to be able to distinguish right from wrong without some rule, balance or standard, such as philosophy alone can give, the knowledge of which inability he calls "the beginning of wisdom." (See pages 124, 5, 6 of Higginson's spirited translation."

He complains not only that "the governing faculty of a bad man is faithless," but that people not instructed in philosophy are ignorant of "the essence of good and evil, and act rashly and by guess;" "that contradiction among the generality of mankind, by which they differ concerning good and evil," showing that moral knowledge can be acquired only by tuition, as was also the opinion of the earliest Stoics.*

The fundamental distinction, however, between the intuitionalists and their rivals, is that the former believe the moral sentiment to be innate, independent and incapable of analysis, while the latter are satisfied that it can be analyzed into simpler elements, and therefore claim the title of derivative moralists, a name which the

* See Higginson's Epictetus, pp. 48, 62, 65, 74, 76, 83, 101–2, 145–53, 175–6, 185–6, 208, 224, 245–7, 299, 315, 335, 345, 354. Diogenes Laertius, Zeno LIV, p. 292, Bohn.

Westminster Review decidedly prefers to that of utilitarian.* In this respect it is very significant that the founder of Stocism introduced a new word for duty, *kathekon*, containing a preposition denoting relation or derivation, and that the last defender of the Portico gives a similar term, *katorthoseis*, for those actions "which proceed by the straight path from a kindred principle to the end appointed."†

Cicero,‡ however, considers that the preposition in these terms for right actions, denotes simply their accordance with nature.

Nature was, indeed, the supreme authority of the Stoics, whose favorite precept, "follow nature," did not mean "follow conscience," as Miss Cobbe asserts on pages 142–3 of Intuitive Morals, where she imagines that she proves it by a remarkably incomplete quotation from Diogenes Laertius, who makes much more reference, than in her extract, to universal nature, an oracle to which the Epicureans appealed as constantly as their stern rivals, without ever attempting to receive its revelations intuitively. The philosophers of both schools agreed with most of their contemporaries in "acknowledging, as the ultimate source of right and wrong in morals, and therefore in institutions, the imaginary law of the imaginary being, Nature." (Mill on Comte, p 65.) And this fallacy was accepted as the ultimate analysis by nearly every moralist who sought any for fifteen centuries after the death of Marcus Aurelius. Indeed, the error still shows itself in the current loose talk about natural rights and desires, unnatural conduct, etc. The fact that the Stoics lived in what Mill calls the abstractional, or ontological, and Comte the metaphysical period of ethics, should not prevent our recognizing them as faithful followers of the derivation method according to their light, as is proved by the following quotations, some of which even show that their authors were in advance of the age and almost anticipated the discoveries of modern Utilitarians, while other passages indicate a habit of estimating the morality of an action according to its tendencies and usefulness.

"In order to distinguish good from evil you should consider not whence it comes, but whither it tends.

"Whatever makes life happy is good by its own right and cannot become evil." (Seneca,Ep.44.section 6.) "Only that which makes

* See the article on the Natural History of Morals, published October, 1869, in Vol. XCII, p. 237, 52. Am. Ed.

† See Diogenes Laertius, Zeno LXII, p. 298, and Marcus Aurelius, V. 14.

‡ *Kata physin.* See De Finibus, III, 14.

us happy is good." (do 85, 20 and 115, 15.) "In being useful the soul moves according to nature." (do 109, 12.) "Whatever is good is always profitable. If it be not profitable, it is not good; if it be it is so." (do 117, 27.) "Utility is the standard of necessity," (or conformity to nature, do 39, 6.) "Public and private utility are inseparable." (do 16, 10.) "The only proper aim of the giver is the advantage of the receiver." (De Benificiis iv, 9, 1.) "Our duty certainly is to be useful to other human beings and to as many as possible, for in doing good to others we perform the common work." (De Otio iii, 5.) "Punish without anger, not as if revenge were sweet, and only so far as it is useful." (De Ira, Lib. ii, 33, 1.) "All men seek what is useful and according to nature." (Epictetus, Discourses, i. 18.) "No one can thiuk anything really useful and not choose it." (do i, 28.) "When therefore any one identifies his interest with those of sanctity, virtue, country, parents, and friends, all these are secured, but whenever he places his interest in anything else than friends, country, family, and justice, then these all give way, borne down by the weight of self-interest. For wherever I and mine are placed, thither must every living being gravitate." do ii, 22, Higginson p. 174.) "Why did Agamemnon and Achilles disagree? Because they did not know what is useful and what is useless." (do ii, 24.) "Consider the antecedents and the consequences of every action." (do iii, 15, also in the Eucheiridion, xxix.) "Every creature is formed by nature for pursuing and admiring the things which appear beneficial." (Ench. xxxi.) When you imagine any pleasure, don't be carried away by it, but wait awhile. Then think how you will grieve and blame yourself for enjoying it, and how you will rejoice and please yourself for having abstained." (Ench. xxxiv.) "This above all is the business of nature, to correct and apply the active powers to what appears fit and beneficial." (Fragment lxiv in Higginson's Epictetus, lxix in Didot's, Paris, 1842.) *

NOTE.—The first ninety-one of these fragments, as Higginson gives them, and some later ones are from Stobaeus, who lived about 300 years after Epictetus, but who shared his vsews so far, and has received such general confidence, that I quote all he furnishes of importance. Others are from Maximus and contain nothing to the purpose. The rest are from Antonius Melissa, a work in the dark ages, some 600 or 1000 years later than than the philosopher whom he quotes at second hand, through the untrustworthy medium of the church fathers. To his extracts I shall make no further reference except to mention that one passage (Higginson cv.;) is decidedly derivative and may fairly be paired off with another, (Higginson xcii,) which is the only expression of intuitionalism I have found among the sayings ascribed to Epictetus.

"Don't consider what others say, do or think, unless it is very necessary and for the common good." (Marcus Aurelius, Commentaries, iii, 4.) "Never labor without regard to the general interest." (do iii, 5.) "Choose the better part. But that which is useful is the better part." (do iii, 6.) "Let no act be done without a purpose." (do vi, 2, Long's translation.) "Do only what is useful to men." do iv, 12.) "Turn the present to profit by aid of wisdom and justice." (do iv, 26.) "How cruel it is not to allow men to strive after what seems to them natural and useful." (do vi, 27.) "Whatever I can do, ought to be directed to this end alone, usefulness to the community." (do vii, 5.) "A rational nature goes on its way well when it directs its movements only to actions universally beneficial, etc. (do viii, 7.) "Repentance is a kind of self-reproof for having neglected something useful." (do viii, 10, Compare Darwin, Descent of man I, 87.) "Let every action be a complete part of social life. Every act of thine, which has no immediate or ultimate reference to a public end, tears thy life asunder." (do ix, 23.) "Let there be effort and exertion resulting in acting for the common good, for this too is according to thy nature.") do ix, 31.) "If I remember that I am a part of the whole I shall do nothing unsocial, but shall turn all my efforts to the common interest." (do x, 6, Long, abridged.) "Thy charge is to provide in every way what is useful to the State." (do xi, 13.) "Our object should be the good of the State, and of mankind also." (do xi, 21.) "First, do nothing inconsiderately, nor without a purpose; Second, make thy acts refer to nothing else than a social end." (do xii, 20, Long.) "And anything which is useful to the universe, is always good and in season." (do xii, 23, Long.)

"The Stoics say that men are created for the sake of mankind, to be useful to each other. Thus we are commanded to follow nature in being mutually and universally useful." (Cicero de Officiis, i, 1, 5.) "Those in charge of public business should look at the advantage of the citizens, and consult that in all they do, forgetting their own interests. A public trust should be administered for the benefit of those giving it, not of him to whom it is given." (do., i, 25, 1 and 2.) "True philosophers have not neglected the advantage and interests of mankind." (do., i, 54, 1.) "Nothing does more to deprave human conduct, than the belief that anything is virtuous which is not virtuous." (do., ii, 3, 3.) "The

Stoics agree that whatever is virtuous is useful, and that nothing is useful which is not virtuous." (do., iii, 3, 4, and 4, 15.) "Panætius taught that virtue ought to be cultivated because it is the cause of utility, that it is never at variance with real but only with imaginary utility, that nothing is useful which is not also right, or right which is not also useful, and that no worse disease has ever invaded human life, than the theory which disjoined these two ideas." (do., iii, 3, 5, and 7, 6.) "The law of nature watches over and holds together the interests of mankind." (Do., iii, 6, 14.) "Duty is always performed when the advantage of mankind is consulted." (Do., iii, 6, 15.) "Although nothing is so contrary to nature as depravity, yet nothing is so much in accordance with nature as utility, and certainly depravity and utility cannot be found together." (Do., iii, 8, 2.) "This is the law of nature which you should obey and follow, that your interest is the universal, and the universal one your own." (Do., iii, 12, 7, and 6, 1.) "He is a good man who benefits as many people as possible and harms nobody." (Do., iii, 18, 9.) "Those who separate utility and morality overthrow the fundamental principles of nature. We all seek utility, are carried away by it, and cannot do otherwise. For who flees away from what is useful? Who does not rather pursue it most diligently?" (Do., iii, 28, 1, 2.) "Whatever is useful is virtuous, though it does not at first seem so." (Do., iii, 28, 9, and 30, 10.)

These quotations show how fully the Stoics recognized utility as the inseparable and characteristic result of virtue; though their position cannot be further explained, until we have considered their language about happiness and pleasure.

The following passages are in harmony with the two about happiness, already quoted from Seneca.

"All men wish to live happily but cannot discern the proper way." (Seneca, De Vita Beata, I. 1.) "To live happily is the same as to live according to nature." (do, do, 8, 3, also 3, 3, and Ep. 124, 7.) "He has reached the perfection of wisdom, who does not place his happiness in another's power." (do, Ep. 23, 2.) "Make yourself happy." (do Ep. 31, 9.) "All men seek happiness. In what do they err? In taking its conditions for itself." (do Ep. 44, 7.) "He who is not happy, has not attained the supreme good." (do Ep. 71, 18.) What is the business of virtue? A life truly prosperous." (Epictetus, Disc. I, 4, Higginson, p. 14) "Suppose then, I should prove to you that you are deficient in what is most necessary and important to happiness, and that hitherto you have taken care of everything rather than your duty." (do ii, 14, Higginson, p. 137.) "Show me some one who is always happy, for I long to see a Stoic." (do ii, 19) "You were not created to be degraded or miserable with others, but to be happy with them. For God made all men to enjoy happiness and peace." (do iii, 24, 1.) "Be contented with a sound mind and a happy life." (do iii, 24, 118.) "Our struggle is for prosperity and happiness itself." (do iii, 25.) "You have applied yourself to philosophy only in name, and have disgraced her principles, as much as you could, by showing that they are unprofitable and useless to those who study them. You have never made peace, tranquillity and equanimity the object of your desires." (do iii, 26, 13.) "What is the object you should seek except a happy life?" (do iv, 4, 4.) "Be mindful, morning, noon and night, that the only way to happiness is this." (do iv, 4, 39.) "Meditate upon your actions. What have I omitted that is conducive to happiness? What have I done contrary to the interests of my friends or of my race? (do iv, 6, 35.) "It is better that your servant should be bad than you unhappy." (do Enchiridion xii, Higginson, p. 379.) "To be happy is a good object and in your own power" (do Fragment, xix Didot.) "It is better to contract yourself within the compass of a small fortune and be happy, than to have a great one and be wretched." (do Frag. xxiv, Didot, xxi, Higginson.)

In the original of the last passage the verb is the one translated be of good cheer, or be merry, in our Bible, (Acts xxvii, 22 and 25; James v., 13.) and corresponding to the adverb rendered cheerfully (Acts xxiv., 10), as well as to the noun selected by Democritus, as the mark of the system thence called Euthumism by Miss Cobbe, (Essay on Intuitive Morals, p. 221.) and signifying "the pursuit of virtue for its intrinsic *i. e.* moral pleasure." In the other quotation from Stobæus, and in all those from the third book, the terms are those familiar ones, whose use by the ancient advocates of Utilitarianism, leads Miss Cobbe to call that system Eudaimonism, meaning "the pursuit of virtue for the sake of the extrinsic, affectional, intellectual and sensual pleasure resulting from it" (do. p. 219). In other passages, however, is found a word peculiar to the Stoics, who thought so much of happiness that they invented for it a new term, *Euroia.* Their views of this favorite idea appear nowhere more clearly than in a long passage of Epictetus (Discourses, book II, ch. xvii., Higginson, p. 151), where the student, who has learned to desire nothing but freedom from passion and trouble, is said to have passed through the first class in philosophy, whence he enters the second class in his desire to know his duties to foreigners, his country, his parents and the Gods. Thus the first degree in Stoicism was to make one's self happy, and the second to be useful to others; which second and higher degree is that mainly dwelt on by Cicero and Murcus Aurelius, as has been already shown.

The Tusculan Disputations and De Finibus of Cicero state at some length, that the Stoics agreed with the Peripatetics, Epicureans and other acknowledged Utilitarians, in honoring happiness as the greatest good and highest aim of man, and differed from them mainly in declaring that the sole and sufficient means of acquiring it was virtue, or, in other words, both active and submissive obedience to the commands, prohibitions and decrees of nature, their favorite watchword being "*sustine et abstine.*"

The peculiar bitterness of the controversy between the Stoics and Epicureans was partly due to the attempts made by the latter, to overthrow the established opinions about theology, politics and metaphysics, and partly to their assertions, that pleasure was not only the means but the synonyme of happiness, that the virtues are chosen for the sake of pleasure and not on their own account.*

It does not appear from Lucretius, Diogenes Laertius, or Cicero, that regard to any happiness but our own was ever inculcated by the Epicureans, and it is certain that they committed the dangerous error of using Greek and Latin terms for pleasure which have an extremely sensual signification, hedone being rightly translated lust in our New Testament, (Titus III, 3, James IV, 13,) and *voluptas* being used in a sense even grosser than that of our derivative voluptuous. Mr. J. S. Mill does not "consider the Epicureans to have been by any means faultless in drawing out their scheme of consequences from the utilitarian principle" (Utilitarianism p. 11;) Professor Bain "cannot but remark that the title or formula of the theory was ill chosen, and was really a misnomer,"

*See Diogenes Laertius, p. 470—3.

(Moral Science, p. 120.) Bishop Cumberland, one of the earliest modern advocates of the greatest happiness principle, attacks Epicurus and his followers vigorously, and two of the best known among the ancient expounders of that principle, Aristotle and Theophrastus, take similar ground, the former denying that pleasure is the chief good or synonyme of happiness and warning his disciples against snares, (Ethics II, 9, and X, 3,) while the latter speaks so strongly of the peculiar guilt of sins committed with pleasure, that his language is quoted with hearty approval by Marcus Aurelius (II, 10.) We should not therefore infer that the Stoics were not Utilitarians, because they opposed Epicureanism, which system indeed had become, before any exposition of their views now extant was written, little else than a cloak for indolence, servility, profligacy, and indifference to the claims of patriotism and philanthropy, as indeed the lives and writings of the best known of the successors of Epicurus prove only too plainly.

Marcus Aurelius, Epictetus and Seneca saw these facts so clearly, and loved practical morality so faithfully, as often to speak of pleasure with unqualified aversion. Seneca, however, frequently distinguishes the voluptas which is brevis, tenuis, corporalis, vana, nimia, poenitenda ac in contrarium abitura, from that which is vera, stabilis, naturalis, necessaria, in animo, etc., (De Vita Beata iv, 2; vi, 1; Ep. 18, 10: 21, 11; 78, 22;) and Epictetus uses hedone with similar caution (Disc. iii, 7.) These two terms are also employed in some remarkable passages which may be regarded as foreshadowing the discovery, now the bulwark of utilitarianism, that pains are the correlatives of actions injurious to the organism, while pleasures are the correlatives of actions conducive to its welfare. "Pleasures are the incentives to life-supporting acts, and pains the deterrents from life-destroying acts. (Herbert Spencer's Psychology, Ed. of 1872, Vol. i, p. 279-284.) With these statements should be carefully compared the following:

"Nature has mingled pleasure with necessary actions, not in order to have us seek after it, but that what we cannot live without may with this addition, become more attractive." (Seneca Ep. 116 3.) Pleasure is the companion, though not the leader, of a virtuous will. When virtue leads, pleasure follows like a shadow." (do, de Vita Beata, viii, 1 and xiii, 5.) "Our nature is to be free, noble and modest. And pleasure should be subjected to these virtues, as a servant and assistant, and sustain us in doing what is commanded by nature." (Epictetus, Discourses iii, 7. 28.) "We do not think that pleasure is commanded us by nature. but that it is a result of what is so commanded, namely. justice, temperance, and freedom." (do Fragment lii, Didot.)

Philosophers who speak thus cannot be charged with ignoring the value of pleasure, which indeed they sometimes acknowledge even more freely.

"Our pleasure is doing good." (Seneca, De Beneficiis iv, 13, 2.) "We shall not have any the less pleasure for giving virtue the precedence, but shall be its masters and governors." (do De Vita Beata xiv, 1.) "It is a great pleasure for me to think of the character of Scipio." (do Ep. 86, 5.) "I permit you to enjoy pleasures, which will come to you more plentifully if you rule them than if you obey them." (do Ep. 116, 1.)

Usually, however, terms, which denote only mental pleasure, like *gaudium, lœtitia* and various forms and derivatives of the verbs *chairo* and *euphraino* are preferred, of which common practice a few instances will be given.

"He has reached the height of wisdom who knows what to rejoice in. Learn this, first of all, O Lucilius." (Seneca Ep., 23, 2.) "I am not depriving you of many pleasures" (voluptates) "but desiring that joy may never fail you." (Do. Ep., 23, 3.) "Nothing which is not right can please anybody always." (Do. Ep., 20, 5.) "You can see that you are not yet sufficiently wise, for the wise man is always joyous. Joy belongs to him alone, and this is the reason that you should wish for wisdom." (Do. Ep., 59, see. 2, 14 and 16.) "The wicked find a fleeting pleasure in what gives the wise man enduring joy." (Do. Ep., 59, 24.) "It is right and natural for the good man to be joyful." (Do. De Ira, II, 6, 5.) "Enjoy the present and accept all things in their season." (Epictetus' Disc. IV, 4, 45.) "Take continual pleasure in passing from one philanthropic action to another, thinking of God." (Marcus Aurelius VI., 7.) "What remains, except to enjoy life by joining one good thing to another, so as not to leave even the smallest interval between." (Do., XII, 29. Long. See also VIII, 26, and X 33.)

The reader may charge the Stoics with self-contradiction in their language about mental pleasure, but he can find none in their refusal to admit bodily pleasure as a legitimate motive or as any part of happiness. Here, indeed, they differed from the Epicureans, but they agreed fully with the keen-sighted Peripatetics. The philosophers of both these schools were wise enough to know that the best way to be happy is to disregard bodily pains and pleasures, and cultivate self-control, kindness of heart, and nobleness of though. It was also characteristic of both Stoics and Peripatetics, though not of the Epicureans, to aim at universal, and not merely personal happiness, and to believe that virtue should be practised for its own sake, that is simply on account of its conformity with the laws of nature. Indeed, the Peripatetics charged the Stoics with stealing all their teachings, merely altering the terms, as thieves do the ear-marks of stolen cattle.*

The position that virtue is sufficient for happpiness, however, was confined to the Stoics, who further differed from the Peripatetics as did the Epicureans also, in refusing to accept the judgment of the wisest as the moral standard, and surpassed all other philosophers, not only in teaching disinterestedness, but in importing that regard for all the interests of their race which has since been called the enthusiasm of humanity.

Stoicism is thus seen to have preferred universal to individual happiness, disregarded bodily pleasures, demurred to accepting even mental ones as motives, believed in following virtue for her own sake, and placed morality on a disinterested basis, scarcely any of which views would be thought compatible with being utilitarian by those who, like Mr. Lecky, consider that term as a synonyme of selfish. Even he, however, makes some discrimination in favor of what he calls "the refined sensuality" of the Mills, Tucker and Austin, while Miss Cobbe distinguishes plainly between the two schools of Private and Public Eudaimonists, as she styles them, in a description much confused by her taking, as the representative of the last named class, Jeremy Bentham, who really belongs, with Paley, the French naturalists of the last century, and the Epicureans, among what we may call the self-regarding or individualistic Utilitarians, who did not believe in disinterestedness or in caring for others' happiness except as a condition of one's own. No wonder that Stoicism appeared trash to a man who finaliy discarded the last four words of his own famous formula, "the greatest hap-

* See Ac. Quaest. II 5. De Finibus II, 23, 27. III, 3. IV, 26, 28. V, 13, 16, 17, 25, 26, 29.

piness of the greatest number," and who, if we may trust the Deontology so far, even declared that "A man can no more cast off regard to his own happiness, meaning the happiness of the moment, than he can cast off his own skin."

The progress of psychology is rapidly destroying the arguments on which these egotists rested, and showing that the real representatives of Utilitarianism are those who, like Bain, Mill, Spencer and others of its most recent advocates, plant themselves on disinterested social sympathy so firmly, and teach regard to universal happiness so plainly, that they deserve no worse epithet than that of humanitarian or philanthropic. Their position is so little understood, that a few characteristic passages must here be quoted from the little book, called "Utilitarianism," by John Stuart Mill, published in 1863, and since reprinted among the Dissertations and Discussions.

"This it is, which, when once the general happiness is recognized as the ethical standard, will constitute the strength of the utilitarian morality. This firm foundation is that of the social feelings of mankind, the desire to be in unity with our fellow creatures, &c., (p. 45).

"Few but those whose mind is a moral blank, could bear to lay out their course of life on the plan of paying no regard to others except so far as their own private interests compels" (Do. end ch. iii., p. 50.) "The utilitarian standard is not the agent's own greatest happiness, but the greatest amount of happiness altogether" (Do. p. 16). The happiness which forms the utilitarian standard of what is right in conduct, is not the agent's own happiness, but that of all concerned. As between his own happiness and that of others, utilitarianism requires him to be as strictly impartial as a disinterested and benevolent specator. In the golden rule of Jesus of Nazareth, we read the complete spirit of the ethics of utility," (p. 24). "Utilitarianism could only attain its end by the general cultivation of nobleness of character" (p. 16). "It maintains not only that virtue is to be desired, but that it is to be desired disinterestedly, for itself" (p. 53). "Readiness to serve the happiness of others by the absolute sacrifice of his own, is the highest virtue which can be found in man" (p. 23). "Virtue in those who love t disinterestedly is desired and cherished, not as a means to happiness, but as a part of their happiness" (p. 53–4). "Virtue, above all things important to the general happiness" (p. 56).

With the above passages should be cited these two from the articles on Comte. " No one, who understands any morality at all, would object to the proposition that egoism is bound, and should always be taught to give way to the well understood interests of enlarged altruism. It is an error often, but falsely, charged against the whole class of utilitarian moralists " to require " that the test of conduct should also be the exclusive motive to it " (p. 125–6 of the Reprint).

Sir James Mackintosh also maintained (according to Bain's Moral Science, p. 264), that " the utility is the remote and final justification of all actions accounted right, but not the immediate motive in the mind of the agent."

These passages give, with but incidental differences, the views not only of Bain and Spencer, but of Hume, Locke and Cumberland, and with these philanthropic utilitarians, the Stoics and Peripatetics would have agreed much more readily than the Epicureans. The Stoical literature is especially rich in passages honoring the social feelings and teaching universal philanthropy.

" Nature endears man to man," (De officiis I. 44.) " Nothing is more natural to man than kindness," (do I, 14, 1.) "All men are plainly in union with each other," (do I, 16, 5.) "Knowledge is empty and isolated, unless accompanied by love of all mankind, and of universal brotherhood," (do I. 44, 8.) " The brotherhood of the whole human race is especially in accordance with nature." (do III. 5, 2.) They say that we should love our fel ow citizens, but not foreigners, destroy the universal fellowship of mankind, with which would perish kindness, benovolence and justice," (do III. 6, 6.) " The same law of nature joins us all together," (do III. 6. 3) " Care for other men and serve the human brotherhood," (do III. 12, 7.) "Nature has inclined us to love our fellow men, and this is the foundation of the law." (De Legibus 1, 15.) " Nature so endears us to each other that no man should ever be unfriendly to another, simply because he is a man," (De Finibus III. 19.) "Nature bids us prefer the general advantage to our own; for all the universe is one common city of men and gods," (do do.) " We are impelled by nature to benefit as many people as possible, born for human brotherhood, and joined together in one great community," (do 20.) "The aim of the Stoic is to be useful, not to himself alone but to all men, both collectively and individually,"(Seneca, De Clem. II. 5, 3.) "Guard religiously the bond which unites man to man and establishes the common rights of all the race," (do ep., 48, 3.) "Philosophy teaches reverence for the gods and love of man. (do ep., 90, 3.) "This is the rule of duty. Nature has made us kindred, implanted in us mutual love, and made us kindly affectioned, so that it is more painful for us to injure than to be injured. She bids our helpful hands be ever ready. Have this verse ever on your lips and in your heart. 'I am human, and I think no other man a stranger.' We are born to live together. Humanity is an arch which falls unless each part sustains the rest," (do ep. 95, 52, 3.) "The wise man thinks himself the citizen and soldier of the universe, and labors as if under orders." (do ep. 120, 12.) "I owe more to the human race than to any individual, (do De Ben., VII. 19, 9.) "Men by nature endeared to each other," (Epictetus III, 24. Higginson, p. 266.) "Man's nature is to be gentle and sociable, and to do good," (do IV. 1, 122, 6.) "I would have death find me doing something benovelent, public-spirited, noble. (do IV 10, 12.) "Nothing is nobler than magnanimity, meekness, and philanthropy," (do Fragment LI.) "I would lay aside all self love, (Marcus Aurelius, II. 5.) "Rational creatures exist for each other," (do IV. 3.) "The sole fruit of this earthly life is a pious disposition and philanthropic activity, (do VI. 30.) "Only what is useful to Rome and to the universe is useful to me," (do VI. 44.) "One thing here is of great worth, to live in fellowship with truth and justice, and yet be benovelent to liars and unjust men," (do VI. 47.) "It is peculiarly human to love even those who do wrong," (do VII. 22.) "Love mankind," (do VII. 31. "Benevolence to our fellow men is peculiarly human," (VIII. 26.) "It is not fit that I should give myself pain, for I have never given pain intentionally to anyone else," (do VIII. 42.) "Among the properties of the rational soul is love of one's neighbor," (do X. 1, 1.) "Have I done anything for the general interest? I have had my reward," (do XI. 4.)

No wonder that J. S. Mill calls the commentaries of Marcus Aurelius "the highest ethical product of the ancient mind." Indeed the writings of these two philosophers are admirably in harmony, like their lives.

It is true that before the discovery, but little more than a century ago, of the doctrine of association of ideas, so little was known of the process by which we rise, from desiring certain qualities, as means to happiness, to desiring them for their own sake, and recognizing them as virtuous, that the Stoics were obliged to content themselves with sometimes enjoining disinterestedness, but not giving any adequate reason, and sometimes demonstrating the tendency of virtue to produce happiness without showing how knowledge of this is compatible with the duty of being disinterested. Similar ignorance of the fact, perhaps never yet made sufficiently prominent, that no happiness can be universal, except that which consists mostly in the enjoyment of the higher pleasures, because these are the only ones which can become objects of common desire, without exciting general strife, compelled the defenders of the Portico to maintain that virtue was the only means of happiness, though they occasionally admitted that mental pleasure can become felicity. In the same way their lack of knowledge of the full psychological value of pleasure, as an indication of utility, as well as of the distinction afterwards made by Mill and Mackintosh, between taking utility as a test or as a motive, forced them either to deny as stoutly that it is the best motive as to disparage its value as a test, or else to use it as a test so inconsiderately as almost to sanction it as a motive. They stated all the facts in turn of the Utilitarian theory, as held by its most advanced modern advocate, but without being able to see the relations of these parts so accurately as to present the whole truth. Their zeal for practical moral culture and universal progress in virtue was another chief cause of these inconsistencies, which, indeed, in that age could scarcely be avoided, except either by the recklessness with which the Epicureans declared pleasure to be the best of motives as well as tests, and even in its grossest forms the equivalent of happiness, or by the insipid understatements which prevented the Peripatetics, despite the consummate genius of their mighty founder, from leaving any deep imprint, except his own, on either literature or history.

The fact that only one school of ancient philosophy was able to produce a crowded series of noble patriots and philanthrophists, among whom Tiberius Gracchus, Cato, Portia, Thrasea, Epictetus, Dion Chrysostom, the younger Pliny, Trajan, Antoninus Pius, and Marcus Aurelius are merely the best known instances, shows that stoicism was able to do the practical work of utilitarianism with a success so peculiar as scarcely to be compatible with serious defects in theory. But these heroes became martyrs so commonly, and uniformly struggled against tyranny and profligacy with such self-denial and self-devotion, as necessarily gave the Stoics a peculiar tendency to asceticism, which, indeed, never hindered their being studious, patriotic and philanthropic beyond comparison, but which often prevented them from weighing the worth of pleasure with scientific accuracy.

Of these struggles and martyrdoms, Mr. Lecky has given us so beautiful, and, despite mistakes, like calling Brutus a Stoic, so valuable a narrative in his History of European Morals, that it is all the more remarkable that he did not see how completely he has answered his own arguments against the value of utilitarianism, which fill a large part of his first volume, by showing, in the remainder of it, what a noble work was done by the obnoxious theory, in the ethical elevation and influence of the most zealous of its ancient advocates. Failure to see the resemblance of stoicism to utilitarianism is, however, to be expected from a writer who so far ignored the position of Mill, Bain, and Spencer, as to call the system, of which they were the leading expositors, selfish. And this failure was much more excusable in works written, like Miss Cobbe's essay on Intuitive Morals, before the broad school of happiness moralists had gained its present prominence. How early in life J. S. Mill accepted Epicurus as the first utilitarian in preference even to Aristotle, we need not inquire, nor how far this view was imbibed from Jeremy Bentham.

The common misunderstanding of the true relationship of the Stoics has been much promoted, among other causes, by the fact that, like other ancient philosophers, they paid such regard to what they called Nature, as to satisfy themselves with appealing to her fancied authority instead of pushing derivative analysis to the last results. Evidence has, however, already been offered to prove that in following Nature the Stoics not only conformed to the principal precepts of the most enlightened Utilitarians, but even used their method, so far as to call only useful qualities and actions natural, a term by which, indeed, they meant little more than that the origin of the claims of utility was a sacred mystery. Indeed, modern science has been obliged to exert all her powers in order to solve this mystery so far as to show that the enlargement and ennoblement of human happiness is the realization of all our finest impulses, dearest wishes and highest hopes.

Ancient philosophers, however, were so blinded by this illusion, as well as so ignorant of the real value of pleasure, that perhaps none of them can, in strictness, be called utilitarian, and it is scarcely worth our while to consider whether the title of founder of the greatest happiness theory should be given, on acount of priority of time, to Aristotle, rather than to either Epicurus or Zeno, or whether his claim also should yield to that of Socrates, whose regard for utility appears in many passages of the Memorabilia.

It is enough to say that the Stoics, despite their noble inconsistences, maintained the most important principles of Utilitarianism in such purity and power, that they must hold the highest place among its forerunners, if not among its originators. Recognition of this fact would not only encourage the use of their writings as introductions, and even in some respects as supplements to those of Mill and Spencer, but would help us value justly the system of philanthropic Utilitarianism by showing how much was done for moral culture by one of its rudimentary forms.

AN EXAMINATION OF PROF. S. H. CARPENTER'S POSITION IN REGARD TO EVOLUTION.

BY HERBERT P. HUBBELL, WINONA, MINN.

If we were called upon to define the position occupied by Dr. Carpenter, in his paper before the February meeting of the Academy of Science, Arts and Letters, we should say that he was an Evolutionist but not a Darwinian.

To make this distinction plain, and to show more clearly his position, we should say that an eyolutionist, as generally understood, is one who believes in evolution as taught by Spencer; that is to say, that matter, inorganic and organic, has arrived at its present degree of complexity by evolution from a simple state through a series of differentiations governed by some unknown law. That countless facts in nature substantiate this position, and that whilst recognizing the present state of nature as forming one extreme of the series, it finds, at present at least, in nebulous matter the other extreme.

Starting as it does with matter in its highest state of complexity it pursues it, by a process of strict inductive reasoning through its ever-varying phases of decreasing complexity until the mind loses itself in an an illimitable expanse of nebulous matter. Darwinism is an attempt to show that in so far as *organic* nature is concerned, evolution is dependent upon some *occult law of generation* co-operating with those conditions in nature necessary to its developmen. Evolution and Darwinianism, then, are in one sense materialistic; they deal wholly with the facts of nature and look to material causes to produce material effects. But Dr. Carpenter does not do this. Though he believes that in nature there is an evolution of matter, the recognition of this fact does not suffice: he goes *beyond* matter, beyond its nebulous state and finds there a Supreme Intelligence "which is the highest generalization of which matter and mind are capable of." This Intelligence, like all intelligences, must be, and is, governed by the laws of rationality, and must in its mental action, proceed either inductively or deductively. Constituting as it does the *highest* generalization, it is debarred from mental activity in the *inductive* direction, and is, consequently, obliged to manifest itself *deductively*. But mind is subjective. It can only manifest itself objectively, and hence, *matter* is such objective manifestation. Matter, therefore, on this hypothesis becomes nothing but the symbol of thought. The Supreme mind manfesting itself according to deductive laws proceeds in a series from the simple to the complex. Hence, matter symbolizing this thought will proceed in the same manner. Differentiations then in matter are not due to generative forces residing in the organism but to thought existing in the supreme mind. And thus it is that Dr. Carpenter is an Evolulionist but not a Darwinian.

The key-stone of Dr. Carpenter's logic is found in a Supreme Intelligence,—not the Supreme Intelligence as generally conceived, but as specially conceived by men, that is to say, as being the highest possible generalization—as governed by the same rational laws that govern us—and as manifesting his thoughts in material forms. It is evident that the surest way to weaken this logical structure will be to weaken this conception.

Let us grant that the mind must proceed either deductively or inductively, the question arises which process has precedence. Is it possible to reason deductively before we have inductively arrived at our deductive stand point, or to reason inductively before we have deductively reached our induction stand point? or in other words do we reason naturally from the particular to the general or from the general to the particular? A moments consideration will inform us that before we can reason deductively, we must have reasoned inductively. The growth of the child's mind is the natural growth, and it is from the individual to the general. The individual facts begin to form into groups of animate and inanimate, and these into subordinate groups, and these into others; there is in fact a constant sinking of individual characteristics into those that are specific, and of these latter into those that are generic, and of these into broader divisions, and thus, step by step, the highest generalization of which matter is capable is reached, which is, as Dr. Carpenter truly says, the highest knowledge. No deductive standpoint, therefore, can be reached save only through induction; but once attained through the instrumentality of a *few* facts, we may use the deductive method to discover the *many*.

"Complete generalization is complete knowledge" not because the generalization contains the *potential* attributes necessary to constitute individualities, but because it is the generalization *stripped* of its individualizing attributes. The individual must exist before the genus, there can be no generalization unless there be a preceding individualization. The individual is lost in the species, the species in the genus, the genus in the order, the order in the class, and the class in the kingdom. The two kingdoms, vegetable and animal, have properties in common which classify them as organic. Organic and inorganic bodies have elements in common which unite them under the head of matter. Matter has weight and density and dimension; if we rise in our generalization we must in some measure eliminate these properties —these individualities. In order to do this we conceive of matter reduced to a state of the greatest rarity—as filling all space—as being, in fact, a homogeneous, illimitabie, imponderable, chaotic mass. But let our conceptions be at their best we must still think of matter as having limits, elements and a degree of density. Our highest generalization is reached when we think of matter as existing in this nebulous state.

Now, conceive a Supreme Intelligence, and what is the effect in our mind? Immediately, our conceptions from being most indistinct and general, are concentrated upon one object having many attributes. For we cannot think of intelligence apart from mind, of mind apart from body, of body apart from members and of members apart from functions. In what sense then can the Supreme Intelligence be considered the "highest generalization," surely not in a logical one, for instead of widening our generalization it narrows it. Following the strict rules of inductive reasoning we *must* stop with *nebulous matter*. A Supreme Intelligence is *not* a higher generalization. If sought by reason at all it must be *teleologically* and not by the rules of induction.

Assuming, however, that the Supreme Intelligence exists and that it is absolutely the highest generalizatiou possible, are we to consider it as a generalization containing *potential* individualizations, or as a generalization *stripped* of its individualizing attributes? It is evident from Dr. Carpenter's reasoning that he considers it the former, whereas, if it could be reached by a process of inductive reasoning, as he assumes, it is equally evident that it would be the latter. Can we conceive of a *Supreme* intelligence as being subject to the laws of mental growth—of being wiser to-day than yesterday? Is not the wisdom infinite, and the same yesterday, to-day and forever? How then can we conceive of *potentialities?* Or on the other hand can we think of any attributes which could be added to it? Is not the Divine mind perfect in all things so far as our conceptions go? How, then, if we can conceive of nothing which can be added to it, can we conceive of it as existing *stripped* of attributes? The Supreme Intelligence is not a generalization, but is, on the contrary, so to speak, *a strongly individualized human intelligence.* Every mental faculty which we possess we conceive as being held by the Divine Mind in a perfected state. Wisdom, knowledge, justice, in infinite completeness go to make up our conception of God. If we increase in wisdom, knowledge and justice, we advance towards him; that is to say, the more strongly individualized our minds become, the nearer do we approach in likeness unto God. But if God were the "highest generalization" the more individualized we became the farther would we be from Him, and this is doubtless a result which Dr. Carpenter would be among the last to desire.

"If the Supreme Intelligence is to communicate with man," says Dr. Carpenter, "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 error, (for we think there is one,) which lurks in this assumption is the error of all theologians, and forms the basis of all their reasonings and of all their conceptions; viz: That man is the *object* of creation—the *end sought* through the formation of matter, and that the Supreme Intelligence is desirous of conveying his thoughts to the consciousness of man. Dr. Carpenter had just been speaking of the purely subjective nature of the conceptions of the artists, and that it was necessary before those conceptions could be communicated to others, that they should, through the instrumentality of the canvas or the marble, seek an objective expression, and to follow this remark with that above quoted is to place the Supreme Intelligence in the artist's position with conceptions to communicate, and implies, before they can be communicated, an objective medium and another consciousness to which the communication is to be made. If man is the highest product of matter—of creative forces—and if we assume a Supreme Intelligence, then the *object* of creation, if discoverable at all, is discoverable by man, or at least it is complete in him. But if, taking the other view, we look upon man as but a link in the chain of being—if we conceive of the forces of nature which in the past have evolved a higher type of matter as working for the same end to-day, our thoughts cease to dwell upon the present, and project themselves into a distant, but ever-perfecting future. The imperfections which surround us and which are the stumbling-blocks in the way to our conception of a *perfect* God, fade out, in the evolving ages, and the mind rests in the thought of a coming time when the divine idea shall be accomplished and when the mysteries which now shroud all things shall have passed away and the "glory of the Lord" shall be revealed.

Prof. Carpenter admits an evolution of matter; he even admits that man is the highest product of evolution; he believes that the supreme intelligence existed alone in his own consciousness, and that before he could exist in any other consciousness he must seek an *objective* material medium through which to express himself. If the supreme intelligence is purely *subjective*, as Dr. Carpenter claims, then anything external to and apart from that intelligence must be *objective*. Man, then, whether considered as matter or mind, is objective. The object of creation, according to Dr. Carpenter, is to communicate subjectivity to subjectivity through objectivity, or in other words the divine conceptions to consciousness through matter. But human consciousness, as we have just seen, is objective to the divine consciousness; hence, the object of creation is not to communicate subjectivity to subjectivity, but subjectivity to objectivity through objectivity, which is nothing more than saying that man is but one of the nicer touches from the hand of the painter; one of the finishing strokes from the hand of the sculptor; one of the pages from the book of the thinker. God is the artist, the universe, the canvas, and man but a pigment which, with other material, goes to further the divine conception.

If matter is objective and the expression of thought, then man, being matter, is objective and an expression of thought. If he is an expression of thought he stands in the same relation to the supreme intelligence that any expression of thought stands. Every object in nature, on Dr. Carpenter's hypothesis, is an expression of thought. Man, then, bears to the supreme intelligence the same relation that any animal or any plant bears. That relation is inscrutible. and so is the relation of man.

We believe in a Supreme Intelligence, and we believe in Evolution. We also believe that evolution in nature exists because the Supreme Intelligence has willed that it should exist; but we cannot believe with Dr. Carpenter that it exists, because there was no other way by which the Supreme Intelligence could manifest itself. For this would be to prescribe bounds for that which is infinite. It is true that we cannot think of God as a rational being without thinking of him as governed by the laws of rationality, nor can we think of Him as a just God. without being governed by the laws of justice, nor can we think of Him as possessing any mental attribute without thinking of the law governing the manifestation of it. Yet these conceptions of God ,are but human, they are efforts of the finite to measure the Infinite, and taking them at their best, our reason tells us that they fall far short of God himself. It is true that in nature there is such an orderly sequence of events, that in recognizing it, we call it law, but to say that this law exists because God designed it, and to say that it exists because a rational God cannot manifest himself in any other way, are two very different things. Nor can we see, if the Supreme Intelligence is governed by the law of rationality, and if it manifest itself in material form, why there should be such enormous intervals of time between the different steps in the divine consciousness as is evidenced by the physical symbols. For if evolution in matter is but the reflection of evolution in the Divine mind, as Dr. Carpenter teaches, then evolution in both is simultaneous. There could, consequently, have been no conception of *man* in the Divine consciousness before his advent physically—for his advent physically is but the reflection of an evolved conecpt in the Divine mind. There could, therefore, have been no *plan* of creation embracing man, for man is the *last* of the series—is the complex as opposed to the simple—the particular as opposed to the general. But the last term in a deductive series must be reached by the law of rationality, that is to say, it must be derived from the first term by a differentiating process, consisting in the addition af attributes not found in the preceding terms. According to Dr. Carpenter, if man had been conceived by the Divine consciousness it must have been by some rational process and such process would have been immediately symbolized in matter. But because it was *not* thus symbolized we are bound to believe that no conception of man existed in the Divine mind until the time of his physical advent.

But we cannot assent to this conclusion; we prefer to believe that before the nebulous mist arose, there existed in the Divine Consciousness a perfect conception of creation—the end to be compassed, and the means to accomplish it. That when the fiat went forth, matter became endowed with certain principles which, acting constantly and uniformly, have evolved the countless forms that people the universe; and that they will continue to be evolved until the divine conception is wrought out. We recognize the *genetic* force as one of those principle; we recognize the tendency of organisms occasionally to depart slightly from their parent forms as the natural result of this principle; we can believe a departure from this departure as natural; and if we recognize two variations, we can recognize a third—a fourth—and any number. We can conceive it possible that a departure, and a continnal redeparture from the parent form might give rise to varieties so different as to be classed as species; we can conceive of species varying to such a degree as to constitute genera; and we can conceive of this "functional impulse" working through countless ages with ever varying effects, as redounding more to the wisdom and glory of God than any number of *successive creations*, be they of the nature of distinct fiats, or the symbols of evolution in the Divine Consciousness.

SECTION OF THE

Mathematical and Physical Sciences.

Title of Paper read before this Section.

Recent Progress in Theoretical Physics. By John E. Davies, A. M., M. D. Professor of Physics in the University of Wisconsin.

RECENT PROGRESS IN THEORETICAL PHYSICS.

BY JOHN E. DAVIES, A. M., M. D.,
Professor of Physics in the University of Wisconsin.

The present paper is the first of a series intended to give, in a collected and condensed form, the results of recent *theoretical* advances in the Physical Sciences. The researches by which these advances have been made are partly experimental and partly mathematical. Some of them are most lucidly presented by Prof. P. G. Tait in his "Recent Advances in Physical Science," while those which I shall present are only briefly mentioned by him, or else are omitted altogether. Prof. Tait, however, alludes to those which he does mention, in such terms as to imply that he regards them, nevertheless, as of the greatest importance, and to be omitted chiefly on account of want of time.

A complete review of these researches would include Clausius' remarkable theorems upon the mechanics of a great number of molecules, and Boltzmann's results in the same direction, together with their application to the theory of heat; the studies of Helmholtz and Thompson upon the vortex motion of fluids and their analogues among magnetic forces and electric currents; Thompson's explanation of the magnetic rotation of the plane of polarization of circularly polarized light, first experimentally shown by Faraday; the experimental researches of Jamin, Rowland, Stoletow, Bouty, and others, in magnetism; Rankine's hypothesis of molecular vortices; Clerk Maxwell's wonderful electro-magnetic theory of light, with the experimental researches thereon by Boltzmann and others; the explanation of anomalous dispersion by Ketteler of Bonn; the mathematical relations of vibratory and translatory motions in fluids, by Challis; the explanation of the blue color and polarization of the sky by Lord Rayleigh; as also his remarkable results upon Resonance and Sound generally; the mathematico-physical discoveries of Kirchoff; the Kinetic Theory ot Diffusion, Conduction and Radiation by Maxwell; the thermo-electrical researches of Tait; and many other researches as well, all tending to the simplification and unity of the Physical Sciences, by showing a probable similarity or identity of cause for the most diverse phenomena.

In the present paper I shall merely *begin* with certain remarkable relations between the formulæ of electro-magnetism and those of fluid motion, first pointed out, so far as I know, by Helmholtz.*

VORTEX MOTION.

In magnetism we have the following formula for the value of V the SCALAR POTENTIAL of a magnet of finite dimensions

$$V = \int\int \frac{6}{r} dS + \int\int\int \frac{9}{r} \, dxdydx \qquad \text{A.}$$

x, y, and z, being the coordinates of any point of the magnetic mass,

6, being what is called the surface density of the magnetic matter, and,

9, the volume density of the same.

The surface density 6, is the resolved part of the intensity of magnetization in the direction of a normal to the surface of the magnet, and the volume-density 9, is what Maxwell has designated as the " convergence " of the magnetization at a given point within the magnet.

This expression for V is similar to that for the *electric* potential at any point, due to the electrification of a body on whose surface there is electricity of density 6, and within its substance a bodily electrification whose density is 9. In both cases, V satisfies Laplace's equation for points outside of the electrical or magnetic mass, and Poisson's equation for points inside of the same. That is, for the first case,

$$\frac{d^2 V}{dx^2} + \frac{d^2 V}{dy^2} + \frac{d^2 V}{dz^2} = 0 \qquad \text{B.}$$

* In the paper as read before the Academy, a somewhat complete synopsis was given of Thompson's explanation of Faraday's experiment on the Magnetic Rotation of Polarized Light; of Clerk Maxwell's Electro-magnetic Theory of Light; and of the Hypothesis of Molecular Vortices. Many points, also, only briefly summarized in this printed paper were elaborated by oral explanations and diagrams, and the terms used in the paper were for the most part carefully defined.

and, for the second case,

$$\frac{d^2V}{dx^2}+\frac{d^2V}{dy^2}+\frac{d^2V}{dz^2}=-4\pi^*\rho \qquad \text{C.}$$

The ordinary magnetic and electric forces are derived from these potentials by the application of Hamilton's operator,

$$\nabla = i\frac{d}{dx}+j\frac{d}{dy}+k\frac{d}{dz};$$

that is, to find the magnetic or electrical attraction or repulsion along a line, we take the differential coefficient of the potential (magnetic or electrical) with reference to the direction of that line. For ordinary magnets the potential V, is single-valued for any given point of space; for electro-magnets V is many-valued like $\tan^{-1}\frac{y}{x}$ having, in fact, an infinite series of values at any given point; these values differing by $4\pi^*i$ where i is the intensity, or strength of the electric current in the electro-magnetic wire.

Carefully to be distinguished from V is another quantity, which, in the case of *solenoidal* distributions of magnetism at least, also fulfills Laplace's Equation. This quantity may be designated by I.

I is a quantity so related to the magnetization that, calling the components of the latter in three directions at right angles to each other, A, B, and C, we have

$$A=\frac{dI}{dx}, \qquad B=\frac{dI}{dy}, \qquad C=\frac{dI}{dz}. \qquad \text{D.}$$

I, which determines the *magnetization (not the magnetic force)* at any point, is called the Potential of Magnetization.

But, besides the SCALAR (or *non-directed*) POTENTIAL, V, and the Potential of Magnetization, I, mentioned above, we have, when considering not only the magnetic *force* but likewise also the magnetic *induction*, a VECTOR (or *directed*) POTENTIAL. The magnetic *induction* is derived from this VECTOR POTENTIAL in a precisely similar manner to the derivation of the magnetic *force* from the SCALAR POTENTIAL, namely: by the application of Hamilton's operator ∇.

If three quantities F, G, and H, be regarded as the components, in three directions, at right angles to each other, of the *scalar*

*Owing to the want of Greek type the printer has placed this letter n to represent 3.1416 the ratio of the circumference of a circle to its diameter.

potential V, then these quantities will satisfy the following conditions:

$$\frac{dH}{dy} - \frac{dG}{dz} = 0; \quad \frac{dF}{dz} - \frac{dH}{dx} = 0; \quad \frac{dG}{dx} - \frac{dF}{dy} = 0. \qquad \text{E.}$$

But if F, G, H, be taken to represent the components of the *vector-potential*, they will satisfy the conditions

$$\frac{dH}{dy} - \frac{dG}{dz} = \text{a}, \quad \frac{dF}{dz} - \frac{dH}{dx} = \text{b}, \quad \frac{dG}{dx} - \frac{dF}{dy} = \text{c}, \qquad \text{F.}$$

where a, b, c, are the components of the magnetic induction. In words, the line integral of the *vector-potential* round a closed curve representing any circuit, is numerically equal to the surface-integral of the magnetic induction over a surface, bounded by the curve representing the circuit.

We have also, if **a**, **b**, **c**, represent components of magnetic force, and u, v, w, components of electric current,

$$4\pi^* u = \frac{d\mathbf{c}}{dy} - \frac{d\mathbf{b}}{dz}$$

$$4\pi^* v = \frac{d\mathbf{a}}{dz} - \frac{d\mathbf{c}}{dx} \qquad \text{G.}$$

$$4\pi^* w = \frac{d\mathbf{b}}{dx} - \frac{d\mathbf{a}}{dy}$$

as the equations of electric currents: or, in words, the line-integral of magnetic force *round* a closed curve is numerically equal to the current *through* the closed curve multiplied by $4\pi^*$.

The values of F, G, H, are also given by the following equations

$$F = \frac{1}{\text{M}} \iiint \frac{u}{r}\, dx\, dy\, dz$$

$$G = \frac{1}{\text{M}} \iiint \frac{v}{r}\, dx\, dy\, dx \qquad \text{H.}$$

$$H = \frac{1}{\text{M}} \iiint \frac{w}{r}\, dx\, dy\, dz$$

where M is the quantity known as the *specific inductive capacity* of a medium, or its *permeability* to magnetic lines of force.

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*The letter π is put for 3.1416.

The components of the vector-potential are related to those of the scalar-potential as follows:

$$\frac{dH}{dy} - \frac{dG}{dz} = - \frac{dV}{dx} = \mathbf{a}$$

$$\frac{dF}{dz} - \frac{dH}{dx} = - \frac{dV}{dy} = \mathbf{b} \qquad \text{I.}$$

$$\frac{dG}{dx} - \frac{dF}{dy} = - \frac{dV}{dz} = \mathbf{c}$$

a, **b**, **c**, being as before the components of magnetic force, derived from the scalar-potential V by differentiation along x, y, z.

The components of the electric current, u, v, w, are known to satisfy the condition

$$\frac{du}{dx} + \frac{dv}{dy} + \frac{dw}{dz} = 0.$$

The components of magnetic induction a, b, c, also satisfy a similar equation

$$\frac{da}{dx} + \frac{db}{dy} + \frac{dc}{dz} = 0.$$

On a careful study of these formulæ, which have been deduced for the potentials and forces of ordinary magnets and electro-magnets, we are impressed with their similarity to the formulæ that express the ordinary motions of an incompressible frictionless fluid. For example, in fluid motion, where u, v, and w, represent the component velocities of an element of the fluid in three rectangular directions, and D represents the density of the fluid, we have the following so-called "Equation of Continuity" of the fluid:

$$\mathrm{D}\left\{\frac{du}{dx} + \frac{dv}{dy} + \frac{dw}{dz}\right\} + \frac{d\mathrm{D}}{dt} + \frac{d\mathrm{D}}{dx}.u + \frac{d\mathrm{D}}{dy}.v + \frac{d\mathrm{D}}{dz}w = 0. \qquad \text{J.}$$

This equation is proven for ordinary motions of fluids, in all works upon the dynamics of fluids. It is merely an analytical statement that in all motions of fluids, however they may expand or contract, and move about in currents or otherwise, there is no change in the *mass* of the fluid caused by such motions. If the fluid be incompressible, there can also be no variation in its *density*, caused either by its own motions or by the lapse of time. Then. the total differential of D in the preceding equation, will be *zero*, and there will be left

$$\frac{du}{dx} + \frac{dv}{dy} + \frac{dw}{dz} = 0, \qquad \text{K.}$$

which is the simplified form of the "equation of continuity" for in-incompressible fluids. Equation (K), is an equation of condition which all incompressible fluids are required to fulfill.

If u, v, w, be made to depend upon the variations of a quantity Q, such that

$$u = \frac{dQ}{dx}; \qquad v = \frac{dQ}{dy}; \qquad w = \frac{dQ}{dz}; \qquad \text{L.}$$

we may call Q the *velocity potential* of the velocities u, v, and w; be-cause it is a quantity the first differential co-efficient of which along a line, x, y, or z, gives the velocity of the fluid along that line. This quantity Q, must, in incompressible fluids, which, since u, v, w, as has been said, satisfy Equation (K), therefore also give

$$\frac{d^2Q}{dx^2} + \frac{d^2Q}{dy^2} + \frac{d^2Q}{dz^2} = 0; \qquad \text{M.}$$

or, in other words, like the scalar magnetic and electric potential V, or the potential of magnetization I, it must satisfy Laplace's equation.

Returning to magnets, and electro-magnets, we have seen that the general expression for the value of the *potential* of any magnet of finite dimensions, at any point in space whose co-ordinates are x', y', z', is, designating the potential by V,

$$V = \iint \frac{6}{r} dS + \iiint \frac{9}{r} dxdydz$$

where the surface part of the integral extends over the whole *surface* of the magnet, designated by S, and the solid part of it (every element of which $= dx, dy, dz$) extends to all portions *within* the surface.

$r =$ the distance from the magnet to the point, x^1, y^1, z^1, where the value of V is taken;

$I = lA + mB + nC$ *i. e.*, the intensity of magnetization *normal* to the surface of the magnet; because

A, B, and C, represent the intensities of the magnetization, along the three co-ordinate axes; and

l, m, n, are the direction-cosines with reference to these axes, of a normal to the surface.

6 is often called, as was said before, the surface-density of the magnetic matter; and

9 = interior-density of magnetic matter;—9 is also

$$=\left(\frac{d\,A}{dx}+\frac{d\,B}{dy}+\frac{d\,C}{dz}\right)=\ 0,$$

when the magnetization is *solenoidal.*

Now, since A, B, C, are the *components of the magnetization* of the magnet, if we take a quantity I such that

$$\frac{d\,\mathrm{I}}{dx}=\mathrm{A}\ ;\qquad \frac{d\,\mathrm{I}}{dy}=\mathrm{B}\ ;\qquad \frac{d\,\mathrm{I}}{dz}=\ \mathrm{C};$$

then, also, as was said before, I may be called the *potential of magnetization*, and it is evident that when the magnetization is *solenoidal*, we shall here also have the condition

$$\frac{d^2\mathrm{I}}{dx^2}+\frac{d^2\mathrm{I}}{dy^2}+\frac{d^2\mathrm{I}}{dz^2}=0 \qquad \mathrm{N}.$$

as in the case given above, [Equation (M)], of the *velocity potential* of fluid flow.

Hence the velocities u, v, w, in the case of fluid flow in incompressible fluids, are the analogues of the electric and magnetic forces in free space, and of the *components of magnetization* in the case of solenoidal magnets. At least, all three sets of quantities are subject to the same analytical conditions. I the Potential of Magnetization gives,

$$\frac{d^2\mathrm{I}}{dx2}+\frac{d^2\mathrm{I}}{dy^2}+\frac{d^2\mathrm{I}}{dz^2}=0.$$

Q, the Velocity Potential of an incompressible fluid, gives

$$\frac{d^2Q}{dx^2}+\frac{d^2Q}{dy^2}+\frac{d^2Q}{dz^2}=0.$$

V, the electric potential gives

$$\frac{d^2V}{dx^2}+\frac{d^2V}{dy^2}+\frac{d^2V}{dz^2}=0.$$

In magnetic and electric distributions, the rate at which V varies along a line, determines the electric or magnetic force in free space along that line.

In magnetization, the rate at which I varies along a line, determines the intensity of the magnetization, at any given point within the magnet, in the direction of that line.

In fluid motion, the rate at which Q varies along a line, determines the velocity of the fluid, at any given point, in the direction of that line.

In the case of ordinary fluid motion, moreover, if the conditions

$$u = \frac{dQ}{dx}; \qquad v = \frac{dQ}{dy}; \qquad w = \frac{dQ}{dz}; \qquad \text{O}$$

hold true, then also we have the conditions

$$\frac{du}{dy} - \frac{dv}{dx} = 0; \qquad \frac{dv}{dz} - \frac{dw}{dy} = 0; \qquad \frac{dw}{dx} - \frac{du}{dz} = 0; \qquad \text{P}$$

as is well known.

We have seen [Eqs. (D) and (E] that precisely similar conditions obtain in the case of ordinary distributions of electricity and magnetism, so long as we confine ourselves to the space outside of that which contains the so-called magnetic or electric matter.

The motions of fluids heretofore discussed in treatises on the dynamics of fluids are such as fulfill the conditions imposed by equations (O) and (P.) They are motions of translation, or of expansion and contraction; oscillatory movements being merely periodic movements of translation, of greater or less extent. All such motions have assumed for them a *velocity potential*, the differential coefficients of which with reference to the coordinates, are the component velocities of the fluid in the direction of the coordinates.

The assumption of a velocity potential necessitates the set of conditions given above in equations (O) and (P.)

But Helmholtz in a remarkable memoir on "Integrals Expressing Vortex Motion" to be found translated by Prof. Tait, in the Philosophical Mag., for 1867, has shown that these conditions *do not hold* if there be some of the elements of the fluid in rotation. In such cases if w^1, w^2, w^3, represent the angular velocities of the rotating fluid element about the coordinate axes, then we have

$$\frac{du}{dy} - \frac{dv}{dx} = 2w^3$$

$$\frac{dw}{dx} - \frac{du}{dz} = 2w^2 \qquad \text{Q}$$

$$\frac{dv}{dz} - \frac{dw}{dy} = 2w^1$$

For these cases there is *no* velocity potential. "It is only when there is no velocity potential that some fluid elements can rotate and that others can move round along a closed curve in a simply-connected space."

Helmholtz calls the motions that have no velocity potential, generally, *vortex motions.*

He shows that in a frictionless fluid, these vortices when once instituted in the fluid, have a wonderful tenacity of existence; that they may go on widening, changing their form under the influence of other vortices, moving about, attracting and repelling each other in consequence of combining their motions; and that they may play amongst themselves all sorts of fantastic games, yet preserve unchanged their identity and living force (i. e. their kinetic energy) so as to be the very types of the unchanging atoms of matter, which are never destroyed.

One simple instance of Helmholtz' results I will state, to make the matter plain. If there be, for example, a single circular vortex ring set up in an indefinitely extended fluid, the center of gravity of the section of the ring (section supposed small) will have from the commencement an approximately constant and very great velocity parallel to the axis of the ring, and this will be directed toward the side *to which* the fluid flows through the ring.

Two ring-formed vortex-filaments having the same axis would mutually affect each other, since each, in addition to its own proper motion has that of its elements of fluid as produced by the other. If they have the same direction of rotation, they travel in the same direction; the foremost ring widens and travels more slowly, the pursuer shrinks and travels faster, till finally, if their velocities are not too different, it overtakes the first and penetrates it. Then the same game goes on in the opposite order, so that the rings pass through each other alternately. If they have equal radii and equal and opposite angular velocities, they will approach each other and widen one another. So also one will widen on coming to a fixed wall. "The motions of circular vortex rings can be studied by drawing rapidly for a short space along the surface of a fluid a half immersed circular disk, or the nearly semi-circular point of a spoon, and quickly withdrawing it. There remain in the fluid half-vortex rings whose axis is in the free surface. These vortex rings travel and widen when they come to a wall, and are widened or contracted by other vortex rings exactly as deduced from theory."*

In this memoir it is also demonstrated that *the product of the velocity of rotation into the cross section of a vortex-filament is constant throughout the whole length of the filament.* Moreover, that a vortex-filament can never end within a fluid, but must either return ring shaped into itself within the fluid, or reach to the boundaries of the fluid.

Precisely similar theorems had been announced by Sir Wm. Thompson in a paper on the Mathematical Theory of Electro-Magnetism in 1847.† Thompson, in this paper, designates the *strength* of an electric current by C‡, and then says: "In a continuous current this quantity is of course *the same for every section;* and, as it is impossible that a continuous stream of electricity can emanate from one body, and be discharged into another, the current must be *re-entering*, or every continuous current must form what is called "a closed circuit." It is found by experiment that whatever be the dimensions or material of the different parts of the conductor along which the current flows, provided always the dimensions of the section be small compared with the distances through which the electro-magnetic action is observed, the quantity C has the same value for all parts of it; and even in the places where the electro-motive force operates, as has been shown by Faraday, as in the liquid of any ordinary galvanic battery, or in a conductor in motion in the neighborhood of a magnet, the electro-magnetic effects are observable, and, probably to exactly the same degree; so that it would probably be found that a galvanic circuit, consisting of a battery of small cells, arranged in a circular arc, and a wire completing the circuit by joining the poles, would produce the same electro-magnetic effects at all points symmetrically situated with reference to the circle, irrespectively of the part of the circuit, whether the cells or the wire; provided always, that the distances considered be great, compared with either the dimensions of a section of the wire, or of any of the cells made by planes perpendicular to the plane of the circle, through its center."

* Professor Tait's book on "The Recent Advances in Physical Science" has two figures, one showing how these vortex rings can be produced, and the other what he directions of rotation and movement will be in a ring once formed.

† See Thompson's "Reprint of Papers on Electro-Statics and Magnetism"—p. 409 et seq.

‡For current strength Thompson uses the Greek letter *gamma*.

The precise character of the movement within the wire, is also shown to be entirely irrelevant in this estimate of the current strength. For "in the theory of electro-magnetism it is unnecessary to adopt any such hypothesis as this [that the electric current consists of matter flowing,] however probable or improbable it may be as an ulterior theory; and all that we could introduce as depending upon it is that, for a linear circuit of varying section or material, the quantity $\mathfrak{C}$ is the same throughout the circuit, and that all finite circuits possessing continuous currents are necessarily closed; two facts which cannot be assumed *a priori*, but which are in reality established by satisfactory experimental evidence."*

$\mathfrak{C}$, the current strength here alluded to, is the product of the so called *intensity* of the current, into the area of the cross-section of the conductor. It may be measured of course by the work it will do in a definite time, either as electrolysis, heat, or other form of work. Helmholtz' angular velocity of the vortex-filament in a fluid, affords a means of forming a mental conception of intensity of current, in electricity, by assimilating it to the rotatory energy in a vortex-filament, which is far superior to any of the illustrations ordinarily used; and this without in any way necessarily implying that the electric current actually involves such rotating elements, although this may really be.

As a linear electro-magnet is completely specified when the form of the closed curve of the current, and $\mathfrak{C}$, the strength, are given; so also a vortex filament is completely specified when the form of its axis and the product of its angular velocity into the area of its cross section are given.

In electro-magnetism we have $iA=i'A'$ for the same circuit. In vortex filaments $qA=q'A'$ for the same filament; q being the angular velocity; $A, A,'$ areas of cross sections; i,i', current intensities. In electricity, magnets are known to circulate around current-conducting wires, and wires reciprocally around magnets. In fluids, vortex-filaments that are straight circulate around each other and their mutual center of gravity; vortex filaments that are circular also revolve around each other, as is shown by the peculiar action described above where the rings alternately pass through each other, by contracting and accelerating their speed, and then widening and moving slower, while the one following contracts and passes through in turn.

* Reprint—p. 410

Helmholtz further shows, in the memoir above alluded to, how to find the velocities, u, v, w, of any portion or element of the fluid when we know w^1, w^2, w^3, the angular velocities of a vortex-filament established in it, by the following method:

Let there be given within a mass of fluid which includes the space S, the values of w^1, w^2, w^3, satisfying the "equation of continuity"

$$\frac{dw^1}{dx} + \frac{dw^2}{dy} + \frac{dw^3}{dz} = 0. \tag{1}$$

Also, u, v, and w, must satisfy a similar equation,

$$\frac{du}{dx} + \frac{dv}{dy} + \frac{dw}{dz} = 0. \tag{2}$$

And likewise also, these conditions,

$$\frac{dv}{dz} - \frac{dw}{dy} = 2w^1; \quad \frac{dw}{dx} - \frac{du}{dz} = 2w^2; \quad \frac{du}{dy} - \frac{dv}{dx} = 2w^3. \tag{3}$$

The conditions for the bounding surface S are supposed to be given according to the particular problem. a, b, c, can be taken as the three angles made with a normal to the surface S; q as the *resultant* angular velocity of the three components w^1, w^2, w^3; T, the angle between the normal to the surface S and the axis of the rotating filament; then we shall have

$$w^1 \cos a + w^2 \cos b + w^3 \cos c = q \cos. T = 0.$$

over the whole of this surface S, or if this surface S cuts any of the vortex-filaments, over the whole of some larger surface S', which includes all the filaments, and their continuations, if there be any in the first surface S.

Now we can find values of u, v, and w, satisfying equations (2) and (3), if

$$\begin{aligned} u &= \frac{dP}{dx} + \frac{dN}{dy} - \frac{dM}{dz} \\ v &= \frac{dP}{dy} + \frac{dL}{dz} - \frac{dN}{dx} \\ w &= \frac{dP}{dz} + \frac{dM}{dx} - \frac{dL}{dy} \end{aligned} \tag{4}$$

and if the functions L, M, N, and P, be taken so as to satisfy also within the larger space S', the couditions

$$\frac{d^2L}{dx^2} + \frac{d^2L}{dy^2} + \frac{d^2L}{dz^2} = 2w^1$$

$$\frac{d^2M}{dx^2} + \frac{d^2M}{dy^2} + \frac{d^2M}{dz^2} = 2w^2$$

$$\frac{d^2N}{dx^2} + \frac{d^2N}{dy^2} + \frac{d^2N}{dz^2} = 2w^3 \qquad (5)$$

$$\frac{d^2P}{dx^2} + \frac{d^2P}{dy^2} + \frac{d^2P}{dz^2} = 0$$

The analogy of these equations (5) to Poisson's equation (C) is at once apparent if

$$-\frac{w1}{2\pi}^{*}; \qquad -\frac{w2}{2\pi}; \qquad -\frac{w^3}{2\pi};$$

be each taken equal to ρ. L, M, N, are quantities which satisfy the same equations as the *vector potentials* of electric currents. They stand in the same relation, in vortex fluid motion, to the angular velocities of the *core* of the vortex filament, as do in electricity the vector-potentials of electric currents, to what might guardedly be called the *mass* of the currents which give rise to these potentials; thus again showing the help we may derive in our notions of electrical strength, mass, density, or whatever we choose to call it, by comparing the "current-penetrated space," to the *core* of a vortex filament. It moreover prominently calls our attention to what may be going on in the space outside the wire, as well as in the substance of the wire itself. Indeed, if r be the distance of a point a, b, c, from a point x, y, z, on the axis of a vortex-filament; and if w^1_a, w^2_a, w^3_a, be the values which w^1, w^2, w^3, have at this point, a, b, c, then we will have

$$\mathrm{L} = -\frac{1}{2\pi}^{*}\iiint\frac{w^1_a}{r}dadbdc$$

$$\mathrm{M} = -\frac{1}{2\pi}^{*}\iiint\frac{w^2_a}{r}dadbdc \qquad (6)$$

$$\mathrm{N} = -\frac{1}{2\pi}^{*}\iiint\frac{w^3_a}{r}dadbdc$$

* π represents the ratio 3.1416.

Equations which are analogous to equations (H), and which suggest that, since $-\frac{1}{2\pi}$* here takes the place of $+\frac{1}{M}$ in those equations, M, or the *magnetic permeability*, may be equal to w^1, w^2, w^3, divided by 9, generally, while here definitely equal to the constant 2π*.

That equation (2) *is* satisfied by the values of u, v, and w given above in equations (4) is shown by differentiating equations (4) and adding; we thus get

first $\frac{du}{dx}=\frac{d^2P}{dx^2}$; $\frac{dv}{dy}=\frac{d^2P}{dy^2}$; $\frac{dw}{dz}=\frac{d^2P}{dz^2}$;

then, on adding

$$\frac{du}{dx}+\frac{dv}{dy}+\frac{dw}{dz}=0.$$

That equations (3) are likewise satisfied, is also shown by differentiating equations (4), and then making the necessary subtractions; noticing the values $2w^1$, $2w^2$, $2w^3$, given by equations (5).

We thus get:

$$\begin{aligned} \frac{dv}{dz}-\frac{dw}{dy}&=2w^1-\frac{d}{dx}\left\{\frac{dL}{dx}+\frac{dM}{dy}+\frac{dN}{dz}\right\} \\ \frac{dw}{dx}-\frac{du}{dz}&=2w^2-\frac{d}{dy}\left\{\frac{dL}{dx}+\frac{dM}{dy}+\frac{dN}{dz}\right\} \qquad (7) \\ \frac{du}{dy}-\frac{dv}{dx}&=2w^3-\frac{d}{dy}\left\{\frac{dL}{dx}+\frac{dM}{dy}+\frac{dN}{dy}\right\} \end{aligned}$$

which, if the second terms of the second members are zero, show equations (3), and likewise equations (Q), to be completely satisfied.

That these second terms *are* zero is shown by first differentiating equations (6) with respect to x, y, and z successively; thus getting results of the form

$$\frac{dL}{dx}=+\frac{1}{2\pi^*}\iiint\frac{w_a^1\,(x-a)}{r^3}\,da\,db\,dc$$

for each coordinate. And then, on integrating these latter results by parts, we get the following three equations:

$$\begin{aligned} \frac{dL}{dx}&=\frac{1}{2\pi}\iint\frac{w_a^1}{r}\,db\,dc-\frac{1}{2\pi}\iiint\frac{1}{r}\cdot\frac{dw_a^1}{da}\,da\,db\,dc \\ \frac{dM}{dy}&=\frac{1}{2\pi}\iint\frac{w_a^2}{r}\,da\,dc-\frac{1}{2\pi}\iiint\frac{1}{r}\cdot\frac{dw_a^2}{db}\,da\,db\,dc \qquad (8) \\ \frac{dN}{dz}&=\frac{1}{2\pi}\iint\frac{w_a^3}{r}\,da\,db-\frac{1}{2\pi}\iiint\frac{1}{r}\cdot\frac{dw_a^3}{dc}\,da\,db\,dc \end{aligned}$$

*The letter π represents the ratio 3.1416.

which, if added, and dS be put for the element of surface, give

$$\frac{dL}{dx}+\frac{dM}{dy}+\frac{dN}{dz}=\frac{1}{2\pi}\iint\left\{w_a^1\cos.a+w_a^2\cos.b+w_a\cos.c\right\}dS$$
$$-\frac{1}{2\pi}\iiint\frac{1}{r}.\left\{\frac{dw_a^1}{da}+\frac{dw_a^2}{db}+\frac{dw_a^3}{dc}\right\}da\,db\,dc.$$

In the second member of this last equation the factors in parentheses in each of the two terms, are known to be equal to zero; consequently,

$$\frac{dL}{dx}+\frac{dM}{dy}+\frac{dN}{dz}=0.$$

Therefore the equations

$$\frac{dv}{dz}-\frac{dw}{dy}=2w^1;\qquad \frac{dw}{dx}-\frac{du}{dz}=2w^2;\qquad \frac{du}{dy}-\frac{dv}{dx}=2w^3;$$

give correctly the relations between the angular velocities of the core of a vortex-filament, and the velocities in the fluid at points outside of, but surrounding the core.

The values of L, M, N, taken from equations (6), being substituted in equations (4), give certain results, the interpretation of which will appear from the next paragraph. These results are

$$\Lambda^u(x-a)+\Lambda^v(y-b)+\Lambda^w(z-c)=0, \qquad (9)$$

indicative of a right angle with r;

$$w_a^1\Lambda^u+w_a^2\Lambda^v+w_a^3\Lambda^w=0, \qquad (10)$$

indicative of a right angle with the axis of the rotating filament;

$$\sqrt{(\Lambda u)^2+(\Lambda v)^2+(\Lambda w)^2}=\frac{dadbdc}{2\pi r^2}.\ q.\sin V; \qquad (11)$$

and

$$qr.\cos V=(x-a)w_a^1+(y-b)w_a^2+(z-c)w_a^3 \qquad (12)$$

Where q is the resultant of w_a^1, w_a^2, w_a^3, and V the angle which q makes with the radius-vector r.

Now it is proven in works on electricity and magnetism* that "the vector-potential *at a given point*, due to a magnetized particle placed at the origin of co-ordinates, is numerically equal to the magnetic moment of the particle, divided by the square of the radius vector to the point, and multiplied by the sine of the angle between the

* Clerk Maxwell's "Electricity and Magnetism," Vol. ii., p. 28.

axis of magnetization and the radius vector; and the *direction* of the vector-potential is perpendicular to the plane of the axis of magnetization and the radius-vector, and is such that to an eye looking in the positive direction along the axis of magnetization, the vector-potential will be drawn *in the direction of rotation of the hands of a watch.*" The results just referred to above, show that the distance-action of vortex-filaments is similar to the electro-magnetic action of current-conducting wires; for they prove that "*each rotating element of fluid* (a) *implies in each other element* (b) *of the same fluid mass, a velocity whose direction is perpendicular to the plane through* (b) *and the axis of rotation* (a). *The magnitude of this velocity is directly proportional to the volume of* (a), *its angular velocity, and the sine of the angle between the line* (a) (b) *and that axis of rotation, and inversely proportional to the square of the distance between* (a) *and* (b)."

Thus the vector-potential of the electric-current, in free space surrounding the wire, has for its analogue the velocity of the fluid element, due to a vortex-filament supposed to occupy the place of the current.

Many other curious analogies between vortex-motions in fluids and the action of magnets and electric currents have been pointed out by Sir Wm. Thompson.*

Of course it is possible that these analogies may be merely formal, and that they arise from the fulfillment of similar mathematical conditions by both the electric current and vortex-motion in fluids.

But whether the relationship shall or shall not ultimately be found to consist in a closer connection than mere formal analogy, one thing is certain. The discovery of the laws governing vortex-motion in fluids constitutes an era in physical science. The differential equations of the motions of fluids although handled by such masters as LaGrange, LaPlace, Euler, and Green, had only been integrated on the special assumption of a velocity-potential; which condition we have seen to hold only in the space outside of those portions ot the fluid which are in rotation. It remained for Helmholtz to make the next great step by integrating these equations under the supposition that no velocity-potential exists; and to show that while the establishment of vortex-motion in fluids, is, on the one hand, a consequence of fluid friction, on the other, that when vortex-fila-

* Sir Wm. Thompson's "Papers on Electrostatics and Magnetism."

ments are once set up in a frictionless fluid they are absolutely indestructible save by the power that originated them. Only an infinite power can set up vortex movement in a perfect fluid without friction, and only an infinite power can destroy such motion when once set up. On this idea Sir Wm. Thompson has based his famous speculation that the *atoms* of matter are merely so many vortex-rings of variable but definite shape for each elementary kind of matter. Such rings possess all the qualities usually attributed to the atoms of matter, being absolutely impenetrable, and possessing when set in vibration that characteristic periodicity of vibration which the spectroscope shows to be the case with the atoms of the elements of matter. As Professor Tait says, "not only can these vortex-rings in a perfect fluid not be cut, but we cannot even so much as get at them, to try to cut them." They rebound from the sharpest edge.

Thus it will be seen that there is at least *an analogy* between vortex-filaments in a perfect fluid and magnetism caused by electric currents. The equations of the electro-magnetic field show this, when compared with the equations of vortex filaments. But this is by no means all.

In Faraday's beautiful experiment of the rotation of the plane of polarized light when passing through a medium which is under the influence of magnetic strain, we have a means of *testing* whether anything of the nature of rotation of small elements, either of gross matter or of some incompressible frictionless fluid be going on in the magnetic field. For, if the magnetic force be in any way the consequence of such minute rotations, we might expect *a priori* that the minute motions which cause light, at least those circular oscillations that constitute circularly polarized light, could in some way be compounded with the minute rotations involved in magnetic phenomena, and be influenced by them. And thus, although we could not directly observe these vortex movements by the senses, we yet might have the means of exploring the magnetic field, by an agent of almost superhuman delicacy in the shape of the oscillations of light. The possibility of the compounding of the magnetic rotations with those of circularly polarized light, which constitutes the explanation Thompson gives of the Magnetic Rotation of Polarized Light, I will take up next.*

* This subject was fully treated in the paper as read before the Academy, but its publication is delayed until cuts can be prepared to illustrate it, and Greek type obtained for the formulæ.

PROCEEDINGS

OF THE

ACADEMY,

SINCE

FEBRUARY, 1874.

Report of the President.

HIS EXCELLENCY HARRISON LUDINGTON,

Governor of Wisconsin:

SIR:—Since the date of my last report, the Wisconsin Academy of Sciences, Arts, and Letters has steadily advanced in prosperity. It has not made large additions to its permanent fund, nor greatly increased the list of its working members. But the very considerable number of scholars and scientists holding memberships, have devoted themselves with increased zeal to the work of the work of the Academy in original investigation, and have produced papers embodying the results of their inquiries which are of considerable value, and must yet more favorably commend the Academy to the respect and confidence of the literary and scientific public.

The Academy is no longer an experiment. The past six years have demonstrated; first, that Wisconsin embraces a large number of persons both competent and experienced as laborers in various fields of research and investigation; and secondly, that it is posible and easy, through such an organization as this, to hold them together in systematic and profitable oc-operation, for the advancement of the arts and sciences, as well as for the intellectual and social progress of the commonwealth.

The present volume of transactions will be found to consist largely of papers in the Department of the Natural Sciences. While all are interesting and valuable, it will appear upon examination that some of these are the fruit of extensive observations in the field, as well as of laborious investigations in the laboratory. Since it is this department which so directly touches the material progress of the State, and which would also especially contribute to the establishment of advantageous relations with kindred organizations in all parts of the world, it will be to the friends and patrons of the academy a ground of satisfaction that its development has been characterized by so strong a bent in this particular direction.

In the other departments there have been fewer laborers. Still, it will not escape observation that many of the best thinkers and investigators of the State have given to the Academy the results of careful and protracted inquiry in the several fields embraced within the broad domain of the Academy.

In this country, Speculative Philosophy finds comparatively little recognition as a means of scientific progress, and is therefore without the cultivation it merits. Nevertheless, it is not without creditable representation in this, as it was not in our last volume of Transactions.

The Department of Social and Political Sciences embraces so vast a range of subjects for inquiry, and appeals so directly and strongly to the public mind that a more rapid growth of it might reasonably have been expected. It is not wanting in activity, however, and gives promise of more substantial progress in the future, through the reinforcements likely to come to it from the learned professions and from special students of Social Philosophy, and of statesmanship.

The Department of Letters is also in need of reinforcements. The contributions heretofore made have been both interesting and valuable, however; some of them justly insuring commendation from distinguished European savans.

At the late annual meeting, the department of the arts was divided into the "Department of Practical Arts" and the "Department of the Fine Arts." Neither of these has yet received much development. Still it is believed that the creation of separate departments will prove advantageous. There are numerous inventors, scientific artizans and practical observers and experimenters in Wisconsin, who, if brought together within the pale of a department of the Academy exclusively devoted to the progress of the useful arts, would make it eminently successful. So, too, there are artists and cultivators of art in sufficient number, if united, to make the Department of the Fine Arts at once a means of mutual advantage, and of increasing art culture in the State, as well as of initiating the formation at the seat of the Academy, and in joint connection with it and the State University, of a Gallery of Art, coupled with an Academy of Design.

Leaving out of view the present paucity of artists within our own State, and the difficulty, supposed to be necessary, of finding adequate patronage outside of the cities, there could hardly be found anywhere in this country, a more suitable or more desirable spot for an institution of the kind suggested. And even the objection alluded to would affect only such artists as are limited to one or two of the several branches of art. The landscape painter, the historic artist, and the idealist in either painting or sculpture, would each find themselves happily placed here, in an exceptionally pure atmosphere, in a region remarkable for its healthfulness, and in the midst of scenery unparalled for beauty. As this is a matter in which the Academy, the State University, artists of the Northwest, and the friends of Art generally, must all feel an interest, we are not without hope that practical results of some importance will follow the effort thus systematically begun.

The Library of the Academy is under the management of a competent and zealous librarian, through whose efforts it must make steady, if not rapid growth. As was stated in my first report (for 1870-'72) it has not been, and is not now, the purpose of the Academy to build up a general library, separate and distinct from that of the State Historical Society, which is fast becoming the great general library of the State, but rather to supplement the forces therein at work by efforts to make collections especially rich in the publications of learned, scientific and other kindred societies and associations of all countries, and in works generally which properly belong to the several departments embraced within the Academy, and which are not likely to be supplied otherwise. Large results in this direction have not been accomplished, but the agencies are at work, and will yield fruits more abundant as the years go on. Regarding the Academy from this standpoint, it is quite desirable that its Transactions should be published annually, instead of biennially; for such more frequent publication would render it easier to effect exchanges with other institutions of like character, as well as with the periodical press of the world.

The Museum of the Academy is making more growth than outwardly appears. For, owing to the connection of several of the members most active in making collections, with the Geological Survey, now in progress, much of the material which would otherwise have come directly to the Museum, has very naturally and properly gone to the State Geologist, for classification, and has not as yet reached its final destination under the law creating the survey, which provides that specimens of all the material collected during its progress shall be deposited with the Academy. It may also be remarked that the officers of the Academy are yet expecting that large contributions will soon be made to the Museum from the considerable number of private collections heretofore formed within this State.

The report of the treasurer, herewith incorporated, sets forth the financial transactions of the Academy for the years 1875 and 1876, together with the condition of its funds at the date of the last annual meeting, just concluded:

WISCONSIN ACADEMY SCIENCE, ARTS AND LETTERS,
TREASURER'S OFFICE,
MADISON, *February* 13, 1877.

Hon. J. W. HOYT, *President:*

I have the honor to report the financial condition of the Academy, as follows:

Total amount of fees and dues received from 58 members	$778 25
Total fees received from 10 life members	1,000 00
Interest on loan	370 00
	2,148 25
Total amount disbursed in payment of warrants to date	777 97
Balance in treasury	1,370 28

GEO. P. DELAPLAINE,
Treasurer.

The following is a list of the papers read since the date of our last publication:

"Views connected with the Railroad Question," by Rev. Chas. Caverno.

"On Industrial Education," by Rev. F. M. Holland.

"A Mastodon found in Racine County," by Dr. P. R. Hoy.

"A Turtle Mound found in Beloit," by Prof. Eaton.

"The Improvement of the Mouth of the Mississippi River," by Capt. John Nader.

The "Elementary Stratification of the Lower Silurian Rocks in South-Central Wisconsin," by Prof. R. D. Irving.

The "Hibernation of the Striped Gopher," by Dr. P. R. Hoy.

"The Law of Embryonic Development the same in Plants as in Animals," by Dr. I. A. Lapham.

"Were the Stoics Utilitarians?" by Rev. F. M. Holland.

"On the Ancient Civilization of America," by Prof. Nicodemus.

"An Account of Recent Examinations of the Ancient Earthworks in Rock county, Wis.," by W. P. Clark, Esq.

"Drift-notes," by Prof. Eaton.

"Minority or Proportional Representation," by Rev. F. M. Holland.

"On the Fishes best suited to stock the small lakes of Wisconsin," by Dr. P. R. Hoy.

"Oconomowoc Lake," by the late Dr. I. A. Lapham.

"On United States' Sovereignty; whence derived and when vested," by Prof. Allen.

"The Barometer in Leveling," by Capt. Nader.

"On River Engineering," by Capt. Nader.

"The Instrument of Exchange," by President G. M. Steele.

"The Inter-convertible Note Scheme," by E. R. Leland, Esq.

"The Kaolin of Wisconsin," by Professor Irving.

"The Revolutionary Movement Among Women," by Dr. J. W. Hoyt.

"An Account of the Aid Rendered by Various Governments to Science and Education," by James D. Butler, LL. D.

"Geological Reconnoisances in Northern Wisconsin," E. T. Sweet, M. S.

"The Encouragement of Art Culture by the State," by Dr. J. W. Hoyt.

"Some new and Remarkable Features of the Lower Magnesian Limestone, and St. Peter Sandstone in Eastern Wisconsin," by Prof. T. C. Chamberlain.

"The Origin of the Present-Infinitive-Passive in Latin and Greek," by Prof. Feuling.

"The Significance of Faraday's Experiment upon the Magnetic Rotatory Polarization of Light; and upon Helmholtz Paper on the Integrals of Vortex Motion; also upon the Theory of Magnetism," by Prof. Davies.

"On Duplex Telegraphy," by Chas. H. Haskins.

In the confident belief that the Academy has before it a career of great usefulness, and that to this end it will be more and more encouraged by an intelligent public, as well as liberally fostered by the State, I have the honor to be, in its behalf,

Very respectfully,

JOHN W. HOYT,
President.

Madison, February, 1876.

Report of the Secretary.

SPECIAL MEETING OF THE ACADEMY.

September 16, 1874.

The members of the Academy met in their rooms at 7½ P. M. The following resolutions were passed:

Resolved, That we sincerely lament the death of John Y. Smith, in whom our Society has lost an active and honored member, and the science of political economy one of its most devoted and useful followers.

Resolved, That the President of the Academy be requested to appoint a member of the Academy to prepare a sketch of his life and works

Resolved, That these resolutions be published in each of the daily papers of this city, and that the General Secretary be requested to forward a copy of these proceedings to the family of the deceased.

The President of the Academy eulogised highly the merits of the deceased member.

The death of Prof. Peter Engelman, of Milwaukee, was announced by Dr. I. A. Lapham, who pronounced a high elogium upon the scientific character of the deceased.

The following resolutions were also passed:

Resolved, That in the death of Prof. Peter Engleman the Academy has lost a valued member, and the cause of education one of its most active promoters.

Resolved, That the President of this Academy is hereby requested to appoint some member to prepare, for the next regular meeting of the Academy, a memoir of his life and labors.

Resolved, That these resolutions be published in the Proceedings of the Academy.

The Treasurer of the Academy, G. P. Delaplaine, Esq., called the attention of members to a remarkable mound, supposed to be very ancient, in the vicinity of the city of Madison.

Prof. Nicodemus, of the State University of Wisconsin, Dr. I. A. Lapham, of Milwaukee, Geo. P. Delaplaine, Esq., of Madison, and Prof. Irving, of the University, were appointed a committee to investigate the mound and furnish to the Academy a report thereon, at an expense to the Academy not exceeding $25.00.

JOHN E. DAVIES,
General Secretary.

FIFTH REGULAR ANNUAL MEETING.

First Session.

ACADEMY ROOMS, Feb. 9, 1875, 7½, P. M.

The fifth annual meeting of the Academy was commenced in their rooms on Tuesday evening, February 9, 1875, at 7½ o'clock; there being a large attendance of members and citizens; the President, Dr. J. W. Hoyt, in the chair; the Secretary, Prof. J. E. Davies. absent by reason of severe illness.

In the absence of the secretary, Prof. James Eaton, of Beloit College, was appointed secretary *pro. tem.*

The treasurer's report was read and referred to an auditing committee consisting of Prof. Nicodemus, Dr. Hoy, and Elisha Burdick, Esq.

The librarian's report was read and accepted.

The rules were suspended and Messrs. E. T. Sweet, R. H. Brown, J. T. Dodge, and Charles N. Gregory were elected annual members.

The first paper of the meeting was read by the Rev. Charles Caverno, on "Views connected with the Railroad Question."

Twenty-three members were present at this meeting of the Academy.

Second Session.

FEBRUARY 10, 9.45 A. M.

During the absence of the President, the chair was occupied by I. A. Lapham, Vice-President of the Academy.

The report of the secretary was read.

The following papers were read and discussed:

On "Industrial Education," by Rev. F. M. Holland, of Baraboo.

"A Mastodon found in Racine County," by Dr. P. R. Hoy, of Racine.

Dr. Holland called attention to a number of bones of a Mastodon found in Baraboo thirty years ago.

A paper was read on "A Turtle Mound in Beloit," by Prof. Eaton of Beloit.

E. R. Leland, of Eau Claire, read a memoir upon the late Peter Engelman, of Milwaukee, a member of this Academy.

Adjourned till 2:30, P. M.

Third Session.

FEBRUARY 10, 2:30, P. M.

The Academy met pursuant to adjournment, with a large attendance.

Dr. I. A. Lapham, Vice-President, in the chair.

Papers were read as follows:

On the "Improvement of the Mouth of the Mississippi River," by Capt. Nader.

On "The Elementary Stratification of the Lower Silurian Rocks in South-Central Wisconsin," by Prof. Irving.

On "The Hibernation of the Striped Gopher," and on "The Catocalae of Racine County," by Dr. Hoy, of Racine.

On "The Law of Embryonic Development, the same in Plants as in Animals," by Dr. I. A. Lapham, of Milwaukee.

The committee appointed to audit the Treasurer's Report gave in their report, which was read and accepted.

The meeting then adjourned till 7:30, P. M.

Fourth Session.

FEBRUARY 10, 7:30 P. M.

The Academy met pursuant to adjournment; with a full attendance.

Prof. S. H. Carpenter, Vice President in the chair. Papers were read as follows:

"Were the Stoics Utilitarians?" by Rev. F. M. Holland of Baraboo.

On "The Ancient Civilization of America," by Professor Nicodemus, of the University of Wisconsin.

"An account of Recent Examinations of the Ancient Earthworks in Rock county, Wisconsin," by W. B. Clark Esq.

"Drift notes" by Prof. James Eaton.

SIXTH ANNUAL MEETING.

First Session.

ACADEMY ROOMS, Feb. 8, 1876, 7:30 P. M.

The sixth annual meeting of the Academy was convened in their rooms on Tuesday evening February 8th, 1876, at 7½ o'clock; there being a large attendance of members and citizens of Madison; the President, Dr. J. W. Hoyt, in the chair.

The minutes of the last previous meeting were read by the Secretary and approved.

After a few remarks by the President of the Academy, on the general progress and success of the Academy during the year, the reports of the Secretary, Treasurer, and Librarian of the Academy were read, accepted and referred to appropriate committees.

The President of the Academy announced that the Hon. George H. Paul, of Milwaukee, Railroad Commissioner for Wisconsin had consented to donate $100 to the Academy, and thereby become a Life Member.

The following gentlemen were elected members.

For Corresponding Members.—Dr. Joseph Buchanan of Louisville, Ky., and S. W. Burnham Esq., Chicago, F. R. A. S. London.

For Annual Members.—E. E. Woodman, Esq., of Baraboo, Wis.; Prof. W. C. Sawyer, of Appleton, Wis.; Hon. Peter Doyle, Secretary of State for Wisconsin; C. H. Haskins, Esq., of Milwaukee, Gen'l. Supt. Northwestern Telegraph Co.; Right Rev. E. R. Welles of Milwaukee, Protestant Episcopal Bishop of Wisconsin; Hon. Harlow S. Orton, of Madison; Gen. E. E. Bryant, of Madison; Hon. S. U. Pinney, of Madison; Hon. J. C. Gregory, of Madison; Rev. John Wilkinson, of Madison; Samuel Shaw, Esq., Principal of High School, Madison; J. W. Wood, Esq., Baraboo; J. O. Culver, Esq., Madison; S. G. Lapham, Esq., of Milwaukee; E. S. Searing, Esq., of Madison; Hon. I C. Sloan, of Madison; Josiah E. Cass, Esq., of Eau Claire; E. A. Birge, State University; T. G. Atwood, Esq., Albion, Wis; J. W. Stuart, Esq., of Madison.

Dr. P. R. Hoy, of Racine, Chairman of the committee appointed to prepare a sketch of the life and character of Hon. I. A. Lapham, LL. D., late Vice President of the Academy, read an exceedingly interesting paper upon the general life and scientific labors of Dr. Lapham. Dr. Hoy feelingly referred to a friendship prolonged for over thirty years. He summed up the important labors of Dr. Lapham by reading the following letter from Prof. Joseph Henry:

SMITHSONION INSTITUTE,
Washington, Feb. 3, 1876.

DR. P. R. HOY, Racine, Wis.:

DEAR SIR: Your letter was received during a great pressure of business, and I now embrace the first opportunity to give it a reply.

The action of Congress in regard to the signal service was due to the immediate exertions of Mr. Lapham through the member of Congress from his district, General Payne, in setting forth the advantages of the system to the commercial interests of the great lakes.

Yours very truly,

[Signed.] JOSEPH HENRY.
Secretary.

E. R. Leland, Esq., of Eau Claire, spoke very eloquently of the virtues, public and private, of the deceased Vice-President, whom he had known intimately for many years.

Remarks were also made by Prof. T. C. Chamberlain, of Beloit, Dr. Lapham's successor as Director of the Geological Survey, of the State, and R. D. Irving, Professor of Geology in the University of Wisconsin.

Dr. S. H. Carpenter, Professor of Logic and English Literature in the University of Wisconsin, read an admirable review of the life, mental characteristics, and writings of the late Hon. John Y. Smith. Dr. Carpenter showed him to be a man of unusual power of mind and great clearness of thought. Prof. W. F. Allen, Professor of Latin and History in the University of Wisconsin, also added his testimony to the statements made in Dr. Carpenter's paper.

A paper upon "Minority or Proportional Representation," by Rev. F. M. Holland, of Baraboo, was then read by Prof. Allen.

Adjourned till Wednesday morning, 9 a. m.

Second Session.

WEDNESDAY MORNING, 9½, o'clock, February 9, 1876.

The Academy met pursuant to adjournment; the President Dr. J. W. Hoyt in the chair. The following papers were then read:

"On the Pre-Historic Copper Implements found in Wisconsin," by James D. Butler, LL. D., of Madison." This paper was read by Professor W. W. Daniells, of the State University of Wisconsin.

"On the Fishes best suited to stock the small lakes of Wisconsin, by Dr. P. R. Hoy, of Racine. Dr. Hoy also read a paper on the Oconomowoc Lakes," prepared by Dr. I. A. Lapham, just before his death.

"United States Sovereignty—whence derived and where vested," by Professor W. F. Allen, of the State University."

"The Barometer in Leveling," by Captain John Nader.

"On River Engineering," a translation from the German, by Captain John Nader, of Madison.

Adjourned till 2½ P. M.

Third Session.

WEDNESDAY AFTERNOON, 2½ P. M.—Feb. 9, 1876.

The Academy met pursuant to adjournment, the President Dr. J. W. Hoyt in the chair. The following papers were then read and discussed:

"On the Instrument of Exchange," by G. M. Steele, DD., President of Lawrence University.

"The Interconvertible Note Scheme," by E. R. Leland, Esq., of Eau Claire.

"On Kaolin in Wisconsin," by Professor R. D. Irving, of the University of Wisconsin.

The Academy then adjourned until 7½ o'clock P. M.

Fourth Session.

FEBRUARY 7th, 7½ o'clock P. M.

The Academy met pursuant to adjournment, the president Dr. J. W. Hoyt in the chair.

Dr. P. R. Hoy then made some popular remarks on the "General Classification of Animals."

Dr. J. W. Hoyt then read a carefully prepared paper on "The Revolutionary Movement among Women."

Adjourned 9 A. M.

Fifth Session.

THURSDAY, February 10, 9 A. M.

The Academy met pursuant to adjournment. The President Dr. J. W. Hoyt in the chair. The following papers were then read and discussed.

"An Account of the aid rendered by Various Governments to Science and Education," by James D. Butler, LL. D.

"Geological Reconnoisances in Northern Wisconsin," by Mr. E. T. Sweet, Assistant on the Geological Survey.

"The Encouragement of Art Culture by the State," by Dr. J. W. Hoyt.

"On some new and remarkable features of the Lower Magnesian Limestone, and St. Peter's Sandstone in Eastern Wisconsin, by Prof. T. C. Chamberlin, Director of the Geological Survey.

Adjourned till 2 o'clock P. M.

Sixth Session.

MONDAY, February 10, 2 o'clock P. M.

Academy met pursuant to adjournment. President J. W. Hoyt in the chair. The following papers were then read and discussed.

"The origin of the Present-Infinitve-Passive in Latin and Greek." by Prof. J. B. Feuling Ph. D., of the University of Wisconsin.

"The Significance of Faraday's Experiment upon the Magnetic Rotatory Polarization of Light," by Prof. J. E. Davies, M. D., of the State University.

"Helmholtz' Paper upon the Integrals of Vortex Motion; and the significance of these Integrals in the theory of Magnetism," by Prof. Davies.

"On Duplex Telegraphy," by Charles H. Haskins, General Superintendent of the Northwestern Telegraph Company, Milwaukee.

The reading of the papers prepared for this meeting having been concluded, the Academy prepared to ballot for the election of officers for the next three years.

The following gentlemen were unanimously elected.

For President, P. R. Hoy, M. D. Racine.

For General Secretary, J. E. Davies, M. D., Madison.

For Vice President of Department of Speculative Philosophy, S. H. Carpenter, LL. D., Madison.

For Vice President of Department of Natural Science, Prof. T. C. Chamberlin, Beloit.

For Vice President of the Department of Social and Political Sciences, Rev. G. M. Steele, D. D. Appleton.

For Vice Presidentof the Department of the Mechanic Arts, Hon. J. I. Case Racine.

For Vice President of the Department of Letters, Rev. A. L. Chapin, D. D. Beloit.

For Vice President of the Department of the Fine Arts, Dr. J. W. Hoyt, Madison.

For Treasurer Geo. P. Delaplaine, Esq., Madison.

For Director of Museum E. T. Sweet, M.E., Sun Prairie.

For Librarian, Charles N. Gregory, M. S., Madison.

After the transaction of other minor business, the Academy adjourned *sine die*.

JOHN E. DAVIES,
General Secretary.

Report of the Librarian.

To the President of the Wisconsin Academy of Sciences, Arts and Letters:

SIR:—I have the honor to report the receipt of the following contributions to the library of the Academy, which have been forwarded by the courtesy of the Smithsonian Institute, Washington D. C.

Bremen Natural Science Society.—Vol. 3, parts 1 and 2, 1872. Vol. 4, part 4, 1875. Vol. 4, part 1, 1876. Supplement No. 4, 1874–5, Supplement No. 5, 1876.

Amiens Linnean Society of the North of France.—Monthly bulletins from May, 1875 to June, 1876, inclusive.

Munich Royal Bavarian Academy of Science.—Transactions for 1875, parts 1 and 2. Two pamphlets on Chemistry. One pamphlet on Schelling.

Harlem Netherlands Society for the Fostering of Industry.—Transactions for 1874, transactions for 1875, and six pamphlets.

Lyons Academy of Science, Belles-Letters and Arts.—Memoirs Volume 16, for 1874–5.

Dresden Society of Natural History.—Transactions for 1875.

Vienna Imperial Royal Zoological and Botanical Society.—Transactions Volume 25, for 1876.

Brunn Natural Historical Society.—Proceedings Volume 13, 1875. Catalogue of Library 1874.

Halle Journal of the Natural Sciences by Dr. Giebel.—Volumes 11 and 12, 1875.

Bern, Swiss Society of Natural History.—Proceedings for 1876. Memoirs.

Bern, Society of Natural Science at Bern.—Transactions 1874, 1875.

London Royal Society.—Volume 23, of Proceedings. Nos. 153 to 163 inclusive. "On the Tides of the Arctic Seas," from Philosophical Transactions of Royal Society.

Neuchatel, Society of Natural Science.—Bulletin received March 1876.

Natural Historical Society of Prussian Rhineland and Westphalia.—Transactions for 30th year 1874, and 31st year 1875.

Konigsberg. Publications of Society of Physical Economy.—Parts one and two, 1873 and 1874.

Gottingen, Royal Society of Learning etc.—Transactions for 1875.

Harlem, Archives of the, "Musee Teyler"—Vol. 1, 2 and 3, and 1st part of vol. 4.

Amsterdam, Royal Academy of Science—Publications from 1865 to 1876 inclusive, in 21 pamphlets.

Belgium, Royal Society of Botany—History of Roses, by Francis Crepin; extract from Bulletin.

Danzig, Natural Historical Society; Transactions—Vol. 3, part 4.

Freiburg, Society of Natural History; Transactions—Vol. 6, part 4.

St. Petersburg, Physical Central Observatory—Annals for, 1874.

Instructions for Meteorological stations, by H. Wilde.

Andennatt, Swiss Society of Natural Philosophy—Report 1874 and 1875.

Bamberg, Society of Natural Philosophy—Tenth report, 1874 and 1874.

Stockholm, The Royal Swedish Academy of Science—Memoir by S. Loren on "Echinoidea," 1875. Transactions for 1872. 11th volume of Synopsis of Transactions, 1875 and 1876. Appendix to Transactions, volume 3, part 1. List of Swedish and Norse members May, 1876.

I have also received, by the kindness of Professor Alexander Agassiz,

Cambridge, Mass., Museum of Comparative Zoology at Harvard College—Bulletin Volume 3, Nos. 11 to 16; volume 4, No. 10.

Also from the State Library of New York,

87th Report of the Regents of the State of New York.

Report of New York State Library for 1875.

Report of New York State Museum of Natural History.

Biographical sketch of Increase A. Lapham, read before the Old Settlers Club; by the kindness of Mr. Seneca Lapham, of Milwaukee.

All of which is most respectfully submitted.

With great respect,

CHARLES N. GREGORY,

Librarian.

List of Officers and Members

OF THE

ACADEMY, 1876.

GENERAL OFFICERS of the ACADEMY.

PRESIDENT:

Dr. P. R. HOY, *Racine.*

VICE-PRESIDENTS:

Dr. S. H. CARPENTER, - - - - - - *Madison.*
Prof. T. C. CHAMBERLIN. - - - - - - *Beloit.*
Rev. G. M. STEELE, D. D. - - - - - - *Appleton.*
Hon. J. I. CASE, - - - - - - - - *Racine.*
Rev. A. L. CHAPIN, D. D. - - - - - - *Beloit.*
Dr. J. W. HOYT, - - - - - - - *Madison.*

GENERAL SECRETARY:

Prof. J. E. DAVIES, M. D., *University of Wisconsin.*

TREASURER:

GEO. P. DELAPLAINE, Esq., *Madison.*

DIRECTOR OF THE MUSEUM:

E. T. SWEET, Esq., *Sun Prairie.*

LIBRARIAN:

CHARLES N. GREGORY, *Madison.*

COUNSELORS EX-OFFICIO:

HIS EXCELLENCY THE GOVERNOR OF THE STATE.
THE LIEUTENANT GOVERNOR.
THE SUPERINTENDENT OF PUBLIC INSTRUCTION.
THE PRESIDENT OF THE STATE UNIVERSITY.
THE PRESIDENT OF THE STATE AGRICULTURAL SOCIETY.
THE SECRETARY OF THE STATE AGRICULTURAL SOCIETY.

OFFICERS OF THE DEPARTMENTS

DEPARTMENT OF SPECULATIVE PHILOSOPHY.

President.—S. H. Carpenter, LL. D., Madison.
Secretary.—Rev. F. M. Holland, Baraboo.
Counsellors.—Dr. John Bascom, President University of Wisconsin; President Oliver Arey, Whitewater, and Rev. A. O. Wright, Fox Lake.

DEPARTMENT OF NATURAL SCIENCES.

President.—Prof. T. C. Chamberlin, Beloit.
Secretary.—Prof. James H. Eaton. Beloit.
Counsellors.—Prof. W. W. Daniells, of the University of Wisconsin; Prof. Foye, of Appleton, and Prof. Thure Kumlein, of Albion.

DEPARTMENT OF SOCIAL AND POLITICAL SCIENCES.

President.—Rev. G. M. Steele, D. D. Appleton.
Secretary.—E. R. Leland, Esq., of Eau Claire.
Counsellors.—Dr. E. B. Wolcott, Milwaukee; Rev. Charles Caverno, Lombard, Ill., and J. B. Parkinson, of Madison.

DEPARTMENT OF THE MECHANIC ARTS.

President.—Hon. J. I. Case, Racine.
Secretary.—Prof. W. J. L. Nicodemus, of the University of Wisconsin.
Counsellors.—Charles H. Haskins, of Milwaukee; Hon. J. L. Mitchell, of Milwaukee, and Capt. John Nader, of Madison.

DEPARTMENT OF THE FINE ARTS.

President.—Dr. J. W. Hoyt, Madison.
Secretary.—Hon. J. E. Thomas, of Sheboygan.
Counsellors.—Mrs. S. F. Dean, Madison; J. R. Stuart Esq., Madison, and Mrs. H. M. Lewis, Madison.

DEPARTMENT OF LETTERS.

President.—Rev. A. L. Chapin. D. D., Beloit.
Secretary.—Prof. J. B. Feuling, of the University of Wisconsin.
Counsellors.—Prof. W. F. Allen, of the University of Wisconsin: Prof. Emerson, Beloit College, and Hon. L. C. Draper, Madison.

MEMBERS OF THE ACADEMY.

ANNUAL MEMBERS.

Allen, W. F., A. M., Professor of Latin and History in the University of Wisconsin.

Arey, Oliver, A. M., President State Normal School, Whitewater, Wis.

Atwood, T. G., Esq., Albion, Wis.

Bascom, John, LL. D, President of the University of Wisconsin.

Bashford, R. M., A. M., Madison, Wis.

Ballentine, W. G., Ripon, Wis.

Butler, J. B., LL. D., Madison, Wis.

Bryant, E. D., Hon., Madison, Wis.

Birge, E. A., A. M., Instructor in Zoology in the University of Wisconsin.

Carpenter, S. H., LL. D., Professor of English Literature and Logic, in the University of Wisconsin.

Chamberlin, T. C., A. M., Professor of Natural History Beloit College, and Director of the Geological Survey of Wisconsin.

Caverno, Charles, Rev., Lombard, Ill.

Chapin, A. L., D. D., President Beloit College, Beloit, Wis.

Charlton, E. A., A. M., President State Normal School, Platteville, Wis.

Cole, Theo. L., M. S., LaCrosse, Wis.

Copeland, H. E., Whitewater.

Conover, O. M., A. M., Madison, Wis.

Cass, Josiah E., Eau Claire, Wis.

Daniells, W. W., M. S., Prof. of Chemistry in the University of Wiscousin.

Davies, J. E., A. M. M. D., Prof. of Astronomy and Physics in the University of Wisconsin.

Delaplaine, Geo. P., Madison, Wis.

De La Matyr, W. A., Mazomanie, Wis.

Dudley, Wm, Madison, Wis.,

Durrie, D. S., Librarian Wisconsin State Historical Society.

Doyle, Peter Hon., Secretary of the State of Wisconsin.

Eaton, James H., Ph. D., Prof. Chemistry Beloit College, Beloit, Wis.

Feuling, J. B., Ph. D., Prof. Comparative Philology and Modern Languages in the University of Wisconsin.

Foye, J. C., A. M., Prof. Physics, Lawrence University, Appleton, Wis.

Gregory, J. C., Madison, Wis.

Gregory, Chas. N. A. M., Madison, Wis.

Holland, F. M. Rev., A. M., Baraboo, Wis.

Hauser, J. L. Rev., A. M., Milwaukee, Wis.

Hawley, C T., Milwaukee, Wis.

Holton, E. D. Hon., Milwaukee, Wis.

Hoy, P. R., M. D., President Wisconsin Academy Sciences, Arts, and Letters, Racine, Wis.

Hoyt, J. W., M. D., Madison, Wis.

Haskins, C. H., General Superintendent Northwestern Telegraph Company, Milwaukee, Wis.

Irving, R. D., A. M. M. E., Prof. of Geology and Mining in the University of Wisconsin.
Kumlein, Thure, Prof. Albion College, Albion, Wis.
Kingston, J. T., Necedah, Wis.
Kerr, Alex., A. M., Prof. Greek in the University of Wisconsin.
Leland, E. R., Eau Claire, Wis.
Lapham, S. G., Milwaukee, Wis.
Marks, Solon, M. D., Milwaukee, Wis.
Mason, R. Z., LL. D., Appleton, Wis.
Nicodemus, W. J. L., C. E., Prof. of Civil and Mechanical Engineering in the University of Wisconsin.
Nader, John, C. E., Madison, Wis.
Orton, Harlow S., Hon., Madison, Wis.
Parkinson, J. B., A. M., Madison, Wis.
Pradt, J. B. Rev., A. M., Madison, Wis.
Preusser, Charles, President Natural History Society, Milwaukee, Wis.
Pinney, S. U, Hon., Madison, Wis.
Reed, Geo., Hon., Manitowoc, Wis.
Roby, H. W., Milwaukee, Wis.
Reade, E. D., C. E., Milwaukee, Wis.
Steele, Rev. Geo., M., D.D., President of Lawrence University, Appleton, Wis.
Shipman, S. V., Chicago, Ill.
Smith, Wm. E. Hon., Milwaukee, Wis.
Searing, Edward, A, M., Superintendent of Public Instruction for the State of Wisconsin.
Sawyer, W. C., Prof. Lawrence University, Appleton, Wis.
Shaw, Samuel, A. M., Principal of High School and City Superintendent of Public Schools, Madison, Wis.
Stuart, J. R., A. M. Madison, Wis.
Sloan, I. C. Hon., Madison, Wis.
Whitford, W. C., A. M., President of Milton College, Milton, Wis.
Wright, A. O. Rev., Fox Lake, Wis.
Welles, E. R., Rt. Rev. S. T. D., Episcopal Bishop of Wisconsin.
Wilkinson, John, Rev. A. M., Madison, Wis.
Wood, J. W., Baraboo, Wis.
Woodman, E. E., Baraboo, Wis.

CORRESPONDING MEMBERS.

Andrews, E. B., LL. D., Prof. Marietta College, Ohio.
Andrews, Edmund, A. M. M. D., Prof. Chicago Medical College, Chicago, Ill.
Blossom, T., M. E., School of Mines, Columbia College, New York.
Bridge, Norman, M. D., Chicago, Ill.
Brinton, J. G, M. D., Philadelphia, Pa.
Buchanan, Joseph, M D., Louisville, Kentucky.
Burnham, S. W., F. R. A. S., Chicago, Ill.
Carr, E. S., M. D., Superintendent Public Instruction, California.
Ebener, F., Ph. D., Baltimore, Md.
Freer, J. C., M. D., President Rush Medical College, Chicago, Ill.
Gatchell, H. P., M. D., Kenosha, Wis.
Gilman, D. C., President John Hopkins' University.
Gill, Theo., M D., Smithsonian Institution, Washington, D. C.
Hopkins, F. V., M. D., Baton Rouge, La.
Haldeman. S. S., LL. D., Prof. University of Pennsylvania, Chickis, Pa.
Horr, Asa, M. D., President Iowa Institute of Arts and Sciences, Dubuque, Iowa.
Harris, W. T., LL. D., St. Louis, Mo.

Hubbell, H. P., Winona, Minn.
Jewell, J. S., A. M. M. D., Evanston, Ill.
Morgan, L. H., LL. D., Rochester, Ill.
Marcy, Oliver, LL. D., Prof. Northwestern University, Evanston, Ill.
McCabe, L. D., D. D., Prof. Wesleyan University, Delaware, Ohio.
McAllister, J. H., Philadelphia, Pa.
Newberry, J. S., LL. D., Prof. Columbia College, New York.
Orton, E., A. M., President Antioch College, Yellow Springs, Ohio.
Porter, W. B., Prof., St. Louis, Mo.
Le Barron, Wm., State Entomologist, Geneva, New York.
Safford, T. H., Director of the Astronomical Observatory of the University of Chicago.
Shaler, N. S., A. M., Professor Harvard University, Cambridge, Mass.
Schele, De Vere M., LL. D., Prof. University of Virginia, Charlotteville, Va.
Thornton, J. Wingate, Boston, Mass.
Trumbull, J. H., LL. D., Hartford, Conn.
Verrill, A. E., A. M., Prof. Yale College, New Haven, Conn.
Van De Warker, Eli, M. D., Syracuse, N. Y.
Watson, James, A. M., Director of the Astronomical Observatory at Ann Arbor, Michigan.
Whitney, W. D., Prof. Yale College, New Haven, Conn.
Winchell, Alex. LL. D. Chancelor Syracuse University, Syracuse, N. Y.

LIFE MEMBERS.

Case, J. I., Hon., Racine, Wis.
Dewey, Nelson, Ex-Governor of Wisconsin, Madison, Wis.
Hagerman, J. J. Esq. Milwaukee, Wis.
Hoyt, J. W., M. D., Madison Wis.
* Lapham, I. A. LL. D, Milwaukee, Wis.
Lawler, John, Esq , Prairie du Chien, Wis.
Mitchell, J. L., Hon., Milwaukee, Wis.
Noonan, J. A. Esq., Milwaukee, Wis.
Paul, G. H., Hon., Milwaukee, Wis.
Thomas, J. E., Hon. Sheboygan Falls, Wis.
Thorpe, J. G., Hon., Eau Claire, Wis.
White, S. A., Hon., Whitewater, Wis.

MEMBERS DECEASED SINCE THE ORGANIZATION OF THE ACADEMY IN 1870.

Rt. Rev. Wm. E. Armitage, S. T. D., Bishop of Wisconsin, and late Vice-President of the Academy of Sciences, died December 7, 1873.
Prof. Peter Engelmann, Milwaukee, Wisconsin.
J. W. Foster, LL. D., late Professor in the University of Chicago, Chicago, Ill.
I. A. Lapham, LL. D., Milwaukee, Wisconsin, First Secretary Wisconsin Academy Science Arts and Letters.
Wm. Stimpson, M. D., late Secretary Chicago Academy of Sciences, Chicago, Illinois.
Hon. John Y. Smith, Madison, Wisconsin.
Hon. A. S. McDill, M. D., Madison, Wisconsin.

* Deceased.

CHARTER, CONSTITUTION AND BY-LAWS

OF THE

Academy of Sciences, Arts and Letters,

OF WISCONSIN

With the Amendments thereto, up to February, 1876.

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 Preuser, Wm. E. Smith, J. C. Foye, Wm. Dudley, P. Englemann, 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 Baetz, Ll. Breese, Thos. S. Allen, S. S. Barlow, Chas. R. Gill, C. L. Harris, 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 enconrage 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:

1st. *The Department of Speculative Philosophy*—

Embracing:
Metaphysics;
Ethics.

2d. *The Department of the Social and Political Sciences*—

Embracing:
Jurisprudence;
Political Science;
Education;
Public Health;
Social Economy.

3d. *The Department of the Natural Sciences*—

Embracing:
The Mathematical and Physical Sciences;
Natural History;
The Anthropological and Ethnological Sciences.

4th. *The Department of the Arts*—

Embracing:
The Practical Arts;
The Fine Arts.

5th. *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 groupe 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, Counselors *ex-officiis*, and three Counselors to be elecected for each Department. The Department Councils shall consist of the President and Secretary of the Academy, the officers of the Department, and three Counselors 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 the 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.

RELATING TO AMENDMENTS.

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.

AMENDMENTS TO THE CONSTITUTION.

Amendment to Section 3: "The Department of the Arts shall be hereafter divided into the Department of the Mechanic Arts and the Department of the Fine Arts."

Passed February 14, 1876.

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.

ELECTION OF OFFICERS.

2. All officers of the Academy shall be elected by ballot.

MEETINGS.

3. 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.

4. 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.

COMMITTEES.

5. 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.

6. 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, of such duplicates of typical specimens in Natural History as the Academy may be able to supply without detriment to its collections.

ORDER OF BUSINESS.

7. 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.

8. The By-Laws may be suspended by a 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 Council.

Since the last Report of the Council on February 11, 1874, the Academy has lost by death three of its most active members: Hon. I. A. Lapham, LL. D., of Milwaukee, late Chief Geologist of Wisconsin, Prof. Peter Engelman of Milwaukee, and Hon. John Y. Smith of Madison, the latter noted for his sound views and able writings in Political Economy.

A short account of the life and character of Dr. Lapham, by E. R. Leland, Esq., of Eau Claire, also one by P. R. Hoy, M. D. President elect of the Academy will be found at the end of this volume.

A sketch of Prof. Peter Engelmann, by Mr. Leland will also be found in the same place.

An account of the life of Hon. John Y. Smith, will be found in the Wisconsin State Historical Society's Report for 1876.

IN MEMORIAM.

PROF. PETER ENGELMANN.

BY E. R. LELAND, ESQ., OF EAU CLAIRE.

Peter Engelmann was born on the 24th of January, 1823, and on the 17th of May, 1874, he died, before he had completed his fifty-second year. The object of this memoir is to give a slight sketch of this existence which was so suddenly cut short at the moment of bearing its best fruit.

It is due to his memory that I should disclaim my fitness for this task, which was only undertaken upon the assurance that else it would remain undone. Without other qualification than the admiration and respect resulting from a rather limited acquaintance—with but meagre details of his life at my command, I shall attempt no adequate biographical sketch, but simply try to declare what the *man was.*

His birthplace was the village of Argenthal, in Rhenish-Prussia. His parents were farmers, as were his elder brothers, and of him they desired to make a farmer also; but in farm life he felt little interest even in boyhood, while, as soon as he could read, he was hungry for books, and eager in his search of knowledge. But social lines are drawn with rigor in Germany, and distinctions of caste observed almost as scrupuously as they are in India, and it was only through the intervention of a fortunate circumstance that he was enabled to escape from the irksome pursuit of the plow and follow his natural bent for learning. The Protestant clergyman of the village, and the superintendent, interested in the boy, on account of his rapid progress under inferior instruction, pursuaded his parents to send him to a better school. To this they finally consented, in the hope to see their son gain the pulpit—than which they had for him no higher ambition—and he was sent to the "Hochere Buergerschule" at Simmern. He went there from his ninth to his fifteenth year, walking a distance of four miles each way every day. When he reached home after his four-mile walk he had his "chores" to do, and then to get his lessons. But he had energy and dilligence enough to overcome these disadvantages, and he received the highest certificates as to his proficiency.

At this time he had no other aim than to gratify the pious ambition of his parents; but this was not to remain the case very long. In 1838 he was—thanks to the aid of his teachers at Simmer, of whom he always spoke with tenderness and gratitude—fitted to be received in the secunda of the gymnasium, at Kreuznach. It was while here, although all his surroundings were calculated to impress his mind with religious faith, that he felt constrained to give up the plan of becoming a pastor; the critical bias of his intellect constantly prompting him to question theologians and demand explanation of the contradictions in their teachings, until finally the old mystic creed of his fathers, lost every title of its influence and authority, and he ceased then, and forever after, to be swayed by its absurd hopes or childish fears.

After studying at Kreuznach for the four years necessary to go through the Secunda and Prima, he passed a successful examination in 1842. The study of history and the natural sciences only served to strengthen his convictions, and, ever frank and outspoken, he found himself in antagonism to his bound-to-be-pious teachers. They could not, however, help giving him in his certificate the most excellent notes in regard to diligence, progress, moral character and good nature. The theologian, inserted the admonition that "he must not forget that nature and her laws are not higher than their Creator."

He went away to the Universities. Of his life there I know little. He joined a secret revolutionary society; but neither revolutionary zeal nor the temptations of student life diverted him from his work. There is evidence that his course was marked by the same good conduct and steadfast industry; for there, as at Kreuznach he was the object of high praise. The certificate given him at Berlin where he studied three years, after one year at Heidelberg, contains twenty notes from various professors, among them Encke, Poggendorf, Dove, Ehrenberg, and Dirichlet, all unanimous in commendation.

On leaving the University there were two courses open to him. One was to choose Astronomy as his calling, which he had studied theoretically and practically under Encke, but this he had not the means to pursue without aid, and he would not as he wrote in his journal "beg protection." The other was to become a teacher at some gymnasium. He decided to apply for a State teacher's examination and passed successfully, though he looked forward to it with apprehension, several of his friends having failed but a short time previously. The theologian among the examiners, to whom he frankly confessed his unbelief, while giving him credit for his knowledge, decided that "he could not teach religion because he did not accept the bible as the source of truth. Royal commissioners in Prussia are very anxious to see that the youth are not misled by unbelieving teachers. Fortunately the result depended, not upon the theologian, Mr. Teressen, but mainly upon Schellbach, Rose, and Ehrenberg, and so he was granted the "facultus docenti."

He then went to the Kreuznach Gymnasium, where he taught for a year and a half with marked success. Here again his frankness stood in the way of his preferment —his outspoken declarations for republicanism preventing him from being regularly installed as a teacher.

When in February 1848 the revolution broke out in France, he hailed it with enthusiasm, and with all the fervent zeal and energy of his nature agitated for the republican idea among the people of Kreuznach. Jointly with some friends he founded a Turn-verein (gymnastic society) and a Buergen-verein (citizens' society) and wrought a radical change in the public opinion. He was given to understand that if he would "hush" he should have a desirable situation, and the Chief Director of Education of the Rhenish Provinces summoned him to an interview and advised him to desist. His answer was an increased revolutionary activity. With a few friends of the cause he founded a democratic club and began publishing a revolutionary paper. The first editor was soon compelled to flee. Engelman succeeded him in February 1849 and conducted the paper till May, when he too, had to leave his Fatherland to escape the dungeon. Another of the friends then continued the paper until it was suppressed by Prussian soldiery.

In Augnst, 1849, Englemann reached New York in a destitute condition. He joined an acquaintance to try "Latin farming" near Marshall, Michigan. The result was as discouraging as might have been expected. One of his first acts was to take out his naturalization papers, for he burned with impatience to "renounce forever his allegiance to the King of Prussia," and to become a citizen of the Republic. After working for awhile as a farm-hand. he went to Milwaukee, and thence to Oshkosh. At the latter place he was taken sick, and lay prostrate for eight weeks, without friend or farthing. Returning to Milwaukee, he was again taken sick; and without money for support, or a single acquaintance, his situation and frame of mind may be more easily imagined than described.

When partially restored, he was engaged by a farmer, three miles from Milwaukee, to instruct two boys for his board. Soon after, he was engaged as teacher for a district school. His success as a teacher soon became manifest, so that children were sent from the city to partake of his instructiou. After the close of the term, although the district sought to retain him at double his former salary, he went back to Milwaukee to seek a more extended field for his educational work. Then it was that the German and English Academy was founded. It commenced school July 1, 1851, giving its director a salary of $25 per month. Here he remained nntil death closed his arduous and unselfish duties.

His plans were far more comprehensive than his achievements. He was not to be permitted to carry them out, but he lived to see his academy advance in members and educational results until it gained the reputation of being one of the best schools of its grade in the Union, a result which it is no exaggeration to say was due to his labors. Engleman was one of the pioneers in the United States of modern rational pedagogy, as opposed to the old school routine of memorizing and reciting; his aim was more to educate and train the young mind for self-instruction, than to cram with undigested knowledge. His methods were based upon the ideas of Pestalozzie and Froebel—though he was a routine follower of no man's lead. It had long been his intention to publish a number of hand-books for the use of schools, among them one of Universal History, and he was about to prepare a teachers manual for mathematics. In this respect his premature death is a serious loss to the cause of education, for his metnod, based upon his rational views, have proved highly satisfactory and successful. In moral teachings he avoided making them repugnant to the pupils by dry catechism, but taught them to love virtue by examples taken from history which were emphasized by his own excellent example.

He introduced natural sciences more largely than is common, that his scholars might learn how to observe—how to read and question the works of nature for themselves, and to apply the scientific methods of investigation to all things; and lastly, he ever sought to transplant his own humane sentim n's; his own chivalrous love for liberty and justice into the minds of the embryo citizens entruste l to his care. One of the good results of his school was the elevation—by a spirit of emulation—of the standard of the public schools of Milwaukee, to a much higher level than they would have otherwise attained.

But the care of this Academy, absorbing as it was, by no means bounded the sphere of his activity. He and his friend Dr. A. Luning, were the principal founders ot the Natural History Society of Wisconsin, and he the Curator of its now very valuable museum from the beginning. He bestowed a great amount of labor upon it; zealously collecting himself, and inciting others to follow his example. Whoever might be lukewarm; he was not. He never wearied of the work; he shrank from no drudgery connected with it. Much, perhaps most of his leisure was given to the work of determining, labeling and arranging specimens. Nor was he niggardly of his precious time to either the mere curiosity gazer, the inquiring young student, or the amateur dabbler in science. The courtesy and kindly interest with which he welcomed all comers, I have occasion to gratefully remember. Since his death, the museum bears his name.

In spite of this exhausting and absorbing professional work, he found time to write many articles for liberal papers, and to give numerous lectures before radical and scientific societies, always without pay, and often illustrated by experiments at his own expense. In short, he sought knowledge, not for the personal gratification which it affords, but to the end that he might aid in its general diffusion, or make some practical application of it for the good of his fellows, and he carried these disinterested labors to an extreme that many of his thrifty countrymen could not understand, and they were, some of them, inclined to call him visionary and a fanatic. He was neither. He had sterling good sense, and he rode no hobbies. His motives lay upon the surface, and if men could not read them aright it was their own oblique vision that was at fault. His whole life was given to the advancement of the race, to liberty of thought, of speech, of life—with a devotion that most men will admire and few have the courage to imitate.

His last illness was a sharp attack of congestion of the lungs, under which he sank very rapidly, retaining consciousness to the last. He died, as he had lived, bravely and calmly; without fear or regret. With characteristic modesty he directed that his funeral should be free from formal obsequies. There were none of the conventional forms, but hundreds followed him to his grave and hid it with flowers as a last feeble tribute to his worth, and, few indeed are the men who have a place in the tender memories of so many hearts as this self-sacrificing teacher. The future of his beloved enterprises—concerning which he had many and ambitious hopes—is now in other hands. They may not suffer, but it will be a long search to find one man who can fill his place.

This, in brief, and most imperfect outline, was the life of Peter Engelmann. It was not, as we have seen an eventful one. His name never became famous, for his were not the qualities which gain fame—as the world goes. Self abnegation, honest steadfastness of purpose, devotion to principal, are prized and valued but are not loudly praised. It is the bold dogmatist, the skilled rhetorician, the sagacious trimmer of sails to the breeze of public opinion, that wins applause.

This modest pedagogue knew none of these tricks of success. With rare rectitude he, in early manhood, put aside a brilliant scientific career, because he prized independence, self-respect, the approval of his conscience, more highly than place and profit and fame; and from his devotion to principle the very nature of his religious belief, removed all taint or suspicion of selfishness, even of the most refined and spiritual sort, for he was an uncompromising materialist.

Forced to the conclusion, that so far as human reason, arguing from the facts of life, can form any judgment on the subject, a self-conscious existence hereafter is an impossibility; he declined to follow those who assume that there is a higher mode of apprehending these facts than reason supplies. He would allow no attributes—cherish no hopes that demanded the sanction of something higher than his understanding; and whatever may be our private beliefs, it is difficult to see how the logical soundness of this position can be assailed.

His belief gives the clue to his aims and his labors. Feeling that the assumptions of the so-called, higher modes of cognition were gratuitous and mischievous, he worked so far as he could for their downfall—but he did not stop here, he was not a mere iconoclast. He saw, what all must see, that there is a growing disposition to question these assumptions, and he was not blind to the dangers of states of transition. He could use no other than the materialistic formula, but with that he did what in him lay to revolutionize and humanize political and social life, so as to fit it to a higher creed. He worked to the end that when men should no longer obey, through fear or hope, the mystical, external commands, that they should already be, through a love of goodness for itself, obedient to the higher, internal commands.

He apprehended no danger to morality, for he well knew that morality is not the fruit of any creed, but the sum of human experience. His last work in this direction, was an answer to an attempt, by one Pastor Streissguth, to *prove* that materialism was error and tended to immorality. The pamphlet has been published since his death, by the Wisconsin Union of Liberal Societies; he therein refutes by unanswerable arguments, as he had by his pure and blameless life, the silly and inconsequent slander, that the morality which flows from scientific materialism can be comprehended in the words, "Let us eat and drink, for to-morrow we die." If a man believes that his sentient existence is restricted to the three-score years on earth, will he therefore anticipate the nothingness of the future by becoming a sot in the present? or will he use his best endeavor to husband this handful of years and make them yield to him the greatest measure of spiritual life?

To say nothing of the many good and able men who cannot base their theory of life upon a belief in a future individuality; there are outside the limits of Christendom millions of human beings who look forward to forgetfulness, and whose lives are by no means marked by a devotion to the grosser pleasures of the world. The assertion, or rather the inference—for it oftenest comes in that shape—that a man will be good only in proportion as he has a lively sense of the pleasures of a coming heaven, or the pains of an inevitable hell, is a rank calumny upon our moral nature. It is safe to assert that no man of noble instincts, pure aspirations, or high moral principle will be demoralized by the contemplation of a limited existence; nor will the brute be ennobled by the prospect which the church presents to his debased imagination.

I will make no apology for thus lamely intruding these truisms. There is need of their occasional reiteration.

No good and pure man lives without divinities—and Engleman's were; humanity, progress, a realization of the high ideals to which his philosophy pointed. Brave and outspoken in uttering his convictions when need was, he was never dogmatic. He did his work in a spirit of true humanity—a humanity that was content cheerfully to accept the place which he believed he held in nature, that of a stepping-stone—one of the myriads by which the race is to gain a glorious future. But he had none of the assumed, servile, oriental abjectures that leads man to revile himself as a worthless worm of the dust, and in the same breath demand, with sublime egotism, why he was created, with his lofty purposes and high aspirations, if he is to *have* a glorious and an undying future? That leads him to deem himself defrauded if, with his matchless intellect, he is not to know a state of being far transcending anything which earth affords, more or less ineffable and gorgeous as his ideas are spiritual and his imagination vivid.

The man who holds and promulgates ideas that are in opposition to the popular beliefs of his age, can scarcely live a bright and cheerful life; but it may contain much of nobleness that compensates for the loss of worldly pleasures. Engelmann was a serious but not a sad man. He bore a burden common to many, but he stood upright under it. He answered the question which man is ever asking "What am I?" by saying "my consciousness is a mere resultant of force acting upon matter and at the death of the flesh it will revert to its former conditions, as sounds revert back to the air in which they were born." We may answer it differently, but we cannot demonstrate that he was mistaken; and we must admire his attitude when brought face to face with a great problem.

It was with eyes open and head erect—true to his creed to the last—hugging no delusive dreams—his highest conception of truth upon his lips. No man can meet death better!

He is at peace, and if it be that the universe holds greater possibilities than were acknowledged in his philosophy, we may be sure, as has been said of one whom in many things he resembled:

"Wherever there is knowledge,
Wherever there is virtue,
Wherever there is beauty,
He will find a home."

INCREASE A. LAPHAM, LL. D.

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

PRESIDENT OF THE ACADEMY.

It becomes my duty, as chairman of the committee appointed for the purpose, ot report on the life and labors of I. A. Lapham, LL. D., one of the organic members and the first Secretary of our Wisconsin Academy of Sciences, Arts, and Letters.

I perform this duty with greater willingness, and, indeed, with a mournful pleasure, remembering Dr. Lapham as a long and well-tried friend. Engaged in similar scientific pursuits, there sprang up between us a close friendship, cemented by sympathy, which lasted nearly thirty years, until his death.

I shall not attempt a complete chronological history of his life, as that has already been so well done by S. S. Sherman for the Old Settlers' Club of Milwaukee, but shall speak principally from personal knowledge, merely introducing a short sketch of his early life by way of preface.

Increase Allen Lapham, whose memory we wish to honor. was born of Quaker parents, in Palmyra, Wayne Co., N. Y., on the 7th of March, 1811. After receiving a common school training he began the study of Engineering under his father's instructions.

When but sixteen years of age he went to Louisville and was employed on the ship canal around the Falls of the Ohio.

At this early date he began the study of Botany, Conchology, and Geology, which he prosecuted as a youthful lover of nature with the enthusiastic zeal which characterized his work during all the years that followed, up to the hour of his death.

While in Louisville he wrote his first scientific paper entitled, "A Notice of the Louisville and Shipping-Port Canal, and the Geology of the Vicinity," which was published in the American Journal of Science and Arts.

This first offering contained many new facts and was highly commended by the elder Silliman as a valuable contribution, coming as it did from a mere boy, what might not be expected from the pen of riper years, wider experience and greater knowledge?

When the canal was completed, young Lapham became assistant engineer of the Ohio canal, which position he held until his appointment in 1833 as Secretary of the State Canal Board of Commissioners, when he moved to Columbns. Here he found time to devote to his specialty, Botany, and formed the acquaintance of many eminent scientific men, among them Prof. J. B. Kirtland.

In the spring of 1836 he landed at the straggling village of Milwaukee, in the then Territory of Michigan, where he continued to live and study for the remaining thirty-nine years of his active and useful life.

My first acquaintance with Dr. Lapham was in 1846, when one morning there landed from the steamer Sultana a small man with a huge collecting box hanging at his side.

He came from Milwaukee and intended returning on foot along the lake-shore in order to collect plants and shells, no easy journey, encumbered, as he soon would be, with a well filled specimen box. He spoke lightly of the undertaking, saying he had performed similar feats before. Truly where the heart is in the work and the mind is fully occupied, labor becomes mere play, and what otherwise would seem drudgery is performed with ease and pleasure.

In after years we were often together, studying the mounds, quarries, forest trees etc., near Racine, and my first impressions of his energy, perseverance, enthusiasm, accuracy and extent of information were all deepened by our subsequent meetings.

He was a quiet unassuming gentleman, benevolent and most hospitable, as both strangers and friends can abundantly testify. He had not the advantages of commanding presence, and was not gifted in public speaking, and being modest to a fault, always inclined to underrate his own abilities and labors, he often did not receive that recognition which his knowledge demanded and which would have been quickly yielded had he possessed more self-assertion or a more combative temperament. Yet, his light could not be hidden, though he succeeded sometimes in shadowing it, and he soon became *the* authority on all scientific subjects, and was often appealed to from city, state and country for information which he alone could furnish.

His politeness and patience under the infliction of ignorant question-askers who often trespassed upon his valuable time with matters of little importance, and his rule of always answering letters asking information, no matter how trifling, show his kind heartedness and unselfishness.

No one could doubt his industry who saw his large, valuable, and well used library, and his extensive and systematically arranged collection of minerals, fossils, shells and antiquities; or who examined his Herbarium of three thousand specimens—the finest in the Northwest—and then remembered in connection with all this his work in other directions. His idea of rest was characteristically shown by his once cataloguing my hundreds of insects for future use in some publication, at a time when he visited me under his physicians' orders to take a needed rest and abstain from business.

He was no politician and never sought office. Such offices as he held sought him.

Among the many services he has rendered to science not the least, is his work in establishing the Signal Service, which has already worked such good in saving wealth and precious lives. As his connection with this enterprise seems to have been enveloped in doubt with some, I wrote to Prof. Henry, Secretary of the Smithsonian for information. In reply I received the following:

"The action of Congress in securing the Signal Service was due to the immediate exertions of Dr. Lapham through the member of Congress from his district, Gen. Payne, in setting forth the advantage of the system in the commercial interest of the Great Lakes." So this matter is settled as Prof. Henry is the end of the law in meteorological affairs,

Was Lapham a self-made man?

Yes, all men are self-made, in one sense, for there can be no unusual attainments without close and persistent study. Lapham, however, never had the advantages of a college education. But was not the book of nature ever open to impart instruction to this student who knew how to read its pages with delight and profit? To his extensive reading and close observation of nature we must not omit to add as an educational element in his life, scarcely to be overestimated, his long continued correspondence with such men as Henry, Baird, Leidy, LeConte, Haldeman, Cassin, Hall, Morton, Kirtland, Agassiz, Gray, Eaton, Silliman, Rogers, Hitchcock, Torrey, Harris and a host of others eminent in science and arts. Another means of improvement, not neglected by Dr. Lapham, was attendance of meetings of societies devoted to the discussion of his loved studies, and where mind comes in contact with mind, with mutual benefit. He was a member of most of the scientific associations of the country, and gave them many valuable written contributions. Some of his articles are published by the Wisconsin Academy, in the Wisconsin and Illinois Agricultural Reports, Agricultural Department of the Patent Office, Historical publications, Smithsonian Contributions to Knowledge, Proceedings of the American Association for the Advancement of Science, American Naturalist, Geological Reports, etc., etc. Besides, he published many pamphlets and maps, both topographical and geological. His writings were brief, clear and devoid of high-sounding words used for effect—he was above such trickery.

In order to judge correctly of men, we must know them under those circumstances and in that place where nature and education have best fitted them to act. To know Dr. Lapham, we must go with him to his workshop—the great out-doors. We stroll out on the prairies. He pulls up the grass and discourses familiarly of the spikes and spikelets, the rachis and glume, inspects the roots, digs down and examines the soil from which they spring. His tongue is unloosed, and he becomes eloquent in spite of himself. We go into the forest. He talks of the various species of trees, the vines that clamber up their trunks and nestle in their branches. He inspects the lichens that grow on the rough bark, examines the moss that adheres to the roots, and unearths a tiny helix that has found a home there. We go to the rapids, and he immediately interests himself in the rare ferns that festoon the rocks with their graceful fronds; or clambers among the quarries, marks the stratification of the Silurian rocks, and chips out rare forms of Crinoids and Trilobites—those wonderful representations of the ocean fauna of the dim past. We seek the mounds—those records of a pre-historic race—dig beneath their foundations and wrest from them their secrets. The position of the bones is carefully noted, their rude pottery restored, the curious stone implements treasured up, and 128 mounds are surveyed and mapped. We stand upon our lake shore and he discourses of the force of the waves, and describes the ingenious contrivance by which he detected the lake's minature lunarwaves. He talks of the force of the winds and their velocity and direction and then looks up the clouds and tells their indications, and speaks of the annual rainfall and of the average temperature of the seasons for the last thirty years, during which time he had kept a faithful record of these phenomena.

His last paper, "Oconomowoc and the Small Lakes of Wisconsin," was prepared for me. The ink was scarcely dry before his soul passed over to the "Shining

Shore," that lovely day, September 14, 1875, was the last of earth to Dr. I. A. Lapham.

The State has lost the service of one who knew more of her Geology, Topography and Botany than any man living, and one who contributed largely to her early prosperity. Milwaukee has lost one of her oldest and best citizens, an upright and honest man. His children have lost a loving father and his accquaintances a devoted friend.

ADDITIONAL TRIBUTE TO THE MEMORY OF DR. LAPHAM.

BY E. R. LELAND, ESQ., EAU CLAIRE, WIS.

MR. PRESIDENT:—I cannot let this occasion go by without trying to pay some tribute to the memory of our lamented and revered fellow-member, whom it was long my privilege to call a friend.

Known to the world as an able scientist; to the many who casually met him, as a modest, manly, cultured gentleman; by the few he was honored and beloved as it falls to the lot of few men to be, for virtues that were not worn upon his sleeve—for a nobility that intimacy alone could reveal.

I do not, however stand here as his eulogist. I should feel that to be a sort of impertinence in me—even if the work had not already been done far better than I could hope to do it.

I desire only to make some acknowledgement of the obligation—now never to be discharged—which Dr. Lapham has laid upon me by many acts of kindness and assistance through all the years since I first knew him. An obligation which, I think many others must share with me, for he was ever ready with kind and helpful sympathy for all. The merest tyro in natural history was sure of warm welcome and encouragement at his hands, and his collection, his library, and above all his valuable time and experience were placed freely at the disposal of the seeker for knowledge.

And he taught wisely; for his nature had nothing of the pedant, his spirit nothing of dogmatism. His was the open mind; ready to learn from all sources, not prone to theorizing nor swift to draw conclusions. He had learned to wait—and there was in his attitude no posturing, nor bidding for popular applause in anything which he did. He toiled for science, from a love of science, but with a thorough and intelligent comprehension of the great possibilities that lie in this field of research.

And it has always seemed to me that when he came to die, the manner of his death was a serene and most fit ending of a life thus spent. No prolonged, distressful struggle, no whispering, crowded room; there were bending over him no beloved faces, agonized with a grief which he could do nothing to assuage. No doctor came,

"With phrase and fame,
To shake his sapient head and give
The ill he could not name,
*   *   *   *   *   *   *
No brother doctor of the soul,
To canvass with official breath,
The future and the viewless things,
Which one who feels death's winnowing wings,
Must needs read clearer, sure, than he!"

He was alone and face to face with Nature, whose life-long lover he had been. Fanned by her softest airs, lulled by her gentlest song, his last conscious act, perhaps, a fresh effort to trace her endless clue, and he passed on, with swift and pangless transition, to the solution of the wonderful mystery which envelops all.