PROCEEDINGS

OF THE

ROCHESTER ACADEMY OF SCIENCE

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OF THE

ROCHESTER ACADEMY OF SCIENCE

VOLUME 2.

OCTOBER, 1891, TO JUNE, 1894.

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1894.

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PROCEEDINGS

OF THE

ROCHESTER ACADEMY OF SCIENCE.

VOLUME 2.

OCTOBER 12, 1891.

STATED MEETING.

The President, PROFESSOR H. L. FAIRCHILD, in the chair.

Thirty-five persons present.

The addition to the Library, during the summer, of 300 volumes and pamphlets was announced.

The Council report recommended:

(1.) The Payment of certain bills.

(2.) The adoption of the following resolutions:

Resolved: That this Society extends to the American Microscopical Society a cordial invitation to hold its annual meeting of 1892 in the city of Rochester, during the month of August, in connection with the American Association for the Advancement of Science and other societies.

Resolved: That the Council shall appoint a special committee, consisting of fellows and members of the Academy who are engaged in microscopical work, to take the necessary measures for the proper entertainment of the American Microscopical Society.

On motion the bills were ordered paid and the resolutions adopted by an unanimous vote.

The Secretary, MR. FRANK C. BAKER, read a paper on

THE CAVES OF YUCATAN.

(*Abstract.*)

The northern portion of Yucatan is very flat and dry and built up entirely of recent limestone deposited on an early fold of the earth's crust. Throughout this whole region there is no surface water, no running streams, and the only source of water supply for the inhabitants is from aguadas or caves. In the western portion there is a range of hills of about a thousand feet elevation, but aside from this the country is very flat. About the Gulf region there are extensive mangrove swamps, but they do not extend for any distance inland. We can descend through this limestone formation in any of the caverns and find species of fossil invertebrates identical with those now found living on the shores of Yucatan.

The first cave visited was nine miles from San Renado, situated in the north-western part of the country. This cave descended to the depth of 180 feet below the surface. There were numerous passages seen branching off in various directions, but only two had been explored and these were not of very great extent. One passage leading in a northerly direction was followed for the length of a quarter of a mile and was found to gradually shelve down to a point, thus preventing further progress.

The second cave was that of Lantun, situated about fifteen miles from Ticul near the Hacienda of Tabi. This cave descended to a depth of 150 feet, and contained some very beautiful stalactitic columns. In one small chamber, about 120 feet below the surface, was found a fountain of clear, cold water contained in a hollow stalagmite. This fountain was always full but never seemed to run over. One interesting feature of this cave was a passage, said to be ten miles in length, which led in a northerly direction and connected a small village with the cave. This was said to have been a place of refuge for the ancient inhabitants when hard pressed by their enemies. The floor of this passage was covered with ripple-marks, as though water had flowed over it at some distant day. No animal life was found in any of these caves excepting a few shells just beneath the opening, which had fallen in or been washed down by the rains.

The paper was illustrated by several blackboard diagrams and was discussed by the President, Dr. Moore, Professor Ward and others.

OCTOBER 26, 1891.

STATED MEETING.

The President, PROFESSOR H. L. FAIRCHILD, in the chair.

Thirty persons present.

In the absence of the author, the Secretary read the following paper:

THE MOLLUSCA OF MONROE COUNTY, N. Y.

BY JOHN WALTON.

The Mollusca form a large group of the Invertebrata and are universally distributed. Anyone therefore, so disposed, may make a collection in his own neighborhood and at almost any season of the year secure specimens for study in regard to their structure and habits.

Such a pursuit has been my pastime for years and has proved both interesting and instructive. As a result of such pleasant labor I submit the following list of the Mollusca of Monroe County, which embraces, I think, all but a few of the minute species. This list includes 135 species and varieties, representing 30 genera and 14 families. Except where otherwise noted, the illustrations have been drawn from living specimens of my own collecting and thoroughly identified. I have made my selection of subjects for illustration mainly because of the uncertainty among students concerning their identity, and the difficulty of obtaining suitably illustrated literature for this purpose; the many excellent works upon the subjects here under consideration being now out of print. Believing that in supplying this lack efficiently a permanent benefit would be rendered to students of our local fauna, I have taken special pains to make these illustrations typical and reliable. For the same reason I have avoided all unnecessary shading, that the proportions and contour of the shell in each case might be the more apparent.

In preparing this paper I acknowledge my indebtedness to the excellent work of G. W. Binney, "Land and Fresh Water Shells of North America," which I have consulted freely. Nor should I omit to mention De Kay's "Mollusca of New York," with finely colored illustrations; and the timely aid of the series of Monographs now being published by the Academy of Natural Sciences, Philadelphia, under the general title of "A Manual of Conchology," with Professor H. A. Pilsbury as its able editor; to all of which works, when practicable, the student is referred for further information concerning the shells of Monroe County.

Class GASTROPODA.

Family STREPOMATIDÆ.

Pleurocera subulare, Lea. (pl. 1, fig. 1, 2.) *Lake Erie.*
Pleurocera intensum, Lea. (pl. 1, fig. 4.)
" *pallidum*, Lea. (pl. 1, fig. 3.)
" *gemma*, De Kay. (pl. 1, fig. 10.)
Goniobasis virginica, Say. (pl. 1, fig. 11, 12, 13.) *Erie canal.*
Goniobasis virginica, var. multilineata, Say. (pl. 1, fig. 14, 15.) *Erie canal.*
Goniobasis livescens, Mke. (pl. 1, fig. 8, 9.) *Erie canal.*
Goniobasis depygis, Say. (pl. 1, fig. 5, 6.) *Irondequoit bay.*
Goniobasis semicarinata, Say. (pl. 1, fig. 7.) *Irondequoit bay.*
Goniobasis Grosvenori, Lea.

Family RISSOIDÆ.

Bythinia tentaculata, Lin. (pl. 2, fig. 1.) *Erie canal.*
Gillia altilis, Lea. (pl. 2, fig. 2.) *Erie canal.*
Amnicola limosa, Say. (pl. 2, fig. 3.) *Genesee river.*
Paludina limosa, Say.
" *porata*, Ad.
Amnicola porata, Say. (pl. 2, fig. 4.) *Erie canal.*
Amnicola orbiculata, Lea. (pl. 2, fig. 5.)
Amnicola pallida, Hald. (pl. 2, fig. 6.)
Amnicola lustrica, Ad.
Amnicola granum, Say. (pl. 2, fig. 7.)
Pomatiopsis lustrica, Say. (pl. 2, fig. 8.)
Amnicola lustrica, Hald.

Family VALVATIDÆ.

Valvata tricarinata, Say. (pl. 2, fig. 9.) *Charlotte.*
Valvata unicarinata, Say.
" *bicarinata*, Say.
Valvata sincera, Say. (pl. 2, fig. 10.) *Erie canal.*

Family PALUDINIDÆ.

Melantho ponderosa, Say. (pl. 3, fig. 1, 2, 3.) *Erie canal.*
Ampullaria crassa, Desh.
Paludina decisa, Rve.
" *regularis*, Lea.

Melantho decisa, Say. (pl. 3, fig. 4–7.) *Erie canal.*
Melania ovularis, Mke.
Paludina limosa, Val.
" *microstoma*, Kirt.
" *cornea*, Val.
" *neros*, De Kay.
" *subsolida*, Anth.
" *decapita*, Anth.
" *milesii*, Lea.

Melantho decisa var. obesa, Lewis. (pl. 3, fig. 9.) *Erie canal.*

Melantho decisa var. genicula, Con. (pl. 3, fig. 11, 12.) *Erie canal.*

Melantho deciso var. integra, Say. (pl. 3, fig. 13.) *Erie canal.*

Melantho decisa var. heterostropha, Kirt. (pl. 3, fig. 10.) *Erie canal.*

Melantho rufa, Hald. (pl. 3, fig. 8.) *Erie canal.*

Family VITRINIDÆ.

Vitrina limpida, Gld. (pl. 2, fig. 11.) *Pittsford.*
Vitrina pellucida, De Kay.
" *Americana*, Pfr.

Family SELENITIDÆ.

Macrocyclis concava, Say. *Pittsford.*
Helix planorboides, Fer.
" *dissidens*, Desh.

Family ZONITIDÆ.

Zonites fuliginosa, Griff. *Rochester.*
Helix capillacea, Pfr.
Omphalina cuprea, Raf.
Hyalina fuliginosas, Tryon.

Zonites intertexta, Bin. *Pittsford.*
Mesomphix intertexta, Tryon.
Hyalina " Bin.

Zonites inornata, Say. *Pittsford.*
Helix glaphyra, Pfr.
" *inornata*, Bin.
Hyalina " Tryon.

Zonites nitida, Müll.
Helix lucida, Drap.
" *Hydrophila*, Ingalls.
Hyalina nitida, Tryon.

Zonites arborea, Say. *Pittsford.*
Helix ottonis, Pfr.
" *Breweri*, Newc.
Hyalina arborea, Morse.
" *Breweri*, Tryon.

Zonites indentata, Say.
Hyalina subrupicola, Dall.
" *indentata*, Morse.

Zonites multidentata, Bin.
Hyalina multidentata, Morse.
Gastrodonta multidentata, Tryon.

Zonites minuscula, Bin.
Helix minuscula, Bin.
" *minutalis*, Morelet.
" *apex*, Adams.
" *Lavelleana*, D'Orb.
" *Mauriniana*, D'Orb.
Pseudohyalina minuscula, Morse.

Zonites viridula, Mke.
Helix electrina, Gld.
" *pura*, Alder.
" *janus*, Adems.
Zonites radiatulus, Rve.
" *striatula*, M. Tand.
Hyalina electrina, Morse.
" " Tryon.
" *viridula*, Bin.

Zonites chersina, Say. *Pittsford.*
Helix egena, Say.
" *fulva*, Drap.
Conulus chersinus, Morse.
" *chersina*, Tryon.
Hyalina fulva, Bin.
" *chersina*, Gld. and Bin.

Zonites suppressa, Say. *Pittsford.*

Family HELICIDÆ.

Mesodon albolabris, Say. *Rochester.*
Helix rufa, De Kay. (immature sp.)

Mesodon albolabris var. dentata. *Pittsford.*

Mesodon thyroides, Say. *Rochester.*
Anchistoma thyroides, H. and A. Ad.
Helix bucculenta, Gld.
" *thyroides*, Pfr.
Mesodon bucculenta, Tryon.

Mesodon Sayii, Bin. *Pittsford.*
Helix diodonta, Say.
" *Sayii*, Bin.
Ulostoma Sayii, Tryon.

***Tachea hortensis,** Müll. *East Rochester.*
Helix subglobosa, Bin.
" " De Kay.

Triodopsis palliata, Say. *Pittsford.*
Helix denotata, Fer.
" *notata*, Desh.
Xolotrema palliata, Tryon.

Triodopsis tridentata, Say. *Rochester.*
Triodopsis lunula, Raf.

Triodopsis fallax, Say. *Rochester.*

Vallonia pulchella, Müll. *Pittsford.*
Helix minuta, Say.
" *costata*, Müll.
Vallonia minuta, Morse.
" " Tryon.

Stenotrema hirsuta, Say. *Rochester.*
Triodopsis hirsuta, Woodward.
Helix fraterna, Wood.
" *porcina*, Say.

Stenotrema monodon, Rac. *Rochester.*
Helix convexa, Chem.
Helicodonta hirsuta, Fer.

Stenotrema monodon var. fraterna, Say. *Rochester.*

Stenotrema monodon var. Leaii, Ward. *Rochester.*

*This is an European species and was picked up near Vick's greenhouses. It was in my possession alive for several days. Possibly it was brought over with some bulbs or plants from England or France.

Patula alternata, Say. *Rochester.*
Anguispira alternata, Morse.
Helix scabra, Lan.
" *strongylodes*, Pfr.
" *mordax*, Shutt.
" *dubia*, Shepp.

Patula perspectiva, Say. *Pittsford.*
Helix patula, Desh.
Anguispira perspectiva, Tryon.

Patula striatella, Anth. *Pittsford.*
Helix ruderata, Ad.
" *Cronkhitei*, Neroc.
Anguispira striatella, Tryon.
Patula Cronkhitei, Tryon.

Strobila labyrinthica, Say. *Pittsford.*

Helicodiscus lineatus, Say. *Rochester.*
Planorbis parallela, Say. ?
Hyalina lineata, Bin.

Family LIMACIDÆ.

***Limax maximus,** Lin. (pl. 4, fig. 4.) *East Rochester.*
Limax antiquorum, Fer.

***Limax flavus,** Lin. (pl. 4, fig. 1.) *East Rochester.*
Limax variegatus, Drap.

***Limax agrestis,** Lin. (pl. 4, fig. 2.)
Limax tunicata, Gld.

Limax campestris, Bin. (pl. 4, fig. 3.) *East Rochester.*
Limax campestris var. occidentalis, Cooper.

Tebennophorus caroliniensis, Bosc. (pl. 4, fig. 6.) *Pittsford.*
Limax togata, Gld.
Phylomicus carolinensis, Fer.
Limax marmoratus, De Kay.

Tebennophorus dorsalis, Bin. (pl. 4, fig. 5.)

As regards the habits of our land snails, their home is in the open woodlands of beech, birch, oak and maple ; they do not frequent the pine lands. I find the *Mesodon albolabris*, *M. thyroides* and *M. Sayii* crawling over the surface of the dead leaves in these woods ; the *Zonites fuliginosa*, *Z. inornata*, *Z. intertexta* and *Macrocyclis concava* invariably under the dead leaves ; the *Triodopsis palliata* favors the

* These three species of *Limax* have been introduced from Europe, and are now plentifully represented in our greenhouses and gardens. Our native species prefer the wooded ravines.

ravines, preferring the underside of a projecting mossy log, where may be found also our native slugs; the *Patula alternata* loves the underside of dead stumps in wet places and also the clefts of shaly ledges where there is considerable moisture; the *Stenotrema monodon*, *S. hirsuta* and *Patula perspectiva* live and thrive under the bark of decaying stumps or old prostrate logs; I found over eighty specimens of the latter under the bark of one such log and all in fine condition. The smaller species of Helix I find under bark, chips or stones and sometimes among moss.

The general impression concerning the food habits of these snails is that they are vegetable feeders; this impression obtains doubtless from the well known fact that some of the species are very destructive to young shoots and plants in greenhouses. Dr. Binney, however, calls attention to the carnivorous habit of *Macrocyclis concava*, which without doubt is true, though I have not observed it personally; he also speaks in another place of a *Mesodon Sayii* devouring its own eggs. Of this cannibal tendency in some of the species I had abundant evidence during the past summer in the *Zonites fuliginosa;* fully one-third of the specimens of this Helix, taken during a special search of two weeks by myself and pupils, were found devouring shell and animal—sometimes of its own species—but more frequently the young of *Mesodon albolabris*, *M. thyroides*, *M. Sayii* and *Triodopsis palliata*. This was in July and possibly the time of year may have somewhat to do with this habit, as in the case of some seed-eating birds that are known to consume large numbers of insects in the feeding of their young and probably of themselves during the breeding season.

Toward the approach of winter these snails hibernate, burrowing beneath the dense carpet of leaves and under logs for this purpose, where they may be safe from their common enemies and the inclemencies of the coming winter. They may be found in these retreats lying with the mouth of the shell upward, within which the animals have made two or more hard glutinous partitions (epiphragms) before entering upon their long winter's rest. Our native Limaces (snails without shells) are found in similar retreats only partially dormant and protected from extreme cold by a thick coating of mucus which they are able to effuse for this purpose.

Very fine and accurate illustrations of our native Helices are given in W. G. Binney's excellent "Manual of American Land Shells," to which the reader is referred for further details concerning this interesting group of the Mollusca.

Family PUPIDÆ.

Pupa muscorum, Lin. (pl. 5, fig. 1.) *Brighton.*
Pupa badia, Ad.
Pupilla badia, Morse.
Pupa Pentodon, Say. (pl. 5, fig. 2.) *Rochester.*
Pupa curvidens, Gld.
" *Tappaniana*, Ad.
Leucochila pentodon, Morse.
Pupilla pentodon, Tryon.
Pupa contracta, Say. (pl. 5, fig. 3.)
Pupa corticaria, Ppr.
" *deltostoma*, Charp.
Leucochila contracta, Morse.
Pupa corticaria, Say. (pl. 5, fig. 4.) *Pittsford.*
Odostomia corticaria, Say.
Carychium corticaria, Fer.
Leucochila corticaria, Morse.
Pupa rupicola, Say. (pl. 5, fig. 5.)
Pupa procera, Gld.
" *carinata*, Gld.
" *gibbosa*, Kust.
" *minuta*, Say.
Vertico rupicola, Bin.
Leucochila rupicola, Tryon.
Pupa fallax, Say. (pl. 5, fig. 6.) *Rochester.*
Cyclostoma marginata, Say.
Bulimus marginatus, Pfr.
" *fallax*, Gld.
Leucochila fallax, Tryon.
Pupilla fallax, Morse.
Pupa armifera, Say. (pl. 5, fig. 7.) *Rochester.*
Pupa milium, Gld. (pl. 5, fig. 8.)
Pupa milium, Gld.
Vertigo milium, Bin.
Pupa simplex, Gld. (pl. 5, fig. 9.) *Irondequoit.*
Pupa simplex, Gld.
Vertigo simplex, Stimpson.

***Vertigo ovata**, Say. (pl. 5, fig. 10.)
Vertigo tridentata, Wolf.
Pupa ovata, Gld.
" *modesta*, Say.
" *ovulum*, Pfr.
Isthmia ovata, Morse.

Carychium exiguum, Say. (pl. 5, fig. 11.) *Rochester.*

Family STENOGYRIDÆ.

Ferussacia subcylindrica, Lin. (pl. 2, fig. 12.) *East Rochester.*
Helix lubrica, Müll.
Bulimus lubricus, Drap.
Achatina lubrica, Pfr.
Zua lubrica, Leach.
Cionella lubrica, Jeff.
Zua subcylindrica, Tryon.
Cionella subcylindrica, Bin.
Bulimus lubricoides, Stimp.
Zua lubricoidea, Morse.
Ferussacia subcylindrica, Bin.

Family SUCCINEIDÆ.

Succinea ovalis, Gld. (pl. 2, fig. 13.) *Charlotte.*
Succinea Decampii, Tryon.
" *calumetensis*, Calk.

Succinea avara, Say. (pl. 2, fig. 15.) *Rochester.*
Succinea Wardiana, Lea.
" *vermeta*, Say.

Succinea obliqua, Say. (pl. 2, fig. 16.) *Pittsford.*
Succinea lineata, De Kay.
" *campestris*, Gld.
" *Greerii*, Tryon.

***Succinea Totteniana**, Lea. (pl. 2, fig. 17.)

Succinea aurea, Lea. (pl. 2, fig 14.) *Rochester.*

Family LIMNÆIDÆ.

Limnæa stagnalis, Lin. (pl. 6, fig. 9.) *Brighton.*
Limnæa jugularis, Say.
" *appressa*, Say.
" *speciosa*, Zieg.

* Reported by Mrs. Olney, as being found in or near Rochester.

Limnæa reflexa, Say. (pl. 6, fig. 5, 6.) *Rochester.*
Limnæa elongata, Say.
" *umbrosus*, Say.
" *exilis*, Lea.
" *distortus*, Ross.

Limnæa elodes, Say. (pl. 6, fig. 1, 2.) *Erie canal.*
Limnæa fragilis, Hald.
" *palustris*, Müll.
" *Nuttalliana*, Lea.
" *plebeia*, Gld.
" *expansa*, Hald.

Limnæa pallida, Ad. (pl. 6, fig. 12, 13.) *Erie canal.*
Limnæa pallida, Hald.
" " De Kay.

Limnæa caperata, Say. *Pittsford.*

Limnæa catascopium, Say. (pl. 6, fig. 10, 11.) *Rochester.*
Limnæa cornea, Val.
" *pinguis*, Say.
" *virginiana*, Lam.
" *sericata*, Zieg.

Limnæa columella, Say. (pl. 6, fig. 3, 4.) *Erie canal.*
Limnæa chalybea, Gld.
" *macrostoma*, Say.
" *acuminata*, Ad.
" *navicula*, Val.
" *strigosa*, Lea.
" *coarctata*, Lea.
" *casta*, Lea.
" *succiniformis*, Ad.
" *columellaris*, Ad.

Limnæa desidiosa, (pl. 6, fig. 7, 8.)

Physa gyrina, Say. (pl. 6, fig. 16, 17.) *Erie canal.*
Physa elliptica, Lea.
" *Hildrethiana*, Lea.

Physa ancillaria, Say. (pl. 6, fig. 18, 21.) *Rochester.*
Physa obesa, De Kay.

Physa heterostropha, Say. (pl. 6, fig. 14, 15.) *Rochester.*
Physa fontana, Hald.
" *cylindrica*, Roe.
" *aurea*, Lea.

Physa plicata, De Kay.
" *osculans*, Hald.
" *striata*, Mke.
" *subarata*, Mke.
" *Charpentieri*, Kust.
" *Philippi*, Kust.
" *inflata*, Lea.
Bulla crassula, Dill.
Cochlea neritoides, List.

Bulimus hypnorum, Lin. (pl. 6, fig. 22.) *Pittsford.*
Physa elongata, Say.
" *glabra*, De Kay.
" *elongatina*, Lewis.
" *turrita*, Sowb.
Aplexa hypnorum, Chem.

Planorbis trivolvis, Say. (pl. 7, fig. 1, 4.) *Charlotte.*
Bulla fluviatilis, Say.
Planorbis regularis, Lea.
" *megasoma*, De Kay. (pl. 7, fig. 5.)
" *corpulentus*, De Kay. (pl. 7, fig. 10.)
" *proboscideus*, Pott.
" *lentus*, Gld.
Cochlea triumorbium, List.

Planorbis campanulatus, Say. (pl. 7, fig. 7, 8.) *Pittsford.*
Planorbis bellus, Lea
" *bicarinatus*, Sowb.
Helix angulata, Shepp.

Planorbis bicarinatus, Say. (pl. 7, fig. 9.) *Rochester.*
Planorbis engonatus, Con.
Helix angulata, Rack.

Planorbis deflectus, Say. (pl. 7, fig. 11.) *Brighton.*
Planorbis virens, Ad.
" *obliquus*, De Kay.

Planorbis parvus, Say. (pl. 7, fig. 6.) *Charlotte.*
Planorbis concavus, Anth.
" *elevatus*, Ad.

Segmentina armigera, Say. (pl. 7, fig. 12.) *Brighton.*

Ancylus rivularis, Say. (pl. 7, fig. 14.) *Genesee river.*

Ancylus tardus, Say. (pl. 7, fig. 13.) *Irondequoit.*

Ancylus parallelus, Hald. (pl. 7, fig. 15.) *Charlotte.*

Class PELECYPODA.

The Unionidæ form a large and distinct group in this class of Mollusca and are generally known under the common names of "river clam," or "river mussel."

Dr. Lea, the great authority on this interesting family, enumerates over eleven thousand recent species and divides them into nine subgenera; three of which, *Unio*, *Margaritana* and *Anodonta* are represented in the United States by about seven hundred and thirty species; a little over one half of the whole number.

There is scarcely a lake, river or creek in this broad country but can furnish some specimens of this bivalve, and often a mere streamlet that one may step over has become the habitat of one or more species. Monroe County having a lake frontage bounding it on the north, with several bays, inlets and creeks; the Genesee river flowing from the southward; and the Erie canal winding through from west to east with its own special fauna, furnishes at least thirty species of this family.

The shells of these molluscs, like bivalves generally, are distinguished by the presence, number and character of certain processes called teeth, which interlock each other under the apex and dorsal margin. In the *Unio* there are 1.2 or 2.2 central, and 1.2 lateral teeth; in *Margaritana* 1.2 central and no laterals; and in *Anodonta* the teeth are absent or almost obsolete. By these features we may determine the genus of a so-called river mussel. (See plate 8, figs. 1, 2, 3.)

River and lake fishing for these molluscs is best accomplished with a row boat and hand net in the fall of the year, when the water is low and the shells have attained the season's growth. The most favorable time for canal work is in the spring as soon as weather will permit, it being customary every year about the month of March to run off the water in order to make any necessary repairs, leaving only a foot or so of mud and water at the bottom. At such times whatever the canal contains can be easily seen and secured. It is a delightful pastime in the sunny days of early spring to traverse the canal and follow in the wake of the musk rat, and if possible forestall him in the appropriation of some choice living specimen; for a shell to be perfect should be taken alive, before the rat has made his dinner of it or the sun has bleached the empty shell.

Dr. Isaac Lea in his great work on the Unionidæ in thirteen folio volumes, gives elaborate lithographic figures of the species. Some of our local Unios are finely illustrated in color by DeKay in his "Mollusca of New York State."

Family UNIONIDÆ.

Unio alatus, Say. *Erie canal.*
Mya alata, Wood.
Lymnadia alata, Sowb.
Metaptera alata, Stimp.

Unio cariosus, Say. *Erie canal.*
Unio ovata, Val.
" *oratus*, Con.

Unio complanatus, Sol. *Genesee river.*
Mya purpurea, Eaton.
Unio purpureus, Say.
" *violaceus*, Speng.
" *purpurascens*, Lam.
" *Georgina*, Lam.
" *fluviatilis*, Green.
" *tortuosus*, Sowb.

Unio gracilis, Bar. *Erie canal.*
Unio planus, Bar.
" *fragilis*, Swain.

Unio gibbosus, Bar. *Erie canal.*
Unio mucronatus, Bar.
" *nasuta*, Lam.
" *dilatatus*, Con.

Unio iris, Lea. *Erie canal.*
Unio subrostratus, Say.
" *nebulosus*, Con.

***Unio novi-eboraci,** Lea. *Erie canal.*
Unio opalinus, Anth.

Unio nasutus, Say. *Erie canal.*
Unio rostratus, Val.
Mya nasuta, Wood.

* This and the preceding are thought to be male and female of the same species.

Unio luteolus, Lam. *Genesee river.*
Unio siliquoideus, Bar.
" *inflatus*, Bar.
" *melinus*, Con.

Unio occidens, Lea. *Erie canal.*
Unio ventricosus, Say.
" *cardium*, Con.

Unio plicatus, Less. *Erie canal.*
Unio peruvianus, Lam.
" *undulata*, Desh.
" *multiplicata*, Desh.
" *crassus*, Bar.
Mya plicata, Eaton.

Unio pressus, Lea. *Genesee river.*
Unio compressa, Lea.
" *compressus*, Con.

Unio radiatus, Lam. *Genesee river.*
Unio Virginiana, Mke.
" *distans*, Anth.
Mya radiata, Gml.
" *oblonga*, Wood.
" *pictorum tenuis*, Chem.

Unio rectus, Lam. *Erie canal.*
Unio prælongus, Bar.
" *arquatus*, Con.

Unio rosaceus, De Kay. *Charlotte.*

Unio rubiginosus, Lea. *Genesee river.*
Unio flavus, Con.
" *cerinus*, Con.
Cumicula rubiginosa, Swain.

Unio Tappanianus, Lea. *Genesee river.*
Unio Viridis, Con.

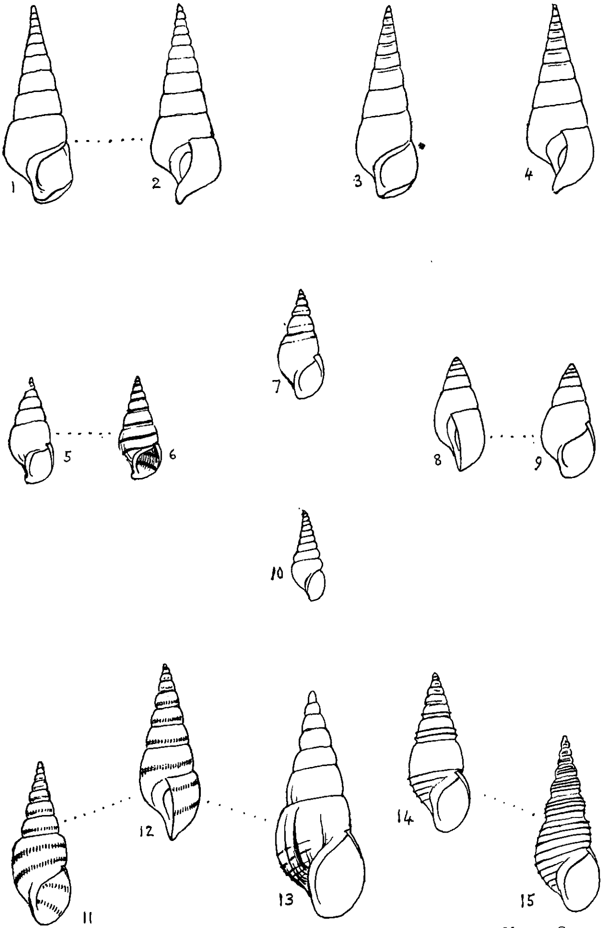
Unio undulatus, Bar. *Erie canal.*
Unio costatus, Raf.
" *plicatus*, Con.
Mya undulata, Eaton.

Margaritana rugosa, Bar. *Genesee river.*
Alasmodonta abducta, Say.
Unio rugosus, Chenu.
Complanaria rugosa, Swain.

PLATE I.

Mollusca of Monroe County.

1, 2.	Pleurocera subulare, Lea.
3.	" subulare var. pallidum, Lea.
4.	" " var. intensum, Lea.
5, 6.	Goniobasis depygis, Say.
7.	" semicarinata, Say.
8, 9.	" livescens, Menke.
10.	" gemma, DeKay. (DeKay's figure) a young subulare.
11, 12, 13.	Goniobasis virginica, Say.
14, 15.	" virginica var. multilineata, Say.



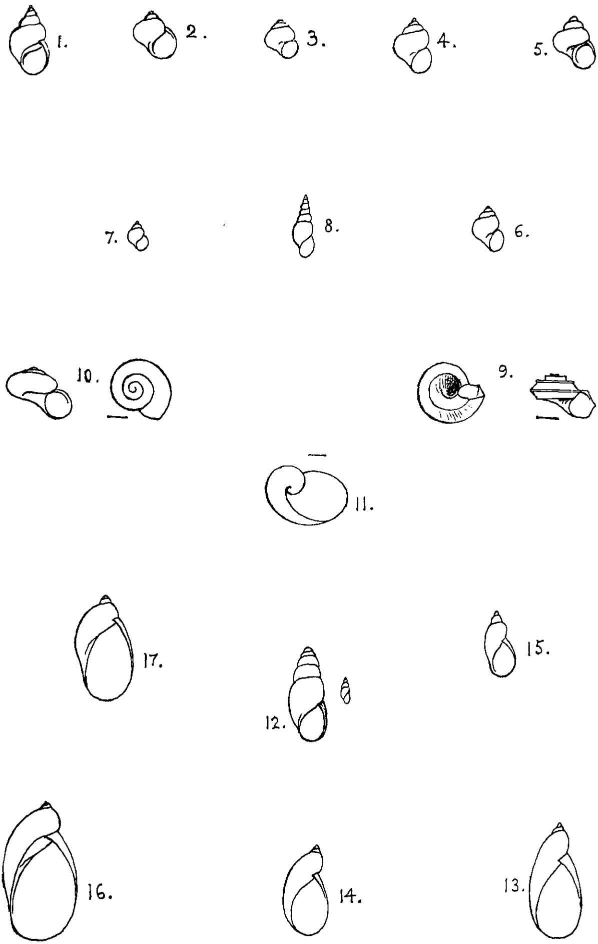
J. Walton, Del.

WALTON—MOLLUSCA OF MONROE COUNTY.

PLATE 2.

Mollusca of Monroe County.

1. Bythinia tentaculata, Lin.
2. Gillia altilis, Lea.
3. Amnicola limosa, Say.
4. " porata, Say.
5. " orbiculata, Lea.
6. " pallida, Hald.
7. " granum, Say.
8. Pomatiopsis lustrica, Say.
9. Valvata tricarinata, Say.
10. " sincera, Say.
11. Vitrina limpida, Gld.
12. Ferussacia subcylindrica, Lin.
13. Succinea ovalis, Gld.
14. " aurea, Lea.
15. " avara, Say.
16. " obliqua, Say.
17. " Totteniana, Lea.



J. Walton, Del.

WALTON—MOLLUSCA OF MONROE COUNTY.

PLATE 3.

Mollusca of Monroe County.

1.	Melantho	ponderosa, Say.	
2, 3.	"	ponderosa, Say.	After Binney.
4, 5, 6.	"	decisa, Say.	Says' figures, after Binney.
7.	"	" Say.	
8.	"	rufa, Hald.	
9.	"	decisa var. obesa, Lewis.	Lewis' type, after Binney.
10.	"	" heterostropha, Kirt.	
11, 12.	"	" var. genicula, Con.	
13.	"	" var. integra, Say.	

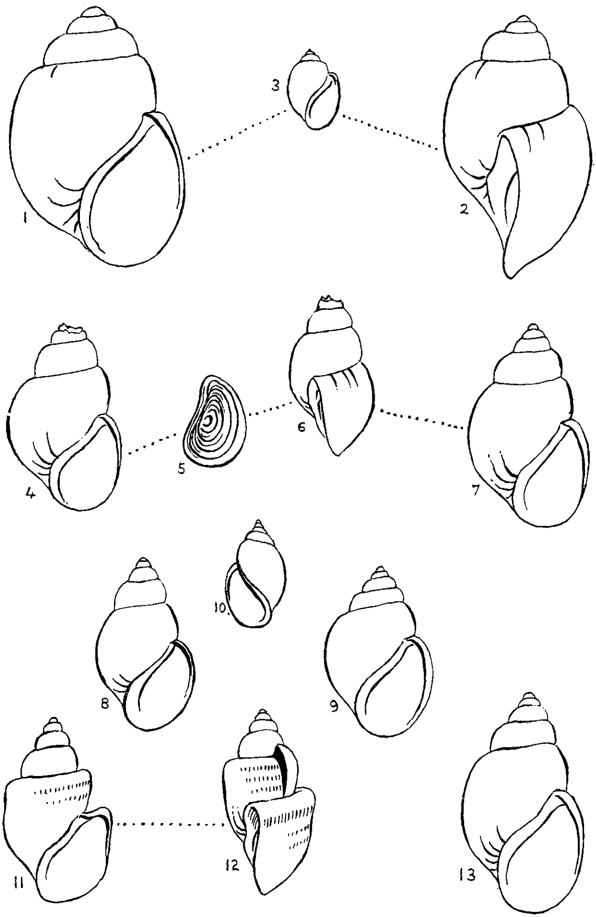


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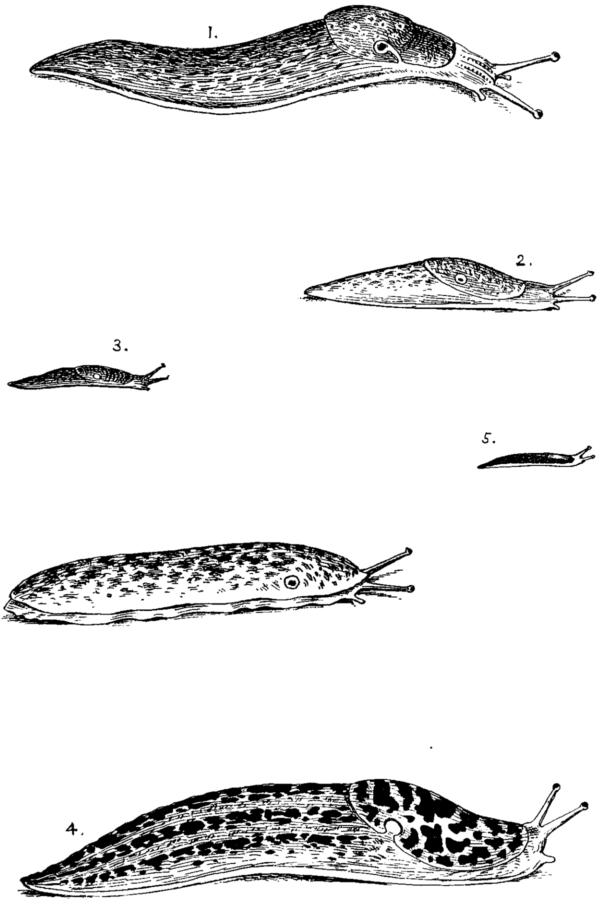
PLATE 4.

Mollusca of Monroe County.

1. Limax flavus, Lin.
2. " agrestis, Lin.
3. " campestris, Bin.
4. " maximus, Lin.
5. Tebennophorus dorsalis, Bin. After Binney's figure.
6. " caroliniensis, Bosc.



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WALTON—MOLLUSCA OF MONROE COUNTY.

PLATE 5.

Mollusca of Monroe County.

1. Pupa muscorum, Lin.
2. " pentodon, Say.
3. " contracta, Say.
4. " corticaria, Say.
5. " rupicola, Say.
6. " fallax, Say.
7. " armifera, Say.
8. Vertigo milium, Gould.
9 " simplex, Gld.
10. " ovata, Say.
11. Carychium exiguum, Say.

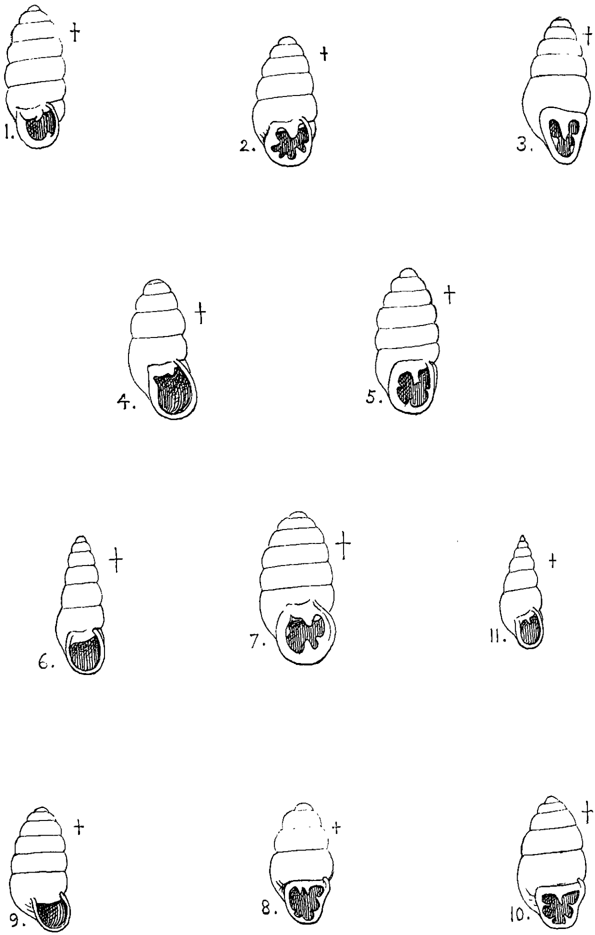

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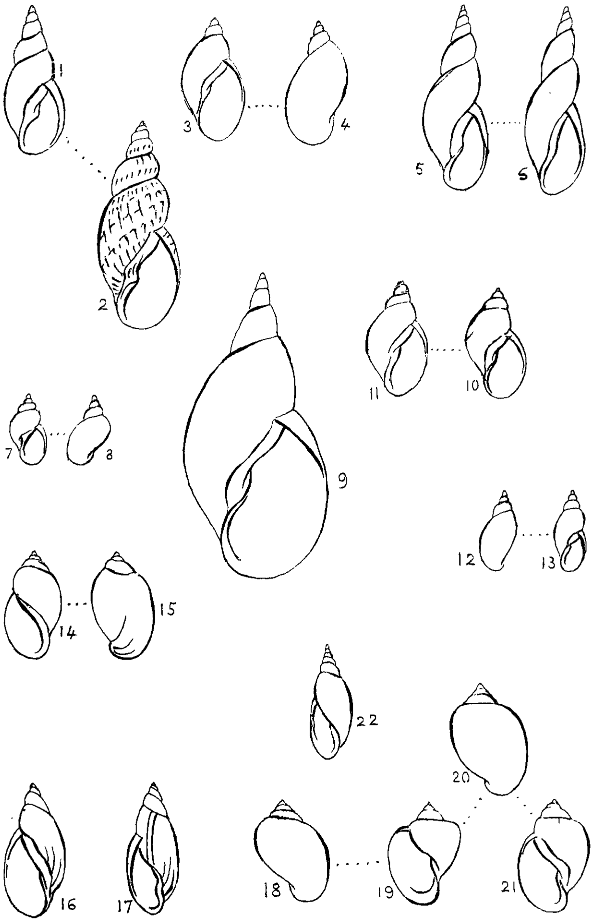
Plate 6.

Mollusca of Monroe County.

1. Limnæa elodes, Say. Say's figure, after Binney.
2. " " Say.
3, 4. " columella, Say.
5. " umbrosa, Say.
6. " reflexa, Say. Say's figure, after Binney.
7, 8. " desidiosa, Say.
9. " stagnalis, Lin.
10, 11. " catascopium, Say.
12, 13. " pallida, Ad.
14, 15, Physa heterostropha, Say.
16. " gyrina, Say.
17. " " var. Hildrethiana, Lea. Lea's figure, after Binney.
18–21. Physa ancillaria, Say.
22. Bulimus hypnorum, Lin.



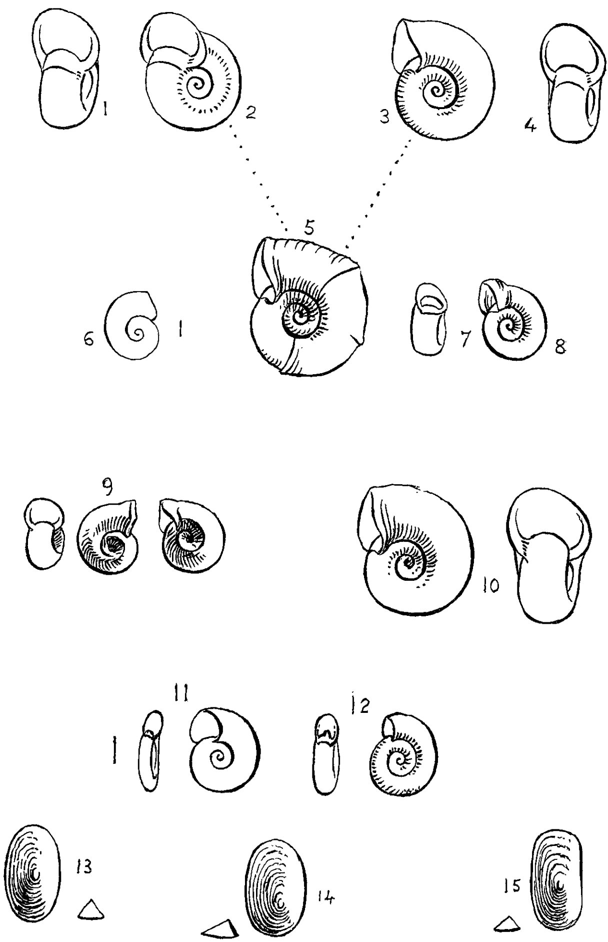
J. Walton, Del.

WALTON—MOLLUSCA OF MONROE COUNTY.

PLATE 7.

Mollusca of Monroe County.

1, 2.	Planorbis	trivolvis, Say. Say's figure, after Binney.
3, 4.	"	trivolvis, Say.
5.	"	megasoma, De Kay.
6.	"	parvus, Say.
7, 8.	"	campanulatus, Say.
9.	"	bicarinatus, Say.
10.	"	corpulentus, De Kay.
11.	"	deflectus, Say.
12.	Segmentina armigera, Say.	
13.	Ancylus tardus, Say.	
14.	"	rivularis, Say.
15.	"	paralellus, Hald.



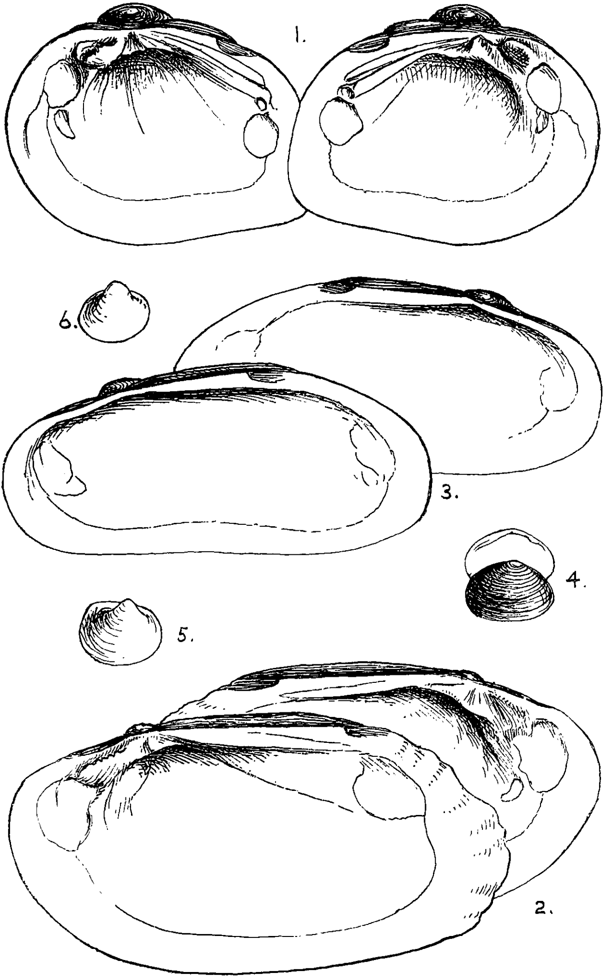
J. Walton, Del.

Walton—Mollusca of Monroe County.

Plate 8.

Mollusca of Monroe County.

1. Unio rubiginosus, Lea.
2. Margaritana rugosa, Bar.
3. Anodonta subcylindracea, Lea.
4. Sphærium similis, Say.
5. " partumeium, Say.
6. Pisidium variabile, Prime.



J. Walton, Del.

Margaritana deltoidea, Lea. *Erie canal.*
Alasmodonta deltoidea, Chenu.

Margaritana marginata, Say. *Erie canal.*
Alasmodonta truncata, Say.
Unio varicosa, Lam.
" *calceolus,* Say.
Alasmodonta corrugata, De Kay.

Anodonta Benedictii, Lea. *Erie canal.*
Anodonta cultrata, Gld.

Anodonta edentula, Say. *Long Pond.*
Anodonta areolata, Swain.
" *unadilla,* De Kay.
Alasmodonta rhombica, Anth.
Hemiodon areolatus, Swain.

Anodonta excurvata, De Kay. *Pittsford.*

Anodonta Ferussaciana, Lea. *Erie canal.*
Alasmodonta Ferussaciana, Kust.

Anodonta ferruginea, Lea. *Genesee river.*

Anodonta fluviatilis, Dill. *Allen's creek.*
Anodonta cataracta, Say.
" *marginata,* Say. Ads.

Anodonta fragilis, Lam. *Pittsford.*
Anodonta pallida, Anth.
" *imbricata,* Anth.
" *flava,* Anth.
" *glandulosa,* Anth.
" *irisans,* Anth.
" *subcarinata,* Currier.

Anodonta imbecillis, Say. *Irondequoit creek.*
Anodonta incerta, Lea.
" *horda,* Gld.

Anodonta implicata, Say. *Charlotte.*
Anodonta Newtoniensis, Lea.
" *implicata,* Gld.

Anodonta Lewisii, Lea. *Erie canal.*

Anodonta salmonia, Lea. *Erie canal.*

Anodonta subcylindracea, Lea. *Irondequoit creek.*

Anodonta undulata, Say.
Anodonta rugosus, Swain.
" *Pennsylvanica*, Lam.
Unio undulata, Desh.
Strophitus undulatus, Stimp.

Unio rosaceus is quite local. I have found it only at Long Pond and the margin of Lake Ontario, between Long Pond and Charlotte. De Kay's figures are very characteristic of all I have collected.

All our local species are found also in the canal and generally in much better condition than elsewhere, owing partly to the fact that the bottom of the canal is covered with a fine sediment of mud and partly to the quiet condition of the water.

The shells found in the canal only are common in the large lakes and their tributaries west of us, and doubtless reach here in their young state with the influx of the water in spring-time when the Erie canal is replenished.

Family CYRENIDÆ.

Sphærium similis, Say. (pl. 8, fig. 4.) *Erie canal.*
Sphærium partumeium, Say. (pl. 8, fig. 5.) *Genesee river.*
Pisidium variabile, Prime. (pl. 8, fig. 6.) *Brighton.*

The paper was illustrated by a collection of the shells of the various species, which collection Mr. Walton presented to the Academy.

Remarks were made upon the paper by Dr. Anna H. Searing, Mr. J. E. Putnam and the President.

A vote of thanks was tendered Mr. Walton for his valuable gift of the collection of Monroe County shells to the cabinet of the Academy.

Mr. J. E. Putnam discussed a recent paper in the Engineering News, on incandescent electric lighting.

NOVEMBER 9, 1891.

STATED MEETING.

The President, PROFESSOR H. L. FAIRCHILD, in the chair.

Sixty persons present.

The Council report recommended:

(1.) The payment of certain bills.

(2.) The election of the following candidates as resident members:

PROFESSOR ARTHUR L. BAKER,
MR. WALTER B. SMITH.

The bills were ordered paid, and the candidates were elected by formal ballot.

The President, PROFESSOR H. L. FAIRCHILD, presented a paper on

THE ORIGIN, STRUCTURE AND HISTORY OF MOUNTAINS.

The paper was illustrated by blackboard diagrams and lantern views.

NOVEMBER 23, 1891.

STATED MEETING.

The President, PROFESSOR H. L. FAIRCHILD, in the chair.

Forty-five persons present.

The following paper was read by title:

NOTES ON A COLLECTION OF SHELLS FROM THE MAURITIUS; WITH A CONSIDERATION OF THE GENUS MAGILUS OF MONTFORT.

BY FRANK C. BAKER.

Several months ago I had occasion to study a large collection of shells from the Island of Mauritius. These were nearly all fresh, live specimens, in many cases with the opercula *in situ*, and with the epidermis intact. The collection numbers some two hundred and fifty species, represented, in most cases, by a score or more individuals.

Many of the species enumerated have a very wide geographical distribution; as for example *Aplustrum physis*, found abundantly throughout the West Indies; and a number of the Cypræidæ, which are common to both the Mauritius and the New Caledonian Archipelago.

Unlike the larger island to the west, Madagascar, the Mauritius has very few species peculiar to itself, and those that are peculiar are mostly confined to the families Testacellidæ and Limacidæ. I believe the present collection to embody a larger number of species, represented by more numerous individuals, than any previous collection which has come to this country from this locality, and I feel that I have been especially favored in having the opportunity of studying it. I trust the following catalogue may be of some assistance to my brother students, who may be working upon the fauna of this interesting region.

Class GASTROPODA.

Order PULMONATA.

Family TESTACELLIDÆ.

1.	**Gibbus**	**Lyonetianus**, *Pallas*. Said to be somewhat rare.		
2.	"	**(Goniodomus) pagodus**, Fér.		
3.	"	**(Plicadomus) sulcatus**, Müller.		
4.	"	"	**Newtoni**, H. Adams.	
5.	"	**(Gonospira) modiolus**, Fér.		
6.	"	"	**Mondraini**, H. Adams.	
7.	"	"	**Barclayi**, H. Adams.	
8.	"	"	**mauritianus**, Morelet.	
9.	"	"	**modiolinus**, Morelet.	
10.	"	"	**teres**, Pfr.	
11.	"	"	**bacillus**, Pfr.	
12.	"	"	sp.	

Of the forty-eight species of Gibbus (not including the subgenus *Ennea* H. & A. Adams) known to science, twenty-one inhabit the Mauritius. All of the foregoing species are found abundantly distributed throughout the island.

Family LIMACIDÆ.

13. **Ariophanta (Cœlatura) scalpta,** *Martens.*

14. " **(Rotula) argenta,** Reeve.

15. " " **semicerina,** Morelet.

16. " " **implicata,** Nevill. An unfigured species said to be quite rare.

17. **Ariophanta (Pachystyla) inversicolor,** Fér. Very common.

18. **Ariophanta (Pachystyla) mauritiana,** Pfr. (=*leucostyla*, Pfr., which is the adult form, *mauritiana* having been described from a juvenile specimen.) Very common, associated with the preceding.

19. **Ariophanta (Caldwellia) philyrina,** Morelet. Rare.

It is rather unfortunate that the old and well-known name *Nanina* should have been changed to *Ariophanta*. *Nanina*, Gray, however, was described in 1834, while *Ariophanta*, des Moulins, was described in 1829, thus making the change necessary.

Family AURICULIDÆ.

20. **Melampus** sp. An abundant form which I have not been able to identify. It has much the appearance of *Melampas cylinaroides*, Mousson, from the Marquesas, but is not as elongate and has a much shorter aperture than that species.

Order OPISTHOBRANCHIATA.

Family APLUSTRIDÆ.

21. **Aplustrum aplustre,** Linn.

22. " **(Hydatina) physis,** Linn.

23. " **(Bullina) scabra,** Chemn. All very common. *Aplustrum physis* is also found in the West Indies.

Family BULLIDÆ.

24. **Acera soluta,** Chemn.

25. **Volvatella Cumingii,?** A. Adams. Found sparingly.

Family APLYSIIDÆ.

26. **Dolabella Rumphii,** Cuvier.

27. " **gigas,** Rang.

Both forms occur very abundantly.

Family UMBRELLIDÆ.

28. **Umbrella indica,** Lam. Very common.

Order CTENOBRANCHIATA.

Family TEREBRIDÆ.

29. **Terebra cingulifera,** Lam. Common.

30. " **cerithina,** Lam. This appears to be a very variable species if one can judge from the material at hand.

31. **Terebra duplicata,** Linn.

32. " **penicillata,** Hinds, var. **venosa,** Hinds. Quite abundant.

Family CONIDÆ.

33. **Conus musicus,** Hwass.

34. " **textile,** Linn., var. **archiepiscopus,** Hwass.

35. " **miliaris,** Hwass, var. **abbreviatus,** Nuttall.

36. " **propinquus,** Smith, (=*tenuisulcatus*, Sowb., preoccupied.)

37. **Conus rattus,** Hwass.

38. " **cernicus,** H. Adams, (does not = *balteatus* Sowb., as considered by some authors.)

39. **Conus catus,** Hwass.

40. " **varius,** Linn.

41. " **Janus,** Hwass. Very rare.

42. " **omaria,** Hwass.

" **omaria,** Hwass, var. **columbrinus,** Lam. Very rare.

43. **Conus Hebræus**, Linn.
" **Hebræus**, Linn., var. **vermiculatus**, Hwass.
44. " **maldivus**, Hwass.
45. " **lithoglyphus**, Meuschen.
46. " **miles**, Linn.
47. " **lividus**, Hwass.
48. " **quercinus**, Hwass.
49. " **betulinus**, Linn.
50. " **virgo**, Linn.
51. " **literatus**, Linn.
52. " **arenatus**, Hwass.
53. " **tessellatus**, Born.
54. " **striatus**, Linn.
55. " **imperialis**, Linn., var. **fuscatus**, Lam.

I am inclined to believe that the variety *viridulus*, Lam., should become a synonym of this variety.

The Mauritius seems to be the metropolis, almost, of the cones, for they are found there in great numbers, both as regards species and individuals. The specimens received from there seem to be in better condition than those received from other localities. All of the species enumerated above were received in considerable quantity.

Family PLEUROTOMIDÆ.

56. **Surcula bijubata**, Reeve. Common.
57. **Drillia** sp.
58. " **(Clavus) echinata**, Lam. Not common.
59. **Clathurella Robillardi**, Barclay.

Family CANCELLARIIDÆ.

60. **Cancellaria (Trigonostoma) scalata**, Sowb. Very common.

Family OLIVIDÆ.

61. **Oliva episcopalis,** Lam. The specimens before me show a great range of variation.

62. **Oliva irisans,** Lam., var. **erythrostoma**, Lam., (=*ponderosa*, Duc.)

63. **Oliva irisans,** Lam., var. **tremulina**, Lam. I have before me two distinct varieties of this species ; one light, with the zigzag markings very distinct, and the other very dark, almost black, so that the markings are scarcely visible.

64. **Oliva** sp. A distinct little shell, but one that I am unable to determine by any of the monographs. It is about an inch in length, of a cream color, with purple, zigzag, longitudinal lines. The interior of the aperture is salmon-colored. The shell looks as though it might be a young *irisans* var. *erythrostoma.*

65. **Ancilla (Anolacia) mauritiana,** Sowb., (= *torosa*, Meuschen.) A very common Mauritian species.

Family HARPIDÆ.

66. **Harpa minor,** Lam. Quite abundant.

Family MITRIDÆ.

67. **Mitra variegata,** Reeve.

68. " **eximia,** A Ad.

69. " **(Swainsonia) filum,** Wood.

70. " " **fissurata,** Lam.

71. " **(Cancilla) flammea,** Quoy.

72. " " **interlirata,** Reeve.

I should hardly include this in the synonomy of *flammea* as Tryon has done. The two shells seem, to me, to be quite distinct.

73. **Mitra (Cancilla) filaris,** Linn. Very common and large. There have been numerous varietal names attached to the various forms of this species, but I cannot see any differential characters. The species is indiscriminately long, short, thin or thick and I can see no good lines of demarcation.

74. **Mitra (Chrysame) ferruginea,** Lam. Quite abundant.

75. **Mitra (Chrysame) pellis-serpentis,** Reeve. A species subject to much variety.

76. **Mitra (Chrysame) turgida,** Reeve.

77. " " **tabanula,** Lam.

78. " " **coronata,** Lam.

79. " " **brumalis,** Reeve.

80. " **(Strigatella) acuminata,** Swains.

81. " " **tigrina,** A. Adams.

82. " " **litterata,** Lam.

83. **Dibaphus Philippii,** Crosse, (= *edentulus*, Swain.)

84. **Turricula lyrata,** Linn. A very common species.

85. " **(Costellaria) speciosa,** Reeve. Rare.

86. " " **militaris,** Reeve, var. **lubens,** Reeve.

87. **Turricula (Costellaria) clathrata,** Reeve.

88. " " **scitula,** A. Adams.

89. " " **Deshayesii,** Reeve.

I have before me a light and a dark variety of this species.

90. **Turricula (Pusia) gemmata,** Sowb.

No habitat is given in any of the monographs for this species.

91. **Turricula (Pusia) aureolata,** Swains.

92. " " **rubra,** Swains.

93. " " **pardalis,** Küster.

94. " " **nodosa,** Reeve.

95. **Cylindra crenulata,** Gmel.

The Mauritius seems to be the metropolis of the Mitridæ fully as much as of the Conidæ. Most of the species enumerated above are quite common, and are received from there in considerable quantities.

Family FASCIOLARIIDÆ.

96. **Fasciolaria (Pleuroploca) trapezium,** Linn.

Quite common. I have before me several large and fine specimens, measuring fully eight inches in length. This species is subject to some variety and on this account several specific names have been given to it, but they are seen to intergrade when an abundance of material is examined and the names therefore cannot stand.

97. **Latirus polygonus,** Gmel. Common.

98. " sp. Common.

99. " **(Peristernia) nassatula,** Lam.

A common shell, subject to extreme variation.

100. **Latirus (Peristernia) incarnata,** Desh. Common.

Family BUCCINIDÆ.

101. **Tritonidea undosa,** Swains.

102. **Pisania marmorata,** Reeve.

103. " **ignea,** Gmel.

All three of the above forms are abundantly represented. The specimens of *Tritonidea undosa* are exceptionally large and fine, and covered by a short, brown, silky epidermis.

Family NASSIDÆ.

104. **Buccinanops (Bullia) mauritiana,** Gray.

A very characteristic species, distinguished at once by the double callous running round the whorls, one above and one below the suture; the whorls are flat-sided instead of being rounded as in the nearly related species. *Buccinopsis Grayi*, Reeve, is probably synonymous.

105. **Nassa coronata,** Brug.

The characteristic light spiral bands, one above and one below the periphery, are not always developed, and the shell is then of a light drab color. The columellar callous is very large and spreading in the specimens before me.

106. **Nassa (Alectrion) hirta,** Kien., var. **crenulata,** Reeve.

I can scarcely consider *crenulata* an absolute synonym of *hirta* as Tryon has done.

107. **Nassa (Alectrion) papillosa,** Linn.

The specimens of this species are very large and fine, measuring nearly two inches in length. The shells are a beautiful flesh-color, and the columellar callous spreads over a considerable portion of the shell. They are much finer than any I have seen from any other locality.

108. **Nassa (Zeuxis) tænia.** Quite common and very large.

109. **Nassa (Zeuxis) gaudiosa,** Hinds. A species with upwards of fifteen synonyms.

110. **Nassa (Zeuxis) punctata,** A. Adams. Scarcely a synonym of *gaudiosa*. The shell is much longer in the spire, smoother and of a dark brown, almost black color, while *gaudiosa* is yellowish with reddish markings.

Family COLUMBELLIDÆ.

111. **Columbella turturina,** Lam.

112. " **(Conoidea) tringa,** Lam., (=*undata*, Duclos.) Both forms quite common.

Family MURICIDÆ.

Sub-family MURICINÆ.

113. **Murex (Pteronotus) triqueter,** Born. Very common. Usually received from Mauritius collectors under the name of *Cumingii*, A. Adams.

114. **Ocinebra pumila,** A. Adams. This species has not been heretofore reported from this region. It is a rare form, judging from the limited number of specimens received.

115. **Ocinebra (Favartia) brevicula,** Sowb. Unusually large and heavy.

116. **Trophon (Aspella) anceps,** Lam. A common form. This species has usually been considered a Ranella, but is more properly placed in Trophon on account of its dentition.

Sub-family PURPURINÆ.

117. **Purpura Persica,** Linn.

118. **Iopas sertum,** Brug.

119. **Vexilla vexillum,** Chemn. These three forms were received in considerable quantities.

120. **Pentadactylus digitatus**, Lam.

" " " var. **lobatus**, Blaino.

121. " **(Morula) cancellatus**, Quoy.

122. " " **undatus**, Chemn.

The above four forms seem to be quite common.

Sub-family CORALLIOPHILINÆ.

123. **Coralliophila exarata**, Pease.

124. " **costularis**, Lam.

125. " **(Coralliobia) fimbriata**, A. Adams.

126. " " **Robillardi**, Liénard.

This group (Coralliobia) was made a sub-genus of Concholepas by the Messrs. Adams, but I agree with Fischer (Manuel de Conchyliologie, p. 647), in considering it a sub-genus under Coralliophila. Tryon (Manual of Conchology, p. 217), makes it a synomym of Magilus, a decision in which I can by no means concur. In the material before me, I am able to distinguish two forms, one (*fimbriata*, A. Ad.,) distinguished by heavy spiral ribs and by the apex being visible and a little raised above the body-whorl, while the other (*Robillardi*, Liénard) is distinguished by numerous spiral lines and by the apex being covered by the body-whorl. I have seen a large number of both of these forms and this distinction holds good throughout the entire series.

127. **Magilus antiquus**, Lam.

128. **Leptoconchus Cumingii**, Desh.

129. " **Maillardi**, Desh.

The Magili are well represented, both in species and specimens, from the young individual of paper-like consistency, to the adult animal with a tube nearly or quite a foot in length.

Family IANTHINIDÆ.

130. **Ianthina fragilis**, Lam., var. **trochoidea**, Reeve.

131. " **globosa**, Linn.

Both forms are very abundant. This genus is subject to such extremes of variation, that it is almost an impossibility to give a diagnosis that will cover one form and exclude all the rest. On this account a large number of specific names have been proposed, amounting to fifty or more, but of these only three can be satisfactorily separated as distinct species, with the addition of four varieties.

Family SCALIDÆ.

132. **Scala rubrolineata,** Sowb.

133. " **(Opalia) lamellosa,** Lam. Both very common.

Family EULIMIDÆ.

134. **Stylifer speciosus,** H. Adams.

135. " sp.

136. **Eulima major,** Sowb. Vide Thes. Conch. t. 169, *f* 4. A species received in considerable numbers from Mauritius collectors. *Eulima arcuata*, Sowb., is said to be a synonym.

137. **Eulima Cumingii,** A. Adams.

Family PYRAMIDELLIDÆ.

138. **Pyramidella dolabrata,** Linn., var. **terebellum,** Müll. A common form, very large and with the spiral chocolate-colored bands very deep and conspicuous.

Family TRITONIDÆ.

139. **Triton tritonis,** Linn. Several small specimens averaging six inches in length.

140. **Triton (Simpulum) pilearis,** Linn. A large number received, including the forms *aquatilis*, Reeve, and *intermedius*, Pease, which are by some authors considered distinct. I can see no good characters by which to separate them.

141. **Triton (Simpulum) rubecula,** Linn.

A beautiful set. Some specimens have black blotches between the spiral ribs.

142. **Triton (Simpulum) gemmatus,** Reeve.

143. " **(Cabestana) labiosus,** Wood.

144. " **(Ranularia) tuberosus,** Lam. From the description, I should say that *T. mauritianus*, Tapparone-Canefri, described without figure, should be placed here as a synonym.

145. **Triton (Colubraria) maculosus,** Gmel.

146. " " **obscurus,** Reeve.

147. " " **decapitatus,** Reeve.

148. **Ranella (Lampas) lampas,** Linn.

149. " " **bufonia,** Gmel.

150. " " **cruentata,** Sowb.

151. " " **granifera,** Lam.

152. " " **affinis,** Brod.

I believe the last two species to be synonymous. The only difference seems to be the larger size of the tubercles in *affinis*.

153. **Ranella (Lampas)** sp.

This specimen was covered with stony algæ, and no characters could be made out.

154. **Ranella (Argobuccinum) pusilla,** Brod. A beautiful little species which does not seem to be at all common.

Family CASSIDIDÆ.

155. **Cassis (Casmaria) vibex,** Linn.

Family DOLIIDÆ.

156. **Dolium perdix,** Linn.

This species enjoys a wide distribution, being found in the Indian Ocean, Polynesia, West Africa, West Indies, Brazil and the Mauritius.

Family CYPRÆIDÆ.

157. **Cypræa scurra,** Chemn. Exceptionally large and fine. Not before reported from the Mauritius.

158. **Cypræa fimbriata,** Gmel. The violet painting of the extremities of the shell is very conspicuous.

159. **Cypræa felina,** Gmel.

160. " **hirundo,** Linn.

161. " **Oweni,** Sowb.

These three forms are very common.

162. **Cypræa caurica**, Linn. Dwarfed variety.
163. " **cruenta**, Gmelin.
164. " **stolida**, Linn.
165. " **mauritiana**, Linn. Very common.
166. " **tigris**, Linn. Very large and fine.
167. " **undata**, Lam.
168. " **clandestina**, Linn.
169. " **punctata**, Linn. Very small.
170. " **cribellum**, Gask.
171. " **esontropia**, Ducl.
172. " **Menkeana**, Desh.
173. " **tabescens**, Sol.
174. " **nucleus**, Linn.
175. " **cicercula**, Linn.
176. " **Adansoni**, Gray. Very rare.
177. **Trivia oryza**, Lam.
178. " **tremeza**, Duclos.

Of the two hundred described species of the family, fifty have been reported from this region and twenty-two are included in this catalogue. In examining a collection from New Caledonia I was very much astonished to find a number of species of the Cypræidæ, (as well as other groups) common to both localities; this is quite a range of geographical distribution.

Family STROMBIDÆ.

179. **Strombus (Euprotomus) lentiginosus**, Linn. Very common.

180. **Strombus (Monodactylus) auris-Dianæ**, Linn.

181. " **(Canarium) hæmastoma**, Sowb. A beautiful species; the surface is closely set with spiral lines and the longitudinal costæ are small and numerous. The columella is of a bright red. A common form.

182. **Strombus (Canarium) gibberulus,** Linn.

183. " " **Samar,** (Chemn.) Dillw.

184. " **(Conomurex) mauritianus,** Lam.

This last is a very common and a very characteristic species of the region ; it is very closely allied to *Strombus luhuanus*, Lin.; but is at once distinguished by the black deposit on the columella.

185. **Pterocera (Millipes) violacea,** Swains.

186. " " **elongata,** Swains.

187. " **(Harpago) rugosa,** Sowb.

The above three species were represented by a number of individuals.

Family CERITHIIDÆ.

188. **Cerithium nodulosum,** Brug.

189. " **echinatum,** Lam.

190. " **(Vertagus) asper,** Linn.

191. " " **obeliscus,** Brug. The smaller form called by Sowerby *cedo-nulli.*

192. **Cerithium (Vertagus) Kochii,** Phil. Said to be quite rare.

Family LITORINIDÆ.

193. **Litorina (Melaraphe) scabra,** Linn. A very common species of wide distribution.

Family CALYPTRÆIDÆ.

194. **Mitrularia tectum-Sinense,** Lam.

Family XENOPHORIDÆ.

195. **Xenophora caperata,** Phil.

Family NATICIDÆ.

196. **Natica marochiensis,** Gmelin. Very common. This species, with its varieties, is found in almost every quarter of the globe.

197. **Natica (Mamma) mamilla,** Linn.

198. **Natica (Mamilla) melanostoma,** Gmelin.

199. " " **maura,** Brug.

200. **Sigaretus planulatus,** Recl.

Family LAMELLARIIDÆ.

201. **Lamellaria (Chelynotus) Berghi,** Desh. A common form.

Family NERITIDÆ.

202. **Nerita albicilla,** Linn. Numerous specimens received.

203. **Nerita (Odontostoma) polita,** Linn. The specimens from the Mauritius are of a uniform gray, mottled with black, and do not seem to vary to any extent.

204. **Neritina gagates,** Lam. Quite a variable species and one very common to the region.

205. **Neritina (Clithon) longispina,** Recluz.

206. " " " var. **mauritiana,** Morelet.

The variety is often twice the size of the typical form and destitute of spines, or at least with an occasional single spine on the shoulder. Very common.

207. **Neritina (Alina) mauritii,** Lesson. Quite well known under the name of *sandwichiensis*, Desh., which is a synonym. Only three specimens received.

208. **Septaria (Elara) suborbicularis,** Sowb.

Family NERITOPSIDÆ.

209. **Neritopsis radula,** Linn. Not uncommon.

Family TURBINIDÆ.

210. **Turbo petholatus,** Linn. The specimens before me are much darker than is usual with this species and are highly polished.

211. **Turbo Japonicus,** Reeve. This shell was described as from Japan, but Sowerby says it is from the Mauritius only. I have never seen one from Japan but have seen numerous specimens from the Island of Mauritius.

212. **Turbo argyrostomus,** Linn.

213. **Turbo setosus,** Gmelin. Both of the above forms were received in considerable numbers.

214. **Tubo radiatus,** Gmel.

Family TROCHIDÆ.

215. **Trochus (Cardinalia) virgatus,** Gmel. Does not seem to be common.

Family HALIOTIDÆ.

216. **Haliotis pustulata,** Reeve. A very variable species received in considerable quantity, and allied to *H. varia*, Linn., but separated from that species by the flattened cords of the surface.

Family FISSURELLIDÆ.

217. **Glyphis Rüppellii,** Sowb. A very common species.

Order POLYPLACOPHORA.

Family CHITONIDÆ.

218. **Acanthopleura borbonica,** Desh. A very common species, very like *Chiton piceus*, Gmelin, from the West Indies.

219. **Chiton** sp. A small species which I was not able to identify.

Class PELECYPODA.

Family OSTREIDÆ.

220. **Ostrea** sp. Small specimens, evidently young individuals, found attached to floating pieces of pumice stone.

Family SPONDYLIDÆ.

221. **Spondylus coccineus,** Lam. Very common.

Family PECTINIDÆ.

222. **Pedum spondyloideum,** Gmelin. Not a common species.

Family AVICULIDÆ.

223. **Avicula (Meleagrina) margaritifera,** Linn.

A number of fine, handsome specimens were in this collection.

224. **Avicula (Meleagrina) Martensi,** Dkr.

A very common form.

225. **Vulsella (Madrela) spongiarum,** Lam.

A number of this form were contained in the collection imbedded in a sponge.

226. **Perna ephippium,** Linn. Judging from the scarcity of this species in collections from the Mauritius, this form must be quite rare at that locality.

Family MYTILIDÆ.

227. **Modiola** sp. A small form which I was not able to satisfactorily identify.

Family ARCIDÆ.

228. **Arca revelata,** Desh.

229. " **(Barbartia) velata,** Sowb.

Neither of the above forms seem to be at all common, judging from the number received.

Family CARDIIDÆ.

230. **Cardium (Trachycardium) mauritianum,** Desh.

231. " " **bicolor,** Sowb.

232. " " sp.

233. " **(Papyridea) papyracea,** Chemn.

All the above more or less common.

Family CYPRINIDÆ.

234. **Libitina guinaica,** Lam.

235. " **angulata,** Lam. Not common.

Family LUCINIDÆ.

236. **Lucina tigrina,** ? Linn. I am not certain that this is the same as our West Indian *tigrina*, but the characters are so nearly alike, that if the two forms were mixed, it would be impossible to separate them.

237. **Lucina** sp. A small form which I was not able to identify.

Family VENERIDÆ.

238. **Meretrix (Lioconcha) tigrina,** Lam. A species of great variation of color pattern.

239. **Meretrix (Pitar) læta,** Linn.

240. **Circe (Crista) pectinata,** Linn.

241. **Dosinia variegata,** Gray. A small species, apparently very common.

242. **Venus (Chione) toreuma,** Gould.

243. " " **Listeri,** Gray.

244. **Tapes litterata,** Linn.

All the above species were well represented in the collection by a number of individuals.

Family DONACIDÆ.

245. **Donax abbreviatus,** ? Lam.

246. " sp. Both common.

Family TELLINIDÆ.

247. **Tellina (Tellinella) rugosa,** Born.

248. " " **virgata,** Linn.

249. " **(Liotellina) radiata,** Linn.

250. " **(Acropagia) scobinata,** Linn.

The above four forms were received in moderate quantity; the Tellinas do not seem to be abundant at the locality where these were obtained.

Family SEMELIDÆ.

251. **Semele borbonica,** Desh. Quite rare.

Revision of the genus Magilus of Montfort.

The genus Magilus has been somewhat of a puzzle, in many respects, to Conchologists, and from its varying habits and the paucity of material at the disposition of the student many errors in description have arisen. In the collection of shells dwelt upon in the first part of this paper, was a suite of over a hundred Magili in all stages of development from the very young shell, so thin and fragile that it seemed as though a breath would break it, to the adult animal with a heavy tube over a foot in length. From this collection and from a number of specimens in my own collection, I have drawn up the following notes:

Messrs. H. and A. Adams, in their "Genera of Recent Mollusca," following Rüppell, distinguished the genus Leptoconchus from Magilus, the differential characters being that Magilus formed a tube and possessed an operculum while Leptoconchus did not; many of the full grown specimens of *Magilus antiquus* before me are strongly suggestive of some of the species included by these authors in Leptoconchus. However, should this character of the absence of operculum prove constant, after the examination of a large quantity of fresh material, the two genera should by all means be separated.

Dr. Paul Fischer, in his Manuel de Conchyliologie, p. 648, separates the two genera on account of the absence of the operculum in Leptoconchus, but acknowledges the difficulty of affixing the generic value.

The animal of Leptoconchus is described as having a greatly thickened and fleshy mantle margin; tentacles small, broad and united at their bases; eyes small and black, on the outer side of the tentacles, near their tips; foot small, short, obtuse and rounded behind, with a thin, expanded disc-like lobe in front; the siphon is obsolete. Of four individuals examined by Rüppell two were males and two females. The males were characterized by the presence of a straight, acuminate verge, swollen and club-shaped at the extremity, placed on the right side of the body. The presence of such an organ in a fixed animal is very extraordinary and requires further investigation.

Troschel was unable to discover any indication of armature upon the lingual ribbon; but this fact might be accounted for by their sedentary habits, which would do away with the need of such an organ, as their food must necessarily be brought to them by the currents; and as they are attached, their food must be of a small, almost microscopic character, as active animals could easily escape them, and so the radula would gradually become reduced to a rudiment through disuse, although the ancestral form might have possessed a very complicated lingual apparatus.

The Magili are so irregular in their growth that other than purely conchological characters must be used for their certain identification, and, while the shells possess some very good characters, I believe that the animal and operculum should be given an equal place in the diagnostic characters.

In the following notes I shall endeavor to establish the synonomy as well as my material, which is unusually abundant, will permit, but until the anatomy of all the forms is thoroughly worked out and their life history studied we cannot hope for anything more than a provisional classification.

Genus MAGILUS, Montfort.

Conch. Syst., 43, 1810.

Campulotus, Guettard, (part) Mém. 3, 540, 1786.

In this genus the animal becomes fixed to some coral (*Meandrina*) and in the adult stage forms a tube and possesses an operculum.

Magilus antiquus, Lam. Pl. 9, f. 1, 2, 3.

An. sans Vert., 2d edition, V, 639.

Magilus costatus, Sowb., Conch. Icon., sp. 5, 1872.

Campulotus Cumingii, H. and A. Ad., Zool. Proc., 430, 1863.

Magilus Cuvieri, Desh., Conch., Réunion, 128, t. 13, f. 6, 7.

Magilus Djedah, Chenu, Ill. Conch., t. 1, f. 3, 4.

Magilus ellipticus, Sowb., Genera, No. 21.

Magilus microcephalus Sowb., Conch. Icon., sp. 3, 1872.

Leptoconchus oblongus, Sowb., H. and A. Adams, Genera 1, 138.

Leptoconchus Peroni, Lam., An. sans Vert., 2d edition, t. 5, p. 639.

Leptoconchus rostratus, A. Ad., Ann. Mag. N. H., 3d ser., XIII, 310, 1864.

Magilus Rüppellii, Desh., Zool. Proc., 105, 1843.

Leptoconchus Schrenkii, Lischke, Mal. Blatt., XVIII, 40, 1871; Jap. Moll., Sup., 45, t. 4, f. 9, 10.

Magilus serratus, Desh., Sowb. in Conch. Icon., sp. 8, 1872.

Leptoconchus serratus, Rüppell, A. Adams, Ann. Mag. N. H., 3d ser., XIII, 310, 1864.

Magilus striatus, Rüppell, Trans. Zool. Soc., 1, 259, t. 35, f. 9, 10.

Magilus tenuis, Chenu. Ill. Conch., t. 1, f. 8 a.

I have before me seventy specimens of this species in every degree of growth from young to adult, so that I am able to place in the synonomy several species which, from the published figures, seem quite distinct. The *M. costatus* of Sowerby I am able to connect with *antiquus* through a very extensive set of specimens which shows that the ribs, on which the species is founded, are but pronounced examples of the spiral striæ so characteristic of *antiquus*.

One very young form before me is smooth, and very much like *Rapa papyracea* in form. The young shells show a great variety in sculpture, from almost smooth, to a wonderful degree of scabrosity. As the shell gets older and prepares to settle down, it thickens the aperture, and the lines of growth become thicker and more crowded together; as it forms its tube it widens the aperture and starts a keel from the base of the columella, which is persistent throughout the life of the animal. The tubes are often twisted into many different shapes, some twisting in a cork-screw-like manner and others simply bending or curving; still others are nearly straight.

Many of the larger tubes are quite heavy and one now before me must weigh nearly a pound, and measures ten inches in length, although somewhat curved, and would measure a foot if straightened out.

One of the specimens fortunately contained the operculum; this is oval, concentrically laminated, twelve mill. in length and six in width; the nucleus is lateral. It is much too small for the aperture of the tube, and would seem to be of but little use to the animal.

M. Rüppellii, (pl. 8, f. 5) Desh., may be retained as a variety characterized by a narrower shell and longer aperture.

Genus LEPTOCONCHUS, Rüppell.

In this genus the adult does not (is not known to) form a tube and there is no operculum; otherwise the animal resembles that of Magilus.

Leptoconchus Cumingii, Desh., Pl. 9, f. 4, 6. Conch. Ile Réunion, 125, t. 12, f. 340, 1863.

Magilus antiquus, Sowb., Conch. Icon., f. 1 b.

Magilus globulosus, Desh., Sowb. in Conch. Icon., sp. 10, 1872.

I have before me ten specimens which seem to represent this species. *Cumingii* is a more elongate, less rounded shell than *Magilus antiquus;* the spire is more or less conical and the whole shell is bullet shaped, or like a minie-ball; the longitudinal sculpture consists of close set lines of growth which are raised into scales at the suture. The aperture is about as long as the spire, oblong-oval in outline, well rounded below and a little pointed above; the columella is rounded, smooth and covered with a heavy, wide-spreading callus.

Some specimens of *Magilus antiquus*, with a tube just started, are strongly suggestive of this species, in the somewhat raised spire. It is difficult, however, to decide whether this is a deflection due to the formation of the tube or is a true *Cumingii.*

Leptoconchus Maillardi, Desh. Pl. 9, f. 7. Conch. Ile Réunion, p. 217.

Magilus Lamarckii, Desh., Conch. Ile Réunion, p. 127 t. 12, f. 1–3.

Magilus solidiuscula, Pease, Sowb. in Conch. Icon., sp 12, 1872.

This species has a pointed spire and aperture and is in a general way spindle shaped. The aperture is long and pointed and about twice the length of the spire; the sculpture consists of longitudinal growth lines, close set and slightly raised into scales at the sutures; the spiral sculpture consists of heavy, squamose liræ with interstices of the same width as the liræ between them; the columellar is rounded and covered with a spreading callus.

I have before me over a dozen specimens of this species and I have no difficulty in separating them at once from any of the related species. In none of the specimens examined have I seen anything approaching the formation of a tube as in Magilus.

Mr. Arthur L. White read a paper entitled:

A DISCUSSION OF THE RECENT EXPERIMENTS ON THE ARTIFICIAL PRODUCTION OF RAIN.

The paper was illustrated by blackboard diagrams, maps and an air pump.

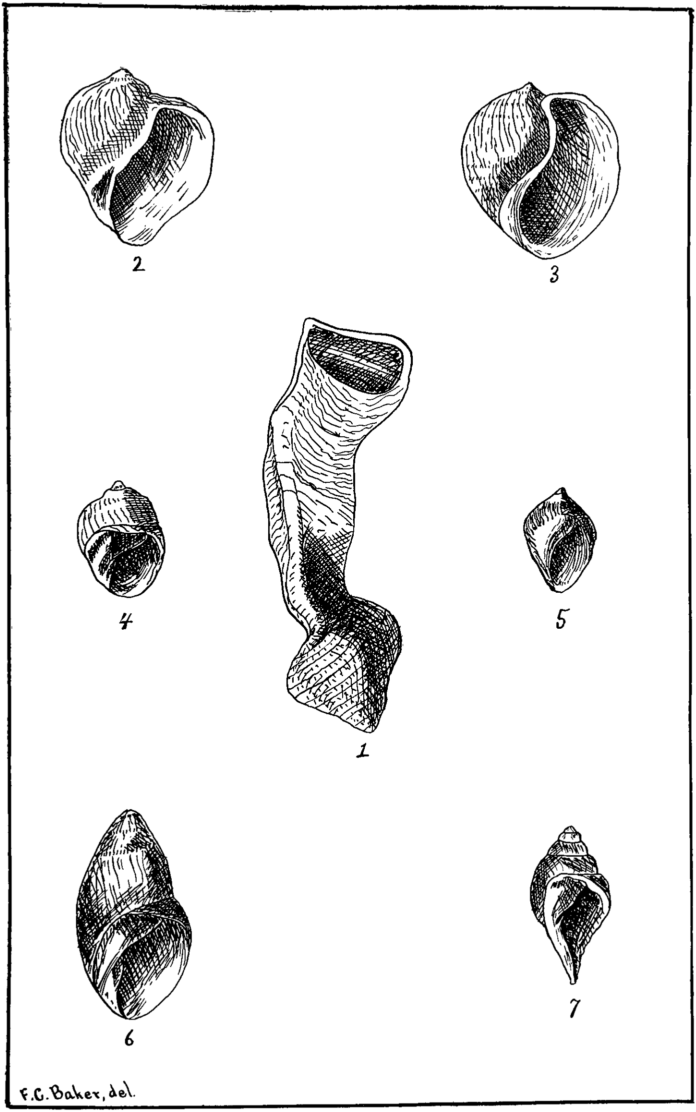
Dr. M. A. Veeder, Mr. Menzo Van Voorhis, the President and others participated in the discussion of the paper.

PLATE 9.

Revision of the Genus Magilus, &c.

1. Magilus antiquus, Lam. Adult form with tube.
2. " antiquus, Lam. Juvenile.
3. " antiquus, Lam. Juvenile. A more rounded form than number 2.
4. Leptoconchus Cumingii, Desh. A depressed form.
5. Magilus antiquus, Lam, var. Rüppellii, Desh.
6. Leptoconchus Cumingii, Desh. Typical form.
7. Leptoconchus Maillardi, Desh.

ALL THE FIGURES ARE NATURAL SIZE.



Baker—Revision of the Genus Magilus, Etc.

DECEMBER 14, 1891.

STATED MEETING.

The President, PROFESSOR H. L. FAIRCHILD, in the chair.

Thirteen persons present.

The Council report recommended :

(1.) The election of the following candidates as resident members.

MRS GEORGE KING,
SERG'T ARTHUR L. WHITE,
MR. C C. LANEY,
MRS. KATHERYN C. MAHON,
MR. GEORGE M. ELLWOOD.

(2.) The payment of certain bills.

(3.) That the Council be authorized to employ a clerk at a salary not to exceed one hundred dollars per annum.

The candidates were elected by a formal ballot, the bills ordered paid and the Council authorized to employ a clerk.

The Council also reported the formation of a committee on entertainment for the reception of the American Microscopical Society in August, as follows :

Chairman, DR. M. L. MALLORY,

CHARLES E. ALLING,
ED. BAUSCH,
A. M. DUMOND,
PROFESSOR S. A. ELLIS,
PROFESSOR S. A. LATTIMORE,
J. EDWARD LINE,
GEORGE W. RAFTER,
J. EUGENE WHITNEY,
DR. J. L. ROSEBOOM,
DR. CHARLES R. SUMNER,
J. M. DAVISON,
ED. E. BAUSCH,
GEORGE R. BAUSCH,
GEORGE W. GOLER,
CARL LOMB,
HENRY LOMB,
RUDOLPH SCHMIDT,
WILLIAM STREETER,
PROFESSOR Z. F. WESTERVELT.

The Secretary, MR. FRANK C. BAKER, gave a lecture on

THE DIGESTIVE SYSTEM OF THE MOLLUSCA.

The subject was illustrated by charts and diagrams.

JANUARY 11, 1892.

THIRTEENTH ANNUAL MEETING.

The President, PROFESSOR H. L. FAIRCHILD, in the chair.

Thirty-one persons present.

The Council report recommended the election of the following candidates as resident members :

DR. P. MAX FOSHAY,
MISS GEORGIANA C. STONE,
MR. ARTHUR R. SELDEN.

The candidates were elected by formal ballot.

The annual reports of the officers and sections were presented.

SECRETARY'S REPORT.

The report of the Secretary, MR. FRANK C. BAKER, is summarized as follows :

During the past year seventeen meetings have been held, at which the average attendance has been fifty-three.

Twenty resident members and one honorary member have been elected and six resignations have been accepted. Six members have been made fellows.

Nineteen papers have been read and six lectures have been given before the Academy during the year. The papers are classified as follows :—Zoölogy five ; Geology and Mineralogy, each three ; Archæology and Botany, each two ; Chemistry, Astronomy, Meteorology and Photography, each one. Of the six lectures three were on Geology, two on Geography and one on Zoölogy.

Two valuable collections have been added to the Cabinet of the Academy this year. PROF. A. L. AREY presented a complete set of specimens illustrating the local Palæontology. MR. JOHN WALTON has given a collection of shells representing the Molluscan fauna of Monroe County.

LIBRARIAN'S REPORT.

The following is an abstract of the report of the Librarian, MISS MARY E. MACAULEY:

Number of bound volumes received during 1891	20
Number of pamphlets	590
Total accessions for the year	610
Whole number of bound volumes in library	82
Whole number of pamphlets	939
Total	1021

Many of the accessions have been the transactions of societies, and these contain many exceedingly valuable papers. Noteworthy additions have also been received from the Smithsonian Institute, the Department of Agriculture and the New York State Museum.

TREASURER'S REPORT.

The Treasurer, MR. E. E. HOWELL, having removed to Washington during the year, no report was made at the annual meeting, but subsequently a report was sent, of which the following is a summary:

Receipts.

Balance from 1890	$ 73.85	
From initiation fees and annual dues	287.00	
From interest	6.28	
Total		$367.13

Expenditures.

Notice of meetings, stationery, postage and various incidental expenses	$167.11	
*Illustrations for proceedings (Brochure 2)	31.50	
Author's reprints of papers	24.00	
Total		$222.61
Balance in treasury		$144.52

* It may be of some interest to state the total cost of Brochure 2 of the first volume of Proceedings, most of which has been paid since the annual meeting. The cost of printing was $204.97; of illustrations, $31.50; and of author's reprints, $24.00; total $260.47. [Ed.]

REPORT OF THE SECTION OF BOTANY.

Read by MRS. J. H. MCGUIRE, Recorder of the Section.

The officers of the Section are: Miss Mary E. Macauley, President; Miss Florence Beckwith, Vice-President; Mrs. J. H. McGuire, Recorder.

Extracts from the Minutes of the Section.

January 16, 1891. Microscopical studies. Mr. Streeter exhibited the streaming of protoplasm in the cells of the Onion. The cyclosis was very well marked. He also exhibited the fibro-vascular bundle in Bryony and a section of Pteris, showing fibro-vascular bundle in underground stem and also the scalariform and sieve tissues; intercellular spaces of leaf-stalk of Water-lily and Rush; epidermis of Narcissus; epidermis of Cabbage; sections of Cedar showing the pitted vessels and the medullary rays.

February 13, 1891. Mr. Dumond exhibited a growing plant of Dandelion with blossoms and fruit. The plant was found in a crevice of a brick wall. The microscopical studies were: soft tissue of pith of Elder; thick-angled tissue of flowering stalk of Rose; stony tissue of Black Walnut; bast and wood fibre; tissue of Soft Maple, showing bordered pits; bast tissue of *Abutilon;* milk tissue of Salsify root, showing starch grains; and sieve tissue of Pumpkin stem.

February 27, 1891. Mr. Dumond showed stomata of Oleander in which the guard cells were found in a depression which extended into the palisade tissue. The depression was lined with hairs, completely concealing the stomata which could only be seen in a cross section. Bone shaped starch granules were shown in Euphorbia. Specimens of *Jungermannia reptans*, *J. trichophylla*, *J. curvifolia* and *Sphagnum cymbifolium*, found in Bergen by Mr. Booth, and mounted by him, were exhibited. Miss Beckwith exhibited *Poa annua*, and reported Chickweed in blossom February 24.

March 27, 1891. Mr. Dumond exhibited two specimens of *Protococcus nivalis*, cultivated by him under varying conditions. One specimen was grown in Hemlock Lake water, the other in water from ice. The latter showed a much more abundant growth than the former. Mr. Dumond also exhibited *Batrachospermum monilliforme.*

Mr. Streeter exhibited a specimen of Alga, having some resemblance to water-flannel. It was reserved for future study. Miss Beckwith reported Chickweed in blossom March 12.

April 10, 1891. A specimen of Tetraspora was examined. The characteristic division by fours was well defined. Other microscopical studies were, epidermis of Century plant, showing needle-shaped crystals and the parenchyma tissue; section of petiole of Verbena showing fibro-vascular bundles; *Drapernaldia glomerata.*

April 10, 1891. Mr. Streeter reported results of study of *Ulothrix zonata.* He had secured a specimen which had completed the stage of conjugation, and was growing vigorously. It had millions of Euglena, which again developed into the resting condition of Protococcus. These changes seemed to him to be identical with the processes of growth of *Batrachospermum monilliforme*, *Drapernaldia glomerata*, *Spirogyra* and others. These observations suggest the idea of a common origin.

April 24, 1891. A large number of spring blossoms shown by members of the Section. Among the microscopical studies was a fine specimen of Peziza. The spore sacs were well defined. The Alga resembling water flannel, referred from a former meeting, and now in a more advanced stage of growth was pronounced to be *Ulothrix zonata.*

May 8, 1891. A fine specimen of Jeffersonia found by Mr. Walton near Pittsford, was exhibited.

Among other spring flowers, five varieties of violet were exhibited, viz: *V. palmata*, *V. cucullata*, *V. blanda*, *V. rostrata*, *V. pubescens.*

A stipe was shown upon which a large number of diatoms were growing.

May 22, 1891. Miss Macauley showed *Floerkia proserpinacoides* found near Fairport, and never before brought to the Section.

May 29, 1891. Miss Beckwith exhibited leaf of Jeffersonia, measuring 6 inches by 4 inches, *Viola palmata*, *V. hastata*, *V. rostrata*, *V. cucullata*, *Camelina sativa*, *Cypripedium pubescens.*

Mr. Dumond exhibited an abnormal plant, destitute of chlorophyll, although growing from a corm, and having roots. Two leaves were developed and a third was partially grown. No one recognized the plant, and its lack of color was the subject of various conjectures.

June 24, 1891. A number of plants found at Bergen were examined, the Section having made a recent excursion to that place. They were: *Cypripedium pubescens*, *C. spectabile*, *Habenaria dilatata*, *Pogonia ophioglossoides*, *Triglochin maritima*, *Linnæa borealis*, *Galium boreale*, *Mitchella repens*, *Vaccinium oxycoccus*, *Cornus Canadensis*, *Diervilla trifida*, *Iris versicolor*, *Sarracenia purpurea*, *Acer spicatum*, *Ariophorum polystachum*, *Chætophora endibiæfolio*, *Batrachospermum monilliforme*.

July 3, 1891. Miss Macauley exhibited *Crepis biennis*, recently introduced and found near Fairport. Miss Macauley also exhibited the following plants from Watkins Glen: *Gillenia trifoliata*, *Rosa lucida*, *Asclepias tuberosa*, *A. cornuti*, *Lysimachia quadrifolia*, *Kalmia latifolia*, *Galium boreale*, *Trifolium agrarium*, *Leonurus cardiaca*, *Castanea sativa*, *Pentstemon pubescens*, *Habenaria dilatata*, *Cypripedium spectabile*.

Dr. Searing exhibited *Ophioglossum vulgatum*, which she had found at Long Pond. This plant has only once before been reported from Monroe County.

Dr. Searing also showed *Elodes campanulata*, *Agaricus cassanus*, *Russula pubescens*, and *Hygrophorus caraphellus*.

July 17, 1891. *Nasturtium sylvestre* was exhibited and reported growing in some abundance on the river road, near Genesee Valley Park. This plant has rarely been found in this locality and its advent was the subject of some discussion. A new station for *Poterium Canadense* in the southwestern part of Monroe County was reported and specimen of the plant exhibited. Also a new station for *Calopogon pulchellus* west of Fairport was reported and specimen exhibited. *Myosotis palustris* was also shown.

July 31, 1891. Miss Macauley exhibited *Asclepias verticillata* and also *Polanisia graveolens* neither of which were before seen in the class.

Miss Beckwith showed a unique specimen of *Rudbeckia hirta* with a dark-colored band around the petals, which gave it some resemblance to Coreopsis.

Aug. 7, 1791. The death of Mr. Edward Walker, a member of the Section was announced and a committee appointed to draft suitable resolutions to report at the next meeting.

Dr. Searing exhibited *Russula rubra*. She also showed *Ammonita pelloides* in four stages of growth. Dr. Searing gave a very instructive talk on the life history of this fungus, illustrating her subject by these specimens.

August 21, 1891. Miss Macauley stated that she had received a communication from Mr. Hankinson, in which he offered to furnish plants which were lacking to complete the herbarium of the Section. Miss Macauley exhibited two growing plants of *Goodyera pubescens* found in the glen near Canandaigua.

September 4, 1891. Dr. Searing exhibited *Solidago rigida.*

Miss Macauley exhibited *Lycopodium dendroidum* in fruit, branches of *Gaylussacia resinosa*, *Andromeda polifolia*, *Cassandra calyculata* from Mendon.

September 18, 1891. Miss Beckwith exhibited *Arctostaphylos Uva-ursi* from near Mumford; this is rarely found so far south, and never before reported in this section. *Gentiana crinita* and *G. quinqueflora* were also shown.

October 23, 1891. Miss Beckwith exhibited *Amarantus blitoides* newly introduced from the West. The latest edition of Gray's Botany reports it as only reaching east as far as western New York.

November 6, 1891. Mr. Streeter illustrated the process of Abscissa with branch and leaves of Horse-chestnut.

Miss Beckwith showed *Linaria Canadensis*, not before seen in the Section, and fruit of *Nemopanthes fascicularis.*

The Curator, Miss Beckwith, reported that 200 specimens of plants had been sent to the Melbourne Botanical Gardens in return for a collection of Australian plants sent from that Society to the Section. Microscopical Studies: Spirogyra, Vaucheria, Lenma, Euglena, Red Protococcus, Nitzschia tenuis, Closterium, and the circulation of protoplasm in Vallisneria.

November 20, 1891. The evening was devoted to the study of Mosses. Dr. Searing described the life history of the genus Hypnum from spore to fruitage, illustrating her subject with drawings and pressed specimens of the different species.

December 4, 1891. Miss Beckwith exhibited a growing plant of *Goodyera pubescens* in fruit, found at Ithaca by Warner W. Gilbert. This exhibit is worthy of special mention, as the plant is rarely seen in blossom or fruit.

A collection of 75 pressed specimens of native Syrian plants was received from Mr. Joseph B. Fuller. The Secretary was instructed to return a suitable acknowledgment of the generous gift to the Section.

December 18, 1891. *Ilex verticillata*, from Seneca Park and *I. lævigata* from River Road were shown.

The study of Acorns was continued from the last meeting. Seven species were reported found in this locality.

Mr. Laney exhibited a large number of leaves of indigenous shrubs and trees.

Miss Beckwith exhibited a fine growing plant of *Camptosorus rhuophyllus* and *Asplenium Trichomanes* sent from Ithaca by W. W. Gilbert, also a specimen of *Usnea barbata.*

January 8, 1892. Microscopical studies: Dr. Searing exhibited *Azolla Caroliniana*, and also papillose leaf of *Hypnum delicatulum.*

Miss Beckwith reported Dandelion in blossom December 14, Chickweed January 1, and Golden-rod in November.

The Curator of Botany, MISS BECKWITH, reported as follows:

Number of mounted specimens in the herbarium	1873
Number of unmounted specimens	700
Total	2573

This includes a collection of nearly 200 Australian plants, a collection of Colorado plants given to the Academy by MISS M. E. MACAULEY, a collection containing about 75 Syrian plants recently donated by MR. JOSEPH B. FULLER, and a collection of Hawaiian ferns given by MRS. FREDERIC S. WEBSTER.

REPORT OF THE SECTION OF GEOLOGY.

The Report of the Section of Geology was read by the Recorder of the Section, Mr. H. L. Preston.

ELECTION OF OFFICERS.

The election of officers for the ensuing year was held, and resulted as follows:

President, H. L. FAIRCHILD.
First Vice-President, A. L. AREY.
Second Vice-President, J. EDW. LINE.
Secretary, FRANK C. BAKER.
Corresponding Secretary, CHARLES W. DODGE.
Treasurer, J. EUGENE WHITNEY.
Librarian, MARY E. MACAULEY.
Councillors, WILLIAM STREETER. HENRY A. WARD.

The following paper was accepted for publication by the Council and read by title:

THE THICKNESS OF THE DEVONIAN AND SILURIAN ROCKS OF WESTERN NEW YORK; APPROXIMATELY ALONG THE LINE OF THE GENESEE RIVER.

By Charles S. Prosser.

CONTENTS:

Introduction.

The October number of the American Geologist for 1890 (1) contained an article on "the thickness of the Devonian and the Silurian rocks of Western Central New York." The present paper is a continuation of that general investigation, and the section crosses western New York somewhat west of the Genesee river. The series of terranes composing this section is identical with that discussed by Prof. Henry S. Williams, in his Bulletin on "The Genesee Section, New York," (2) together with those of the Lower Devonian and Silurian. Many of the well sections described in this paper are near localities at which Professor Williams has described outcrop sections

(1.) *Op. cit.*, vol. vi, pp. 199-211.
(2.) Bull. U. S. Geol. Surv., No. 41: On the Fossil Faunas of the Upper Devonian—The Genesee Section, New York, 1887.

in the Bulletin just mentioned, consequently it does not seem inappropriate to designate it the Genesee Section.

The section crosses Allegany, Wyoming, Genesee and Monroe Counties, and is in the main compiled from the records of wells near Richburgh and Clarksville, Allegany Co., Castile and the Warsaw salt region of Wyoming Co., LeRoy and Batavia, Genesee Co., and Brockport and Rochester, Monroe Co. Geologically the section commences with the Olean conglomerate and its equivalents, which occur at or near the summit of the highest hills in southern Allegany and Cattaraugus Counties, New York, and in northern McKean County, Pennsylvania. Then it crosses New York State, passing through the several terranes composing the Devonian and Silurian systems, and terminates probably with the top of the Archean as shown by the record of the Rochester well.

THE GENESEE SECTION.

In reviewing the history of the geology of western New York, there seems to be special reason for carefully describing this section.

In 1838 Professor James Hall, at that time State Geologist of the Fourth District of New York, published a geological "Section from the mouth of the Genesee River to Instantur, Penn." (1) Among the towns touched by this section are Rochester, Caledonia, Mt. Morris, Portage, Angelica and Wellsville, N. Y., thence through Coudersport and Smithport to Instantur. It will be noticed immediately that in a general way the New York part of this section follows quite closely the direction of the one outlined for this paper. It is interesting to note briefly the correlations made on this section and in the accompanying description. The author says: "I consider the rocks of the 4th District as belonging to the old red sandstone and the carboniferous groups, and to be above the Silurian system of Mr. Murchison." (2)

The Medina red sandstone was considered as belonging to the "Old Red Sandstone." The next general correlation is that of the Upper Helderberg or Corniferous, which is called Carboniferous or Mountain limestone. (3) The remainder of the section is included

(1.) 2d Ann. Rept. Fourth Geol. Dist., N. Y.

(2.) *Ibid.*, p. 291.

(3.) *Ibid.*, p. 292, where it is stated that "Upon the Gypseous [Onondaga Salt group or Salina] rocks lies the mountain limestone, commencing at Caledonia and near West Mendon, and extending as far south as Avon." While on the section between Caledonia and York it is given as "Carboniferous or Mountain Limestone." Also see foot note on p. 302 and p. 307.

in the Carboniferous and the first coal was noted at Instantur, Penn.

The above correlation apparently did not consider the previous statement of Conrad, that the red sandstone on the Niagara and Genesee rivers "has been referred by some geologists to the New, by others to the Old red sandstone of Europe, with neither of which does it bear the remotest analogy in the contained organic remains, or in its relation to other rocks. Indeed it is far below the strata which Mr. Richard C. Taylor, with great appearance of probability, refers to the old red sandstone, and which are wanting in the third district [this part of the third district formed the northern portion of the fourth district in the following reports]." (1)

In the report of 1839 there was no direct reference to the correlation of the preceding report ; but several local names were proposed. (2)

The report for 1840 shows it had been decided that the thin layers of red sandstone and shale in Allegany Co., were stratigraphical equivalents of the rocks near Tioga, Penn., which had been referred by Mr. Taylor to the "Old Red Sandstone." Professor Hall wrote : "In tracing this rock westward, [from Tioga] we find it bordering the southern limits of the State, and in Allegany Co. extending north of the line." (3) "I have not yet identified it beyond [west of] the Genesee. At this place near the mouth of Dyke Creek, at Wellsville, it contains fragments of bones resembling those at Tioga." * * * *

"This rock forms the limit between the Silurian and Carboniferous systems and may be regarded as one of the most important of the whole series." (4) While in the final report Professor Hall said : "At Wellsville, * * * * the rocks of this group [Chemung] terminate, and are succeeded by some thin ferruginous strata of the Old Red sandstone, and this again by grey diagonally laminated sandstone and conglomerate." (5)

In 1838 Professor Dewey stated that the dip "along the Genesee river is one foot in eighty to one hundred feet. If we call it only one in a hundred, in fifty miles, which is less than the distance to the southern boundary of the State, the dip would place the rocks two

(1.) 1st Ann. Rept. Third Geol. Dist., N. Y., 1837, p. 167.

(2.) 3d Ann. Rept. Fourth Geol. Dist., N. Y., where it is stated on p. 288 "With regard to the arrangement and succession of rocks presented in the section accompanying the report of last year, I have no important alterations to suggest."

(3.) 4th Ann. Rept. Fourth Geol. Dist., N. Y., p. 393.

(4.) *Ibid.*, p. 394.

(5.) Geol. N. Y., Pt. IV, 1843, p. 250. In connection with this see Prof. H. S. Williams' description of a quarry at Wellsville, in Bull. U. S. Geol. Surv., No. 41, pp. 77, 78.

thousand six hundred and forty feet or half a mile below their relative situation near Lake Ontario." (1) The red Medina of the Genesee Falls was correlated with "the *old red sandstone* of European geologists." While it was further stated: "On this sandstone rests a series of slates, limestones, shales,and siliceous strata, which corresponds perfectly to the mountain limestone of Europe." (2)

For a continuation of the history of the correlation of these terranes, bringing the classification into harmony with that of the present, the reader is referred to the excellent presentation of the subject in the correlation paper of Professor H. S. Williams on the Devonian and Carboniferous. (3)

Correlation of the Upper Devonian and Lower Carboniferous.

The first well record to be considered is that of one situated between Richburgh and Clarksville, Allegany Co.; but before giving this record it is necessary to hastily review the geological position of the Olean conglomerate and underlying rocks. The opinions of the geologists who have recently studied this series of rocks most thoroughly—Ashburner, Carll and H. S. Williams—are not in complete harmony as to their geological age, therefore it is necessary to state briefly the different correlations and to indicate which is followed in this paper.

Ashburner in 1880 published the following section of the rocks of McKean County, Penn.: (4)

Base of the
Pottsville conglomerate, No. XII—Olean conglomerate
Mauch Chunk, No. XI—Cannel slate............10′ (5)

Pocono, No. X,	Upper—Shales and sandstones..	60′	250′ (6)
	Middle—Sub-Olean conglomerate	40′	
	Lower—Shales and sandstones...	150′	

(1.) Am. Jour. Science, 1st ser., vol. xxxiii, p. 121.

(2.) *Ibid.*, p. 122.

(3.) Bull. U. S. Geol. Surv., No. 80, in particular Chapters I and II.

(4.) Report R, 2d Geol. Surv. Penn. The Geology of McKean Co. See the "vertical section" on p. 43 and the detailed account of the following part of the section from p. 56 to p. 76. Also, a paper by the same author on "The Bradford oil district of Pennsylvania," in Trans. Am. Inst. Min. Eng., vol. vii, p. 316-328, and especially pp. 320, 321.

(5.) *Ibid.*, p. 64. "Generally throughout central and northern McKean the Mauch Chunk formation is represented by 5 to 10 feet of ferruginous argillaceous shale or black slate, sometimes containing cannelly layers or a thin slaty coal, (*Marshburg lower coal.*)"

(6.) *Ibid.*, p. 65. "The thickness of the entire group varies; at Bradford it is 247 feet."

Catskill, No. IX	Red and gray shale and sandstone	250′	
Upper Chemung, No. VIII.	Gray shale and sandstone	350′	1300′ ([1])
	Red and gray shale and sandstone		
	Mansfield red beds	300′	
	Gray shale and sandstone	650′	
Middle Chemung	Bradford oil sandstone	45′	
Lower Chemung, No. VIII	Gray shale and sandstone	645′+	

In 1887 Ashburner first published his correlation of the Richburgh oil and gas sand of Allegany Co., N. Y., with that of the Bradford. He said: "According to Mr. Carll this sand [the oil-sand of Allegany district] lies about 150 feet below the Clarendon Third sand. From my own examinations, made in both the Allegany and Bradford oil districts and across the intervening country, I was disposed to regard this sand as identical with the Bradford, which lies between 300 and 400 feet below the Clarendon Third sand." ([2]) In 1888 this opinion is stated positively, as follows: "The geological horizon of the Allegany oil and gas-sand which is commonly and locally known as the Richburgh is the same as that of the main producing oil and gas-sands of the Bradford region, known by the oil-well drillers as the Bradford third sand." ([3]) Also, "It may be accepted as beyond question that the productive oil and gas-sands in the vicinity of Richburgh, Bolivar, Allentown, the Waugh and Porter well and at Bradford are geologically the same, although they differ much in their physical characteristics." ([4])

Mr. John F. Carll, who has carefully studied the conglomerates of southwestern New York and northwestern Pennsylvania, mentioned in 1887 an outlier of the Olean conglomerate "near the center of Genesee township, Allegany County, [N. Y.]" at an altitude of "about 800′ above little Genesee creek and 2350′ above ocean." ([5]) In this report Mr. Carll gave a generalized section for 800′ of the rocks below

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(1.) *Ibid.*, p. 73. "The average thickness of this member may be stated at 1300 feet. At Bradford it is 1281 feet."

(2.) Trans. Am. Inst. Min. Eng., vol. xv, p. 519.

(3.) *Ibid.*, vol. xvi, p. 927.

(4.) *Ibid.*, p. 929. On pp. 928 and 929 the data upon which this correlation is based are given. Briefly, it is that the Olean Conglomerate is identified in southern Allegany Co. The Cranston well No. 1, in Genesee township, shows that the Richburgh oil and gas sand is 1729 feet below the bottom of the Olean conglomerate, while at Bradford it is 1779 feet. Other wells in the Allegany district do not differ to any considerable extent in the thickness of the rocks between the Olean conglomerate and the Richburgh sand. In 1883 Mr. Carll published the statement that from the base of the Olean conglomerate to the top of the Richburgh sand was 1600′ (2d Geol. Surv. Penn., I4, p. 165.)

(5.) Ann. Rept. Geol. Surv. Penn. for 1886, Pt. II, Oil and Gas Region, p. 636.

the Olean conglomerate of Allegany Co., New York, which is as follows:

"1. Olean conglomerate.

2. Gray sandstones and sandy shale. Pocono type 175′

3. Greenish-gray sandstones and red and gray shale. Catskill type ---------------------------------- 225′ to 400′

4. Massive flat pebble conglomerate. Catskill type 25′ to 425′

5. A repetition of No. 3. Catskill type ----------- 125′ to 550′

6. Shales and flaggy sandstones. Chemung type 250′ to 800′"(1)

In reference to the correlation of this and other sections the author wrote: "In designating the different divisions on these sections, it must not be understood that the rocks belong unquestionably to the groups indicated. It is to be remembered that the divisions between Pocono, Catskill and Chemung are purely arbitrary throughout all the country under examination, for there seem to be no *positive data*, either lithological or palæontological, to indicate exactly where the dividing lines should be drawn. Red rocks are evidently no sure guide, for an abundance of red is found in one locality or another in all these groups." (2)

In 1888 Professor Henry S. Williams published a Bulletin on "The Genesee Section, New York," (3) in which the rocks of Allegany Co., N. Y. are described and compared with the Bradford section of Pennsylvania. A flat pebble conglomerate with some red jasper pebbles is described from near the head of Wolf creek, west of West Clarksville, which lies between 1,950′ and 2,000′ A. T. (4)

About five miles south of the Wolf creek conglomerate and north of Little Genesee is a conglomerate composed of round and larger pebbles forming the so-called "rock city." The Professor says: "Chemung fossils were rarely seen above the horizon of the first (Wolf creek) conglomerate and but for a short distance. After the green, micaceous and flaggy shales, and the soft, red iron shales had fairly set in, the Chemung fauna ceased."

"With the incoming of the second conglomerate of Little Genesee 'rock city,' there was deposited a coarse mixture of clay, iron ore, and yellow sand with fossils. This ferruginous sandstone is charac-

(1.) *Ibid.*, p. 639.

(2.) *Ibid.*, p. 639; also, see plate I, section 1. On p. 640, for the Bradford section, Carll makes the top of the Catskill 250′ below the base of the Olean conglomerate, which agrees closely with Ashburner's 252′. But Carll calls the Catskill 320′ thick instead of 250′, so that the top of Carll's Chemung is 570′ below the base of the Olean conglomerate, against Ashburner's 502′.

(3.) Bull. U. S. Geol. Surv., No. 41. The title page gives the date of publication as 1887; but although the copy was transmitted to the Survey on August 2, 1886, owing to delay, it was not published until the latter part of 1888.

(4.) *Ibid.*, p. 86.

terized by a *Rhynchonella* [*R. allegania* Wms.] of large size * * *, but it also contains frequent specimens of *Spirifera disjuncta*, linking its fauna with the Chemung fauna below." (1)

"The specimens [of *Rhynchonella*] have been found in the ferruginous sandstones underlying the conglomerate at Olean and Little Genesee, in New York, and at Bradford, McKean County, Pa." (2)

Again, "Above this conglomerate [Wolf creek] it is rare to find any Chemung fossils, but they do not entirely cease till the second conglomerate of Genesee 'rock city,' the Olean conglomerate. Between the two conglomerates are red and green, argillaceous shales (the former sometimes bearing Chemung fossils), with flaggy, micaceous, green shales and sandstones. The intervals between these two conglomerates may average about three hundred feet." (3)

In the "conclusions" Professor Williams states that the flat pebble (Wolf creek) conglomerate is "at the top of the Chemung and containing a fauna of decided Chemung type, which is distinct in some features, but appears in the shales below.

"These underlying shales in New York gradually run into genuine Chemung rocks and fauna and cannot be discriminated from them by any sharp line of distinction." (4)

In comparing the Allegany section with the authoritative one of the Dennis well, near Bradford, Professor Williams regards stratum No. 15 of the Dennis well as the equivalent of the Wolf creek conglomerate. (5) The top of No. 15 is 330′ below the base of the Olean conglomerate and is in the Red Catskill of Ashburner, 167′ above the top of the Chemung. (6)

As a result of this comparison it will be noticed that at Bradford,

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(1.) *Ibid.*, p. 87.

(2.) *Ibid.*, p. 88.

(3.) *Ibid.*, p. 89.

(4.) *Ibid.*, p. 103. In attempting to correlate the sandstones and shales between these two conglomerates Professor Williams' opinion was sought, and October 7th, 1891, he wrote me the following letter:

"In a geological series running upward I give the name of the typical formation, as *Chemung*, to the rocks in which the typical fauna is contained, and include as of the same formation the rocks above so long as they contain the same fauna. If the fauna changes, as in the case of the Little Genesee conglomerate, I should give the formation a different name, and in case no typical Chemung fauna occurred above I should speak of it as Upper Devonian, and not as a member of the Chemung Period.

"If the fauna changes from marine to fresh water or brackish water, in this case I would call the fauna Catskill, even if it occurred below distinct beds of Chemung, with the marine fauna, possibly giving some local name. It is the custom in this country and in Europe to consider *Spirifera disjuncta* as confined to the Devonian, so that as long as it existed, I would apply the general name Upper Devonian and Chemung."

The Professor states that the above is a general rule which he follows in the correlation of the Upper Devonian, consequently it is probably better to call the rocks between the two conglomerates simply Upper Devonian.

(5.) *Ibid.*, p. 100; also, see p. 30.

(6.) See the record of the Dennis well, 2d Geol. Surv. Penn., R, pp. 287–290, especially pp. 288, 290.

Carll places the top of the Chemung 570′ below the base of the Olean conglomerate, Ashburner 502′ and Williams 330′. Professor Williams identified specimens of *Spirifera disjuncta* Sow., *Palæanatina typa* Hall, and other fossils from the horizon which he considers the equivalent of the flat pebble conglomerate, (1) and this evidence is regarded by the writer as of greater value than that upon which Carll and Ashburner divided the section.

In support of this opinion is the additional fact that Professor Hall has referred the conglomerate at Portville, Cattaraugus Co., N. Y., to the Chemung group (2) and this conglomerate was positively identified by Professor Williams as equivalent to the Wolf creek flat pebble conglomerate. (3)

Records of the Wells.

The first well record to be considered is that of well No. 91 of the United Natural Gas Co., which is located on the Hatch farm, lot No. 2, in the southeastern part of Clarksville township, Allegany Co., two miles northwest of Richburgh and nearly two and one half miles southeast of West Clarksville. It was drilled during the early part of 1888 by Mr. H. W. Hatch of Richburgh, N. Y., to whose kindness I am indebted for a set of samples and from whom I have received other samples and information of much value in this investigation. No oil was obtained, but gas in sufficient amount to raise a pressure of 100 lbs. in about twenty minutes. September 15th, 1890, Mr. Hatch wrote me that he should estimate the daily production of the well as approximately 400,000 cu. ft. of natural gas.

By the aneroid barometer Mr. Gilbert D. Harris, of the U. S. Geological Survey, determined the altitude of the mouth of the well to be 625′ above the R. R. station at Richburgh. According to Mr. Frank M. Baker, Agent for Receiver of the Bradford, Eldred and Cuba

(1.) *Ibid.*, p. 101.

(2.) Geol. Surv. N. Y, Palæontology, Vol. V, pt. I, Lamellibranchiata II, 1885, under the description of three species of *Palæanatina* on pages 488–490.

In connection with the above see what Professor Hall wrote in 1867 about the Allegany Co. conglomerates: "In the collections of the geological survey these fossiliferous conglomerates were arranged as a part of the Chemung group, while the coarser non-fossiliferous rocks of similar character in Allegany and Cattaraugus counties were considered as outliers of the Carboniferous conglomerate. We have since learned, however, that the conglomerate of the southwestern counties of the State is a constituent member of the Chemung group. The red shaly and arenaceous strata, sometimes observed beneath the conglomerate, are merely subordinate beds of little significance and in no way related to the red rocks of the Catskill group to which they have sometimes been referred." (*Ibid.*, Vol. IV, pt. I, note following preface.)

(3.) Bull. U. S. Geol. Surv., No. 41, p. 90, where Prof. Williams wrote: "The fossils found at its top [the Portville conglomerate] and the relations of the rock to those below and above leave no doubt of its identity with the Wolf creek conglomerate four miles to the north."

R. R. Co., the elevation of Richburgh is 1675′ A. T., (1) which would make the altitude of the mouth of the well 2300′ A. T. (2)

The top of the Wolf creek conglomerate west of West Clarksville is stated by Professor Williams to be not over 2,000′ A. T., (3) and the rate of dip for Allegany Co. is 25′ per mile. (4)

This well is two miles + farther south than the outcrop of the Wolf creek conglomerate, so that the position of this conglomerate in the well may be called about 1950′ A. T., and the mouth of the well is 350′ higher than the Wolf creek conglomerate. (5)

According to Professor Williams the average distance between the two conglomerates is 300′. (6) Then the mouth of well No. 91 would be geologically at least near the top of the red and green shales between the 1st and 2d conglomerates and not far from the horizon of the Little Genesee or Olean conglomerate.

Record of Well No. 91, of the United Natural Gas Co. of Clarksville, Allegany Co., New York.

The depth of the well is 1441′, from it eighty-four samples of drillings were received, and since this is probably the best set of specimens from any well in the Richburgh region a concise description of each sample will be given.

No. of Sample.	Depth.	Description of Sample.	Thickness of Strata.
1.	19′.	Greenish, argillaceous shale with fragments of fossil plants. An occasional brownish-red chip. Non-calcareous.	
2.	38′.	Mainly light green, soft argillaceous shale. Two large chips of reddish, somewhat arenaceous shale.	58′ of greenish shale.

(1.) Mr. Baker also gives the elevation of Bolivar, New York, as - - - - 1625′ A. T.
Little Genesee, New York, as - 1585′ "
West Clarksville, New York, as - 1697′ "
all of which stations are not mentioned in the 2d edition of Gannett's "Dictionary of Altitudes in the U. S." Bull. U. S. Geol. Surv., No. 76, 1891.

(2.) The above elevation of the well is somewhat more than Mr. Hatch's determination. At first Mr. Hatch reported it as about 575′ above the R. R. station at Bolivar, which would make the elevation about 2200′ A. T.; but in a subsequent letter, January 24th 1891, he called the altitude 2225′. Mr. Harris states that "520′ of the height has actually been leveled, and I can vouch for the other hundred." (Letter, October 9th, 1891.)

(3.) Bull. U. S. Geol. Surv., No. 41, p. 86.

(4.) *Ibid.*, p. 103.

(5.) Mr. Harris wrote Oct. 23: "Conglomerate fragments are by no means rare over the whole Richburgh area; but I noticed particularly fossiliferous conglomerate fragments between the altitudes 250′–350′ below the top of well No. 91. In fact, I saw no fossils in place above these altitudes in any of the rocks. No red beds were seen, the rocks as exposed along the roads were light-colored, mainly bluish-greenish and generally not thick bedded and arenaceous, but shaly. This applies only to beds exposed along the highway from altitudes 200′–400′ below the mouth of No. 91."

(6.) *Ibid.*, p. 89.

NO. OF SAMPLE.	DEPTH.	DESCRIPTION OF SAMPLE.	THICKNESS OF STRATA.
3.	58′.	Mainly dark red finely arenaceous chips.	19′ red shale.
4.	77′.	Mainly micaceous, greenish-gray, moderately coarse grained sandstone (?). A few dark red arenaceous chips.	
5.	96′.	Light gray sandstone, composed mostly of quartz grains, a little coarser than No. 4.	
6.	116′.	Ditto.	
7.	135′.	Slightly greenish-gray and finer grained chips than Nos. 5 and 6.	77′ gray sandstone.
8.	154′.	Mostly bluish, argillaceous shale with some olive chips.	20′ bluish shale.
9.	174′.	Grayish-buff, micaceous, fine grained sandstone (?).	19′ sandstone.
10.	193′.	Bluish-gray, argillaceous and finely arenaceous shale.	19′ shale.
11.	212′.	Mixture of blue and reddish, argillaceous shale with greenish-gray sandstone (?).	
12.	232′.	Bluish, argillaceous shale with light gray sandstone (?).	39′ shale and sandstone (?).
13.	251′.	Clear blue, argillaceous shale, slightly arenaceous.	
14.	270′.	About the same as No. 13.	
15.	290′.	Ditto.	
16.	309′.	Bluish to greenish, argillaceous shale.	
17.	328′.	Bluish, argillaceous shale.	
18.	348′.	Blue shale with a few grayish, arenaceous chips.	
19.	367′.	Ditto.	155′ mainly
20.	386′.	Ditto.	blue shale.
21.	406′.	Mixture of brownish-red, finely arenaceous chips with gray arenaceous and blue shale.	19′ mottled shales (?).
22.	425′.	Fine powder of dark gray color.	
23.	444′.	Bluish-gray, argillaceous shale, a little coarser chips than No. 22.	

NO. OF SAMPLE.	DEPTH.	DESCRIPTION OF SAMPLE.	THICKNESS OF STRATA.
24.	464'.	Mainly gray, finely arenaceous shale (?), with a few bluish and brownish-red arenaceous chips.	
25.	483'.	Mainly olive to grayish, argillaceous shale, a few brownish-red chips.	97' grayish shale (?).
26.	502'.	Olive to grayish, argillaceous shale.	
27.	522'.	Mainly light gray, fine grained, micaceous sandstone (?).	19' sand-stone (?).
28.	541'.	Greenish-gray, argillaceous shales.	
29.	560'.	Ditto.	39' shales.
30.	580'.	Bluish, argillaceous shale and light gray, fine grained sandstone (?).	38' blue shale and sandstone (?).
31.	599'.	Ditto.	
32.	618'.	Clear olive, argillaceous shale.	20' olive shale.
33.	638'.	Fine chips of light gray, fine grained sandstone.	19' gray sandstone.
34 (?).	657'.	Bluish, argillaceous shale.	19' bluish shale.
35.	676'.	Light-gray, fine grained sandstone mixed with blue shale.	
36.	696'.	Ditto.	
37.	715'.	Ditto.	
38.	(Wanting.)		
39.	759'.	Ditto.	
40.	770'.	Ditto, only rather more of the bluish, somewhat arenaceous chips. (1st sand of Mr. Hatch.)	116' mainly gray sandstone.
41.	792'.	Mostly bluish, finely arenaceous shale (?).	38' shale and sandstone (?).
42.	812'.	Light gray sandstone, mixed with bluish chips.	
43.	830'.	Olive, argillaceous shale mixed with red, oölitic iron ore. (1)	16' olive shale and red iron ore.
44.	846'.	Olive to bluish, argillaceous shale.	
45.	(Wanting.)		

(1.) Prof. Williams found oölitic red iron ore in an olive shale near Cuba, Allegany Co. (Bull. U. S. Geol. Surv., No. 41, pp. 67, 69.) The Cuba locality is about nine miles north of this well with an approximate altitude of 1700'. If we call the dip 25' per mile for the nine miles, then the position of the iron ore in well 91 ought to be at about 1475' A. T. Calling the altitude of the mouth of the well 2300', then the iron ore actually found in the well is at an altitude of 1470' A. T.

NO. OF SAMPLE.	DEPTH.	DESCRIPTION OF SAMPLE.	THICKNESS OF STRATA.
46.	879'.	About the same as No. 44, with a few brownish-red chips.	
47. (?)	896'.	Ditto.	
48. (?)	912'.	Bluish-gray and somewhat arenaceous.	
49.	929'.	Bluish-gray and light gray, somewhat arenaceous chips. The light gray are calcareous.	
50.	945'.	Olive, argillaceous shale, some of the chips micaceous and somewhat arenaceous, a few slightly purplish.	
51.	962'.	Olive to greenish-gray, argillaceous shale, slightly micaceous and arenaceous.	165' mainly olive to bluish-gray argillaceous shale.
52.	978'.	Olive to bluish-gray, argillaceous shale, a few slightly purplish chips.	
53.	995'.	Bluish-gray and light gray calcareous chips.	
54.	1011'.	Greenish-gray, finely arenaceous sandstone (?).	49' greenish-gray sandstone (?).
55.	1028'.	Ditto.	
56.	1044'.	Ditto, only slightly more calcareous.	
57.	1060'.	Darker gray sandstone, with some olive, argillaceous shale. (2d sand of Mr. Hatch.)	
58.	1075'.	Ditto, mixed with bluish shale.	
59.	1090'.	Gray, fine grained sandstone mixed with bluish shale.	60' gray sandstone.
60.	1105'.	Gray sandstone and shale mixed.	
61.	1120'.	Greenish-gray shale (?) with fragments of fossils.	
62.	1135'.	Olive, argillaceous shale, slightly arenaceous.	
63.	1150'.	Mostly dark to slightly brownish-gray chips, some olive shale.	
64.	1165'.	Olive, argillaceous shale.	
65.	1180'.	Olive, slightly arenaceous chips.	
66.	1195'.	Dark gray shale with some light gray, finely arenaceous sandstone (?).	
67.	1210'.	Mainly greenish-gray, argillaceous shale.	135' mostly olive and gray shale.
68.	1225'.	Ditto.	
69.	1240'.	Ditto.	

NO. OF SAMPLE.	DEPTH.	DESCRIPTION OF SAMPLE.	THICKNESS OF STRATA.
70.	1255'.	Light gray, fine grained sandstone mixed with greenish-gray shale.	
71.	1270'.	Mainly slightly darker gray sandstone with some shale.	30' light gray sandstone.
72.	1285'.	Mainly slightly brownish-gray, fine grained sandstone, with a little shale. Fragments of fossils. (Stray sand of Mr. Hatch.)	
73.	1300'.	Very fine chips of the brownish-gray sandstone.	
74.	1315'.	Ditto, only larger chips with small fragments of fossils and some shale.	
75.	1330'.	Clear sample of brownish-gray sandstone. Fragments of fossils (?).	
76.	1345'.	Sandstone with some arenaceous shale.	
77.	1357'.	Brownish-gray sandstone with a little shale. Duplicate of No. 75. (Top of gas sand of Mr. Hatch.)	
78.	1369'.	Ditto, with very little shale. Fragments of shells (?).	
79.	1382'.	Brownish-gray sandstone mixed about equally with greenish-gray shale. Fragments of fossils. (Bottom of gas sand of Mr. Hatch.)	108' mainly brownish gray sandstone.
80.	1393'.	Greenish-gray, argillaceous shale.	
81.	1404'.	Ditto, with slightly brownish-gray sandstone.	22' shale.
82.	1415'.	Mainly slightly brownish-gray, fine grained, micaceous sandstone. A little greenish-gray, argillaceous shale. (Top of oil sand of Mr. Hatch.)	
83.	1428'.	Ditto.	
84.	1441'.	Some of the brownish-gray sandstone, but more of the greenish-gray shale. (Bottom of the oil sand of Mr. Hatch.) Bottom of well.	26' brownish-gray sandstone.

The facts brought out by the above record may be expressed in the following concise diagrammatic form.

SECTION OF WELL NO. 91, CLARKSVILLE, ALLEGANY CO., NEW YORK.

Approximate Altitude 2300′ A. T.

DEPTH.	THICKNESS.	KIND OF ROCK.
58′	58′	Greenish shale.
77′	19′	Red shale (?).
154′	77′	Gray sandstone.
174′	20′	Bluish shale.
193′	19′	Grayish-buff sandstone (?).
212′	19′	Bluish-gray shale.
251′	39′	Mixed shale and sandstone (?).
406′	155′	Blue shale.
425′	19′	Mottled shale (?).
522′	97′	Grayish shale (?).
541′	19′	Light gray sandstone.
580′	39′	Greenish-gray shale.
618′	38′	Blue shale and light gray sandstone (?).
638′	20′	Olive shale.
657′	19′	Light gray sandstone.
676′	19′	Bluish shale.
792′	116′	Mainly light gray sandstone. (1st sand at 770′.)
830′	38′	Bluish shale and light gray sandstone (?).
846′	16′	Olive shale mixed with red iron ore.
1011′	165′	Mainly olive to bluish-gray shale.
1060′	49′	Greenish-gray sandstone (?).
1120′	60′	Gray sandstone. (2d sand at 1060′.)

DEPTH.	THICKNESS.	KIND OF ROCK.
	135′	Mostly olive and gray shale.
1255′		
	30′	Light gray sandstone.
1285′		
	108′	Mainly brownish-gray sandstone. Stray sand at 1285′. Top of gas sand at 1357′. Bottom " " " 1382′.
1393′		
	22′	Greenish-gray shale.
1415′		
	26′	Brownish-gray sandstone. Top of oil sand at 1415′. Bottom " " " 1441′.
1441′		Bottom of well.

In December, 1887, Mr. Hatch sent me three specimens of gas sand containing fossils, which were thrown out of the well by the explosion of a "shot." The specimens came from well No. 90 of the United Natural Gas Co., which, according to Mr. Harris, is 700′ west of and 10′ higher than well No. 91. Mr. Hatch wrote December 10th, as follows: "I have sent you some very fine specimens of our gas sand, showing the finest and most perfect fossils that I have seen in this field." Unfortunately, owing to change of residence, these valuable specimens have been mislaid among the large collections of Devonian material at Cornell University. At the time of their receipt the fossils were examined rather hastily and *Spirifera* (*S. disjuncta* I think) and *Rhynchonella* were recognized.

In March, 1891, Mr. Hatch forwarded me some large specimens of oil sand from another well on the Hatch farm; but 184′ lower than well No. 91. The top of the oil sand in this well is 1236′ and the bottom 1270′. The top of the oil sand in this well agrees very closely with that of well No. 91; 1415′, depth in No. 91,— 184′ = 1231′, a difference of only five feet. March 27th, Mr. Hatch wrote: "These pieces are different sand from any of those among the samples of well No. 91. The difference between them is that these specimens are from a productive oil bearing rock, while the oil sand of No. 91 is a barren rock taking the place of the other and better sand."

In the interpretation of these well records there are several differences from published observations.

1st. If the altitude of the mouth of well No. 91 be correct, then we might expect indications of the Wolf creek conglomerate in the samples from near 350′. But the drillings show a quartz sandstone from 96′ to 116′ and possibly at 135′, which is lithologically nearer what would be expected for the Wolf creek conglomerate than the lower sandstones. At 174′ is a grayish-buff sandstone (?) and from 212′ to 251′ a mixture of shale and gray to greenish-gray sandstone (?), then from 251′ to 406′ nearly bluish, argillaceous shale.

2d. If the mouth of the well is 2300′ A. T. and near the horizon of the Olean conglomerate, and if the top of the Richburgh oil sand was reached at 1415′, or 1420′ according to the last well, then the distance from the base of the Olean conglomerate to the top of the Richburgh oil sand is only about 1420′ instead of 1729′ as stated by Ashburner, (1) a difference of about 300.′ Or, if Ashburner were correct as to the distance, then the bottom of this well would be about 300′ above the top of the Richburgh oil sand. However, Mr. Hatch is confident that the well reached the oil sand and wrote me October 16, 1891, as follows: "I am certain that wells No. 90 and 91 are through the Richburgh oil and gas level. The bottom of the well No. 90 is 1499′; below the regular gas sand nothing was found except slate."

3d. Data given by Professor Williams are both for and against the opinion that wells No. 90 and 91 reached the horizon of the Richburgh oil sand. Against it is the fact that fragments of fossils were noted from the brownish-gray sandstone as low as 1382′, which is stated by Mr. Hatch to be the bottom of the gas sand, and good specimens of fossils were sent from the gas sand of well No. 90. Professor Williams stated that in the oil sand of Varney & Co.'s well No. 11 at Bolivar, "no traces of fossils were seen." And the Professor concluded: "It is probable that this sandstone [Richburgh oil sand] is represented at the surface farther north by the Portage sandstones at Portageville." (2) Also, when describing the outcrop at Portageville, the Professor said: "The petroleum odor associated with all these gray sandstones following the black shales of the Portage group, gives strong reason for the opinion that they are the sandstones which occur farther south, and there, covered by thick masses of overlying strata, contain the oils reached by drilling." (3)

(1.) Trans. Am. Inst. Min. Eng., vol. xvi, pp. 928, 929. There is a slight discrepancy in Ashburner's account of the Cranston Wells, Nos. 1 and 2, on lot 29, Genesee township, from which this distance was obtained. On page 928 it is stated that the top of the Richburgh oil sand was struck in well No. 1 at a depth of 1704′ and in the table on p. 932 it is given as 1632′, a difference of 72′. On p. 928 well No. 2 reached the Richburgh sand at 1709′ and on p. 932 at 1655′, a difference of 54′.

(2.) Bull. U. S. Geol. Surv., No. 41, p. 90.

(3.) *Ibid.*, p. 52.

If Professor Williams' correlation of the Richburgh oil sand with the Portage sandstone be correct, then the fossils in the gas sand of the wells on lot No. 2 prove that they did not reach the Richburgh sand.

On the other side, assuming that the elevation of the mouth of well No. 91 is 2300′ A. T., and comparing the elevation of the top of the oil sand above sea level with that of the Richburgh wells, we find that there is not much difference. The top of the oil sand in well No. 91 is about 880′ A. T., and Professor Williams states that the average altitude of the top of the Richburgh oil sand in nine of the Varney & Co. wells "is 800 feet above the sea, or something over a thousand feet below the flat pebble conglomerate of the Upper Chemung." (1) Professor Williams also makes the distance from the base of the Olean conglomerate to the top of the Richburgh oil sand about the same as in well No. 91. The top of the flat pebble conglomerate is given as 1875′, which is based on the supposition that the R. R. station at Bolivar is 1600′. Since the station is 1625′, then the top of the conglomerate would be 1900′ A. T. 1900′ — 800′ (top of oil sand in wells) = 1100′ for the distance from the flat pebble conglomerate to the top of the oil sand. 1100′ + 300′ (average distance between the conglomerates) = 1400′ for the distance from the base of the Olean conglomerate to the top of the Richburgh oil sand.

Since well No. 91 is not much farther north than the Varney & Co. wells, the above statements seem to show that well No. 91 did reach the Richburgh oil sand; that this sand, or at most only 33′ above it, is fossiliferous containing Chemung species and consequently that the Richburgh sand is in the Chemung. If this correlation be correct then the Richburgh oil sand is above the Portage sandstones and Ashburner was correct in referring the Allegany oil sandstones to the Chemung. (2)

It appears to the writer that the explanation of the confusing views on the stratigraphical geology of southwestern New York and northwestern Pennsylvania is due in great measure to the belief of some geologists in the "persistent parallelism of strata" for considerable distances. While, as a matter of fact, it is probable that the lith-

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(1.) *Ibid.*, p. 90.

(2.) 2d Geol. Surv. Pa. R, 1880, in the "vertical section of the rocks of McKean Co.," on p. 43 the Bradford oil sand is given as middle Chemung. And in the Trans. Am. Inst. Min. Eng., vol. xvi, pp. 927, 929, the Richburgh oil sand is positively correlated with the Bradford oil sand by Ashburner.

ological characters of these strata change decidedly in the course of not very considerable distances. Professor Williams in reviewing the geology of this region has admirably stated this opinion in the following language: "The fact seems to be, as we review the records of the survey [Pennsylvania] that the data of lithologic character of rocks and of the thickness of the deposits were so constantly variable that the 'theory of persistent parallelism of strata' was little more than a theory, the exceptions to which were as numerous as the illustrations. It was a cut-and-try system of matching together innumerable sections, made up of irregular combinations of shales, sandstones, conglomerates, and limestones of various color, thickness and texture. Whenever the gaps were over a mile or two long the adjustment of the theoretical dip, a few feet more or less to the mile, would enable the parallelism to fit any particular stratum in a given section. The fact that those who showed evidence of having noted the fossils, although they may not have identified them, were invariably nearer right than those who neglected them, strengthens the belief that the fossils, even in this case, were the most valuable means of correlation." ([1])

In reference to the stratigraphical geology of the Allegany region, Professor Williams wrote me as follows, October 31, 1891: "Regarding the relations of the Richburgh sands and the Olean conglomerate, I remember that at the time [when writing Bulletin No. 41] the statistics were confusing. I was then inclined to the opinion that there were very sudden changes in the neighborhood of the oil sands—laterally—*i. e.* on passing across the strata horizontally; and later studies led me to consider the 'theory of persistent parallelism of strata' very unsatisfactory as a means of correlation. It may be satisfactory, then the next half mile may give perfectly unsatisfactory results. I think only the fossils can be depended upon and even these must be examined as faunas as well as individuals, for obtaining the best results in correlation."

(1.) Bull. U. S. Geol. Surv., No. 80, pp. 111, 112.

CLARKSVILLE WELL, ABOUT ONE MILE SOUTHWEST OF WEST CLARKSVILLE, ALLEGANY CO., NEW YORK.

Altitude about 1736′ A. T.

DEPTH.		CHEMUNG STAGE.
100′	....	Olive, argillaceous shale, slightly calcareous.
125′	....	Lithologic characters about the same, fragments of Brachiopod shells, (? *Productella.*)
150′	....	Ditto, fragments of Brachiopods (one possibly a *Discina.*)
200′	....	Light gray and olive chips, calcareous with fragments of shells.
275′	....	Mostly light gray sandstone, with fragments of Brachiopods.
375′	....	Darker gray sandstone with fragments of Brachiopods. "First sand" of driller.
410′	....	Light gray, fine grained sandstone, salt water. "Salt sand" of driller.
435′	....	Olive to greenish-gray argillaceous shale, fragments of shells.
675′	....	Light gray sandstone mixed with dark gray argillaceous shale. "Second sand" of driller.
750′	....	Ditto, with fragments of fossils.
800′	....	Greenish-gray argillaceous shale with fragments of fossils.
900′	....	Brownish, micaceous sandstone which contains plenty of Brachiopod fragments. Called the "Richburgh or Bolivar sand" by driller.
925′	....	Greenish to dark gray argillaceous shale.
975′	....	Mainly brownish-gray sandstone, fragments of fossils.
1055′	....	{ The Clarksville oil sand. Greenish-gray argillaceous shale.
		Bottom of well.

The Clarksville well was drilled during October, 1891, and I am indebted to Mr. T. B. Love, of West Clarksville, for a set of samples and a record of this well. Mr. Love states that the Clarksville oil sand, which he considers as 75 feet below the Richburgh or Bolivar sand, is 30 feet in thickness. There is no gas, except in the oil sand, and then only a small amount. The wells start with eight to ten bbls. of oil per day, but in about thirty days decline to two or three bbls.

and will yield that amount for years ; the sand being close grained, it drains slowly.

From the central and northern portions of Allegany Co. the writer has not yet been fortunate enough to secure specimens for examination. On this account it is not possible to correlate positively the bottom of the Richburgh wells with those of the southern part of Wyoming Co. A number of wells have been drilled in this region and the drillers' record of several is given below ; but without samples for examination it is not safe to attempt the correlation of these records. ([1])

(1.) June 6th, 1891, Mr. A. W. McQueen, of Nile, Allegany Co., N. Y., furnished me the following partial records of wells drilled by himself in this region.

"A well at Nile 'getting the sand' at 1200′ would commence in blue slate (or shale) and continue the same to about 400′, excepting three or four white sands, from 3′ to 5′ thick. From 400′ to 600′ is mostly a hard blue rock, having marble white streaks in places; at about 600′ we get a white sand 20′ to 30′ thick [1st sand ?]. Soft blue rock now runs the well down to 880′, where we get the second sand, which is about 20′ thick, dark colored and followed by 10′ of blue slate, after which we get the same sand again, this time with salt water (about ½ barrel an hour). This is followed by 270′ of what seems to be a pure slate, not a particle of grit in it, until the last 20′ or 30′, when a few little 'shells' are met with; only a little 'skim' of oil sand is found here, 3′ to 8′, and wells produce from 2 to 15 barrels per day. For a distance of 400′ below the oil sand there is nothing but a dark colored slate rock."

The above record may be expressed diagrammatically as follows:

SECTION AT NILE, N. Y.

Depth.	*Thickness.*	*Kind of Rock.*
	400′	Blue shale.
400′		
	200′	Hard blue rock with marble white streaks.
600′		
	30′	White sand [1st sand (?)].
630′		
	250′	Soft blue rock.
880′		
	20′	"2d sand," dark colored.
900′		
	10′	Blue slate.
910′		
	?	Sand again with salt water.
?		
	270′	Pure slate, no grit until the last 20′ to 30′ when there are a few "shells." Oil sand 3′ to 8′.
1200′ (?)		
	400′	Dark colored slate.
1600′ (?)		

"A well drilled in Friendship village had the same formations down to and including the salt water; below which we found only a soft blue slate or shale, getting quite dark colored when we had finished at 600′ below the salt water. Total depth of well 1330′ and it was located about 20′ above the N. Y., L. E. & W. R. R. station." The altitude of the N. Y., L. E. & W. R. R. station at Friendship is 1539′ (Bull. U. S. Geol. Surv., No. 76, p. 143) which would make the altitude of the mouth of this well about 1560′.

Two wells were drilled by Mr. McQueen near Marshall, in New Hudson township, about five miles from the Genesee river. "No. 2 was on the level of Crowford creek and was drilled to the depth of 2075′. No gas or oil and no sand rock, except a very little near the top of the well. From 1200′ to bottom of well the rock was nearly or quite all slate; at about 1800′ a rock filled with copper-colored particles, supposed to be iron pyrites, 20′ to 30′ thick; below this a soft slate, nearly a perfect coal black, and finished with the rock still very dark colored. No. 1 was about 1000′ from the 2d, was drilled about 1400′ and found a little gas which burned for two weeks.

"Another well four miles from Belfast, on Wigwam creek, in Allen township, was drilled to a depth of 1520′. The formations were about the same, though I found at 720′ about three feet of close (very fine) white sand with gas and oil. The well made a barrel of oil per day for a week or so when gas and oil failed. The oil was of very light color.

"All wells in the northern part of this county showed a soft slate or shale formation, light in color at the top and dark at the bottom."

The next well record, that is of value for this general section, is that of one drilled in 1883, near Castile, Wyoming Co., New York.

At Portage Falls, near Portageville, the top of the Portage sandstones, which form the summit of the Portage stage, has an approximate altitude of 1200′. [1] Castile is approximately four miles north of Portageville, and if the dip in this region be about 50′ to the mile as stated by Professor Williams, [2] then the top of the Portage sandstone at Castile would be in the neighborhood of 1400′ A. T. The altitude of the N. Y., L. E. & W. R. R. station at Castile is 1400′, [3] or at the "Summit" 1431′, which would be about the horizon for the top of the Portage. This probable geological horizon for the mouth of the Castile well is confirmed by the statement of Professor Irving P. Bishop, who stated that it "started in the sandstones of the Upper Portage, * * * * being also at nearly the highest elevation of the Erie R. R. between New York and Buffalo. It is also the deepest well yet sunk in the salt district." [4]

Mr. Geo. H. Bush, of Castile, furnished me with a partial record of this well together with some specimens of drillings. A section of this well is given by Professor Bishop [5] and from this data, in connection with the information furnished by Mr. Bush, the following section has been compiled.

(1.) Bull. U. S. Geol. Surv., No. 41, p. 52

(2.) *Ibid.*, p. 103.

(3.) Gannett, in Bull. No. 5, U. S. Geol. Surv., p. 205, gave Castile as 1401′ and Castile summit 1431′. In the 2d Ed., Bull. No. 76, p. 78, Castile is given as 1431′. In Macfarlane's Am. Geol. Railway Guide, 2d Ed., p. 125, Castile is given as 1401′. October 10th, 1891, Mr. Carl W. Buchholz, Civil Engineer of the N. Y., L. E. & W. R. R. Co. gave me the following altitude of stations, taken from the lithograph profile of the "Erie" R. R.

Portage	1314′
Castile	1400′
Silver Springs	1406′
Rock Glen	1331′
Warsaw	1326′

The altitude of Silver Springs and Rock Glen is not given in Bull. U. S. Geol. Surv., No. 76.

November 7, 1891, Mr. Geo. H. Bush of Castile, wrote me that the mouth of the Castile well is about fifty rods from the N. Y., L. E. and W. R. R. station and about 10′ lower than the R. R. track; which would make the altitude of the mouth of the well about 1390′.

(4.) Rept. on the Salt Fields of western New York. In 5th Ann. Report of the State Geologist [of New York] for the year 1885. Assembly Doc. for 1886, No. 105, p. 24.

(5.) *Ibid.*, pp. 25, 26. The section is copied by Dr. Engelhardt in the Ann. Rept. Supt. Onondaga Salt Springs for 1888. Assembly Doc. for 1889, No. 43, Charts No. II and IV; also, see p. 19.

Section of Castile Well,

from data given by Professor Bishop and Mr. Bush.

Approximate altitude 1390′ A. T.

DEPTH.	THICKNESS.	KIND OF ROCK.	FORMATION.
	49′	Soil.	
49′	----	Near top of Portage.	
	180′	"Argillaceous sandstone, 175′—180′." [1]	Portage.
229′	----		
	786′	"Blue shale, nearly uniform in color and hardness."	Genesee.
1015′	----		
	10′	"Flint shell (?)."	
1025′	----		
	650′	"Building stone, nearly like the first."	Hamilton.
1675′	----		
	100′	"Black shale, lower part much darker than the upper."	Marcellus.
1775′	——		
	140′	"Corniferous limestone."	Upper Helderberg.
1915′	----		
	320′	"Alternate layers of hard and soft rocks."	Lower Helderberg.
2235′	----		
	100′	"Soft slate saturated with brine."	Onondaga Salt group. [3]
2335′	----		
	35′	"Salt and shale mixed."	
2370′	----		
	45′	"Clear rock salt."	
2415′	----		
	40′	"Shales."	
2455′	----		
	70′	"Salt and shale, five feet of which was salt." [2]	
2525′	——		

Bottom of well in bluish-gray marl and limestone. Salt crystals.

(1.) In the totals for the well it is evidently called 180′.

(2.) Mr. Bush writes that 65′ of this stratum was pure rock salt. Dr. Engelhardt states that the well "is 2,525′ deep, with two salt beds, the upper forty-five feet thick, followed by forty feet shale, and a lower one, which was penetrated seventy feet without passing through this rock-salt vein" (*Ibid.*, p. 19.) But on Charts II, III and IV, accompanying this report Engelhardt has followed Bishop precisely.

(3.) In the above section it is possible to indicate only in a general way the position of the different terranes.

Although the first stratum of rock salt is about 2400′ in depth, some 600′ deeper than in the Warsaw wells, still it has been worked and Mr. Bush informs me that several thousand barrels of salt have been manufactured.

At Silver Springs, two miles northwest of Castile, are the salt works of the Duncan Salt Co., who have drilled five wells at this place.

Section of Silver Springs Well.

Compiled from data given by Professor Bishop. (1)

Approximate altitude 1391′ A. T. (2)

DEPTH.	THICKNESS.	KIND OF ROCK.	FORMATION.
	222′	"Gravel and quicksand."	Portage. Genesee. Hamilton. Marcellus.
222′	----		
	1299′	"Slate and sandstones."	
1521′	——		
	140′	"Corniferous limestone."	Upper Helderberg.
1661′	----		Lower Helderberg.
	320′	"Limestone (Helderberg (?))."	Onondaga Salt group.
1981′	----		
	128′	"Slate."	
2109′	----		
	15′	"Salt and shale mixed."	
2124′	----		
	10′	"Pure salt."	
2134′	----		
	45′	"Slate."	
2179′	----		
	75′	"Salt, pure."	
2254′	——	Bottom of well.	

(1.) Fifth ann. Rept. State Geologist [of New York] for 1885, p. 25. Dr. Engelhardt mentions three wells at this place, and states that there are "two salt veins of twenty and sixty feet thickness in each, separated by thirty-five to forty feet shale" (Ann. Rept. Supt. Onondaga Salt Springs, for 1888, p. 19). But on Chart II Engelhardt copies Professor Bishop's section without change and the data on Chart III also agree with Bishop.

(2.) October 29th, 1891, Mr. J. W. Duncan, President of the Duncan Salt Co., wrote me that the above well was about 1500′ south of the N. Y., L. E. & W. R. R. station at Silver Springs and about 15′ below the level of the railroad.

At Perry, six + miles NNE of Castile, two wells have been drilled and from the first of these wells samples were obtained daily by Professor I. P. Bishop, who kindly sent them to me for re-examination.

SECTION OF THE PERRY WELL. (1)

Approximate altitude 1350′ A. T. (2)

DEPTH.	KIND OF ROCK.	FORMATION.
176′	Argillaceous and finely arenaceous shale of light gray color.	Portage.
259′	Dark gray, clear, argillaceous shale; streak white.	
380′	Ditto, some of the fragments with a slightly brownish streak but mostly with a white streak.	
560′	Blackish, argillaceous shale with fairly brownish streak.	
620′	Gray, argillaceous shale with white streak, non-calcareous.	
775′	Slightly darker gray argillaceous shale, non-calcareous, streak white.	
800′	Dark gray argillaceous shale with brownish-gray streak, non-calcareous.	
920′	Bluish-gray argillaceous shale, calcareous. Fossils, especially Bryozoans.	Hamilton. (3)
1000′	Grayish, calcareous, argillaceous shale. Fossils, Crinoid stems	
1135′	Bluish-gray, calcareous, argillaceous shale. Fossils, *Chonetes*, *Ambocœlia umbonata* (Con.) Hall.	
1284′	Very dark gray, argillaceous shale; calcareous and fossiliferous with a slightly brownish streak.	
1462′	Dark gray limestone, strong effervescence in HCl.	Upper Helderberg.
1475′	Ditto.	
1520′	Light gray limestone with strong effervescence.	
1675′	Dark gray limestone, which effervesces very slowly in cold HCl, and is increased on heating.	Onondaga Salt group.

(1.) Prof. Bishop gives an interesting account of this well in the 5th Ann. Rept. State Geologist [of New York] for 1885, pp. 24, 25.

(2.) Prof. Bishop writes me that he has been unable to secure the authentic elevation of the mouth of this well; but from his knowledge of the slope from Castile it is estimated to be within 10′ of 1350′ above tide. The well is located within the corporation and near the railroad station.

(3.) The top of the Hamilton is probably higher in the well, possibly between the samples from 620′ and 775′; but the samples are not complete enough in order to show the division between the Genesee and Hamilton.

DEPTH.	KIND OF ROCK.	FORMATION.
1710′	Partly lighter gray chips than the above with stronger effervescence in cold HCl.	
1770′	Dark gray chips; scarcely any effervescence in cold HCl, but effervesces slowly on heating.	
1839′	Dark gray to drab magnesian limestone. Last sample.	Onondaga Salt group.

At Rock Glen, five and three-fourths miles north-west of Castile and about three miles south of Warsaw village, a number of wells have been drilled. The salt works of Alexander Kerr, Brother & Co., are located at this place and through the kindness of Mr. Sam'l T. Kerr an excellent set of samples was obtained from one of their wells. The well was commenced in November, 1890, and finished in January, 1891. Its mouth, according to Mr. Kerr, is about 25′ below the tracks of the N. Y., L. E. & W. R. R., which would make its altitude about 1306′ A. T., and it was drilled to a depth of 2138′.

DETAILED RECORD OF THE KERR WELL AT ROCK GLEN, WYOMING CO, NEW YORK.

NO. OF SAMPLE.	DEPTH.	DESCRIPTION OF SAMPLE.	
1.	20′.	Coarse gravel.	
2.	40′.	Clay 20′.	
3.	70′.	Fine gravel.	
4.	95′.	Arenaceous clay; top of rock.	95′ of drift.
5.	114′.	Three large chips, one fine grained micaceous, greenish-gray sandstone; the others argillaceous, olive shale that can be scratched by the nail. Characteristic Portage shale and sandstone.	
6.	185′.	Fine chips of slightly arenaceous, grayish to olive shales.	
7.	285′.	Gray shales, some of the chips have a slightly brownish streak, slightly calcareous.	
8.	350′.	Dark gray, argillaceous shale, not calcareous, streak nearly white.	
9.	410′.	Ditto.	Portage sandstones and shales.
10.	475′.	Very argillaceous grayish to olive shales.	

NO. OF SAMPLE.	DEPTH.	DESCRIPTION OF SAMPLE.	
11.	550′.	Mainly a blackish, argillaceous shale with brownish streak. This is hardly typical Genesee shale; but if not Genesee is similar to a recurring black shale which has been described by Professor Williams and others from surface outcrops. (1)	Genesee (?).
12.	600′.	Ditto.	
13.	650′.	Ditto.	Genesee.
14.	700′.	Dark gray to bluish, argillaceous slightly arenaceous shale. Streak white, non-calcareous.	
15.	750′.	Gray argillaceous shale. One chip contains two small Lamellibranchs, one of which resembles a young shell of *Nucula bellistriata* (Con.) Hall; and one specimen of *Styliola fissurella* Hall.	
16.	800′.	Lithology same as No. 15.	
17.	850′.	Darker gray, argillaceous shale.	
18.	900′.	Dark gray shale, part of it finely arenaceous. Some of the chips have a slightly brownish streak, slightly calcareous, with "a flow of gas."	
19.	950′.	Light gray, argillaceous shale, streak white, quite calcareous. A dorsal valve of a *Discina*, which may be compared with *D. doria* Hall, and a fragment of another shell.	
20.	1000′.	Shale, ditto. "Gas sufficient for 5 or 6 lights, or for 2 stoves. The volume was greater and the flow steadier than in any other well we have had [in the Warsaw region]" Mr. S. T. Kerr.	

(1.) Bull. Geol. Surv., No. 41, pp. 23-25, 31-34, 41, 47-50.

Prof. Hall, in 1879, called attention to this fact in central and western New York and said "this black slate [Genesee] is succeeded by a green or olive slate or shale, followed by successive alternations of black or greenish shales" (Geol. Surv., N. Y. Palæontology, vol. v, pt. II, pp. 150, 151).

Then Dr. Clarke, in 1885, described a "Lower and Upper Black Band" in the Naples Shales of Ontario Co., of which he said: "Further west they lose their persistency and become a series of thin beds alternating with the greenish shales and flag-stones" (Bull. U. S. Geol. Surv., No. 16, pp. 36, 37).

NO. OF SAMPLE.	DEPTH.	DESCRIPTION OF SAMPLE.	
21.	1050′.	Light gray, calcareous shale, effervesces slightly in HCl. There is another box marked "1050′ limestone," which has very fine chips of dark gray color, with strong effervescence. Similar to a limestone.	
22.	1100′.	Very light to darkish gray, strongly calcareous chips. Fragments of fossils.	
23.	1150′.	Dark gray, argillaceous shale, quite calcareous with slight brownish streak.	
24.	1200′.	Dark to bluish gray shale. Streak slightly brownish, quite calcareous. Fragment of a fossil shell, (?) *Spirifera mucronata* (Con.) Billings.	
25.	1250′.	About the same as No. 24.	
26.	1300′.	Dark gray argillaceous shale.	
27.	1350′.	Nearly black, argillaceous shale which is slightly arenaceous. Streak slightly brownish; somewhat calcareous.	Hamilton.
28.	1400′.	Black, argillaceous shale, with dark brown streak and non-calcareous. Drillers log "black shale 45′."	Marcellus.
29.	1450′.	Dark and light gray, fine chips, which are strongly calcareous. Some of the black Marcellus. Drillers "sand rock; Corniferous limestone."	
30.	1500′.	Light gray limestone; very finely powdered, strong effervescence. Drillers "hard sandy limestone."	
31.	1550′.	Ditto.	
32.	1590′.	Ditto. Drillers log "bottom of hard sandy limestone, thickness 140′."	Upper Helderberg.
33.	1700′.	Dark gray limestone with very fine chips. Effervescence not strong at first in cold HCl, but gradually increases. One of the somewhat magnesian limestones of the Onondaga Salt group.	
34.	1753′.	Ditto.	

NO. OF SAMPLE.	DEPTH.	DESCRIPTION OF SAMPLE.	
35.	1800′.	Rather dark gray to drab limestone, effervescence slow at first, but becomes strong on heating the HCl ; a magnesian limestone.	
36.	1850′.	Same as preceding with small fragments of white gypsum.	
37.	1900′.	Greenish and brownish red marlytes or calcareous shales. Some fine white chips, probably selenite. Drillers log "through the limestone." Upper part of the lower division of the Onondaga Salt group.	
38.	1950′.	Mostly greenish, finely arenaceous and but slightly calcareous shales (?). Effervescence increased by heating the HCl ; but does not become strong. Some brownish red chips. "Sandy shale" of driller.	
39.	2000′.	Ditto.	
40.	2030′.	Top of 1st rock salt stratum, 15′ thick.	
41.	2045′.	Greenish marlyte, effervescence strong after being a short time in HCl. Drillers log "40′ of shale."	
42.	2085′.	Top of 2d rock salt stratum, 50′ in thickness, 2135′ bottom of rock salt.	
43.	2136′.	Mainly fine chips of a drab marlyte, effervescence marked after a short time in cold HCl. A few chips of greenish, argillaceous shale.	
	2138′.	Bottom of well. Drillers log "tools drawn 3′ below base of salt bed."	Onondaga Salt group.

Diagrammatic Section of the Kerr Well at Rock Glen, New York.

Approximate altitude 1306′ A. T.

Depth.	Thickness.	Kind of rock.	
	95′	Drift; clay and gravel.	
95′	——	Rock, sandstone and shale.	
	455′	Portage.	
550′	----	Blackish shale, top of Genesee (?).	
	100′	Genesee.	
650′	----?	Base of Genesee.	
	750′	Limestone at 1100′. Hamilton.	
1400′	——		
	50′	Marcellus.	
1450′	——		
	140′	Upper Helderberg.	
1590′	----?	Base of Upper Helderberg.	
	310′	Lower Helderberg.	
		Dark gray magnesian limestone at 1700′.	Onondaga Salt group.
1900′	----		
	130′	Greenish and brownish-red marlytes.	
2030′	----		
	15′	1st rock salt stratum.	
2045′	----		
	40′	Greenish-gray marlyte.	
2085′	----		
	50′	2d rock salt stratum.	
2135′	----		
2138′	——	Drab marlyte.	
		Bottom of well.	

Since the Kerr well is located in the Warsaw salt basin the preceding section will serve as a standard one for the rocks of that region, through which so many wells have been and will be drilled in order to reach the beds of rock salt. A number of wells have been drilled at this locality (1) and the above section agrees fairly well with the one reported by Professor Bishop, (2) which is given below for the purpose of comparison.

(1.) See Ann. Rept. Supt. Onondaga Salt Springs for 1888, p. 19.

(2.) 5th Ann. Rept. State Geologist [of New York] for 1885, p. 24. This section is copied by Dr. Engelhardt, *ibid.*, chart No. II.

SECTION OF ROCK GLEN WELL.

Compiled from data given by Professor Bishop.

Altitude 1310' A. T.

DEPTH.	THICKNESS.	KIND OF ROCK.	FORMATION.
	128½'	"Soil."	
128½'			Portage.
	1361½'	"Sandstone and shale."	Genesee. Hamilton. Marcellus.
1490'			
	140'	"Corniferous limestone."	Upper Helderberg.
1630'			Lower Helderberg.
	385'	"Lower Helderberg."	Onondaga Salt group.
2015'			
	25'	"Salt."	
2040'			
	31'	"Shale."	
2071'			
	40'	"Salt."	
2011'		Bottom of well.	

At Warsaw, nine miles NNW of Castile, several wells have been drilled on the western side of the valley. Of the considerable number of wells drilled near Warsaw, one of the best for our purpose is the Gouinlock and Humphrey well (formerly called Humphrey-Stedman), which is located a short distance north of the "Erie" station and is reported by the driller, Mr. Thos. Percy, as two feet lower than the R. R. track, which would give an altitude of 1324' for the mouth of the well. This well is mentioned in a general way by Dr. Engelhardt, (1) while Professor Bishop gives a partial record of the well, which was much more complete after the salt was reached giving the thickness of the different layers of salt and shale (2). These data have been supplemented by information furnished by Mr. Percy, which was kindly given me by Dr. H. S. Williams, and also by notes sent me by Dr. W. C. Gouinlock.

(1.) Ann. Rept. Supt. Onondaga Salt Springs, for 1888, p. 18.
(2.) 5th Ann. Rept. State Geologist [of New York] for 1885, p. 23.

SECTION OF GOUINLOCK AND HUMPHREY WELL, NEAR "ERIE" STATION, AT WARSAW, N. Y.

Altitude 1324′ A. T.

DEPTH.	THICKNESS.	KIND OF ROCK.	FORMATION.
	12′	Drift.	
12′	----		
	1218′		Portage. Genesee. Hamilton.
1230′	——	Marcellus, "about 40′."	
	150′	"Corniferous limestone."	Upper Helderberg.
1380′	——		Lower Helderberg.
	60′	"50′—60′ soft shale."	Onondaga Salt group.
1440′	----	2d limestone. "200′—250′ softer than Corniferous, but drills hard."	
1800′	----	"Indications of rock salt."	
1803′	----	Rock salt. (1)	
	19′	"Salt and shale."	
1822′	----		
	3′	Salt.	
1825′	----		
	12′	Salt and shale.	
1837′	----		
	24′	Salt.	
1861′	----		
	2′	Shale with a little salt.	
1863′	----		
	16′	Salt.	
1879′	——	Bottom of well.	

On the eastern side of the valley, along the line of the Buffalo, Rochester and Pittsburgh Railway, are a considerable number of salt wells, and the records of several of them will be of value for our purpose. About ten rods from the station of the B., R. & P. R. R. is one of the Gouinlock and Humphrey wells.

(1.) There is a slight difference in the record of the lower portion of this well as reported by Professor Bishop and Dr. Gouinlock and that furnished by Mr. Percy. Bishop and Gouinlock report that salt was reached at a depth of 1803′ and that the well was drilled 76′ deeper, making its total depth 1879′. Mr. Percy's notes give the depth at which salt was reached as 1807′ and then state that it was drilled 84′ deeper, making it 12′ deeper than the other record, or with a total depth of 1891′.

SECTION OF GOUINLOCK AND HUMPHREY WELL, NEAR B., R. & P. R. R. STATION AT WARSAW, N. Y. (1)

Approximate altitude 1125′ A. T. (2)

DEPTH.	THICKNESS.	KIND OF ROCK.	FORMATION.
	17′	Clay.	
17′	----		
	1011′	"Shales."	Portage. Genesee. Hamilton. Marcellus.
1028′	----		
	148′	"Corniferous limestone."	Upper Helderberg.
1176′	----		Lower Helderberg.
	75′	"Shales."	Onondaga Salt group.
1251′	----		
	300′	Limestones.	
1551′	----		
	45′	"Shale."	
1596′	----		
	37′	"Salt and shale mixed."	
1633′	----		
	68′	"Main salt bed."	
1701′	----	Bottom of well. (3)	

The Warsaw Salt Co. has six wells about one half mile north of the B., R. & P. R. R. station. The records of two of these wells are given by Professor Bishop. It is stated that they "vary slightly in depth owing to difference of elevation of the place where the well was begun," (4) and the following section is compiled from the record of the well which is reported with greater fullness :

(1.) Compiled from data given by Prof. Bishop (5th Ann. Rept. State Geologist [of New York] for 1885, p. 22) and Dr. H. S. Williams.

(2.) Dr. Engelhardt gives the elevation as 1,125′ (Ann. Rept. Supt. Onondaga Salt Springs for 1888, chart No. III).

Prof. Williams says "mouth about level with depot," and Gannett gives the elevation of the railroad as 1117′ (Bull. U. S. Geol. Surv., No. 76, p. 370).

(3.) Mr. I. Wm. Smith of Syracuse, N. Y., has furnished me the following section of the above well :

Surface earth	8′
Slate or shale	1020′
Hard rock	150′
Limestone, &c	456′
Salt rock	68′

Dr. Gouinlock mentions a second well, owned by the same company, which is 1745′ in depth.

(4.) 5th Ann. Rept. State Geologist [of New York] for 1885, p. 22.

SECTION OF WARSAW SALT COMPANY'S WELL, ½ MILE NORTH OF B., R. & P. R. R. STATION AT WARSAW, N. Y.

Approximate altitude 1190′ A. T.(1)

DEPTH.	THICKNESS.	KIND OF ROCK.	FORMATION.
	16′	Clay.	
16′			
	940′	Shale.	Portage. Genesee. Hamilton. Marcellus.
956′			
	156′	"Corniferous limestone."	Upper Helderberg.
1112′			Lower Helderberg.
	430′	Limestone and shale.	Onondaga Salt group.
1542′			
	30′	"Shale and salt mixed."	
1572′			
	6′	1st salt stratum.	
1578′			
	6′	Shale. (2)	
1584′			
	70′	2d salt stratum.	
1654′		Bottom of well. (3)	

(1.) Ann. Rept. Supt. Onondaga Salt Springs for 1888, chart No. III.

(2.) Dr. Engelhardt gives the thickness of the last layer of shale as 10′ instead of 6′, which makes a total depth of 1658′ (*Ibid.*, chart No. II.) It is also stated that these wells have "an average depth of 1650 feet and seventy-five feet of rock salt in several layers, with shale between" (*Ibid.*, p. 18).

(3.) In Well No. 4 of this company, salt was reached at 1510′ and the total depth of the well is 1621′ (5th Ann. Rept. State Geologist [of New York] for 1885, p. 22).

Mr. I. W. Smith of Syracuse, kindly gave me the following record of another well of the Warsaw Salt Co. (formerly known as the Wing and Evans), which is stated to be near the above well.

DEPTH.	THICKNESS.	KIND OF ROCK.	FORMATION.
	17′	Clay.	
17′			
	956′	Shale.	Portage. Genesee. Hamilton. Marcellus.
973′		Corniferous limestone.	Upper Helderberg.
	148′		Lower Helderberg.
1121′			
	71′	"Flint."	Onondaga Salt group.
1192′			
	354′	Limestone.	
1546′			
	90′	Shale and Salt.	
1636′			
	64′	Rock salt.	
1700′		Bottom of well.	

In October, 1890, Dr. W. C. Gouinlock wrote me as follows in reference to the wells of the Warsaw salt district: "The rocks drilled through in all the wells are similar. The rock salt dips to the southwest 40′ to the mile and the surface rises several hundred feet from Pearl Creek to Rock Glen (the Kerr Salt Works). The Corniferous limestone comes to the surface at Le Roy, and the same rock at the B., R. & P. R. R. station [Warsaw] is 1028′ down. The salt lies pretty uniformly at 530′ to 550′ below this rock. The difference in the depth of the wells is always the surface difference above the Corniferous limestone, or 'hard rock' as the drillers call it. The salt strata are about 80′ in thickness."

About one mile north of the B., R. & P. R. R. station at Warsaw, on the lower side of the track, is the well of the Standard Salt Co., a section of which is as follows:

SECTION OF THE STANDARD SALT COMPANY'S WELL.

Approximate Altitude 1045′ A. T. (1)

DEPTH.	THICKNESS.	KIND OF ROCK.	FORMATION.
	26′	Clay.	
26′	----		
	874′	Shale.	Lower Portage. Genesee. Hamilton. Marcellus.
900′	——		Upper Helderberg.
	148′	Corniferous limestone.	Lower Helderberg.
1048′	----		Onondaga Salt group.
	457′	Limestone; shale with salt at bottom. (2) 1st salt at 1488′.	
1505′	----		
	40′	Rock salt.	
1545′	----		
	104′	Red shale or sandstone. (3)	
1649′	----	Bottom of well.	

(1.) Ann. Report Supt. Onondaga Salt Springs for 1888, chart No. III.

(2.) Prof. Bishop gives the "limestone, shale and salt" as 40′ and the "rock salt" as 457′. It is evident that there is a mistake in this portion of the section; but a record of the same well communicated to me by Mr. Smith gives the section as above, so it is quite clear that the printer transposed the figures in Prof. Bishop's section (5th Ann. Rept. State Geologist [of New York] for 1885, p. 21). Dr. Engelhardt gives the "limestone, shale and salt" as 440′ and the "rock salt" as 57′, (Ann. Rept. Supt. Onondaga Salt Springs for 1888, chart No. II); while on p. 18 it is stated that the

Thirty rods north of the Standard well, on the eastern side of the railroad are the two wells of the Miller Salt Co. The following section of one of these wells is compiled from data given by Professor Bishop. (1)

SECTION OF THE MILLER SALT COMPANY'S WELL.

Approximate altitude 1085′ A. T. (2)

DEPTH.	THICKNESS	KIND OF ROCK.	FORMATION
	935′	Shale.	Lower Portage. Genesee. Hamilton. Marcellus.
935′	——		
	147′	"Corniferous limestone."	Upper Helderberg.
1082′	----		Lower Helderberg.
	12′	Shale.	Onondaga Salt group.
1094′	----		
	400′	Limestone.	
1494′	----		
	30′	Shale and salt.	
1524′	----		
	85′	Rock salt. (3)	
1609′	----	Bottom of well.	

At Saltvale, about three miles north of Warsaw or three miles south of Wyoming, are the two wells of the Crystal Salt Co. Professor Bishop gives the following section of well No. 1: (4)

well is "1,650 feet in depth, with a salt vein of only twenty-seven feet thickness." On chart No. III the first salt is given as 1488′. In data obtained by Prof. Williams about this well the Corniferous limestone is given as 900′, first salt as 1505′ and bottom of salt as 1574′.

(3.) It will be noticed that this well shows the presence of the red shales of the Onondaga Salt group, below the salt horizon. Prof. Hall did not find surface exposures of this shale in western New York and wrote "the red shale forming the *lower* division of the group [Onondaga Salt group] * * * I have not been able to find west of the Genesee river."

"West of the Genesee * * * * the red shale has either thinned out or lost its color, gradually becoming a bluish green; while otherwise the lithological character remains the same" (Geol. of N. Y., Pt. IV, p. 119).

Farther west in Ontario the red shales are present in the lower part of the Onondaga Salt group as was described by Dr. T. Sterry Hunt, who stated that the lower strata "consisted chiefly of reddish and bluish shales, with inter-stratified beds of gypsum" (Am. Jour. Science, 2d ser., Vol. xlvi, (1868) p. 359). The probable occurrence of the red shales near Chippawa village, Ontario, and on the Welland canal, near Port Robinson, was inferred by Sir Wm. Logan, from the fact that "the clay for a considerable extent in that neighborhood, has a red color, such as might be expected from the disintegration of the red shales, which occur at the base of the formation in New York" (Geol. Surv. Canada. Rept. of Prog. from its commencement to 1863, p. 347).

(1.) 5th Ann. Rept. State Geologist [of New York] for 1885, p. 21.

(2.) Ann. Rept. Supt. Onondaga Salt Springs for 1888, Chart No. III.

(3.) Dr. Engelhardt says, "The Miller salt works obtain their brine from two wells of about 1,600 feet depth with nearly 100 feet of a rock salt vein in one, and less than a fifty-foot vein in the other, though the wells are only a short distance apart" (*ibid.*, p. 18); but on Chart No. II. Prof. Bishop's section is given without modification.

(4.) 5th Ann. Rept. State Geologist [of New York] for 1885, p. 21.

SECTION OF THE CRYSTAL SALT COMPANY'S WELL.

Approximate altitude 980′ A. T. (1)

DEPTH.	THICKNESS.	KIND OF ROCK.	FORMATION.
	136′	Sand and gravel.	
136′	----		
	634′	Shale.	Genesee. Hamilton. Marcellus.
770′	——		
	146′	"Corniferous limestone."	Upper Helderberg.
916′	----		Lower Helderberg.
	15′	Shale.	Onondaga Salt group.
931′	----		Onondaga Salt group.
	394′	Limestone.	Onondaga Salt group.
1325′	----		Onondaga Salt group.
	50′	Salt and shale.	Onondaga Salt group.
1375′	----		Onondaga Salt group.
	61′	Rock salt.	Onondaga Salt group.
1436′	——	Bottom of well.	Onondaga Salt group.

One mile south of Wyoming on the western side of the valley is the "Pioneer" salt well, in which rock salt was first found in New York state in 1878. A section of this well was published by Dr. Engelhardt in 1882. (2) The section is repeated in the report of the following year and again in 1889. There are slight variations in the three accounts of this well; but in the main the last report has been followed in the compilation of the section given below:

(1.) Ann. Rept. Supt. Onondaga Salt springs for 1888, Chart No. III.

(2.) Ann. Rept. Supt. Onondaga Salt Springs for 1881, Assem. Doc. for 1882, No. 16, p. 20. Prof. Bishop states that a section of this well was published by Mr. Jas. Macfarlane in the *Syracuse* [*N. Y.*] *Journal*, in the latter part of July, 1878 (5th Ann. Rept. State Geologist [of New York], for 1885, p. 21).

SECTION OF THE FIRST OR "PIONEER" WYOMING WELL.

Approximate altitude 1004′ A. T. (1)

DEPTH.	THICKNESS.	KIND OF ROCK.	FORMATION.
	40′	Soil and clay.	
40′	----		
	40′	Bluish shales.	Portage. (?)
80′	----		
	220′	Black shales becoming lighter below.	Genesee.
300′	----		
	10′	Limestone.	Hamilton.
310′	----		
	363′	Light colored shale and very black near the base.	Marcellus.
673′	——		Upper Helderberg.
	100′	Corniferous limestone.	Lower Helderberg.
773′	----		Onondaga Salt group.
	92′	Limestone.	
865′	----		
	405′	Drab colored limestone and gypseous shales.	
1270′	----		
	70′	Salt alternating with shale.	
1340′	----		
	190′	Red shales alternating with drab and dark colored shales. (2)	
1530′	——	Bottom of well.	

(1.) Ann. Rept. Supt. Onondaga Salt Springs for 1888, Chart No. III.

(2.) The thickness of the layers in the above section is taken from Chart No. II of Engelhardt's report for 1888, but the description is in part from his earlier accounts. In the first account the thickness of the "shales alternating with gypsum and limestone," just above the salt, is given as 362′ instead of 405′ (Ann. Rept. Supt. Onondaga Salt Springs for 1881, p. 20). The account the following year gives the Hamilton limestone as 5′ thick instead of 10′; the shales below this limestone as 345′ instead of 363′; from the top of the Corniferous limestone to the top of the salt as 610′ instead of 597′; and the red shales as 200′ instead of 190′ (*Ibid.*, 1882, Assem. Doc. for 1883, No. 35, p. 25). The section quoted by Professor Bishop gives it as 660′ from the mouth of the well to the top of the Corniferous limestone instead of 673′; and from the top of the limestone to the salt as 610′ instead of 597′ (5th Ann. Rept. State Geologist [of New York] for 1885, p. 21).

Mr. James Macfarlane, in his account of this well, stated that the salt was reached at a depth of 1279′; that it was 70′ thick, of which 40′ or 50′ consisted of pure salt; then the well was continued to a depth of 1530′ through red shales and sandstones of the salt group; and that the Niagara limestone was reached at 1562′ (Am. Jour. Science, 3d ser., Vol. xvi, 1878, p. 144).

In the village of Wyoming is the well of the Globe Salt Company. The surface rock is stated by Professor Bishop to be Genesee shale. (1)

SECTION OF THE GLOBE SALT COMPANY'S WELL.

Approximate altitude 958′ A. T. (2)

DEPTH.	THICKNESS.	KIND OF ROCK.	FORMATION.
	1220′		Genesee. Hamilton. Marcellus. Upper Helderberg. Lower Helderberg.
1220′	----		Onondaga Salt group.
	20′	Salt and shale mixed.	
1249′	----		
	81′	Rock salt.	
1321′	----	Bottom of well.	

One mile north of Wyoming, near the track of the B., R. & P. R. R., is the Moulton well.

SECTION OF THE MOULTON WELL.

Approximate altitude 925′ A. T. (3)

DEPTH.	THICKNESS.	KIND OF ROCK.	FORMATION.
	3′	Soil.	
3′	----		
	552′	Arenaceous and argillaceous shales.	Hamilton. Marcellus.
555′	——		
	152′	Corniferous limestone.	Upper Helderberg.
707′	----		Lower Helderberg.

(1.) *Ibid.*, p. 20, and the data for the above section are also given on p. 20.
(2.) Ann. Rept. Supt. Onondaga Salt Springs for 1888, Chart No. III.
(3.) *Ibid.*, Chart No. III.

DEPTH.	THICKNESS.	KIND OF ROCK.	FORMATION.
	60′	Shale.	Onondaga Salt group.
767′	----		
	323′	Limestone.	
1090′	----		
	34′	Shale.	
1124′	----		
	27′	Shale and salt.	
1151′	----		
	85′	Rock salt.	
1236′	----		
	5′	Shale.	
1241′	——	Bottom of well. (1)	

At Pearl Creek, nine miles north of Warsaw or three miles north of Wyoming, are two wells. Their approximate altitude is 952′ A. T. (2); one is 1194′ deep with 20′ of rock salt and the other 1182′ deep with 25′ of rock salt. (3)

A well was drilled four miles south of Le Roy at the junction of the B., R. & P. R. R. with the D., L. & W. R. R., which gave the following section.

SECTION OF WELL FOUR MILES SOUTH OF LE ROY.

Approximate altitude 925′ A. T. (4)

DEPTH.	THICKNESS.	KIND OF ROCK.	FORMATION.
	46′	Gravel.	
46′	----		Hamilton.
	192′	Shale.	Marcellus.
238′	——		
	146′	Corniferous limestone.	Upper Helderberg.
384′	----		Lower Helderberg.
	454′	Limestone.	Onondaga Salt group.
838′	----		
	40′	Rock salt.	
878′	——	Bottom of well. (5)	

(1.) The section is compiled from data given by Prof. Bishop (5th Ann. Rept. State Geologist [of New York] for 1885, p. 20). The same section is copied by Dr. Engelhardt (Ann. Rept. Supt. Onondaga Salt Springs for 1888, Chart No. II).

(2.) *Ibid.*, Chart No. III.

(3.) *Ibid.*, p. 17.

(4.) *Ibid.*, Chart No. III.

(5.) Section compiled from data given by Prof. Bishop (5th Ann. Rept. State Geologist [of New York] for 1885, p. 20). The section is copied by Dr. Engelhardt without change (Ann. Rept. Supt. Onondaga Salt Springs for 1888, Chart No. II); but on Chart No. IV 7′ of shale is given below the salt, making the total depth 885′.

SECTION OF WELL NO. 2 AT LE ROY, NEW YORK, EIGHTEEN MILES NORTH OF WARSAW.

Approximate altitude 863′ A. T. (1)

DEPTH.	THICKNESS.	KIND OF ROCK.	FORMATION.
	22′	Soil.	
22′			
	11′	Marcellus shale.	
33′			
	137′	Corniferous limestone.	Upper Helderberg.
170′			Lower Helderberg.
	440′	Limestone and shales.	Onondaga Salt group.
610′		Brine in shale mixed with salt.	Onondaga Salt group.
	380′		Onondaga Salt group.
990′		Niagara limestone and bottom of well. (2)	

In the latter part of 1887 a well was drilled at Batavia, ten miles west of Le Roy, and through the kindness of Mr. D. L. Dodgson of that town, a set of samples was obtained for examination. The well is located south of the village on the bank of Tonawanda creek and is reported as six feet lower than the station of the N Y. Central & Hudson River R. R. According to Gannett the elevation of the Batavia station is 895′ A. T., (3) which would make the mouth of the Batavia well 889′ A. T.

DETAILED RECORD OF THE BATAVIA WELL, AT BATAVIA, GENESEE CO., NEW YORK.

NO. OF SAMPLE.	DEPTH.	DESCRIPTION OF SAMPLE.
1.	40′.	Black, argillaceous shale, with dark brown streak; one chip with iron pyrites. Marcellus.
2.	100′.	Mainly light gray limestone chips; but with some dark gray. Strong effervescence in cold HCl. Upper Helderberg.
3.	150′.	Mainly dark gray limestone mixed with chert; some light gray chips. (4)

(1.) *Ibid.*, Chart No. III.

(2.) The section is compiled from data published by Prof. Bishop (5th Ann. Rept. State Geologist [of New York] for 1885, p. 19).

(3.) Bull. U. S. Geol. Surv., No. 76, p. 43.

(4.) Prof. Hall noted the large amount of hornstone in the surface exposures of the Corniferous limestone in the vicinity of Le Roy (Geol. N. Y., Pt. IV, pp. 166, 167, see especially the section along Allen creek below Le Roy).

NO. OF SAMPLE.	DEPTH.	DESCRIPTION OF SAMPLE.
4.	200′.	Mostly light gray limestone and chert; some of the dark gray chips.
5.	250′.	Drab colored limestone, moderate effervescence in cold HCl; lithologic character quite different from No. 4. Waterlime or upper Onondaga Salt group. (1)
6.	300′.	Dark gray chips which effervesce very slowly in cold HCl, increased by heating, leaves large residue.
7.	350′.	Dark gray, somewhat calcareous chips. Effervescence increased by heating.
8.	400′.	Ditto, only rather more calcareous.
9.	450′.	Dark gray to slightly greenish-gray argillaceous shales. Slightly calcareous.
10.	550′.	Dark gray chips, about the same as No. 8, more calcareous than No. 9.
11.	600′.	Grayish, somewhat calcareous chips mixed with crystals of rock salt. Mr. Dodgson reported about 15′ of salt.
12.	650′.	Greenish-gray shale, some very slightly pinkish. No effervescence in cold HCl. Mr. Dodgson reported red shale at about 650′, but only 6′–8′ in thickness with indications of salt.
13.	700′.	Greenish-gray with some slightly purplish chips. Some effervescence in cold HCl. Fragments of gypsum.
14.	750′.	Dark gray limestone, effervescence moderately strong in cold HCl, after a few minutes. Some of the chips show spots of resinous lustre as was described by Professor Hall in 1843. (2)
15.	800′.	Ditto, nearly all the chips have a resinous lustre. (3)
16.	840′.	Dull gray to drab chips which are very fine.
17.	900′.	About the same as No. 16.

(1.) It is difficult in well samples to decide where the Upper Helderberg stops and the Onondaga Salt group commences (see Harris, Amer. Geol., Vol. VII, p. 170); but of these samples No. 4 is characteristic of the Upper Helderberg and No. 5 of the upper Onondaga Salt group.

(2.) Geol. of N. Y., Pt. IV, p. 85.

(3.) Sample No. 14, is a dark gray limestone which seems to be near the character of the Niagara; but No. 15, which is not quite so dark in color, must be Niagara. Prof. Hall says: "The lithological characters alone of the two upper divisions [of the Niagara] are everywhere sufficient to distinguish this part of the rock from all other limestones in the State; these are, its brittle nature, the glistening surface of the minute crystalline laminæ of which the mass is composed, and its harsh or apparently siliceous character" (Geol. N. Y., Pt. IV, p. 87). In No. 15 is a large chip on which the glistening laminæ are very conspicuous, they are also noticeable on the largest chips of No. 14.

NO. OF SAMPLE.	DEPTH.	DESCRIPTION OF SAMPLE.
18.	1000′.	Dark gray to bluish-gray argillaceous shale, non-calcareous. (1)
19.	1100′.	Red argillaceous and finely arenaceous chips. Medina.
20.	1200′.	Pure quartz sandstone, slight reddish tint; 70′ in thickness.
21.	1650′.	Dark red (chocolate) finely arenaceous chips.
22.	2000′.	About the same as No. 21. Bottom of well still in the Medina.

DIAGRAMMATIC SECTION OF THE BATAVIA WELL, AT BATAVIA, NEW YORK.

Altitude 889′ A. T.

DEPTH.	THICKNESS.	KIND OF ROCK.
	40′	Drift.
40′	----	
	60′	Marcellus.
100′	——	
	150′	Upper Helderberg. Lower Helderberg.
250′	——	
	500′	About 15′ rock salt at 600′. } Onondaga Salt group.
750′	----	? Top of Niagara limestone.
	250′	Niagara.
1000′	----	Clinton (?).
	100′	Probably mostly Medina. (2)
1100′	----	Medina.
	900′	
2000′	——	Bottom of well in Medina.

In the summer of 1883 a well was drilled at Brockport, about 16½ miles east of north from LeRoy, and an account of this well together with some samples was furnished by Mr. John H. Kingsbury.

(1.) It is very difficult to decide whether this sample ought to be referred to the Niagara or Clinton shale. Prof. Hall in 1852 called attention to the similarity of the lithologic characters of these two groups in western New York, when he wrote: "The lithologic characters of the Clinton and Niagara groups are so similar that they could well be united" (Geol. Surv. N. Y., Palæontology, Vol. II, p. 107). But from a comparison of other well records and samples it is probable that No. 18 is from near the bottom of the Clinton.

(2.) Sample No. 18 from 1000′ is probably from near the base of the Clinton. The next sample No. 19 from 1100′ is Medina and probably most of the 100′ between samples Nos. 18 and 19 belongs to the Medina, which would give it a thickness of at least nearly 1000′ in this well.

The mouth of the well must be near the top of the Medina, which outcrops at that locality. At 1200′ a slight flow of gas was obtained, which made a flame about ten inches in height from a ¾ inch gas pipe.

SECTION OF THE BROCKPORT WELL, AT BROCKPORT, MONROE CO., NEW YORK.

Altitude 538′ A. T. (1)

DEPTH.	THICKNESS.	KIND OF ROCK.	
		Medina.	Medina.
500′	----	Red shale.	
900′	----	Darker red shale.	
950′	----	Very dark red shale.	
1000′	——		
		Gray and bluish chips, about ¼ are light gray and slightly calcareous.	Hudson and Utica shale.
1400′	----	Blue shale and sandstone.	
2000′	——	Blue compact limestone.	
		Trenton and bottom of well.	

During the winter of 1890-91 a well was drilled at Rochester, about 22 miles northeast of Le Roy, by Messrs. Otis and Gorsline. Samples were saved which have been carefully studied by Professor H. L. Fairchild, who has very kindly furnished me with advance pages of his paper describing this well. (2)

SECTION OF THE ROCHESTER WELL, AT ROCHESTER, MONROE CO., NEW YORK, AS REPORTED BY PROFESSOR H. L. FAIRCHILD.

Altitude 506′ A. T.

DEPTH.	THICKNESS.	KIND OF ROCK.	
	22′	Drift.	
22′	----		
	228′	Niagara and Clinton.	
250′	——		
	1158′	Medina—red 1075′— and Oswego or Oneida 83′.	1158′.
1408′	——		

(1.) Engelhardt. Rept. Supt. Onondaga Salt Springs for 1888, p. 16, Chart No. III.

(2.) A Section of the Strata at Rochester, N. Y., as shown by a deep boring. Proc. Rochester Academy of Science, Vol. I, pp. 182–186. The section of the well is given on pp. 183, 184.

A duplicate set of samples of the Rochester well was presented to the National Museum by Professor Fairchild and these specimens have been studied by the writer, who cordially agrees with Professor Fairchild's interpretation of the record.

DEPTH.	THICKNESS.	FORMATION.
	598′	Hudson and Utica. (1)
2006′		
	954′	Trenton.
2960′		
	137′	Calciferous (?).
3097′		
	.3′	Archean (?).*
3100′		Bottom of well.

Professor Fairchild writes:—"No allowance is here made for errors in measurement by the drillers. I think that eleven feet should be taken from the Niagara and added to the Medina making the latter 1169 feet thick." (Letter of October 6, 1891).

From the preceding well sections, a general section has been compiled giving the approximate thickness of the different formations, together with the total thickness from the Olean conglomerate (?)

(1.) Sample No. 34, at 1818′ is a dark blue argillaceous shale which in lithologic characters resembles the Utica shale. But, the next sample, No. 35 from 1868′, is a bluish shale like the Hudson above. Sample No. 36, at 1912′, is undoubtedly Utica and No. 37 from 1928′ is likewise a dark blue argillaceous shale.

(*) [NOTE.—The following letters to Professor H. L. Fairchild from Professor J. E. Wolff, Instructor in Petrology at Harvard University, concerning the petrographical examination of the samples of rock from the Rochester well, supposed to be Archean, are self explanatory, and this seems to be the most appropriate place for their insertion. For the original article by Professor Fairchild describing the samples from this well see Vol. I of the Proceedings, pp. 182–186. *Ed.*

CAMBRIDGE, MASS., April 21, 1892.

DEAR PROF. FAIRCHILD:—I have had a number of thin sections prepared of the material you sent me from the Rochester deep well with the following results:

Sample 62 in slides. The fragments of shale are microscopically composed of small rounded grains of quartz, more angular ones of feldspar, (both orthoclase, plagioclase, microcline, and microperthite) and a cement stained yellow by iron hydrate, apparently composed of a micaceous element with some calcite. Some of the fragments are of a fine-grained limestone.

Sample 63 in slides. Sample in grains effervesces with cold conc. HCl, strongly if warmed. Fragments of fine-grained limestone, often containing round grains of quartz of larger size than the calcite grains; also fragments of loose quartz, part of which have certainly been broken out of the above limestone. There are also fragments of the same fine-grained grit or shale as in 62, very feldspathic. There is one large fragment of microperthite (intergrowth of two feldspars characteristic of Laurentian gneisses) and also one fragment of a rather fine-grained gneiss composed of microcline and quartz. The last two fragments are undoubtedly from the Archean gneiss, but of course might have come from pebbles in the basement rock resting on the Archean. Also fragments of calcareous quartzite composed of rounded grains of quartz with a calcareous cement.

Sample 64 is composed of pure quartz grains, ferruginous and masses of limonite. Occasionally a grain of microcline or other feldspar.

The points that strike me are that in sample 63 the limestone contains frequent large apparently clastic grains of quartz and that the quartzite is also calcareous. This is the character of the Cambrian (Stockbridge) limestone at Rutland, Vt., in proximity to the underlying Olenellus quartzite. The fragments of feldspar from the Archean and of fragments of gneiss suggest close proximity to the Archean at least. That both in this and 64 there should be so little feldspar comparatively makes me doubt whether these come actually from gneiss, the hornblende or mica might be supposed to have floated off, but there ought to be more feldspar. It would look more like a feldspathic quartzite very close to gneiss. * * * *

Yours very truly, J. E. WOLFF.

CAMBRIDGE, MASS., May 6, 1892.

DEAR PROF. FAIRCHILD:—In reply to your letter of April 29th, the sample 63, which I have, effervesces gently with cold concentrated HCl, and violently when slightly warmed, showing a dolomitic tendency. The microscopic description shows that there are grains of calcareous quartzite, quartz-bearing limestone or dolomite, and fine-grained grit or shale, so that it is a mixture of fragments of three kinds besides the feldspar and gneiss. You are welcome to make any use you can of these microscopic determinations although they do not seem decisive enough to have great weight in the question whether or not the Archean was struck. * * * *

Yours very truly, J. E. WOLFF.]

down to the Archean (?). With two exceptions the thickness of each formation is obtained from some well record and the wells which have furnished most of the data for this general section are the Clarksville, Castile, Rock Glen, Batavia and Rochester.

A General Geological Section of Western New York, not far west of the Genesee River.

DEPTH.	THICKNESS.	FORMATION.
0′	——	Little Genesee conglomerate = Olean conglomerate (?).
	300′	Upper Devonian (estimated).
300′	----	Wolf creek conglomerate.
	1150′+	Chemung. ([1])
1450′+	----	
	900′	Portage (estimated in part). ([2])
2350′	----	
	100′	Genesee shale. ([3])
2450′	----	
	750′	Hamilton.
3200′	——	
	50′	Marcellus shale.
3250′	——	
	150′	Upper Helderberg and ? Lower Helderberg. ([4])
3400′	——	
	600′	Onondaga Salt group. ([5])
4000′	——	
	250′+	Niagara and Clinton.
4250′+	——	

(1.) It is probable that the Clarksville well, No. 91, does not reach the bottom of the Chemung and in that case 1150′ is not the entire thickness of this stage.

(2.) From a comparison of the well sections there was about 825′ of Portage in the Castile well. But that well did not commence at the top of the Portage, so that it is better to call this stage at least 900′ in thickness and it may be considerably thicker.

(3.) The first black shale seen may not be the top of the Genesee, but some of the black bands in the lower part of the Portage, in which case 100′ is probably greater than the true thickness of the Genesee shale.

(4.) There is from 140′-150′ of rock that lithologically it is not possible to separate from the Upper Helderberg; but it is possible that part of this limestone ought to be referred to the Onondaga Salt group. Mr. Harris noted the same difficulty in the Jamestown well (Am. Geol. Vol. VII, p. 170).

(5.) The wells throughout the salt district indicate a thickness of from 500′ to a little more than 600′ for the Onondaga Salt group.

DEPTH.	THICKNESS.	FORMATION.
	1158′	Medina, including 83′ of Oswego sandstone.
5408′		
	598′	Hudson and Utica.
6006′		
	954′	Trenton.
6960′		
	137′	Calciferous (?).
7097′		
	3′	Archean (?).
7100′		

In order to show the variation of the above section from our previous knowledge of the thickness of these terranes, a general geological section ranging through the same series of formations has been compiled from books and geological articles. In the compilation of this section the maximum thickness of the terranes, as near the line of section as possible, has been taken. The notes following the section give the authority and reference to the work in which may be found the statement of the thickness of the various terranes.

A Generalized Geological Section along the Genesee River, from the Olean Conglomerate to the Archean of Ontario,

Compiled from various books and articles.

DEPTH.	THICKNESS.	FORMATION.
0′		Olean conglomerate (Little Genesee conglomerate?).
	300′ (*a.*)	Upper Devonian.
300′		Wolf creek conglomerate (flat pebble).
	1500′ (?) (*b.*)	Chemung.
1800′		
	1000′ (*c.*)	Portage.
2800′		
	90′ (*d.*)	Genesee.
2890′		
	400′ (*e.*)	Hamilton.
3290′		
	50′ (*f.*)	Marcellus.
3340′		

DEPTH.	THICKNESS.	FORMATION.
	90′ (*g.*)	Upper Helderberg.
3430′	—— ⟶	Place of { Oriskany and Lower Helderberg.
	600′ (*h.*)	Waterlime and Onondaga Salt group.
4030′	——	
	180′ (*i.*)	Niagara.
4210′	——	
	80′ (*j.*)	Clinton.
4290′	——	
	700′ (*k.*)	Medina.
4990′	——	
	1030′ (?) (*l.*)	Hudson and Utica.
6020′	——	
	750′ (*m.*)	Trenton.
6770′	——	
	40′ (*n.*)	Calciferous (?) and Potsdam (?).
6810′	——	
		Archean.

Authority and reference for the thickness of the terranes, as given in the preceding section.

a. Prof. Henry S. Williams stated that the distance between the little Genesee (Olean) and the Wolf creek (flat pebble) conglomerates "may average about 300′" (Bull. U. S. Geol. Surv., No. 41, p. 89). It is probable that Prof. Hall saw both the flat and angular pebble conglomerates, without distinguishing their different stratigraphical positions. He mentions a conglomerate "about three or four miles south of Wellsville" (4th An. Rept. Fourth Geol. Dist. N. Y., 1840, p. 409); again "in Scio it is found on the high grounds near the sources of some small streams flowing into the Allegany and Genesee," and finally "in the town of Genesee, about three miles north of the Pa. line, and near the center of that town, the conglomerate, essentially the same as at

Scio, occurs on the highest hills" (*Ibid.*, p. 410). The exposure last mentioned is probably the one called Little Genesee by Professor Williams and regarded as equivalent to the Olean conglomerate.

b. Professor Hall wrote: "The summit of the Portage group, on the Genesee river is less than 1200 feet above tide water. * * * * The highest hills toward the south part of the State are scarcely less than 2500 feet above tide water, showing a difference of elevation between the two groups of 1300 feet. Allowing for undulations, which render the dip irregular, the whole thickness is above 1500 feet" (Geol. N. Y., Pt. IV, p. 260). Since Professor Hall did not distinguish between the flat and the angular pebble conglomerates it is difficult to decide which of these conglomerates should be taken for the top of his Chemung. From certain statements we are inclined to think that the 1500′ was intended to represent the thickness of the rocks from the top of the Portage to the base of the Olean conglomerate. A comparison of Professor Hall's "Section from the mouth of the Genesee river to Instantur, Penn." and the "Vertical section showing the relative thickness of the different rocks" (2d An. Rept. Fourth Geol. Dist. N. Y., 1838) seems to indicate that then he considered the rocks from an "argillaceous iron ore" stratum near Wellsville, N. Y., down to "olive shale and sandstone" near Portage as 1750′ in thickness. These rocks correspond pretty closely with the limits of what Professor Hall later defined as the Chemung group of this region; but the thickness would be overestimated if it were based on the supposition that the dip amounted "to 50 or 60 feet in the mile" (*Ibid.*, p. 291).

Professor Williams' investigations seem to assign a thickness of between 1500′ and 1600′ to the rocks between the Wolf creek conglomerate and the top of the Portage sandstones. The altitude of the top of the Portage sandstone at Portage Falls is about 1200′ (Bull. U. S. Geol. Surv., No. 41, p. 52); altitude of Wolf creek conglomerate west of West Clarksville about 1950′ (*Ibid.* p. 86); hence 1950′—1200′=750′. The distance between the two places is about 33 miles which with a dip of 25′ to the mile (*Ibid.*, p. 103) would equal 825′. Then 750′+825′=1575′ for the thickness of that series of rocks.

Mr. Harris, by computation and the record of the Jamestown well, makes the thickness of the rocks from the Panama conglomerate to the Portage, all of which is Chemung, 1390′ (Am. Geol. Vol. VII, p. 165, pl. 4).

Prof. Hall wrote : " The thickness of this group [Portage] on the Genesee cannot be less than one thousand feet " (Geol. of N. Y., Pt. IV, p. 238, also, see p. 217). In 1840 Professor Hall gave the thickness of the Cashaqua shale (lower part of Portage) as 110′ (4th An. Rept. Fourth Geol. Dist. N. Y., p. 390), which is given as the same in the final report (*Op. cit.*, p. 227) ; but in the 4th An. Rept. the Gardeau (Middle Portage) and Portage sandstones (Upper Portage) are stated to "occupy a thickness of more than 1000 feet" (*Op. cit.*, p. 392), which makes the thickness of the entire Portage more than 1110′. The vertical section of 1838 gave a thickness of 500′ from the "olive shales and sandstones" down to "bituminous shales" (2d An. Rept. Fourth Geol. Dist. N. Y.) ; but this did not reach the base of the Portage and probably not its top as defined later. In 1879 it was given as "one thousand feet or more in central New York" (Geol. Surv. N. Y., Pal. Vol. V, Pt. II, p. 151).

Dr. Clarke in 1885 stated : "In Ontario County the entire series of Portage strata is very perfectly developed, reaching a thickness of between 800 and 1,000 feet" (Bull. U. S. Geol. Surv. No. 16, p. 36). This series is composed of about 365′ belonging to the Cashaqua and Gardeau subdivisions (*Ibid.*, pp. 36, 37), which are called Naples shales by Clarke, and about 600′ of Portage sandstones (*Ibid.*, p. 67, also, see p. 75). In the 4th An. Rept. of the [N. Y.] State Geologist for 1884, Dr. Clarke gave the thickness of the Naples shales in Ontario Co., as from "350—400 feet" (Assembly Doc. No. 161 for 1885, p. 20) and the Portage sandstones as from "600—700 feet" (*Ibid.*, p. 21).

Sir Wm. Logan in 1863 stated : "To the south of Lake Erie, in New York, * * * The Portage and Chemung sandstones have a thickness of 2,000 feet ; which increases to 3,000, farther to the eastward" (Geol. Surv. of Canada, Rept. of Prog. from its commencement to 1863, p. 389). Mr. Harris assigns a thickness of 1315′ to the Portage in the Jamestown well (Am. Geol., Vol. VII, p. 174, pl. 4) ; which would make the combined thickness of the Chemung and Portage at least 2705′ for the Jamestown region and well (*Ibid.*, pp. 165, 174, pl. 4).

d. Hall's "vertical section" of 1838 gave 180′ of "bituminous shales containing septaria" in the vicinity of Mt. Morris (2d An. Rept. Fourth Geol. Dist. N. Y.); but this probably included the recurring black shales in the lower Portage. In 1839 the thickness of the upper Black shale (Genesee), in Seneca Co., was given as 150′ (3d An. Rept. Fourth Geol. Dist. N. Y., p. 301). While in the final report Professor Hall said: "On the shores of Seneca lake and in Ontario county the thickness of this rock is about 150 feet. * * * * After passing the Genesee river in a westerly direction, it soon becomes evident that the rock has diminished in thickness. * * * * On the shore of Lake Erie * * * [it] is but twenty-three feet seven inches" (Geol. N. Y., Pt. IV, p. 221). Dr. Clarke gives the thickness as 160′ along the shores of Canandaigua lake (Bull. U. S. Geol. Surv., No. 16, pp. 13, 14). With the thickness on Canandaigua lake 160′ and on Lake Erie nearly 24′, if the decrease in thickness were uniform then north of Warsaw the Genesee would be about 92′ thick. In the Jamestown well it is about 65′ (Harris, Am. Geol., Vol. VII, pl. 4; see p. 169).

e. The Tully limestone does not reach the Genesee river and consequently the next lower formation in this section is the Hamilton. Professor Hall wrote in 1839: "The Tully limestone I have observed but at two points in Ontario county; one in the bed of Flint creek at Bethel [now Gorham], * * * * the other four miles northwest of that village" (3d An. Rept. Fourth Geol. Dist. N. Y., p. 313). In the final report the Professor said: "On Canandaigua lake, it [Tully] is represented by a few inches of impure calcareous matter," and further: "This rock is virtually absent at all places west of Canandaigua lake" (Geol. N. Y., Pt. IV, p. 213). Dr. Clarke says: "This formation [Tully] is lacking in New York west of the village of Bethel, in the township of Gorham, but for a distance of ten or fifteen miles west of its last appearance its influence seems marked by the clearly defined separation between the shales of the Genesee and those of the underlying Hamilton" (Bull. U. S. Geol. Surv., No. 16, p. 17). Finally, in reference to the distribution of the Tully see the map of the "Geographical distribution of the Tully limestone, in central New York" by Prof. S. G. Williams in the Sixth An. Rept. State Geologist [N. Y.] for 1886; also, p. 14.

Prof. Hall on the "vertical section" of 1838 gave 400′ as belonging to the "Calcareous shales of the Mountain limestone;" but judging from the accompanying section along the Genesee river this division did not extend to the base of the Hamilton (2d An. Rept. Fourth Geol. Dist. N. Y.). In the final report the Professor gave its thickness on Lake Erie as less than 500′ and not less than 1000′ on the eastern limit of the fourth district, along Cayuga lake (Geol. N. Y., Pt. IV, p. 194). Dr. Clarke makes the thickness of the Hamilton in Ontario Co. probably greater than 400′ (Rept. State Geol. [N. Y.] for 1884, pp. 12–17). The Jamestown well has about 395′ of Hamilton (Harris, Am. Geol., Vol. VII, pl. 4, see pp. 169, 170).

f. Prof. Hall wrote: "The greatest thickness of this rock [Marcellus], where it can be measured accurately, does not amount to more than fifty feet" (Geol. N. Y., Pt. IV, p. 179). Dr. Clarke assigns it "a thickness of about 100 feet" in Ontario Co. (Rept. State Geol. [N. Y.] for 1884, p. 11). Mr. Harris calls it about 50′ thick in the Jamestown well (Am. Geol., Vol. VII, pl. 4, p. 170).

g. Hall's "vertical section" of 1838 gave a thickness of 350′ to what he then called the "Carboniferous or Mountain limestone" (2d An. Rept. Fourth Geol. Dist. N. Y., and see p. 307); but this apparently included the Marcellus and the base of the Hamilton. In 1843 the Professor considered "The point of greatest thickness [of the Corniferous limestone] actually measured is on Allen's creek [at Le Roy (?)], where it is seventy-one and a half feet" (Geol. N. Y., Pt. IV, p. 168). While the Onondaga limestone at Le Roy is possibly 20′ in thickness (*Ibid.*, p. 157). Prof. G. F. Wright gave the thickness of the Corniferous lime rock as 148′ in the shaft of the salt mine at Piffard Station, Livingston Co. (Science, Vol. VIII, p. 52). Dr. Clarke called the Upper Helderberg of Ontario Co. about 70′ in thickness (Rept. State Geol. [N. Y.] for 1884, p. 10). Mr. Harris reported about 150′ of Upper Helderberg in the Jamestown well (Am. Geol., Vol. VII, pl. 4, p. 170).

h. The Oriskany sandstone is scarcely represented in this section. Prof. Hall said: "In Monroe county, its only representative is a layer of greenish conglomerate about four inches thick. * * * The last place in the district where it has been noticed is in the bed of Black creek at Morganville in Genesee county" (Geol. N. Y., Pt. IV, p. 146). Dr. Clarke wrote: "it [Oriskany] is not known with certainty west of Manchester, Ontario Co." (Rept. State Geol. [N. Y.] for 1884, p. 10).

The presence of the Lower Helderberg limestone in this section also seems doubtful. The Waterlime or Hydraulic limestone of western New York was stated by Professor Hall to lie beneath the Lower Helderberg waterlime of eastern New York and he called it the fourth or upper division of the Onondaga Salt group (Geol. N. Y., Pt. IV, pp. 128, 129, 141; also, see sections 55 and 56 on p. 139). Dr. T. Sterry Hunt in describing the geology of the Ontario peninsula said: "Here are found non-fossiliferous strata, having the character of the so-called Waterlime beds, which belong to the summit of the Salina formation" (Am. Jour. Science, 2d ser Vol. XLVI, 1868, p. 359). Professor Hall's map of 1874 giving the distribution of the Niagara and Lower Helderberg formations does not give any Lower Helderberg west of Ontario Co., while in the sections the "Water-lime formation" is given as intermediate between the Lower Helderberg and Onondaga Salt group (27th An. Rept. N. Y. State Mus. Nat. Hist., 1875, map, and see p. 128). The same position was assigned to the Water-lime by Professor Hall in 1859 (Geol. Surv. N. Y., Palæontology, Vol. III, Pt. I, Text, p. 385), although the author was inclined to refer it to the Onondaga Salt group (*Ibid.*, p. 387). The latter view is also taken by Dr. Clarke in 1889 (8th An. Rept. State Geol. [N. Y.] for 1888, p. 81). Finally, Ashburner stated: "The Buffalo cement bed [Water-lime of western N. Y.] is one of the top strata of the Salina, and does not belong to the Water-lime group [Lower Helderberg], as popularly supposed" (Trans. Am. Inst. Min. Eng., Vol. XVIII, 1890, p. 301. Also, see Ashburner in *ibid.*, Vol. XVII, p. 399, foot note †). On the contrary Professor Dana refers these beds to the Lower Helderberg (Man. of Geol., 3d ed., pp. 235, 236).

Hall's "vertical section" of 1838 assigned a thickness of 400′ to the "gypseous slates and marls," which agrees very closely with the limits of the Onondaga Salt group (2d An. Rept. Fourth Geol. Dist. N. Y.; also, see pp. 303–307 for a description of the rocks). Dr. Clarke gave the thickness of the Salina for Ontario Co. as "probably between 600 and 700 feet" (Rept. State Geol. [N. Y.] for 1884, p. 10). It thins slowly to the west, having a thickness of 475′ in the Buffalo well (Ashburner, Trans. Am. Inst. Min. Eng., Vol. XVII, p. 402). Professor Hall wrote Ashburner:

"My estimate of the prevailing thickness of the Salina formation on the west of the Genesee river is about 800 feet." But the Professor in the above estimate assigned too great a thickness to the red shale at the base of the group, which he says "may be 300 feet or more thick" (Trans. Am. Inst. Min. Eng., Vol. XVII, p. 400).

i. Prof. Hall, 1838, gave 150′ of "geodiferous and bituminous limestone" at Rochester and 110′ of "Calcareous shales" below (2d An. Rept. Fourth Geol. Dist. N. Y., vertical section and description of rocks on pp. 300–303). But the lower 18′ of the "calcareous shales" is the "upper limestone" of the Clinton, and it is not clear but that some of the Onondaga Salt group was included in the upper division. In 1843 the thickness of the Niagara shale at Rochester is given as about 100′ and the limestone as "about seventy or eighty feet at Rochester" (Geol. N. Y., Pt. IV., p. 97). Logan said: "At Rochester it [the Niagara] attains a thickness of about 180 feet" (Geol. Surv. of Canada. Rept. of Prog. from its commencement to 1863, p. 321).

j. The section of 1838 gave 61′ of "argillaceous shales, limestone, iron ore and green shale" to which 18′ of the overlying "calcareous shales" should be added, making 79′ of what was later named the Clinton (2d An. Rept. Fourth Geol. Dist. N. Y., vertical section; and see pp. 297–300 for a description of the rocks). In the final report the thickness of the Clinton on the Genesee river is stated to be 80′ 6″ (Geol. N. Y., Pt. IV, pp. 66, 67).

k. Hall's "vertical section" of 1838 gave a thickness of 300′ of "red marl and sandstone" along the Genesee river from Carthage to lake Ontario (2d An. Rept. Fourth Geol. Dist. N. Y., see pp. 294–297 for a description of the rocks). In 1843 the Professor reported its thickness along the Niagara river as about 350′, which he considered as probably less than half its thickness, and stated that it thinned to the eastward (Geol. N. Y., Pt. IV, p. 43). Logan thought that, apparently near Rochester, the entire thickness "of the formation [Medina] may be somewhat under 600 feet" (Geol. Surv. of Canada. Rept. of Prog. to 1863, p. 310).

l. Mr. Walcott reported 880′ of Lorraine sandstone and shales and 120′ of Utica shale in a well at Fulton, Oswego Co., N. Y., which he says "indicates a thickness of 1000 feet for the rocks of the Hudson period in northwestern New York" (Bull. Geol. Soc. Am., Vol. 1, p. 349). Prosser found that the Hudson period has a thickness of 1030′ in the well at Wolcott, Wayne Co., N. Y. (Am. Geol., Vol. VI, p. 204). Professor Hall stated: "The usual estimates of the thickness of this group [Hudson including Utica shale; see Geol. Surv. N. Y., Palæontology, Vol. III, Pt. 1, Text, p. 14] in central and northwestern New York are from 800 to 1000 feet" (*Ibid.*, p. 20, foot note). In the St. Catharines, Ontario, well, Ashburner reported the Hudson and Utica as 785′ in thickness (Trans. Am. Inst. Min. Eng., Vol. XVIII, p. 301). Logan gave the thickness of the Utica shale in Collingwood township, on Nottawasaga bay, at the head of Georgian bay, as "between fifty and a hundred feet" (Geol. Surv. of Canada. Rept. of Prog. to 1863, p. 211); and the Hudson as 770′ in thickness at the same locality (*Ibid.*, p. 213).

m. Sir Wm. Logan estimated the thickness of the Trenton along the Trent river in Ontario, which is nearly north of Rochester, as about 750′ (*Ibid.*, p. 188). Farther west he gave "about 150 feet for the Birdseye and Black River formation on lake Couchiching, and from 500 to 600 feet for the Trenton formation on lake Simcoe" (*Ibid.*, p. 193). The well at Wolcott passed through 750′ of Trenton without reaching its bottom (Prosser, Am. Geol. Vol. VI, p. 204); while its thickness in the St. Catharines well was 677′ (Ashburner, Trans. Am. Inst. Min. Eng., Vol. XVIII, p. 301).

n. Logan said there was no certain fossil evidence that the Calciferous occurred on the western side of the Laurentian ridge which crosses the St. Lawrence at the Thousand Islands (Geol. Surv. of Canada. Rept. of Prog. to 1863, p. 118). To the west of this region, Logan wrote: "No indication of the Potsdam formation has been observed in Canada, unless eight feet of red soft calcareous sandstone at Marmora [which is nearly north of Rochester], resting on the gneiss and succeeded by certain beds of limestone without observed fossils for thirty feet upwards, be supposed to represent it" (*Ibid.*, p. 100; also, see section on pp. 181, 182, where the base rests on "contorted Laurentian gneiss"). Ashburner states that the St Catharines well penetrates the Calciferous sandstone to the depth of 18′ (Trans. Am. Inst. Min. Eng., Vol. XVIII, p. 301).

Conclusion.

Taking the sum of these maximum estimates, we have a series of rocks 6810′ in thickness between the base of the Olean conglomerate and the top of the Archean (?). The same section compiled from a series of well records gives a thickness of 7100′. This is probably not a sufficient thickness for the entire section, since in the upper part of the series it is very probable that the Chemung is thicker than 1150′, and possibly the Portage may have a greater thickness than 900′. It is interesting to compare this section with Hall's of 1838 and note what change has occurred in fifty-three years. It is hardly possible to select a horizon in the upper part of the sections that is precisely equivalent; but it is thought that the stratum of "argillaceous iron ore" near Wellsville, at the top of the sub-division which was later called Chemung, is not far below the horizon of the Wolf creek conglomerate. The thickness of the series of rocks from this stratum down to the mouth of the Genesee river, according to Hall's section of 1838, is 4201′. The section compiled from well records, allowing the same thickness—300′—for the Medina on the Genesee river as in Hall's section, shows that the same series has a thickness of more than 4250′; but on account of our failure to yet obtain the exact thickness of the Chemung and Portage it can not be stated how much more than 4250′ the total thickness may be. In the section compiled from various sources of information this series has an estimated maximum thickness of 4290′. However, the comparison of the three sections shows that the early section of Professor Hall was carefully constructed and, when the development of the science at that time is taken into account, it reflects great credit upon the early work of the veteran geologist and paleontologist of New York state. The rocks above this "argillaceous iron ore" stratum up to the base of the lowest coal at Instantur, Pennsylvania, Professor Hall estimated to have a thickness of 1850′, making the thickness of the entire series from the base of the coal to the mouth of the Genesee river, 300′ down in the Medina, 6051′.

If this Genesee section be compared with the one of "Western Central New York" [1] it will be noticed that the probable thickness of the series agrees much more closely with the estimated maximum thickness than it did in the case of that section. This is due in a measure to the fact that for the upper and middle parts of the Genesee section the estimated thickness agrees better with the actual thick-

(1.) Am. Geol., Vol. VI, pp. 199-211.

ness than it did in the eastern section, and furthermore for the lower part of the section the published records of other wells have been used, which although at a considerable distance from the line of this section approximate nearer the actual thickness of these formations than do the earlier estimates. It is well to bear in mind the fact that the study of these well records is giving us more accurate knowledge of the thickness of the New York formations, so that any general section, carefully drawn up at present will be nearer the real thickness of the rocks than it could have been before any of these records were published. This point is brought out in a very clear manner by comparing the record of the Rochester well (1) with that of the Wolcott well, (2) forty-one miles east of Rochester. At Rochester, the thickness from the top of the Medina to the top of the Trenton is 1756′ and at Wolcott 1720′. It may be added that in both of these wells the top of the Medina as well as the top of the Trenton is sharply defined, so that there can be very little doubt as to the limits of this series of rocks. Leaving out of consideration all well records, a conservative estimate of the thickness of this series of rocks at Rochester, based on published data, would be from 1250′ to 1500′.

The following paper was read :

PRELIMINARY NOTICE OF THE DISCOVERY OF STRATA OF THE GUELPH FORMATION IN ROCHESTER, N. Y.

By Albert L. Arey, C. E.

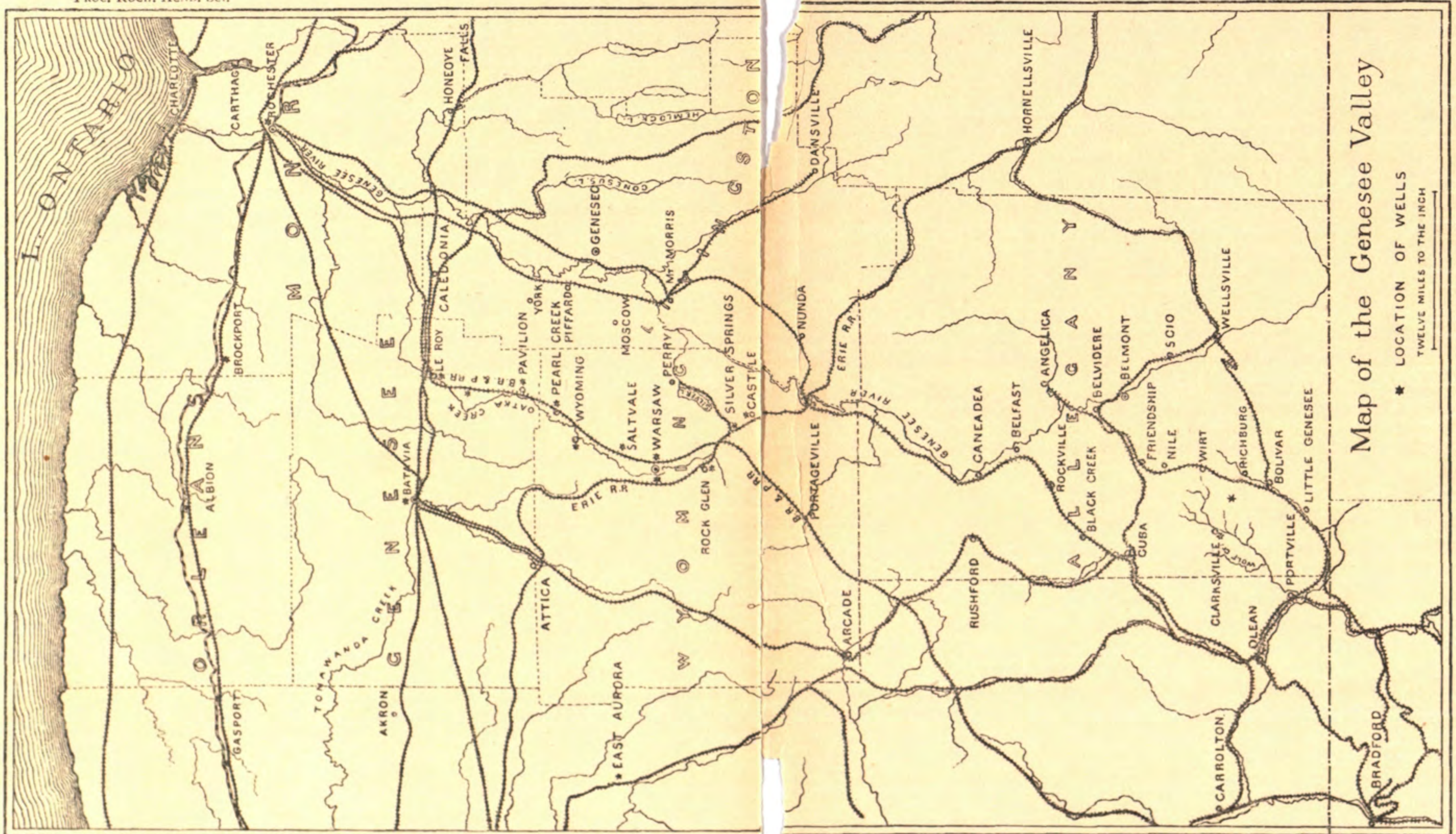
In the southwestern part of this city on Frost Ave. and Summer street is Pike's quarry, the top rock covered by only two or three feet of soil is glaciated and nearly everywhere retains both the polish and the striæ left by the glacier. The rock contains very few fossils, near the top a few of the characteristic Corals and Sponges of the Niagara group—some ten feet below this crystals of Dolamite, Zinc blende, Galenite and Flour spar are abundant : at this level two or three fine Orthocerata and several specimens of Hall's so called Platystoma hemispherica have been found.

From a layer about twenty feet further down fine specimens of selenite and gypsum have been taken which greatly resemble those for which the Niagara of Lockport has so long been famous.

These qualities determine the rock, the typical Niagara limestone.

(1.) Fairchild, Proc. Rochester Acad. Sci., Vol. I, pp. 184, 186.
(2.) Prosser, Am. Geol., Vol. VI, p. 204.

[Pages 104–112 Printed Nov. 11, 1892.]


Map of the Genesee Valley
✱ LOCATION OF WELLS
TWELVE MILES TO THE INCH
L. ONTARIO
CHARLOTTE
CARTHAGE
ROCHESTER
HONEOYE FALLS
HEMLOCK L.
CONESUS L.
GENESEE RIVER
BROCKPORT
ALBION
GASPORT
TONAWANDA CREEK
AKRON
BATAVIA
LE ROY
CALEDONIA
B. R. & P. RR.
OATKA CREEK
PAVILION
YORK
PEARL CREEK
PIFFARD
GENESEO
MOSCOW
MT. MORRIS
WYOMING
SALTVALE
WARSAW
PERRY
SILVER SPRINGS
CASTILE
ROCK GLEN
ERIE R.R.
ATTICA
EAST AURORA
DANSVILLE
NUNDA
PORTAGEVILLE
ARCADE
HORNELLSVILLE
CANEADEA
RUSHFORD
BELFAST
ANGELICA
ROCKVILLE
BLACK CREEK
BELVIDERE
BELMONT
SCIO
FRIENDSHIP
NILE
CUBA
WIRT
WELLSVILLE
RICHBURG
BOLIVAR
LITTLE GENESEE
CLARKSVILLE
PORTVILLE
OLEAN
CARROLTON
BRADFORD
ORLEANS
MONROE
GENESEE
LIVINGSTON
WYOMING
ALLEGANY

Five or six hundred feet southwest of Pike's quarry on a slight rise of ground is Nellis' lime kiln, where for forty or fifty years the upper two layers of rock have been burned, while those below have been sold as building stone. These upper layers each about two feet thick are a magnesian limestone, dark grey when freshly fractured but weathering to a light brown, they are badly broken but clearly in place and become particularly interesting on account of the great number of strange fossils which they contain.

Rocks resting on the New York Niagara limestone would be likely to represent Chicago and Racine beds, the much abused Guelph beds or a new formation, and in order to determine whether the new fauna corresponds with that of either of the above formations a study of the general characteristics of each fauna was made.

In the table which follows the numbers of species of each class found in various outcrops of rocks of the Niagara epoch are given.

The first column is based upon the collection which I have been able to make from these layers, the second column gives the number of Canadian Guelph species described in Vols. I. and III. Paleozoic Fossils also including those incorrectly attributed to the Onondaga Salt Group in Vol. II Pal. of N. Y. The third column, the Wisconsin Guelph fauna, is from Vol. IV, Geology of Wisconsin.

The fauna of the Racine limestone is based upon Professor Hall's paper published in the Regents' Twentieth Annual Report on the Condition of the N. Y. State Museum.

The Chicago limestone fauna here given includes the species described in the twentieth report above mentioned, and also those described by Winchell and Marcy in their paper read before the Boston Society of Natural History in 1865 and such of those described by McChesney in 1861 as seemed to be distinct species.

The twenty-eighth report of the N. Y. State Museum of Natural History was taken as representing the fauna of the Waldron Ill. shale, and the remaining columns are mainly as given in Vol. II. of the Paleontology of New York.

The numbers given do not include all the fossils which have been described from the different localities, but it is believed that neither the discoveries which have been made since the works upon which they are based were published, nor those which may be made in the future will materially change the characteristics of the various faunas.

	Rochester Guelph.	Canadian Guelph.	Wisconsin Guelph.	Racine Limestone.	Chicago Limestone.	Waldron Ill Shale.	N.Y. Niagara Shale.	N.Y. Niagara Limestone.
Cœlenterata and Bryozoa,	8	6	16	?	16	37	38	28
Crinoidea, - - -	0	0	3	32	12	17	25	4
Brachiopoda, - -	9	13	19	7	15	31	37	4
Lamellibranchiata, - -	5	7	2	10	17	7	8	1
Gasteropoda, - -	21	42	21	18	17	5	3	1
Cephalopoda, - - -	11	17	10	16	15	2	9	3
Trilobita, - - -	1	2	1	10	9	14	11	2

A comparison of these columns shows that the new fauna agrees with that of the Canadian Guelph in the following particulars: the absence of Echinoderms, the rarity of the trilobites, and in the large proportion of Gasteropoda and Cephalopoda, really a closer agreement in general characteristics than that of the Wisconsin and Canadian Guelph faunas.

It is not now deemed best to dwell upon the differences between the new fauna and those represented in the remaining columns further than to remark that that difference is greater than is shown by the figures, the species of Gasteropoda from the new fauna are none of them identical with those of the New York Niagara shale or of the Niagara limestone, the same fact is true of the Cephalopoda and the other classes excepting three species which are also found in the Canadian Guelph fauna.

Beginning with the Niagara shale and tracing the development of this fauna through the Chicago and Racine groups to the Wisconsin Guelph, and finally to the Canadian Guelph, there appears to have been a gradual extinction of the Cœlenterata, Bryozoa, Echinodermata, Brachiopoda and Trilobita, and a marked development of the Cephalopoda and Gasteropoda, a fact which has an important bearing upon the relations of the Chicago and Racine beds to the other strata of the Niagara epoch and which the writer hopes to discuss in a subsequent paper.

Of the species found here twenty-three have already been shown to be identical with or very closely allied to Canadian Guelph species, among these may be mentioned the following:

Murchisonia macrospira,
" logani.
Pleurotomaria Durhamensis.
" Galtensis.

Cyclonema sulcatum.
Trochonema pauper, var.
Straparolus crenulatus.
Bucania augustata.
Certoceras myrice.
" brevicorne.
Orthoceras Selwini.
Phragmoceras parvum.
Trochoceras Desplainense.
Zaphrentis Racinensis.
Favosites occidens.
Etc., Etc.

The specimens are usually nicely preserved and form a valuable addition to our knowledge of the external characteristics of the Guelph fossils.

JANUARY 25, 1892.

STATED MEETING.

The President, PROFESSOR H. L. FAIRCHILD in the chair.

A large audience present.

The first lecture of the Popular Lecture Course for 1892 was given by DR. JULIUS POHLMAN of Buffalo, on

POPULAR MODERN SUPERSTITIONS.

The lecture was illustrated by numerous experiments.

FEBRUARY 8, 1892.

STATED MEETING.

The President, PROFESSOR H. L. FAIRCHILD, in the chair.

Fifty-one persons present.

The Curator of Botany, MISS BECKWITH, announced that a collection of botanical specimens from the Island of St. Helena, had been presented to the Academy by LIEUT. COMMANDER FRANKLIN HANFORD, U. S. N.

The COUNCIL report recommended :

(1.) The election of MR. CHAS. H. WILTSIE for resident membership.

(2.) The election of the following members, as fellows :

PROFESSOR ARTHUR L. BAKER,
MR. CHARLES W. SEELYE,
DR. M. A. VEEDER,
PROFESSOR CHARLES W. DODGE,
MR. WALTER B. SMITH,
MR. CHARLES H. WARD.

(3.) The election of the following corresponding members :

DR. JULIUS POHLMAN, Buffalo.
PROFESSOR W. H. LENNON, Brockport, N. Y.
DR. H. CARRINGTON BOLTON, New York.
DR. O. A. DERBY, Sao Paulo, Brazil.

(4.) The election of MR. CHAS. D. WALCOTT, Washington, D. C., as honorary member.

(5.) The payment of certain bills.

Under a suspension of the rules the candidates recommended for resident membership, fellowship, honorary membership and corresponding membership were elected by formal ballot. The bills were ordered paid.

The PRESIDENT made a statement to the effect that, as the AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE had accepted the invitation to hold its next annual meeting in Rochester, it was proper that all the institutions of the city should join in making preparations for the entertainment of the visiting association in a manner creditable to the city. It was eminently fitting that the Academy of Science should take the initiative in this matter, and the President suggested that, as the time had now come for some action to be taken, a special committee should be appointed by the Academy to secure concert of action among the many scientific, educational and civic bodies of the city.

PROFESSOR A. L. AREY moved that the President be constituted chairman of such a special committee with power to appoint six other members. The motion was carried.

The PRESIDENT appointed the following persons to serve on above committee :

PROFESSOR ALBERT L. AREY,
MR. JOSEPH O'CONNOR,
DR. E. M. MOORE, SR.,
REV. C. B. GARDNER,
PROFESSOR S. A. LATTIMORE,
DR. J. EDWARD LINE.

DR. M. A. VEEDER distributed among the audience a number of slips for keeping records of auroras, which he hoped many of those present would fill out. He also made a few remarks explanatory of the slips and upon auroras in general.

DR. VEEDER distributed the following printed report upon

THE AURORAS OF JANUARY, 1892.

The following results appear to be justified by the reports of observations thus far received. As was anticipated and announced in advance to many of those receiving blanks for recording observations, the finest display of the month, and an aurora of the first magnitude, appeared on January 5th. Sporadic, and for the most part very faint displays, were reported on January 15th, 20th, 21st, 25th, 26th, 27th, 28th and 29th, those on the last three dates named being the best defined.

The reports from stations along the base line adopted, extending from Washington northward into Canada, show that the aurora of January 5th had a probable altitude of 175 miles and perhaps upwards. The amount of sky covered at different stations shows that the plane of the southern margin of the chief portion of the luminous mass reached the earth at a point on the 77th meridian not far from 45 degrees north latitude. Comparison with observations on other meridians shows that the aurora tended to reach its maximum brightness at the same hours of local time, rather than at the same hours of absolute time. A study of the arrangement of the arches and patches of light reported from different stations reveals the fact that they are very largely of the nature of halos, their position depending as much upon the position of the observer as upon the general source of illumination in the auroral mass. As in the case of a rainbow, each observer sees his own arch and consequently the elevation will be approximately the same at stations not too far apart to prevent the arch from being seen at all. In this way, also, the differences in the prismatic colors displayed, even at stations quite close together, may be accounted for. Hence the difficulty of employing arches or colors for the estimation of altitude. It is suspected that this may be true of streamers also.

The method of recording the absence as well as the presence of the aurora at each observation has made it apparent, especially in connection with the lesser displays of the month, that even well defined auroras may be confined within quite narrow limits, appearing, for example, at southern stations when absent at those directly northward. The aurora thus exhibits a tendency to frequent certain localities, presumably because of some peculiarity of the soil or topography of the country; but further observations in regard to this point are desirable.

Disturbed areas upon the sun, containing both spots and faculæ, appeared by rotation on January 4th, 6th, 15th, 21st, 28th, 29th and 30th. Thus the dates of auroral display during the month, and the extent of the displays reported, has been in exact conformity with the relations to solar and associated conditions described in the paper upon the Zodiacal Light, copies of which have been distributed generally to observers co-operating, and which may be obtained from the undersigned, from whom, also, blanks and circulars for auroral observations may be had. M. A. VEEDER.

February 8, 1892. Lyons, New York.

The following is a condensed form of the record slip distributed:

RECORDS OF OBSERVATIONS OF AURORAS.

Name and Postoffice Address of Observer,..............................

Latitude and Longitude of Station,..............................

INSTRUCTIONS.

Note the exact time at which an observation is made and *always* enter the result in the table, stating specifically whether an aurora was seen or not, or if clouds, moonlight, etc., intervene; note that fact in the proper column. A blank space will be understood as signifying that no observation was made. If but a single observation can be had each evening, the best hour is probably from 9 to 10 o'clock P. M. When an aurora is seen give as complete a description as possible of its location and of any changes which it may undergo, employing for this purpose the blank space following the table. NOTE ESPECIALLY THE TIME AND ZENITH DISTANCE OF ALL PROMINENT FEATURES. Return to M. A. VEEDER, Lyons, New York, U. S. A.

AURORAS SEEN DURING THE MONTH OF.................. 189 .

	6 to 7 P. M.	7 to 8 P. M.	8 to 9 P. M.	9 to 10 P. M.	10 to 11 P. M.	11 to 12 P. M.	12 to 6 A. M.
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DESCRIPTIONS.

LYONS, NEW YORK, U. S. A.,..189

DEAR SIR :—If unable to make the records provided for in the accompanying blanks, you will confer a favor by handing them, together with this circular, to some one who may be able so to do. Even a single observation each evening properly recorded will be of service. More blanks may be obtained from the undersigned if desired.

In order to determine the local distribution and altitude of the aurora, it is desirable to have numerous observers suitably distributed throughout the area covered by the observations so as to secure as full information as possible as to the extent to which an aurora was present or absent during each hour. In case that an aurora is not reported from any given locality it is necessary to have the means of determining whether this failure was due to lack of observation, or to cloudiness, etc., or whether the aurora was really absent. For this reason it is desirable that there be as few blanks as possible in the table, although even the most fragmentary record may become of importance for purposes of comparison with others. The results already obtained warrant the belief that by concerted effort information of practical value may be secured. During the coming year auroras will probably increase in frequency, especially near the equinoxes and a single display having well defined characteristics, like that from Sept. 8th to 11th, 1891, may, if thoroughly observed, lead to most important conclusions.

Yours truly. M. A. VEEDER.

HON. MARTIN W. COOKE read the two papers on the program:

SUGGESTIONS IN RESPECT TO THE CAUSE OF THE MOVEMENT OF ICEBERGS TOWARDS THE EQUATOR.

THEORY OF THE CAUSE OF THE GULF STREAM.

The papers were illustrated by a chart of the world, a globe and numerous blackboard diagrams. The discussion on the papers was participated in by DR. VEEDER, MR. ARTHUR L. WHITE, PROFESSOR ARTHUR L. BAKER, the PRESIDENT and others.

On motion a vote of thanks was extended to LIEUT. COM. HANFORD for his generous gift to the Herbarium of the Academy.

FEBRUARY 29, 1892.

STATED MEETING.

The President, PROFESSOR H. L. FAIRCHILD in the chair.

A large audience present.

The PRESIDENT made a few remarks concerning the proposed topographical survey of New York State and suggested that it would be appropriate for the Academy of Science to take some action to further the accomplishment of the work by encouraging the State to authorize the survey.

MR. STREETER moved that a committee of three be appointed by the president to draft suitable resolutions and take such other action as they may deem necessary or expedient to aid the project. The motion was carried and the President appointed to serve on this committee the following members:

MR. EMIL KUICHLING,
MR. THEODORE BACON,
PROFESSOR ARTHUR L. BAKER.

The PRESIDENT now introduced PROFESSOR W. R. DUDLEY of Cornell University, who gave the second lecture of the Popular Lecture Course on

THE GEOGRAPHICAL DISTRIBUTION OF THE APPALACHIAN FLORA.

The lecture was illustrated by lantern views.

MARCH 14, 1892.

BUSINESS MEETING.

The President, PROFESSOR H. L. FAIRCHILD in the chair.

Thirty persons present.

The COUNCIL report recommended :

(1.) The election of MR. HOWARD L. OSGOOD as an active member.

(2.) The payment of certain bills.

The candidate was elected by formal ballot and the bills were ordered paid.

PROFESSOR ARTHUR L. BAKER read a paper entitled :

NON-EUCLIDEAN GEOMETRY.

The paper was illustrated by black-board diagrams and demonstrations.

The discussion was participated in by PROFESSOR AREY, MR. J. E. PUTNAM, the PRESIDENT and others.

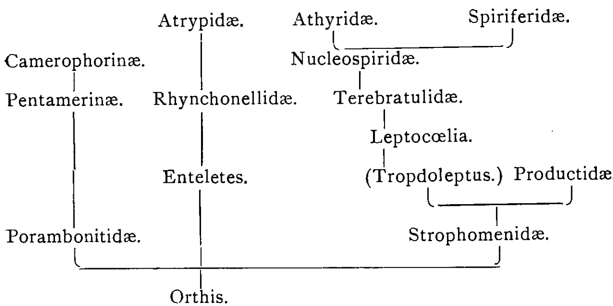
In the absence of the author, PROFESSOR A. L. AREY read the following paper :

ON THE BRACHIAL APPARATUS OF HINGED BRACHIOPODA AND ON THEIR PHYLOGENY.

BY H. S. WILLIAMS.

A serious difficulty met with in attempting to make a natural classification of Brachiopoda, has arisen from the uncertainty or ignorance as to the true relationship between the calcified loop of the Terebratulidæ and spiral processes of the Helicopegmata.

In the Report on the Salt Range Fossils of India, (Mem. Geol. Surv., India, Series XIII, Productive lime-stone fossils, IV, fasc. 3., pp. 549–550, Calcutta, 1884), Waagen proposed the following arrangement of the Hinged-Brachiopoda (Arthropomata) as an expression of his idea of the affinities of the various families :



In this classification it will be seen that Waagen makes the Athyridæ and Spiriferidæ, through the Nucleospiridæ to be the successors or descendants of the Terebratulidæ.

Davidson, commenting upon a letter from Waagen, communicating the above classification, (Mon. Brit. Foss. Brachiopoda, Vol. V. pp. 389–390) remarked :

"The subject will, however, demand much further consideration, for the passage between the loop-bearing Terebratulidæ and the spiral-bearing Spiriferidæ has not yet been discovered." This remark of Davidson was published in the last month of 1884, and I have been unable to find that any one since then has been able to throw light upon the difficulty involved.

The following suggestions will, I think, point to the nature of the modifications by which these two important groups of Brachiopods were differentiated.

In attempting to explain the relationship of the several families of Brachiopods in a course of lectures on the History of Organisms, (delivered at Cornell University, this particular lecture, on Feb. 16, 1892,) I found it necessary to explain why the fleshy spiral arms of the Terebratulidæ coil in a reversed direction from those of the calcified spiral supports in the Spiriferidæ.

In studying out this problem the following facts were observed:

According to the latest reported range of genera of Terebratulacæ, given by Davidson, (Lc. p. 353), the following genera have been found in the Silurian:

Waldheimia, *Centronella* Billings, *Renessellæria* and *Leptocalia* Hall.

This includes the sub-family *Centronellinæ* and the genus *Waldheimia* of the sub-family *Terebratulidæ*.

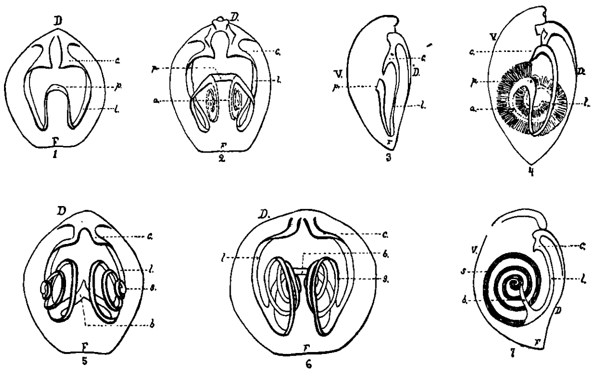
The characters given for *Centronellinæ* are "Loop long, composed of two ribbon-shaped lamellæ with ctruræ, the lamellæ uniting at their anterior extremities, and a more or less developed vertical lamellæ rises between." (p. 353). The two spires of *Waldheimia*, *W. Mawii* Dav. and *W. Glassii* Dav., (Brit. Foss. Brac. Sil. Sup., Vol. V, p. 76, 79) are both small forms from the Wenlock, the first from the upper, the second from the lower beds. The characters of the brachial apparatus of the former species were perfectly made out by Mr. Glass, who, with Davidson, did so much to elaborate these delicate internal structures of Brachiopods.

The character which unites all these early genera of the Terebratulidæ is the long loop. (See figures 1 and 3.)

Three genera of the Spiriferacæ, reported from the lower silurian are characterized by a considerable extension of what Davidson has called "the primary lamellæ of the spiral coils." These are *Zygospira*, in which the lamellæ are produced laterally and are connected by a long bridge or cross-bar, *Anazyga* of similar form but the bridge is attached near the front at the point where the first coil of the spiral turns toward the ventral valve and upwards, and *Hindella*, in which the departure between the primary lamellæ and the bridge was at the extreme front extension of the apparatus. (See figure 6.)

The association of these facts led me, several years ago, to think there was some natural relationship existing between the calcified apparatus of the two families, and a year ago I expressed in my course of lectures the belief that they were closely related, but the difficulty of showing the way in which one form could result from modification of the other was not removed. Coming again this year to the same place in my lecture course I attacked the problem anew and this time in a purely inductive way.

I analyzed the two forms and found in each a thin calcified lamella, (*l*) proceeding downward from the cural process (*c*) following the curve of the inside of the dorsal valve (*d*) in the Spiriferidæ, continuing to the front, then curving upward along the inside of the ventral valve (v, fig. 7) to near the crural process—but curving outward and following the same course to form a spiral coil (*s*.) The primary lamellæ of the coils of the two sides are joined by a cross-bar (*b*) somewhere between the points of the crura on the front extremity of the primary lamellæ before they begin their upward turn. (See figures 5, 6, 7.)



In the Terebratulidæ, there are the same calcified lamellæ (l. figs. 1, 2, 3 and 4) from each of the cruræ (*c*) in the same way following the curve of the inside of the dorsal valve (*d*) toward the front (*f*); at the front they turn backward, forming a loop (*p*) by folding, so that the exterior surface (facing the side of the shell) of the primary lamella becomes the interior face of the part which is bent upward to form the loop. In the living forms there is, proceeding from the backward folded end of the loop, a coil (*a*) of fleshy spiral arms—but the direction of the coiling is the reverse of that of the spire (*s*) of the Spiriferidæ, that is, when viewed from the side the primary coil of the spire passes from the upper end of the calcified loops toward the neutral valve and follows the curve of the inside of that valve towards the front when it approaches the dorsal valve and curves backward towards its origin. (Compare figures 4 and 7.)

The conclusion which I felt safe in drawing, was that the spiral coils, calcified in the extinct Spiriferidæ, were the supports of fleshy brachiæ, as in the living Terebratulidæ, and the question which arose was how to explain the difference in direction of coiling of the arms in the two types. The solution of this problem resulted in explaining the relationship of the two families.

The difficulty was so great, that I made some models of the lamellæ of thin brass and made spiral coils of copper wire and experimented with the models to see how one could be changed into the other.

With this device, imitating the characters of the loop of the living *Waldheima* and its fleshy spiral arms, I discovered that doubling back the lamellæ with the spirals attached beyond the bend caused a reversal of the direction of the coil from that presented by it when attached before the bend, thus producing the exact difference observed on comparing *Waldheima* and *Anazyga* (see figs. 2 and 6.)

This experiment showed that the fundamental difference between the brachial apparatus of the two families does not consist alone in the presence of a calcified spiral in one and its absence in the other, but in the fact that in the Spiriferidæ the primary lamellæ are continued directly into the spiral coils, whereas in the Terbratulidæ the primary lamella on each side is doubled back upon itself to near the position of the mouth from which point the spiral part of the arm begins, the reversal of direction of the coils of the spiral resulting from this reflexion of the primary lamellæ.

This difference and the relationship is best seen in the earlier types, as *Anazyga* (fig. 6.) (See also *Dayia*, fig. 7), and *Waldheimia* (figs. 2 and 4). In both of these forms the primary lamellæ (*l*) are long, but in *Anazyga* and *Dayia* the bridge (*b*) connecting the lamellæ of the two sides sets off before the beginning of the spiral coil, while in *Waldheimia* (4) the bridge, or connecting part (*b* of fig. 2), does not occur till after the reflection of the lamellæ to form the loop.

In the short-looped Terebratulidæ (*Terebratulina*, etc.,) the primary lamellæ are not calcified down to the front and the reflected and looped part of the apparatus is not supported by calcified lamella. In the greater number of the genera of spiral-bearing brachiopoda (the Helicopegmata) the bridge connecting the lamellæ is higher up than in *Anazyga*, *Zygospera* and *Hindella*. Thus pointing to the conclusion that the earlier forms were all with long primary lamellæ, and that the forms in which the primary lamellæ were so far extended forward as to be reflected backward before the coiling of the arms, developed into the Terebratulidæ in which no calcified support for the coils was produced, and that the forms in which the lamellæ were continued directly into the spiral coils without reversal of direction became the Spiriferidæ, in which the spiral coil of the arms is supported by calcified lamellæ.

From these facts I inferred that the two families at the stage of their differentation, in the lower Silurian or earlier, were a continuous series differentiating from a common stock.

With this interpretation of the relations of the several forms to each other, we conclude that the Pegmatobranchia were developed from, or, strictly speaking, show closer affinities with the primitive stock than with any particular family of the Eleutherobranchia, and as a suborder find their natural place between the two divisions of the Eleutherobranchia, for which I would propose the subordinal names, *Orthidacea*, to include the Orthidæ, Strophomenidæ and Productidæ and *Pentameracea* to include the families Pentameridæ, Rhynchonellidæ and Porambonitidæ.

The following table will express the phylogenetic relations of the several families suggested by the above considerations.

Pentameracea (H. S. W.)	Rhynchonellidæ. Pentameridæ. Porambonitidæ.
Pegmatobranchia (Neumayr.)	Terebratulidæ. Thecididæ. Stringocephalidæ. Spiriferidæ. Koninchidæ.
Orthidacea (H. S. W.)	Orthidæ. Strophomenidæ. Productidæ.

The paper was illustrated by a model of the spiral "arms" and was discussed by the PRESIDENT and others.

MARCH 28, 1892.

STATED MEETING.

The President, PROFESSOR H. L. FAIRCHILD, in the chair.

A large audience present.

The PRESIDENT announced that MR. JOSEPH B. FULLER had presented to the Academy his very valuable herbarium, and read the following report from the Curator of Botany, MISS FLORENCE BECKWITH:

"The Academy is again the recipient of an addition to its collections. Mr. Joseph B. Fuller, of this city, has presented to the Society a collection of pressed plants for its herbarium. The collection comprises over 2500 specimens, representing more than 900 species, and is very valuable on many accounts. It was begun in 1851 when a great portion of what is now within the limits of the city was covered by the forest, and when the banks of the river, on both sides from the upper falls down, afforded a rich field for botanists. Many of the specimens were rare when they were collected, and great numbers of them are now extinct in the localities in which they were found. Any one who botanizes over this field now, will sadly realize that our native flora is fast being exterminated, and a collection which shows what once grew here will be more and more valuable every year. The specimens also represent years of patient study and careful research, and are especially valuable for the correctness with which they are named.

"They do not represent local flora exclusively, quite a number of them being from the White Mountains and some from the western prairies and other parts of the United States. Mr. Fuller modestly calls it a collection of dried plants, but it is a herbarium in itself, and we are particularly fortunate in being favored with the gift."

The PRESIDENT further announced that PROFESSOR S. A. ELLIS had presented to the library of the Academy the four volumes of "Contributions to the Natural History of the United States," by Louis Agassiz.

A written report from the committee appointed at the meeting of February 29, to represent the Academy in urging upon the State Legislature the necessity for a topographical survey of the State was read by the President. The State Engineer in a letter to the committee announced that the combined efforts of those asking for the survey had already resulted in partial success, in securing a small appropriation for the work this year from the Legislature, with good prospects for further success.

The PRESIDENT announced the death of a member of the Academy, MR. ROBERT BUNKER, who had been a faithful member and who had presented to the Academy his entomological collection. The President said it would be eminently fitting for the Academy to take some action in regard to Mr. Bunker's death.

On motion the following committee was appointed by the President to draft and transmit to the family resolutions of regret and sympathy.

MR. WILLIAM STREETER,
MR. JAMES W. ALLIS,
PROFESSOR S. A. ELLIS.

The third lecture of the Popular Lecture Course was given by PROFESSOR HENRY S. WILLIAMS of Cornell University, entitled :

THE MARCH OF THE GIANTS.

The lecture was illustrated by lantern views.

APRIL 11, 1892.

BUSINESS MEETING.

The President, PROFESSOR H. L. FAIRCHILD, in the chair.

Fifteen persons present.

The PRESIDENT announced that there would be no report from the COUNCIL, as they had been unable to hold a meeting. He thought the best plan would be to postpone regular business and, after the remainder of the program for the evening had been carried out, to adjourn to Monday evening, April 18.

On motion all business was postponed for one week.

The PRESIDENT announced that the Secretary, MR. FRANK C. BAKER, had resigned and said some action should be taken in the matter of securing a person to act as Secretary until an election could be held.

On motion Mr. Baker's resignation was accepted, and Dr. P. Max Foshay was elected Acting Secretary.

The President introduced Dr. P. Max Foshay, who read a paper entitled :

THE LATEST PHASE OF THE ARYAN CONTROVERSY.

April 18, 1892.

ADJOURNED BUSINESS MEETING.

The President, Professor H. L. Fairchild, in the chair.

Seventeen persons present.

The Council report recommended :

(1.) The election as active members of the following persons :

Mr. Chas. D. Chichester,
Mr. Cyrus F. Paine,
Mrs. John Walton,
Mr. E. H. Griffith,
Dr. Frank F. Dow.

(2.) The election as life member of Mr. Joseph B. Fuller.

(3.) The payment of certain bills.

(4.) That the price of extra volumes of the Proceedings be fixed as follows :

One volume to members, - - -	$2.00
" " to non-members, - -	3.00
Single brochure to members, - -	1.00
" " to non-members, -	2.00

The members were elected as recommended. The bills were ordered paid and the prices fixed on extra volumes of the Proceedings.

On motion a vote of thanks was extended to Professor S. A. Ellis, for the valuable gift to the Academy's library of Louis Agassiz's "Contributions to the Natural History of the United States."

The following paper having been accepted for publication by the Council was read by title :

ON THE SEPARATION OF MINERALS OF HIGH SPECIFIC GRAVITY.

By E. W. Dafert, M. A., Ph. D. and O. A. Derby, F. G. S.

(*Communicated from the laboratory of the Commissão Geographica e Geologica de São Paulo, Brazil.*

The various processes that have been devised during the past few years for the separation of fine grained mineral mixtures by means of heavy liquids, the electro magnet, etc., have greatly extended the field of mineralogical and petrographical research and are of almost daily application in the laboratory. By their use, the rarest accessory elements may be quickly and readily isolated from the superabundant essential elements and, within certain limits, separated from each other, for the purposes of study and identification. The application of the *batea* described by one of us in a recent number of this journal, renders practicable the obtaining of sufficient quantities for analysis of these rare and fine grained minerals, and thus their separation in a state of purity becomes a matter of great importance.

The limit of complete separation by means of heavy liquids is at present fixed at sp. gr. 3.60–3.65, obtained by Retgers (*Neues Jahrbuch, 1889, II. p. 188*) by saturating methyline iodide with iodoform and iodine. This limit has been extended to sp. gr. 5 by Bréon and Retgers, by the use of fused zinc, tin and silver salts, but these processes have, in our hands at least, proved very tedious and unsatisfactory. Under the most favorable hypothesis, the process by fusion does not dispense with the subsequent sorting under the lens, since the operator cannot follow the separation closely with the eye and the division of the cooled ingot at the proper point is a matter of chance.

The separation by the electro-magnet is limited by the magnetic properties of the minerals and, even when applicable, is seldom so complete as to dispense with the use of the lens. In general, therefore, it may be said that above sp. gr. 3.6 and with minerals that do not vary greatly in magnetic properties, the most that can be obtained is a *concentration* of the different minerals in different portions, that greatly facilitates the process of sorting.

In seeking a process of general applicability that would at least give a satisfactory concentration, it has seemed to us that the best hope of a solution was to be found in the principle of a moving column of liquid, long employed for an essentially different purpose in agricultural chemical laboratories. A very neat little apparatus for this purpose has already been devised by M. Thoulet (Fouqué et Lévy, *Minéralogie Micrographique, p. 120*) but it does not appear to have come into general use. The essential defects of the method have been indicated by Prof. Rosenbusch (*Mik. Phys. 1885, I., p. 206*) as follows: "The separation of a mixture of different minerals of equal grain through the mechanical effect of a stream of water is not obtainable with any degree of exactness; the division takes place prin ipally according to size and form of the grains, so that flakes are moved more readily than grains, and not according to the specific gravity, even when this is very different among the components of the mixture." This condemnation of the principle is, however, too absolute as will be seen by the results obtained by the apparatus described below. Once that the idea of *complete separation*, impossible to obtain above sp. gr. 3.6, is abandoned, and we content ourselves with a more or less satisfactory *coucentration*, the principle objections to the process disappear and, with the improvements of which it is susceptible, it becomes a valuable aid in the laboratory.

*1. Description of the Apparatus.**

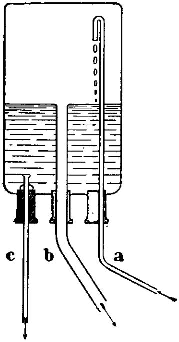


FIG. 1

Starting on the basis of the Thoulet apparatus, we have modfied the separator (fig. 2) in such a way as to permit the withdrawal of the lighter material in a perfectly regular manner without disturbing the operation (thus incidentally making the apparatus continuous in its action) and to do away with secondary currents within the tube. To this, we have added the accessories (figs. 1, 3 and 5) for securing, automatically, regularity in the current.

The pressure regulator (fig. 1) may be made from a simple Wolff flask and should be placed at about two meters, at most, above the work table. The dimensions of the single parts are: cubic contents of flask, 2 liters; diameter of tube *a*, 3 mm.; of tube *b*, 10 mm.; of tube *c*, 3 mm.

* The apparatus here described can be obtained from C. Gerhardt, Marquarte Lager, Bonn.

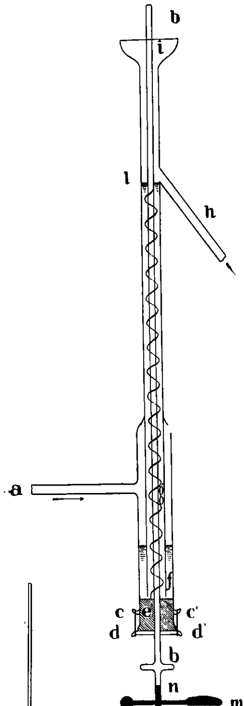


FIG. 2

The regulator is connected by glass and rubber tubing with the separator (fig. 2). The latter consists of two distinct parts of glass, the separating tube proper *l*, *a*, *h* and the draw-tube *b*. The liquid enters at *a*, flows at *f* in the closed space of the inner tube *g* and mounting upward to *l* escapes by the tube *h*. The rubber cork *e* must close the tube *g* in such a way as to leave only a small circular passage. With a little practice it is easy to place the cork so as to fulfill this condition and to regulate the entrance of the liquid in the tube *g* at will. Inside of *g* is a loose spiral of fine platinum wire of about ¼ mm. diameter and with about 40 coils of 5.5 mm. diameter, the object of which will be explained later.

The substance to be separated is introduced through the funnel-shaped opening *l* and remains wholly in the tube *g* which should be so arranged with reference to the cork *e* as not to allow it to escape. If in especially heavy mixtures, grains accumulate at one side so as to partially close the entrance to the tube *g* they can easily be displaced and set in motion by giving a slight tap to the apparatus.

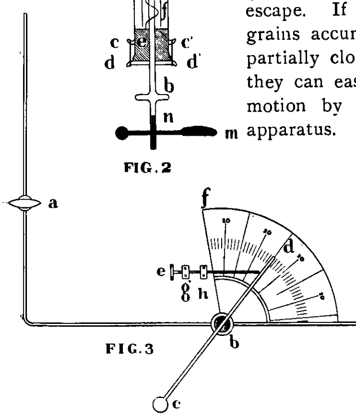


FIG. 3

In the connecting tube between regulator and separator are placed two cocks, of which one *a* (fig. 3) is an ordinary glass cock, while the other is a "precision cock" whose construction is readily seen from figs. 3 and 4 and which will be referred to farther on.

The dimensions of the apparatus with which experiments have been made are: fig. 3, diameter of tube and cocks, 4 mm.; fig. 2, diamter of *a*, 4 mm., *f* 10 mm., *g*, 7 mm., *b*, 3 mm.; height of *f*, 140 mm., *g*, 330 mm., *b*, 520 mm., to *l*, 280 mm.

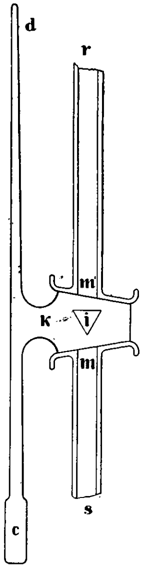


FIG. 4

The technical points that were kept steadily in view in devising the apparatus are the following:

1.—Water is preferable to all other liquids for the purpose of separation.

2.—One must not only be able to sharply regulate the velocity of the current, but also to re-establish it at any given time with approximate accuracy.

3.—In any given sand the separation according to specific gravity is only possible when,

(*a.*)—The mixture to be separated is as far as possible of equal grain, in which is included not only equality as regards volume, but also, so far as possible, similarity of form as well.

(*b.*)—When the substance to be separated never can leave the liquid column, settle in some point outside of it, come irregularly into motion and then remain at rest, etc.

(*c.*)—When in the moving column of liquid the current is as uniform as possible, and, especially, moving in all parts in the same direction.

(*d.*)—When the apparatus in no place affords an opportunity for the formation of "false currents," as for example, at the joints which may form eddies in the current and thus impede a regular separation.

(*e.*)—When after the arrangement in the current of the mineral elements according to specific gravity, the withdrawal is effected without disturbance of the pressure or of the direction of the current in the fluid column.

(*f.*)—When the current is as weak as practicable, and finally

(*g.*)—When the operation of separation can be repeated as often as may be desirable.

Numerous experiments with different forms of apparatus and under various conditions for the purpose of determining how far these theoretically desirable points are attainable in practice, lead to the following conclusions:

1.—A priori, it would appear that the denser the liquid employed, the more complete should be the separation, because the same lifting power could be obtained with a weaker current. Contrary to our expectations, we found that the difference between the action of a current of water and one of the Thoulet solution is not sufficient to make the employment of the latter advisable, and as any advantage derived from a weakening of the force of the current is more than compensated by the greater facility and economy of working with water. A repetition of the process with water will generally be found more satisfactory than an attempt to obtain an equally good separation with a single operation by the use of heavy liquids.

In dealing with extremely heavy minerals, cases might arise in which the use of heavy liquids would be of advantage, so that a description of the apparatus fig. 5, employed in our experiments will not be out of place.

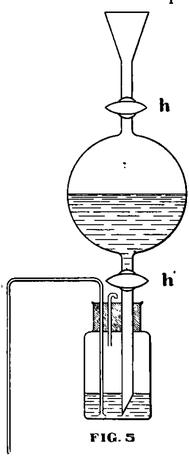


FIG. 5

200 cu. cm. of liquid are sufficient for uninterrupted work. The other parts of the apparatus require no special alteration. The mode of mounting and operating the regulator will be understood without further description since it has long been employed for water baths. For convenience in filling the reservoir balloon, two rather wide cocks, *h* and *h'* are employed. From time to time the liquid that has run through the apparatus is restored to the balloon by opening the cock *h* and closing *h'*. After pouring in the liquid, *h* is again closed and *h'* opened. These cocks require to be rather wide (about 10 mm.) in order not to impede the passage of air at *h* and of the liquid at *h'*.

2.—The problem of regulating the current is solved with sufficient accuracy by the arrangement shown in figs. 1, 3 and 4. Fig. 1 is the pressure regulator kept at a constant level by the overflow tube *b*. After opening the cock in connection with the supply tube *a*, the regulator requires no further attention. The flow is regulated by the cocks *a* and *b*, fig. 3. The first is for coarse adjustment, rapid opening or closing, etc. The second, on the contrary is a "precision cock," whose special features (scale, counterpoise and triangular valve) are seen in figs. 3 and 4. The necessary sensibility of the cock is obtained through "a triangular opening working in a circular socket" instead of the usual circular opening. The wax that the glassblowers are so fond of putting in their cocks must be carefully removed before using, as its presence makes the regulation of the flow impossible.

3.—The condition *a* cannot be completely satisfied. A close approximation to regularity of grain may however be obtained by the use of fine sieves (bolting cloth makes the best) and by repeating the separation in water with a strong current and a higher column of sand. It must be confessed, however, that this is the weak point of the apparatus and that we have only partially succeeded in removing the difficulties of a difference in the size and form of the mineral grains. If a solution of this problem were practicable, it is evident that the method would be the most complete imaginable. This, however, is impossible and in practice we have found that with careful work, the difficulty can be so far overcome that, notwithstanding this defficiency, the method is very useful.

The conditions *b*—*e* are almost completely satisfied in the apparatus above described, as a simple inspection will show, whereas in all the previously devised separators that have come to our knowledge a regular separation is excluded by the very form of the apparatus.

In observing the motion of the particles in any ordinary separating apparatus, it will be seen that even in the narrowest tube, grains of equal size and specific gravity show by sinking, the existence of a counter current that renders impossible a separation according to specific gravity. This difficulty may be overcome in three ways:

(*a*)—By provoking a circular motion in all the mineral mass floating in the liquid column, by twirling the apparatus.

(*b*)—By producing a spirally flowing water column which will force back into the current at another point, every mineral particle that gets out of the current.

(*c*)—By the introduction in the current of a spiral which diverts the counter currents and throws them again into the proper upward flowing stream.

All three of these are technically practicable. They also appear to be of equal efficiency when certain conditions are satisfied. We have chosen principle *c* as being the simplest to arrange in the apparatus. An experiment with and without the spiral will show a marked difference in the practicability of the process of water separation. We should remark that the spiral should neither rest on the inner nor the outer tube, and therefore the diameter of the coils should be larger than that of the inner tube and smaller than that of the outer one. The proper thickness of wire to produce the best results may be determined by experiment within the limits fixed by the above condition.

The fulfillment of conditions *f* and *g* rests with the operator.

II. Manipulation of the Apparatus.

We give below a somewhat detailed description of the mode of operating our apparatus, because it often happens that, from inobservance of certain rules or ignorance of certain wrinkles, a new contrivance is frequently put aside as worthless, that with more careful testing has given very good results.

In operating the apparatus, the following order should be observed :

1.—The water regulator is prepared for the whole duration of the operation by opening the cock to the supply tube *a*, fig. 1.

2.—After carefully joining together the different parts of the apparatus, the cock *a*, fig. 3, is opened and water slowly admitted into the separator. It is important that no air bubbles are allowed to remain in the connecting tubes and that the water should rise to the height of a few centimeters in the space *f*. The exclusion of bubbles may be easily effected by filling the space *f* from a wash-bottle before joining the separator and regulator, and by filling in the same manner the rubber tube by which these two parts are joined.

3.—Before the liquid column reaches the point *l*, (fig. 2,) the lateral tube *h* is closed with a rubber tube and screw-clip and the whole apparatus is then filled up to the funnel *i*, when the cock *a*, (fig. 3,) is again closed.

4.—The mineral mixture is introduced through the funnel *i*. The particles sink and lodge in the space *g*. The size of the grains must not be too great to move freely in this space so that in the case of a coarse sand, a larger apparatus than the one here described may be required. The amount to be operated upon at one time will naturally depend upon the size of the space *g*, which should not be over a quarter full. In our experimental apparatus, we have operated upon about two grammes at a time. The apparatus will operate equally well upon very much smaller amounts, and is *continuous* in its action, since it is clear that, after the first portion is withdrawn, another can be added without any derangement of the apparatus.

5.—After the introduction of the material, the screw-clip on the rubber overflow tube attached at *h* is opened and all the liquid above *l* allowed to run off, while any grains that may have remained adhering to the tube above *l* are washed down by a spirt from the wash-bottle. By operating carefully, that is, slowly, in the introduction of the mineral, there is not the slightest danger that the grains in falling into the space *g* will lodge in the tube *h* and thus be lost. If by chance any do so enter, they may be easily recovered by drawing off the water from *h*.

6.—The separation proper may now commence. The cock *a*, (fig. 3,) is opened, and *b* is so regulated as to set the mineral mass slowly in motion. This operation requires some care, as not infrequently the sand hangs together and only after a little time, moves as separate grains. A slight tapping of the apparatus is often of good effect at this point of the operation. The current should be so regulated as to raise the column of moving sand to near the point *l*, taking care, however, not to allow it to enter the tube *h*. In a short time the lightest and heaviest grains will be seen to be concentrated at the highest and lowest parts of the column respectively, while in the median portion of the column are the minerals of intermediate specific gravity mixed with the larger grains of the lighter and the smaller of the heavier minerals.

7.—The withdrawal of the sand in as many successive portions as may be desired, commencing with the lightest, is effected by lowering the tube *b* until its upper opening reaches the point at which a separation is desirable. Care should be taken to do this so gradually as not to lower the level of the liquid at *l* whereby the force of the current would be influenced. As soon as the upper end of the tube reaches the column of moving sand, the grains that pass its level sink quietly and regularly into it, without in any way influencing the separation still going on at the lower levels. By opening the spring-clip *m*, the contents of the tube *b* can be drawn off at any time. This operation should also be effected with care so as not to bring the level of the liquid column below *l* and so alter the pressure. It is clear that by successive lowerings of the tube *b*, the entire contents of the apparatus can be drawn off in as many portions as may be desired. A good plan is to draw off liquid enough from *b* to bring the sand accumulated in it into the free portion below the cork where the separated part can be readily examined with a lens and the proper level for the tube, or the proper time for drawing off, be thus determined more accurately than by watching the moving grains in the apparatus.

If the object in view is to obtain a quantity of the heavier element alone, a useful wrinkle is to combine this method of drawing off with that of an alternating weaker and stronger current so as to send into the tube *b* the grains of mean specific gravity along with the lighter ones, the tube in this case being lowered down to the level at which, with the normal current, the lowest of the lighter grains swim. In this way, for example, we have obtained nearly pure monazite (sp. gr. 5) from a mixture with titaniferous iron (sp. gr. 4.75.)

8.—With a fine adjustment of the current and a repetition of the process on the parts already passed in the apparatus, the separation may be made nearly perfect. As the withdrawal of material is perfectly under control and as uniformity of grain can be nearly obtained by repetitions of the process, the rest depends on the skill of the operator and particularly on the facility with which he recognizes the different minerals in the dancing column of sand within the tube. Naturally the composition of the sand operated upon and the relative specific gravity of its different elements should be previously known from a preliminary examination, and the movements of some mineral that, from its well characterized color or aspect, can be readily followed by the eye, should be taken as a guide. If the mixture does not already contain such a characteristic guide mineral, it is advantageous to add a few grains of one, which can afterwards be separated by the electro-magnet or by picking out under the lens. Garnet, ruttle, titaniferous iron, zircon and monazite give a good range of color and specific gravity from which selection for this purpose can be made, and, in any collection containing numerous samples of sand, will almost always be at hand.

To test the process, the heavy residue from a decomposed muscovite granite was passed once through the apparatus, withdrawn in two portions, and the different minerals completely separated under the lens and weighed. The sand was prepared by passing through a Thoulet solution of about specific gravity 3, partially cleaned of iron minerals with the electro-magnet and screened between bolting cloth Nos. 1 and 4 (20 and 25 holes to a centimeter). The residue then consisted principally of titaniferous iron, monazite and xenotime with a few grains of staurolite, tourmaline and muscovite, the total quantity being 1.77 grammes. The following table gives the percentages of the three principal minerals in the original sample, in the lighter (I) and heavier (II) portions, and those of the total amount of each mineral in the two portions

	Original Sample.	Part I.	Part II.	% To Total in I.	% To Total in II.
Xenotime (sp. gr. 4.45 ±) -	18.5%	26.5%	6.3%	86.5%	13.5%
Titaniferous Iron, (sp. gr. 4.75 ±)	31.95	45.0	12.1	84.9	15.1
Monazite, (sp. gr. 5 ±) - -	49.6	28.5	81.6	34.7	65.3

In another test on about three grammes of the same residue screened between Nos. 4 and 5 bolting cloth (25 and 27 holes to a centimeter) and withdrawn in three portions, light (I), medium (II) and heavy (III), the result was as follows :

	Original	I.	II.	III.	% in I.	% in II.	% in III.
Xenotime, -	23.6%	36.7%	42.2%	11.8%	7.5%	62.3%	30.2%
Titaniferous Iron,	19.5	14.4	33.3	11.9	3.5	59.5	37.0
Monazite, - -	56.9	48.9	24.4	76.3	4.1	15.0	80.9

These results obtained at a *single* operation with an improvised experimental apparatus in which, from the lack of proper materials, neither the regulating cock nor the spiral could be arranged to our complete satisfaction, show very clearly the capabilities of the process. It should be remarked that in the second table the showing is not as good as it should be since part I contained a considerable amount of lighter minerals (tourmaline, staurolite, limonite, muscovite and quartz) mingled with such fine fragments of monazite and titaniferous iron, that no attempt at a complete separation by picking out was made except for the xenotime. All the dark colored grains in this portion were reckoned as iron and all the light colored ones, not clearly xenotime, as monazite, so that the percentage of the heavier minerals are altogether too high in the second column. Even so, however, the percentages to the total of each mineral in this portion are very satisfactory. The sand was a particularly difficult one to deal with on account of the fragmentary condition of a part of the monazite grains causing great variation in shape which impeded the grading by size in the screens.

It will be noticed that while the concentration of the monazite is most satisfactory in the second operation, that of the lighter minerals is best in the first. This is due to differences (voluntary or otherwise) in the manipulation of the draw-tube and shows the impossibility of obtaining *constant* results owing to the personal equation of the operator, that is to say, on his quickness of eye in following the dance of the different colored grains and on his judgment as to the proper height of the draw-tube and the proper time for drawing off the sand accumulated in it. It will readily be seen that practice will make a vast difference in these respects, so that with a little use, results more perfect than those above recorded may be expected.

The PRESIDENT read a paper entitled:

A DESCRIPTION OF SOME PLANTS OF THE COAL ERA.

The paper was illustrated by charts and fossils and was discussed by MR. PUTNAM, DR. FOSHAY and others.

APRIL 25, 1892.

The President, PROFESSOR H. L. FAIRCHILD, in the chair.

A very large audience present.

On motion all business was postponed.

The fourth lecture of the Popular Lecture Course was given by DR. H. CARRINGTON BOLTON, of New York, entitled:

FOUR WEEKS IN THE WILDERNESS OF SINAI.

The lecture was illustrated by lantern views.

MAY 9, 1892.

BUSINESS MEETING.

The President, PROFESSOR H. L. FAIRCHILD, in the chair.

Thirty-three persons present.

The COUNCIL report recommended:

(1.) The election of the following persons as active members:

MR. E. R. ANDREWS,
MR. MARSENUS H. BRIGGS,
HON. GEO. F. DANFORTH,
MR. WM. EASTWOOD,
MR. W. H. GORSLINE,
MR. MONTGOMERY E. LEARY,
MRS. HELEN M. MILLER,
MRS. HOWARD OSGOOD,

Mr. C. M. Everest,
Mr. Jas. P. Fleming,
Mr. David Hays,
Mr. A. M. Lindsay,
Rev. Howard Osgood,
Mr. Ira L. Otis,
Mrs. Charles B. Potter,
Gen. John A. Reynolds,
Mrs. Ruth Siddons,
Mr. John F. Brayer,
Mr. G. Hanmer Croughton,
Hon. John M. Davy,
Mrs. Wm. Eastwood,
Mr. John Fahy,
Mr. Gilman H. Perkins,
Mr. Joseph E. Putnam,
Mr. Clinton Rogers,
Mrs. Edward Meigs Smith,
Rev. H. H. Stebbins,
Mr. Geo. F. Slocum,
Dr. Henry T. Williams,
Dr. Charles T. Howard,
Dr. Edwin Banton,
Mrs. H. H. Stebbins,
Mr. Edw. H. Vredenburg,
Mr. Thomas G. Young,
Mr. Albert C. Walker,
Mr. T. J. Sarle.

(2.) The election of the following members as Fellows:

Mr. Joseph B. Fuller,
Mr. E. H. Griffith,
Mr. A. M. Dumond,
President David J. Hill,
Dr. P. Max Foshay.

(3.) The payment of certain bills.

On motion the rules were suspended and the candidates for active membership were elected at once. The bills were ordered paid.

The Corresponding Secretary, Professor Charles W. Dodge, made a report and read letters from a number of corresponding members, among whom were: Professor W. W. Dudley, Mr. G. K. Gilbert, Professor Joseph Leidy, Professor H. S. Williams, Dr. Charles S. Dolley, Dr. H. Carrington Bolton and Mr. Chas D. Wolcott.

Mr. Geo. W. Rafter read a letter from Dr. A. C. Mercer, asking the Academy of Science to take some action in the matter of a testimonial which it is proposed to give to Dr. R. L. Maddox of England, the inventor of the photographic dry plate.

On motion the following committee was appointed by the President with power to act in the matter:

Mr. Geo. W. Rafter,
Dr. Charles Forbes,
Dr. J. Edw. Line.

The President now introduced DR. M. A. VEEDER, who read a paper entitled:

THUNDERSTORMS,

BY M. A. VEEDER.

The present study of thunderstorms has grown out of the research in regard to auroras and their associated conditions, some of the results of which have been presented before the Academy and published in the proceedings in previous years. In general it has been found that auroras and their attendant magnetic storms occur when spots, or faculæ, or both are at the sun's eastern limb, and near the plane of the earth's orbit. Inasmuch as the proofs of this proposition have an important bearing upon the subject of thunderstorms, and may not be accessible to many receiving this paper, it is necessary to rehearse them somewhat at length.

By counting the stations reporting auroras each day and arranging the numbers thus obtained in periods, it is found that the time of recurrence is twenty-seven days six hours and forty minutes. This result was obtained within four minutes from magnetic observations alone. The four minutes were added after it had been discovered that this slight lengthening of the period would secure conformity with Carrington's determination of the time of a synodic revolution from the average rate of rotation of spots, which value also has been adopted at the Greenwich Observatory.

So far as is known to the writer this determination has never been made in the case of magnetic phenomena with such accuracy heretofore. Round numbers and general statements based upon records from too few stations or for too short a time, are entirely inadequate for the purposes of the present investigation. It is not enough to know that there is recurrence at intervals of about a month. The limits of probable error should be less than any considerable fraction of even a single day. The tables upon which the period that has been named is based cover nearly two hundred years, and comprise nearly all reports of auroras in existence, as well as records of magnetic storms for a considerable number of years. These tables are so voluminous that only specimen extracts, such as that appended to the paper upon the Zodiacal Light in the Proceedings last year, have been published. This extensive and thorough tabulation has reduced the limit of probable error to a question of a few minutes more or less. An error amounting to as much as half a day would multiply itself so as to become a whole week in the course of a single year, and would be very plainly perceptible in tables such as those which have been constructed. Thus there is no liability whatever to confusion with the time of a synodic revolution of the moon which differs more than two days from the period of auroral recurrence. On the other hand the conformity with the rotation period of the sun is exact, and is capable of verification in ways that will appear in the further course of the discussion.

The evidence being so clear that there is recurrence of auroras at the interval of a synodic revolution of the sun, it becomes of interest to compare their daily prevalence with the coincident condition of the sun's surface. For this purpose suppose the entire surface of the sun to have been divided meridionally into as many lunes as there are days in the synodic interval, and make for each of these divisions a list of the sizes of all sun-spots observed each day throughout the year as given in the Greenwich Records of Photographic Results. From these records also it is known where each lune was located upon any given day or series of days. Upon the first day of each auroral or synodic period for example, each lune returns to a particular part of the sun's disc, which in turn is occupied on the next day by the lune following and so on. By this method it is learned that upon series of dates characterized by recurrence of the aurora, disturbed portions of the sun are always at the eastern limb appearing by rotation. It is true that for many years past instances have been numerous in which at the time of an aurora a disturbance has been located just west of the meridian, but this latter relation is adventitious and depends upon the fact that the chief seats of solar activity recently have been three in number and about nine days apart so that when one is at the eastern limb another is apt to be just beyond the meridian. In years when there is cessation of activity at one or more of these centers it becomes evident that it is the eastern limb effect that persists, that assumed to proceed from the meridian disappearing when the disturbances are far enough apart to avoid any possibility of confusing the one with the other. It is to be noted also that at times when all these centers are active at the proper interval from each other there is increased liability to confuse the direct effect of a disturbance at the eastern limb with that of the one next preceding because of the fact that when an aurora appears there seems to be a reactionary inductive effect from the earth itself towards the sun which tends to increase the size of any sun spots near the meridian in a manner that will be more fully explained in a subsequent paragraph in which sun spots are shown to depend upon a reflux of magnetic induction toward the sun whenever its surroundings become more highly charged.

That this relation of auroras and magnetic storms to the location of disturbed areas at the eastern limb is not adventitious is shown also by the manner of recurrence. At each return the beginning is abrupt and strong, and the subsequent decline gradual. This is apparent in the case of auroras, but is best seen in the tracings from the magnetographs which record magnetic storms automatically. For example, the outbreaks of February 13th and March 12th, 1892, were distinguished by phenomenal characteristics, and began suddenly and violently at the exact interval of twenty-seven and one-quarter days. Consequently the originating solar disturbance could not have undergone any change of location whatever on the sun's surface, its magnetic effect recurring at an interval differing but a few minutes from the synodic period obtained as the result of the present research. If in such a case the originating disturbance were at the meridian, or elsewhere than at the eastern limb, it is possible that there might be abruptness and violence of beginning but there could not be such exactness of periodicity corresponding to the time of a synodic revolution of the sun.

The tables to which reference has been made show also that these recurrences of the aurora are not continuous, but are best defined near the equinoxes, and almost disappear near the solstices. In numerous instances single series of recurrences at one equinox do not reappear in the same location in the tables until the return of the corresponding equinox in the year following. This happens even in years in which the disturbed condition is constant, so that disturbances even when large and active fail to exercise their full magnetic effect at all seasons of the year. No hint as to the explanation of this was secured until the latitude of the disturbed areas was taken into the account, whereupon it became apparent that proximity to the plane of the earth's orbit is requisite. Spots and faculæ are not scattered promiscuously upon all parts of the sun but are confined to narrow belts at a distance of several degrees north and south from the equator. Because of the inclination of the sun's axis to the plane of the earth's orbit, it is only at the equinoxes that the earth approaches the heliocentric zenith of one or the other of these belts. Whatever may be the explanation it is only when thus in range that the earth experiences the full magnetic effect. Thus when a disturbed area is upon one side of the sun's Equator solely, its effect reaches the earth only while the latter is opposite the corresponding hemisphere. In the paper upon the Zodiacal Light presented to the Academy last year, evidence was adduced which tends to show that this behaviour of magnetic storms and auroras may depend upon a peculiar disc-like distribution in space of the meteoric debris surrounding the sun, which becomes visible as the lateral extensions of the corona seen during eclipses and as the zodiacal column and which has the requisite physical properties and location to serve as a conducting medium under the limitations actually found to exist.

It is possible that the red sunset glows whose revival has been recently reported in the absence of volcanic eruptions may be due to dust of cosmical origin as well as to that from purely terrestrial sources as was thought to be the case following the eruption of Krakatoa in 1883. Certainly we are justified in inferring that such dust is present in interplanetary space and serves as a medium for the play of electrical discharges from the fact that what seems to have been a true aurora has been observed attached to the moon and moving with it. Such observations are necessarily rare, the appearance being commonly overpowered by the glare of moonlight, or it is disregarded as being nothing more than a mere cloud or halo. If however the observation is confirmed and the lunar aurora is found to be a reality, there being no atmosphere in that vicinity, it is positive proof that neither ice crystals nor air particles nor other atmospheric contents serve exclusively as the medium of conduction, but that the meteoric dust of interplanetary space has a part to perform. Thus also the peculiarities of the spectrum of the aurora are consistent with the idea that they depend upon the play of electrical discharges upon dust particles suspended in interplanetary space or practically in vacuo, under which condition there is increased facility of conduction and increased luminosity as is shown by ordinary vacum tube experiments.

Having thus identified to some extent at least, the conditions under which magnetic impulses arise we are in a condition to attack the thunderstorm question. It is to be noted that the thunderstorm is a very local affair, having but little if any effect on the magnetic needle. Consequently it is more difficult than in the case of auroras to secure information in regard to its daily prevalence, and it is impossible to check the results by comparison with the coincident behaviour of the needle. We are compelled for the most part to rely upon the history of out-breaks of marked severity, or at unusual seasons, as for instance, in the winter. This is less satisfactory than the systematic and very complete tabulation that is possible in the case of auroras. Still it is the best that can be done, and may afford important clues.

Thunderstorms being electrical it is natural to expect that they should be related in some way to auroras which also are of electrical origin. This expectation has been realized by the discovery that hunderstorms not unfrequently take the place of auroras in the regular order of recurrence. There seems to be a substitutive or reciprocal relation between these two classes of phenomena, the one taking the place of the other, wholly or in part, under conditions now in process of investigation, and with reference to whose study the present paper is essentially a report of progress.

Evidence has been secured which indicates that thunderstorms prevail most widely when disturbed areas are at the sun's eastern limb, and at a distance from the plane of the earth's orbit, thus differing from auroras in whose case, proximity to that plane appears to be essential. This difference in the location of the originating disturbance appears to modify the method of conduction of the electrical impulses, the earth in the one case being in exact range with lines of force and conducting medium experiences the species of impulse known as magnetic, and in the other case being somewhat out of range encounters instead disruptive discharges which fall at points where the attendant terrestrial conditions are most favorable.

There are resemblances between the behaviour of thunderstorms and auroras consistent with such community of origin. Both occur in well defined belts which undergo changes of latitude in corresponding cycles of about eleven years duration, and are concentric with the magnetic poles of the earth rather than with the axis of rotation, thus corresponding to a like arrangement of belts of equal atmospheric pressure. Both exhibit daily maxima and secondary maxima at certain hours of local time, depending upon concentration of effect at points which maintain a fixed position with respect to the source of induction but which are movable with respect to the earth itself. In the case of thunderstorms the chief maximum is in the afternoon and the secondary maximum between midnight and morning, even hail as well as thunder and lightning having been known to occur during the night. The corresponding maxima of auroras fall in the evening and early morning. Accordingly when an aurora in the eastern hemisphere is coincident with thunderstorms in the western and vice-versa, the substitution may depend in part at least upon this relation to certain hours of local time, as well as upon differences in respect to the humidity of the atmosphere and the like, affecting its conductivity. The system of concerted observation organized by the writer in which a large number of observers are participating has revealed a tendency to the localization of the aurora somewhat similar to that apparent in the case of thunderstorms but not so strongly marked. The conditions under which this localization of the aurora occurs appear to be connected in some way with the sharp bending of the lines of equal magnetic declination, as for example in the Adirondack region and Northern Maine and near the mouth of the Ohio River. There are laws also governing the relative prevalence of these phenomena at different seasons of the year which require further study from the point of view in regard to solar origin here indicated. It is sufficient for the purposes of the present discussion to point out that there is such similarity in the behaviour of auroras and thunderstorms in many important particulars as is consistent with their having a common origin.

Thunderstorms also exhibit definite relations to conditions of atmospheric pressure that appear to be under the control of these characteristic solar impulses. This may be shown in the following manner: From the Daily International Weather Maps the location each day of all centers of high barometer throughout the greater part of the northern hemisphere may be obtained. Thus it may be shown that at times these centers all suddenly begin to move eastward as if by a common impulse. This happens under the precise solar conditions that attend the aurora and thunderstorm. It is most pronounced near the equinoxes when auroras also are at a maximum. Associated with it at all seasons there is marked intensification of storms. This occasions the phenomenon of well-defined storm periods, but there is not one universal storm. On the contrary, anti-cyclones as well as cyclones are strengthened as atmospheric movements become more energetic, so that during these very storm periods the weather in particular localities is much finer than common.

Other evidence that the atmosphere as a whole is under the control of induction from the sun, is to be found in the fact, that in certain years when forces of this character are at a maximum, there is a re-arrangement of the distribution of atmospheric pressure on a grand scale. Anti-cyclones with greater heat in summer and greater cold in winter, become more persistent in high latitudes, and cyclones appear in the tropics, the belts of thunderstorms and auroras also descending to lower latitudes. In years of minimum on the other hand there are anti-cyclones and drouths in the tropics and cyclonic conditions in high latitudes, with cool summers and mild winters. In such years drift ice comes down from the Arctic regions all winter. Coincidently auroras and thunderstorms become less frequent and appear in higher latitudes.

The theory has been advocated that these re-arrangements of pressure and coincident peculiarities depend upon accidental terrestrial conditions. It has been said for example, that drift ice in the North Atlantic would produce unusual cold over the adjacent continents. That this is not so appears from what has just been stated in the preceding paragraph. It is precisely when the winters are mildest over the northern parts of Europe and America that such ice is most abundant.

It has been customary also to ascribe such wholesale re-arrangements in weather conditions to variations in the sun's power of heat emission. This has been done upon purely theoretical grounds, no direct evidence of any such variation having been secured by the exposure of properly arranged thermometers to the direct rays of the sun in the most favorable localities that can be found. Furthermore, when the averages from a sufficiently large number of stations are compared, it is found that the excesses and deficiencies offset each other in such a manner that the general result is but an insignificant departure from the normal. In other words, there are re-arrangements of distribution but the quantity remains the same. From the point of view of the present discussion the question as to the variability of solar heat resolves itself into an inquiry as to whether the inductive forces emanating from the sun under the limitations that have been pointed out are of a thermo-electric nature.

The periodicity corresponding to the time of a synodic revolution and the confinement of magnetic effect to a very small portion of each transit, which portion remains the same at successive returns, indicate that the motion of rotation and not heat radiation is concerned in the propagation earthward of these impulses. Rays of heat pass indifferently in every direction through a homogeneous medium such as is that surrounding the sun. Hence there is no possibility of accounting for the eastern limb effect by the agency of heat rays inasmuch as this would necessitate their emission in a single direction only. The same is true of light radiations. Whatever may be the merit of the electro-magnetic theory of light it does not apply in this case. In other words the magnetic effect of solar disturbances does not depend upon their visibility. If this were the case magnetic storms and auroras would continue all the while in certain years, whereas even when the sun is most disturbed continuance for as long a time as a single week is extremely rare.

It is the motion of rotation of portions of the sun's surface that have been electrified by the action of eruptive forces that developes currents upon precisely the same principles as are employed in the construction of dynamos. In other words, if the sun were to cease rotating there would be no origination and conduction of currents through the agency of induction acting upon surrounding meteoric debris or otherwise, no matter how much eruptive energy might be displayed. But such currents having been originated their propagation in a certain direction exclusively corresponds to what is known generally in regard to the behaviour of such forces. During magnetic storms for example, the telegraph lines in some one direction may be entirely disabled while all others are working freely. Thus induction developes lines of force, temporary poles, attractions and repulsions and the like, which in the case of the sun are simply exhibited upon a grander scale. The principles involved do not differ from those being familiarized in the ordinary commercial applications of magnetism and electricity. The thunderstorm and the aurora are but the flashing of the spark incidental to the charging up and whirling of the great dynamos best known as sun and planets.

The simplest electrometer experiment shows that the atmosphere is constantly electrified. That such electrification is capable of producing motion is shown by the play of air currents about the points of an electrical machine in operation. Such an experiment affords a presumption at least that the same thing may occur on a larger scale in nature. The eastward push of anti-cyclones, and attendant intensification of storms, and the vast re-arrangements of the distribution of pressure both in isolated cases and continuously in series of months and years all occur in such manner and with such surroundings as are consistent with the view that they depend upon these inductive forces and none other. Certainly there can be no heating up of continents or seas in a single day adequate to account for such intensification of barometric conditions and rapidity of movement as often appears.

In years when magnetic forces are at a maximum the belts of sun spots on each side of the solar equator are transferred to higher latitudes, as though the force of induction had reacted upon the sun itself. This corresponds precisely to the coincident change in the location of the belts of anti-cyclones upon the earth due to the same cause, they also being concentric with the magnetic poles rather than with the axis of rotation. Certainly in the case of the sun, this belt-like arrangement and its transference back and forth in latitude cannot be due to any heating up of the equatorial regions from an external source, there being no other sun shining upon our sun competent to produce such effect. That it is the reflux of magnetic induction that creates the spots upon the sun is shown by the fact that they haunt the localities where the eruptive forces concerned in the production of the aurora are most active. Spots not unfrequently increase in size as they reach some particular part of the visible disc as though there were something in that vicinity independent of the sun or at least not moving with it capable of originating them. This something certainly cannot be heat from an external source and the manner of its action is such that it is very unlikely that it is gravitation, or in other words tidal stress, but it is very probable meteoric or planetary matter that has become specially charged as the result of some preceding outbreak which has occurred with such abruptness and force as to have left its impress upon the sub-permanent magnetism of particles in some one direction from the sun, causing a reactionary effect upon the other sections as they pass that point.

The relation of what is known as the eleven year period of sun spots to the perihelions of Jupiter illustrates very clearly the manner in which magnetic induction is originated in the sun and propagated back and forth throughout the solar system in the manner described in the preceding paragraph, It is found that in cycles of one hundred and sixty-six years the perihelions of Jupiter make one complete round of coincidences with all phases of sun-spot activity from maximum to minimum and back again. It follows from this that the perihelion position of Jupiter cannot determine the times of recurrence of any particular phase or degree of solar activity inasmuch as it is coincident in regular order with them all. Just now the perihelions coincide with sun-spot maxima but going backward they gradually recede until about eighty-three years ago they fell almost precisely midway between such maxima and did not again coincide as at present until one hundred and sixty-six years ago. Thus the average sun-spot period is shorter than a revolution of Jupiter in the ratio of fourteen to fifteen. Nor is it possible to explain this shortening by bringing into the account the perihelions of the other planets or their alignments with each other at conjunction or opposition. There is no configuration of planetary positions that coincides with any particular phase of the eleven year period. The proof is very positive that variation in gravitational or tidal stresses is not the cause of the manifest periodicity at this interval. Nor have we evidence of the existence of anything else external to the sun itself capable of producing recurring solar convulsions on so vast a scale. Certainly there is no periodic intrusion into the solar system of meteoric matter adequate to produce so great an effect. If such were the case it is impossible that the earth itself should escape consequent disaster. In short so far as existing knowledge extends we are absolutely shut up to the conclusion that the forces chiefly concerned are wholly internal to the sun itself, and that the eleven year periodicity simply represents what may be termed the co-efficient of solar viscosity. Thus the accumulation and bursting forth of the pent up forces must recur at intervals whose equality with each other depends upon the extent to which the mass of the sun is homogeneous and uniformly coherent. The sun itself being hot does not strictly speaking become a magnet in virtue of these recurring activities, but the turmoil of eruption as in the case of the terrestrial volcano generates electrical currents locally, which in the case of the sun occupy the cooler overlaying portions of the photosphere and which are propagated throughout the solar system in strict conformity to the laws governing magnetic induction particularly as exemplified in the case of rotating bodies. Now it is evident that proximity to the source of induction will increase the effect experienced which will be greater also in proportion to the size of the body thus exposed. Thus Jupiter being the largest planet when nearest the sun receives and transmits a proportionately greater effect. Thus when the perihelions of Jupiter become coincident with the recurring maxima of solar activity all the effects of such activity both direct and indirect are strengthened, the planet in virtue of consequent increase in its sub-permanent magnetism acting like a great storage battery for their accumulation as well as their transmission. Thus there is increased reaction upon the sun itself in the manner indicated in the last paragraph and sun spots become larger than when the perihelions of Jupiter do not coincide with maxima of solar activity. There is in like manner increased reaction upon other members of the solar system, and magnetic storms and auroras on the earth become stronger at such times. As has already been explained, coincidence of the perihelions of Jupiter with maxima of solar activity recur in cycles of about one hundred and sixty-six years and the resultant strengthening of such maxima may be traced backward at corresponding intervals as far as we have any record or for about eighteen hundred years. Evidence of similar action and reaction in respect to the other planets as well as Jupiter has been found, that between the moon and earth being especially well marked in a periodic strengthening of magnetic storms apparently dependant upon the perihelion position of the former in its orbit.

Thus relations to electrical induction come out distinctly in a multitude of ways, and the study of thunderstorms as a practical exemplification of the action of these forces becomes increasingly interesting. The idea based upon certain laboratory experiments which ascribes such storms to the storing up of positive electricity in the upper atmosphere through the evaporation of a saline solution such as are the waters of the ocean, and the discharge of this electricity disruptively in the case of thunderstorms and quietly in the case of auroras is utterly inadequate. If this be the proper explanation there must have been an enormous amount of such evaporation for a curiously limited interval on Feb. 13th, 1892, and exactly twenty-seven and one-quarter days later, it must have begun again in a very strange way in order to account for the world-wide magnetic storms and splendid auroras of those dates. The evaporation theory certainly fails to account for the facts in such a case as this, and is equally deficient as an explanation of widespread outbreaks of thunderstorms.

The atmospheric conditions to which thunderstorms are incidental present peculiarities that require examination in detail. Upon any weather map there appear areas of high barometer termed anti-cyclones, from each of which air currents proceed outward in every direction until they meet the corresponding outflow from adjacent anti-cyclones. In a belt along this line of meeting, storm action is most severe. Here there is conflict of winds, air strata at different altitudes moving in different directions with sudden shifts, and rapid changes of temperature and more or less cloudiness and precipitation. Along this line are eddyings and whirls some of which reach the dimensions of the rotary storms designated cyclones. In the midst of this turmoil, but not at the seat of lowest pressure thunderstorms are most apt to occur. The ordinary theory is that all this atmospheric commotion is due to the agency of heat and gravitation modified somewhat by the deflecting force of the earth's rotation, and that the thunderstorm is generated on the spot and is not due to any form of induction from the sun.

It may prove to be advantageous to examine this theory somewhat in detail. According to this view masses of air warmed by the sun's rays or by condensation of aqueous vapor and liberation of latent heat, as the case may be, are supposed to acquire buoyancy so as to rise in such manner as to permit the air from surrounding localities to gravitate into the place thus made vacant with the velocities and in the directions shown on the weather maps. In order that this theory may be justified, it is necessary that there be evidence of the existence of a vertical column of air ascending with such velocity and to such distance as to correspond with the velocity and extent of the horizontal movement. That is to say, in the case of a cyclonic area of ordinary size, covering a part of New England for example, the upward movement must be on such a scale as would produce a pull on the wind vanes in Chicago very commonly and even in Omaha or Salt Lake City at times. The aspiration of a column of air a thousand miles or more in length against all the irregularities presented by the earth's surface and at velocities of from ten to twenty miles an hour at least, is no small task, and yet the column of air whose vertical movement is supposed to accomplish all this cannot be more than about five miles high, unless it extend beyond the limit of storm action and cloud stratification, which is very improbable. Indeed storms have been noted at the base of Mt. Washington which did not affect the wind direction at the summit. Moreover the very best appliances that have been devised for the measurement of any upward movement of the air, reveal only exceedingly small velocities as compared with those in a horizontal direction.

Again in the case of a very energetic storm remaining almost stationary, like the famous New York blizzard, the indraught and uprush theory assumes that there is a constant abstraction of air from surrounding localities for hundreds of miles at velocities ranging from twenty-five to fifty miles an hour. If all this air is actually drawn into the center of the storm and does not simply circulate around it, it would seem that there should be some indication of such accumulation in that vicinity. The barometer however gives no evidence in such cases of any piling up or massing together of air, not even to such an extent as would account for a gravitational outflow in the upper strata to compensate for the gravitational inflow assumed to exist at the surface of the earth. On the contrary, the harder the wind blows and the more swiftly the storm rotates the lower the pressure at the center, showing that instead of there being any increase in the weight of the total air column or any choking backward due to accumulation of air above there is exactly the opposite. This being the case it is difficult to see how the horizontal component of motion can be gravitation.

There is difficulty also in reconciling the movement upward or downward in cyclones and anti-cyclones with the accompanying distribution of heat. The air overlying centers of low barometer has been found to be very much colder than the normal for corresponding altitudes. There appears to be a dip downward of a stratum of very cold air instead of the projection upward of warm air. The limits of this cold are sharply defined and do not shade off gradually as would be the case if it were cooling due to the expansion of a rising column of air from which the pressure is being moved. In the case of thunderstorms which have been held to be typical examples of the indraught and uprush idea, the projection downward of cold air is so extreme that it reaches the surface of the earth and presents so sharp a margin that the temperature commonly falls fifteen or twenty degrees in two or three minutes as the storm breaks and rises again as it passes away. Moreover in such storms the wind at the surface of the earth blows briskly outward in every direction as well as that of the storm's advance, which is the very reverse of an indraught. This has been noticed even when there has been little or no precipitation, so that the projection downward cannot be due to entanglement with rain drops. Indeed the rain itself not unfrequently appears to be upborne and whirled along by the gust, and it is precisely in those storms where the downpour is heaviest that the lines of descent of the rain drops are most nearly vertical and there is no gust at all. In like manner in the case of a waterspout which came aboard of a ship there was found to be snow at its center, so that here also there must have been a very decided dipping downward of cold air. In view of facts such as these it is difficult to see how the vertical component of motion in cyclones can be heat.

So likewise in the case of anti-cyclones the temperatures at different altitudes do not account for the direction of movement. The writer has made a list of instances in which the temperature on Mt. Washington was higher than at surrounding stations at lower levels, from which it appears that as a rule this happens during the passage of centers of high barometer. Thus the out-flowing air currents from such centers are compelled to derive their supply from the descent of masses of air relatively warmer than that at the surface of the earth. Such air being warmer ought not to descend at all, or if compelled to descend in virtue of the general circulation of the atmosphere, it ought to be warmed in the process by virtue of increasing compression by superincumbent air strata as it reaches lower levels. But instead of becoming warmer it becomes colder. Thus in the case of anti-cyclones also it is difficult to see how the vertical component of motion can depend upon temperature.

Again air leaving centers of high barometer or approaching centers of low barometer does not advance in a radial direction, but makes a fairly constant angle with that direction. Thus the wind vanes are always oblique to the isobars. This so far as is known to the writer has uniformly been ascribed to the deflecting force of the earth's rotation. But when an attempt has been made to secure a numerical value for this deflection the discrepancy between the answers obtained from different sources has been very large. No two have agreed with each other, and not one has given a value corresponding to the angle which the wind arrows make with the isobars. As a matter of fact, this angle on an average corresponds to a departure of about eighty miles for every hundred miles advance in a radial direction. It would seem that if the deflecting force of the earth's rotation were capable of producing a deviation so great as this, to say nothing of the sharper whirl apparent in the tornado, something of the sort should be apparent elsewhere, as for instance in the case of projectiles. But no marksman thinks of making any allowance whatever for the deflecting force of the earth's rotation, not even to the extent of a single foot, to say nothing of any such amount as eighty feet for every hundred that the mark is distant, which is what would be required in order to correspond with the ordinary ratio of wind deviation.

Thus at many points there are serious difficulties in reconciling current ideas in regard to the forces concerned in atmospheric movements with observed facts. The question arises as to whether some important factor has not been omitted and whether a better explanation is not possible. As has been pointed out there is positive evidence that electrical and magnetic impulses of direct solar origin are concerned in atmospheric control. From this point of view the cyclonic and anti-cyclonic wind spirals are referable not to the deflecting force of the earth's rotation, but to the passage between the earth and its surroundings of electrical currents, the air particles in consequence being arranged in the precise manner that appears in the ordinary laboratory experiment in which iron filings are disposed in spirals on a card pierced by a wire through which a current is passing. So too the stratification of masses of air of different temperatures in a manner contrary to gravitation presents no great difficulty, it being due to electrical attractions and repulsions which are competent to antagonize gravitation in the manner actually encountered in these cases. From this point of view also the disproportion between the horizontal and vertical movements which has been pointed out does not present any difficulty, electrical attractions and repulsions and not the buoyancy of the air being the prime motor. In like manner the perpetuation of vertical motion and continuance of centers of low barometer become possible in spite of the tendency of gravitation to cause their cessation by filling up. So too the general eastward push of anti-cyclones and the change of type of weather in different years, and even the diurnal ebb and flow of barometric pressure best seen in the tropics, all occur in such relations and with such concomitants and regular order of sequence as are consistent with the idea that they are due to inductive forces, originated and propagated in the manner that has been indicated and bearing but little if any relation to variability of the sun's power of heat emission.

These views have resulted not from theoretical considerations, but from attempts to classify the phenomena in question in conformity with their most obvious relations. Not only the categories of time and place but also the intimate nature of the phenomena themselves have been considered. In other words it is not a question of mere coincidence, an adequate underlying principle, namely that of induction, being everywhere apparent. In tracing out the ramifications of this principle it is possible that there may have been mistakes of detail. Nor is it claimed that the research is anywhere near complete even in respect to essential features. The purpose of the present discussion will have been accomplished if it shall have been made logically impossible for any one to pretend to have made an adequate study of the thunderstorm or aurora without having taken into the account the relations here pointed out.

The paper was discussed by MR. J. E. PUTNAM.

MAY 23, 1892.

STATED MEETING.

The President, PROFESSOR H. L. FAIRCHILD, in the chair.

A large audience present.

PROFESSOR CHARLES WRIGHT DODGE, gave the fifth lecture of the Popular Lecture Course, on

THE YEAST PLANT; ITS STRUCTURE AND PHYSIOLOGY.

The lecture was illustrated by charts, microscopes and experiments.

JUNE 13, 1892.

STATED BUSINESS MEETING.

The President, PROFESSOR H. L. FAIRCHILD, in the chair.

The Council report recommended :

(1.) The payment of certain bills.

(2.) The election of the following persons as active members :

MR. GEORGE D. HALE,
MR. SAMUEL SLOAN,
MRS. SAMUEL SLOAN,
HON. DONALD MCNAUGHTON,
MRS. J. W. OOTHOUT,
MRS. HENRY G. DANFORTH.

(3.) That the Academy hold a meeting in August complimentary to the American Association for the Advancement of Science.

The bills were ordered paid and the members elected by formal ballot. It was voted to hold a midsummer meeting.

The following candidates for fellowship, nominated May 9th, were elected fellows by a formal ballot :

MR. JOSEPH B. FULLER,
MR. E. H. GRIFFITH,
MR. A. M. DUMOND,
PRESIDENT DAVID J. HILL,
DR. P. MAX FOSHAY.

The President announced that in pursuance of notice given May 9, an election for Secretary would now be held.

DR. P. MAX FOSHAY was elected Secretary by formal ballot.

Under a suspension of the rules, the following candidates for membership, nominated at this meeting, were elected members by ballot :

COL. N. P. POND,
MRS. N. P. POND,
MRS. JOHN VAN VOORHIS,
MRS. CORNELIA WARING,
MISS MARGARET MORTON,
DR. PAULINE MORTON.

JUNE 27, 1892.

STATED MEETING.

The President, PROFESSOR H. L. FAIRCHILD, in the chair.

Nineteen persons present.

In the absence of the Secretary, MR. J. M. DAVISON was appointed Secretary pro-tem.

The Curator of Botany, MISS FLORENCE BECKWITH, announced that Mr. Gilbert Van Ingen had presented 170 specimens of plants to the Herbarium of the Academy.

PROFESSOR S. A. ELLIS, of the committee to draft resolutions on the death of our late member MR. ROBERT BUNKER, made the following report:

ROCHESTER, N. Y., June 27, 1892.

To the Rochester Academy of Science, PROF. H. L. FAIRCHILD, Pres't.

DEAR SIR:—Your committee, appointed to present a memorial of the late Robert Bunker, beg leave to submit the following:

Robert Bunker, son of Laban and Deborah Bunker, was born in Ghent, Columbia Co., N. Y., November 20th, 1820. At the age of seven years, he removed with his parents to this city, where he died March 6th, 1892.

He attended the common schools until the age of fourteen or fifteen, when he entered his father's shop, to learn the trade of a cooper.

It was at this time, that he developed a taste for Entomology and began collecting and rearing butterflies and moths. While pursuing his studies and experiments in Entomology, he took up the study of the microscope and acquired considerable skill in the use of that instrument.

He was a charter member of the Rochester Academy of Science and President of the Entomological section of the Society.

Soon after the re-organization of the Academy of Science, he presented to it the entomological collection, which bears his name. A special feature of the collection, is the large number and variety of moths it contains.

Mr. Bunker was a man of decided literary taste, and his contributions to the "Canadian Entomologist," "Vick's Magazine" and other scientific publications, show him to have been an acute and intelligent observer of insect life.

He had considerable correspondence with entomologists abroad with whom he effected some valuable exchanges.

The "Entomological News" says of him: "He was personally a man of strong traits of character, upright and honorable in every relation of life; broad minded yet positive in his opinions; genial and courteous in his intercourse with friends and neighbors,"—in which we heartily concur.

His death is sincerely mourned by his entomological friends, by the members of this Academy and by this community, among whom, more than three score years of his life was spent. Mr. Bunker was married May 21st, 1854, to Miss Jane E. Bills, of Clarkson, N. Y., who survives him.

Respectfully submitted,

S. A. Ellis,
Wm. Streeter,
James W. Allis,
Committee.

The following paper was then read:

PRELIMINARY NOTE OF A NEW METEORITE FROM KENTON COUNTY, KENTUCKY,

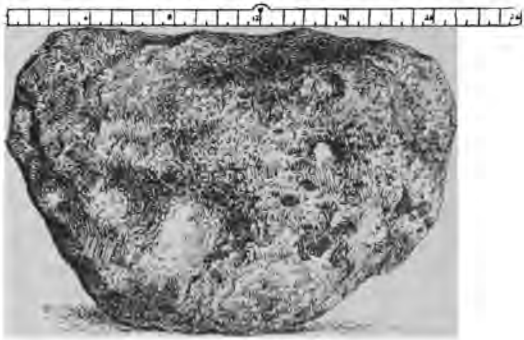
By H. L. Preston.

On May 15th, Professor Henry A. Ward received a letter from Mr. R. H. Fitzhugh, Bryson City, N. C., telling of a meteorite he had identified in Kenton County, Kentucky.

In Professor Ward's absence Mr. Frank A. Ward started me off the same night to look up the meteorite.

I arrived at Bracht station on the Cincinnati Southern R. R. Friday morning and drove as far as the roads would permit toward Mr. Geo. W. Cornelius' farm. He being away from home, his wife showed me the "metal" as they called it, and it proved to be a beautiful meteorite of the siderite variety, 533 x 356 x 203 millimeters (21 x 14 x 8 inches) in its greatest diameters, and weighed 163.0665 kilograms (359½ pounds.)

In form in certain directions it very much resembles a nautilus, and has numerous but mostly shallow pittings, a few deep pittings occurring however on the side shown in the accompanying cut, which gives a good idea of the general outlines of the meteorite.



1-7 NATURAL SIZE.

This meteorite is entirely free from crust.

I saw Mr. Cornelius on the evening of the next day and obtained from him the following facts in relation to the meteorite.

About the middle of August, 1889, while cleaning out a spring situated at the head of a gully some three-quarters of a mile from his present home in Kenton County, eight miles south of Independence, the county seat, he struck with his hoe something that had a metallic ring: obtaining assistance he took the mass out, finding that it was interlocked in the roots of an ash tree from thirteen to fourteen inches in diameter, and was between three and four feet below the normal surface.

He let the mass lie by the spring until August, 1890, when he removed it to his woodshed, where it has lain until purchased by me for the Ward collection of meteorites and it is now at our establishment in Rochester, N. Y.

For the following analysis of this meteorite I am indebted to Mr. Davison.

Analysis of Kenton County Kentucky Meteorite :

Fe	91.59
Ni	7.65
Co	.84
Cu	trace.
C	.12
S	trace.
P	trace.
	100.20

JOHN M. DAVISON,
Reynolds' Laboratory, University of Rochester.

In the course of a conversation with Mr. S. J. Cornelius, a brother of the gentleman of whom I purchased the meteorite, he mentioned the fact, that about three o'clock on the seventh of July, 1873, while returning from a picnic in this locality, and when within a half mile of where the metorite was subsequently found, he heard a great rumbling in the heavens, which appeared to last three or four minutes and was followed by a quivering of the earth. As the day was clear he could not account for this phenomena. I met at least seven other people who distinctly remembered the picnic and the "rumbling in the heavens," and some one or two the "quiver in the earth."

(Is there any connection between this date and the fall of this meteor?)

Mr. Preston also read extracts from a publication by the British Museum on the history of meteorites and theories as to their origin. He exhibited a cast of the new meteorite and sections of typical metallic, stony and mixed meteorites, showing the Widemanstätten figures, nodules, troilite, pittings, and crust characteristic of these bodies.

An interesting exhibit was that of a cast of a meteorite now in the British Museum. This is in three pieces, a large and two smaller ones and the fragments were found many miles apart, but so fitting together as to make it evident that they were once united. One of the smaller fragments is entirely encrusted, showing that it had been torn from the mass early in its flight while its velocity was still such as with the resistance of the air to raise the surface of the mass to the melting point. The other small fragment thrown off as the body neared the earth, is also encrusted save at the place of separation from the parent mass where the surface is unfused and fresh, showing that, when it parted, the steady resistance of the air had so checked its speed that fusion was no longer possible. So with the fires of youth quenched and an independent career denied it, it settled upon the shelves of the Museum by the side of its more brilliant brother, by a happy law of compensation serving as useful and honorable an end.

The President exhibited photographs showing pitting made by tadpoles in the muddy bed of the old canal, and a laminated rock with bullæ made when it was plastic by imprisoned marsh gas—the reverse side bearing a strong resemblance to the work of the tadpoles in the canal mud.

The following paper was read by title:

HYMENOMYCETEÆ OF ORLEANS COUNTY, N. Y.,

By Dr. Charles E. Fairman.

The following Hymenomyceteæ or Fleshy Fungi, comprising Mushrooms, Toadstools, Shelf Fungi and allied forms were mostly collected at Lyndonville, N. Y. I have given the reference to the Reports of Professor Peck when I have found that the species under consideration had been previously listed in the Reports, so far as I have been able to discover. The species listed number 126. In my paper on Fungi of Western New York in Proceedings of the Rochester Academy of Science, Vol. I, Aug., 1890, the number of Hymenomyceteæ was given as 96. The number has been brought up to 126 by subsequent collections.

FUNGACEÆ.

I. FUNGI SUPERIORES.

HYMENOMYCETEÆ.

Fam. 1. AGARICINEÆ.

Sect. 1. LEUCOSPORÆ.

Amanita Pers.

1. **Amanita pantherina** D'C. Peck Bull. N. Y. S. M. Vol. I. No. 2, page 25. Panther mushroom.

Thin dry woods and maple groves. Lyndonville, Aug., Sept.

2. **Amanita nivalis** Peck. 33d Rep. Snow white Amanita. Woods. Lyndonville, Sept., 1889.

The European mycologists consider *A. nivalis*, Grev. to be only a white variety of *A. vaginata*, Bull. We have both forms in this country and they are probably distinct. If the European mycologists are correct in their identification of Greville's plant then our plant will stand as *Amanita nivalis*, Peck, not of Greville.

3. **Amanita phalloides** Fr. Pk. 23 Rep., p. 69. Phallus-like Amanita. Woods. Lyndonville, July, 1890.

Lepiota Fr.

4. **Lepiota procera** Scop. Pk. 23 Rep., p. 71, 35 Rep., p. 152. Parasol mushroom. Common in woods, pastures, and by roadsides. July, Oct. Lyndonville.

5. **Lepiota cristata** A. and S. Pk. 35 Rep., p. 155. Crested Lepiota. On lawns. Lyndonville. Aug., Sept.

ARMILLARIA Fr.

6. **Armillaria mellea** Vahl. Pk. 23 Rep., p. 73, 24 Rep., p. 102, 33 Rep., p. 36. Honey colored mushroom. On ground in woods on Lake Shore, Yates. Sept., 1886.

TRICHOLOMA Fr.

7. **Tricholoma alba** Schaeff. Pk. 35 Rep., p. 131, 44 Rep. p. 57. White Agaric. Greenman's woods, Yates, July, 1886.

CLITOCYBE Fr.

8. **Clitocybe laccata** Scop. Pk., 23 Rep., p. 77. Woods, Ridgeway.

9. **Clitocybe nebularis** Batsch. Pk. 23 Rep., p. 76. Clouded Clitocybe. Ours is the small and pale form. Lyndonville, June, 1889.

COLLYBIA Fr.

10. **Collybia Leaiana** Berk. Pk. 38 Rep., p. 109. Lea's Collybia. On rotting logs in woods. Ridgeway, May, 1886.

11. **Collybia dryophila** Bull. Pk. 23 Rep., p. 69. Oak-loving Collybia. Woods, Ridgeway, Spring, Autumn.

12. **Collybia radicata** Relh. Pk. 23 Rep., p. 79, 31 Rep., p. 54. Rooted mushroom. Very common in woods and pastures. Yates and Ridgeway. Easily recognized by its tail-like fusiform root.

MYCENA Fr.

13. **Mycena galericulata** Scop. Pk. 23 Rep., p. 81, 26 Rep., p. 90. Peaked Mycena. On rotten stumps. Yates, Orleans Co., May, 1886.

OMPHALIA Fr.

14. **Omphalia campanella** Batsch. Pk. 23 Rep., p. 85. Bell-shaped mushroom. Edge of woods. Lyndonville, June–Sept.

PLEUROTUS Fr.

15. **Pleurotus ostreatus** Jacq. Pk. 22 Rep., p. 77. Oyster mushroom. On trunks of willow trees. County Line road, North Ridgeway. Not common. Nov., 1885.

16. **Pleurotus striatulus** Fr. Pk. 30 Rep., p. 39. Striate Pleurotus. On fallen maple and elm branches. Yates, Orleans Co., March, 1886. Very small and easily overlooked.

17. **Pleurotus sapidus** Kalchb. Pk. 29 Rep. p. 38. Ridgeway. Common in woods. Generally caespitose. Spring to Autumn.

18. **Pleurotus septicus** Fr. Pk. 31 Rep., p. 32. Septic Pleurotus On rotten wood. Yates, Orleans Co., April, 1888.

19. **Pleurotus pubescens** Peck. Pk. 44 Rep., p. 18. Downy Pleurotus. Ridgeway, N. Y., Aug. Described by Peck from specimens found growing on trunks of standing trees, and was the only new species of Agaric collected by the author in Orleans County. It grew sub-caespitose.

Hygrophorus Fr.

20. **Hygrophorus luridus** (doubtful). Edge of thin woods, Yates, Orleans Co.

21. **Hygrophorus Cantharellus** Schw. Pk. 23 Rep., p. 114. Chantarelle Hygrophorus. Swamps. Lyndonville, July.

22. **Hygrophorus borealis** Peck. Pk. 26 Rep., p. 64. Damp shaded places in woods. Lyndonville, Sept.

Lactarius Fr.

23. **Lactarius trivialis** Fr. Peck N. Y. Species of Lactarius, 38 Rep., p. 120. Woods, Lyndonville, July, 1889. Common Lactarius.

24. **Lactarius fuliginosus** Fr. Peck N. Y. species of Lactarius, 38 Rep., p. 128. Smoky or dingy Lactarius. Edge of thin woods, Lyndonville, July and August.

25. **Lactarius cinereus** Peck. Peck N. Y. Species of Lactarius, 38 Rep., p. 122. Cinereous Lactarius. Woods, Yates, Orleans Co., August.

26. **Lactarius camphoratus** Fr. Peck N. Y. Species Lactarius, p. 132, Rep. 38. Camphor Lactarius. Swamps, Lyndonville, July and August.

27. **Lactarius glyciosmus** Fr. Peck N. Y. Species of Lactarius, 38 Rep., p. 123. Fragrant or Scented Lactarius. Edge of woods, Lyndonville, September.

Russula Pers.

28. **Russula purpurina** Q. and S. Pk. 42 Rep., p. 24. Purple Russula. Thin woods, Ridgeway, Orleans County. A beautiful plant. Peck found it in mossy ground in woods of balsam. It occurs

with us under beech and maple trees. Rare and only reported from one other locality in United States.

CANTHARELLUS Adans.

29. **Cantharellus cibarius** Fr. Peck N. Y. Species of Cantharellus, Bull. N. Y. State Mus., Vol. I, No. 2, page 38. Edible Chantarelle. Woods Ridgeway and Yates, Orleans Co., N. Y., July to September.

30. **Cantharellus infundibuliformis** Scop. Peck N. Y. Species Canth, Bull. N. Y. S. M., Vol. 1, No. 2, page 41. Funnel shaped Chantarelle. Woods Lyndonville, July to Oct. Common.

31. **Cantharellus aurantiacus** Fr. Peck N. Y. Species Canth. l. c., page 35. Orange Chantarelle. False Chantarelle. Edge of swamps and woods, Lyndonville, Aug., Sept.

32. **Cantharellus floccosus** Schw. Peck N. Y. Species Canth. loc. cit., page 37. Floccose Chantarelle. Borders of woods, Lyndonville, Sept.

MARASMIUS Fr.

33. **Marasmius rotula** Fr. Pk. 23 Rep., p. 125. On dead twigs. Common. Spring to Autumn, Lyndonville.

34. **Marasmius siccus** Schw. Pk. 23 Rep., p. 126. Dry Marasmius. In wet marshes, Lyndonville, July. Our specimens are the small form and the same as *M. campanulatus* Peck, which should be considered a synonym of *M. siccus* Schw.

35. **Marasmius anomalus** Peck. Pk. 24 Rep., p. 76. On sticks in woods, Yates, Orleans Co. Not common. Aug.

36. **Marasmius glabellus** Peck. Pk. 26 Rep., p. 66. On leaves and twigs in woods, Lyndonville. Aug.

LENTINUS Fr.

37. **Lentinus lepideus** Fr. Pk. 23 Rep., p. 126. Scaly Lentinus. On railroad ties on R., W. and O. R. R., near Millers, N. Y. July. Rare.

38. **Lentinus strigosus** Schw. On logs in woods. Lyndonville.

PANUS Fr.

39. **Panus stipticus** Fr. Pk. 33 Rep., p. 36. Astringent Panus. Common everywhere on stumps, etc.

LENZITES Fr.

40. **Lenzites betulina** Fr. Pk. 33 Rep., p. 36. Birch Lenzites. Common on logs, stumps, etc.

41. **Lenzites sepiaria** Fr. Pk. 35 Rep., p. 146. Hedge or Fence Lenzites. Abnormal resupinate form, found on old horse blocks, at North Ridgeway, N. Y.

42. **Lenzites corrugata** Klotzsch. Wrinkled Lenzites. On dead willows in marsh, Lyndonville, April, 1888.

43. **Lenzites crataegi** Berk. Hawthorn Lenzites. On dead cornus trees, marshes, Lyndonville.

SCHIZOPHYLLUM Fr.

44. **Schizophyllum commune** Fr. Pk. 22 Rep., p. 81. Common on old stumps everywhere. Also a form which agrees well with the description of Var. *palmatum* Debeaux, Sacc. Syll., Vol. IX, p. 81, was found at Lyndonville on old apple tree stumps.

Sect. 2. RHODOSPORÆ.

PLUTEUS Fr.

45. **Pluteus cervinus** Schæff. Peck N. Y. Species of Pluteus, 38 Rep, p. 134. Fawn colored Agaric. On stumps in woods, not common. Somerset, May, 1886.

Sect. 3. OCHROSPORÆ.

PHOLIOTA Fr.

46. **Pholiota adiposa** Fr. Pk. 23 Rep., p. 90. Stout or obese Pholiota. On logs in woods, Lyndonville, June, 1886.

47. **Pholiota marginata** Batsch. Margined Pholiota. Woods Lyndonville. This fungus is a variable one and is deceiving because the annulus is often slight and evanescent.

48. **Pholiota praecox** Pers. Early Agaric. Early Pholiota. Lawns and pastures, Lyndonville.

INOCYBE Fr.

49. **Inocybe geophylla** Sow. Pk. 26 Rep., p. 90. On the ground in woods, Lyndonville.

50. **Inocybe lanuginosa** Bull. Hab. same as preceding.

FLAMMULA Fr.

51. **Flammula sapinea** Fr. Pk. 32 Rep., p. 29. Pine Flammula. On trees in woods, Lyndonville.

NAUCORIA Fr.

52. **Naucoria semiorbicularis** Bull. Pk. 23 Rep., p. 93. Half-round Naucoria. Very common on lawns, Lyndonville, June to September. When young the pileus is viscid. May be distinguished from *Stropharia semiglobata*, Batsch, by not having a ring or annulus on the stem.

CREPIDOTUS Fr.

53. **Crepidotus dorsalis** Peck. Pk. 24 Rep., p. 69. On logs, Lyndonville, July, 1886.

Sect. 4. MELANOSPORÆ.

AGARICUS Linn.

54. **Agaricus campestris** Linn. Pk. 23 Rep., p. 97. Common Mushroom. On flats along Johnsons Creek, Yates, Orleans Co., and meadows, Ridgeway, N. Y., Sept. and Oct.

55. **Agaricus placomyces** Peck. Pk. 29 Rep., p. 40. On lawns under shade trees, Lyndonville, N. Y., Aug, Sept.

STROPHARIA Fr.

56. **Stropharia semiglobata** Batsch. Pk. 23 Rep., p. 98. Hemispherical Mushroom. Common on dung by roadsides.

HYPHOLOMA Fr.

57. **Hypholoma sublateritium** Schæff. Pk. 22 Rep., p. 78. Brick colored Hypholoma. We have the typical form and also var. *perplexum*, Peck. On lawns and edge of woods. Lyndonville, Aug., Sept.

COPRINUS Pers.

58. **Coprinus micaceus** Fr. Pk. 23 Rep., p. 104. Roadsides, Lyndonville, June to Aug.

59. **Coprinus plicatilis** Fr. Pk. 23 Rep., p. 104. On rich lawns, Lyndonville, May.

60. **Coprinus ephemerus** Fr. Pk. 23 Rep., p. 105. On manure piles, Lyndonville, May.

61. **Coprinus picaceus** Fr. var. *ebulbosus* Pk. Peck 44 Rep., p. 20. The original specimens were found growing upon a log in damp shaded woods, Lyndonville. Distinguished by the absence of a bulb.

62. **Coprinus fimetarius** Fr. Common on dunghills. Lyndonville.

PANÆOLUS Fr.

63. **Panæolus solidipes** Peck. Pk. 23 Rep., p. 101. On manure heaps, Lyndonville, June to September. Noteworthy from being more substantial than most of the fimicolous Agarics.

64. **Panæolus campanulatus** L. Pk. 23 Rep., p. 102. Hab. as in 63. Lyndonville, June–Sept.

Family 2. POLYPOREÆ Fr.

BOLETUS Dill.

Viscipelles.

65. **Boletus piperatus** Bull. Peck Boleti of U. S. Bull N. Y. S. M. No. 8, page 102. Peppery Boletus. Woods, Lyndonville.

Subpruinosi.

66. **Boletus pallidus** Frost. Peck Boleti of U. S. loc. cit. p. 113. Pale Boletus. Woods, Lyndonville.

Subtomentosi.

67. **Boletus chrysenteron** Fr. Peck Boleti of U. S. loc. cit. page 116. Red-cracked Boletus. Woods, Lyndonville and Ridgeway. Common. Known by the red streaks in the cracks of the pileus.

68. **Boletus sulphureus** Fr. Sulphur Boletus. Lyndonville.

Edules.

69. **Boletus variipes** Peck. Pk. Boleti U. S. loc. cit. page 133. Variable Stemmed Boletus. Woods, Lyndonville.

Hyporhodii.

70. **Boletus felleus** Bull. Pk. Boleti U. S. l. c., page 154. Bitter Boletus. Edge of Woods, Lyndonville and Ridgeway.

Cariosi.

71. **Boletus cyanescens** Bull. Pk. Boleti U. S. l. c., p. 156,

Bluing Boletus. Yates and Ridgeway, Orleans Co. Wounds of the flesh turn instantly blue.

BOLETINUS Kalchbr.

72. **Boletinus porosus** Peck var. opacus. Pk. Boleti U. S. loc. cit. Eccentric Stemmed Boletinus. Woods, Somerset, Niagara Co., N.Y.

POLYPORUS Fr.

73. **Polyporus abietinus** Fr. Pk. 22 Rep., p. 84. Fir Polyporus. Common on hemlock logs, Lyndonville.

74. **Polyporus applanatus** Fr. Pk. 22 Rep., p. 83. Flattened Polyporus. Common on trunks of trees and fallen logs. Woods, Yates, Carlton, Ridgeway, Orleans County.

75. **Polyporus biformis.** Klotzsch, Linn. VIII, p. 486. Pk. 22 Rep., p. 83. Not common. Hab. not recorded.

76. **Polyporus brumalis** Fr. Pk. 22 rep., p. 82. Winter Polyporus. On stumps of *Ailanthus glandulosus* L., and on sticks on ground in woods. Yates, Orleans Co.

77. **Polyporus cæruleoporus** Peck. Pk. 26 Rep., p. 68, 32 Rep., p. 57. On ground in woods under hemlock trees. Lyndonville.

78. **Polyporus cinnabarinus** Fr. Pk. 22 Rep., p. 83. Cinnabar Polyporus. On old cherry tree branches. Ridgeway and Yates.

79. **Polyporus conchatus** Fr. Shell-shaped Polyporus. Resupinate form. Lyndonville.

80. **Polyporus elegans** Fr. Pk. 25 Rep., p. 109. On decaying logs in woods. Yates, Orleans Co.

81. **Polyporus fomentarius** Fr. Pk. 22 Rep., p. 82. On stumps and logs. Ridgeway. Not common.

82. **Polyporus griseus** Peck. Pk. 26 Rep., p. 68. Peck's Grey Polyporus. On ground in woods under hemlock trees. July, 1889, Lyndonville.

83. **Polyporus hirsutus** Fr. Pk. 22 Rep., p. 83. On dead trunks of trees. Hairy Polyporus. Common.

84. **Polyporus lucidus** Fr. Pk. 22 Rep., p. 82; 34 Rep., p. 57. Shining Polyporus. Varnished-stem Polyporus. Common in woods about old hemlock stumps. Lyndonville, Ridgeway.

85. **Polyporus perennis** Fr. Pk. 22 Rep., p. 82. On ground in woods. Lyndonville.

86. **Polyporus pubescens** Fr. On old stumps in woods. Not common. Lyndonville. Downy Polyporus.

87. **Polyporus sulphureus** Fr. On trunks of dead trees and stumps. Lyndonville. Sulphur Polyporus. Often forms large masses.

88. **Polyporus Vaillantii** Fr. Pk. 24 Rep., p. 79. Vaillants Polyporus. On twigs and logs. Uncommon and variable. Lyndonville, Ridgeway.

89. **Polyporus versicolor** Fr. Pk. 22 Rep., p. 84. Changeable Polyporus. On dead stumps. Common. Lyndonville, Carlton, Ridgeway, Orleans County.

MUCRONOPORUS Ellis and Everhart.

90. **Mucronoporus ignarius** (Fr.) E. and E. Pol. ignarius Fr. in Pk. 33 Rep., p. 36. Ridgeway, Orleans County.

91. **Mucronoporus ferruginosus** (Schrad.) E. and E. *P. ferroginosus* in Pk. 26 Rep., p. 70. Resupinate form on limbs of trees. Yates, Orleans Co.

PORIA Fr.

92. **Poria contigua** Fr. Under-side of rails on ground. Lake Shore, Yates, Orleans Co.

93. **Poria obducens** Pers. Pk. 30 Rep., p. 46. Hab. same as No. 92.

TRAMETES Fr.

94. **Trametes mollis** Fr. On dead branches in woods. Rare. Lyndonville.

DÆDALEA Pers.

95. **Dædalea Unicolor** Fr. Common on stumps, etc. Yates and Ridgeway, Orleans Co.

FAVOLUS Fr.

96. **Favolus alveolarius** (D C). Common on fallen branches, especially of Carya species.

American Mycologists are at variance in regard to the proper specific name of this fungus. In Bulletin Iowa Agric. Coll. Nov. 1884, p. 147 and Ellis N. A. F., No. 604, it is referred to *Favolus Europæus* Fr. While Morgan in Mycol. Flora Miami Valley refers it to *Favolus Canadensis* Klotzsch. The plant deserves therefore more than a passing reference. Stevenson (British Fungi, Vol. 2, page 227) gives the following description of the Genus :

" Favolus (favus-honeycomb) Fr. Elench, p. 44, Hymenium reticulate, cellular or alveolate. Alveoli radiating, formed of the densely anastomosing gills, elongated. Spores white (in pairs ?). Dimidiate, somewhat stipitate, fleshy, pliant. Annual, growing on wood, differing in entire appearance and structure from the preceding genera, wherefore they were formerly referred not to Polypori but to Cantharelli or Merulii, Fr. Hym. Eur., p. 590."

In Mycologic Flora Miami Valley, April, 1886, p. 5, Morgan describes our species and gives the following notes concerning it:

"*Favolus Canadensis* Klotzsch."

"Pileus fleshy tough, thin, reniform, fibrillose scaly and tawny, becoming pale and glabrous. Stipe eccentric or lateral, very short or obsolete. Alveoli angular, elongated, whitish; the dissepiments becoming thin, rigid and dentate, spores oblong, .012 by .007 m. m.

"In woods on fallen branches, especially of hickory. Common. Pileus 1–2½ inches in breadth, sessile or with a very short stipe. Specimens with an excentric stipe resemble *Polyporus lentus* Berk., but the pores are much larger than those of that species. This is undoubtedly the *Polyporus Boucheanus* Kl. of Lea's Catalogue, as is confirmed in the notices of Berkeley under No. 44; but Fries in the Novæ Symbolæ seems to indicate that these American forms are not his species and certainly the description in the Epicrisis does not apply to our plant. Specimens from New England gathered by me are glabrous or scantily fibrillose, and may be the *F. Alutaceus* B. and Mont.: they are no doubt what is meant by *Polyporus Boucheanus* Var. *peponinus* B. and C. in the Notices of N. A. Fungi under No. 44. The original description of Klotzsch was based upon a single specimen in the herbarium of Hooker, and it applies remarkably well to our plant, except that the pileus is sometimes lobed as in *F. Alutaceus* B. and Mont."

At this point it is interesting to compare the characters assigned in Epicrisis to the species mentioned, which are subjoined:

FAVOLUS EUROPÆUS.

"Pileo carnoso-lento tenui *orbiculari glabro* lævi albido, stipite brevi laterali, alveolis profundis subrotundis reticulatis. Merulius Alveolarius Dec. Fr. 5, p. 43. S. M., p. 322. In Gallia meridionali."

FAVOLUS CANADENSIS.

"Pileo carnoso-lento rigente reniformi *squamoso fulvo*, stipite obsoleto, alveolis elongatis tenuibus albidis, Klotzsch in Linn. VII, p. 197. In Canada."

POLYPORUS BOUCHEANUS.

"Pileo carnoso-lento, plano inæquali *lævi dein squamoso*, gilvo, stipite excentrico curto *tomentoso* deorsum fuscente, poris tenuibus demum *alveolaribus* oblongo hexagonis dentatis dilute aurantiacis, Klotzsch in Linn., VIII, p. 316. Ad truncos Betulæ Cfr. Favolus, cui adscripsit Klotzsch."

Mr. J. B. Ellis in lit., March 9, 1888, says: "I have specimens of Favolus from various parts of the U. S. and Canada, and they all seem to me to be the same thing, and Cooke, Saccardo and Winter, to whom I have sent specimens, all call it *Favolus Europaeus*, Fr. I suspect that F. *Canadensis* Klotzsch is the same thing, but I do not absolutely know it to be so." On the other side Professor Charles H. Peck writes me under date of Feb. 14, 1888: "We have two or three forms which have been referred by various persons sometimes to *F. Europæus or F. Canadensis*, and sometimes to *Polyporus Boucheanus.* One I think is *F. Canadensis* Kl., as does also Morgan. Kalchbrenner when living also took the same view."

Mr. John Macoun, Botanist of Canadian Geological and Natural History Survey, wrote me April 23, 1889, from Bunad Inlet, B. C.: "I collect two species of Favolus, one of them being *F. Canadensis.* As far as I am aware none grow on this coast." After a number of years of observation of the variety of forms which Favolus assumes as it grows here, and after comparison of specimens from other localities labelled Canadensis and Europæus I am unable to find any good characters to separate them. It is probable that the forms run together. I believe that the tawny variety often becomes bleached by exposure to the weather, and as a result we have a paler and glabrous form. Nor can I detect constant histological differences. The species is considered to be the same as *Merulius alveolarius* published by De Candolle in Flore Francais (from 1805 to 1815). *Favolus Europæus* was published in Fr. Epicrisis, 1836–1838. Hence I have restored the specific name alveolarius and call our specimens *Favolus alveolarius* (D. C.)

GLŒOPORUS Mont.

97. **Glœoporus conchoides** Mont. Pk. 30 Rep., p. 75. This is considered to be the same as *Polyporus nigropurpurascens* Schw. On fallen logs in woods. Yates, Orleans Co., March, 1886.

SOLENIA Hoffm.

98. **Solenia ochracea** Hoffm. Pk. 25 Rep., p. 83. Occurs

abundantly upon fallen branches of various species of Salix, Cornus, Tilia, etc., in woods, Lyndonville.

Family 3. HYDNEÆ Fr.

Hydnum L.

99. **Hydnum coralloides** Scop. Common on logs and branches in moist woods.

100. **Hydnum versipelle** Fr. Woods, Somerset, Niagara Co.

101. **Hydnum rufescens** Pers. In woods. Regarded by Fries as a variety of Hydnum repandens.

Irpex Fr.

102. **Irpex sinuosus** Fr. Pk. 30 Rep., p. 46. On dead twigs and branches, woods, Lyndonville.

103. **Irpex obliquus** Fr. Pk. 30 Rep., p. 46. Hab. same as preceding.

Grandinia Fr.

104. **Grandinia granulosa** Fr. In woods on fallen branches. April, Lyndonville.

Odontia Pers.

105. **Odontia fimbriata** Pers. Pk. 24 Rep., p. 80. On Maple bark, Yates, Orleans Co., May, 1890.

Family 4. THELEPHOREÆ Pers.

Craterellus Fr.

106. **Craterellus lutescens** Fr. Edge of thin woods, Yates.

Stereum Pers.

107. **Stereum fasciatum** (Schw.) Fr. Pk. 22 Rep., p. 81. On sticks in woods. It is doubtful if the species is really distinct from *Stereum versicolor* of which it is probably a mere form.

108. **Stereum striatum** Fr. Pk. 22 Rep., p. 86. This is the *Thelephora sericea* of Schweinitz. Common on fallen branches.

109. **Stereum albobadium** Schw. Pk. 24 Rep., p. 80. On wood in wood piles, Yates, Orleans Co.

110. **Stereum purpureum** Fr. Pk. 30 Rep., p. 75. On apple tree stumps, Lyndonville, April, 1888.

111. **Stereum complicatum** Fr. Pk. 22 Rep., p. 86. On old logs in woods, Ridgeway.

112. **Stereum radiatum** Peck. Pk. 26 Rep., p. 72. On Hemlock frames of cellar doors, Lyndonville, June, 1890.

HYMENOCHÆTE Lev.

113. **Hymenochæte tabacina** Lev. Pk. 22 Rep., p. 86. On dead limbs and branches, woods, Lyndonville. Our specimens appear to be the form described by Schweinitz as *Thelephora* (*Stereum*) *imbricatula*.

114. **Hymenochæte corrugata** Berk. On dead twigs, Yates, Orleans Co., May, 1890.

CORTICIUM Fr.

115. **Corticium incarnatum** Fr. Pk. 24 Rep., p. 80. Common everywhere on twigs and branches.

116. **Corticium salicinum** Fr. Pk. 24 Rep., p. 81. On twigs in woods, Yates, Orleans Co.

117. **Corticium livido-cœruleum** Karst. On limbs on ground in woods, April.

118. **Corticium alutarium** B. & C. On logs in woods, Ridgeway.

PENIOPHORA Cooke.

119. **Peniophora rhodella** (Peck) Sacc. Sacc. Syll. Fung., Vol. IX, page 239. Corticium Peck in 42 Rep., p. 28. The original specimens sent to Prof. Peck and upon which he founded the species were found on the inner surface of bark lying on ground in woods, Lyndonville, N. Y.

CYPHELLA Fr.

120. **Cyphella pezizoides** Zopf. On dead branches of basswood (Tilia.) Peck refers our specimens to *Cyphella Tiliæ*.

Family 5. CLAVARIEÆ Corda.

CLAVARIA Vaill.

121. **Clavaria aurea** Schæff. On ground in woods, late autumn, Yates, Orleans Co.

Family 6. TREMELLINEÆ Fr.

Exidia Fr.

122. **Exidia glandulosa** Fr. Pk. 22 Rep., p. 88. On small twigs on ground in wet places in the woods. Also occurs on *Rhus toxicodendron* branches, Yates and Ridgeway, Orleans Co., April, May.

123. **Exidia albida** (Huds.) Bref. On moist stumps, Ridgeway.

Tremella Dill.

124. **Tremella mesenterica** Retz. Pk. 22 Rep., p. 88. Common on moist hemlock stumps.

Dacryomyces Nees.

125. **Dacryomyces deliquescens** Dub. Common on wet fences in early spring or in a wet season.

126. **Dacryomyces fragiformis** Nees. On wood in piles in moist places, August, 1886, Lyndonville.

August 22, 1892.

SPECIAL MEETING.

Held in Music Hall, Y. M. C. A. Building, Complimentary to the American Association for the Advancement of Science.

The President, Professor H. L. Fairchild in the chair.

Mr. Grove Karl Gilbert of Washington, D. C., gave an address upon

COON BUTTE AND THE THEORIES OF ITS ORIGIN.

The lecture was illustrated with lantern views, and a relief map of the volcanic crater.

OCTOBER 10, 1892.

STATED BUSINESS MEETING.

The President, PROFESSOR H. L. FAIRCHILD, in the chair.

Forty-six persons present.

The Council report recommended the payment of certain bills, which by vote were ordered paid.

The resignation of the Secretary, DR. P. MAX FOSHAY was accepted, and a committee consisting of Reverend C. B. Gardner, Dr. J. E. Line, and Professor Charles W. Dodge, was appointed to draft resolutions of regret, who reported later as follows:

"As we have been called upon to receive the resignation of our worthy Secretary, Dr. P. Max Foshay, on account of his removal from the city, we cannot let acceptance of it pass without an expression of our sincere regret at the loss of so faithful and efficient a Secretary and so valuable a member of our Academy. Dr. Foshay having performed the principal part of the work of preparing our proceedings for publication, and furnished one of our most valuable scientific papers has merited our hearty thanks for his labor, and an expression of our appreciation of his success. We wish that he may be equally useful and acceptable elsewhere."

The report was unanimously adopted.

A letter from Professor F. C. Chamberlain of the Chicago University was read, soliciting contributions of the proceedings of the Society.

The following resolution was adopted :

Resolved:—That the hearty thanks of the society be extended to Mr. G. K. Gilbert for his lecture of Aug. 22, in Music Hall, under the auspices of the Society and complimentary to the American Association for the Advancement of Science.

Miss Beckwith announced that Mr. Gilbert Van Ingen, formerly of Cornell University, now of Yale University, had presented to the Academy a second collection of plants for the herbarium, consisting of 550 specimens, representing 335 species ; many being rare, and the collection as a whole being one of great value. 64 species embracing 117 specimens are new to our herbarium.

MR. F. D. PHINNEY, gave an interesting description of

BURMA, ITS LANGUAGE AND PEOPLE.

A vote of thanks was extended to Mr. Phinney.

OCTOBER 24, 1892.

STATED MEETING.

The President, PROFESSOR H. L. FAIRCHILD, in the chair.

Sixty persons present.

PROFESSOR H. F. BURTON read a paper on

BUILDING MATERIALS AND METHODS OF CONSTRUCTION EMPLOYED IN ANCIENT ROME.

The paper was illustrated with samples of the rock and other building materials.

NOVEMBER 14, 1892.

STATED BUSINESS MEETING.

The President, PROFESSOR H. L. FAIRCHILD, in the chair.

About fifty persons present.

The Council report recommended :

(1.) The election of MR. GILBERT VAN INGEN, as corresponding member.

(2.) The election of MISS HARRIET B. STARK, MR. A. W. LAWTON, DR. EVELINE P. BALLENTINE and MR. ELON HUNTINGTON, as active members.

(3.) The payment of certain bills.

The candidates for active membership were elected as recommended and the bills ordered paid. The election of the corresponding member went over under the rules.

In pursuance of a notice given at a previous meeting for the election of a Secretary, PROFESSOR ARTHUR LATHAM BAKER was elected Secretary.

REV. JOHN WALTON reported progress toward the completion of the collection of Mollusca presented to the Academy.

The President exhibited, with a descriptive commentary,

LANTERN VIEWS OF MEXICO.

DECEMBER 12, 1892.

STATED BUSINESS MEETING.

The President, PROFESSOR H. L. FAIRCHILD, in the chair.

A small number of members present.

The Council report recommended that the Secretary assume the clerical duties of the Treasurer, and receive an annual compensation of $200.

Action was deferred until next meeting.

The President introduced MR. HEINRICH RIES, of the New York State Geological Survey, who gave a short talk on

THE CLAYS OF NEW YORK STATE.

MISS FLORENCE BECKWITH read the following paper:

VARIATION OF RAY-FLOWERS IN RUDBECKIA HIRTA.

The first and principal variation to which attention is called is that of dark marks at the base of the ray-flowers. (See plate 11.)

In the summer of 1891, I found in a field, in the town of Gates, near Rochester, a few blossoms of *Rudbeckia hirta*, *L*, which differed from the normal type (fig. 1) in having a band of dark color at the base of the rays. This variation had never before been noticed by any of the members of the Botanical Section or by other local botanists to whom the flowers were shown. In 1892 the same field was again visited and more blossoms showing the same variation were found. This season a number of flowers with different markings were gathered, and these specimens seemed to form a well marked series. In some (fig. 2) there were only faint lines, like pencilings, at the base of the rays; in others (fig. 3) the lines were heavier and darker, the center line sometimes extending from the base to the apex of the ray; others showed small brown spots at the base; the rays of some of the heads (fig. 4) were all more or less shaded with brown; some (fig. 5) showed a band of orange; and at last the series culminated in specimens (fig. 8) in which the band at the base of the rays was as distinct and as dark in color as in *Coreopsis*. As the band grew more distinct in color the flowers decreased in size, those showing the darkest coloring being not much larger than the blossoms of *Coreopsis*. This observation corresponds to what may be seen in some other genera of the Compositæ.

PLATE II.

Rudbeckia hirta L. showing variations in color.

1. Flower of normal yellow types.
2. Flowers with faint lines like pencilings at the base of the rays.
3. Rays with heavier lines at the base and one line extending from the base to the apex.
4. Rays shaded with brown.
5. Rays with a distinct and heavy orange band at the base.
6. A deepening of the normal yellow color at the base of the rays forming a dingy, yellowish brown band.
7. A light brown band at the base of the rays.
8. A full band of deep brown at the base of the rays.

Beckwith—Rudbeckia hirta.

The dark-banded flowers of both *Coreopsis* and *Gaillardia* are smaller than those of light color.

In a field about one-fourth of a mile distant from the first one visited, I found in 1892 a few blossoms showing faint pencilings on the rays, such as have been described, but none with a complete dark band.

Flowers showing an orange-colored band were reported in the fall of 1891, in "Meehans' Monthly," as having been noticed for the first time in the vicinity of Boston and Philadelphia.

If the plant has ever shown this variation before, it is strange that it has not been noted and reported, and it is equally strange if it has only recently taken this new departure. In a somewhat extended search in other directions around Rochester I have failed to find any other specimens than those of the normal type.

Another variation worthy of notice, is that flowers of the normal yellow color have been found with two or more circles of ray-florets, giving the appearance of so-called semi-double blossoms; these were also found in the same fields.

Specimens showing the variations which have here been described, have been placed in the herbarium of the Academy.

Professor Henry A. Ward showed a meteorite which he had recently received from Japan, from the village of Kesen, and read the following paper:

PRELIMINARY NOTICE OF A NEW METEORITE FROM JAPAN.

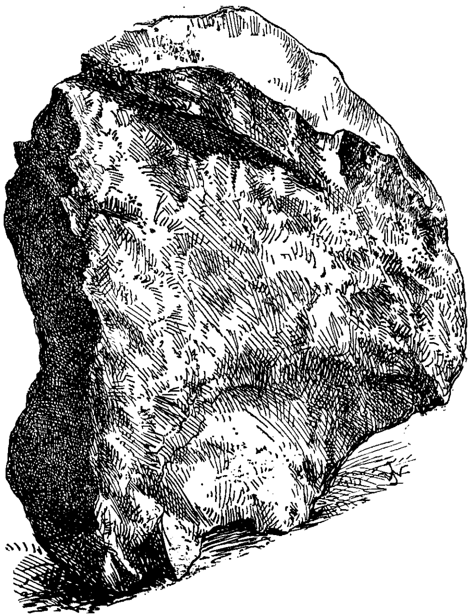
By Professor Henry A. Ward.

Several months ago a friend, Mr. Alan Owston, who had been traveling in the interior of the main island of Japan, told me that he had seen what he thought to be a stone meteorite in a temple of Iwate. As the result of considerable correspondence this specimen has been sent to me, reaching me early in December. It was accompanied by a letter in Japanese language of which the following is a translation:

"This meteorite which I send you herewith fell about forty years ago, viz: in the 3d year of Ka-yei, at dawn on the 4th day of the 5th month, (13th June, 1850). It fell obliquely from the W.N.W. with a great sound like thunder, at the village of Kesen in the district of Kesen in this Prefecture. It entered the ground five feet, and remained hot for two days. The original size was said to be about equal to 2½ sho of rice. This would be about 1½ cubic feet. There were ten or more pieces of it which have been distributed about in various places.

(Signed) SATO KENJI, of Nota village, Iwate Prefecture."

The specimen which I have received is 6$\frac{1}{16}$ ounces in weight. Its shape is an irregular triangle about 6½ inches in its greatest (vertical) diameter, and about 5 inches thick (see figure). Two long patches an inch wide on either side of the mass are covered with crust; the rest is



KESEN METEORITE, TWO-THIRDS NATURAL SIZE.

broken surface, showing inner structure. The crust has the usual characteristic pittings, very clearly indented, yet shallow. It is of a dull blackish brown color, with a pebbled or grained appearance. Close examination shows numerous shining metallic points, apparently of iron, with reddish stains, doubtless due to the oxidation of these. This surface shows clear signs of fusion; but there is no *flow* of the melted part, which might give clue to the direction of flight of the mass. The interior shows no signs of arrangement either in planes or concentric. There are several short fine fissures or fractures from one and a half to two inches in length, some of which reach to the lower side of the surface. They are not parallel, and they were doubtless caused by the shock of reaching the earth. One inner face however seems a little smoothed, as if prior to the breaking off of the contiguous piece there had been a sliding of surfaces. This stone is eminently chondritic. There is a fine-grained paste, and through it are distributed little rounded grains. Both the matrix and the grains are of the same material,—the minerals olivene and enstatite. This is all that is visible to the naked eye. But an ordinary low power lens shows many bright metallic points. Also glossy, waxy pimples of red color, perhaps an effusion of chloride of iron. Some larger blotches of iron rust occur here and there. In determining the metallic portion of the meteorite (whith has been done by Mr. John M. Davison of the Reynolds Laboratory of the University of Rochester), pieces of the mass were finely crushed and the metal separated by the magnet, washed in alcohol aud dried rapidly. Its weight having been taken, it was dissolved in nitric acid, and a little insoluble stony matter was separated, weighed and deducted from it. A mean of two determinations made in this way gave the metallic proportion about 16 per cent. of the whole mass. This is an unusual per cent. of metal,—much more than in the Waconda, which stone resembles in some respects the Kesen,—which we now name this new meteorite from Japan.

We are expecting to soon receive some other pieces, which may give new facts; and also a fuller examination of the mineral constituents—metallic and non-metallic,—will be made ere long.

Professor Ward formally christened the meteorite the "Kesen Meteorite," and gave a short description of the peculiar features of meteorites, particularly the plasmagraphs or mould marks, illustrated by the specimen before the Academy.

A general discussion followed, which was participated in by many of those present.

JANUARY 9, 1893.

FOURTEENTH ANNUAL MEETING.

The President, PROFESSOR H. L. FAIRCHILD, in the chair.

Thirty-four persons present.

The Council report announced the appointment of the following Curators: MR. J. B. FULLER, Curator in Botany; MR. SHELLEY G. CRUMP, Curator in Conchology; PROFESSOR ALBERT L. AREY, Curator in Geology, and recommended:

(1.) The payment of certain bills, and

(2.) The election of MISS CAROLYN D. WOOD, as an active member.

The appointment of Curators was affirmed, the bills were ordered paid and the candidate elected by formal ballot.

The Annual Reports of the officers and sections were presented as follows:

SECRETARY'S REPORT.

The report of the Secretary, PROFESSOR A. L. BAKER, is summarized as follows:

During the past year eighteen meetings have been held.

Sixty-six active members, one honorary member and one life member have been elected. Sixteen members have been made fellows.

The total membership is:

Honorary members	10
Corresponding members	33
Active members	155
Fellows	40
Life members	1

Nineteen papers have been read, classified as follows: Geology, three; Meteorology, four; Botany, two; Ethnology, one; Mathematics, one; Zoölogy, one; Petrography, one; Archeology, one; Geography, two; Physiography, two; Paleontology, one.

Six lectures have been given, classified as follows:—Botany, two; Geography, one; Psychology, one; Geology, one; Paleontology, one.

Report of Corresponding Secretary.

The Report of the Corresponding Secretary was in his absence, read by the Secretary, as follows:

During the past year the work of the Corresponding Secretary has consisted mainly in distributing the Proceedings and receiving acknowledgments and exchanges in return. Of the last Brochure one hundred fifty-two (152) copies have been sent to active members, thirty-three (33) copies to corresponding members, and nine (9) to honorary members. In exchange for publications received from other scientific bodies, institutions of learning, libraries and investigators, one hundred forty-one (141) copies have been distributed in the United States and Canada, and two hundred ninety-six (296) have been sent to various places in Europe, Central and South America, Asia, Africa and Oceanica.

Applications for copies of the proceedings are frequently received from dealers in scientific publications and from libraries and societies not upon the exchange list.

Foreign exchanges are sent through the Smithsonian Institution with no other expense to the Academy than the railroad charges. The cost of distributing six hundred thirty-one (631) copies of the last Brochurė will be about twenty-five dollars ($25.00).

Respectfully,

Charles Wright Dodge,
Corresponding Secretary.

Treasurer's Report.

The Treasurer, Mr. J. Eugene Whitney, presented his report, of which the following is a summary:

Balance on hand, January, 1892	$144 52
Receipts during the year	651 00
Total	$795 52
Disbursements during the year	460 71
Balance on hand	$334 81

Number of members in arrears for dues, 23.

Librarian's Report.

The Librarian would respectfully offer the following report :

Number of bound volumes received during 1892,	10	
Number of pamphlets	572	
Total accessions for the year		582
Number of bound volumes in library	92	
Number of pamphlets	1511	
Total number of titles		1603

Mary E. Macauley,
Librarian.

Report of Botanical Section.

Read by Mrs. J. H. McGuire, Recorder of the Section.

The officers of the Society are : Miss Mary E. Macauley, President; Miss Florence Beckwith, Vice-President ; Mrs. J. H. McGuire, Recorder.

Extracts from the Minutes of the Section.

February 5, 1892. Over twenty-five specimens of Conifers were exhibited. Of these, a few were native, the remainder cultivated. Branches of ten species of Cornus were also examined.

February 26, 1892. The study of Conifers was continued.

Mrs. E. L. Maguire showed a number of pressed specimens of Western plants.

Dr. Searing showed pressed specimens of *Bryophyllum*, *Berberis a quifolium*, *Erigenia bulbosa*, *Mentzelia ornata*, and *Sarcodes sanguinea* the snow plant.

March 11, 1892. Mrs. King showed twigs of *Paulownia imperialis*, having buds, and last year's fruit.

Miss Beckwith exhibited seeds (mounted) of this tree, which were examined with the microscope.

Miss Macauley showed pods and seeds of Catalpa.

The subject of Conifers was resumed and the causes of the variations in the size of leaves of the same species, were discussed.

Miss Beckwith stated that Prof. Dudley had offered to the Academy, for the herbarium, such specimens of grasses, sedges and willows, as might be lacking to complete the list for this region.

Mr. Joseph B. Fuller proposed to present to the Academy his collection of unmounted specimens of plants, representing over nine hundred species, some of which are now extinct in this locality.

March 25, 1892. Microscopical studies.

Mr. Dumond exhibited *Bacillus subtillus* of twenty-four hours' growth. The bacteria were obtained from a boiled infusion of hay, planted on the inner surface of a cooked potato. Mr. Dumond stated that he had found them highly motile, but when exhibited to the class no motion was seen. Mr. Dumond also showed specimens of Oscillaria. In addition to the common forms, were some in the form of a spiral coil, narrowing from the base to the top, like a cone.

April 8, 1892. The subject of study was the red and the white Maples.

Mr. Fuller stated that he had found *Acer rubrum* with yellowish petals.

Mr. Fuller showed a specimen of *Ulmus racemosa*. Blossoms of *Sanguinaria Canadensis*, and *Hepatica* were shown.

April 22, 1892. Among the numerous Spring blossoms shown, were typical specimens of *Hepatica triloba* and *H. acutiloba*, showing the difference in the species in a marked degree.

Mr. Laney exhibited a number of willows, a large and interesting collection of branches of California shrubs, and a large cone of *Pinus ponderosa*.

Miss Beckwith exhibited a collection of plants from Tennessee among which were *Rhododendron nudiflorum, and R. viscosum*, *Houstonia cærulia*, *Anemonella thalictroides*, *Cornus Florida*, *Æsculus glabra*, and *Æ. flava*, *Cercis Canadensis*, *Hepatica triloba*, and berries of Smilax *bona-nox*. These were especially interesting as showing the earlier blossoming in that latitude.

May 6, 1892. Mr. Fuller reported finding *Ranunculus fascicularis* April 27.

Mr. Laney reported that Mr. H. B. Brown had found one specimen of *Daphne Mezereum* in Seneca Park. Also, that *Amelanchier Canadensis* was now in blossom.

May 20, 1892. Mr. Fuller exhibited specimens of *Lamium maculatum*, (cultivated) and *L. amplexicaule*, (native) comparing and noting the existing differences. Among the very large number of plants examined were, *Chrysosplenium Americanum*, and *Lycopodium lucidulum*.

June 3, 1892. Mr. Fuller exhibited specimens of leaves of Maple, showing the differences between the red and the white varieties.

Mrs. King showed *Erigeron Philadelphicus*, *Lathyrus ochroleucus*, and a leaf of *Hepatica*, having an extra lobe.

Miss Beckwith showed a pressed specimen of a double *Trillium*, found in Agate, Lewis Co., Washington.

A number of leaves of different species of oaks were examined.

A number of flowers were also examined, among which were, *Habenaria bracteata*, *Castilleia coccinea*, *Viola striata*, *Polygala paucifolia* and *Staphylea trifolia*.

In microscopical studies, Mr. Streeter exhibited some very fine specimens of *Euglena*, and a species of *Oscillaria*, having a brown color, and not heretofore exhibited in the Section.

June 17, 1892. An excursion to Bergen on the eleventh inst., was made by the members of the Section.

They reported having found forty-eight species. Among those most worthy of notice were: *Listera cordata*, *Arethusa bulbosa*, *Habenaria Hookeri*, *Cypripedium spectabile*, *C. candidum*, *C. parviflorum*. *C. pubescens*, *Linnæa borealis*, *Pyrola chlorantha*, *Vaccinium stamineum*, *Ledum latifolium*, *Quercus bicolor*, *Gaylussaccia resinosa*, *Asclepias quadrifolia*, *Triglochin maritima*, *Sarracenia purpurea*, *Acer spicatum*, *Smilacina bifolia*, *S. trifolia*, *S. stellata*, *Trientalis Americana*, *Myrica Gale*, *Polygala paucifolia*, *Medeola Virginiana*, *Valeriana sylvatica*, *Mitella nuda*, *M. diphylla*, *Coptis trifolia* in fruit, *Lonicera oblongifolia*, *Aphyllon uniflorum*, and the unnamed variety of *Salix lucida* referred to by Professor Dudley in the "Cayuga Flora."

Among other plants exhibited were, *Eriophorum polystachyon*, *Oryzopsis Canadensis*, *Potentilla fruticosa*, and *Senecio aureus*, *var. Balsamitæ*. A collection of dried grasses from Dutchess County was also shown.

July 1, 1892. Mr. Laney showed a large variety of cultivated flowering shrubs.

Mr. Fuller showed specimens of *Pentstemon lævigatus* found at Pittsford.

Miss Macauley exhibited a rose found growing in this city, with stem extended through the flower bearing a bud on the summit.

Miss Beckwith exhibited a spike of *Digitalis lanata*, found near Canandaigua.

Mrs. Kempe showed *Leucanthemum vulgare*, having tubular ray-flowers, found in Greece. These daisies were found by Mrs. Kempe in the same locality in 1889, and are similar to specimens sent to the

Academy from Poughkeepsie by Mr. Gilbert Van Ingen. In the appendix of Gray's 5th edition, such abnormal growths are mentioned.

Dr. Searing exhibited a number of pressed specimens of Cypress, and other California plants collected by her on her recent trip to that State.

July 29, 1892. Miss Beckwith exhibited an interesting series of *Rudbeckia hirta;* beginning with the usual type, the series showed a tendency to variation in color at the base of the rays, the first having slight marks at the base, others a deeper hue, until a complete ring was shown, which in the last one was as conspicuous as the dark band of *Coreopsis*. A letter from Mr. Thomas Meehan, of Philadelphia, to whom Miss Beckwith had sent specimens was read.

Miss Beckwith exhibited specimens of *Rhododendron maximum* from the vicinity of Buffalo, and *Moneses uniflora*, collected in Irondequoit, near the Sea Breeze, by Warner W. Gilbert, and not before brought to the Section.

Miss Macauley reported that she had found *Moneses* for the first time, also near the Sea Breeze.

Miss Beckwith also showed the ordinary *blue Brunella*, and two specimens of unusual colors, one pink, the other white.

August 12, 1892. Miss Beckwith reported the arrival of a collection of plants for the Academy from Mr. Gilbert Van Ingen. This collection comprises 550 specimens of 335 species.

September 23, 1892. Among a large number of plants examined were *Gentiana crinita*, *G. Andrewsii*, and *G. quinqueflora*.

October 7, 1892. Mr. Fuller showed a specimen of *Campanula rotundifolia*, having the cluster of round leaves at base, and which also showed the gradual change to *lanceolate;* also, *Cratægus tomentosa*, *C. Crus-galli* and *C. punctata*, red and yellow fruited.

Dr. Searing showed a cone of Sugar Pine from Yosemite Valley, Cal. This cone was over a foot long.

October 21, 1892. Mr. Dunbar showed plants of *Sarracenia purpurea;* also, *Andromeda polifolia*, *potentilla fruticosa*, *Lycopodium clavatum*, *Cassandra cucullata*, *Abies nigra* and others from Mendon Ponds. Mr. Dunbar also showed a number of specimens of Evergreens from the estate of Charles A. Dana on Long Island, who is said to have the finest collection of these trees in this country.

December 2, 1892. Mr. Dunbar exhibited *Cnicus laciniata* and several species of cultivated Japanese plants.

December 16, 1892. Professor Lennon exhibited pressed specimens of *Trifolium procumbens*, just introduced this year in Brockport; also, *Potentilla recta*, and a new unnamed Vetch.

Mr. Dunbar showed pressed specimens of *Calamintha glabella*, gathered at Niagara Falls, and berries of *Smilax rotundifolia*, and various shrubs from foreign countries.

Mr. Laney reported a new station for *Rhododendron maximum*, it having been discovered in Penfield, by Mr. James H. Brown. This is justly regarded as a very important discovery, for the station is decidedly north of its usual habitat. A few stations are known near Buffalo, and only about twelve in the entire state.

December 30, 1892. Mr. Fuller showed pressed specimens of leaves of *Rhus juglandifolia* and *Juglans nigra*, noting differences.

Report of Curator in Botany.

During the year 1892 there were added to the herbarium of the Academy a small collection of Ferns from the Island of St. Helena, the gift of Lieutenant Commander Franklin Hanford, U. S. N.; a collection of about 2,500 specimens from Mr. Joseph B. Fuller; and two collections, numbering in all over 500 specimens from Mr. Gilbert Van Ingen of Poughkeepsie. Through the kindness of Dr. Daniel G. Hastings of this city, we have also been recently favored by the gift of a part of the herbarium of the late Dr. Samuel G. Bradley, of West Greece, who was one of the early botanists of this section of country, and who is often quoted as an authority on the flora of this vicinity. This herbarium, though dating back in part to 1843 is in a very good state of preservation, and will not only be very valuable to us for comparison, but will also enable us to add some to the list of our native flora. There are about 250 specimens in this collection.

There are now in the herbarium, including Dr. Bradley's collection, about 5,000 specimens, over 2,100 of which are regularly mounted and labeled.

The collections given us have added many species new to the herbarium.

Florence Beckwith,
Curator in Botany.

Mr. Gilbert Van Ingen of Yale University, was elected a corresponding member.

It was voted that the Secretary be paid a salary of $200.

ELECTION OF OFFICERS.

The following officers were elected for the ensuing year:

President, HERMAN L. FAIRCHILD.
First Vice-President, J. M. DAVISON.
Second Vice-President, M. L. MALLORY.
Secretary, ARTHUR LATHAM BAKER.
Corresponding Secretary, CHARLES W. DODGE.
Treasurer, J. EUGENE WHITNEY.
Librarian, MISS MARY E. MACAULEY.
Councillors, { H. L. PRESTON. F. W. WARNER.

In the absence of the author the following paper was read by the President:

ESKERS NEAR ROCHESTER, N. Y.

A DISCUSSION OF THE STRUCTURE AND ORIGIN OF THE PINNACLE HILLS.*

BY WARREN UPHAM.

CONTENTS.

THE AREA SPECIALLY STUDIED.

On the southeastern border of Rochester, N. Y., a remarkable esker series, named the Pinnacle hills, extends nearly four miles from east-northeast to west-southwest, rising from an approximately level country and forming the only conspicuous elevations of land close to that city. Under the guidance of Mr. G. K. Gilbert, this esker was examined by most of the geologists who attended the meetings of the Geological Society of America and of Section E of the American Association for the Advancement of Science in Rochester last August, and on the following morning about an hour was

*This paper was originally prepared for and read at the Ottawa meeting of the Geological Society of America, December 29, 1892.

given to discussion of the manner of its formation through the agency of the ice-sheet and the streams produced by its melting. Before stating some of the opinions brought out in that discussion, and attempting a full inquiry concerning the processes of accumulation of this and other eskers and kames, we will first go again, as I did on following days, over the Pinnacle hills and describe their contour and numerous sections exposed by excavations for road material and for the passage of streets. The other drift deposits and contour of their vicinity will be noted, and a second series of eskers lying several miles farther southeast in Pittsford, which I also examined, will be described, with their relationship to prominent drumlins near, and to terminal moraines more remote, on the south.

Description of the Pinnacle Hills.

From Brighton village and station on the New York Central railroad, three miles southeast from the station in Rochester, this prominent range of hills extends in an almost straight course about four and a half miles west-southwesterly to the Genesee river close south of the State dam. In passing the east end of this esker, the Erie canal turns from a due east to a due south course. Along its first mile from Brighton the esker rises 75 to 150 feet above the country on each side, and declines in height from 125 to 75 feet near the western end of this portion, where it is known as Cobb's hill. Immediately to the west, near the residence of Mrs. W. H. Cobb, a sag in the esker, as it was originally, before being cut down for the extension of Monroe avenue, had a height of only about 50 feet. Next westward the esker rises in the distance of a half mile to its highest point, called the Pinnacle, 200 feet above the nearly plain region on the north and south. Thence the continuation of the esker along its next two miles, varying in altitude mainly from 150 to 100 feet above the general level, is occupied, in order from east to west, by the St. Patrick Cemetery, the Highland Park, which includes the Mt. Hope reservoir in its western part, and the extensive Mt. Hope Cemetery. In its next mile west to the river, the ridge is lower, having a height of only 80 to 50 feet above the State dam. The northeastern end of this hill range at Brighton is very definite, overlooking a wide expanse of the low land; but its western end is indefinite, for in the line of its continuation west of the Genesee it is represented along a distance of at least two miles (which is as far as my examination extended) by a low ridge, mostly 30 to 40 feet above the general level. Between the Mount Hope Cemetery and the Genesee river and farther to the west, the material of the ridge is largely till, which shows that low portion to be a marginal or interlobate moraine; but the high range of the Pinnacle hills from Brighton to the Mt. Hope Cemetery is clearly an esker, 3½ miles long, consisting of interbedded gravel and sand, here and there enclosing boulders, sometimes in surprising abundance, but containing no till in the extensive sections nor on its surface.

The width of this hill range is mostly about a sixth of a mile, but varies from a tenth to a half of a mile. Along its whole extent it is a single range, nowhere presenting a combination of parallel series of hills; but, in some parts, especially in the Highland Park and near the reservoir, it is incised on each side by ravines between spurs and outlying hillocks of the main belt, and its top is occasionally very uneven in contour, with infrequent bowl-shaped hollows 10 to 50 feet below the surrounding surface. The profile of its crest line undulates in an irregular way, generally varying 50 to 100 feet in height upon each mile or half mile; and it nowhere maintains a level course for any considerable distance. In the vicinity of the Pinnacle and in many other places, the slopes on each side are very steep, ranging to a maximum of about 30 degrees; and the crest line has occasional slopes of half this steepness. More commonly, however, the slopes vary from 6 to 15 degrees, having from 10 to 25 feet of ascent in a distance of 100 feet.

When my first contribution to geology was published, sixteen years ago, "On the origin of Kames or Eskers in New Hampshire," (1) these classes of the modified drift, produced jointly by the ice-sheet and the water of its melting, had not been discriminated from each other. Every knoll, hillock or hill, short or long ridge, or series or network of ridges composed of irregularly and often anticlinally bedded gravel and sand, retaining nearly the original form in which it was accumulated, was then called interchangeably a *kame*, *esker*, or *as*, or a series of *kames*, *eskers*, or *asar*. The first of these terms is of Scottish, the second of Irish, and the third of Scandinavian origin, the last being Anglicized to *osar*, with *osars* as its plural form. It is found very desirable, however, to subdivide these gravel and sand accumulations into two classes, as proposed by McGee (2) and Chamberlin, (3) giving to the hillocks and short ridges the name

(1.) Proc. A. A. A. S., Vol. XXV, for 1876, pp. 216–225.
(2.) Report of the International Geological Congress, second session, Boulogne, 1881, p. 621.
(3.) U. S. Geological Survey, Third Annual Report for 1881–82, p. 299; Am. Jour. Sci., III, Vol. XXVII, 1884, p. 389.

kames, while the prolonged ridges are termed *eskers* or *osars*, excepting their peculiar development in northeastern Iowa, where they are composed chiefly of loess or fine silt and have received the name *paha*, alike whether singular or plural. (1) Kames, as thus defined, usually or often constitute an important part of the terminal moraines, and they are also frequent on many other portions of our drift sheet. Eskers are found likewise both in the vicinity of terminal moraines, sometimes being evidently of closely contemporaneous origin, and also remote from moraine belts. In length the eskers or osars vary from a mile or less to several miles, and in Maine and Sweden they extend in many continuous series, 20, 50, and even 100 miles or more. Their courses are commonly somewhat crooked, like those of rivers, but in general they run in parallelism with the glacial striæ and directions in which the ice-sheet moved and carried its boulders and other drift.

The structure of the Pinnacle hills esker is well exhibited near its northeast end, near Monroe avenue, and at various places separated only by short intervals, thence westward to Mt. Hope avenue and cemetery, by excavations for the use of its gravel and sand in road-making and masonry. Less than a quarter of a mile south of Brighton, a cut on the northern slope of the east end of the esker, just east of the north to south road (Arbutus avenue), has a depth of about 30 feet and length of some 12 rods. The upper 10 feet are fine gravel and sand, almost levelly bedded, beneath which the remainder of the section consists of very coarse but distinctly stratified gravel, with a nearly uniform dip of 15° W. S. W. This coarse gravel contains cobbles and rock fragments of all sizes, up to 1½ feet in length, packed closely together, their interstices being filled with finer gravel, sand, and very fine silt. About two thirds of all the stones are much water-worn, so as to have rounded forms; nearly all of the remaining third are somewhat worn, being subangular; and only about a twentieth part are rather sharply angular, with little or no evidence of attrition in their transportation by the glacial river. Fully half of the small gravel, up to six inches in diameter, are Medina sandstone; and about a third of the cobbles and masses from 6 to 18 inches in diameter are Archæan gneissoid rocks. Only four boulders of larger size, none of these exceeding four feet in diameter, were seen in this section.

Close west of this road, nearly opposite to the foregoing and at a distance of 10 to 30 rods southwest from it, a larger excavation,

(1.) W J McGee, "The Pleistocene History of northeastern Iowa," in the Eleventh Annua Report of the U. S. Geol. Survey, for 1889-90.

also in the northern side of the esker, consists almost wholly of fine gravel and sand, with stratification mostly inclined 5° to 20° southward. This section, 30 to 40 feet deep, and the surface of the esker immediately adjoining it, have only very rare boulders; but within a short distance the southern slope of the ridge, where it is cut for the road, has many boulders on the surface and in the upper 10 feet of the gravel and sand. The rather broadly rounded top of the esker is here about 80 feet above the general level on the north, east and south. In its central part, 25 feet below the top and some 20 rods from its northern base, a small space of this section, 10 feet long and 6 feet in height, shows three sharp faults, each having 2 to 3 feet of displacement, with overthrust from south to north. The beds overlying the faulted portion, which was near the bottom of the excavation, and the continuations of the faulted layers away from this place on each side, were undisturbed, dipping 10° to 15° S. or S. S. W. Fifteen to 40 feet east from these faults, slightly higher beds show eight repetitions, within a thickness of 8 feet, of layers of gray gravel, 3 to 12 inches thick, separated by layers of fine yellow sand 1 to 3 inches thick. These alternations probably represent the rapid and strong currents of a glacial river during the fast melting of the ice surface by day and the slow currents at night, when ablation was at its minimum or ceased.

Another large excavation 300 to 500 feet west of the last, likewise in the northern side of the esker, has a vertical face of 40 to 50 feet, consisting of interbedded gravel and sand in its upper half, while its lower half is mostly sand. The largest cobbles in the gravel are about one foot in diameter, and no boulders were observed. Mainly the dip is 10° to 20° southward, but at the east end of this section its upper 10 to 15 feet are much contorted, with a prevailing northerly dip of 10° to 15°.

In the southeastern side of the esker, opposite to Mrs. W. H. Cobb's house, an excavation about 25 rods long and 50 to 60 feet high consists in its upper part, to a depth of 6 to 20 feet from the surface along its whole extent, of sand and very coarse gravel enclosing exceedingly abundant boulders of all sizes up to 6 or 8 feet in diameter, far more plentiful than in the ordinary till of this region. Below this portion, the remainder of the section, extending downward 30 to 40 feet, is irregularly interstratified gravel and sand, with only infrequent boulders. The whole section shows stratification by currents of water, and according to my estimate nineteen twentieths of the gravel and small rock fragments are rounded or at least much worn on their edges and corners.

Other sections which were examined in our excursion on the northern slope of the esker near this place and about a quarter of a mile to the northeast, show the same astonishing profusion of boulders with the upper coarse gravel, underlain by beds having fewer boulders. The gravel and sand are characterized by irregular and often oblique bedding, variable thickness of individual layers, and occasional oblique or nearly vertical faults with small amount of displacement (1). Boulders are also strown in considerable numbers on the surface of this part of the esker, but elsewhere along most of its extent they are usually rare both on the surface and in excavations. Mr. Gilbert called attention to the origin of the boulders, and pointed out the very significant fact that many of them are of the Niagara limestone, which can have been transported no more than three or four miles from its parent ledges, since the northern limit of this formation lies within that distance. Some of these boulders were seen on or near the Pinnacle, at least 200 feet above the outcrops on the plain country northeastward from which they must have been derived.

Continuing over the Pinnacle and through the Highland Park, I examined numerous sections, all of which were interbedded gravel and sand with only very rare boulders or more commonly none. Occasionally, however, a boulder 5 or even 10 feet in diameter is found on the surface, or in a section, remarkably in contrast with the water-deposited sand and gravel, in which the largest pebbles and cobbles range from a few inches to a foot, or seldom one and a half feet in diameter. From the Pinnacle to the Mount Hope cemetery, most of the excavations are chiefly sand.

The cut made west of this cemetery by a branch of the New York, Lake Erie & Western railroad has a length of nearly a quarter of a mile from north to south and is from 15 to 25 feet deep. Large portions of this section are true till, or clay, sand, and small and large rock fragments, mingled in an unstratified deposit; but, like the till of the surrounding country, it contains only few large boulders. Among the half dozen boulders of greater size than two feet in length seen in the eastern face of this excavation, one of the largest, about five feet in diameter, was Niagara limestone. With the depos-

(1.) Numbers 323, 324 and 325 of the list of photographs of the Geological Society of America (Bulletin, G. S. A., Vol. III, p. 472) are views of sections of the Pinnacle hills esker at this locality, photographed and presented by Professor H. L. Fairchild.

its of till are many intercalated layers of stratified sand, from 1 to 5 feet in thickness, often continuous along a distance of 100 feet or more. These layers are mostly horizontal or only slightly inclined, and no contortion nor evidence of erosion or tumultuous pushing forward was observed.

Beyond its intersection by the Genesee river, this ridge is the site of the Rapids Cemetery, and thence it extends nearly due west two miles along or close to Brooks avenue. It rises by usually gentle slopes 30 to 40 feet above the land on its south and north sides, and has a width of 25 to 50 rods, being often quite irregular in contour, which with its clayey soil and occasional boulders, gives it a morainic aspect. Where it is cut by the Buffalo, Rochester & Pittsburgh railroad, nearly two miles west of the river and between an eighth and a third of a mile north of Brooks avenue, several recent excavations showed about half of its material to be till, and the remainder very compact stratified sand. These unlike deposits are irregularly accumulated together, but no interblending was seen. The till has no marks of water action, and the sand is free from boulders or gravel, and is horizontally bedded or nearly so, being sometimes 5 to 15 feet thick with an exposed extent of fully 100 feet.

Relationship to the surrounding Country.—Throughout the city of Rochester, excepting the Pinnacle hills and the gorge of the Genesee below its falls, the surface is nearly a plain, with slight descent toward Lake Ontario. The underlying Niagara and Clinton formations are covered generally with only 10 to 20 feet of drift, which is mainly till and in small tracts stratified clay or sand and fine gravel. Northward from Rochester, the surface in Irondequoit and Greece townhips declines with a gradual slope 200 to 250 feet in the distance of 5 to 7 miles to Lake Ontario.

The fjord-like Irondequoit bay, lying between Irondequoit township on the west and Webster and Penfield on the east, stretches about five miles southward from Lake Ontario, with a width varying from one mile to a half mile, bordered by cliffs 100 to 200 feet high, which rise to the general plain on each side. The maximum depth of Irondequoit bay is 80 feet, which must be added to the height of the bluffs to give the total depth of the eroded valley; and its southern end, where the Irondequoit river flows into it, is about five miles east from the center of Rochester. Before the Ice age the Genesee doubtless entered the lake through this valley, probably leaving its present course near the mouth of the Honeoye creek, flowing eastward, through Bush township and the southern part of Mendon, and thence northward along the Irondequoit river and bay. In the southeast edge of Pittsford the Irondequoit, where it is crossed by the Erie canal and for three miles southward, is about 100 feet lower than the Genesee near the south line of the city of Rochester, above the State dam. Especially thick accumulations of the glacial drift in Mendon caused the Genesee after the Ice age to take its new course through Rochester; and its rock gorge, extending from the center of this city to its mouth at Charlotte, has been eroded during the Postglacial or Recent epoch, of which, like the gorges below the falls of Niagara and of St. Anthony, it affords a means of measurement, if the extent of recession of the Genesee falls during the present century can be determined.

Southward and eastward, elevations of equal height with the Pinnacle hills are first found at the distance of 7 to 10 miles, being prominent drift accumulations later to be described in this paper, lying in the southwest part of Pittsford and northwestern Mendon, and between Victor and Fairport.

The relation of the Pinnacle hills to the adjoining region will be further exhibited by the following list of altitudes, which are mostly derived from maps in the office of Mr. J. Y. McClintock, city engineer of Rochester, others being from the United States Lake Survey. They all are referred to mean tide sea level.

Altitudes in Rochester and its Vicinity.

	Feet above the sea.
Lake Ontario, low and high water, 245–249; ordinary stage	247
Iroquois beach, between Irondequoit bay and the Genesee river (Gilbert)	436
Erie canal, coping and tow-path of viaduct crossing the Genesee river in Rochester, 510; water	508
New York Central railroad track at Rochester station	516
Wide Waters of the Erie canal on southeastern line of Rochester	500
Railroad at Brighton station	460
Canal at Brighton	480
Summit of Arbutus avenue one-fourth mile south of Brighton, crossing the east end of the Pinnacle hills esker	536
Top of esker about 50 rods west of last	570
Top of esker one-third mile farther west	652
Depression close southwest of last	590
Highest point of Cobb's hill, one-third mile farther W. S. W.	663
Top of esker about 40 rods westward	608

	Feet above the sea.
Intersection of Monroe and Highland avenues, at Mrs. W. H. Cobb's residence, immediately south of last	544
The Pinnacle, one-half mile farther west	749
Summit of Pinnacle avenue, crossing the esker one-third mile farther west	583
Top of esker in Highland park, at the Memorial Pavilion	650
Mt. Hope reservoir, water surface	634
Summit of South avenue	617
Summit of Mt. Hope avenue	622
Highest portions of the esker in Mt. Hope cemetery, about	675
Crest of morainic ridge extending westward as a continuation of the Pinnacle hills, where it is cut by the Genesee Valley branch of the New York, Lake Erie & Western railroad	583
Same, on east bank of the Genesee river	559
Same, west of the river, at the Rapids cemetery and onward	555–560
Genesee river above the State dam, near the foregoing	508
At foot of this dam	504
At the Clarissa street bridge	502
At the Court street bridge	493
At the Andrews street bridge	484
Upper falls, top of rock, 476; water in ordinary stage at brink and foot of the fall	473–387
Above and below the Middle falls	374–348
At mouth of Deep Hollow creek and brink of Lower falls	345
At foot of Lower falls	251
At the steamboat landing, about one mile north of the last, on the level of lake Ontario	247
Seneca Park bridge, spanning the gorge close below the Lower falls	460
Highest ground at the Rochester University	520
Canal and railroad at Pittsford, about	460
Irondequoit river under the viaduct of the Erie canal, about	400
Turk's hill, a station of the U. S. Lake Survey triangulation, near the south line of Perinton township, about 12 miles southeast from the Pinnacle hills	928
Rush reservoir of the Rochester Water Works, 9 miles south of the Mt. Hope reservoir	753
Hemlock lake (maximum depth, 87 feet), source of the Rochester water supply, 19 miles from the Rush reservoir	898

ESKERS IN PITTSFORD.

From 2½ to 3 miles southeast of Brighton, the New York Central railroad makes a long cut through the northern end of a second esker series, which takes a course approximately at right angles with that of the Pinnacle hills. Beginning close south of Allen's creek, in the southwest corner of Penfield township, this belt of kames and eskers runs south-southeasterly through the east half of Pittsford and about a mile into the southwestern corner of Perinton, terminating in a sand plateau, which abuts upon the western base of the prominent Turk's hill range of drumloid drift. The length of this Pittsford esker series is about seven miles.

In its northern third, extending from Allen's creek southward to about a mile east of Pittsford village, the width of this belt varies mainly from a half mile to fully one mile, and it consists of a principal broad north to south esker ridge, becoming narrower and interrupted southward, with a considerable lateral expansion, especially on the east, in kames, or short ridges, mounds and hillocks, all being composed of sand and gravel, with infrequent enclosed boulders. The cut for the railroad is about a half mile long and 50 feet deep. Its greater part is yellow sand, nearly horizontal in stratification, excepting at the margins, where the bedding is more irregular, prevailingly dipping downward like the surface slopes. In this sand are occasional thin gravelly layers, but these are nowhere conspicuous. Very rare embedded boulders were seen. Only two, which were respectively about 3 and 5 feet in diameter, were exposed in the section at the time of my visit, and scarcely a half dozen in total lie at the foot of the banks on both sides of the railroad. The basal part of this section, however, for about an eighth of a mile west from its center, consists of coarse gray gravel, containing very closely packed gravel stones and cobbles up to 6 or 8 inches in diameter, but no larger boulders. On the north side of the excavation the gravel reaches to a height of about 20 feet above the track, and displays a very distinct anticlinal stratification.

About 1½ miles southeast from this railroad cut, a small excavation for the passage of a north to south road through a kame deposit, chiefly of sand, near the east line of Pittsford and the east border of the esker and kame belt, reveals a boulder 3½ feet in diameter, embedded 10 feet below the surface. Beneath and above the boulder, the stratification of the sand and gravel is contorted and curved, in conformability with the outline of the rock mass.

After an interruption or gap about 40 rods in length, the more southern portion of the series, from a point about a mile east-southeast of Pittsford village to its termination about a mile southeast and south of the village of Bushnell's Basin in Perinton, is well described as follows, by Mr. Charles R. Dryer, in a paper which also treats of the Pinnacle hills, Irondequoit bay, and the massive hill ranges of till south of Pittsford and Fairport (1). Mr. Dryer, following the early usage of the term *kame*, applies it to the narrow esker ridge, with steep slopes and sharp crest, which he describes one to three miles southeast of Pittsford, succeeded in the next mile or more by a sand plain or plateau.

"The north end is a sharp ridge of very coarse gravel, fifty feet in height, one mile long, and in shape like a rude fish-hook. It is separated from the southern portion by the channel of Irondequoit river, which has cut the kame completely in two. In the southern portion the gravel is overlaid by fifty feet of fine sand which spreads out toward the southeast in a sheet a mile or more in width. This kame forms a dam across the valley, complete except for an interval of less than one-fourth of a mile on its western side. The Erie canal avails itself of this kame to cross the valley and by a fifty-foot embankment restores what probably once existed as a natural feature. South of the kame the valley is as level as a floor for three miles up the stream and was evidently once the site of a lake whose waters were held back by the kame as a dam."

Relationship to Drumlins and Terminal Moraines on the south.—To understand the history of the recession of the ice-sheet in this region and of the accumulation of its drift, it is needful for us to take for a moment a somewhat broad view southward. Beginning within a half mile south of Pittsford, drumlins are admirably developed upon an area extending six or seven miles to the south, into the northwest part of Mendon. They also form the crests of a massive drift ridge which stretches from Fairport south to Victor, culminating in Turk's hill; and beyond a depression, through which the railroad from Rochester to Canandaigua passes, similar massive, drumlin-crowned highlands extend from Victor several miles to the south and southwest. These highlands appear to me referable to the class of drumlins, rather than to that of terminal moraines marking the outlines of the ice-front at any stage of temporary halt in its general retreat. Eastward from this region, drumlins occur in extraordinary abundance for a distance of 60 miles, to the vicinity of Syracuse (2).

(1.) The Glacial Geology of the Irondequoit Region, Am. Geologist, Vol. V, pp. 202-207, with map, April, 1890.

(2.) L. Johnson, "The Parallel Hills of Western New York," Trans., N. Y. Acad. of Sci., Vol. I, 1882, pp. 78-80; Annals, do., Vol. II, pp. 249-266, with map.
D. F. Lincoln, "Glaciation in the Finger Lake Region of New York," Am. Jour., Sci., III, Vol, XLIV, pp. 290-301, Oct., 1892.
Warren Upham, "Conditions of Accumulation of Drumlins," Am. Geologist, Vol. X, pp. 339-362, Dec., 1892.

Between 35 and 60 miles south of Rochester, conspicuous terminal moraines run approximately from west to east, as described and mapped by Professor T. C. Chamberlin [1]. On the meridian of Rochester these moraines are somewhat interblended, fragmentary, and irregular in their development upon a width of nearly 25 miles from the southern ends of Conesus and Hemlock lakes southward to the vicinity of Hornellsville. Farther to the east, for a distance of about 150 miles, to the Catskill mountains and the Mohawk river, they are more distinctly developed as two morainic belts, of which the southern one is traced in a slowly curving course, convex toward the south, along the valleys of the Canisteo, Tioga and upper Susquehanna rivers, while the northern one passes in a more sharply curved and lobate course by the south ends of the Finger lakes to Ilion and Herkimer on the Mohawk. In the valleys extending southward from the heads of the larger Finger lakes the thickness of the northern moraine appears to be several hundreds of feet, and in the case of Seneca lake perhaps more than 1,000 feet; but on the intervening plateaus the thickness of the morainic drift is comparatively insignificant, averaging probably no more than 25 to 50 feet upon widths varying from one to two or three miles.

A more distant moraine, however, lying on and near the boundary of the glacial drift, extends from the vicinity of Salamanca, N. Y., east-southeasterly to the Delaware river at Belvidere, N. J., and to Staten Island, the Narrows, and Long Island. This moraine, described in Pennsylvania by Professors Lewis and Wright, [2] passes about 100 miles south of Rochester.

Relationship to Glacial Movements.—The currents of the ice-sheet flowed perpendicularly toward its boundaries and marginal moraines, that is, to the south or somewhat west of south for the region about Rochester and Pittsford; but during the recession of the ice from that area, its currents were in some portions deflected much to the west, because of more rapid melting of the ice on that side and consequent indentations or embayments in its border. This faster melting on the west was probably at first due in large part to the laving action of the glacial Lake Warren, which extended from the western part of the basin of Lake Ontario over the upper Laurentian lakes, outflowing at Chicago to the Des Plaines, Illinois, and Mississippi rivers; and in the later stage of the glacial recession when the Roch-

(1.) Third Annual Report of the U. S. Geol. Survey, for 1881-82, pp. 351-360, with Plate XXXIII.

(2.) Report Z, Second Geol. Survey of Pennsylvania.

ester and Pittsford eskers were formed, the ice-melting was likewise promoted by the incipient Lake Iroquois, outflowing by Rome to the Mohawk and Hudson.

According to notations of glacial striæ by Chamberlin, Gilbert, and Dryer, their courses are as follows: near the northeast corner of the city of Rochester, S. S. W. to S. W.; near the southwestern boundary of this city, S. W. to W. S. W.; and in Greece, the next township northwest of Rochester, four courses, intersecting or on contiguous rock exposures, S. S. E., S. S. W., S. W., and W. The southward courses are doubtless somewhat earlier than those running to the southwest and west, which belong to the short time when the glacial currents were deflected during the departure of the ice. Upon all the region of the Finger lakes the glacial striation is approximately from north to south, in parallelism with these lakes and the intervening ridges and plateaus. On the north the grand ice currents over the Province of Ontario moved mainly southward, with convergence from the southern part of Georgian Bay southeasterly, and from Montreal and the upper St. Lawrence southwesterly, toward the basin of Lake Ontario and the great re-entrant angle of the glacial border at Salamanca in southwestern New York.

The trends of eskers and drumlins testify of the directions of the currents of the ice-sheet as trustworthily as the courses of glacial striation on the bed-rocks, with which the esker and drumlin ridges are parallel. Both these classes of drift accumulations, however, were formed near the border of the ice during its recession at the close of the Glacial period; and they consequently often record local deflections of the glacial currents caused by unequal rates of melting and the resultant sinuosities of the ice-front. The Pittsford esker series, trending south-southeast, is nearly parallel with the general movement of the ice-sheet, both during the time of its maximum extent and thickness and during the decadence; but the Pinnacle hills, trending west-southwest, show that a considerable local indentation or embayment in the waning ice-border there turned its currents much to the west from their former course.

Probable Origin of these Eskers.

Although these two esker series, lying only a few miles apart, differ about 90° in their trends, they were probably formed at the same time or one very soon after the other, as might happen by diversion of a glacial river from one avenue into another near its point of discharge from the ice-sheet. Each series seems to be attributable to deposition in the ice-walled channel of a stream of water flowing down from the surface of the melting ice-sheet, where the gravel and sand had been gathered from the previously englacial drift that had been exposed by ablation as a superglacial stratum. Near their mouths, or places of discharge to the land surface, these rivers appear to have flowed in valleys or gorges inclosed by unmelted plateaus of the ice-margin, upon which much drift rested. In some sections of our drift formations, as of Third and Fourth Cliffs in Scituate, Mass., which are partially eroded drumlins on the shore of the ocean, thick beds of stratified gravel and sand are found which were undoubtedly laid down by subglacial streams ([1]). But such beds formed under the ice-sheet are rare in most parts of the country, and the eskers here described and all others which have come under my examination of extensive areas in New England, and in Minnesota, northern Iowa, the Dakotas, and Manitoba, I believe to have been deposited in ice-walled channels open above to the sky.

Before proceeding to consider more in detail the structure and materials of these eskers in their bearing on this view of their mode of accumulation, it will be desirable to notice former expressions of opinion as to the origin of the Pinnacle hills. The earliest reference to this esker is by James Hall, in his report on the Fourth Geological District of New York, published in 1843. In pages 323 and 324 he gives a figure and description of the section where the ridge is intersected by Monroe avenue. "The gravel," Professor Hall remarks, "consists principally of waterworn fragments of the Niagara limestone, on which the whole deposit rests, and of the sandstones and limestones on the north. There are some boulders of the limestone, from two to four feet in diameter, worn perfectly smooth, or often striated with shallow grooves; and from the fact that this is the subjacent rock, they have received their rounded forms and smooth surfaces from attrition near the spot where we now find them." When this was written, the glacial theory of Agassiz had been published only a few years, and was not apprehended by Hall with such clearness as to seem adequate to account for this and our other drift deposits. It was observed that in this section "nearly all the strata dip towards the west," whence it was concluded that "the accumulation doubtless took place from

(1.) Proceedings of the Boston Society of Natural History, Vol. XXIV, 1889, pp. 228-242; Vol. XXV, 1891, pp. 228-242.

this direction, from the heaping of the coarse gravel upon the fine sand."

Mr. Charles R. Dryer, in the article before cited, calls both the Pinnacle hills and the Pittsford series kames, implying their deposition in the channels of glacial rivers. He especially notices that on the area where, if prolonged to the northeast and north, they would intersect, the valley of Irondequoit bay has been apparently filled with stratified sand and gravel to a height of 150 feet or more above the lake, as indicated by narrow terraces at such height left on each side of the bay. The level of the glacial Lake Iroquois during a late stage of its history, according to Mr. Gilbert, sank here considerably below the shore of Lake Ontario, and the depth of the Irondequoit bay suggests that the depression of this southern part of the glacial lake, permitting erosion of the former plain of modified drift in the Irondequoit valley, reached at least 80 feet beneath the present water level.

The discussion concerning the origin of the Pinnacle hills after the excursion to them last summer by members of Section E of the American Association was opened by Mr. Gilbert, who drew on the blackboard a sketch map of the esker series and the region about it and called attention to the narrowness of the east and west belts of outcrop of the several geologic formations. The Niagara limestone, occupying a belt that ranges from 2 to 7 miles in width through this part of New York, underlies the Pinnacle hills and much of the city of Rochester. Next northward the Clinton formation has a similar width, and beyond this the Medina sandstone outcrops on a somewhat wider belt which adjoins Lake Ontario. Each of these formations and the Archæan rocks of Canada are represented in the gravel and boulders of this hill range, and it is especially notable that usually the Niagara limestone is very plentiful, both as gravel and as boulders, which vary in size up to ten feet in diameter. Evidently this limestone drift can have been transported only a few miles, and its occurrence in the highest portions of the Pinnacle hills must be taken into account in inquiring how they were accumulated, for which, however, Mr. Gilbert had not framed any complete and detailed explanation.

Professor G. F. Wright and Mr. C. W. Hayes spoke of their own observations and those of Prof. I. C. Russell on glaciers in Alaska, where much superglacial drift is exposed on the wasting borders of the ice-fields and portions of it are washed away by rains and streams, which in most cases carry it finally into crevasses and subglacial water courses, like those of the Yahtse river and Fountain stream described by Russell as flowing out from beneath the Malaspina glacier. In these subglacial channels the streams must be building up eskers, while gently sloping gravel and sand plains are being deposited by the silt-laden waters in their course from the ice-front to the sea (1).

Professor E. W. Claypole drew a section of the marginal portion of the ice-sheet, showing how, in his opinion, the Pinnacle hills were formed by a stream which gathered drift from the melting ice surface, and then fell through a crevasse and deposited the sand, gravel, and boulders in a tunnel under the ice.

Following these speakers, I remarked that the absence of any covering of till upon the top and slopes of this esker, such as must have fallen upon it from the englacial and superglacial drift of its roof of ice if it were formed in a subglacial tunnel, leads me to believe that its stream was wholly superglacial, and that the esker was deposited in a deep ice-walled gorge, open above to the sky, eroded in the border of the ice-sheet by the melting action of the running water.

The purpose of the present essay will be completed by more fully considering the probable manner of transportation of the many boulders found in some portions of the gravel and sand of the Pinnacle hills, the relationship of this esker to the lower morainic ridge continuous from it westward, the abrupt eastward ending of the Pinnacle hills range, and similar features of the Pittsford esker series, with the inquiry constantly in mind whether these features support the view that these eskers were derived from previously englacial drift and accumulated in superglacial channels. It will be needful at the same time to consider the drainage from the ice-border in its relations to the glacial Lake Warren and to the beginnings of Lake Iroquois. Beyond this we ought to learn, if possible, whether the same explanation is generally applicable to eskers in other regions.

The leading reason for our special interest in the Pinnacle hills is the demonstrably near sources of their Niagara limestone boulders, which have been transported only a few miles and yet were uplifted at least 100 to 200 feet into the ice-sheet from an approximately plain country. Here we have a demonstration of the competency of the glacial currents to gather drift into the lower part of the ice-sheet from a nearly flat area, and we may understand how this takes place by the differential movements of the upper, middle and lower portions of the ice. Upon a belt of the ice-sheet extending many miles

(1). For description of the present process of formation of eskers and sand plains by rivers of the Malaspina glacier, see Russell's paper on "Mt. St. Elias and its Glaciers," Am. Jour. Sci., III, Vol. XLIII, pp. 169–182, with map, March, 1892 inward from the retreating margin, its surface had a considerable slope, so that the upper currents of the ice, unsupported on the outer side, would move much faster than its lower currents which were impeded by friction on the land. There would be accordingly within this belt a strong tendency of the ice to flow outward with somewhat curved currents, tending first to carry the onwardly moving drift gradually upward into the ice-sheet, and later to bear it downward and deposit it partly beneath the edge of the ice and partly along the ice boundary. The Niagara boulders, and others from the Clinton and Medina formations farther north, having been borne upward as englacial drift to a greater altitude than the Pinnacle hills, were exposed on the surface of the ice-sheet by its ablation and were swept by torrents bearing ice rafts, or probably sometimes by avalanches, into the river channel. Their great profusion in certain parts of this esker implies unusual abundance in and upon the contiguous portions of the ice-sheet, which may have resulted from convergent glacial currents and perhaps from a temporary re-advance of the thicker tract of the ice, massing its superglacial drift stratum in a way analogous with the accumulation of terminal morainic hills, which often are equally charged with boulders.

The morainic ridge continuing westward from the Mt. Hope cemetery seems probably to have been formed along the margin of the ice, on the northern side of a re-entrant angle or embayment into which the glacial river depositing the esker of the Pinnacle hills debouched. Close south of this ridge, a brick yard beside the Buffalo, Rochester & Pittsburgh railroad works the stratified clay which the river discharged into the shallow glacial lake of the embayment.

Finding so abrupt an end of this esker at Brighton, we are constrained to believe that the powerful river by which it was accumulated suddenly ceased to flow here. The neighboring Pittsford esker apparently shows the site of the new glacial channel, previously the course of some smaller stream, which then became the main avenue of drainage from the rapidly melting ice-fields of this region. But when the Pittsford esker had gradually grown in its length from the west flank of the Turk's hill range northward to the present site of Allen's creek, the glacial river which formed it was again diverted ; or more probably thenceforward it emptied into a marginal lake so broad and deep that no distinct esker was made, the gravel and sand being then laid down in the valley which now holds Irondequoit bay.

If the eroded drift from the area north of the Pinnacle hills was carried upward by glacial currents having an average ascent of one degree, it would rise within one mile 92 feet and within two or three miles would be higher than the tops of these hills. Currents ascending at this rate, or even two or three degrees or more, may very probably have existed in the lowest part of the ice sheet, on account of the acceleration of its upper currents, within distances from 20 to 50 miles or more back from its boundary. By these currents much drift eroded from the land surface would be gradually incorporated in the comparatively sluggish lower part of the ice, reaching altitudes 100 to 1,000 feet above the ground within a few miles from its sources.

It is also to be remarked that the rounded or at least subangular forms of the greater part of the pebbles and small rock fragments in the esker gravel do not necessarily imply wearing by the stream during a long transportation. Daubrée placed angular fragments of granite and quartz, ranging from the size of one's fist to that of a hazel nut, with water in slowly revolving cylinders and found that they became perfectly rounded when the revolutions amounted to 25 kilometers or about 15 miles. (1) Within a third of this distance probably some of the fragments had been well rounded, and in a less distance nearly all would be worn to subangular forms.

Many features of the modified drift, comprising glacial flood plains, eskers and kames, show that the melting of the ice-sheet at the close of the Glacial period was mostly very rapid. In the vicinity of Rochester it was hastened by the laving action of the glacial lakes on its southern border. Lake Warren had formed a beach which extends to the south side of the east end of Lake Erie, where its altitude is 860 feet above the sea. (2) At the time of formation of the Pinnacle hills and Pittsford esker series, the ice-border in New York appears to have receded so far that the water of the upper Laurentian lakes was no longer held up to the level of Lake Warren, which had outflowed at Chicago, and avenues of drainage seem already to have been opened eastward along the ice-border past the northern ends of the Finger lakes to the Mohawk valley. Undoubtedly the deposition of these esker gravel and sand beds took place above the level of such fringing lakes, which from the Genesee and Irondequoit basins could have no place of outflow eastward lower than by the way of Victor and Mud creek. The divide at Victor is somewhat higher than the general surface on which these eskers lie ; hence it seems probable that when the esker beds were laid down in their ice-walled channels a depth of some 100 feet, more or less, of ice still remained unmelted

(1.) Etudes Synthétiques de Géologie Expérimentale, 1879, pp. 2[illegible]8–250.
(2.) Bulletin, G S. A., Vol. II, pp. 258–265 ; Vol. III, pp. 484–4[illegible].

beneath them. In like manner I have shown that certain eskers in New Hampshire and Manitoba were underlain by ice at the time of their accumulation and by its melting away were afterward allowed to sink to the land. [1]

Application of this Explanation to Eskers elsewhere.

If eskers were subglacial deposits, we should expect them to be often covered wholly or partly with the englacial drift, as boulders and loose deposits of till, which would be permitted to fall upon them when the ice-roof was melted away. Such a roof would be more or less overspread with the drift that had been contained in the higher portions of the ice-sheet and was exposed on its surface by ablation. Sections indeed are occasionally found, where subglacial beds of modified drift have become covered by subglacial and englacial till; [2] but these usually differ widely in their character from the torrential esker and kame deposits, which very rarely contain or bear upon their surface any considerable abundance of boulders or other drift materials that have not evidently been transported, worn, and assorted by water. In nearly all the localities where I have observed boulders or masses of till imbedded within eskers or lying on their surface, the most probable explanation of their derivation has been by falling from the enclosing ice-walls of channels open to the sky, or by being brought while frozen in ice-floes. [3] At only one place, in Dover, N. H., I have found a portion of an esker covered with a deposit of boulders and till which may have fallen from a melting ice-roof, though another interpretation seems to me preferable. [4]

A different view is taken by Professor W. M. Davis, who regards certain eskers in the vicinity of Auburndale, Mass., which I have repeatedly examined with him and other glacialists, as probably of subglacial origin. [5] These eskers I think to have been formed in ice-walled channels, open above and underlain by a slight depth of ice. Extending southward from them are associated sand plains or plateaus, deposited just outside the ice-front by the streams which produced the esker ridges. Professor Davis describes a backwardly dipping strati-

(1.) Geology of New Hampshire, Vol. III, 1878, pp. 107,116. Geol. and Nat. Hist. Survey of Canada, Annual Report, new series, Vol. IV, for 1888-89, pp. 39-41 E.

(2.) Geology of N. H., Vol. III, pp. 108, 131-137, 289-291. Geol. and Nat. Hist. Survey of Minnesota, Eighth Annual Report, for 1879, pp. 113, 114; Final Report, Vols. I and II. Proceedings of the Boston Society of Natural History, Vol. XXIV, 1889, pp, 231-5, 237-9.

(3.) Geology of N. H., Vol. III, pp. 43, 46, 85, 88, 90, 92, 127, 145, 148, 158, 160, 162. Geology of Minn., Final Report, Vol. II, p. 550. Geol. and Nat. Hist. Survey of Canada, Annual Report, Vol. IV, pp. 40-42 E.

(4.) Geology of N. H., Vol. III, p. 159.

(5). Bulletin, G. S. A., Vol. I, pp. 195-202, with sections, Proceedings of the Boston Society of Natural History, vol. XXV, 1892, pp. 477-499.

fication of the beds forming the edge of the plains where they adjoined the ice-sheet, and attributes it to the upflow of subglacial waters bringing with them the sediments which make the plain and reach to a considerable distance, having in their lower portion, on the greater part of their area, the forwardly dipping stratification that is characteristic of deltas or of deposits swept by torrential currents into the slowly flowing broad expanse of flooded rivers. It seems to me, however, more probable that the back-set beds were formed by the downward and backward transfer of sand from the surface of the plain, to fill in succession the small spaces from which the ice-sheet was gradually withdrawn.

Because the summer melting of the North American ice-sheet in the Champlain epoch, or closing stage of the Glacial period, was far more rapid than that of the Alaskan glaciers at the present day, the previously existing small subglacial stream-courses were inadequate for the transportation of the large supplies of englacial drift then set free, by which, indeed, the subglacial tunnels appear to have been mostly obstructed and closed. The waters of the glacial melting and of accompanying rains therefore flowed, as I believe, in channels on the ice surface, often near their mouths more like cañons than like ordinary land valleys, there depositing the eskers and kames.

My studies of the Pinnacle hills and Pittsford esker series, of the very massive kame deposits forming the greater part of the outermost terminal moraine on Long Island eastward from Roslyn (1), of the large kame called the Devil's Heart, rising in a somewhat conical hill 175 feet above the adjoining country south of Devil's lake in North Dakota, and of the esker named Bird's hill, seven miles northeast of Winnipeg (2), seem to me to demonstrate, beyond all doubt, that their material, and probably likewise that of eskers and kames generally, was supplied by superglacial streams from the plentiful englacial drift, and could not have been brought from drift beneath the ice by subglacial drainage.

(1). Am. Jour. Sci., III, Vol. XVIII., pp. 84–88, Aug., 1879.
(2). Geol. and Nat. Hist. Survey of Canada, Annual report, new series, Vol. IV, for 1888-89, pp. 38-42 E, with section.

JANUARY 23, 1893.

STATED MEETING.

The President, PROFESSOR H. L. FAIRCHILD, in the chair.

About one hundred persons present.

The first lecture of the Popular Lecture Course was given by MR. FRANK D. PHINNEY, entitled :

LIFE AND SCENES IN BURMA.

The lecture was illustrated by a large number of lantern views of natural scenery and products; the people, their villages and handiwork; images, objects and places of worship; the monasteries, pagodas and their surroundings.

FEBRUARY 13, 1893.

STATED MEETING.

The President, PROFESSOR H. L. FAIRCHILD, in the chair.

Forty-five persons present.

The Council report recommended :

(1.) The payment of a bill for Secretary's expenses.

(2.) The election of the following persons as active members :

DR. J. E. BISSELL,
DR. CHARLES F. HOWELL,
MRS. E. L. MAGUIRE,
MR. WILLIAM W. PARCE.

The bill was ordered paid, and the candidates were elected by formal ballot.

DR. LEWIS SWIFT delivered an astronomical lecture entitled

OVERHEAD.

A vote of thanks was given the lecturer.

FEBRUARY 27, 1893.

STATED MEETING.

The President, PROFESSOR H. L. FAIRCHILD, in the chair.

One hundred sixty persons present.

The second lecture of the Popular Lecture Course was delivered by PRESIDENT DAVID J. HILL, of the University of Rochester, entitled :

THE ETHNOGRAPHY OF THE PACIFIC ISLANDS.

The lecture consisted of a sketch of the physical geography of the Pacific Islands and a description of their flora and fauna, with an account of the arts of life and social customs, illustrated with lantern slides.

MARCH 13, 1893.

STATED MEETING.

The President, PROFESSOR H. L. FAIRCHILD, in the chair.

Forty-five persons present.

The Council report recommended the election as active members of MR. and MRS. GEORGE C. BUELL. The report was adopted, and the candidates were elected by formal ballot.

The Librarian, MISS MARY E. MACAULEY, announced the addition of one hundred fifty titles to the library.

The following paper was read :

NOTE ON THE CLASSIFICATION OF SURDS AND IRRATIONALS.

BY PROFESSOR ARTHUR LATHAM BAKER.

Under the head of SURDS, the typical statement of the text books is—" If the root of a quantity cannot be exactly obtained, the indicated root is called a *Surd* or *Irrational Quantity.*"

To make the inference doubly sure, that Surd and Irrational Quantity are synonymous terms, some add—" Quantities which are not surds are termed rational quantities."

The same confusion is noticeable in dictionaries, encyclopedias, and text books, and even in the latest authority, the Century Dictionary, where surds and irrationals are treated as synonymous terms; and I know of no text book where the same errors are not noticeable.

The fallacy of this definition and the necessity for a clear distinction between the terms is shown in the theorem which always closely follows, viz.—The square root of a rational quantity cannot be partly rational and partly a quadratic surd (*irrational*). The parenthesis and italics are mine.

The proof to the contrary, objectively put, is

$$\sqrt{3} = 1.732 \ldots \quad = 1 + 0.732 \ldots$$

which shows that a quadratic surd *is* equal to a rational quantity plus an irrational quantity.

The truth is that the irrational part is a pure irrational which has not the properties of a large class of irrationals to which some distinctive name should be given, preferably that of *surd*.

The correct analysis and definition should be:—

Irrational or incommensurable numbers are divided into *Surds* and *Non Surds*.

Surds are the indicated or incommensurable roots of commensurable quantities, such as, $\sqrt{3}$, $\sqrt{2}$, etc.

Non Surds are the indicated or incommensurable roots of incommensurable numbers, *i. e.*, all irrationals which are not surds, as

$$\pi = \sqrt{\pi^2}, \quad \pi^2, \quad \sqrt{\sqrt{3}-1} = 0.732 \ldots, \text{ etc.}$$

It may be that non surds are transcendentals which can not be graphically represented by the ruler and compass as can the surds, $\sqrt{2}$, $\sqrt{3}$, etc.

NOTE. Since this paper was read, Dupuis' Algebra and Van Velzer and Sclichter's Algebra have appeared in which the distinction here suggested has been made. So far as I know, other text books conservatively adhere to the erroneous definition, though several years ago the attention of a number of authors had been called to the error.

The following paper was then read by MR. JOSEPH E. PUTNAM:

DISCUSSION OF SOME PRACTICAL POINTS ABOUT ELECTRIC MOTORS.

The paper was illustrated by experiments.

MARCH 27, 1893.

STATED MEETING.

Vice-President, DR. M. L. MALLORY, in the chair.

A large audience present.

The third lecture of the Popular Lecture Course was delivered by PROFESSOR H. F. BURTON, of the University of Rochester, entitled :

THE ARCHITECTURAL SPLENDOR OF ANCIENT ROME.

The purpose of the lecture was to give an impression of the grandeur of the ancient city of Rome at the time of its highest development. Stereopticon views were shown representing various buildings in Ancient Rome in their original form, so far as can be ascertained. These representations were derived from the works of eminent archæologists, such as Canina, Piranesi, Bühlmann and others. Among the objects represented were the walls and gates of the city ; the Roman Forum ; the temples of the Capitoline hill ; the palaces upon the Palatine ; the Fora of Julius Cæsar, Augustus and Trajan ; the Pantheon ; the theatre of Pompey ; the Colosseum ; the Circus Maximus ; the baths of Caracalla and Diocletian ; and, finally, the roadside tombs and the imperial Mausolea.

The lecturer said in part : "It is difficult for us to conceive of the magnificence of Rome for two reasons : because there exists no modern city with which it can properly be compared, and because the remains of Ancient Rome are so scanty, so bare and ugly, that to the ordinary observer they suggest nothing but ruin and decay."

"The beauty of the city of Rome was due to three causes, namely : to its location, to the material used in its buildings, and to the architectural skill employed in their construction."

"The site of Rome had the advantage of great variety of elevation, presenting an alternation of steep hills and low lying valleys, of level plains and gradual slopes. Its hills were crowded with palaces and temples, and the observer who stood upon them beheld the city itself, spread out like a map before him, and might look far down the Tiber valley to the sea, or across the level country to the snow-capped mountains."

"The building materials used in Rome were at first rough volcanic rock and limestone in huge blocks ; later, concrete faced with red brick; and, finally, marble and granite of every variety; white marble from Greece and the islands of the Aegean Sea; mottled pink and brown marbles from Asia Minor, yellow marbles from Africa, and gray and red granite from Egypt. Bronze was extensively used for temple doors and as a covering for roofs, and was frequently overlaid with gold."

"The Romans borrowed from their neighbors whatever architectural forms they found suited to their own needs. They learned from the Etruscans the principle of the arch, and employed it extensively in all its forms, the simple arch, the vault, and the dome. From the Greeks they obtained the colonnade with its three orders of columns, Doric, Ionic, Corinthian. But the Romans were not content to borrow only; they combined the arch and the colonnade in a great variety of forms with fine decorative effect. They displayed in their architecture great practical originality in the application of known principles and methods in the development of new architectural types."

"This survey of the great structures of Ancient Rome suggests the regret that such splendid works of architecture should have disappeared from the earth. But the wealth of Rome, which made possible its magnificence, was gained not by honest industry, but by conquest and plunder; when, therefore, Roman imperialism went down, making way for modern liberty, it was fitting that the gorgeous palaces that had housed it should fall into ruins. That which was best in Rome has survived. We have her literature and her history, her system of government and jurisprudence, and we need not lament the loss of her marble and bronze."

APRIL 10, 1893.

STATED MEETING.

The meeting was held in the Geological Lecture Room, Sibley Hall, University of Rochester.

The President, PROFESSOR H. L. FAIRCHILD, in the chair.

Twenty-seven persons present.

The Council report recommended that $50.00 be appropriated to cover the expenses of the Popular Lecture Course, the bills to be approved by the President and Secretary.

The report was adopted, and the appropriation made.

The following paper was read by the President:

THE EVOLUTION OF THE UNGULATE MAMMALS.

By Herman Le Roy Fairchild.

(Abstract.)

This group of mammals was divided by Cuvier into two orders, the Ruminants and the Pachyderms. The living Ruminants form a very distinct group, marked by persistent features, namely, horns and hoofs in pairs, upper incisors wanting, stomachs complex, and the habit of rumination. But it was found that the fossil representatives of these orders did not fall into such a classification, and Professor Owen showed that the foot structure was a more persistent and fundamental distinction. The order Ungulata, as now constituted, includes the mammals formerly classed as Ruminants and Solidungula, and all those formerly called Pachyderms, except the Proboscidians. Of the larger mammals, both extinct and living, this is the most numerous and comprehensive order.

The members of this order walk on the extremity of the toes, which are protected or encased in a greatly expanded nail or hoof (ungula). This apparently superficial character is but one element in the structure of the ungulate foot, which structure is of the utmost value in tracing relationship of the fossil mammals, and the study of it forms one of the most fascinating chapters in Comparative Anatomy.

The number of digits of full size never exceeds four, at least the first digit being always obliterated. As the limbs are used only for locomotion, never for prehension, clavicles are useless and therefore wanting. The molar teeth are massive, with broad crowns suited for grinding vegetable food, although the primitive species were probably omnivorous, like a few living forms. The brain is proportionately small, and the food canal unusually long.

The Ungulates were the most numerous and important mammals of Tertiary time, and those ancient species were the ancestors of the present specialized forms, the line of descent being clearly traced in some cases, especially in the horse, the most highly differentiated species.

The division of this order, proposed by Owen, into Artiodactyla (even-toed), and Perissodactyla (odd-toed), applies to the extinct forms, which as early as the lowest Eocene were thus separated, notwithstanding their generalization in other respects. The present tendency of the study is to regard the Artiodactyla and the Perissodactyla, not as constituting one order, but as two parallel series derived from the Condylarthra of Cope, the primitive type of hoofed mammals. *Phenacodus*, found at the base of the Eocene in America, having a small brain, five toes and tuberculated molars, possesses characteristics which point to the primitive ungulate type.

In the evolution of the present Ungulates there are two elements of special interest. The primitive ancestors of the order were probably omnivorous, like the existing pig, with tuberculated (bunodont) molars. But the specialized forms, as the horse of the odd-toed, and the ruminants among the even-toed, have developed molars better fitted for grinding, which have the enamel disposed on the effective surface in double crescents (selenodont dentition), whose convexity is turned inwards in the upper teeth and outwards in the lower. The other factor in the evolution was the relation of the small bones of the wrists and ankles to the surviving digits. In the loss of the side digits, and the enlargement of the central ones, it became necessary for the latter to either appropriate the carpal or tarsal bones belonging to the side digits, or for their own small bones to become properly enlarged. Nature employed both methods; but it has been shown by Kowalevsky, the Russian naturalist, that the first or appropriative method was the better, and that all the species in both sections in which the latter (inadaptive) plan occurred have become extinct.

The lacustrine deposits of the Rocky Mountain region have furnished great variety and numbers of Tertiary ungulates, which have been studied by Leidy, Cope, Marsh and Scott. They have found that all the existing genera of Perissodactyla, and the Camel and Peccary among Artiodactyla are true American types, and might have populated the Old World by migration.

ARTIODACTYLA. In this division the digits are four or two in number, and the axis of the limb passes between the third and fourth, which make a symmetrical pair, and by their compressed form have suggested the term "cloven-footed." The femur has no third trochanter. The dorso-lumbar vertebræ are usually nineteen. The true horns are in transverse pairs, with osseous horn-cores. The antlers of the *Cervidae* are themselves osseous, and deciduous, and are not regarded as true horns. The stomach is complex and the cæcum small. The hornless species have usually long canines. Some extinct forms as *Oreodon* and *Hyopotamus* had five digits on the fore foot.

Among larger mammals, now living, this division is the most numerous, and is extensively represented in the Tertiary, beginning with the Eocene. The species were few in the Eocene and included no ruminants. The earliest were apparently the ancestors of the Hogs, and had the tubercular (bunodont) dentition, which was common in the Artiodactyla through all the Tertiary, but is now found only in the Hogs and Hippopotami (non-ruminants).

The selenodont dentition is found in the upper Eocene, but a primitive or transitional form occurred in *Homacodon*, which lived in the middle Eocene, having a nearly continuous series of teeth, and the typical number, 44.

The two plans of foot structure are found in the Tertiary with both kinds of dentition, but no species survive with the "inadaptive" plan.

The Camels and Llamas diverged from the primitive stock in the Eocene, and became in the Pliocene the most abundant of the larger animals, except the Horse family. The hollow-horned ruminants appeared in Europe in the Miocene, but have not been found in America earlier than the Pliocene.

The true Sheep, Goats, Giraffe, Hippopotamus, and Old World Suillines (*Sus*, *Porcus*, *Phacochærus*), have not been discovered in America. The Suilline type, the most generalized of the Artiodactyla, and with bunodont dentition, began in America in the lower Eocene, and has been abundant ever since, being now represented by the Peccaries.

PERISSODACTYLA. These are the oldest and most abundant ungulates of the Eocene, and as a group are less specialized than the Artiodactyla, although the Horse, in feet and teeth, is the most highly differentiated species. In all the living species the hind feet have an odd number (3 or 1) of toes, and the Tapir is the only one with an even number (4) on the fore feet. The axis of the limbs passes through the third digit. In living species there are never less than twenty-two dorso-lumbar vertebræ, the femur has a third trochanter, and the horns, if present, are placed on the median line of the head, and are not supported on horn cores. In the extinct *Titanotherium* there are a pair of horn cores placed transversely. The stomach is simple and the cæcum large.

There are but three families now living, represented by the Horse, Rhinoceros, and Tapir, but these are closely connected by numerous extinct forms. Cope enumerated (1883) one hundred and ninety-two species, of which nineteen are living. He regards his *Systemodon* and *Ectocion* as parent types.

The complete pedigree of the Horse has been traced by Marsh, from the little *Eohippus*, of the lower Eocene, with four toes and the rudiment of the first on the fore feet, and three on the hind feet, through seven intermediate genera of successive horizons in the Tertiary, to the modern genus, *Equus*, in the upper Pliocene. *Miohippus*, from the lower Miocene, resembles *Anchitherium* Leidy, and *Protohippus* of the upper Miocene most resembles *Hipparion*. Marsh finds some forty extinct species in this group. It is certain that the horse originated in America, and roamed over both continents in Post-Tertiary time, and then for an unknown reason became extinct.

The *Paleotherium* is closely related to the early members of the Horse family, and Cope includes here some of the supposed ancestors of the horse. The family is entirely extinct since the Pliocene.

The Rhinoceros family has many representatives and a long line of ancestry in the Tertiary. *Cœnopus* from the Miocene of America is the earliest member of the family, of which there seem to have been two branches. *Diceratherium* had a transverse pair of horns on the nasal bones. Several species are found in American Pliocene, but none later. The living species have three toes on each foot, and horns on the median line.

The Tapirs constituted another family of American origin. It began in the Eocene, and exists to-day in South America and East India. They have three toes on the hind feet, with four on the fore feet, but the axis of the arm passes through the third digit. It is the most generalized type of living Perissodactyla.

The *Titanotherium* family is found only in the upper Eocene and lower Miocene of the American lake-beds.

Of the Lophiodontidæ Cope enumerates fifty species, all from the Eocene of America and Europe. They vary in size from that of a Rabbit to that of an Ox, and resemble most, among living aaimals, the Tapirs.

The paper was illustrated by exhibition of fossils and lantern views.

APRIL 24, 1893.

STATED MEETING.

The President, PROFESSOR H. L. FAIRCHILD, in the chair.

Seventy persons present.

The fourth lecture of the Popular Lecture Course was delivered by PROFESSOR LESTER F. WARD, of the U. S. Geological Survey, Washington, D. C., entitled:

THE VEGETATION OF THE ANCIENT WORLD.

The lecturer began with some remarks on the age of the different fossil forests, illustrated by the lantern views, using some of the estimates that have been lately made by eminent geologists as to the number of years that have elapsed since the beds containing the fossils were deposited. The lecture consisted of an explanation of some thirty views thrown on a screen, representing in chronological order the several floras that paleontology has revealed, beginning with the Devonian, as illustrated by Dawson, showing the great Carboniferous flora, chiefly from views from Heer and Gran d'Eury, then passing up through the Mesozoic and Tertiary to the Pleistocene. The Mesozoic and Cenozoic ages were largely illustrated from American specimens that have been figured in the works of Fontaine, Lesquereux, Newberry, and the lecturer.

MAY 8, 1893.

STATED MEETING.

The President, PROFESSOR H. L. FAIRCHILD, in the chair.

Seventy persons present.

The report of the Council recommended:

(1.) The payment of certain bills.

(2.) The election of DR. DANIEL G. HASTINGS as an active member.

The report of the Council was adopted and the candidate was elected by formal ballot.

The following paper was read:

BACTERIA AND THE PUBLIC HEALTH.

BY PROFESSOR CHARLES WRIGHT DODGE.

The lecture, which was popular in its nature, was introduced by a brief glance at the yeast plant, which in its structure and some of its habits bears a general resemblance to bacteria. The morphological and physiological means of classification of bacteria were mentioned, then the various points of structure, the functions of the different parts and the methods of reproduction were discussed. The conditions of life as shown by the relation of bacteria to moisture, air, temperature, food supply and light were reviewed, and mention made of the products of the vital activities of bacteria, *e.g.*, fermentation, putrefaction, nitrification, and the formation of gases and pigments, and the exhibition of fluorescence and phosphorescence. Some of the methods by which bacteria are studied were illustrated, and the special apparatus used in bacteriological investigation exhibited and explained. The lecturer then passed on to a general discussion of these organisms in their relation to man, taking up briefly the topics of dust and ventilation, water supply, filtration and sewage, clothing, food, social customs, etc., as sources of infection. A hasty glance at certain common diseases as diphtheria, tuberculosis, typhoid fever and cholera was then made, the reasons given for considering such diseases of bacterial origin; some of the possible sources of infection named, and precautions given to assist in avoiding infection.

The lecture was illustrated by charts showing the structural features of various forms of bacteria; by a large number of pure cultures on various nutritive media to show characteristic growths; by mixed cultures made by exposure of culture plates to air, water, etc.; and by cultures made from various foods, and from books, money, clothing, etc., etc. Microscopic preparations of pathogenic and non-pathogenic bacteria, and sections of infected tissue were shown. The various utensils and pieces of apparatus used in a bacteriological laboratory were also exhibited.

The paper was profusely illustrated by cultures of bacteria, microscopical slides and bacteriological apparatus.

June 12, 1893

STATED MEETING.

The President, Professor H. L. Fairchild, in the chair.

Ten persons present.

The Council report recommended the payment of certain bills. The report was adopted and the bills ordered paid.

Upon motion the Rules were suspended, and Professor Lester F. Ward was elected an Honorary Member.

Dr. M. A. Veeder spoke of the Foucault pendulum experiment, and its relation to the movement of storms.

After discussion, it was voted to appoint a committee of five members to conduct a pendulum experiment in Rochester with a non-magnetic wire, and at a limited expense.

The following committee was appointed: Dr. M. A. Veeder, Prof. A. L Arey, Prof. A. L Baker, Mr. Arthur L. White, Mr. William Streeter.

Dr. M. A. Veeder made a report upon the subject of auroras and the observation of auroral phenomena. He spoke of the preparation made by Lieut. Peary and others to take observations in high latitudes and the coöperation of foreign governments, notably the Scandinavian and Russian, and stated that a mass of material had been accumulated in this line as a result of action initiated by this Society.

October 9, 1893.

STATED MEETING.

The President, Professor H. L. Fairchild, in the chair.

A small number of persons present.

The Council report recommended the payment of certain bills, which were ordered paid.

Hon. Martin W. Cooke read a paper on

THE FIGURE OF THE EARTH.

(Abstract.)

The figure of the earth is due to the constant action of forces which determine the pressure of the particles constituting the globe. It is the same that it would be if the earth were composed entirely of water. Such a globe of water affected only by its own gravitation would assume the form of a perfect sphere. Its rotation would bring into operation another force called centrifugal force. Both these forces act upon each particle separately—gravitation drawing it towards the centre of the globe and the other force urging it away from its own centre of gyration in the direction of the radius. At the equator the centre of gyration is the centre of the earth and the operation of the centrifugal force is there in direct opposition to the earth-pull. In every change of latitude along any meridian there is a change in the direction in which the force of gravitation, or earth-pull, acts upon the particles; but the direction in space in which the centrifugal force urges them does not change, for the centres of gyration change along the axis with every change of latitude.

The intensity of the earth-pull, affecting particles of the same mass, varies slightly by reason of the ellipticity of the earth from the equator along any meridian to the pole; but the intensity of the centrifugal force varies as the cosine from maximum, at the equator, which is about one two hundred eighty-ninth of the earth-pull, and vanishes at the pole. Inasmuch as the earth-pull changes from opposition at the equator for every change of latitude, the weaker force (the centrifugal) is resolved—one component acting vertically, or in direct opposition to the earth-pull, and the other at right angles to it and towards the equator.

It was claimed that the earth-pull upon a particle at the 60th parallel of latitude minus the vertical component of the centrifugal force affecting the same particle, plus its horizontal component, constitutes a combination of forces greater than any affecting particles upon any other parallel of latitude. The force so combined with that of the earth-pull is .366 of the whole centrifugal force of a particle at the equator; at the 30th parallel the vertical component of the centrifugal force of a particle is equal to the horizontal component and one counteracts the effect of the other in its pressure. At the 70th degree the difference between the horizontal component and the vertical, in favor of the horizontal, is equal to .3 of the centrifugal force of a particle at the equator. The equilibrium is maintained by the difference of level. The shallower vertical plane at the 60th parallel sustains the deeper planes at the other degrees of latitude.

It was contended that the pressure of a particle at the surface, under the influence of these three forces, is represented by the earth-pull minus the vertical component plus the horizontal component while equilibrium obtains. It was conceded that if the centrifugal force should act at all points vertically, or in direct opposition to the earth-pull, or if the whole force should act at right angles to it, the globe would asume the form of an ellipsoid; but it was shown that none of these conditions obtains. The reader maintained that the greatest pressure in the vertical plane is at the 60th parallel of latitude and that such pressure varies but slightly between the 70th and 40th degrees of latitude. From the 40th parallel it diminishes rapidly, with a corresponding rise of the surface, to the equator, and from the 70th parallel it diminishes to the pole. The argument was that the shape is maintained by the varying pressures in the different vertical planes, and is higher or lower as this pressure is weaker or stronger; and, consequently, that the shape of the surface of the earth between the 70th and 40th parallels is very nearly that of a sphere but with the lowest point at the 60th parallel. The shape is maintained by this varying pressure—the bulging at the equator commencing in both hemispheres at the sixtieth parallel of latitude.

October 23, 1893.

STATED MEETING.

The President, Professor H. L. Fairchild, in the chair.

Forty persons present.

Remarks regarding scientific observations made during the previous summer were made by Dr. E. V. Stoddard and Mr. F. W. Warner.

The death was announced of Mr. George H. Harris. Upon motion of Dr. Stoddard the President was authorized to appoint a committee to prepare resolutions upon the death of Mr. Harris.

The President subsequent to the meeting appointed as the above committee, Mr. S. A. Ellis, Mr. Adelbert Cronise, Mr. H. C. Brewster.

The following paper was read:

THE GEOLOGICAL HISTORY OF ROCHESTER, N. Y.

By Herman LeRoy Fairchild.

To interpret from the rocks the long geological story of this locality some fundamental geological principles must be clearly in mind.

The vast majority of all sedimentary rocks (to which group belong all those of Rochester, except the superficial drift) are layers of detritus formed in the sea, and derived from the decay and wash of neighboring land. Such accumulations are possible through the oscillations of level, which may slowly carry great continental areas under the sea, to re-elevate them, probably, at a later time. The thickness of strata may bear a direct relation to the amount of subsidence. This does not signify that the continental areas and the oceanic basins ever change places, but simply that submerged areas of a continent are no less part of the geological continent in that they lie below sea level. Whether or not a portion of the continent be dry land depends upon slight changes of attitude toward the plane of water surface.

The character of sediments indicates the conditions under which they were formed. A gravel deposit means strong currents and consequently shallow water, and a near source of supply. Finer material, as sand, indicates less velocity of water, probably greater depth and greater distance from land. A pure quartz sand indicates a great amount of movement, immediately or remotely, necessary to remove by trituration, assorting and solution the other minerals of the original crystalline composite rock. A stratum of shale (indurated silt) can be deposited only in slack water, and if of great horizontal extent indicates considerable depth of sea and probably long transportation.

Shallow water deposits are frequently marked by sinuosities due to waves. Exposure above water at low tide is shown by several features, as shrinkage-cracks, rill-marks, rain-pits. A near shore-line is proven by cross or oblique bedding, and other phenomena produced by variable currents due to changing winds and tides. Climatic conditions, and to some extent depth, are indicated by the nature of the organic remains.

Limestone rocks are produced by the comminution of the calcareous framework of low organisms. Such rock may be formed upon the place where the animals grow, the detritus mingling with the larger masses, as in the coral limestone now forming upon reefs in tropic seas, requiring pure water and violent wave action; or the detritus may be far borne by currents and left as a fine, structureless, organic sediment. If derived from the destruction of older limestone rocks, the lime sediment may be mingled with other silt in any proportion.

Aqueous sediments of volcanic origin are distinguished by their mineralogic character, and deposits entirely of meteoric origin are confined to ocean areas far from land.

Beneath the city of Rochester the drill has penetrated to a depth of over 3,000 feet, giving us fortunately a section (1) of the underlying strata down near to the crystalline base. From the character of these rocks we may read the main events in the history of this locality since Archean time, for even geological history with its "millions of years" has its early period of the unknown. What the local conditions were during Archean and Algonkian time, a duration as great, perhaps, as all time since, we can only conjecture. This area may have been a portion of the early land mass, which supplied by its destruction the material for Archean strata, or from the earliest time it may have been continually under the continental sea.

The following table gives the Rochester strata in order of superposition, the oldest at the bottom :—

CONDENSED SECTION OF THE ROCHESTER STRATA.

Magnesian limestone	60+	feet,	Niagara Group.
Dark shale	80	"	" "
Limestone and shale partings	18	"	Clinton Group.
Green and purple shale	24	"	" "
Limestone	14	"	" "
Green shale	24	"	" "
Red sandstone and shale	1075	"	Medina Group.
Blue and gray sandstone	83	"	" (Oneida) Group.
Dark shale	598	"	Hudson-Utica Group.
Dark limestone	954	"	Trenton Group.
Gray limestone	40	"	Calciferous Group.
Dark shaly limestone	50	"	" "
Black magnesian limestone	44	"	" "
Dark calcareous shale	3	"	" "
White siliceous magnesian limestone	2	"	(?)
Ferruginous quartz	(?)		(?)

(1) The record of this well is published in detail in these Proceedings, Vol. 1, pp. 182-186. "A Section of the Strata at Rochester, N. Y., as shown by a deep boring." By H. L. Fairchild. Republished with notes in article by C. S. Prosser in this Volume, pp. 91-92.

Beginning with the oldest legible record, we have a white granular calcareous rock, ([2]) which in age may be Calciferous, or the previous Cambrian, or, possibly, the still earlier Archean. The uncertainty arises from our lack of information as to subjacent rock which was only touched by the drill. Under the microscope the grains of this siliceous limestone rock appear rounded or water-worn, the effect of the grinding, transporting and assorting power of water, and indicating detrital origin. This sand was deposited in not very deep sea, nor very far from land, which was probably somewhere to the north or northeast. The particular conditions did not exist long, for only some two feet of this limestone was laid down. Then there came a deepening of the water, and withdrawal of the shore-line, or else by the interposing of some barrier to the currents the latter were checked or diverted. These changes in the geography may be regarded as inaugurating a new geologic period, the Canadian or Calciferous. The sediment became a silt (now indurated into a calcareous shale) being the finer portion of some land-derived detritus mingled with some calcareous matter. It reached only the small depth of three feet when the oceanic conditions of the locality were intensified, and the sediment became nearly pure lime, the land silt being excluded. This dark limestone accumulated to a depth of 44 feet. Then the changing geography again allowed some silt to reach the area, and 50 feet of dark gray, clayey limestone accumulated. Again the silt was excluded, and 40 feet of pure, drab-colored limestone were formed. These Calciferous beds, consisting of 134 feet of variable limestones resting upon a thin base of shale, represent marine conditions, with the exclusion of strong currents bearing coarse detritus.

Concerning the life history of this period we have knowledge from the fossils of the same geologic horizon accessible at other localities. If any vertebrates lived they have not been found. But below the vertebrates there was a profusion of animal life representing all the great marine groups. Crustaceans were abundant, chiefly trilobites. Mollusks predominated, especially brachiopods. Plants so far as known, were wholly marine.

(2) In the well-record as originally published (see foot-note above) this rock was called a sandstone. An analysis of the sample (63), which contains some black shale derived from the stratum next above, made by Mr. V. J. Chambers of the University of Rochester, gives the following:—

Insoluble in hydrocholic acid,		63 per cent.
Soluble in hydrochloric acid—		
$CaCO_3$	20.93	
$MgCO_3$	14.08	
Residue	1.99	37 per cent.
		100 per cent.

Following the Canadian period was an epoch called the Trenton, during which the sea-bottom here was slowly sinking, thus permitting the accumulation of a great limestone terrane. Organic growth and decay during a vast time is represented by 954 feet of dark limestone. Roughly estimating from the present growth of coral reefs, this limestone of the Trenton would require 190,000 years. It might have taken a much greater time. Plant and animal life was slowly changing, and the oldest known fishes, the first vertebrates, are found in this horizon (3) in Colorado.

The close of the Trenton and the beginning of a new epoch was determined by such change in geographic features as to throw open this region to wash of land, thus stopping the growth of lime-producing organisms and the accumulation of limestone, and producing instead a deposition of silt or clay. In New York terminology, this epoch is known as the Hudson or Hudson-Utica (the names indicating localities where the strata are found at the present surface), and is represented here by 598 feet of dark-colored shales, which required for their accumulation a vast duration. The Trenton limestone terrane and the Hudson shale terrane, together representing the Trenton period, are both widely developed, eastward to the Hudson river, and westward through the Mississippi region, indicating that the marine conditions were widely uniform in those early times, and that the source of silt supply, or the dry land, was probably to the north.

The close of the Trenton period is the end of the great age of the Lower Silurian, which includes all the formations thus far considered. The transition is marked here by the change from silt to sand deposit due to shallowing of the sea, but this locality was not lifted entirely out of water as were areas in the east. The next formation is 83 feet of gray and blue shaly sandstone belonging to the Oneida or Oswego epoch and regarded as the base of the Medina, from the fact of its local character.

The Oneida epoch and all the subsequent time represented by our strata are included in the Niagara period of the Upper Silurian age. But the strata are various and important, and mark minor time divisions. The blue-gray sands of the Oneida were soon buried beneath the dark red sands of the Medina. Over 1,000 feet of this sediment accumulated, of which the uppermost 100 feet shows in the lower Genesee ravine. The Medina beds indicate wide-spread

(3) Bull. Geol. Soc. Amer., Vol. 3, pp. 153-172. "Preliminary Notes on the Discovery of a Vertebrate Fauna in Silurian (Ordovician) Strata," By C. D. Walcott.

shallow waters, a slowly subsiding sea bottom, and the degradation of some land area of iron-bearing rocks, which should supply the peroxide of iron that gives the red color. This is a remarkable formation in composition, thickness and extent. The conditions seem to have been such as are usually transitory, but which in this case persisted for a vast time over considerable area. The shallow depth was here preserved by slow subsidence, although slight changes of conditions produced variations in the texture of the rock.

The deposition of the red Medina sands ended with remarkable abruptness, and subsequently, whether immediately or not is uncertain, a fine greenish silt was filtered over the bottom, and this continued until in this locality 24 feet were accumulated. Probably this indicates a sudden increase of depth. By some physical change the velocity of the currents over this locality was certainly checked, either by increase of depth or by the raising of barriers. This shale, called the Lower Green Shale of the Clinton, terminated as abruptly as it began. The argillaceous was replaced by calcareous sediment, and 14 feet of limestone accumulated, the Lower Clinton (or Pentamerus) limestone. These sudden and frequent changes of sedimentation, from siliceous to argillaceous, from argillaceous to calcareous, or the reverse, are difficult to explain for want of knowledge as to the physical conditions of the surrounding regions.

Near the base of the Lower Clinton limestone occurs a bed of hematite iron ore of singular character. It is about a foot in thickness, chiefly pure peroxide of iron, more or less minutely concretionary, fossiliferous, and probably accumulated upon the sea-bottom as a sediment. (4) In other areas of the Clinton the ore may have a different horizon or position in the succession of beds, and in some localities it is of considerable thickness. The source of this iron is unknown. (5)

When the lime deposition gave place to silt another 24 feet of greenish clay were formed. In this Upper Green Shale of the Clinton there are found at one horizon lenticular masses of pure limestone wholly composed of the consolidated shells of a tiny Brachiopod mollusk (*Leptocœlia*) which formed colonies at certain spots upon the muddy sea bottom. These masses of molluscan limestone are exceedingly interesting, and clearly prove and illustrate the organic

(4) "On the Clinton Iron Ore," by C. H. Smyth, Jr., Amer. Jour. Sci., Vol. XLIII, pp. 487-496.

(5) All these strata, from the Medina upward, are clearly shown and are accessible for examination along the old road known as Buell Avenue, north of Seneca Park bridge, below the lower falls, west side of the ravine.

origin of the rock. The lens-like masses sometimes blend horizontally and form an irregular thin stratum, making what Dr. James Hall fifty years ago named the "Pearly Layer." (6)

Again the silt gave place to limestone, but the change was gradual and not complete. Thin beds of limestone with layers of silt intervening make the 18 feet of the Upper Limestone of the Clinton group. With the lime accumulation there was considerable silica, and masses of chert are found and siliceous replacement of the fossils.

The Clinton epoch in time is thus represented here by alternating strata, two strata of shale and two of limestone, all requiring deep or comparatively quiet waters. The alternation of muddy water, producing silt deposit, and clear water, allowing limestone accumulation, became in the Upper Limestone rapid and sudden changes, apparently not dependent upon changes of depth, but upon varying direction of the sea currents. When the currents reaching this locality came from near some land the detritus was swept in and shale accumulated, but a change in the direction of the currents bringing in the wash from some coral reef or limestone beach permitted the calcareous accumulation.

From the limestone and silt of the Upper Clinton, the change was to a coarser silt or arenaceous clay. Of this firmer shale 80 feet were deposited here, called Niagara Shale. This was succeeded and buried by the Niagara limestone, these two strata making the Niagara group. Further westward, as at Lockport, this limestone formed as a veritable coral reef, and even here large corals are found imbedded in the finer mass.

With this Niagara limestone ends the visible hard-rock record of our history. But it is certain that some later records have been destroyed—that is, some higher strata have been removed. The sea bottom would hardly be elevated so quickly as not to permit some detrital deposits upon the limestone, and probably heavy beds of shale and even limestone once capped the Niagara in this locality, which has itself been deeply eroded. Our strata dip or incline slightly to the southward. As we pass south we find in successively higher horizons the shales of the Salina group, and the limestones of the Onondaga and the Corniferous, all of which may have extended northward so as to bury this locality. So we can never determine the geologic date when sedimentation ceased here. But there was a day, sometime during either the Upper Silurian or the

(6) Natural History of New York, Part IV, Survey of the Fourth Geological District, by James Hall, Albany, 1843.

Devonian ages, when by the slow uplift of the land northward this Silurian sea-border region was permanently elevated above the Devonian sea. Immediately rock formation ceased and rock destruction began. Since that day, and for an immense duration of time, the history of our region has been wholly one of degradation. This was by chemical decay and disintegration under atmospheric agencies, erosion by rain and streams, the loosened material being borne off to the sea to form the marine sediments, now uplifted as rocks of later ages, or still forming in the oceanic waters. How long could this have lasted? We can gain a faint idea of the immensity of the time by enumerating the formations which have accumulated since the Niagara period: the remainder of the Upper Silurian formation with about 3,000 feet of shale and limestone; the Devonian with 20,000 feet of shale and sandstone and limestone, and four well marked periods; the Carboniferous with its three periods and 20,000 feet of sediments; the Triassic with 15,000 feet of sediments; the Jurassic with 5,000 feet; the Cretaceous with 30,000 feet; the Tertiary with three periods and 20,000 feet; a total of over 100,000 feet of slowly forming marine sediments. Geologic time, that is, since the ocean existed, has been estimated by geologists from 20,000,000 to 200,000,000 years. Probably the time since the Niagara is about one-half of the whole. During all these ages the work of destruction was carried on over this region, and a great depth of rock was doubtless removed. The topography or surface configuration was unlike that of the present, and this northern part of the continent stood in the Tertiary at a higher altitude. The drainage must have been very different and much more vigorous. There may have been in later time a stream having partly the same hydrographic basin as the Genesee, but of its course and features nothing is definitely known. Lake Ontario was not then in existence. There were no lakes and no cataracts in all this region, as they belong to the adolescent phase of streams. The character of the surface material was unlike that of to-day, being a true soil of decomposition, not a sheet of transported matter or drift.

The characteristic land life of the several ages came into being, flourished, culminated and disappeared: Amphibians in the Devonian and Carboniferous; true reptiles in the Carboniferous and Reptilian; Mammals and Birds in the Reptilian and Tertiary. During the Tertiary the Mastodon and Mammoth roamed over this region, with other strange creatures. No good evidences of man are found.

The forests probably surpassed those of to-day in the size and luxuriance of individual plants, for the climate was sub-tropical.

At last there came a remarkable change. It was felt at first in a slow lowering of temperature. Then with a decided change of climate, due to the height of land and the southward creeping of the polar ice-cap, came a change in the fauna and flora. In course of time the arctic ice-sheet reached and buried this region and expanded to the southward. For many thousands of years accumulation of snow in the highlands north caused a slow movement of the continental glacier over this area. The depth of ice at its maximum may well have been as much as two thousand feet. (7) By its weight and motion the superficial decomposed rocks were pulverized and removed, and in some places the erosion ate deep into the solid strata. The old drainage channels were either obliterated or filled with debris; a sheet of heterogenous drift was spread all over the uplands; huge masses of unassorted rocks and clay were accumulated at numerous places, while ridges of partially assorted matter were piled up by the action of the sub-glacial rivers. The Pinnacle Hills are a deposit of the latter kind. (8) Some American glacialists believe that there were two or more glacial epochs, with one or more interglacial epochs, when the ice sheet retreated far to the north, and that during the interval drainage channels were established, and vegetation took possession of the surface, or peat accumulated in the swamps, to be destroyed or buried under the re-advance of the ice. During the latter part of the Ice age the prevailing motion here was from the northeast, and the country is strewn with a great variety of hard boulders brought from the St. Lawrence and Canadian regions and intermediate points.

The evidence of human occupation of this northern region during glacial times has probably been over-estimated, and is not established to the satisfaction of the geologists.

The lake basin of Ontario was produced during the Ice age, probably by enlarging a pre-existent Tertiary valley and river channel, with some movements of depression and elevation of adjacent areas. After the recession of the ice-sheet from this area the Ontario depression was flooded, due to subsidence of the land, and the barrier of the ice in its northward retreat, so that a larger

(7) The distance from Rochester southward to the glacial boundary is about 75 miles. An average gradient of the glacier surface of 30 feet per mile would give something over 2,000 feet. See Professor T. C. Chamberlin's maps of the glaciated area in Third Ann. Rep., U. S. Geolog. Survey.

(8) "Eskers near Rochester, N. Y." By Warren Upham, in this volume, pp. 181–200.

lake called Lake Iroquois, (9) covered portions of this region and left shore lines or beaches, of which the "Ridge Road" is the most conspicuous near Rochester. Areas below the level of that beach have their glacial drift in many places covered thinly with lacustrine silt. Irondequoit bay was probably filled with such lake deposit. The final retreat of the ice and the lowering of the lake left the atmospheric agencies free to produce the surface configuration and drainage which we now have. The lacustrine deposits and underlying glacial drift have been eroded, producing the sand hills and the peculiar topography about Irondequoit, while the Genesee has carved for itself through the drift and rock strata the ravine in which it now flows. Niagara canyon has a history similar to that of our Genesee, and estimates upon its rate of formation allow several thousand years. The conclusions from all sources as to the length of time since the Glacial period seem to indicate that it has been only some 6,000 to 10,000 years. (10)

As exposed land above the sea our locality is very old, and has witnessed the greatest physical changes of the continents, in land expansion and mountain-making, and the evolution of the higher forms of life.

The geologic history of this locality may be summarized as consisting of four great divisions; first, the time of continuous submergence beneath the sea and sedimentation, lasting from the Archean to perhaps the Devonian; second, the time of exposure above the sea and erosion, from the Devonian to the Glacial period; third, the relatively short time of glaciation; and fourth, the present brief period of the renewal of the conditions of subaërial erosion.

The paper was discussed by Dr. E. V. Stoddard, Professor A. L. Arey and others.

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(9) See articles: Warren Upham, *Bulletin of the Geological Society of America*, Vol. 2, pp. 260–264. G. K. Gilbert, "Changes of Level in the Great Lakes," *The Forum*, Vol. 5, June, 1888, "The History of the Niagara River," 6th Ann. Rep. Commissioners of the State Reservation at Niagara, for 1889, Albany, 1890. J. W. Spencer, "The Deformation of Iroquois Beach and Birth of Lake Ontario," *Amer. Jour. Sci.*, Vol. 40, 1890, pp. 443-451.

(10) For a succinct statement of the concurrence of geological evidence bearing upon this point, see *The Journal of Geology*, Vol. II, page 142, in article on "The Glacial Succession in Norway," by Andr. M. Hansen.

NOVEMBER 14, 1893.

STATED MEETING.

The President, PROFESSOR H. L. FAIRCHILD, in the chair.

Thirty persons present.

The Council report recommended :

(1.) The payment of certain bills.

(2.) The election of the following candidates as active members :

MR. WILLIAM C. BARRY,
MR. WILLIAM E. CRANE,
MR. JAMES B. MORMAN,
MR. EDWARD D. T. SWIFT.

The report was adopted, the bills ordered paid, and the candidates were elected by formal ballot.

The Librarian, MISS MARY E. MACAULEY, made the following report which was read by the Secretary :

The Librarian would respectfully submit the following brief report : Since the adjournment of the Society in June, there have been received about three hundred pamphlets and fourteen bound volumes. As the exchange list of the Academy now includes the leading foreign societies, as well as those of America, we are in almost daily receipt of valuable additions covering the whole field of science, so that by the end of the year the library will probably number 2,500 volumes. We also receive regularly a number of valuable periodicals. Among these may be mentioned *The American Naturalist; Amer. Microscopical Journal; Botanical Gazette; Bulletin Amer. Geographical Society; School of Mines Quarterly; Canadian Entomologist; Technology Quarterly.* MARY E. MACAULEY,
Librarian.

The following memorial was read :

A MEMORIAL OF GEORGE H. HARRIS.

BY MR. J. G. D'OLIER.

In the year 1816, there moved to Rochester from Otsego county, N. Y., a Mr. Daniel Harris. This gentleman purchased a farm which included what is now Mount Hope Cemetery, and built a log cabin in front of where Mr. Ellwanger's residence now stands. With other children he brought with him Daniel Ely Harris, a boy of three years. Young Daniel's boyhood was spent on the farm, sharing the hardships and pleasure of pioneer life.

In 1836, Daniel Harris married Miss Strickland, a relative of Agnes Strickland, authoress of "The Lives of the Queens of England" and a sister of General Silas A. Strickland. Of this marriage was born George Henry Harris, the subject of our sketch, in West Greece, Monroe county, on the 29th of December, 1843.

During George Harris's early years his father was a contractor, which probably accounts for the fact that while yet a lad he had lived in Charlotte, Rochester, Hinsdale and Buffalo. His grandfather was also interested in public works and almost ruined himself on a contract to deepen a section of the Erie canal, having to blast an immense quantity of rock not counted on. When George was a lad of twelve years his father moved with the family to Green Bay, Wisconsin, where he engaged in the lumbering business. As the boy was in delicate health the physician advised his father to take him out of school and let him run wild in the woods for a year. That year instilled in the boy a love of nature, canoe, camp and rifle that never waned while life lasted. It was always a pleasure to him to live over in memory those days, telling of the many adventures that he had with a young companion. Having regained his health he was apprenticed, at the age of fifteen, to a watchmaker. This man was a student of history, and without doubt it was largely due to his influence that the boy's taste turned to historical subjects. Three years later he came back to Rochester and entered Pierce's Military Academy, in a building that stands on the northeast corner of Spring and Fitzhugh streets. As in everything he undertook he soon mastered the details of military tactics, and in 1863 he joined Company K, 54th Regiment, in which he held the rank of orderly sergeant. When his regiment was disbanded he returned to Rochester, and his health again failing, he engaged in farming for a time, after which he went to Oil City, and in the spring of 1868 to Omaha. Here, after trying farming and store keeping, he was appointed on the night force of the post office. In this duty he came near ending his career in a bloody adventure with a burglar. Later he was appointed first mail clerk between Omaha and St. Joseph.

Trusting to a friend to get out papers for a claim which he had taken up near Omaha, and upon which he had spent all his spare cash, he found like many another that the friend had played him false and had taken out the papers in his own name. Returning to Rochester he studied surveying and landscape gardening under Mr. Stillson at Mount Hope.

In 1872 he married Miss Julia E. Hughes, and moved to Peterborough, Canada, where he laid out and beautified the Little Lake cemetery, which stands to-day a monument to his skill as a landscape gardener, being one of the most beautiful in the Dominion. Having finished his work in Peterborough he moved to Detroit, Mich., where he took charge of Elmwood cemetery, but once more his delicate health stood in his way and he was forced to give it up. He then returned to Rochester. This was about 1877.

And now commences that part of his life which is most interesting to us. Two years after coming back his family went away for a time, and to while away the lonesome hours after his day's work was done, he took up the study of history, reading everything he could get relating in any way to the early settlement of the Genesee Country, as well as all works bearing on the Seneca Indians. He also took long tramps following up the old Indian trails and locating their villages, looking up old settlers and gleaning from them all they could remember of pioneers and pioneer life. It was most interesting to listen to him catechise some old resident, awakening memories by some incident of long ago. Mr. Harris made friends wherever he went. His gentle nature coupled with a rare faculty of thinking about the little things of life endeared him to his friends and companions. A striking characteristic was his capacity for details.

All his life Mr. Harris was a frequent contributor to the newspapers, and on all sorts of subjects. For several years he was editor of the "Odd Fellows' Column" in the *Rochester Herald;* but his contributions to the history of the Genesee Country have given him a unique place among local historians and entitle him to more than a passing notice by this Society. His best known work, that has made his name familiar to all students of our early Indian History, is "The Aboriginal Occupation of the Lower Genesee Country." The value of this work cannot be too highly estimated, containing as it does facts gathered from old residents, with whom would have perished much that is of great interest, had it not been for the untiring labors of Mr. Harris.

In Mr. Harris's terminology of the Genesee Country he has left us a most valuable collection of Indian names. In tracing the Indian paths or trails that once crossed and re-crossed the Genesee Valley like a network, he had a field of labor distinctively his own and that he excelled in it is witnessed by the following letter from the Honorable George S. Conover :

To the Editor of the Morning Herald:

The Seneca Indians have long been aware of the great interest that George H. Harris of Rochester, N. Y., has manifested in resurrecting Indian history, and the energy he has exhibited in locating the sites of their former villages. On account of the remarkable success he has had in tracing out and locating the Indian paths or trails that once laced the Genesee Valley, they have recognized and called him the Pathfinder. A letter lately received from Chester C. Lay, the United States interpreter for the Senecas on the Cattaraugus reservation, says that in recognition of so eminent an Indianologist as Mr. Harris has become, it has been decided to show their appreciation by adopting him into the tribe and bestowing upon him the name of Ho-tar-shan-nyooh, meaning "he has found the path," or "The Pathfinder." As Mr. Lay is of the Wolf Clan, it necessarily follows that Mr. Harris among his Indian brethren will be recognized as a member of the Wolf Clan, the same clan to which Red Jacket belonged. This is a well merited tribute and worthily bestowed, as Mr. Harris has been for many years a diligent and painstaking investigator of early local history, and has won for himself an enviable reputation, being an acknowledged authority on Indian antiquities of the region around Rochester and the Genesee Valley.

Geneva, N. Y., February, 1889. (Signed) HY-WE-SAUS.

In making researches Mr. Harris was struck by the prominent part played in the early history of Western New York by Horatio Jones, his name recurring again and again. He was a man of good family, whose early training, coupled with a fine physique and wonderful powers of endurance, eminently fitted him for the remarkable sequence of adventures through which he passed. Running away from home when a boy, to fight the Indians, he was captured, made to run the gauntlet and finally adopted by a Seneca family. Becoming master of the language and customs, he obtained the entire confidence and esteem of the Indians and figured prominently in many important treaties as interpreter. Indeed Mr. Harris found this man to be so woven into the early history of the country that he became impressed with the idea of making him the grand figure around which to group the many startling scenes of early times. This plan he carried out; and in writing the life of Horatio Jones he has written the history of the Genesee Country, at the same time working in numerous incidents of Indian life, warfare, captivity, hunting and sport, that will make the book of thrilling interest. Before he laid down his pen forever he had brought his hero down to a point where everything of historical value had been recorded, and it only required a few closing scenes to have the work ready for publication. Mr. Harris left many other manuscripts which when compiled will undoubtedly be of much public interest.

The following letter is a touching tribute to his memory :

HON. G. S. CONOVER,

MY DEAR FRIEND :—I have just learned of the death of Geo. H. Harris, Esq., that eminent co-laborer in the field of Indian investigation, and I assure you my heart is sad at the unexpected intelligence. One by one the old familiar names and faces fade from view, and that band of faithful, earnest workers in the broad field of local research becomes smaller in numbers. Cut down in the prime of life, full of ripe experience, only fifty years of age, his loss is, indeed, irreparable. Often during my journeys in making personal investigation of the many historic localities connected with our early history, have I crossed the trails where he had visited, and I found but one opinion concerning him, the courteous gentleman, the ripe scholar, the faithful investigator. Often have I compared his conclusions with my own, after a careful survey, and have been compelled to acknowledge the rare fidelity of his work. In his wanderings he was beloved by all with whom he came in contact, the learned and the unlearned, the rich and the poor. He was an enthusiastic lover of Nature and many of his happiest hours were spent in traversing her forests and streams. A few weeks since I received a kindly note from him in acknowledgment of a trivial favor granted which I shall ever treasure, as it breathes the innate nobleness of the man ; full of the purest suggestions, and wishing me all success in my humble efforts to unveil the secrets of our early Indian history. God bless his memory ! My heart goes out in love and sympathy to his family in this their hour of deep affliction.

I am yours truly,

Shortsville, N. Y., Oct. 16, 1893. IRVING W. COATES.

Mr. Harris was an honorary member of the Buffalo, Waterloo, and Livingston County Historical Societies, and an active member of the Rochester Academy of Science, the Rochester Historical Society, and the American Association for the Advancement of Science.

WRITINGS OF GEORGE H. HARRIS.

Western New York. Sketches, Incidents and Historical Events of the Early Inhabitants. *Rochester Sunday Morning Herald.* August 17th to December 21, 1879.

Site of an Ancient Town Discovered near Rochester. *Rochester Sunday Morning Herald.* December 7, 1879.

Mound Builders. *Rochester Sunday Morning Herald.* October 31st and November 7, 1880.

An Ancient Fort. *Rochester Sunday Morning Herald.* January 25, 1880.

Aboriginal Remains on the Genesee. *Rochester Sunday Morning Herald.* October 23, 1881.

A Canoe Cruise Down the Genesee. *Rochester Sunday Morning Herald.* October 29 to November 26, 1882.

Western New York. The First Newspaper. *Victor Herald.* August 10, 1882.

Was He a Mound Builder? *Rochester Post-Express.* March 12, 1882.

Aboriginal Occupation of the Lower Genesee Country—being the first fifteen chapters of *Peck's History of Rochester.* 1884.

Early History of Western New York. *Livingston County Herald* January 28, 1886. *Rochester Post-Express.* January 13, 1886.

Joseph Brant. *Rochester Post-Express.* October, 1886.

Invasion of '64. *Rochester Post-Express.* February 7, 1887.

De Nonville's Expedition. *Rochester Morning Herald.* July 27, 1887.

An Historic Elm. The Story of the Great Elm on the Markham Estate. *Rochester Democrat and Chronicle.* May 13, 1888.

Aboriginal Terminology of the Genesee River. *Proceedings Rochester Historical Society.* 1889.

Pioneers of the Genesee Valley, the Markhams. *Proceedings Rochester Historical Society.* 1889.

Aboriginal History of Irondequoit. *Rochester Union and Advertiser.* March 9, 1889.

Traces of the Red Man, Shall the Parks be Named in Their Honor? *Rochester Morning Herald.* March 26, 1889.

Letters from the Pathfinder. *Rochester Post-Express.* September 14–15, 1889.

Root Foods of the Seneca Indians. *Proceedings Rochester Academy of Science, Vol. 1, pp. 106–117.*

Indian Bread Root. *Waterloo Observer.* May, 1890.

Indian Implements Found in Irondequoit. *Rochester Post-Express.* June 9, 1891. (Note in *Proc. Roch. Acad. of Sci., Vol I, p. 181.*)

Guy Markham; a Talk with the aged Pioneer. *Rochester Post Express.* January 3, 1891.

Guy Markham; Ninety-first Anniversary Celebrated in a Log Cabin. *Rochester Post-Express.* September 18, 1891.

Pioneers of the Genesee Valley; Van Campen and Church. *Rochester Post-Express.* May 21, 1892.

The Removal to Mount Hope Cemetery, in 1841, of the Remains of Lieutenant Thomas Boyd and other Soldiers of General Sullivan's Army. *Journals of Gen. John Sullivan's Indian Expedition.*

Elihu H. Grover. Sketches of His Life, with Historical Reminiscences. *Rochester Post Express.* May 2, 18—.

Campaigns of Baron La Hontan. *Rochester Post-Express.* August 4, 1892.

Mr. S. A. Ellis, in behalf of the committee on memorial resolutions, read a report as follows:

To the Rochester Academy of Science:—

Your Committee appointed to prepare a memorial of the late George H. Harris, beg leave to submit the following, and would respectfully recommend that it be entered upon the minutes of the Academy and that an engrossed copy be sent to the family of the deceased :

In the death of Mr. Harris, the Academy has lost one of its most helpful and valued members. He was widely known as a diligent and successful student of Indian history, especially that of the Six Nations, and was very familiar with the history of the early settlers of the Genesee Country. He was the trusted friend of the leading Seneca Chiefs now living; was an adopted Seneca and received the name of Pathfinder, on account of the information he had given regarding the "trails" through this region. In all matters relating to the Indians of Northern New York,—their life, manners, customs, burial places, castles, etc., his knowledge was both accurate and complete. He was a most conscientious and painstaking investigator, never committing himself to any statement until he was sure of his facts. This quality gave to all his work a permanent value and made him a safe guide in the fields of research he explored. It is to be hoped that the many interesting and valuable papers he had read before various societies and scientific associations, together with a large amount of material yet unpublished, may eventually be put into permanent form. They contain much valuable information not obtainable elsewhere. His collection of Indian relics, books and manuscripts bearing upon the subjects of his investigations, is the largest and best in this section.

Mr. Harris was a very busy man, having the management of a large property that demanded his constant care and attention, and it is worthy of record that his historical studies and investigations were carried on in the intervals of business and on holidays, periods that most men make little account of.

He was a most genial friend and an agreeable companion, and those who had the privilege of a holiday stroll with him in search of a "lost trail," the site of an Indian village, old burial place or camp ground, will not soon forget the delightful occasion. His loss in the realm of local history is irreparable, as he leaves no successor.

The sympathy of the members of the Academy is extended to the bereaved and sorrowing family.

S. A. Ellis,
Adelbert Cronise,
Henry C. Brewster,
Committee.

The report was unanimously adopted as the sentiment of the Society, and ordered published.

MR. ARTHUR L. WHITE, U. S. Weather Observer, read a paper entitled:

THE EFFECT UPON CLIMATE OF DEFORESTATION AND AFFORESTATION.

In this paper Mr. White suggested that the decadence of ancient Asiatic civilization might be partly due to unfavorable climatic conditions produced by deforestation. He gave statistics of the amount of woodland in the United States and in New York; the rate of timber destruction, and showed how at the present rate of cutting there would soon be a dangerous lack of forest. He discussed the causes of rainfall and the climatic effects of forests, and also considered their hygienic, economic and æsthetic value.

Remarks were made by Mr. Arthur S. Hamilton, President of the Forestry Association, and Mr. Herbert Wadsworth, of Avon, N. Y.

The President read a communication from the Smithsonian Institution in reference to the Hodgkins fund prizes for essays upon the properties of atmospheric air.

The President described briefly the results of the work of Mr. Frank Leverett in tracing glacial moraines through Western New York, and stated that the Pinnacle Hills esker was found to terminate at its western extremity near the Fireman's monument, Mount Hope Cemetery, in a low moraine passing through the southwestern and southern portion of the city in a direction approximately northwest and southeast.

DECEMBER 11, 1893.

STATED MEETING.

The President, PROFESSOR H. L. FAIRCHILD, in the chair.

A small number of persons present.

The following paper was read:

THE MECHANICAL PROBLEMS INVOLVED IN IMPROVED CANAL NAVIGATION.

By F. W. Warner.

(Abstract.)

It has been proved by actual experiment in this country as well as in Holland that it costs only about one-third as much to transport goods by canal as by rail. In railroad transportation, besides the coal and water used, the important factors of the wear and tear of ties, rails, plates, the rolling stock, the expensive lubricants, and necessary attention are all to be considered. In canal transportation these factors are all eliminated, and the weight of the freight and boat rests upon the water which is the best and cheapest lubricant in overcoming the friction of motion. In making the comparison of cost, however, it must be taken into consideration that the railroads have for the last forty years received the best thoughts of the most skillful inventors, and thousands of patents on new and useful appliances have been granted by the government, which have had for their object increasing the efficiency of the roads and decreasing the cost of transportation. It is different, however, in the matter of canal navigation, for transportation on the canals is hardly up to the standard of efficiency and economy which it had attained forty years ago.

The subject of the efficient and economical use of the water ways presents the most promising field for the skillful inventor. With the best mechanical and engineering skill given to canal navigation, we would find that the carrying capacity of the canal could be increased ten-fold and the cost of transportation could be reduced to a fraction of the present rate.

The problems which are involved in the subject of improved canal navigation are many and of a widely differing nature. In a brief paper it is only possible to outline some of them and offer suggestions as to their solution.

The problems of navigation naturally fall under the following heads: first, what motive power will prove most practicable of application, can be supplied at the lowest cost, and show the best results in speed; second, in what manner can this power be best utilized in moving boats; third, how can we best overcome the resistance offered by the water to the progress of the boats.

The first of these propositions has received the greatest attention but is in reality of the least importance. Electricity does precisely what is done by steam, and is more or less expensive according to the methods by which it is generated. It is certain that animal power which is now in almost universal use will soon be superseded by generated power; but exactly what that power will be is of little importance as compared with the other questions involved.

It is highly probable that electric energy generated by water power will be used on the ground of economy. There is sufficient water power, at the present time, running to waste between Buffalo and Albany to do the work of the Erie Canal for many times its present volume of business.

The question of the manner in which the power is to be applied opens up a wide and important field for study and experiment. The successful introduction of generated power upon the water ways will depend largely upon the manner in which the power is applied.

There are four methods presented by which the power may be applied: first, the power may be applied by the revolution of paddle wheels or propellers acting upon the water; second, the power may be applied in connection with a rail or cable suspended over the canal and above the boat; third, it may be applied in connection with rails or cables submerged and lying on or near the bottom of the canal; fourth, it may be applied to a motor or other device on the berm bank or on the tow path.

The propulsion of canal boats by steam power is in common use It is open to the objection of being injurious to the canal unless the entire prism of the canal is rubbled. The banks of an ordinary canal are washed down and weakened and the bottom is correspondingly filled. The power is largely wasted in agitating and pushing against the elusive and unstable water. Should the same power be exerted with a base or purchase upon *terra firma*, as, for instance, in pulling with a rope secured to a fixed object, a far greater speed would be made.

It is far easier to push a boat forward with a pole than to propel it with oars. Study and experiment on this line will inevitably lead one to the conclusion that the canal boat of the future will not be moved by a paddle or propellor, but will either have the motive power on land or upon the boat and acting upon a fixed object.

It is undoubtedly a practicable scheme to move a boat either by power, carried by the boat, acting upon a fixed rail suspended above the boat or by means of a moving overhead cable. There is no reason why a suspended moving cable drawing the boats might not be as practicable as a cable railroad. A suspended geared rail or sprocket chain, so suspended as to resist a longitudinal strain, and insulated so as to convey an electric current, with a trolley wheel geared so as to mesh into the trolley rail, would move a boat just as a street car is moved on the trolley system. Other practicable methods under this head have already been the subject of study and experiment. It is no less practicable to move the boats by means of submerged cables like the Belgian system which have already been operated on the Erie canal, or by submerged tracks, using either geared traction or beam track and partially submerged wheels. Several systems on this plan have been elaborated which would, if fairly demonstrated, possibly prove efficient and valuable.

By far the most simple and probably the most practicable method of applying generated power, is to apply it on the tow path, by traction; that is, a motor drawing the boat. Three mules with their sharp shoes gripping the path will draw two loaded boats two and a half miles per hour; while it will take an engine of from forty to fifty horse power, turning the propellor, to accomplish the same result. A motor of twenty horse power will draw a train of ten or more boats, if arranged under proper conditions, at a speed of from four to five miles per hour.

A traction motor would probably do best if operated by electricity. It should be low, narrow and heavy. Double tracks would admit of boats passing in both directions. A guard rail running lengthwise on the top of the motor, with the ends sweeping nearly to the ground, would act as an automatic device for picking up and passing the tow ropes. When navigation is suspended the tow path railroad could be used for transporting of freight and passengers.

The question of how to overcome the resistance of the water is probably the most interesting and important with which we have to deal. It is found in marine engineering that a steamer, we will say, of three hundred feet in length and thirty feet beam can be propelled almost as fast as a steamer but two hundred feet in length and the same beam, using the same power. For the same reason a single log fifty feet in length will tow much easier than five logs, each ten feet in length, connected by lines. The motive power is expended largely in displacing the water as the boat advances. Each boat in this way makes its own displacement. The motive power should be economized in making one displacement of the water for a train of eight or ten boats. The boats should be built with a convex bow and a concave stern so that when coupled together the train is flexible and can conform to the bends in the canal. The stern or rudder boat should be built so as to best answer the purpose of a rudder and be operated by ropes connected with the windlass on the bow boat. The places where the boats are connected should be covered with iron aprons so as to make an unbroken water line. These aprons could be worked by the man at the wheel so as to throw them out at right angles with the boats and act as a brake in checking the speed.

The greatest commercial need of the country at the present time is cheaper transportation between the great west and the seaboard. Capital is awaiting the development of a perfected system of canal navigation before constructing a great system of water ways from the Mississippi to the Atlantic. It only remains to combine the firm iron grip on *terra firma* of an improved motor with the heavy freights in boat trains, floating on the quiet waters of the canal, to reduce the freight rates to a mere fraction of the present cost. The problem of canal navigation can undoubtedly be solved on the lines above indicated.

The paper was discussed by Professor A. L. Arey, Mr. J. Y. McClintock, Mr. J. E. Putnam and others.

JANUARY 8, 1894.

FIFTEENTH ANNUAL MEETING.

The President, PROFESSOR H. L. FAIRCHILD, in the chair.

On account of the small number of members present, due to the stormy weather, the business of the Annual Meeting was deferred to the next stated meeting of the Academy.

JANUARY 22, 1894.

DEFERRED FIFTEENTH ANNUAL MEETING.

The President, PROFESSOR H. L. FAIRCHILD, in the chair.

A large number of persons present.

The Council report recommended the appropriation of money for Secretary's expenses. The report was adopted.

The Annual Reports of the officers were presented, as follows :

SECRETARY'S REPORT.

The report of the Secretary, PROFESSOR ARTHUR L. BAKER, is summarized as follows :

During the year fourteen meetings have been held, with an average attendance, not counting the popular lectures, of thirty three.

Eleven papers have been read, classified as follows:—Geology, two ; Astronomy, Bacteriology, Biography, Engineering, Geodesy, Mathematics, Mechanics, Meteorology, Zoölogy, one each.

Four popular lectures have been delivered, one each in Archeology, Ethnography, Geography, Paleobotany.

Twelve active members and one honorary member have been elected, and twelve members have been lost by death or resignation. The present membership is as follows:—honorary members, 10; corresponding members, 33 ; life members, 1 ; fellows, 37 ; active members, 118. Total membership, 199.

CORRESPONDING SECRETARY'S REPORT.

PROFESSOR CHARLES WRIGHT DODGE, the Corresponding Secretary, presented a report as follows :

As heretofore the work of this office has consisted mainly in distributing the publications of the Academy and receiving those of other societies sent in return. Of Brochure 2, Volume II, there have been distributed three hundred ten (310) copies to foreign societies, one hundred eighty (180) to societies in the United States and Canada, and thirty-three (33) to corresponding, eight (8) to honorary and one hundred fifty-one (151) to active members. The total number distributed is six hundred eighty-two (682), an increase of fifty-one (51) over the number of the last brochure. This increase is due entirely to the fact that many prominent societies, mainly foreign, have sent their publications with the request that ours be sent in exchange. Thus, the Academy with very little cost to itself is gradually acquiring an extensive and valuable library consisting mainly of the papers published by the original investigators belonging to the various scientific societies of the world.

Respectfully,

CHARLES WRIGHT DODGE,
Corresponding Secretary.

Treasurer's Report.

The Treasurer, Mr. J. Eugene Whitney, made a report of the finances of the year, of which the following is a summary :

Balance on hand, January, 1893,	$334 81
Receipts during the year,	466 00
Total,	$800 81
Disbursements during the year, as per vouchers	638 68
Balance,	$162 13

Librarian's Report.

The report of the Librarian, Miss Mary E. Macauley, was not read at this meeting, but is here summarized as follows :

Number of bound volumes received during 1893, 32 ; number of unbound volumes and pamphlets, 953 ; total accession for the year, 985.

Number of bound volumes in the library, 125 ; number of unbound volumes and pamphlets, 2,464. Total, 2,588.

Botanical Curator's Report.

The Curator in Botany, Mr. J. B. Fuller, stated that during the year there had been added to the herbarium about 300 specimens, collected by members of the Botanical Section. The total number of mounted and labeled specimens is now 3,210.

Report of Botanical Section.

Read by Mrs. J. H. McGuire, Recorder of the Section.

The Section has held its meetings with regularity every two weeks during the whole year, and has met, as has long been the custom, at the residence of Mr. William Streeter. To Mr. Streeter the Section and the Society are under great obligation for his hospitality and his devotion of time and material to the botanical work.

The officers of the Section are : President, Miss Mary E. Macauley ; Vice-President, Miss Florence Beckwith ; Recorder, Mrs. J. H. McGuire.

Extracts from the Minutes of the Section.

January 13, 1893. Dr. Anna H. Searing exhibited specimens collected last Spring on her trip through Mexico, California, Colorado and Kansas. These specimens numbered about 175 and were mounted and labeled. Among the genera most largely represented were: *Gilia*, *Astragalus*, *Lupinus*, *Trifolium* and *Allium*.

A specimen from Roane Mountain, Tenn., referred to Dr. Searing for identification, was found to be *Leiophyllum buxifolium*, var. *prostratum*.

Miss Beckwith exhibited a number of specimens, mostly from the White Mountains, from Dr. Bradley's herbarium, lately presented to the Academy.

January 27, 1893. Miss Beckwith exhibited diatomaceous earth found near Los Angeles, Cal., in 1892, and sent to the Academy of Science by the San Francisco Microscopical Society. Mr. A. M. Dumond showed a cultivated water-plant, *Eichornia Crassipes*, *major*, having a vigorous growth.

Mr. Dumond exhibited *Scendesmus quadri-caudatus*, and *Lemna trisulca*, and reported having found *Spirogyra* in conjugation after October 20th.

February 10, 1893. Dr. Searing exhibited representative specimens of pressed ferns, arranged to show the variations in growth in different localities. There were 106 specimens of 27 genera, found in Binghamton, N. Y., Pennsylvania, Vermont, Florida, Colorado, California, Bermudas, Bahamas, Mexico, Brazil, Ecuador, England, Ireland, Switzerland, Capri, Italy, Mesopotamia, New Zealand and the Sandwich Islands.

Mr. John Dunbar exhibited a number of cultivated shrubs.

February 23, 1893. Mr. C. C. Laney exhibited buds of *Alnus serrulata*, a small branch of Georgia Pine with cones, and a number of pressed plants from California.

Miss Beckwith exhibited a series of Ferns belonging to Mr. Seeley's collection, and loaned by him to the Section. The specimens were some which had been received from P. Neill Fraser, a noted fern collector and cultivator of Edinburgh, Scotland, being fronds taken from plants raised from spores by E. J. Lowe, the author of "Ferns, British and Foreign." These fronds, representing about 65 varieties, were all from *Asplenium filix-fœmina*, and showed great diversities of forms. Some of these were but slight changes from the typical form, by the forking of a few of the terminal pinnæ, others would have still more of the pinnæ forked until the whole frond including every pinnule was involved in change. In some cases the outline of the fronds was almost linear, caused by contraction and curling. It is impossible adequately to describe the changes of form presented by these specimens by the incision, forking, tasselation and curling of the pinnules and pinnæ and manifold variations of all parts of the fronds. The susceptibility of this species of *Asplenium* to modifications of its form under the influences of cultivation, as displayed in this set of specimens, has enabled fern cultivators to originate almost innumerable varieties from which have been selected those most pleasing and desirable, and these are propagated by division, perpetuating their peculiarities. They are raised as pot and basket plants for their ornamental qualities. More than a hundred varieties of this species are named and described in trade catalogues. One of the most beautiful varieties was named "Victoria, Queen of Lady-ferns."

Microscopical Studies.—Mr. Streeter exhibited filterings of Hemlock water in which were found *Cyclotella aperculata*, *Fragellaria capucina*, *Asterionella formosa*, *Botrycoccus Braunii*, *Gleocystus vesiculosa*, besides Infusoria and Rhizopods.

Miss Beckwith showed a flower stalk of a cultivated hybrid French Canna, "Madame Crozy." The falling of the pollen before the opening of the bud is said to be a peculiarity of this plant.

Mr. Laney reported finding *Ailanthus* growing wild on the river bank at Seneca Park.

Mr. W. W. Parce stated that he had observed in budding the Grape Fruit on the Orange, that the roots supporting the side bearing the former were larger and lighter in color than those supporting the latter, from which he would infer that each twig had its own specific root.

Microscopical Studies.—The examination of Hemlock water was continued by Mr. Streeter who showed *Staurastrium monticulosum*, *Cœlospharium Kutzingianum*, *Cosmarium depressum*, *Chlamydococcus pluvialis*, and others.

March 22, 1893. Microscopical Studies.—Among the objects examined were: *Scendesmus quadri caudatus*, *Protococcus*, *Pandorina*, *Navicula peregrina*, *N. digitus*, *Nitzschia panduriformis*, *N. coarctata*, and *Pleurosigma Spenceri*.

May 5, 1893. Miss Beckwith showed *Peziza coccinea*, and specimens of *Hepatica* having round sepals and twice the usual number.

They will be planted in Highland Park that further developments may be noted.

May 12, 1893. Twenty-six species were collected in woods west of Sea Breeze at this date. Among them were: *Coptis trifolia*, *Aralia trifolia*, *Chrysosplenium Americanum*, *Viola sagittata*, and *Saxifraga Pennsylvanica* in bud.

May 19, 1893. Miss Beckwith exhibited *Corydalis flavula* from Lime Rock, reported for the first time from this vicinity.

June 5, 1893. Professor W. H. Lennon, who had just returned from Bergen, reported having found there *Mitella nuda*, *Listera cordata*, *Cypripedium candidum*, *Ranunculus multifidus*, and a number of Carices. He also reported finding *Stellaria graminea* and *Alyssum calycinum* in Holley.

Miss Beckwith exhibited some specimens of *Climacium Americanum* in fruit, and reported having found a new station at Riga swamp for *Orchis spectabile*, *Cypripedium spectabile*, *Mitella nuda*, *Streptopus roseus*, *Acer spicatum*, *Linnæa borealis*, and *Drosera rotundifolia*.

Mr. Dunbar exhibited *Polygala Senega*, *Waldsteinia fragarioides*, *Staphylea trifolia* and other plants.

June 19, 1893. Miss Macauley gave a report of the excursion to Bergen swamp on the 17th instant and exhibited specimens of flowers obtained, among which were: *Smilacina stellata*, *Polygala paucifolia*, and *Arethusa bulbosa*. *Cypripedium spectabile* was not yet in blossom, but *candidum*, *parviflorum*, and *pubescens* were abundant, as were also *Linnæa borealis* and *Sarracenia purpurea*. There were also found eight species of Ferns, three Mosses and eleven Carices.

Mr. A. M. Baxter exhibited *Spiranthes latifolia*, and *Liparis Læselii*, both rare in this vicinity; the latter was found at Adams Basin.

Mr. John Walton exhibited *Conopholis Americana*.

Miss Beckwith showed specimens of *Aphyllon uniflora*, found in Brighton.

July 3, 1893. Dr. Searing exhibited *Mertensia Virginica* and *Rhododendron maximum* found in Penfield, and pressed specimens of *Pogonia*.

Mr. John Walton exhibited a large number of original drawings in life colors, to be printed in his forthcoming work, "Our Native Flora."

Mr. Dunbar showed a fine collection of cultivated plants.

July 17, 1893. Mr. Baxter exhibited *Calopogon pulchellus*, *Pogonia* *ophioglossoides*, *Nymphæa odorata*, *Rosa setigera*, and *R. Caroliniana* from Mendon ponds.

Miss Beckwith reported finding *Rudbeckia hirta* with variations in color at the base of the petals, the same as she had found for two years previous in Gates. The markings and band of brown were very distinct. As this is the third year they have been found, they seem to have become established in that particular locality. (See former article in this volume, pp. 170–171.)

July 31, 1893. *Habenaria tridentata*, *Asplenium Filix-fœmina*, *A. thelypteroides*, *Solidago juncea*, *Hypericum Kalmianum*, were shown by Mr. Baxter and others.

August 14, 1893. Mr. Baxter exhibited a number of plants from Mendon Ponds, among which were: *Utricularia cornuta*, *Lycopodium clavatum*, *L. obscurum var. dendroideum*, *L. lucidulum*, *Nemopanthes fascicularis*, *Eriophorum Virginicum* (rare), *Scleria verticillata* (rare), *Dulichium spathaceum*, and *Scheuchzeria palustris*.

August 28, 1893. Mr. Baxter exhibited *Lechea major*, *Spiranthes gracilis*, *Drosera intermedia*, from Mendon, *Camptosorus rhizophyllus*, from Ogden, *Ophioglossum vulgatum*, *Chenopodium Botrys*, *Pogonia pendula* (rare), in fruit, and *Bartonia tenella* (rare), having both flower and fruit, from Adams Basin.

September 11, 1893. Mr. Baxter showed *Viola rotundifolia*, *Dicksonia pilosiuscula* and *Aspidium acrostichoides*, the latter having the pinnules divided and subdivided.

Dr. Searing gave a brief account of the meetings of the A. A. A. S. at Madison, Wis., and exhibited a number of the following pressed specimens from that vicinity: *Liatris squarrosa*, *Polygonum cilinode*, *P. Virginianum*, *Polygala sanguinea*, *Monotropa Hypopitys*, *Sullivantia Ohionis*, *Lycopus rubellus*, *Gerardia grandiflora*, *Solidago ulmifolia*, *Physostegia Virginiana*, *Corallorhiza odontorhiza*.

September 25, 1893. Miss Beckwith showed several specimens of *Monotropa uniflora* which had a decided pink color.

Mr. Baxter exhibited specimens of *Amphicarpæa monoica*, showing the underground blossoms.

Dr. Searing read a list of thirty-nine Fungi gathered by herself and Miss Beckwith the preceding week, as follows:—

1. *Amanita phalloides*, Fr.
2. " *rubescens*, Pers.
3. " *volvatus*, Peck.
4. " *strobiloformis*, Vitt.
5. *Lepiota oblitus*, Peck.
6. *Lepiota granulosus*, Batch.
7. " *acutesquamosus*, Wein.
8. *Clitocybe nebularis*, Batsch.
9. " *truncicola*, Peck.
10. " *carnosior*, Peck.

11. *Clitocybe candicans*, Pers.
12. *Collybia radicata*, Relh.
13. *Omphalia campanella*, Batsch.
14. " *umbellifera*, L. Pk.
15. *Hygrophorus conicus*, Fr.
16. " *ceraceus*, Fr.
17. *Russula lepida*, Fr.—Mild.
18. " *incarnata*, Mild.
19. *Marasmius campanulatus*, Peck.
20. *Pluteus cervinus*, Schæff.
21. *Pluteus longistriatus*, Peck.
22. " *admirabilis*, Peck.
23. *Inocybe violaceifolia*, Peck.
24. *Naucoria autumnalis*, Peck.
25. *Cortinarius autumnalis*, Peck.
26. *Cortinarius alboviolaceus*, Pers.
27. *Hebeloma rimosus*, Bull.
28. " *flocculosus*, Berk.
29. " *subochraceus*, Peck.
30. *Galera tener*, Schæff.
31. *Hypholoma perplexus*, Peck.
32. *Boletus sublutens*, Peck.
32. " *subaureus*, Peck.
34. *Polyporus lucidus*, Fr.
35. *Craterellus cornucopioides*, Fr.
36. *Clavaria fragilis*, Holmsk.
37. " *Kunzei*, Fr.
38. " *flava*.
39. " *cinerea*, Bull.

October 6, 1893. Mr. Baxter showed *Magnolia acuminata* in fruit, and also the fruit of *Asimina triloba*.

Mr. Laney showed *Hamamelis* in blossom.

Miss Beckwith exhibited a specimen of fungus donated to the Section by the President of the Academy. This fungus was said to have been found growing upon a timber in a coal mine at Scranton, Pa. It is about twenty-two inches long, consisting of a linear, slightly curved series of bulbous masses, the initial one having a diameter of two and one-half inches, and the series, sixteen in number, growing smaller to the terminal one with a diameter of one and one-fourth inches. At the top are two small, irregular, lateral bulbs or excrescences. It was suggested that the form might have been an interrupted attempt at maturing. The fungus has a hard, smooth rind, with no trace of pores.

October 20, 1893. Mr. Dunbar exhibited the fruit of twelve species of Roses showing a surprising variety in the shape and appearance of the fruit.

Dr. Searing exhibited specimens of *Salvinia natans* from Ohio. It is stated in Gray's Botany that this plant is found in Western New York but it has never been reported in this vicinity.

Mr. J. B. Fuller and Mr. Laney showed a fine collection of acorns comprising fruit from the White Oak, Bur Oak, Swamp White Oak, Chestnut Oak (*Q. Muhlenbergii*), Red, Scarlet and Black Oaks, and from an English Oak (*Q. pedunculata*).

Miss Beckwith showed pressed specimens of *Myrica cerifera* in fruit.

November 3, 1893. Miss Beckwith showed specimens of fungi which were pronounced by Dr. Searing to be *Cyathus striatus*.

Dr. Searing reported three species of fungi new to the locality.

November 17, 1893. Mr. Dunbar exhibited a number of Japanese shrubs and plants.

Mr. Baxter showed *Crepis tectorum.*

December 1, 1893. Mr. Fuller reported on a plant brought to the last meeting by Mr. Dunbar, and referred to him. He found it to be *Solanum rostratum*, introduced from the Southwest. The last edition of Gray's Manual includes it, and says it has become established as far as Tennessee. Mr. Fuller formerly found it abundant near Lyell Avenue, but had not seen it in twelve years.

Mr. Baxter exhibited fruited specimens of *Asplenium ebeneum*, obtained down the river November 30th.

Miss Beckwith showed pressed flowers from the Rocky Mts.

Mr. Stone mentioned finding *Myrica Gale* as a common shrub near Charlotte along the river. *Myrica cerifera* was also reported growing at Seneca Park, a single specimen.

December 15, 1893. Miss Macauley exhibited a book of California flowers artistically mounted and labeled. Also a large number of pressed plants from Connecticut.

Miss Beckwith showed a branch of Coffee plant with berries from Brazil, and a box of Paraguay Tea.

December 29, 1893. Mr. Dunbar exhibited fifteen species and varieties of *Rhus*, eight of which were from native trees and seven from foreign. The comparative properties of the different species were discussed.

Miss Beckwith showed *Peziza coccinea* gathered that day. Last Spring a decaying branch bearing a number of *Peziza* was brought from the woods, placed on the ground and partially covered; from it had sprung this specimen with several others.

Mr. Baxter showed two specimens of dandelion picked in full blossom on Christmas.

ELECTION OF OFFICERS.

The annual election of officers for the ensuing year was held, and resulted as follows:

President, HERMAN L. FAIRCHILD.
First Vice-President, J. M. DAVISON.
Second Vice-President, M. L. MALLORY.
Secretary, ARTHUR LATHAM BAKER.
Corresponding Secretary, CHARLES W. DODGE.

Treasurer, F. W. WARNER.
Librarian, MISS FLORENCE BECKWITH.
Councillors,

For three years, { MISS MARY E MACAULEY. / J. E. ROSEBOOM.
For two years, (to fill vacancy), { J. Y. MCCLINTOCK. / J. EUGENE WHITNEY.

A communication was read from Mr. E. H. Eaton, of Canandaigua, requesting licenses for himself and Mr. A. P. Wilbur to collect ornithological material. It was voted that the Academy grant such certificate, and the carrying into effect of the matter was left in the hands of the officers.

PROFESSOR CHARLES WRIGHT DODGE presented a paper illustrated by lantern views, entitled :

THE STRUCTURE AND HABITS OF SOME WATER ORGANISMS.

The lecture was a popular account of the structure, mode of life, habits, reproduction, diseases, etc., of certain animals and plants sometimes found in water coming from Hemlock Lake. The object of the lecture was to interest members of the Academy in the study of these and of related organisms, all of which may be found at various times in water coming from faucets for domestic supply. Among the organisms described were: *Paramecium*, *Amœba*, *Vorticella*, *Actinophrys*, *Protococcus*, *Spirogyra*, *Ædogonium*, etc.

The lecture was illustrated by numerous lantern slides.

FEBRUARY 26, 1894.

STATED MEETING.

The President, PROFESSOR H. L. FAIRCHILD, in the chair.

A small number of persons present.

Upon the suggestion of the President it was voted that certain Fellows of the Society be appointed to report, from time to time, matters of interest in the progress of their respective sciences. In pursuance of the above action, the President appointed as follows :

In Biology, C. W. Dodge; Botany, Florence Beckwith; Chemistry, J. M. Davison; Electricity, J. E. Putnam; Engineering, J. Y. McClintock; Geology, H. L. Fairchild; Hygiene, E. V. Stoddard; Mathematics, A. L. Baker; Medicine, M. L. Mallory; Meteorology, M. A. Veeder; Physics, A. L. Arey; Physiology, J. L. Roseboom; Zoölogy, Henry A. Ward.

The following paper was read:

SOLAR ELECTRICAL ENERGY NOT TRANSMITTED BY RADIATION.

By M. A. Veeder.

Radiation consists essentially of the divergence from common points of origin of minute wave motions traversing the ether of space. The medium in which these motions occur is beyond the reach of direct observation by any of our senses, and its motions are known to us only by the effects which they produce upon material substances. Light rays are themselves unseen although they make surrounding objects visible. Heat radiations which produce warmth as they fall upon the surface of the earth have no such effect upon the void of interplanetary space. Chemical rays are inoperative save only as they fall upon materials sensitive to their impulse. The thing that is conveyed in all these cases is simply a mode of motion of the ether. It is not light or heat or chemical force that is transferred through space but a system of pulsations which are capable of originating by direct contact the phenomena of color, visibility, heat or chemical changes, as the case may be, in bodies having the requisite physical properties. Even vital action may be caused by the impulse of such radiations, as is seen in the growth of plants exposed to light and heat, but it does not follow that vitality is a property of the ether.

The same distinction obtains in connection with such electrical effects as attend the impact of ether waves upon particular substances. Electricity is not a property of the ether in this sense at all, and there is no conveyance of electrical force whatever, but only of wave motions which are capable of having electrical effects under certain conditions, the same as all other forms of motion are capable of disturbing pre-existing electrical equilibrium even while incapable of the origination or conveyance of electrical force. Thus the faintest whisper falling upon the receiver of a telephone starts currents which are plainly perceptible. The atmospheric sound waves in such a case are not themselves electrical but in virtue of their motion, simply, produce electrical effects in the telephone. In the absence of such an apparatus they remain sound waves only, and do not have any such effects as appear in the case supposed. The energy that produces the currents resides not in the pulsations of the air, which have no power whatever in and by themselves to traverse the conducting wire, but in the molecular stresses and balancings existing in the materials of which the telephone is composed, which depend upon the possession by the apparatus itself of the requisite physical properties which in this case are of an electrical nature.

So when ether waves fall upon particular substances it is molecular or atomic motion only that is imparted. The effect produced whether chemical, electrical, or vital depends entirely upon the constitution of the substance receiving the impulse. It is the nature of the properties of the species of matter of which it is composed and not of those of the ether of space which determines what will be the result of the molecular motions imparted. This brings us to the consideration of the question as to what is meant by a property of matter.

The geometrical conception of matter and force which deals only with external forms and space relations is wholly inadequate. Matter thus conceived of is inert, and logically some form of inertia is its only property. Those who hold this view are obliged to assume that there is no lost motion but simply transformation of motion throughout the universe producing constant atomic agitation and ether pulsation. Accordingly there can be no motion without pre-existing motion and so on *ad infinitum*. It would seem very difficult, however, to analyze such a property of matter as elasticity into component motions in accordance with any principle of inertia which requires that the motion should be in straight lines. Nor will the assumption of the existence of complicated vortical motions whose origination is unexplained help the case. Atomic motions of any sort that can be conceived of would be subject to deformation by elastic strain as much as the shape of the body itself, and it becomes necessary to assume that there is some force or property inherent in the atoms that causes them to seek readjustment to a particular form whether they be in motion or at rest among themselves. This force whatever it may be although it maintains a certain form of arrangement among the atoms cannot be conceived of as having dimensions and shape. It is one of the properties of matter that does not come under the category of space relations.

So when a body falls to the ground and thenceforth remains stationary in that location it is not conceivable that it is held in place by any form of ether pulsation or atomic movement. It simply has weight, which is a property as essential to the existence of matter as is occupancy of space, but which cannot be represented under the same forms of statement. It is a force and is not to be pictured out as visibly extended and having parts and dimensions. In other words it does not come under the category of space relations. So likewise the thing that puts power into a gunpowder explosion cannot be defined otherwise than as being chemical force. In like manner the thing that puts life into a tree is vital force. These and all the other properties that might be named, such as cohesiveness, capillary attraction and the like, are essential to the very existence of matter in the forms in which we find it. Iron would not be iron if its chemical properties were lacking. A rose would not be a rose without the power of life and growth. So color, temperature, and electrical conditions are essential to various forms of existence as they actually appear.

On the other hand the manifestations of energy resultant from these properties cannot be had in the absence of the particular substances in which they reside. Even if the ether of space should have any of these properties they are not those of matter in the ordinary forms with which we are familiar. Thus if the ether has any electrical conductivity whatever, which is doubtful, it certainly is almost infinitely small as compared with that of iron wire and various other material substances.

Without entering further into the discussion of their general relations we proceed to the consideration of the behavior of magnetic storms specifically. Such storms may be expected to afford a test case as to the manner of conveyance of electrical energy through interplanetary space, they plainly being of extra-terrestrial origin. Here, if anywhere, evidence of transmission of electrical forces through radiation should appear. As a matter of fact such magnetic disturbances are apt to begin abruptly, it may be throughout the entire earth at practically the same instant of time. Thus in the case of very powerful outbreaks, within a few seconds at most, the magnets in all observatories begin to give evidence of agitation which is of such fitful and variable character that it cannot bear any relation whatever to preliminary heating or cooling, which would necessarily be slow and confined to parts of the earth exposed directly to heat radiations. In other words the evidence is conclusive that magnetic perturbations are not of thermo-electric origin and have nothing whatever to do with heat radiations. In like manner there is no relation whatever to light radiations. The photographic tracings which register automatically the movements of the magnets give a complete record of the times of occurrence of such storms, from which it appears that they must depend upon conditions entirely unlike those concerned in the radiation of light and heat. The maximum effect of magnetic storms is not recorded upon the side of the earth exposed to the direct rays of the sun but upon that opposite. So, too, the auroras accompanying magnetic storms, as seen in the Arctic regions at times when daylight does not interfere with their observation throughout the entire twenty-four hours, appear on the side of the earth away from the sun. Thus there is no diffusion of effect such as appears in the case of radiation. On the contrary there is concentration of the maximum phases of any particular outbreak at a definite hour angle from the sun and at certain latitudes which have reference to the magnetic poles of the earth. Furthermore there are recurrences of magnetic storms at the precise interval of a rotation of the sun as viewed from the earth, which is advancing in its orbit in the same direction that the sun is revolving on its axis. At each return at this interval magnetic storms and auroras as a rule begin suddenly and strongly and die out gradually, ceasing entirely most commonly within two or three days. From this it appears that whatever it is upon the sun that exercises these terrestrial magnetic effects has this power only when in a certain very definite location relative to the position of the earth. If outbreaks located promiscuously on every part of even the visible surface of the sun were able to have these effects, periodicity at the interval of a synodic rotation or any other regular interval would be impossible. Thus the impulse that produces a magnetic storm instead of being diffused indifferently in every direction from its point of origin, as are light rays, is confined to one direction exclusively. In short there is no analogy whatever between the behavior of magnetic storms and the origin and diffusion of heat and light radiations.

Our conception of radiant energy as exhibited in the case of heat and light has arisen from the analogy of atmospheric sound waves in which the ultimate particles composing the conducting medium are supposed to be thrown into a state of rythmical vibration. There is a bounding and rebounding of elastic particles against each other extending indefinitely in every direction from the point of origin of the sound. The resultant motions are in straight lines radiating from that point so long as the conducting medium remains homogeneous, the law of inertia not permitting any deviation from such direction in the case of bodies moving under its control exclusively. If however the continuity of the conducting medium be interrupted, secondary phenomena such as reflection, refraction or absorption may occur at the point of interruption. In order to the conveyance of heat and light in a manner altogether similar to that of sound it is only necessary to presuppose the existence of a medium more subtle and elastic than air, such as the ether is supposed to be. In this way the chief peculiarities in the behavior of heat and light radiations may be satisfactorily accounted for, but not the peculiarities which attend the conveyance from sun to earth of the impulses which originate magnetic storms.

It is true that light rays may have electrical effects, as for example when they come in contact with selenium. This signifies nothing more than that ether pulsations may produce a certain amount of superficial atomic readjustment such as appears in photography. If on the other hand chemical or electrical action in their turn originate light rays, these have no power to transmit the very force on which their origin depends. Were it otherwise, an electric light would be a deadly thing. If the power of the current traversing the carbons were conveyed by radiation to surrounding objects, it would cause serious inconvenience if not death to any individual so unfortunate as to be exposed to its rays. As a matter of fact, however, there is no reception or dispersion of electric force by radiation, certain small vibratory motions of the ether only being conveyed by this means which produce certain electrical effects mechanically, which are wholly insignificant as compared with the force of the dynamo traversing the conducting wire.

Such electrical effects as attend light rays persist uniformly and continuously so long as exposure to the source from which they emanate continues. Thus selenium has increased electrical conductivity in sun light which disappears in a darkened room just as photography ceases in like manner. Magnetic storms on the other hand are strongest on the darkened side of the earth, and instead of proceeding evenly and uniformly are characterized by large and fitful variations from hour to hour and moment to moment. In short there is no correspondence whatever between the behavior of such storms and the manner in which radiations of heat and light are originated and propagated from sun to earth.

Recently it has been discovered by Hertz that there are ether waves which do not produce light or heat or any other manifestation of radiant energy but still are capable of having electrical effects. These electric waves can be reflected the same as light waves and exhibit the remarkable peculiarity of passing through substances such as wood, which are impervious to light. Still they are wave motions only and are subject to the limitations which have been indicated throughout the course of the discussion. Their behavior resembles that of sound waves so closely that the term electrical resonance has been employed to designate their modes of action, which involve interference phenomena similar to those attended by increase or diminution of effect in acoustics. They are simply waves of a particular length and consequently have their own characteristic effects just as others of different lengths have chemical, or heating, or luminous effects chiefly. Mere differences of wave length does not alter the principles of radiation.

Nor will it help matters to conceive of vortices or rotary movements of the ether having complicated systems of interferences. It is possible that something of the sort may exist in magnetic fields that are sufficiently strong but the effects thus produced in immediate proximity to the poles of a magnet have nothing whatever to do with radiation in the ordinary sense of that term. Thus the rotary magnetic field of Tesla and phenomena of kindred character do not enter into the question under discussion.

Not only is proof lacking that electrical energy is transferred by radiation from one locality to another, but there is positive proof on the other hand that it is thus conveyed with the utmost facility by the process known as conduction. Such conveyance by the agency of material substances having the requisite physical properties is consistent with the view that electricity is essentially a property of matter and not of the ether of space which was discussed at the outset. Electrical action of every species is to be classed with such properties of atoms as cohesiveness, chemical affinity, weight and the like, all of which are concerned in procuring definite forms of aggregation of matter. Thus in the case of particles free to move there are electro-magnetic systems of arrangement which have been fully identified and whose prominent characteristics are well known.

In the case of particles not free to move there are stresses and urgings which tend to bring about this same form of arrangement. It is in virtue of the possession of such properties that a magnet lifts its armature and holds it in position and not because of any bombardment of ether pulsations. This power of attraction, like that of gravitation, resides in the atoms themselves and does not depend upon anything external to them. Unlike gravitation, however, electrical attraction or repulsion does not even seem to act at a distance, its conveyance requiring a proper medium, thus involving perfect continuity in a series of material atoms in touch with each other. In the absence of a proper conducting medium, whether embodied in a wire or in the dust-like contents of interplanetary space, there can be no conveyance of electrical energy a single inch, to say nothing of any such distance as from sun to earth.

From this point of view all that we know about electricity is that it is a property of atoms which after the analogy of chemical affinity causes them to combine pole to pole in such manner as to satisfy what may be termed their electrical valency or power of entering into definite forms of adjustment in respect to each other. As well might we deny the existence of the attraction of gravitation, which does not appear to have any conceivable relation to ether waves, as to refuse to admit the existence of other forms of attractive force which may likewise be independent of ether waves and atomic oscillations of every sort. If only electrical currents were concerned it would be a question of motions, perhaps. The final outcome of electrical action is, however, an adjustment of stresses in particular directions having reference to poles and lines of force, so as to produce a state of equilibrium and consequent cessation of motion. Just as the armature of a magnet ceases to move and is held stationary when it reaches its proper position in contact with the poles, so too the atoms of which it is composed doubtless reach a definite adjustment and consequent quiet under the influence of electrical strain. The case is precisely similar to that in which a body falls to the earth and remains motionless thereon. If a body in this condition can be conceived of as being compelled to cling to the earth by the impulse of ether motions, a similar explanation might become possible in connection with the modes of operation of electrical forces above indicated. To the writer such a view appears to involve far greater difficulties than those sought to be explained. There is the question as to what must be the character of the motions of the ether that could accomplish such results, and the further question as to the manner in which these motions are sustained. With our present knowledge it seems preferable to assume as the starting point the existence of properties inherent in the atoms and independent of motion of any sort. To do otherwise than this is to resolve not only the properties of matter but matter itself into a question of wave length, the very existence of matter being unthinkable apart from that of its properties. In all reasonings something must be taken for granted as ultimate. In this case it is the existence of matter and of its properties, among which are those that characterize electrical action.

If the ether have electrical properties, the evidence is clear that they differ from those of matter which fit it to become a conducting medium. It is possible that light waves may excite some species of electrical action in the ether of space just as they do when falling upon material atoms. So on the other hand electrical action brought to bear upon any part of the ether of space may modify the light waves in that location. It is true that light has electro-magnetic relations which are a proper subject of investigation. The modification of light waves consisting in what has been termed their electro-magnetic rotation, which may perhaps depend upon certain electrical properties of the ether, does not transform them into anything else than light waves. They do not transmit anything except vibratory motions which may have electrical effects upon the ether of space and material atoms, but which do not transfer electrical energy from one locality to another. Ether pulsations produce only very strictly localized and small disturbances of electrical equilibrium in the atoms exposed to their direct impulses. In order so to do they do not deplete any source of supply, nor originate any bipolar system of arrangement of force, or in other words do not become a conducting medium in any sense of that term. Their mode of action is that of electrical excitation and not of conduction. The energy developed by a dynamo or concentrated in a storage battery finds no outlet by radiation. Not all the power of the sun itself could produce an electrical charge strong enough to be conveyed by radiation. It is not strange that those who incline to the ether wave theory of transmission of electrical energy hesitate to admit the solar origin of magnetic storms.

The transmission of electrical energy by conduction, on the other hand, is accomplished with the utmost facility. Telegraphic signals have been conveyed across the Atlantic by means of a proper conducting wire and a battery no larger than a thimble. So too, for the conveyance of power to electric motors surprisingly small quantities of conducting material in the form of wire may be used. The facility of conduction is so great for such vast amounts of power and for such long distances that there is no difficulty in supposing that there may be conveyance from sun to earth provided that the proper medium exists in interplanetary space. The writer has examined a large number of meteorites and has found that they all possess magnetic properties such as would result from subjecting them to long continued induction. Thus the impalpable dust and rarefied vapors of interplanetary space as well as the larger particles and masses of matter, including even the planets themselves, under the conditions of pressure and temperature existing in space, may serve as the means of conduction. Meteoric dust and debris is certainly composed of material that is well fitted for purposes of conduction and gives distinct evidence of having been actually so employed, and it is altogether likely that the low temperature of space and the partial vacuum there existing may facilitate the process.

Conduction like radiation does not involve any transference of material substance. It depends upon the development of stresses in the conducting medium along what are known as lines of force which are not uniformly diffused but extend in particular directions exclusively, just as appears in connection with the behavior of magnetic storms which are originated by impulses conveyed from the sun at a particular angle exclusively. In like manner the concentration of inductive effect at certain poles accounts for the localization of the maximum phases of such storms, which has been described, and there is nothing inconsistent in the fact that this localization should be on the side of the earth away from the sun.

The whole process of the origination of magnetic storms appears to be substantially as follows: Particular portions of the sun's surface and cooler immediate surroundings are electrified by what has every mark of being volcanic action. The motion of rotation of the sun carrying forward these charged portions of its surface develops currents dynamically which act inductively along lines of force wherever there is conducting material within their scope. There is no conveyance by radiation or in a manner similar to that in which heat and light are emitted from the sun. The laws governing the process are entirely different from those of radiation and have reference to the principles of conduction as they appear under the conditions existing in interplanetary space. It is a mode of solar action that is distinct and that must be considered by itself. The final outcome of the temporary, subpermanent and permanent effects of the electro-magnetic impulses thus originated and distributed is a magnetic system comprising within its scope the entire solar system and depending upon the properties of matter rather than of an ether simply. With this clue it becomes possible to trace out the modes of action and reaction and transference of stores of electrical energy in such manner as could not otherwise be done. Following this line of investigation it is already becoming quite certain that electro-magnetic forces play a much more important part in the economy of the solar system than has heretofore been supposed. The physicist who has a clear apprehension of the nature of the properties of matter is the coming man in astronomy. The geometer has had his day. The present purpose will have been served if the proper method of attacking the problems at issue and systematizing observations shall have been indicated.

The paper was discussed by several members.

MARCH 12, 1894.

STATED MEETING.

The President, PROFESSOR H. L. FAIRCHILD, in the chair.

A small number of persons present.

The Council report recommended that a bill of F. A. Steward, for drawing a map of Monroe County and vicinity, to accompany the forthcoming Flora of Monroe County, be referred to two members, with power to authorize payment.

The report was adopted and the chair appointed Mr. J. Y. McClintock and Professor A. L. Baker.

MR. J. Y. MCCLINTOCK read a paper:

SOME RECENT ENGINEERING PROBLEMS IN ROCHESTER.

Under reviews in departments of science Miss Florence Beckwith presented the following notes, on Hybridity in Willows.

The study of willows has always been attended with great difficulty on account of the great variety of forms, and the extreme variability of these forms. The question of hybridity has been gradually assuming more importance, and there is a growing belief among botanists that more hybrids occur than was formerly supposed.

In a recent article on "Nithsdale Willows," by Mr. James Fingland, in the Transactions of the Dumfriesshire and Galloway Natural History and Antiquarian Society, this subject is discussed, and from it the following facts are gathered :

In 1838 Sir J. E. Smith, in his "English Flora," said that he had labored thirty years at the task of specific definition, and as a result of his studies gave sixty-four species.

Since that time the estimated number of species has varied according to the opinions of different botanical authors. The last edition of the "London Catalogue of Plants" gave ninety-six forms of British Willows, thirty-one having specific rank, the rest being classed as varieties or sub-species.

Not long since Dr F. Buchanan White published in the Journal of the Linnean Society a work entitled a "Revision of British Willows," in which he introduces a new system of classification, and overturns previous methods. He bases his classification on a recognition of the circumstance of hybridization being an active element in causing the great variability in willows, a fact which the early salicologists were unwilling to admit.

It has been found that binary and ternary hybrids exist spontaneously, and by experiments in cross-fertilization it has been proved that plants could be obtained that represented a pedigree of six species.

Theoretically it is said that any one species of willow may hybridize with any other, but, practically, the number of natural hybrids is limited, owing to different periods of flowering, and non-proximity of many species. In the "Revision" the number of true species is reckoned as seventeen, and the number of hybrids as forty-one, but the latter number has been added to since the author published his work.

Miss Beckwith also presented notes upon the number of species of plants as estimated by an Italian botanist, P. A. Saccardo. The total number now estimated is : Phanerogams, 105,231 ; Cryptogams, 68,475. Total, 173,706.

Miss Mary E. Macauley presented some willow catkins which had developed unusually early, also a specimen of Japanese Witch Hazel, in blossom, from Seneca Park.

Professor A. L. Baker, by means of a diagram, illustrated and explained the perturbed path of the Lexell-Brooks comet, showing the original 6 year orbit of 1770 and 1775, which in 1779 was by the proximity of Jupiter changed into a 34 year orbit which was again, in the year 1846, changed by the attraction of Saturn into a 47 year orbit. This was again, in the year 1886, changed by renewed proximity of Jupiter into a 7 year orbit which brought the comet once more within sight of the earth, the comet having been lost in 1779 and recognized in 1889 after much laborious calculation as the long lost comet of 1770 and 1775.

APRIL 9, 1894.

STATED MEETING.

The President, PROFESSOR H. L. FAIRCHILD, in the chair.

A small audience present.

The Secretary read the following paper:

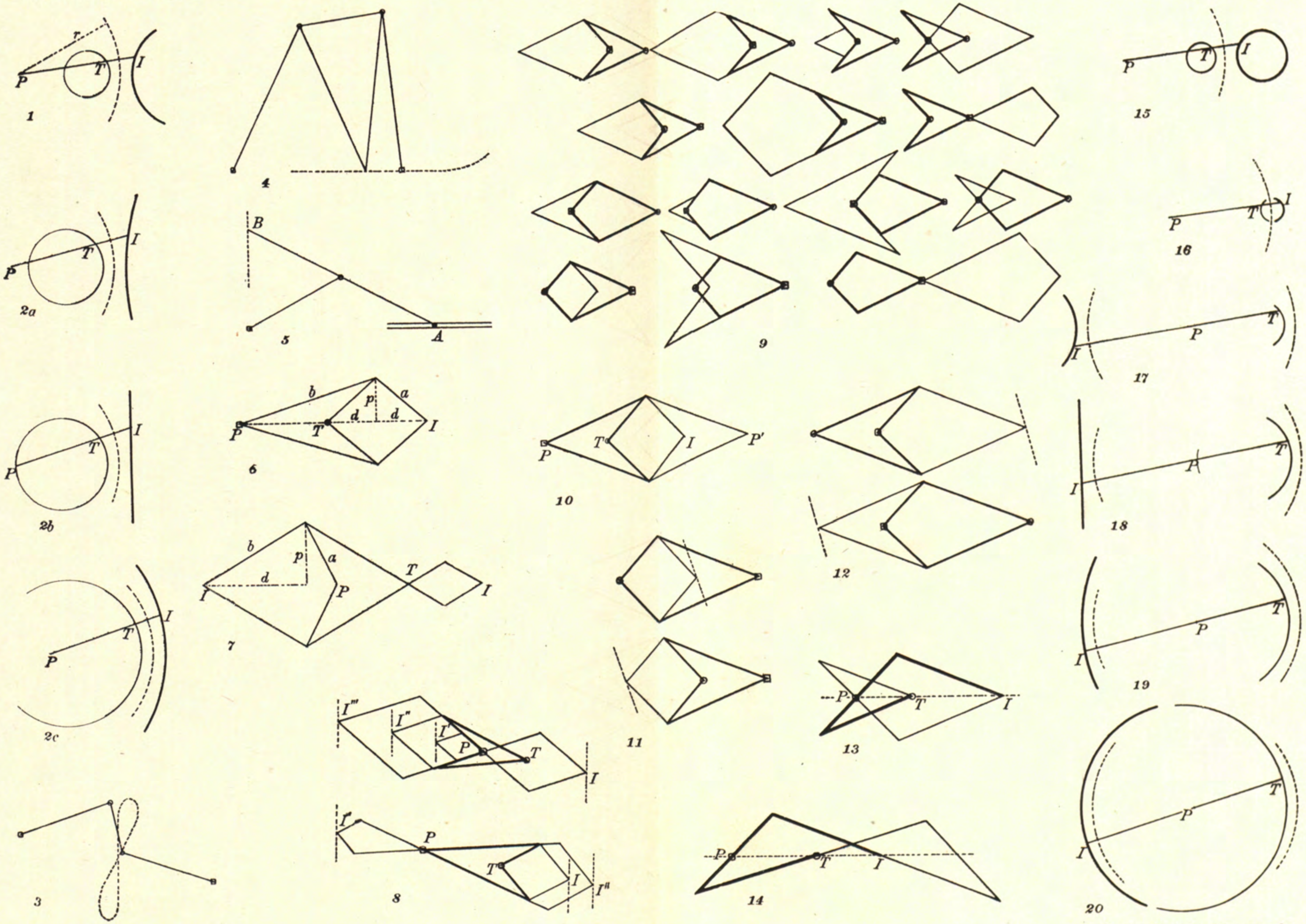
CIRCULAR INVERSION AND ITS BEARING ON THE PEAUCELLIER CELL AND THE STRAIGHT LINE.

BY ARTHUR L. BAKER.

If you will throw your memories back to the days of your geometry, you will recall a theorem which runs in this wise:—If from a fixed point without a circle a secant is drawn, the product of the secant and its external segment is constant in whatever direction the secant is drawn, and is equal to the square of the tangent from the point to the circle.

Like most of the theorems of elementary mathematics this is a degraded case of a far more general theorem which runs as follows:— For every point on one side of a central curve called the curve of inversion, there is a corresponding point on the other side such that the product of the distances of the two points from the centre is equal to the square of the radius vector which passes through the two points, and to every curve traced by the one point corresponds a curve traced by the other point, called the inverse of the traced curve.

We will consider only the special cases of the curve of inversion



BAKER—CIRCULAR INVERSION, &C.

and the traced curve being circles, in which case the inverse curve is also a circle, as is shown by substituting in the polar equation of the circle

$$\rho^2 - 2\rho a \cos\theta + a^2 - r^2 = 0,$$

$\frac{k^2}{R}$ for ρ, since $\rho R = k^2$, ρ being the radius vector of the circle to be inverted, and R the radius vector of the curve of inversion.

This substitution gives

$$R^2 - 2R\frac{k^2 a}{a^2 - r^2}\cos\theta - \frac{k^4}{a^2 - r^2} = 0,$$

which is evidently the equation of a circle also.

This will be better understood after a glance at fig. 1, (plate 12) where P is the centre of the circle of inversion, T the tracing point, and I the inverse of the point T, r being the radius of the circle of inversion. Here $PT \cdot PI = r^2$. The curves traced by P and I are also shown, both being circles. Fig. 2 shows the effect of enlarging the radius of the circle traced by T, the dexter vertex of the horizontal diameter of T being fixed. You will notice that as the circle T enlarges, the circle I also enlarges, only much more rapidly, and finally its arc becomes a straight line, and then begins to curve the other way. I is a straight line when T passes through the centre of inversion. This is shown by making $r = a$, in which case the equation above becomes

$$R\cos\theta = \text{constant},$$

the equation of a straight line.

Now if we can only harness P, I and T together by some mechanical contrivance, so that the product $PI \cdot PT$ shall be constant, it will only be necessary to make T move in a circle *through* P to get I to trace a straight line.

The importance of this will be appreciated when I state that previous to the year 1864 there was no known method of tracing a straight line primarily by the continuous sweep of a tracing point. By primarily I mean without first having some other straight line as a guide. I do not mean to say that there were no straight lines previous to 1864, but they were drawn by means of a straight edge which had been previously constructed by trial, taking off "here a little, there a little," until finally it satisfied the eye of its maker. You will appreciate the significance of this if you try to construct a circular ruler by cutting a circle as near as you can and then correcting it by trial until you have a satisfactory result. Practically you would not do this, but would describe your circle with one sweep of the tracing point of a pair of compasses.

To accomplish the same thing in the case of a straight line had long been the object of mechanicians from the days of Watts on. The problem was usually spoken of as that of parallel motion. Watts accomplished it partially by means of the mechanism shown in fig. 3, where the line traced (dotted) is shown nearly straight on one side of the figure 8, but decidedly not straight beyond certain limits. In this mechanism the short arm is perpendicular to the two equal radial arms when they are parallel. Later, Richard Roberts of Manchester devised the linkage shown in fig. 4, in which the distances between the fixed points is twice the distance between the two movable pivots, the long arms being of equal length. The fixed pivots are designated by ▫ and the movable pivots by ○. Within limits, as shown, the line is nearly straight. Other methods have been devised but they either merely approximate, or else depend upon straight line guides, as in the parallel motion of Scott Russell shown in fig. 5, where the point A slides in guides, as shown, and the point B describes the straight line.

Finally, in 1864, Peaucellier, a French officer of Engineers, devised the mechanism shown in skeleton in fig. 6, in which $PT \cdot PI =$ constant, T and I being opposite vertices of a rhombus. To show that this product is constant, consider that

$$b^2 = p^2 + (PT + d)^2, \quad \text{and} \quad a^2 = p^2 + d^2, \quad \text{whence}$$
$$b^2 - a^2 = (PT + d)^2 - d^2$$
$$= (PT + 2d) \cdot (PT) = PI \cdot PT = \text{constant},$$

since the arms a and b are invariable in length.

Now if T be constrained to move on a circumference through P, I will, as we have just seen, describe a straight line. A radial arm connecting T with a fixed point equidistant from P and T would accomplish this.

In this machine we have the famous Peaucellier cell. If you wonder at the word cell, I must refer you to the International Dictionary where you will find—Cell: The space between the ribs of a vaulted roof; or to Murray's New English Dictionary—One of the number of spaces into which a surface is divided by linear partitions; one of the compartments into which anything is divided.

As a modification of this, take any point I', fig. 7, by constructing the rhombus $I'T$, similar to TI, and connect the point P as shown.

Then just as in the previous figure, $b^2 = p^2 + d^2$, $a^2 = (d - PT)^2 + p^2$, and $b^2 - a^2 = d^2 - (d - PT)^2$

$$= (2d - PT)\ PT = PI' \cdot PT = \text{constant}.$$

Hence I' will describe a straight line.

The point I' is evidently connected with the former cell by enlarging or diminishing, even through evanescence, the rhombus TI.

Several tracing points can be had in the same cell, as shown in fig. 8, where the points I, I', I'', I''' all describe straight lines, as shown. The points I', I'', etc., are evidently found by increasing or diminishing, even through evanescence, the tetragram PI.

From this we get a rule for constructing a Peaucellier cell.

Construct a double isosceles tetragram (not a rhombus) with one vertex fixed (the pivot) and the other vertex constrained (by a radial arm) to move on a circle through the pivot. On the pivot legs construct another tetragram forming a rhombus with the other pair of legs. The vertex of this second tetragram will describe a straight line. This second tetragram can be enlarged or diminished, even through evanescence.

In fig. 9 I have drawn the cells resulting from the application of of this rule. ▫ indicates the pivot P, and ∘ the point T traveling on the arc of a circle through the pivot.

If to the single cell we add another pair of arms so as to form a rhombus with the pivot arms, we get the double cell of fig. 10. Since P' is symmetrical with P, and $PT \cdot PI = \text{const.}$, $P'I \cdot P'T = \text{const.}$, and P' may be taken as the pivot and either T or I as the circle tracing point (see fig. 11). By taking T as the pivot and applying the rule for the construction of cells we get $TP \cdot TP' = \text{const.}$ (fig. 12). If we have the cell shown in fig. 13, in which $PT \cdot PI = \text{const.}$, and remove the light arms, replacing them as shown in fig. 14, the geometrical relation between the points P, T, and I will not be altered, nor will their mechanical connection be lost, and we will have a cell of four arms instead of six as heretofore. From the symmetry of the figure $II' \cdot IT = \text{const.}$, $IP\ II' = \text{const.}$, $TP \cdot TI' = \text{const.}$, as in the double cell.

Various modifications of this cell or linkage as it is sometimes called have been devised for different purposes, a short account of which will be found in Kempe's "How to Draw a Straight Line."

Before closing, permit me to call your attention to one phase of circular inversion that will show more clearly how your early theorem in Geometry is connected with the inversion diagrams that I have already shown you.

In fig. 2, I supposed the circle *T* to enlarge toward the left, the dexter vertex remaining fixed. I shall now let the circle diminish, the dexter vertex being always fixed. The circle I will also diminish as shown in fig. 15. This diminution will continue until both become points at the same moment. Then as the sinister vertex of *T* passes through the dexter vertex *to the right*, *I* begins to enlarge to the *left*, and finally *T* and *I* coincide, as shown in fig. 16, and we have the case of the geometries :—The product of the segments of a pivoted secant is constant.

So far I have spoken only of what might be called positive inversion, that is, inversion where the distance *PI* is laid off *along* the line *PT*. If the distance *PI* be laid off *backward* instead of along *PI*, we get what might be called negative inversion, which differs from the case we have been considering in that the *I* circle appears on the left of the curve of inversion in an exactly symmetrical position to that for positive inversion.

Thus figs. 15 and 16 would become figs. 17 and 20. Figs. 18 and 19 show the intermediate steps.

Fig. 20 brings us to another familiar theorem of Geometry, viz.: If any chord is drawn through a fixed point within a circle, the product of its segments is constant.

You will notice the close connection between these two elementary theorems of Geometry, a connection which the geometries fail to bring out, but which could be very plainly shown, even in elementary works, if the two theorems were combined into one, as follows :—

The product of the segments of a pivoted secant made by the pivot (internal or external) is equal to the square of the line from the pivot to the circle, the line being perpendicular to a diameter through its extremity. If the pivot is internal the diameter will pass through it ; if external the diameter will pass through the end of the line which is on the circle.

For the case in which *I* is a straight line, those interested in mathematics will recognize a special case of *pole* and *polar*, for which many interesting correspondences might be drawn.

Hon. Martin W. Cooke discussed and illustrated with diagrams the law of the ellipse described by a body thrown from a revolving planet.

APRIL 23, 1894.

STATED MEETING.

The President, PROFESSOR H. L. FAIRCHILD, in the chair.

Twenty persons present.

Under the call for notes in departments of science, the following two papers were read :

A BIOGRAPHICAL SKETCH OF DR. SAMUEL BEACH BRADLEY.

BY FLORENCE BECKWITH.

Dr. Bradley, if not the earliest, was certainly one of the earliest botanists of this section of country, and it is thought proper that the Academy should put on record some of the facts of his life, since his work was done in this vicinity, and we possess a portion of his herbarium, the gift of Dr. D. G. Hastings, of this city.

As a botanist Dr. Bradley had a wide reputation. He is often quoted as an authority in catalogues of plants, and in Gray's Botany (5th edition) he is mentioned in like manner. The period of his work is covered by the years of his residence in Monroe county, or from 1825 to 1880.

He was a close and accurate observer, and his work along the lake shore and the inlets and ponds adjoining was particularly thorough. Some of the plants he found here have since become extinct, or, at least, have never been reported by any other botanist, and many others are now extremely rare. In "Paine's Catalogue of Plants of Oneida County and Vicinity," published in 1865, Dr. Bradley is given as the sole authority in this vicinity for twenty-one species of plants. In the list of plants of Monroe and adjoining counties which this Society is soon to publish, there are eleven species credited to Dr. Bradley alone, no other local botanist having observed them. *Limnobium spongia* was reported by him as found in Braddock's bay, but has not been seen by any later botanist, although sought for. During the 1892 meeting of the American Association for the Advancement of Science the visiting botanists spent an afternoon in the locality without finding the plant.

For the following sketch of Dr. Bradley's life, we are indebted to Mrs. Annie Hastings Gott, whose family were his life-long friends.

Samuel Beach Bradley, son of the Rev. Joel and Mary Anne

Beach Bradley, was born in Westmoreland, Oneida county, N. Y., in August, 1796, and died at his home in West Greece, Monroe county, in September, 1880, at the age of 84 years.

He graduated at Union College, Schenectady, in 1814, and then studied medicine with Dr. Seth Hastings, of Clinton, Oneida county. Dr. Hastings had an extensive botanical garden for the special use of his students, and it was here that Dr. Bradley became interested in botany, and he made a thorough study of the local plants.

Dr. Bradley practised medicine for a time in Eaton, N. Y., and at the age of 21 he married Miss Cornelia Bradley, whose death a few months after their marriage shadowed his life for many years. At this time he gave himself up to the solace of his books, especially to the languages, both modern and classical, and during his whole life, up to his last illness, he daily read some portion of Scripture in both Greek and Hebrew.

He came to Parma, N. Y., in 1820, and in 1823 was a member of the Assembly. He settled in West Greece, Monroe county, in 1825. He used to say that at that time Greece was infinitely more attractive in every way than the settlement that has grown to be Rochester, and as the Ridge Road had begun to be settled, it seemed to offer much better inducements to a physician. It was about this time that he began his botanical work in this section, and it was his delight to explore every swamp and woods for rare plants. He kept up his interest in botany as long as he lived, and the last few months of his life were devoted to naming and rearranging the specimens in his herbarium. He corresponded with many eminent botanists of his day, and he is often quoted as an authority on the plants of this vicinity. The greater part of his herbarium was given after his death to the Northwestern University, Evanston, Illinois.

Dr. Bradley's love for books was one of his characteristics. He was a very correct Latin scholar, and gave much time to the best authors. He had a very large collection of the best French authors, and also read with ease German and Italian. He had also studied Sanskrit, Arabic and Anglo-Saxon. He was an earnest student of history, and a most indefatigable reader of the best literature, both modern and classical.

In character Dr. Bradley was a perfect type of a Christian gentleman. He had a warm sympathy for all who suffered, and a broad charity which made him kind to all alike, no matter how unworthy. He was the trusted friend and counselor of many who else had been friendless. His long residence in Greece gave him an intimate knowledge of nearly every family and person for miles around, and he was loved and honored by all who knew him. In person he was rather stout, with broad shoulders and a beautiful head. His forehead was broad and high, and his eyes were dark and brilliant, lighting up as he became interested in conversation. His whole countenance was very expressive. His manners were cordial and his hospitality unbounded. Notwithstanding all his book-lore, he never seemed to lack interest in even the most humble or commonplace person who laid claim to his attention. He was especially interested in the young, and was always ready to help any student. For many years he taught a Bible class, or, in the absence of a pastor, conducted services in the Congregational church. Cheerfulness, love of humor, ready wit and quick repartee were among his prominent characteristics. His intellectual life was intense and vigorous.

In 1831 he married Mrs. Sarah Bartlett Crane. His three children are Miss Cornelia Bradley and Mrs. Gilbert Cromwell, of Ogden, and Dr. William Bradley, of Evanston, Illinois.

The President read the following paper:

THE LENGTH OF GEOLOGIC TIME.

BY HERMAN LEROY FAIRCHILD.

The problem of the Earth's age has a peculiar interest, none the less from its uncertainty, and improbability of exact solution. The most frequent question asked the geologist is one relating to time. How many years ago was this or that event or phenomenon?

The problem has been approached from two directions; by the geologists, basing estimates upon the present rate of land destruction and marine sedimentation, as applied to the total thickness of sedimentary rocks; and by the physicists, calculating from the laws of matter and radiant energy the time required for cooling and condensation of the earth. The geological method, resting upon the theory of uniformity, is simple, but the data are complex and elusive; the physical method has to make large assumptions regarding the behavior of matter under conditions of heat and pressure transcending all experience.

Estimates upon the length of geologic time have been made by many geologists. When the uniformitarian theory came into general acceptance, a half century ago, and it was recognized that the earth, as we see it, is the result of steady action of the same geologic forces and agencies that are working to-day, it was naturally believed that the age of the earth must be of indefinite duration. For merely the sedimentary rocks a minimum time of hundreds of millions of years was claimed. For the pre-Silurian and crystalline rocks, and the preceding molten stage of the earth no limit could be given. This was the inevitable swing of the intellectual pendulum away from the catastrophic or cataclysmic theory and the Biblical chronology.

To these extreme views a check was given by the physicists. In 1862 Sir William Thompson challenged the geologists by announcing that from the laws of heat radiation not over 100 millions of years could be allowed for the cooling of the earth to its present condition from a fluid state. Other physicists later gave much less range of time. The geologists were led to moderate their claims, and to make closer estimates, until now there is substantial agreement between the two classes of scientific men.

By a comparison of the character and amount of sediments the relative lengths of the great geologic time divisions are not difficult to approximate. But a determination in years is difficult because of the lack of any constant quantity with time value. As a time unit various phenomena have been taken; the rate of degradation of the continents; the growth of river deltas; the formation of river canyons; and the amount of rock disintegration and stream erosion since the ice invasion in our northern lands. The results are confessedly inexact, but have a fair agreement.

In the past year three important essays upon the subject have appeared, one from the physical standpoint, and two from the geological. In the January, 1893, issue of the *American Journal of Science*, Mr. Clarence King revises the physical conclusions in the light of new data upon the behavior of diabase rock under experimental conditions of heat and pressure. His conclusion is that the age of the earth since its molten state cannot be over 24 million years. An article by Mr. Warren Upham in the March, 1893, number of the same journal, reviews the arguments and estimates of earlier writers, and favors 48 million years for our stratified rocks (since beginning of Cambrian time), or 100 millions for geologic time (since the ocean existed). The Vice-Presidential Address of Mr. C. D. Walcott before Section E of the American Association for the Advancement of Science, at Madison, Wisconsin, in August last, was printed in the *American Geologist* in December. By a careful and detailed study of the sedimentary rocks of Paleozoic time in western America as a basis for comparison and computation, and modifying the time ratios of Haughton and Dana, he concludes that post-Archean time is between 25 to 30 million years as a minimum, and 60 to 70 million years as a maximum. More definitely he gives 27,650,000 years for the fossiliferous rocks and 55 million years for geologic time (since the beginning of the Archean).

Following is a table of estimates of various writers, the physicists placed last. The first column gives those estimates which cover only the time of the fossil-bearing or unaltered sediments, that is, since the beginning of Cambrian time. The second column gives those estimates which include all of "geologic time," that is, since the beginning of the Archean, or since the present agencies began their work. This time would be covered by the existence of the ocean. The third class of estimates are those which cover all the duration of the earth since a state of extreme heat. The estimates of the physicists fall into this third class.

		For fossiliferous sediments.	For existence of ocean.
(1)	Sir Charles Lyell	240 million years.	
(2)	Dr. Samuel Haughton	133 " "	200 million years
(3)	Dr. James Croll	60 " "	72 " "
(4)	Dr. Charles Darwin		200 " "
(5)	Sir Alfred Wallace		28 " "
(6)	Sir Archibald Geikie	100 " "	
(7)	Mr. T. Mellard Reade	95 " "	
(8)	Prof. J. D. Dana	48 " "	
(9)	Prof. Joseph LeConte	30 " "	
(10)	Mr. Warren Upham	48 " "	100 " "
(11)	Mr. C. D. Walcott	28 " "	55 " "
(12)	Mr. W. J. McGee	2400 " "	

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(2) Haughton:—"Six Lectures on Physical Geography," 1880, p. 94; *Philos. Mag.*, XXVI, Dec., 1877, p. 545.
(3) Croll:—"Climate and Time," 1875, p. 342.
(4) Darwin (Chas.):—"Origin of Species," 5th Ed., 1871, p. 291.
(5) Wallace:—"Island Life," 2d Ed., 1892, pp. 222-223.
(6) Geikie:—"Presidential Address," 62d Meeting Brit. Assoc. Adv. Sci., 1892; (*Nature*, Aug. 4, 1892, and in *Smithsonian Report* for 1892).
(7) Reade:—*Geological Magazine*, Vol. 10, 1893, pp. 99-100.
(8) Dana:—"Manual of Geology," 3d Ed., 1880, pp. 590-591.
(9) Le Conte:—"Elements of Geology," 1888, pp. 275-276.
(10) Upham:—*Amer. Jour. Sci.*, Vol. XLV, March, 1893, pp. 209-220.
(11) Walcott:—*Amer. Geologist*, Vol. XII, December, 1893, pp. 333-368.
(12) McGee:—*Science*, June 9, 1893, p. 309.

		Since molten state.
(13)	Prof. A. de Lapparent	80 million years.
(14)	Dr. Alexander Winchell	3 " "
(15)	Sir William Thomson	100 " "
(16)	Prof. George H. Darwin	57 " "
(17)	Prof. Guthrie Tait	10 " "
(18)	Prof. Simon Newcomb	14 " "
(19)	Mr. Clarence King	24 " "

Excluding the two extreme estimates in the above table, it will be seen that the late estimates are in fair agreement and, as compared with former views, are reasonably definite. There is substantial agreement not only among the geologists, but between the geologists and the physicists.

Estimates of the relative duration of the greater geologic time divisions have been made as follows:

	Paleozoic.	Mesozoic.	Cenozoic.
Dana	12	3	1
Winchell	9	3	1
Williams, H. S.	15	3	1
Walcott	12	5	2

Mr. Walcott's estimate, according to his proportion given above is, for the Paleozoic, 17,500,000 years; Mesozoic, 7,240,000 years; Cenozoic, 2,900,000 years; total for the fossiliferous sedimentary rocks, 27,650,000 years.

The time since the departure of the ice of the Glacial period from this portion of the continent has been estimated by several eminent authorities, from different data, and their figures fall within 6,000 to 10,000 years.

Mr. F. W. Warner described a new ammonia motor now constructing in New York city.

A letter from Dr. M. A. Veeder was read, relating to the co-operation of the telegraph companies in transmitting reports of auroras and electric disturbances.

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(13) de Lapparent:—*Bull. Soc. Geol. France*, 3d Ser., Vol. 18, 1890, pp. 351-355.
(14) Winchell:—"World Life," 1883, p. 378.
(15) Thomson:—*Trans. Roy. Soc. Edinburgh*, Vol. XIII, Pt. 1, p. 157; "Treatise on Natural Philosophy" (Thomson and Tait), Appendix D.
(16) Darwin (G. H.):—*Phil. Trans. Roy. Soc.*, Pt. 2, 1879.
(17) Tait:—"Recent Advances in Physical Science," 3d Ed., 1885, p. 169.
(18) Newcomb:—"Popular Astronomy," pp. 505-519.
(19) King:—*Amer. Jour. Sci.*, Vol. XLV, January, 1893, pp. 1-20.

Dr. C. T. Howard exhibited specimens of buds and leaves infested by the bud moth (*Tinetocera ocellana*).

The President referred to Circular No. 3 of the Department of Agriculture relating to the Scale insect (*Aspidiotus perniciosus*) which has become troublesome in the Eastern states.

MAY 14, 1894.

STATED MEETING.

The President, PROFESSOR H. L. FAIRCHILD, in the chair.

Forty-five persons present.

The Council report announced that at the next business meeting an election would be held to fill the vacancy in the office of Second Vice-President, caused by the death of Dr. M. L. Mallory, and recommended that the Academy give its support and co-operation to the movement initiated by the Scientific Alliance of New York City to secure lower rates of postage on scientific material. The recommendation of the Council was adopted.

Mr. J. Y. McClintock exhibited a photographic copy of a topographical map of Rochester and vicinity made by the co-operation of the United States Geological Survey and the New York State Engineer and Surveyor. Later in the evening, the following resolution, introduced by Mr. McClintock, was adopted :—

Resolved, That the Rochester Academy of Science urges upon the State Engineer and Surveyor, and the Director of the United States Geological Survey, the desirability of making the "Rochester Sheet" of the New York State Topographical Map cover the territory northward to the shore of Lake Ontario, so as to include the shore line entirely across the sheet.

The following memorial sketch of Dr. M. L. Mallory, Second Vice-President of the Society, was then read :

A MEMORIAL OF MAITLAND L. MALLORY, M. D.

BY WILLIAM STREETER.

When an esteemed citizen in public life is removed from the field of his labors all have a sense of individual loss. The Rochester

Academy of Science has suffered such loss in the sudden demise of a Vice-President, one of its oldest and most honored Fellows, an officer of sound judgment and rare executive ability.

We have not yet sufficiently recovered from the shock which the tidings of Dr. Maitland L. Mallory's death occasioned, to speak of it but in sighs and sorrowful ejaculations. I shall not attempt any extended eulogy, but merely call to mind a few of those traits of character which won for him a place so dear in the hearts of his friends and associates.

Through the daily press we have become familiar with the story of his early life, and some of his later achievements, but while he was admired and respected by all who knew him for his many good qualities, it was only to his most intimate friends that he was fully revealed. We who have had the pleasure of working with him on different lines of investigation, have invariably found him imbued with the true scientific spirit—a close observer, a deep and clear reasoner, an ardent lover of Nature, whose aim it was to understand thoroughly her methods, and possessing so many of her secrets, yet too great and too well aware of the vastness of the unknowable to be at all vain or conceited. I have often been surprised at his knowledge of sciences to which he made no claim as a specialist.

An enthusiastic student, his library outside of his professional literature embraced most of the standard, technical works in a wide range of subjects, especially in the fields of microscopy. A man of rare and refined tastes, his standard was exalted, and the true and beautiful alone attracted him.

With ample means at his command and a generosity which caused him to do more than his full share in any enterprise where money was required, he would shoulder the greater part of the burden in such a way as to relieve all from embarrassment, as the Microscopical Section will bear me witness.

While fond of out-door sports, and with steady nerve and unerring eye, he was in sportsman's phrase "a dead shot," it was as a naturalist, and not as one who simply "goes a-killing" and ruthlessly slaughters everything in his path. More in the interest of science than of sport he would carefully select a fine specimen and bring it down, while others of its kind would pass under his immediate notice, unharmed. So while in the true sense a hunter he was in no sense a wanton destroyer of the denizens of the forest.

Though born upon British soil, he came to the States as the home of his adoption and was an American citizen in the full meaning of the term, a lover of the republic and of republican institutions.

He took a lively interest in all that pertains to the elevation and enlightenment of the masses. A true philanthropist, his chosen profession was for the alleviation of suffering humanity. His skill and untiring efforts have restored to health and happiness hundreds who survive to honor his memory. The Monroe County Medical Society, the New York State Medical Society, the Pathological Society, the City Hospital, the Western New York Institute for Deaf Mutes, the Rochester Board of Health, alike lament the untimely removal of one, for many years so closely identified with their interests.

The plans which he developed for the systematic study of our water-supply, if fully carried out, would be of very great importance to the city of Rochester, and would place upon record facts and data which might be the means of tracing disease and epidemics, and would place within easy reach a means of comparison for all future time.

His work in scientific research was methodical and painstaking, and his reputation far exceeded local bounds, as his connection with the American Microscopical Society, the British Royal Society of Microscopy and the American Association for the Advancement of Science bears witness.

A warm friend of Dr. Mallory recently wrote :—"His youth and early manhood were not free from adversity, which was nobly met and valiantly conquered. The struggles of youth gave way to the successes of manhood, and there was developed a finely-rounded and symmetrical character. His mental endowment was of that cumulative kind which could rapidly take up new pursuits and almost intuitively absorb their substance and master their details. This was true in many and widely diverse directions. A casual observer could not form an idea from his calm and dignified manner of his manifold acquirements. It was only as one became better acquainted with him that he was really appreciated, and to those who knew him best his life for many years was a constant inspiration to higher achievement."

Physician, philanthropist, scientist, scholar, patriot, citizen, comrade and friend, we shall miss the words of greeting, warm from thy heart, we shall miss thee from the familiar walks of life, and the entire community is indeed bereft! From the depths of overflowing hearts we may truly say as did Antony of the noble Roman,—

" His life was gentle and the elements
So mixed in him that Nature might stand up
And say to all the world, 'This was a man.'"

The following resolution was offered by Dr. J. Edward Line:

"Resolved that the memorial of our late fellow member, Dr. Maitland L. Mallory, as prepared and read by Major William Streeter, be and hereby is adopted as the sentiment of this Society; that this memorial be spread upon the minutes, and printed in the Proceedings of the Academy; and that copies be sent to the American Association for the Advancement of Science, the American Microscopical Society, and the Royal Microscopical Society, London, of which societies Dr. Mallory had long been a member."

In seconding this resolution personal tributes to the character and works of Dr. Mallory were offered by Mr. J. Y. McClintock, Professor S. A. Lattimore and Dr. George W. Goler, former associates of the deceased physician. These tributes referred particularly to his work upon the City Board of Health, and to his generous interest in many institutions and charities.

The resolution was unanimously adopted.

The following paper was read:

THE RECENT EPIDEMIC OF TYPHOID FEVER IN BUFFALO.

By S. A. Lattimore.

About the beginning of last March the attention of the Department of Health of the City of Buffalo was attracted to the fact that an unusually large number of cases of typhoid fever were being reported by physicians. The number increased daily, reaching one hundred and twenty-two on the eleventh. Suddenly the presence of an epidemic was recognized. Through the press the distressing news was immediately conveyed to the whole city. Anxiety became alarm, and alarm soon became panic. Without the slightest warning, and from an utterly unknown source, a city of three hundred thousand people found itself suddenly invaded by a pestilence, striking down its victims in nearly every quarter, and respecting no rank or class. Every inhabitant was menaced. Three questions sprang simultaneously from every lip :—Whence came this pestilence? When will it cease? What can be done? And there was no answer.

Of this epidemic I have been asked to give the Academy of Science a brief account. I have accepted the invitation with hesitation because I am well aware that any account I can give you will be more or less imperfect from the lack of some, and possibly many, of the data essential to a complete history. And yet it seems to me that a study of this case, even in its broader outlines may be useful, not because it has contributed any new facts to sanitary science, but because it powerfully emphasizes the importance of putting to practical use the knowledge we already possess.

The study of an epidemic is usually involved in great difficulty. When it attracts the attention, it is often too late to ascertain the causes and conditions from which it sprang; they have either ceased or changed, leaving no certain trace, and relegating us to conjecture and inference. When, as in this case, it is possible to trace the causes to their natural results, and make out a complete history of the epidemic from its beginning to its end, it constitutes a most important contribution to sanitary science, as it shows us the true means of prevention, which is the great object to be sought.

Epidemics have been noticed in history ever since history began to be written, but never seriously and scientifically studied until very recently. In former ages people cowered in helpless and hopeless terror before the pestilence. It walked in darkness, there was no search light to turn upon it. It was the unapproachable mystery, the embodiment of divine, omnipotent and indiscriminate fury. What a change has taken place! Does cholera break out in India, the leading nations of the world dispatch their most learned and intrepid scientists to study it where it rages most violently. Does yellow fever, the terrible legacy left to the white race by the African slave trade, rage in tropical ports, thither flock the heroic students to study its causes and its nature. On the discoveries thus made must be based all intelligent means of prevention by disinfection and quarantine.

Thus it is that sanitary science is pre-eminently a coöperative product. It is the final result of many distinct but contributing sciences. Singularly, too, it is largely the direct outcome of calamity and disaster. The sanitary legislation of England, beginning only forty years ago, which has already so largely blessed the entire civilized world, found its incentive in the Crimean war. The sanitary movement in this country, ten years later, leading to the organization of state boards of health, and enabling us repeatedly to defy and baffle the approach of the most destructive epidemic of modern times, originated in the awful experiences of the southern rebellion. Thus we profit by the hard experience of our ancestors.

The recent epidemic of typhoid fever in the city of Buffalo is noteworthy as an instance in which nearly, if not all, the data necessary for a complete history, as to its cause, its progress and its cessation, were collected and studied on the spot and at the time by competent scientific observers. Such a history, I have no doubt, will ultimately be furnished from official sources.

A brief visit to the city of Buffalo at the height of the epidemic afforded me the opportunity of learning most of the facts presented in this account, from officers of the Department of Health, from a number of leading physicians and prominent citizens. Some of the gentlemen have kindly furnished additional information since the cessation of the epidemic.

A clear comprehension of the cause of this outbreak requires some knowledge of the following facts. The waters of Lake Erie flow northward through the Niagara river. On the eastern bank of this river and at its origin lies the city. The main water-supply of the city is derived from the river at a point almost opposite Fort Porter. Just below the Fort is the pumping station from which a tunnel extends under the river, terminating at "the crib," which protects the inlet, and is situated near the middle of the stream. Near the eastern shore, at Bird Island, another inlet communicates with the tunnel. (A diagram was exhibited and explained.) The reservoir is of small area and is not depended upon for storage purposes, but rather to equalize the pressure maintained by the pumping engines, which are driven without intermission. The daily consumption averages about seventy-five million gallons. The distributing mains are so constructed that a direct distribution from the pumping station is secured, while but a small part of the water ever enters the reservoir. The circulation in the mains is therefore necessarily and constantly active. The inlet is approximately opposite the middle of the city on a north and south line. A large area of the southern part of the city, embracing Buffalo creek, the Hamburg canal and the city ship canal leading from the coal, lumber and railway docks, discharges its sewage into the river *above the inlet.* As the current is rapid, the sewage is carried down along the eastern shore, and, at least in theory, is not supposed to reach the middle of the river where "the crib" is situated. The Bird Island inlet, however, lies full in its way, but is kept closed. All these facts bear upon the history of the case.

The epidemic prevailed from the beginning to the end of March. During these thirty days the total number of cases reported was four hundred and fifty-three and considering the difficulty of obtaining complete statistics in such cases I think we may reasonably conclude that this epidemic produced a thousand cases of typhoid fever. Happily the number of fatal cases was small.

No sooner was the presence of an epidemic recognized than a vigorous and intelligent search for the cause was instituted as the necessary preliminary to any rational scheme for its abatement. Guided by the bacterial theory of the origin of typhoid fever, attention was directed at once to the water-supply. The following facts were discovered. During the latter part of February strong winds from the north or northeast had been prevalent, setting back the water in Lake Erie, and lowering the level of Niagara river so much that the quantity entering the tunnel at "the crib" was greatly diminished. Consequently the supply in the reservoir was being rapidly exhausted on account of its small capacity, and the pressure was being reduced to so low a point as to cause serious apprehension in the event of a conflagration. Most unfortunately, and most unaccountably, in this emergency, the gates of the unused inlet at Bird Island, on the east side of the river, were opened and the sewage-laden water was pumped into the mains of the city, and the requisite fire-pressure secured. This event, it will be observed, preceded the outbreak of the epidemic approximately by the ordinary period of incubation for the typhoid bacillus. To transform the theory into a demonstration, if, indeed, any were needed, and to render the chain of evidence complete, Dr. William G. Bissell, Acting Bacteriologist to the Department of Health, not only detected Eberth's *Bacillus typhosus* in water taken from the city mains March 7th, but successfully cultivated it in various media.

A significant fact was observed during the period of the epidemic, that in those parts of the city to which the water mains had not been extended, and where, in consequence, ordinary wells are in use, and also in a section supplied from artesian wells, no case of typhoid fever was reported.

I call your attention to a map of Buffalo on which the location of each reported case is accurately marked. A study of this map is more impressive than any verbal description could possibly be. I am indebted to the courtesy of Dr. Ernest Wende, Health Commissioner, for its loan from his office.

At the beginning of the epidemic the Department of Health fully recognized the gravity of the situation, and the imperative necessity of discovering and applying a prompt and intelligent remedy. The Academy of Medicine was on the alert, and appointed a number of the leading physicians of the city as an advisory committee to coöperate with the officers of the Department of Health. These movements of officials and scientific men naturally and unavoidably intensified the public alarm. Bulletins of advice were issued by the Health Commissioner for the instruction of the citizens, in which was urged the importance of sterilizing all water used for domestic purposes. The Superintendents of all railways entering the city were warned against the danger of supplying passenger cars with water from the city mains. The faucets in the public schools were ordered closed, and the children carried from home bottles of sterilized water.

The situation prompted such questions as these :—How long will the epidemic probably continue ? May not this be only the beginning rather than the culmination or the end of the pestilence ? In view of the fact that the many miles of water mains, and possibly the reservoir itself, were now thoroughly infected, and that the *Bacillus typhosus* is capable of living and multiplying in water at ordinary temperatures, and might thus take up its permanent abode there, no reassuring answers to such questions as these could be given. The forecast was truly gloomy if not threatening. The demand that something should be done to arrest the ravages of the epidemic was urgently pressed upon the health authorities. Meanwhile they and their advisers were earnestly considering the question,—What can be done ? Before a solution of this problem could be reached there were happy indications that the pestilence had passed its culmination and was unquestionably abating. The number of cases reported declined daily, until by the end of the month the normal rate had been reached, and the epidemic had ceased.

This sketch would not be complete without allusion to a method of disinfection novel in its method, and unusual in its magnitude. Although the trouble appeared to have passed, a return was still feared, and it was determined to attempt the disinfection of the reservoir. To this end, it was completely emptied, and a solution composed of eighty-five pounds of liquid bromine, dissolved in twelve thousand gallons of water, was applied to the walls and floor of the reservoir with the full power of a steam fire-engine, the engineer keeping well to the windward.

Allow me now to summarize very briefly the significant facts already stated somewhat in detail:

In the month of February, by an amazing blunder, water beyond all question sewage-laden, was pumped into the mains and used by the unsuspecting citizens. Almost immediately after the contamination of the water, as I am credibly informed, "nearly every one in the city was more or less ill with dysentery accompanied with griping pain in the bowels, and a rise of temperature to about 103°. In two or three days this subsided." At the beginning of March the epidemic was recognized, reaching its maximum daily number reported, 122 cases, on the eleventh, and declining through the next twenty days. A condition inseparable from every case was the use of water from the city supply. Others escaped without exception. The chemical analysis of the water by the City Chemist, Dr. Herbert M. Hill, showed evidence of contamination. The bacteriological examination, by the Acting Bacteriologist, Dr. William G. Bissell, demonstrated in water drawn from the mains, the presence of the essential cause of typhoid fever, the *Bacillus typhosus*. Previous to this discovery, I was assured by a number of prominent physicians that they knew of no diversity of opinion among the medical profession, that the epidemic was due directly and wholly to the contamination of the city water supply by the city sewage

The short duration of the epidemic was probably due to the peculiar construction of the water works system, which causes a rapid circulation, and thus the uninfected water taken from "the crib" in midstream soon swept the mains free from the fatal bacilli.

As incidentally connected with this case, it may be mentioned that during the prevalence of the epidemic in Buffalo, grave apprehensions of danger seized the minds of the inhabitants of some of the villages which derive their water supply from the lower part of the river, such as the villages of Niagara Falls and Suspension Bridge, and threats were made of legal processes to restrain the city of Buffalo from contaminating their water supply. The epidemic having ceased in Buffalo, the *modus vivendi* has no doubt been resumed, to continue until the next explosion, when it will be too late to apply a remedy for that time.

Has not the sad experience of our sister city a most impressive lesson for the citizens of Rochester? It is true that it may not have taught us any new facts in sanitary science, but it certainly has placed a tremendous emphasis on the importance of putting what we do know into daily practice. Who can compute the cost of a thousand cases of such illness? What is the pecuniary cost in loss of valuable time, and in the expense of nursing and medical attendance? Who can estimate the physical suffering, the mental distress of those afflicted, each the center of a sympathizing circle, beside the loss of valuable lives?

You may say that Buffalo will never repeat this irreparable blunder, and in Rochester it is impossible. But let us remember that the invisible causes of contagious diseases are wonderfully transportable, and have free passes on all lines of travel, and so may find access to our water-supply by other means than by pumping in city sewage. We should remember, also, that there are other pathogenic bacilli besides those of typhoid fever, with whose life histories and nature we should be thoroughly acquainted, in order that we may be forearmed.

With the facts of the Buffalo epidemic clearly before us, can we say that the apprehensions of the lower villages were wholly groundless, as they thought of the entire sewage from a city of 300,000 people being poured into the water from which they must drink? Consider the contamination which many large cities are daily pouring into Lake Erie and Lake Ontario, and ask yourself if such facts can contribute to the peace of mind of any thoughtful person who draws his supply of water from either of these lakes. We may, I think, congratulate ourselves that our enlarged supply is to be obtained from Hemlock Lake rather than from Lake Ontario.

The trend and drift of these suggestions may be fairly considered selfish, though in a broad sense. They are in the direction of self-protection and self-preservation. But it may be well to remind ourselves that our city is not an island in the ocean, it has a vicinage and neighbors near and remote. They have rights as well as we, and on these rights we may not trespass. Has a city any more right than a private citizen to render itself a nuisance by discharging its waste upon their property, and rendering odious, if not dangerous, the air they must breathe and the water they must drink? Is it a premature question to ask if the time has not almost come when cities shall no longer convert the natural waterways into sewers, and the lakes into reservoirs for their sewage? Methods of sewage disposal and disinfection have been already so far perfected that in my opinion, at no distant day, compulsory destruction of all offensive and dangerous waste material, of whatsoever kind, may be legally enforced without serious expense or inconvenience, Again, are we quite rational and sensible in the relative estimate we place upon our most cherished possessions? Do we not strangely, insanely under-rate health and life and over-rate greatly the mere things which possess absolutely no value at all apart from life and health? For example, look at our splendid and costly equipment for the protection of our property. See these big fellows who look so handsome in blue and gold. We keep an army of them, 162 in number. We take great comfort in them. With what a sense of sweet security we fall asleep as we hear the familiar though unmusical signal of our guardian angels prowling around! With what municipal pride do we review them on the Fourth of July and other gala days! And we pay for them, more or less cheerfully, $161,664 a year. Then again take a glance at our magnificent fire department,—its luxurious houses, its prancing horses, its glittering engines, trucks, and hose-carts. Then, too, look at the intricate electric net-work which spreads over the city like a metallic veil, and brings us all in touch with the great bell in the city hall tower, which startles us with its harsh clang whenever fire touches the humblest hovel. All this costs us $187,826 a year. Do we say, what is the use of all this, we have had no serious conflagrations for years? No, we do not reason that way. We talk about protection and prevention in these matters. But the menace of infectious diseases is as imminent as that of fire. And surely a man's life is of more value than the house he lives in, be it hovel or palace. Yet when the fire of fever breaks out there is no startling alarm from the great bell, no smoke and thunder of flashing engines, or sudden gathering of crowds in the street. No, the poor victim is left to fight his battle as best he can, with friends, nurse and doctor, as silent and well nigh helpless witnesses of the struggle.

We should be ready to meet and exterminate any epidemic which may suddenly make its appearance, as we fight fire. Where is our trained sanitary police? Where our equipment of hospitals and disinfecting appliances and supplies kept in readiness for instant use, before the pestilence has time to smite down a thousand unprotected victims? It is wise in time of peace to place ourselves on a war-footing against the attacks of epidemics, whose tactics are now, thanks to brave and laborious scientists, not wholly mysterious to us, and thus promote and preserve our peace of mind, and safety of life and health. Such an investment of money would be a profitable one. No stronger element of prosperity can a city possess, or greater attractions for good citizens can it offer, than a low death rate and a high health grade.

Lastly, the experience of our neighboring city once more shows with what unthinking complacency we commit ourselves supinely every day to the discretion and unproved competency of the man at the throttle lever or the pilot's wheel. The opening of a valve in a moment of thoughtlessness let in an army, as the hosts of Cyrus who entered Babylon by way of the bed of the river Euphrates. In the light of such an experience, how clear it is that the safety of this city requires that the purity of Hemlock Lake should be guarded as if it were a mine of diamonds. If the present means and methods employed for its protection are good, let them be made better, and progressively better, as sanitary science gives us more and more intelligence and light. Nothing less than unrelaxing vigilance, the certified intelligence, and fidelity of every officer charged with the administration of this trust, can give the people of this city that sense of safety and security which the city owes them.

Remarks were made by Dr. M. A. Veeder, Mr. J. Y. McClintock, Dr. George W. Goler, Major William Streeter and the President.

The third paper of the evening was presented, as follows:

THE PITCH LAKE OF TRINIDAD.

By Adelbert Cronise.

CONTENTS.

The Island.

The Pitch Lake of Trinidad is not only a great natural curiosity, but as the source of our "Trinidad Asphalt" it is a place of scientific and commercial interest. A run of sixteen days from New York, on a course considerably east of south, takes us to the island of Trinidad, the most southerly of that group of the West Indies which we call the Windward Islands, lying within eleven degrees of the equator and in the longitude of the eastern part of Nova Scotia, or fifteen east from

Washington. The island is separated from South America by the Gulf of Paria ; and LaBrea, the point at which we land to reach the Pitch Lake, is on the west side of the island opposite the easterly coast of Venezuela. Much of the island is wooded and mountainous, the highest of the peaks rising to a height of about three thousand feet.

The Lake.

From LaBrea a walk of a mile over a made asphalt road through jungle and forest leads up to the lake, which is a hundred and thirty-eight feet above the sea-level, the land sloping up to it from three sides. The lake is of somewhat irregular shape, approximately round, and has an area of 109 acres as determined by the government survey. The surface of the lake is a number of feet higher than the level of the ground immediately about it, having been lifted by the pressure from below. (*See plate 13.*)

The material of the lake is solid to a depth of several feet, except in a few spots near the centre where it remains in a soft condition, but usually not hot or boiling as often described. Consul Pierce states that in the hottest part of the day he has seen a man walk into this softest part without harm, that it only came to the calves of his legs, and that it was pliable as soft putty but did not stick. Also that in the cool of the morning he has seen a man walk over the softest spot without sinking deeper than his foot. As this part is not always the same it is possible that at times it may have been, as it has been described, a cauldron of boiling pitch.

Although approximately level, being a few inches highest in the centre, the surface of the lake is far from smooth, being marked by many fissures two or three feet in width and slightly depressed spots, all of which are filled with rain water. In going about one has to pick his way among the larger puddles and jump many of the small connecting streams. Each of the hundreds of irregular portions separated by this network of fissures is claimed to have a slow revolving motion upon a horizontal axis at right angles to a line from the centre of the lake, the motion of the surface being from the centre toward the circumference. Such a motion would account for the roots, leaves and bits of wood of comparatively recent vegetation which are constantly being brought to the surface. The motion is claimed to be caused by the great daily change in temperature, often from 60° at night to 140° in the day, or 80° change, and an unequal upward motion of the mass below, increasing toward the centre of the lake.

Scattered about the surface of the lake are about thirty small patches of shallow earth covered with bushes and small trees. Mr. McCarthy, the local manager of the Trinidad Asphalt Company, states that he removed the layer of earth forming one of these islands and that the pitch below then rose to the general level of the lake.

The Pitch Lake has been the subject of many exaggerations, misrepresentations and romances, not only by mere travelers but by writers of supposed authority. Two of our leading encyclopedias state that its circumference is about three miles, which would give it four times its actual area. In a paper recently read before the American Institute of Mining Engineers the lake is stated to be three miles from the sea, while in fact it is but one, and both elevation and size are incorrectly stated. An official history of the English Exposition of 1851 states that the Pitch Lake is on the highest land in the island, which is 3,100 feet, while the actual elevation of the lake is but 138 feet. The same authority states that "there is an active submarine volcano near the coast," while another writer says that there is "a submarine volcano which at times makes a noise like thunder and emits naphtha and petroleum." The simple truth is that in one spot near the shore a little oil and gas rise to the surface of the sea. The "noise like thunder" probably refers to the report from the bursting of the bubbles of gas. The few small patches of vegetation upon the lake have been exaggerated to resemble the Thousand Islands of the St. Lawrence.

The Pitch.

The asphaltum or "pitch" at the surface is of a brownish-black color and hard to the touch. Even in the hot sun of the tropics it is brittle, except at the centre, so that a pick struck into it will break out pieces of several cubic feet in size. Although brittle it is porous and light so that one man lifts the large pieces into the carts without assistance. After digging down to a depth of three or four feet the pitch is found somewhat softer, and elastic rather than brittle, and the pit is then left to fill up again. Within a day or two the pressure from below will have raised the elastic bottom of the pit to the level of the surrounding surface, but as it is hardened by exposure to the air this lifting is checked and the surface remains nearly level. In this way probably over half a million tons have been taken out within a small area near the margin of the lake without lowering its level.

The statements of the amount of pitch in the lake, varying from two to four million tons, while mere guesses, seem to me to be under

Cronise—Pitch Lake of Trinidad.

the truth. If half a million tons has been taken out from a small area without appreciably lowering the surface it is impossible to make an estimate of any value as to the extent of the supply.

The origin of this never failing supply of pitch is not certainly known. The theories of vegetable, animal, mineral and volcanic origin have been much discussed. The nearest that can be said is that it is from the decomposition of organic matter.

The term "pitch," probably from the Greek πιτυς, the pine tree, was first applied to the residuum of boiled tar, or vegetable pitch. It is now applied also to some of those mineral substances of an oily or resinous nature known as bitumens, composed chiefly of carbon and hydrogen, and varying from naphtha, the most volatile, to pit-coal the most solid. The relation of the pitch of Trinidad, or asphaltum, to the most important of the series is as follows:

Bitumens. {
Naphtha,
Petroleum,
Mineral Tar, or Maltha,
Elastic Bitumen, or Elaterite,
Asphaltum,
Pit Coal.

The bitumens of this series merge into one another so that it is impossible to make clear distinctions.

Exploitation.

The Pitch Lake is the property of the government of Trinidad. Until a few years ago licenses to take asphalt from the lake were given to various parties. These different parties being in competition with one another decided to combine and secure if possible the exclusive right to the lake. As the licenses were not exclusive they were not valuable enough to bring much revenue to the government, and the export duty of twenty cents per ton brought little more. The licensees proposed to the government that if they could have the exclusive right to take asphalt from the lake for a term of years they would guarantee $36,000 a year and pay forty cents a ton for the asphalt taken, and would submit to an export duty of $1.20 a ton. The object in proposing an increased duty was to deter the competition of those who were mining "land asphalt" in the island. The proposition was accepted, The licensees, many of whom were English, organized as "The Trinidad Asphalt Company," a corporation under the laws of New Jersey, with their principal office in Port of Spain, Trinidad. A contract according to the proposed terms was then made by this company with the Trinidad government for twenty-one years. In 1893 the government received a revenue of about $150,000 from the lake.

In addition to the forty cents a ton for the pitch and one dollar twenty cents a ton export duty, the cost of digging the pitch, carting it to the pier at LaBrea and loading it on the steamer is about one dollar fifty cents a ton, or in all three dollars ten cents a ton on board.

The pitch sent to the United States is shipped in bulk as it is dug out from the lake. In the hold of the vessel the pitch softens with the heat and the pieces coalesce into a semi-fluid mass. On reaching the north the mass becomes hard and has to be broken out with picks as when first taken from the lake. In some cases, from unusual heat or a long voyage, the mass became so soft as to list to leeward, and the vessels being unable to right themselves have been wrecked.

The pitch sent to Europe is first refined at LaBrea. When melted all foreign matter, amounting to from 10 to 20 per cent., floats or settles to the bottom, and the pure asphaltum, there known as "pitch épurée", is drawn off and shipped to Europe in barrels.

Most of the Trinidad asphaltum used in this country is bought crude of the Trinidad Asphalt Company by the Warren Chemical and Manufacturing Company and refined at its works at Hunters Point, New York, and then sold to the different paving companies. One of the paving companies, the Barber, has a refinery of its own at Hunters Point and another at Washington.

Asphaltic Pavements.

The Trinidad Lake asphaltum in its natural condition is too brittle for our northern cold. To correct this it is toughened by using with it about 12 per cent. of another bitumen higher in the scale, viz., the residuum of petroleum. This combination is both hard and tough, hard enough not to become soft in the heat of summer and tough enough not to crack in the cold of winter. In this condition it is known as bituminous mastic, or paving cement.

To this mastic or cement fine, sharp sand and powdered carbonate of lime are added, in the proportion of 12 to 16 per cent. mastic, 73 to 67 per cent. sand, and 15 to 17 per cent. carbonate of lime, to make a pavement which will resist wear.

The four conditions from the lake to the pavement are, approximately,—

1. Crude Pitch, { 80 to 90% asphaltum, 20 to 10% foreign matter.
2. Pitch Épurée, or refined asphaltum.
3. Paving Cement, { 88% asphaltum, 12% petroleum residuum.
4. Asphaltic Pavement, { 12 to 16% paving cement, 73 to 67% clean sand, 15 to 17% pulverized carbonate of lime.

This pavement, substantially so made, is the one now laid by most of the American asphalt paving companies, the Warren-Scharf Company and the Barber Company which work in most parts of the country, and the Rochester Vulcanite and other companies which operate locally in their several cities or sections. The pavement originally laid by the Rochester Vulcanite Company was a compound of Trinidad asphalt, sulphur, lime, cement, sand, stone dust and distillate of coal tar, but the pavement now laid by this company is substantially the same as that first described above.

Trinidad Land Asphalt.

Besides the "lake asphalt" from Trinidad the island furnishes what is known as "land asphalt," referred to above. This is mined in several places in the island, near LaBrea, and is estimated to cover 3,000 acres. Nearly all of this is covered with earth. Whether it is an old overflow from the lake or comes from the rich bituminous sandstone beneath is a much discussed question. It is harder and contains more impurities or foreign matter than the lake pitch. Even when refined it is said to be inferior to the lake product. Pavements of this land asphalt were recently laid in Denver by the West Indies Asphalt Company, now defunct, under the claim that it was "Trinidad Asphalt" and complied with their contract. The pavements were taken up within the year and the company compelled to pay for repaving with lake asphalt. Those interested in the land asphalt claim for it that it is from the same source and of the same quality when refined as the lake asphalt. Large quantities of the land asphalt are used, as the Trinidad Custom House receipts for the March quarter of 1892 show an export of 10,233 tons, nearly all to the United States, which would indicate about 40,000 tons a year. The customs receipts for the same period indicate an export of lake asphalt of about a hundred thousand tons a year.

ASPHALTS AND ASPHALTIC ROCKS.

There has been much discussion as to the use of the word "asphalt." In this paper it has been used as a synonym for asphaltum, in which sense it is used in the Encyclopedias. The word asphalt is also applied popularly to the mixture of asphaltum, mineral tar and sand used for pavements, and this use is recognized by Webster and The Century in their second definition. In Europe the word asphalt is applied to the bituminous limestones or asphaltic rocks there used for asphaltic pavements, and foreign writers have assumed to correct our use of the word and say that there are few "asphalt pavements" in America, and that nearly all so-called are an imitation mixture. Their use of it is referred to by the Century Dictionary but is not recognized as a definition, while our use is sustained by nearly all authorities.

The most noted supplies of asphaltum and asphaltic rocks may be arranged in the order of their hardness as follows :—

- Asphaltum,
  - Semi-liquid,
    - Hit, Asiatic Turkey,
    - Coast Counties of California.
  - Solid,
    - Cuba,
    - California,
    - Trinidad "Lake Asphalt,"
    - " "Land Asphalt."

- Asphaltic Rocks,
  - Sandstones,
    - California, Utah and Kentucky,
    - Val-de-Travers, Switzerland.
  - Limestones,
    - Val-de-Travers, Switzerland,
    - Ragusa, Sicily,
    - Vorwohle, Germany,
    - Seyssel, France.

The bitumen used by the Babylonians to cement together the bricks in their public and private buildings is supposed to have been a semi-liquid, similar to the mineral tar, the oil being absorbed by the bricks, leaving a perfect and imperishable cement of asphalt. It is stated by Herodotus (I, 179) that in the walls of Babylon were used bricks baked in kilns, and that hot asphalt was used as cement. From this use as a cement is possibly the derivation of "asphaltum" from *a*, not, and *sphalo*, to cause to slip. The source of this ancient supply was the fountains of Is, (modern Hit, on the right bank of the Euphrates), which still flow abundantly.

The California asphalt is of two kinds, the semi-liquid, similar to that used by the Babylonians, more like a mineral tar than a true asphalt, and a solid asphalt which is used in road building without mixing with other substances. About forty thousand tons a year of this California asphalt is now used, but the cost of transportation by land prevents its use here in the east as it can be brought much cheaper from Trinidad or Europe. In Kansas City the California Asphalt Company of San Francisco is about to establish a plant and introduce its use in that section.

The hardest in the series are the bituminous sandstones of California, Utah and Kentucky and the bituminous limestones or asphaltic rocks of Switzerland, Sicily, Germany and France. The rock from Val-de-Travers in the Canton of Neufchatel contains 20 per cent of asphalt, that from Ragusa, Sicily, 12 per cent. and the Vorwohle rock 11 per cent. Those from Seyssel, France, are the hardest and contain but 10 per cent. of asphalt to 90 per cent. of carbonate of lime. These rocks are of a brown color, and slightly malleable, and break with an irregular fracture. They are reduced by grinding or roasting. Those richest in asphalt form a good pavement without mixture. To the hardest a small percentage of mineral tar is added to produce a paving compound, or the German rock is mixed with the softer Sicilian rock in the proportion of one to three, as is done by the Rock Asphalt Pavement Company of this city.

The world's supply of asphalt is not limited to the supplies named, but quantities of it are found in Canada, Venezuela, Peru, Mexico, Argentina, Turkey, Syria and other countries. However it is not probable that any large supply will be found which is at the same time so pure, so easily taken out and so near a shipping point as that of the Pitch Lake.

The paper was illustrated by specimens of the Trinidad and other asphaltums, and the commercial products.

Remarks upon the paper of Mr. Cronise were made by Professor A. L. Baker, Mr. Elon Huntington, Professor S. A. Lattimore and several other members.

Professor A. L. Arey drew the attention of the Academy to a locality in Seneca Park, on the river bank, which had been formerly regarded by the late Mr. George Harris as an Indian quarry and shop site for the manufacture of flint implements, and stated that this was an out-crop of the chert-bearing limestone of the Upper Clinton.

May 28, 1894.

STATED MEETING.

The President, Professor H. L. Fairchild, in the chair.

Thirty persons present.

The following paper was read :

NOTES ON OPHIDIANS OF THE SOUTHERN STATES.

By F. W. Warner.

A person accustomed to out door life in the South must become more or less familiar with the southern serpents. The warm sun, the softer atmosphere and the rank vegetation are peculiarly favorable to their existence. The sinuous lines of the serpents are seen in the streams, they are continually crossing one's path, and the planter as he is turning over the soil is constantly dislodging them from their holes. The number of the serpents which are encountered is not so much a matter of surprise as their great variety. They are large and small, long and short, venomous and innocuous. There are ground snakes, tree snakes, water snakes, sand snakes and burrowing snakes. The serpents encountered are frequently new species, which those who are best informed in snake lore can at once neither name nor classify. This fact is not so strange when it is known that there are 1,800 species of serpents described and named.

All of the ophidians are not necessarily our natural enemies. Some of them seem to be desirous of living on friendly terms with man, and are even capable of being domesticated ; others are unfriendly and aggressive, but the great mass of them desire to keep away from human habitations and simply want to be let alone.

We encounter these limbless denizens of meadow and forest in all colors of skin. Some are repulsive looking, with loose and flabby dress, coarse, dull, or black, with light colored lining and reveals. Some prefer solid colors and wear a jacket of brilliant red, green or yellow, with a vest of lighter hues. Others dress in stripes with a striking effect of dark and light in strong contrast. Some express a taste for plaids, and wear a handsome plaid coat with a yellow waistcoat and red tie. Again others are dressed in Scotch plaids with a singularly harmonious shading of red, green and brown. Then there is a great variety of odd figures worked into the ophidian wardrobe, polka dots, diamonds, rings, ovals, and various nondescript figures.

These creatures not only show great variety of taste in their garments but they are most extravagant in dressing. They will wear a brand new garment but a season when they cast it away on some brush pile and don an entire new suit.

An important and unusual peculiarity in the ophidian race is that the female is larger and stronger than the male. Two large rattlesnakes were killed on the same spot on a plantation in Louisiana. They had evidently attained their growth as they were both over nine feet in length. The female was found to be five inches longer than the male. In many birds and quadrupeds we find a great distinction in dress in favor of the male. But in ophidian society the female is dressed in brighter colors and a handsomer wardrobe.

Serpents differ widely in their size, proportions, colors and other physical characters, but they differ still more in their habits, temper and instincts. The study of ophidians from this point of view would be most interesting and instructive.

There are some serpents that are always annoyed and irritated at the presence of man. They are always ready for a fight and begin at once to hiss and snap in a vicious and threatening manner. If one finds himself in the presence of one of these creatures it is difficult to part company without a fight. The water moccasin (*Toxicophis picivorus*) is of this class; it is unfriendly and always ready for a fight. The moccasin lies along the margin of a stream or catches upon driftwood and lazily watches for his prey, which consists of fish and frogs. They sometimes grow to enormous size, being short and thick. I once dispatched one of these monsters which would measure fully fifteen inches in circumference.

The Pit viper or common rattler, is found in all the Southern States, and is the most dreaded of all serpents. A gang of negroes will leave their work and run to a place of safety when the presence of a rattlesnake is suspected. The rattler will not attack a man unless disturbed or provoked to a fight and even will run away if given a chance. He will always give due notice of his presence by springing his rattle and also by an unpleasant odor.

The bull snake, which I have been unable to classify, is a long, heavy, muscular fellow, frequently growing to a length of seven or eight feet. He is of a reddish brown color with faint stripes and has a large oval head. He makes a noise like the bellowing of a bull. This snake is very shy and is seldom seen or captured. I have never encountered a specimen except in Georgia. The living one I examined was nearly six feet long.

There are serpents which do not resent the intrusion of man and show a desire to be on friendly terms. It is known that the rat snake of India, (*Ptyas mucosus*,) although by nature ill tempered and treacherous, is frequently domesticated and makes himself extremely valuable in catching rats, mice and other vermin. While residing in London I made friends at the Zoological Gardens with a splendid specimen of the rat catcher, eight feet in length. He would lay his head upon my arm while I stroked his head and neck. He showed his pleasure by shutting his eyes and gently raising his head to increase the pressure of my hand and evidently enjoyed the caresses as much as the drug store tom cat when receiving the same attention.

From my observation I think the chain snake, or king snake, of the south, (*Ophibolus getulus*,) is capable of being domesticated in the same manner as the *Ptyas mucosus*. I succeeding in attracting a king snake to my engine house and for more than a year he kept away all other serpents as well as the rats and mice which before had been extremely troublesome. The pretty creature would show himself quite frequently and take the food we placed for him, but we never succeeded in handling him. Many mills and even private houses have these snakes domesticated and they are as harmless as a cat, but more vigilant and useful. The creature is a very dude among snakes. His garment is in broad stripe of brilliant red, bronze and gold, worn diagonally across his back like the long twisted links of a chain. His collar is white and he has a red tie. No one in the south will ever kill or wound a king snake and the negroes hold him as exempt from harm as a sailor does an albatross. The king snake does not take his name simply from his royal robes but he is the veritable king of serpents. He will attack and kill the largest black snake, pilot or rattler with perfect confidence and win an easy victory. He will seize his enemy by the neck and coil rapidly about his body. He causes death probably by stretching himself and parting the vertebræ of his victim.

There is a wide difference in the courage and instincts of serpents. Some will resent the least interference and boldly advance to attack, while others are cowardly. The southern black adder is a large puffy braggart, but is really a coward and has the instinct of the opossum; in the presence of danger he feigns death but when the coast is clear he will open his eyes and make off to a place of safety.

In the south one hears many wonderful accounts of certain snakes and their marvelous peculiarities and these are generally believed by the people. The so-called "glass snake" (*Ophiosaurus ventralis*) is a subject of romance. It is not a true ophidian but in reality belongs to the saurians. A careful dissection shows the rudimentary legs, which with its other characteristics betray its relationship to the lizard family. The popular name is due to the brittleness of the tail, which may be broken, by preasure or a blow, into sections. It is thus quite plain to see how the greater part of the length of the creature can be easily broken off by a slight blow, and how a detached portion would have an amount of nervous vitality which would enable it to propel itself for some distance. It would, however, be absurd to suppose that the two portions would meet and join. The living body will, however, reproduce a caudal appendage which will enable it to reappear in public within a year and pass as a respectable member of reptilian society.

Do not try to kill every snake you see. The greater part of them are harmless and some are friendly to the human race. Most of them are useful in killing moles, field mice and other animals injurious to crops.

Remarks were made upon the subject of Mr. Warner's paper by Mr. Charles H. Ward, Mr. Elon Huntington and Mr. J. E. Putnam.

Mr. Charles H. Ward exhibited and described some living specimens of the "Gila Monster" (*Heloderma suspectum.*) About fifteen specimens were shown in a metal tank. In color they were mottled black and orange. They were quite inactive, excepting the largest one, which was removed from the tank, and handled with circumspection. It was about fifteen inches long and six inches in girth.

Mr. Ward also exhibited two alcoholic specimens of the "Surinam toad" (*Pipa Americana*), one a male and the other a female. Upon the back of the latter the young of the animal were present in several stages of development. There was an informal discussion regarding these specimens exhibited by Mr. Ward.

Professor C. W. Dodge described the life history and the physiology of respiration in the young of the *Pipa.*

The remainder of the evening was occupied with reviews in departments of science as follows:

Professor C. W. Dodge spoke on "Fatigue of Nerve Cells," giving an account of an investigation made by Dr. Hodge, of Clark University, upon the visible changes which take place in nerve cells as a result of their functional activity.

"The cells of resting or unworked nerve ganglia were found to be large, rounded in outline, full of granular protoplasm, with large rounded nuclei which stained faintly with a variety of dyes. In contrast to these, fatigued cells were shrunken in size, the protoplasm contained a large number of spaces filled with watery fluid, the nuclei were much shrunken and irregular in outline and the nuclei stained deeply with the same dyes which stained the nuclei of resting cells only faintly.

"These differences indicate that the activity of the nerve cells had been accompanied by a loss of the material substance or protoplasm, of which the cell is composed, as well as by a change in the chemical nature of the substance.

"Dr. Hodge's experiments go to prove that all nervous activity whether in the direction of voluntary motion or of thought, is accompanied by an actual destruction of the material composing the nerve cells. His experiment also shows that the fatigue cells, if allowed to rest gradually regained the condition of the unworked cells. Here then, is proof of the necessity of rest for people who are nervously exhausted."

Mr. E. J. Putnam remarked upon the new dynamos of the Citizen's Light and Power Co. He described them as a novelty from the Westinghouse Co., furnishing both a continuous and alternating current with the same armature and winding.

City Surveyor, J. Y. McClintock, who had just returned from a trip up the Genesee River, made an address on which the substance is as follows:

"We have lately seen in the Genesee valley the third greatest flood which has occurred for thirty or forty years; studies have been made to determine at what rate of speed the height of the flood traveled from Mt. Morris to Rochester, and as this flood ran great enough to cover the broad flats, it gave a good example. I found that the flood was at its height as follows; Mt. Morris, May 21st, 3 a. m.; Geneseo, May 21st, 12 m.; York, May 22d, 9 a. m.; Avon, May 23d, 6 a. m.; Rochester, May 23d, 2 p. m.

"The distances down the general course of the valley are as follows: Mt. Morris to Geneseo, 5½ miles; Geneseo to York, 3 miles; York to Avon, 5½ miles; Avon to Rochester, 18 miles.

"This shows that the flood starting from Mt. Morris moved at the following speeds: To Geneseo, six-tenths miles per hour; from there to York, fourteen-one-hundreths miles per hour; from there to Avon, twenty-one-one-hundreths miles per hour; and from there to Rochester, Court street dam, two and one-quarter miles per hour. The total time from Mt. Morris to Rochester, 59 hours.

"Apparently the velocity increases gradually, although not regularly, but depending upon the width of the valley, which is very much narrower below Avon than above and affords less storage capacity.

"From our observations at Rochester, we had come to the conclusion that the flow of water during this flood was nearly one-third less than was the flow of 1865, when so much damage was done. I was able to verify this conclusion by interviews with old residents at various points along the river. At York the high water of 1865 was about three feet above that of 1894; at Avon it was somewhat over two feet.

"One other important point was as to whether the great flats would furnish storage room for the flood, below the surface of its ground, to any such extent as is usually assumed. This I was able to learn by ocular demonstration.

"The river banks proper are generally quite steep, of clayey soil, from eight to twelve feet high, and as the level of the river has fallen from twelve to fifteen feet within a few days the ground has not had time to dry out, but was exuding water from its whole surface. This showed that the flats act as a great storage. The importance of this will be shown by Mr. Rafter in his forthcoming report on the proposed storage dam. He will call attention to the fact that the 60 to 80 square miles of flats when soaked with water will hold far more than the great reservoir to be made."

JUNE 11, 1894.

STATED MEETING.

The President, PROFESSOR H. L. FAIRCHILD, in the chair.

Thirty-five persons present.

The Council report recommended:

(1.) The payment of certain bills.

(2.) The election of the following candidates as active members: MISS JOSEPHINE HOFFMAN, MR. CLIFTON J. SARLE, MR. EDWARD P. WEBSTER.

(3.) The election of MR. J. EUGENE WHITNEY as Second Vice-President, in place of DR. M. L. MALLORY, deceased.

The bills were ordered paid, and the candidates were elected by formal ballot.

By a formal ballot of the Society Mr. Whitney was elected Second Vice-President for the remainder of the year.

The Librarian, Miss Beckwith, reported the accession to the library since the annual meeting in January, of three hundred titles; two hundred of these from foreign countries, and one hundred from various societies and institutions of the United States.

Mr. F. W. Warner exhibited a curious membranous sheet of tissue, without at once explaining its origin. It was brown in color, very thin, tough, but soft and flexible, and in appearance resembling a very thin sheet of rubber, excepting it was not elastic. Mr. Warner finally explained that it was the "mother" from vinegar. He had washed and scraped it and had treated it with potash and with ammonia, to remove the acid and the vinegar odor, but without success in respect to the latter.

MR. ELON HUNTINGTON read a paper entitled:

THE EARTH'S ROTATION AND INTERIOR HEAT.

The paper was a discussion of the physical problems connected with the earth.

MR. CHARLES H. WARD exhibited plaster casts of a hand and foot illustrating a case of abnormal enlargement of the extremities, a disease known as Acromegaly, and read an interesting account of the subject from which these casts were made, and presented the facts already known concerning this newly recognized disease. He discussed the effect of the disease upon various portions of the body, and stated the fact that the "pituitary body" in the brain was always affected. By a diagram on the blackboard he explained the theoretical relation of the "pituitary body" to the cavities of the embryo.

The matter was discussed by Dr. E. V. Stoddard.

JUNE 25, 1894.

STATED MEETING.

The President, PROFESSOR H. L. FAIRCHILD, in the chair.

Forty-seven persons present.

The following paper was presented :

ON THE USE OF CONCRETE FOR THE PROPOSED STORAGE DAM AT MOUNT MORRIS.

BY GEORGE W. RAFTER.

After some remarks upon the matter of Mr. Rafter's paper, the President stated that the remainder of the meeting would be held under the direction of the Botanical Section, as had been announced upon the notices of the meeting. The President then yielded the chair to the Chairman of the Section, MISS MARY E. MACAULEY.

The first paper announced on the printed program was read for the author by the Recorder of the Section, MRS. J. H. MCGUIRE, as follows :

ON VOLVOX GLOBATOR.

BY A. M. DUMOND.

These beautiful forms forcibly remind me of the ancient Egyptian symbol of life, a flying globe, and may it not be that that wonderful people, away back in the dim ages of the past, knew and studied this interesting form ? *Volvox globator*, when fully grown, varies from $\frac{1}{30}$ to $\frac{1}{50}$ of an inch in diameter. It is a colony, composed of thousands of cells called gonidia, so grouped together that they form a hollow sphere, the inner surface of which is studded with thousands of green points, while the outer surface has the appearance of a nearly transparent globe composed of hexagonal cells, bound together by a net-work of wonderful beauty ; each of the hexagonal cells, or gonidia, of which there are several thousand, is, when free, a somewhat pear-shaped cell, about $\frac{1}{3000}$ of an inch in diameter, containing chlorophyl grains and with traces of starch diffused through its protoplasmic contents.

A red spot is also usually perceptible, which is generally believed to consist of altered chlorophyl. From the small end of this pear-shaped cell project two cilia, which are evidently a portion of the protoplasm of the cell thrust out through openings in the cell-wall, with which they lash the water, thereby propelling their colonial globe. Each cell is the center of six other cells with which it is connected by the retaining net-work just mentioned, which not only serves the purpose of binding the whole colony together, but the further and more important purpose of putting each individual in communication with every other individual in the colony.

There is, without doubt, a free circulation of water through the globe at all times, thus supplying food and oxygen to both parent and offspring.

Dr. Carpenter, in speaking of these gonidia, says: "It is impossible not to recognize the precise similarity between the structure of this body and that of the motile encysted cell of *Protococcus pluvialis*. There is, in fact, no perceptible difference between them, save that which arises from the regular aggregation of the cells in *Volvox*, which normally are detached in *Protococcus*." Professor Williams says: "A singular provision is made in the structure of the gonidia, consisting of a slender elastic filament, by which each is attached to the cell-wall. At times it is seen to thrust itself out as if in search of food, it is then seen quickly to recover its former position by means of the contractility of the elastic filament."

Another interesting fact not generally noted in regard to *Volvox*, first pointed out by Mr. Buck, of the Royal Society, is that "at certain times, under favorable conditions, individual members of the colony detach themselves and lead an independent life; but it is noted that when this is the case the gonidia are double, hence the colony is not ruptured by the departure of the individual." Again, Dr. Hicks says: "Under favorable conditions the contents of the cell may be converted into a free moving mass of naked protoplasm, a veritable *Amœba* to all appearances, and as such it will vacate its cell and go roaming about in the cavity of the *Volvox*." The intent and destiny of these last forms is not known.

Professor Cohn is to be credited with the honor of having done much toward working out the generative processes of *Volvox*, which are as follows: Any one or more of the gonidia may increase in size, when it is seen to be composed of a number of somewhat angular green masses, separated by the interposition of a somewhat transparent substance, the whole being inclosed in a transparent envelope of considerable thickness. This, the young *Volvox*, increasing in size, soon appears like a button attached to the inner surface of the parent

Volvox. Later it appears to be attached to the parent by the adhesion of its transparent envelope at the point of contact only, and soon after it is observed to be detached and revolving within the body of the parent. As many as twenty young colonies may be seen in some instances within the body of the parent. Even at this early stage in the life of the young *Volvox*, there may be seen certain cells within itself, of a larger growth than their fellows, which are destined to become still other colonies. This is the ordinary mode of multiplication in *Volvox*, and is essentially a process of cell subdivision, taking place during the greater part of the season, and under favorable circumstances is repeated many times, a mature individual developing from an embryo in a few hours.

The process above described is the common or asexual form of reproduction. Sometimes, however, as Autumn approaches, certain of the cells undergo changes by which they are converted, some into sperm cells, others into germ cells, the greater number, however, remaining sterile. These cells are at first distinguishable only by their larger size. The sperm cells begin to undergo subdivision when they have attained about three times the size of the normal cell. This subdivision is peculiar, in that it is not on the binary plan but the whole mass resolves itself into a number of cells at one and the same time. These secondary cells are seen to consist of an elongated body of an orange or red color, provided with a pair of long cilia. As the sperm cell approaches maturity, the contained cells may be seen in motion. The motion continues with greater violence as they approach the time of their liberation, which is effected by the giving way of the wall of the sperm cell, when the young antherozoids disperse to all parts of the cavity of the *Volvox* sphere. Meanwhile the germ cells continue to increase in size, but do not undergo subdivision, becoming filled with a dark green substance, gradually changing from its original pear-shape to a globular form, projecting into the cavity of the *Volvox*, and at the same time acquiring a gelatinous envelope. In this gelatinous envelope the antherozoids literally bury themselves, penetrating to the interior, where they appear to dissolve, thus becoming incorporated with the contents of the germ cells. Evidently this is a form of conjugation. The product of this fusion is a resting spore, which on the breaking up of the *Volvox* falls to the bottom of the water, where it remains a longer or a shorter time, and finally develops into a perfect *Volvox*. Some authorities believe that the resting spores begin to develop on the approach of the following spring; others believe that it is necessary that they be thoroughly dried before they will develop. I will only say that in my experience, I am sure of finding *Volvox* in its season in certain ponds that dry up in the summer, but not at all sure of finding them elsewhere.

The fish-like odor emitted by *Volvox* during the sexual process of reproduction, is, without doubt, somewhat analogous to the odor emitted by flowering plants when in bloom, and like that, this odor is present at no other time.*

The writer in the company of an honored member of this society has, on several occasions within the year, visited a pond, the waters of which were teeming with *Volvox*, frequently fully five hundred to the cubic inch of water, and yet there was no suggestion of an odor arising therefrom, neither during the development nor the decay of the plant. It is a fact that *Volvox* emits the fish-like odor *only* during periods of reproduction *by the sexual process*. It is a further fact that this sexual reproduction does not take place annually, but only on rare occasions at intervals of several years, and has not occurred in this vicinity since 1888. It is, therefore, not a regular alternation of generation, but a form of revivification.

In noticing the movements of a *Volvox*, one is often impressed with the manner in which it will change its course, apparently to avoid an obstacle in its path. It will advance or retreat, revolve or come to rest, in as good order as did ever a Roman or Egyptian war galley, under the eye of an Anthony or Cleopatra, indicating a will and a purpose in its movements. Its ability in this direction is best seen where the sphere has been rent or ruptured; one may frequently see an irregular fragment, consisting of one-tenth to nine-tenths of the original sphere, moving through the water *in a direct line*.

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*The Executive Board of this city, in its annual report for 1888-89, published a report on the "Cause of the odor and taste of the Hemlock Lake water," in which there are two quite serious errors, for which the printer might have been responsible. As I have never seen these errors corrected I take this opportunity of doing so. The principal error (on page 44) is as to the process of reproduction then taking place. It was not the *asexual* process of reproduction, as the report states, but the *sexual* (or rarer) process. The other error referred to occurs in a foot-note on the same page, and naturally follows the first error. These errors may seem to be of small moment, but when we remember that the facts therein sought to be recorded are misstated, and therefore misleading, we are not surprised to learn that some Algæists have even gone so far as to openly question whether we were dealing with *Volvox globator*, in short, whether or not we knew the organism. Because these facts were not made clear in the report above referred to, the correctness of the conclusions of the Microscopical Section is unjustly questioned by other scientists, and yet not without apparently good grounds for their conclusions.

It is a well known fact that *Volvox*, and, for that matter, all the motile chlorophyl-producing forms of either animal or vegetable microscopic life, are powerfully attracted by the light, either solar or artificial. "And no wonder (you say) because without the aid of sunlight the creature could not produce chlorophyl," and frequently one will find that in these chlorophyl-bearing motile forms the red or perhaps black eye-spot is present. To my mind this is sufficient evidence to prove that the red eye-spot is an organ of vision, capable of making its possessor sensible of the direction from which light proceeds.

In the beginning of the present decade Professor Balbiani, in a lecture before the College de France, announced his discovery of a true crystalline lens in the eye-spot of *Pandorina morum*, a form well known as being a relative of *Volvox globator*.

The paper was illustrated by large water colored paintings and by living specimens of *Volvox* under microscopes.

Remarks were made by Mr. Rafter in explanation and justification of the statements in the paper criticized by Mr. Dumond.

Mr. Dumond stated in reply that the paper referred to did not correctly state the conclusions of the Microscopical Section.

The next paper was entitled:

OUR TREES.

By C. C. Laney.

This paper gave a description of the cultivated trees, chiefly in the grounds along East Avenue, in Rochester. In illustration Mr. Laney exhibited leafy branches and flowers from a large number of the rare and interesting trees to which he had referred. This paper is published in full in the *Democrat and Chronicle* of Wednesday, June 27th.

Remarks upon the paper were made by Miss M. E. Macauley, Mr. John Walton and Mr. G. T. Fish.

The third paper read was:

THE FLORA OF LONG POND.

By Anna H. Searing.

The flora under consideration is for the most part found upon the sand-bar, between Lake Ontario and Long Pond, which is one of a series extending from Braddock's Bay to Charlotte.

The method of formation of this and similar deposits is within the province of the geologist to describe; a work which Mr. G. K. Gilbert has already done in a most satisfactory manner.

On the lake side the accumulation seems to be pure sand and gravel, upon which the flora is very limited, but there is a considerable number of large trees. Indeed, this beach has more of the arboreal vegetation than we are accustomed to see upon such sandy beaches.

Toward the marshy border, where a rich black alluvial deposit has mingled with the sand, the ordinary flora of such districts flourishes. At the immediate margin where Long Pond in its fluctuations sometimes encroaches, more or less of a marshy tract is left, and becomes the favorite habitat of rushes, sedges and aquatic grasses; also other plants of which I will speak hereafter. And finally in the shallow water are the true water-plants found in similar situations in other localities.

The changes which have taken place since man became an inhabitant of the beach are to be noted, since some members of our flora are shy of the footsteps of man, and do not gracefully accept civilization. Some plants which I recognized when the beach was in a comparatively primitive condition, I have not seen for some time.

Of the *Ranunculaceæ*, the peculiar water form of *Ranunculus aquatilis*, var. *trichophyllus*, finds here the requisite conditions for growth and flourishes correspondingly. *Ranunculus Pennsylvanicus* is not infrequently found on the borderland of moisture. The water lilies are so abundant in the water they need scarcely be mentioned. *Cakile Americana* is increasingly abundant. So far as I have noticed this so-called sea-rocket favors sandy lake beaches in preference to maritime borders. *Elodes Virginiana* was found so near to Long Pond that it cannot practically be excluded from our list. *Hibiscus Moscheutos*, the elegant swamp rose-mallow, was noticed a few years since by Rev. John E. Baker, in the marsh on the opposite side of Long Pond and adjacent to Cranberry Pond; it was also observed in 1892 by others. *Lathyrus maritimus* was formerly found in more or less abundance near to the sandy shores of the lake. I think it has passed away in the conflict for existence. *Astragalus Canadensis*, which is the only species of this genus having a foothold here, but which is abundantly represented in some portions of the West beyond the Mississippi, is increasingly abundant, indicating that by the aid of its rather shrubby growth it is able to overcome the possibly adverse influences of surroundings. Of the species of *Potentilla*, some of which are rather abundant, *Potentilla paradoxa*, now known as *supina*, is rare, but is given by Gray as found in this locality. It seems rather shy of civilization, having disappeared from former stations, but is still found tolerably abundant somewhat nearer to Braddock's Bay. Of the water-milfoil family, we find *Myriophyllum spicatum*, growing in water of some depth.

Nesæa verticillata is an interesting member of our marsh flora, forming a good illustration for study of the transformation of underground stems to the varying needs of plants situated where the environments of water and land are fluctuating.

Of the *Polygonums*, many of which are water-loving plants, there are seven species and varieties.

Utricularia vulgaris is common. *Scrophularia nodosa*, formerly found, has, I think, entirely disappeared. Our beautiful *Convolvulus sepium* luxuriates not only in the native marshy tract, but even makes beautiful the track of the railway.

Euphorbia polygonifolia is a denizen of the sands, but has never been abundant. Of the *Araceæ* we have the common *Acorus calamus* or sweet flag. *Peltandra Virginica*, I have found but once and now that has disappeared. Most of the water plants found in other localities are also found here, but of these most interest attaches to the *Juncaceæ*, of which there are nine of the species *Juncus*.

Of the *Cyperaceæ*, or sedge family, there are four species of *Cyperus*, seven of *Eleocharis*, four of *Scirpus*, and sixteen of *Carex*. The rare *Dulichium spathaceum* has also been found. *Eriophorum cyperinum* is quite abundant.

The *Gramineæ*, or grass family, has some very interesting members. Among these are the stately *Zizania*, with its distinct but not widely separated panicles of sterile and fertile flowers, and the peculiar *Leersias*.

Sporobolus cryptandrus has, I think, disappeared. *Calamagrostis Canadensis*, the beautiful blue-joint grass, which has thriven upon the meadows bordering Long Pond, cannot, it is to be feared, survive the present conditions. *Ammophila arundinacea*, said to be found on sandy sea beaches from New Jersey to Maine, has evidently found that the general conditions of the sandy banks bordering our great lakes are not adverse to its growth ; while it has evidently a utilitarian function in preventing the drifting of the sand in inconvenient locations by means of its root masses. The spikes of this grass are not dissimilar in appearance to heads of wheat. *Spartina cynosuroides*, the fresh water cord-grass, is not clearly distinguishable from the maritime species. It is a tall, coarse grass, but evidently has not held its strength in this locality. *Phalaris arundinacea* is a tall-growing species of the Canary grass genus. The *Glycerias*, of which three are found here, have no more beautiful species than *Glyceria fluitans*, which is one of our most graceful marsh grasses. Yet the *Phragmites communis*, with its heavy panicles of silky spikelets, must be awarded the palm in the entire series of attractive grasses of this flora. The *Andropogons* are represented by the species *furcatus*. Six species of *Panicums* have formerly been found here, but the most rare and notable, *Panicum*, *virgatum* has disappeared.

Characeæ, or stoneworts, have a representative which has a habit of appearing and disappearing in quiet waters in a very strange manner. One summer the deep trench by the railway was almost filled, while the next season there was scarcely a trace remaining.

The marsh fern, *Aspidium thelypteris*, and *Ophioglossum vulgatum*, are representatives of the ferns.

One rare moss, *Drummondia clavellata*, is alone worth mentioning.

In conclusion, I would say that of the plants and trees noticed, there are seventy genera.

Professor Henry A. Ward exhibited a specimen of marine algæ from the coast of California, and described the plant's structure and the growth of the fields of giant algæ which border the Pacific coast.

Exhibits of material were made by the Section, as follows: A series of original sketches of native flowers, both plain and in water colors, was shown by Mr. John Walton. These drawings were very beautiful and perfect representations, both as regards drawing and coloring, of a large number of our wild flowers.

Mr. William Streeter showed living *Volvox*, illustrating the paper of Mr. Dumond.

Members of the Section exhibited a large number of species of rare native plants collected from Bergen swamp, the shores of Irondequoit bay, and other localities; among these were *Sarracenia purpurea*, *Cypripedium pubescens*, *C. spectabile*, *Liparis liliifolia*, *L. Lœselii*, *Spiranthes Romanzoffiana*, *Arethusa bulbosa*, *Habenaria hyperborea*, *H. lacera*, *Calopogon pulchellus*, *Tofieldia glutinosa*, *Lilium Canadense*, *Moneses uniflora*, *Monotropa Hypopitys*, *Aphyllon uniflora*, *Linnæa borealis*, *Valeriana sylvatica*.

A collection of twelve grasses was exhibited by Mr. C. M. Booth.

ACCESSIONS TO THE LIBRARY,

to March, 1895,

BY FLORENCE BECKWITH, *Librarian.*

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PROF. W. C. WILKINSON................ ....Chicago, Ill.
PROF. HENRY S. WILLIAMS...... ....New Haven, Conn.

ACTIVE MEMBERS.

*Indicates a Fellow.
†Indicates a Life Member.

ALBAUGH, W. M..................... ....225 South Fitzhugh street.
*ALLIS, JAMES W........ ....7 Third street.
ANDREWS, E. R.................. ....455 Exchange street.
BACON, E. H.. .. ..174 University avenue.
BACON, HON. THEODORE................ ....20 Gibbs street.
*BAKER, PROF. ARTHUR L........................University of Rochester.
BALLENTINE, DR. EVELINE P............. ....State Hospital.
BANTON, DR. EDWIN......... ....105 Franklin street.
BARNARD, HOUSTON........................ ....267 State street.
BARRY, W. C...............................Ellwanger & Barry Building.
*BAUSCH, EDWARD.......... ....541 North St. Paul street.
*BECKWITH, MISS FLORENCE...... ....394 Alexander street.
BISSELL, DR. E. J..............................75 South Fitzhugh street.
BRAYER, JOHN F.......................................50 Clifton street.
BREWSTER, HENRY C.................................353 East avenue.
BREWSTER, MRS. HENRY C............................ 353 East avenue.
BRIGGS, MARSENUS H......... ....657 East Main street.
BRISTOW, FRANK W.................... ....163 Plymouth avenue.
BROWN, LEGRAND................... ....16 State street.
BROTSCH, F. A..13 City Hall.
BUELL, GEORGE C......................................9 Livingston Park.
BUELL, MRS. GEORGE C..............................9 Livingston Park.
CARTWRIGHT, ROBERT.................................... 6 Bates street.
CLARK, GATES A... 61 Swan street.
CLEMENT, FRANK H........... .... 46 Lorimer street.
COOKE, HON. MARTIN W.........................12 Portsmouth Terrace.
CRAFTS, FRED H.......................................97 Glenwood Park.
*CRONISE, ADELBERT....................307 Ellwanger & Barry Building.

CROUGHTON, G. HANMER....62 State street.
*CRUMP, SHELLEY G....Pittsford, N. Y.
DANFORTH, HON. GEORGE F....544 West avenue.
DANFORTH, MRS. HENRY G....533 West avenue.
DAVIS, JOHN A....63 German Insurance Building.
*DAVISON, J. M....60 Oxford street.
DAVY, HON. JOHN M....67 Marshall street.
*DODGE, PROF. CHARLES WRIGHT....University of Rochester.
DODGSON, FRANK L....414 Ellwanger & Barry Building.
DOW, DR. FRANK F....68 Vick Park.
DUMBLE, A. E....44 State street.
*DUMOND, A. M....70 Mt. Hope avenue.
EASTWOOD, WILLIAM....35 South Clinton street.
EASTWOOD, MRS. WILLIAM....35 South Clinton street.
*ELLIS, DR. S. A....13 Clifton street.
ERBE, GUSTAVE....724 North St. Paul street.
EVEREST, C. M....350 West avenue.
FAHY, JOHN....288 East avenue.
*FAIRCHILD, PROF. H. L....University of Rochester.
FISHER, EDWIN A....16 Reynolds street.
*†FULLER, JOSEPH B....449 Central avenue.
*GARDNER, REV. C. B....8 New York street.
GOLER, DR. GEORGE W....84 Plymouth avenue.
GORDON, FRED FORCE....75 South Union street.
GOULD, MRS. AUGUSTA B....39 Savannah street.
GRAY, WILLIAM C....418 Powers Block.
HAASS, G. HERMAN....573 North St. Paul street.
HALE, PROF. GEORGE D....5 Gibbs street.
HASTINGS, DR. D. G....7 Park avenue.
HEVERON, JOHN J....32 Emmett street.
*HILL, PRES. DAVID J....University of Rochester.
HOFFMAN, MISS JOSEPHINE....239 Central avenue.
HOTCHKIN, GEORGE A....111½ Ambrose street.
HOWARD, DR. CHARLES T....24 Chestnut street.
HOWELL, DR. CHARLES F....569 Powers Block.
HUMPHREY, GEORGE P....27 Atkinson street.
HUNTINGTON, ELON....762 North St. Paul street.
ILES, MISS EMMA E....58 University avenue.
JONES, HORATIO....81 Bartlett street.
JORDAN, WILLIAM F....74 Edinburgh street.
KEMPE, MRS. J. J....14 Grove street.
KENYON, JOHN W....162 Meigs street.
KING, MISS ADA M....8 Briggs Place.
KING, MISS ELLA G....8 Briggs Place.
KING, MRS. GEORGE C....Clinton street and Central avenue.
*KUICHLING, EMIL....209 North Clinton street.
LA FORGE, LAWRENCE....Alfred, N. Y.

LANEY, C. C....65 Park avenue.
LAWRENCE, HENRY E.... University of Rochester.
LEWERENZ, ALFRED C....207 South Fitzhugh street.
LEWIS, MISS KATHERINE....6 Meigs street.
LINDSAY, A. M....373 East avenue.
*LINE, DR. J. EDWARD....50 Rowley street.
LINN, DR. S. H....243 Alexander street.
LITTLE, J. L....162 Plymouth avenue.
LOMB, CARL F....44 Chatham street.
LOMB, HENRY....48 Clinton place.
*MACAULEY, MISS MARY E....95 Kenilworth Terrace.
MC CARTNEY, DR. J. H....501 Granite Building.
MC CARTNEY, MRS. J. H....501 Granite Building.
MC CLINTOCK, J. Y....16 City Hall.
*MC GUIRE, MRS. J. H....30 North Fitzhugh street.
MC MILLAN, WILLIAM S....85 South Union street.
MC QUARLES DE QUARLES, JACOB....176 South Fitzhugh street.
MAGUIRE, MRS. E. L....Avon, N. Y.
*MANN, A. S....21 South Goodman street.
MORMAN, J. B....160 North Union street.
MORTON, DR. PAULINE....86 University avenue.
MUNGER, C. N....65 Garson avenue.
NEHR, CLARENCE R....W. N. Y. & P. R. R.
O'CONNOR, JOSEPH....146 Frank street.
OOTHOUT, MRS. J. W....401 East avenue.
OTIS, IRA L....274 Alexander street.
PAINE, CYRUS F....242 East avenue.
PARCE, WILLIAM W....34 Meigs street.
PERKINS, GILMAN H....221 East avenue.
PHINNEY, HERMAN K....8 Brighton avenue.
POND, COL. N. P....261 Monroe avenue.
POND, MRS. N. P....261 Monroe avenue.
POTTER, MRS. CHARLES B....111 Spring street.
POTTER, CHARLES H....46 Hand street.
POWELL, H. T....474 Lyell avenue.
PRATT, CHARLES N....52 Garson avenue.
*PRESTON, H. L....Ward's Natural Science Establishment.
PUTNAM, JOSEPH E....23 Boardman avenue.
*RAFTER, GEORGE W....403 Bronson avenue.
RAYMOND, CHARLES L....42 Riverside avenue.
RECHE, MISS HELEN L....31 Howell street.
ROGERS, CLINTON.... 127 Spring street.
*ROSEBOOM, DR. J. L....628 East Main street.
SARLE, CLIFTON J....39 First street.
SCHMIDT, RUDOLPH....561 North St. Paul street.
SCRANTOM, E. H....11 East street.
SELDEN, ARTHUR L....42 Gibbs street.

*Seelye, Charles W....................................10 Elk street.
Siddons, Mrs. Ruth....................................45 Prince street.
Sill, Stuart Ely....................................157 South Fitzhugh street.
Sims, J. Watson....................................12½ Mathews street.
Skinner, John F....................................42 Boardman avenue.
Sloan, Samuel....................................72 South Clinton street.
Sloan, Mrs. Samuel....................................72 South Clinton street.
Slocum, G. Fort....................................58 Brighton avenue.
Smith, J. Moreau....................................227 East avenue.
Sprague, M. W....................................26 James street.
Stark, Miss Harriet B....................................27 Rowley street.
Stebbins, Rev. H. H....................................24 Prince street.
Stebbins, Mrs. H. H....................................24 Prince street.
Stewart, William J....................................16 City Hall.
*Stoddard, Dr. E. V....................................68 South Washington street.
Stone, Miss Georgiana C....................................Livingston Park Seminary.
Storey, William R....................................711 Ellwanger & Barry Building.
*Streeter, William....................................14 Scio street.
Strowger, O. H....................................5 Stewart street.
Sumner, Dr. Charles R....................................31 South Clinton street.
Thompson, Gaylord....................................317 Troup street.
Tibbits, George S....................................97 Woodward avenue.
Van Voorhis, Mrs. John....................................256 East avenue.
Vredenburgh, Edw. H....................................122 South Fitzhugh street.
Walker, Albert C....................................25 East street.
*Walton, Rev. John....................................7 Keeler street.
*Ward, Charles H....................................11 Upton Park.
*Ward, Frank A....................................12 Grove Place.
*Ward, Prof. Henry A....................................18 College avenue.
Warner, F. W....................................203 Granite Building.
Wells, Mrs. H. E....................................103 Meigs street.
*Westervelt, Prof. Z. F....................................Deaf Mute Institute.
Williams, Dr. Henry T....................................52 Clinton Place.
*Whitney, J. Eugene....................................62 Brighton avenue.
Wiltsie, Charles H....................................37 South Washington street.
Yawman, Philip H....................................168 University avenue.

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