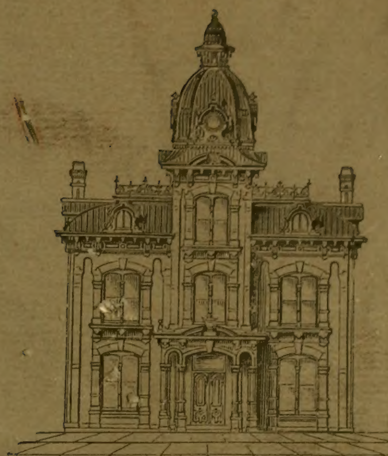

TRANSACTIONS

OF

VASSAR BROTHERS INSTITUT

AND ITS

SCIENTIFIC SECTION

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VASSAR BROTHERS INSTITUTE,

AND ITS

SCIENTIFIC SECTION.

POUGHKEEPSIE, N. Y.

1883-1884.

VOL. II. PART I.

PUSLISHING COMMITTEE:

W. G. STEVENSON, W. B. DWIGHT,
A. P. VAN GIESON, H. V. PELTON.

EDITOR:
W. G. STEVENSON.

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PART II.

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TRANSACTIONS

OF

VASSAR BROTHERS INSTITUTE,

POUGHKEEPSIE, N. Y.

1883—1884.

OCTOBER 2, 1883—ELEVENTH REGULAR MEETING.

J. Elmendorf, D. D., president, in the chair; thirty-six members and one hundred fifty guests present.

Dr. Stevenson announced the receipt, by the trustees, of $25,000 from Mr. Vassar, as an endowment fund for the Institute, and moved the adoption of the following preamble and resolution:

WHEREAS, Mr. John Guy Vassar has given to Vassar Brothers Institute twenty-five thousand dollars, the income of which is to be applied for museum and library purposes and for the general work of the society; therefore,

Resolved, That in this generous gift we have renewed evidence of Mr. Vassar's desire to benefit this community by securing the objects for which this society was founded—the promotion of useful knowledge in science, letters and art—and we return to Mr. Vassar our earnest thanks and gratitude.

One member was elected.

Joachim Elmendorf, D.D., president of the Institute, gave the following

INAUGURAL ADDRESS.

Members of the Institute, Ladies and Gentlemen: I cordially welcome you to this opening service of our course for 1883–84. It occurred to me that Vassar Brothers Institute might furnish a topic, whose discussion would not be destitute of interest and might permit some useful suggestions.

Because the dedication address, as we will gratefully remember it, of Dr. T. Sterry Hunt, to which many of us listened with so much delight and profit, was so exclusively the masterly treatment of a strictly scientific subject, the theme I have chosen, seemed thus to be left for me.

The genuine Institute, like the true poet, is born and not made. And as, at its birth, it is a symbol of the intellectual life of the community from which it springs, so in all its growth and through the period of its maturity, it is an index of the quality and quantity of that life. It can come forth and exist and thrive amid most scanty, defective and depressing material appointments, but it is most fortunate when it can command, at once, an architectural expression and realization, every way confirmative of its existence, helpful in its work and worthy as its home and temple, to share its fame.

The essential conditions of an Institute, with objects as definite, varied and elevated as this has, as thoroughly organized and established and as liberally endowed as this already is, are rarely found in a city of the size of ours. Mind and money in sufficient measure there may be, but the will to consecrate both with adequate labor and liberality to such cause, results from a combination of unusual and harmonious influences.

It might suffice the historian in his search for its origin, to find the mind whose aggressive thought grew into the first definite idea of its need and possibility. Yet that mind, consciously, or unconsciously, felt the inspiration of forces that were issuing from favoring facts. The presence in our community of both literary and scientific taste and ability cultured, organizing, persistent and progressive, had been demonstrated. Teachers of the natural sciences, whose eminence had shed luster upon the educational institutions with which they had been connected, were of us, and were known to be ready to contribute freely of the rich treasures of their mental acquisitions. Art too, had its representatives here, whose merited repute and known public spirit easily suggested a distinct department for the promotion of its interests, and the exemplification of its principles of beauty and truth. And the large pecuniary means, indispensable to the undertaking, were marvelously waiting for princely bestowment, in the hands of those who, with full appreciation of its glory and beneficence, would follow the example of an illustrious kindred, and farther create and link the honored name—Vassar—with the best facilities for the cultivation and triumphs of mind.

So the idea rapidly became a realization, and Poughkeepsie was enriched with an Institute that merits our warmest gratitude, and may properly stir our best pride.

But possessions that are easily gained are not always valued at their full worth.

Few, surely, fail to appreciate the great addition to our public buildings, which the costly and elegant structure in which we are gathered makes, or in a general way, the proof it furnishes of a superior and influential intellectuality. But whether the important ends which it was designed to subserve shall be effected, depends upon several things, which ought to be understood and kept in mind.

The declared objects of Vassar Brothers Institute "are to promote education and useful knowledge in the departments of science, literature, and art, by investigating and discussing subjects appertaining thereto, and by establishing and maintaining a museum, a library, and a collection of works of art and objects of historic interest in furtherance of such objects." These objects, by natural distribution, furnish the specific end of each section, according to the meaning of its title.

To promote education seems at first glance an object as definite and comprehensible as it is admirable and important. Yet, if it were permissible to raise and press the question, "How is education contemplated to be promoted?" we might be plunged in a sea of controversy of unknown depths. Since the discussion began between Socrates and his successor, Plato, on one side, and the sophists of their day on the other, and which soon grew into a bitter contest, there have been the most conflicting views among teachers as to the best methods of intellectual discipline, of imparting instruction, the subjects of study, the supreme aim of education and the like, and these questions were never more rife than they are now. Reformations and radical revolutions in our ideas and systems of education are urged with growing intensity in the ascent, from the primary school to the university. While all these will be proper subjects for the Institute's investigations and discussions, the education which it proposes to promote may be understood in the large sense, which Prof. Faraday once gave the term, "as including all that belongs to the improvement of the mind, either by the acquisition of the knowledge of others, or by the increase of it through its own exertions."

Then the knowledge to be promoted is "useful knowledge" in the departments of science, literature, and art. How useful? is a fair inquiry, which merits a thoughtful answer. Is only that knowledge useful, which is capable of application to some practical enterprise or work, and so may be seen to possess a pecuniary value? In other words, is the usefulness of knowledge to be estimated according to its mere qualifying power in the discharge of life's duties? Such conclusion were sadly utilitarian. Lord Bacon, said: "Knowledge is not a shop for barter and sale; but a rich store-house for the glory of the Creator and the relief of man's estate."

Is not that knowledge useful, apart from any use to be made of it, which abides as the sign of the permanent mental discipline and development, which resulted from its methodical acquisition? Is not the joy of knowledge useful? When after the laborious mastery of the apparently arbitrary and disjointed elements of a new language or a new science, their union in the mind of the student opens to his enraptured perception the treasures of the promised truths, is not that intense exhilaration and satisfaction of learning useful, with an elevation and strength of meaning that shames the idea of low utility?

Whether or not we agree with Aristotle, who like Plato, as Herbert Spencer tells us, "comes to the conclusion that the pleasures of the intellect, reached by the contemplative life, constitute the highest happiness," we believe that knowledge, that is not essentially evil, is a good, and, like virtue, is its own reward. And while its purposeless acquisition may create only walking cyclopedias, who "affect us as rich possibilities, but helpless to themselves and their times, do not speak to our want," yet its increase in any mind enlarges the measure or heightens the quality of individual existence, and best endows one with the power of usefulness, if the habit of imparting be connected with that of acquiring it. This, too, as Mrs. Sigourney wrote, "increases mental wealth, by putting it in circulation. And it enhances the value of our knowledge to ourselves, not only in its depth, confirmation and readiness for use, but in that acquaintance of human nature, that self-command and that reaction of moral training, which are above all price."

The fields in which the Institute proposes to promote useful knowledge are most ample and inviting. These, as we have seen, are the departments of science, literature and art.

SCIENCE.

The term science possesses a resistless charm for honest acquirers and promoters of knowledge, because its object is truth, and its very name is a perpetual promise of the communication of certain knowledge: of wholly reliable conclusions or facts.

Only pure science, however, which is built on self-evident truths, can fully redeem the promise. Much knowledge, that is properly scientific is, and will necessarily continue to be, tentative. Its authority will rule until discoveries shall show that it was incomplete or erroneous, when it must be corrected or discarded. The science of chemistry, for example, is showing that even substances which were accepted and declared to be elemental are compounds. Scientific theories, which from time to time have been held to be true and received the confident endorsement of the scientists of their period, have been found to be altogether untenable.

Baron Paul Holbach's *System of Nature*, which commanded the sweeping assent of the mind of his day, is now almost wholly neglected or disregarded. President Porter in accounting for this says, "that its science is antiquated, having literally been left behind in every point of detail, by the rush of discovery and experiment since he wrote."

We hear the suggestion occasionally issuing from influential sources, that even the great science of geology may need to be greatly modified or radically reconstructed. Certain is it, that the reading of the masterly address of the retiring President, Principal Dawson, made at the recent meeting of the American Association for the Advancement of Science, leaves no distincter impression upon the mind, than the unsettledness of many geological conclusions that have been deemed most firmly settled. He refers as to other points, to the theory of "the mode of the formation of coal," held most confidently by himself and many of the most eminent geologists that have lived. And then after citing discoveries of authoritative microscopists in different countries, which bear against their theory, and the impression these have made he declares, "it may be, that all that we can do, will be required to rescue from total ruin the results of our labors."

Such are the experiences, in connection with the natural modesty of really gifted natures, which make true scientists so cautious and unassuming in their assertions of and claims for scientific knowledge. In its very nature all finite knowledge that is not axiomatic is progressive. "Knowledge grows," remarks Prof. Youmans, and throughout his writings we find such statements as these: "Perhaps the most correct conception of science that has yet been formed is that, which regards it as the highest stage of growing knowledge." In another place: "It matters nothing whether the subjects are stones or stars, human souls or the complication of social relation; that most perfect knowledge of each, which reveals its uniformities constitutes its special science. Science, therefore, he adds, is the revelation to reason of the policy by which God administers the affairs of the world."

Prof. Dawson years ago said: "In the wider sense of the term science, it really includes all that intellectual education can effect."

Dr. Peabody declares: "Science is literally applicable to all knowledge, and its use might be extended to daily events and ordinary affairs without any departure from the peculiar or technical sense in which it is commonly employed."

So we see that, from the atom of the universe up to its Infinite Creator and Governor, whether it be earth or element, creature, material or sentient, body, mind, spirit, anything, concerning which a rational theory can be propounded, in the measure that it can be established, becomes a subject of science.

The essential character and relative importance of particular sciences and classes of science change with the changing conditions of humanity. If the ruling mind of the age be visionary, the wildest speculations and most baseless dreams will be dignified with the titles, philosophy and science. If a healthier intellectual activity bear sway, metaphysical studies will prevail and the science of mind become the absorbing subject. And, when from discoverable or unknown causes, the best thought, tiring of subjective analyses and subtleties, turns to external objects with patient and penetrating observation and experiment, the physical sciences rise into corresponding prominence and make sublime progress. It is not necessary to say that this is pre-eminently the scientific epoch in which we live.

The slightest acquaintance with the history of the growth of knowledge shows us that the opening doors into new sections of the temple of science have hinged upon the discoveries, and been forced by the power of rarely endowed individuals. The providential method of progress has been the taking captive a great soul with some great truth, and then the preparation of the way for its revelation, as its earthly author, with self-sacrificing devotion and exhaustless energy, through all difficulties and over all opposition, pressed on to its demonstration. Such minds can spurn routine, and, without transgressing, transcend formulated law; or better, can rise into affinity with higher laws of their spheres, and becoming their expositors, sweep away consecrated and cumbrous formulas and realize the grand idea of "lengthening life by shortening the road to knowledge."

In an instructive address, before the Royal Society of Great Britain, a few years ago, "On the influence of science upon intellectual education," Rev. Dr. Whewell held the view, "that every great advance in intellectual education has been the effect of some considerable scientific discovery or group of discoveries;" and he declared with equal confidence, that "the influence which has effected the advance has been that of the intellectual achievements of one or two gifted men at the beginning of those epochs."

When we remember what the inversion of the methods of interpreting nature, from the deductive to the inductive effected at once, and has since accomplished, who shall limit the possibilities of impulse, expansion, conquest, which may be given to the whole family of sciences, by the discoveries of any single heaven appointed mind? And when we think of the incompleteness of all the great sciences and the warring theories within them, and then remember the demonstrated quality and recognized standing of minds in our own association, why may we not expect the flashing of some grand, harmonizing principle into one or more of them, that shall make and mark an era of scientific progress, and link our Institute with a glory that shall grow with the ages?

Whether this shall be or not, the influence of all true work here will surely make more probable the realization of the expressed thrilling hope, when "a science of sciences" shall show that the sciences are not isolated things, but are so bound together as to constitute a unity, which is a reflection of the unity of nature and of the unity of that Supreme Reason which pervades all and originates all intelligence.

LITERATURE.

The range of the department of literature is worldwide and extends backward to the first historical record.

Craik's conception goes quite beyond this. He says, "Literature is composed of words, of thought reduced to the form of words; but the words need not be written;

it is enough that they be spoken or sung, or even only conceived." Unwritten or unuttered co-temporaneous literary conceptions may be worthy of consideration, and may indeed seem very important to those who have them and who dream that they are clever, and are complacently waiting for circumstances to disclose the rich mines of their intellects, but it is improbable that either ambition or enthusiasm will start any member of the Institute on a search after the unrecorded conceptions of Shakspeare, Bacon or Homer for investigation and discussion.

Better, and surely enough for us, is the literature that is defined, "the collective body of literary productions embracing the entire results of knowledge and fancy preserved in writings."

The contemplation of this aggregation, by one in any way responsibly related to it, is well nigh overwhelming. All that is called poetry, from the song that thrills the ages to that which chills as agues: all the annals of historic research: all the reports of the sayings and doings of the endless sessions of numberless deliberative bodies; all the sermons, orations, dissertations, countless as the leaves of primeval forests: all the tomes little and big of philosophers, scientists and authors of every name: all the unclassified wisdom of the wise, all the unclassifiable folly of the fools, all the drivel of idiotic conceit and assurance, which have found their way into enduring forms, have been increasing century after century, until the wonder is, that St. John's supposition that, "even the world itself could not contain the books that should be written," has not become a literal fact.

When one recalls the groaning of Solomon over the measure of study obligatory on the men of his day, through the persistence of their book-makers, it is affecting to think what his agitation would be, if he could make the round of one of our greatest modern libraries, like the

Paris National, with its two million bound volumes and one hundred fifty thousand manuscripts.

There is no doubt that a great plague of our day is the plague of books. Like the frogs of Egypt, books force themselves in distressing numbers into our houses, bed-chambers, beds; into the houses of our servants, and into the very kneading-troughs, where, generally, they are found in the worst yellow covers, badly begrimed. The best parts of the earth would be cleaner, sweeter, safer, if mountains of superfluous and worse, literature, might illumine them with a bon-fire bigger than the world ever saw. A book-critic wrote thus, "There are a hundred books worth reading to every one that the ordinary reader has time or opportunity for perusing; and there are ten thousand that are absolutely or relatively unworthy of perusal." The literary discussions of the Institute can hardly fail to indicate many of the best books, to those who shall hear them.

The legitimate work of the members, according to the declared purpose of the department, will carry them below the mere literary traits and details of standard productions, and past their historic connections even, to the forces which formed them, and the leading influences, social, moral, religious, which are operative in and through them. This philosophic mastery of their profounder principles and character will impart a keener appreciation of their merits and defects, and develop a literary taste and judgment, which shall be increasingly discriminating and authoritative. It would not be easy, also, to over-estimate the value of both the stimulating and restraining power exerted by the encomiums and protests properly issuing from a body like this. The warning voices that have been raised not too soon, and are sounding in crushing condemnation not too severe, against the sentimental, sensual, sceptical literature of modern æstheticism, will here be distinctly and fervently echoed.

Here its affectations, puerilities, poverty of thought, demoralizing influence and immoral teachings and tendency can be shown in a way that will deeply impress on all thoughtful minds the value of literary sincerity, high moral purpose, purity, truth, faith. Here, too, the claims of authors and their works, which are generally neglected, if not forgotten, may be revived and successfully pressed. "Any one," says an eminent writer, "who will take the trouble to ascertain the fact, will find how completely even our great poets and other writers of the last generation have already faded from the view of the present, with the most numerous class of the educated and reading public. Scarcely anything is generally read, except the publications of the day. Yet nothing is more certain," he adds, "than that no true cultivation can be so acquired."

It is much, in every view, to have a clear and cleansing and refreshing stream from the fountains of "English pure and undefiled," flowing into our literary life. It is much to have the flame on our altar of literature fed by the finest beaten oil of former centuries. If anything can, the contrast of its pure and steady and pervading radiance with the meteoric flashes and fantastic colored lights, of much of our modern popular writings, will check the growing desire for mere sensationalism, which as a method degrades, as a means deceives, and as an end destroys. While we regard the Institute's literary record with high satisfaction, we anticipate its work in this department with exhilarating anticipation.

ART.

No object could be more timely or important than that which aims to promote useful knowledge in the department of art.

Several years ago it was declared by an intelligent and careful artist-author, that "the art-idea had taken full possession of the public mind." The facts cited to prove his assertion were "the large number of people engaged in the production of art; the numerous books issuing from the press indicating a general demand for instructive art literature; the multiplying forms of art manifestation, not only in the main departments of sculpture, architecture and painting, but in the numerous branches of decorative art." The years that have followed his statement have surely emphasized it and confirmed its truth. Yet, it is scarcely a question whether clear views and convictions concerning art were the causes of the noted interest; and even less is it a question whether real knowledge of art has kept pace with the spread of this seeming interest.

Quite early in the century it was a bitter regret of Benjamin Robèrt Haydon, that the nobility and higher classes of Great Britain had "so little dependence on their own judgment in art." And he properly attributed the lack to defect of education.

While those of exceptional sensibility to the truth and power of art, without any specific knowledge of its history or principles, may reach, intuitively, a confident and just estimate of works of art:—as a genius may become an eminent artist without or in spite of instructors, yet, those of ordinary gifts, can gain independent conclusions in art that deserve to be called judgments, only by study more persistent, and instruction more systematic, than most give and receive.

There is the science as well as the sense of beauty in every department of art: the science and the sense of form in sculpture; of color, form, grouping in painting; of proportions and detail in architecture; of melody and harmony in music; of rhythmical expression in poetry. And while any exemplifications of these great arts may excite pleasurable feeling in uninstructed observers, a knowledge of the combined and illustrated facts and principles, only, can make the kindled emotion intelligent, inspiring, satisfying.

The perusal of any competent treatise, like Taine's *Lectures on the Philosophy of Art*, shows us what is involved in the mastery of any system of interpretation, which shall enable us to discern real artistic merit, distinguish the true from the false, and with equal justice approve or condemn the work subject to our criticism.

It must be immediately apparent, that if the "art instinct," as it has been called, i. e., the popular taste of a community, which is compounded of desire for and appreciation of art, is to become influential in elevating the standard of art, and compelling the betterment of artists, and so grow into an established principle, whose power shall refine individual character and ennoble the public life, this must result from genuine educational agencies.

"What is art," asks Taine, "and in what does its nature consist?" and then after thirty pages of masterly discussion, apt illustration and advancing definition,—all of which cast clearer light on his train of thought,—he reaches the answer "that the aim of art is to manifest a predominant character, some salient principal quality, some important point of view, some essential condition of being in the object." This is comprehensible. And we easily infer, that according to the artist's success in achieving this aim, his productions are true exemplifications of art.

It is the misfortune of learners in a general way, that so much of what writers and speakers on art give us, seems the affectation of an enthusiasm, which they are helpless to explain or impart.

It may be possible, "that in the visible common place of every day," as one says, the artist may find "the means for impassioned expressions of emotional impulse addressing the moral sense through the sensibility"—

which he calls art; but common sense suggests that subjects vary endlessly, and that even genius cannot make anything more of a subject than is naturally in it. And unsophisticated reason asks why appointed and accepted teachers cannot oftener talk and write about art and nature in words that mean something to ordinary intelligence, rather than in stilted technicalities and iterated, tiresome platitudes, which so often amount to *vox et preteria nihil* and much disappointment?

Nature in its relation to art, must be the great, divine, universal system of things in which we live, soliciting the student of nature, according to the penetration and range of his own insight, to discern their beauties, and interpret their meaning in words or tones or forms or colors, to the apprehension of the common mind.

And that the common mind may be readier to receive and appreciate and realize the uplifting power of true beauty, its misty impressions of art need to be cleared by specific, adapted instruction as to its nature, principles and aims; its restricted idea of art needs to be expanded, so that the word shall bring to the thought poetry, music, architecture, as quickly as it now suggests painting and sculpture, and shall rouse the expectations of fresh revelations of beauty by the former, equally as by the latter.

The often pained modesty of the common mind may also need to be told that, in the early periods of Greek art, and in its most brilliant epochs, draped figures, especially female figures, outnumbered those that were nude "fifty to one;" and it may also be assured that, no true art-interests, through the growth and dominance of true art principles and aims, can now or ever demand the creations of chisel or pencil, which shall wound the most refined sensibility; or can make that delicate and proper which is essentially indelicate or nude.

It is very pleasing to believe that this Institute, by the efforts of those in charge of the department of art, may definitely assist in this good work of educating the mind that is common to us all, and that in spite of the difficulties which are thrown in the way by a too ambitious and captious literature, abounding with visionary theories, conflicting criticisms, changing standards, inflated opinions and meaningless twattle, many here may be helped more and more clearly to see that "God has made everything beautiful in His time," and has given to every soul that faculty of taste, through whose exercise he comes to the knowledge and appreciation of the beautiful.

These mere glimpses at the fields which the Institute has appropriated and which its members propose to work, show that we have undertaken a serious business; serious in the senses—laborious, difficult, responsible.

There are those who greatly affect science, and yet reach scientific conclusions as easily as the political editor writes the virtues of his party. They leap startling distances and land upon the mere theoretic suggestions of acknowledged scientists, which seem to support their prepossessions, and glory, as if they were standing firmly on the rock of truth. Yet some measure of "the immense amount of precaution," which John Stuart Mill declares to be necessary to a scientific experiment, is needed in proper scientific investigation.

In discussion too, the distinction between science and philosophy, between theory and fact, between inference from the most striking analogies and sober demonstration, between cause and method, between the names of things and the things themselves, so often overlooked, must be maintained. As we purpose and shall effect the promotion of useful scientific knowledge by investigation and discussion, all the conditions that have been found necessary to success elsewhere, must here be fulfilled. And contentment with anything less than a realization of our proclaimed object, will be a surrender to difficulties, a compromise of principle, a violation of pledges and an abuse of our trust.

The work of literary investigation and discussion is accessible to a larger number of our members, than is that of the scientific and art departments. It is easier to discuss, in a general way, literary topics, than those of science or art, because a superficial knowledge of the former is more easily obtained and goes farther in talk, than does a smattering of the latter. Nevertheless, in that of literature, as in the other departments, William Wirt's oft-quoted words will be found true: "there is no excellence without great labor." Careful preparation only, will enable one to do justice to his subject or to himself. Abundant scope is given for the exercise of every mental quality in extemporaneous expression of the thoughts kindled on the occasion, but the brightest and warmest flashings of such, shall be of fuel gathered before and stored in the mind. Not mental diversion for the sake of a passing gratification, but real intellectual refreshment, invigoration and growth, must be the aim and result of our meetings, or they will fall below the published and proper standard of our Institute. The preparations have been too costly, the professions too exalted, the possibilities are too grand, to permit without reproach, its descent to the level of the ordinary debating club. In order to secure thoroughness of work, permanence of results and the avoidance of common-place, thoughtful ones of our number have already anticipated the need of carefully prearranged subjects, which will demand lengthened, continuous study, and secure connected discussions. Whatever the precise methods may be which, from time to time shall be adopted, it is certain that Vassar Brothers Institute can fulfill its mission, only in the measure that its members shall give it their faithful, pains-taking, persistent, united labors.

Moreover, in order to its continuous progress, the pronounced co-operative sympathy of our people must be bestowed on it. It is not too much to ask or to expect that there will be a large local membership, or that this will be largely represented at the regular meetings, to encourage and stimulate the working members to make their best efforts. Such measure of pecuniary and moral support is surely due from those who are to share so largely the behoof of its best success.

For beyond the intellectual benefits to accrue from investigations and discussions to the working members of the Institute and those who form its regular audiences, its further objects—"the establishing and maintaining a museum, a library and a collection of works of art,"—must excite the interest and challenge the appreciation and endorsement of every thoughtful citizen.

A museum, that shall gather and garner all obtainable specimens of the natural history of this region, will be a place of growing attractiveness, and of increasing importance as an educating agency.

Carlyle wrote of "the winged and wingless neighbors" that were continually meeting him, and much regretted that he did not better know them. All who desire to do so, can make the familiar acquaintance of our "winged and wingless neighbors," through their beautiful representatives collected and collecting in our museum. Many other curious and interesting objects, already numbering over three thousand, are taking their places there; and their number and value shall increase now and in the future, according to the enthusiasm and generosity of those, by whose contributions this part of our Institute must grow.

The library and art collection contemplated, if touched, were a theme for a whole address. These, with the museum, are the permanent elements of the Institute and point impressively, through a promising present, to a future of ever unfolding importance. Every rare and valuable book and every gem of art gathered here will be casting light upon inquiring minds, and kindling and gratifying a love for the beautiful, long after our actual connection with them has ceased.

It is in a perceived appreciation of the Institute's purposes and work, that its most generous and worthy donor can get the only present return for his munificent gift, and the assurance that it was wisely bestowed.

It is in a progressive realization of its objects, that he shall have a pledge of its future prosperity and usefulness, and an earnest of the enviable honor and gratitude with which his memory shall be crowned through coming years. And I know, I but feebly voice the feeling of the entire community, when I utter the fervent hope, that he may long be permitted to witness the steady growth of Vassar Brothers Institute, and to rejoice in the subdued but solid glory, which its mingled radiance of science, literature and art shall shed upon this city of his and our love.

OCTOBER 9, 1883—TWELFTH REGULAR MEETING.

L. C. Cooley, Ph.D., vice-president, in the chair; thirty-five members and one hundred twenty-five guests present.

Dr. Stevenson gave notice of proposed amendments to articles ii., iii., vi., vii. and xii. of the by-laws.

Seven members were elected.

Prof. W. B. Dwight, chairman of the Scientific Section, gave an address on "Specialization in Natural Science." (This address is published in Part ii. of this volume.)

OCTOBER 23, 1883—THIRTEENTH REGULAR MEETING.

J. Elmendorf, D.D., president, in the chair; nineteen members and seventy-five guests present.

The amendments to the by-laws as proposed at the last regular meeting were adopted.

Mr. Elsworth proposed the following amendment to article xv. of the by-laws: "The distribution of the income of the fund, specifically set apart for 'museum, scientific, library, and publication' purposes, shall be under the direction of a committee of four members of the Institute, two of whom, at least, shall be members of the Scientific Section. Such committee shall be annually appointed by the President, and shall report annually to the Institute and to the board of trustees."

One member was elected.

Mr. Edward Burgess, chairman of the Literary Section, gave an address relative to the work of this Section. While the speaker did not choose to give his address any formal title, it may be set forth in a single line from Pope: "The proper study of mankind is man." The speaker urged his hearers to study their own kind through every medium, and especially through literature in all its forms,—biography, history, biology, theology, &c., &c. Dwelling on the subject of biography, he said that to learn the foibles of great men was to receive a lesson in humility and charity, when we see that such have their weaknesses no less than their humble brethren. The main purpose of the address was evidently to urge upon the Literary Section the great advantage of system in the preparation of their papers. He dwelt with special emphasis on the value of biography as a study—it brought one into such intimate communication, as it were, with the leaders of mankind in all ages. The address elicited a discussion by President Elmendorf and Messrs. Gardner, Bartlett, Elsworth and Stevenson.

NOVEMBER 13, 1883—FOURTEENTH REGULAR MEETING.

J. Elmendorf, D.D., president, in the chair; fifteen members present.

The amendments to the by-laws, as proposed at the last regular meeting, were adopted.

The president appointed Messrs. Stevenson, Dwight, Elsworth and Arnold, committee on museum and library.

DECEMBER 4, 1883—FIFTEENTH REGULAR MEETING.

J. Elmendorf, D.D., president, in the chair; thirty-five members and two hundred guests present.

Mr. E. J. Miller, of Albany, N.Y., gave an address on "London Stone," of which the following is an abstract:

The American traveler approaching London, first catches sight of objects of familiar appearance, the dome of St. Paul's and the tower of London—made familiar by publications, pictures, &c. Going from St. Paul's to the tower by a straight road, he passes many antiquities; and passing on he will come to a stone monument with an opening near its top, this opening containing a small stone, little larger than a man's head. We can learn all about St. Paul's, the Tower, and hundreds of other notable things, but why, when and by whom was this stone, known as the 'London Stone,' erected?

It has not always occupied its present position, where it has stood only eighty-five years, and is guarded now by iron work from possible injury.

No record of this monument exists—no print or description of its extent, except by Hutton, a printer, who jotted down everything that came to his notice, and who visited the spot. He gives the dimensions as about four feet high and two feet broad.

Whether it is a Roman milestone marking the converging point of some fifteen roads leading out of London, the corner stone of a heathen temple, or was set up in the public meeting place of the people, were hypotheses supported by an avalanche of antiquarian lore.

and opposed by an array of witnessing improbabilties. Dates were assigned as early as fifty-five years before Christ for its existence. Jack Cade, striking this stone with his sword in 1450, made his first proclamation. The whole history of London clusters about this venerable relic which, as the speaker was inclined to believe, marked the open field where the public assemblages of the ancient people of London were held, for legislation counsel, and great doings.

President Elmendorf spoke in eulogistic terms of the address, and invited the members to discuss the subject presented.

Dr. Stevenson expressed his pleasure in listening to an address which reviewed at such length and so critically so much of ancient lore, and moved "that the thanks of the Institute be given to Mr. Miller for his interesting and instructive paper."

Mr. Bartlett seconded the motion, and complimented the speaker of the evening for the address given.

The motion was carried.

JANUARY 8, 1884—SIXTEENTH REGULAR MEETING.

J. Elmendorf, D.D., president, in the chair; twenty members and one hundred guests present.

James M. DeGarmo, Ph.D., read a paper entitled "The Eternal Heavens." The speaker said it was customary, both in scientific and popular writings, to speak of the celestial vault as "the eternal heavens"—as enduring, continuing forever. So they have come to be looked upon as the very type of the unchangeable and the permanent. The expression "eternal heavens," in various modified forms, has crept into current literature, especially religious literature, and a specific meaning has become attached to it; and "the stars in their courses" are the symbols of perpetuity, and the representatives of infinite calm and rest. But the whole idea involves a misunderstanding of the facts. Not only are their orbital motions swift and far-reaching, but they are themselves the theatres of mighty convulsions, involving terrific tornadoes, conflagrations, and upheavals, compared with which the terrestrial convulsions are but pigmies. Worlds are consumed and worlds collide; comets from infinite space are caught by the attraction of planets and all their direction changed; masses change from stars into nebulæ, and from nebulæ back again to stars, and probably infinite star-dust is hurled into mid-space by stellar eruptions. The solid hills of our earth are changing, wasting, and going into the sea. Everywhere, too, molecular motion is going on—chemical changes and cosmical changes advancing together. All our thought, then, of the heavens as abiding, remaining forever, must be changed. They cannot abide; but the permanent is to be found, if at all, in the great creative and regulating force that is the initiative of all this change. To that, and not to the material universe, must man, in his weakness and powerlessness, look for abiding peace, for permanent, enduring being.

The subject of the paper was discussed by Messrs. Cooley, Dwight, Bartlett, Van Vliet, Warring and Stevenson.

FEBRUARY 5, 1884—SEVENTEENTH REGULAR MEETING.

J. Elmendorf, D.D., president, in the chair; fifteen members and sixty guests present.

Professor Dwight gave notice of a proposed amendment of article iii., of the by-laws, changing the initiation fee from \$5 to \$3, and the annual dues from \$4 to \$3.

Three members were elected.

C. B. Warring, Ph.D., addressed the society on "Evolution, and its Relation to the Mosaic Account of Creation," which was further discussed by Messrs. Elmendorf, Bartlett, Dwight and Stevenson.

MARCH 4, 1884—EIGHTEENTH REGULAR MEETING.

J. Elmendorf, D.D., president, in the chair; nineteen members and one hundred thirty guests present.

The amendments to the by-laws proposed at the last regular meeting were adopted.

Mr. John I. Platt read a paper on "Education by the State," of which the following is an abstract: The purpose of the State in providing education is to secure its own welfare by training good citizens, and no other object can justify the use of public money for the support of schools. The attributes of good citizenship are peaceableness, honesty, patriotism, virtue, thrift, intelligence and sufficient information. Of these virtue and duty are more important than learning, and the training of character is more important than the training of the intellect. Character is formed and morality is inculcated by teaching, and no system of education is or can be complete which does not include the principles of morality and thrift in its course of study. There should be text books prepared for this purpose and these things should be taught as a required study in every school. And, finally, religion is too closely connected with the welfare and usefulness of the individual and the strength and honor of the State to be neglected. While we must respect freedom of opinion religion should not be excluded, and any plan that will permit it to resume its proper place in our common schools without offending the prejudices of sect, should be welcomed, and wherever and whenever practicable should be put in force.

The subject of the paper was discussed by President Elmendorf, and Messrs. Gardner, Crosby, Nilan, Dwight and Stevenson.

APRIL 1, 1884—NINETEENTH REGULAR MEETING.

J. Elmendorf, D.D., president, in the chair; twenty seven members and four hundred fifty guests present.

Rev. H. L. Ziegenfuss gave an address, (with lantern illustrations), on "Colorado: considered geographically, geologically, and industrially."

"THE OBJECTS AND DUTIES OF THE ART SECTION."

BY PROF. HENRY VAN INGEN, CHAIRMAN.

Every work of art should possess two qualities:—

1st. Beauty in the selection of the subject and in the objects which represent the subject; and,

2d. Beauty in the execution of the objects.

The distinctions between the different schools of art, from the earliest times, have been founded on the predominance of either one or the other of these two qualities. What else was the meaning of the criticism made by Quintilian on the Discobolus by Myron, when he said: "What can be worse in form or more painful to the eye than this quoit-player. If, however, any person should undertake to censure it as being unnatural, he would only show his ignorance by blaming that which gives the peculiar value to this work."

In regard to this criticism, I would say, that the general idea which we have of man represents his figure to us in an erect position, and that the nearer we remain in our statue or painting to this, the easier it will be to represent one of its essential beauties. The farther we depart from this vertical line the less dignity our work will possess.

Myron's statue dates back to four hundred fifty years before our era, when the general style of art aimed not at close imitation, but at grandeur of form.

The first quality of which I spoke, represents the aim of art, the second the means.

Every school of art has commenced with the first quality, but after acquiring the second it has given this the place of both. In every case this has resulted in the entire decline of the school itself.

The school of Phidias represented the grand beauty of Greek art, and Praxiteles added thereto gracefulness and perfection of execution.

The Romans fully appreciated the latter quality, but did not attain to the intrinsic beauty of the first school. Hence as they made the execution their aim, art gradually declined and finally almost perished under their dominion.

The early painters of Italy and of the Netherlands represented the various religious subjects in a child-like and naif manner. In contemplating them we are struck by the devotional feeling which prevails in their representations of sacred subjects. Yet we cannot help smiling at the awkward forms through which these sublime subjects are represented.

The execution, drawing, and coloring, improve gradually until Michael Angelo appears. With his bold and powerful execution he prescribed the style to modern art. This Michael-Angelesque style spread throughout Europe, and influenced all artists. In striving to imitate him, however, these artists copied only his execution, failing to attain the beauty of his selection of subjects. The general decline of art in the eighteenth century was the natural result of this mannerism. In the last half of the sixteenth century, the brothers Carracci founded the eclectic school. In this they tried to unite the beauties of Michael Angelo, of the Venetians and of Correggio, to those of the school of Raphael. They might have succeeded in giving to the world the most perfect works existing, but they failed utterly. The reason of their failure was that they imitated these several masters themselves, instead of studying the beauties of nature which these artists had pointed out in their works.

After this short review of the varied effect of these two essential elements of art on the old art of Europe, let us look nearer home and consider for a moment their effect on the art of painting in America.

The art of America only dates back a very short period of time. Copley, Trumbull, West, Allston, Inman, Cole, Mount, Morse and others are the first American artists. Then follow some who are still living—Weir, Huntington, Church, etc.

Every one of these men aimed at the high function which art ought to fill; and tried to reach it by their individual efforts. A few of them studied abroad, but at a time when art in Europe was based on the most romantic principles.

The pictures of most of these men look weak, and lack thoroughness of drawing and form, when they are compared with the foreign pictures of the present time. They lack the qualities which belong to a fine chiaroscuro, and for this reason they have not that appearance of reality so attractive in works of the present school of Europe.

The young American artists of to-day perceiving this lack in the execution of the art of their country, have gone abroad and have studied in the large art centres at Paris and Munich. Many of them have since returned and have exhibited their work at home. After a careful and unbiased examination of the merits of their pictures we must come to the following general conclusion:

Most of these young men in the pursuit of art have mistaken the means for art itself. Although they have only acquired what they call technique, they consider themselves accomplished artists. Let us look at the large number of American artists who have studied in Munich, and what do they show us: Most of them exhibit as works of art mere studies in the handling of the brush, painted from what they call a picturesque arrangement of all kinds of articles, which often are entirely disconnected.

Perhaps some of them show us a cleverly-handled painting of a most hideous, but, perhaps, picturesque-looking man or woman. They appear to select the most detestable-looking models, and thus try to see how well they can represent them with the fewest possible touches.

Now this last quality, ease of execution, is a fine element in art. That of the Munich portrait-school is based on the style of Frans Halls, the Dutch painter.

In short, this new school of American painters are satisfied to call only one part of the art its whole. They say painting is the art of imitation, and without this technical imitation there can be no visible picture. You may have the most poetical thought or conception, yet if there is no adequate execution the world will never be the wiser for it. This is very true. These artists forget, however, the true aim of art.

The aim of painting is not merely to represent the natural beauties of objects, but also moral and intellectual beauties, the representation of which will, so to say, render virtue visible. The objects selected by the artist ought to familiarize the people with beauty and harmony, and thus form their taste; while the subject will contribute to make them better and happier.

Believing this to be the true aim of art, let us as an art club for a moment consider our own duties towards art and towards society.

Article i., of our by-laws, states that our object "is the promotion of the fine arts, by means of practical work and instruction in the study of art; by lectures on, and discussions of subjects relating thereto; and by securing, maintaining and exhibiting a collection of works and objects of art."

How can we best attain this end?

The knowledge of the beautiful furnishes the key to the liberal and noble quality of art; just as the knowledge of perspective furnishes the key to the entire technical part of the representation.

The last part, the technical representation, can only be acquired by the study of drawing and painting from nature. This can be done best in classes, where students by honest emulation aim at great perfection. This drawing in connection with the study of composition, chiaroscuro and coloring gives what we call the language of art. This language should be perfectly learned by the art-student in order that he may be able to communicate readily his ideas. He should be such a master of this language that he is enabled by it to communicate all the different modes of expression.

We take, for instance, these two pictures as illustrations. Both are intended to convey a religious impression on the beholder. The first, a crucifixion, by Castagno, was made by an artist who was thoroughly impressed by his subject, and who knew that the lines and forms in a religious subject should be simple, dignified, and pure. He has even drawn his figures with a sort of timidity, as if they themselves approached the holy subject with awe and reverence.

We shall find this quality one of the greatest charms of the primitive modern school;—a charm which lasted until in Michael Angelo's time the naif following of the forms of nature was abandoned to give place to an unbounded passion for extravagant lines and forms.

The artist of this picture then, being a master of the technical parts of art, or of the language, was enabled by it to produce the right impression on our mind.

How is it with the artist of the second picture? It is one of Prang's prize Christmas cards. He does not understand the human form sufficiently to be able to select from among his models those who by their simplicity, purity and grace would be in keeping with his subject. Instead of purity, chastity and grace he puts before us the most vulgar of forms, and selects in an unpardonable manner such attitudes as will surely invite the sensuous eye to dwell upon them. I should consider it almost a duty on the part of educators to try and repress the sale of such vulgar trash, especially as this picture comes with an authority in having received a prize for its artistic merit.

I suppose you begin to see what I meant when I said that the Art Section of Vassar Brothers Institute had a duty to perform towards the public. It should take care that the language of the art is properly taught, so that it will not, as in this case, prove detrimental to good taste and morals. This instruction then should be intrusted to a liberal and thoroughly educated artist, and should be entirely under his direction. His method should be theoretical, and broad enough to meet and guide the various individual likings and feelings of the different pupils. He should try to develop the individuality of each student, and to make him see through his own eyes. After a student in this way has acquired what I call the language of his art, which embraces the power of executing all forms, he will, if he is a true American, paint American art. It will not be necessary for him to go abroad.

Just think of it! The young American artists who a few years ago refused to exhibit in the National Academy of Design, opened an exhibition of their own, and called it the exhibition of "The Society of American Artists." Nearly all the pictures that I saw there were imitations of the style of some celebrated European, usually Munich, artist. What was more, the figures selected, and in many cases the subjects, were all European. Most of them were rather low European at that. This shows us that the only way to have American art, is to educate our artists in America. So much in regard to the formation of classes for instruction.

Let me speak now of our lectures. They, too, should be practical, and as much as possible should be given by professional artists. Their aim should be to supply the required knowledge of the beautiful, teaching how and what to select and how to compose. They, in short, should supply the complement to the classes, and with them complete the instruction of that language which may be made so eloquent and so powerful for good.

Now, the next and last point to consider is the giving of exhibitions and the forming of a collection of works of art. Let me state, at this point, that this forming of a collection is one of the most important duties intrusted to this Section. Nothing is more capable of forming our taste—which is in reality the sentiment for the beautiful—than productions of art, in which we can observe, study, and become familiar with all the combinations which together produce this beauty. If works of art lack this beauty their influence will be dangerous, for they will help to introduce a bad taste. Moreover, since examples of bad taste find also admirers, these vices in art, receiving favor from some, will not only introduce but also encourage a bad taste. "To form and purify the taste," says Sulzer, "is a great national duty. So we must not neglect to look into the analysis of art, by the aid of which we may reach this aim of purifying and forming the taste, and, consequently, improve the morals."

Most people, in acknowledging this moral influence of art, place it merely in the subjects which the artist may select for his painting. I go farther, and find it also in the execution of the work and in a subject which may in itself be entirely devoid of any moral or intellectual significance.

All people will agree that the harmony between the parts themselves, and between the parts and the whole, is as necessary in the performance of a moral act as in a painting or a statue. So, by the study of art, this love for order, for proportion, for harmony, becomes a virtue. Hence, it may be brought into every object with which we are connected. This love for order becomes taste in matters of pleasure and virtue when it is brought into our moral life. If it is neglected in youth we shall feel the bad results of the neglect through life.

I would, for these reasons, impress this Section with the importance of zealously watching the beginning and growth of these intended exhibitions and this proposed collection. I would suggest that a committee be appointed yearly as a jury, with power. It would be the duty of this committee to refuse as a gift, or otherwise, anything which was not artistically valuable.

Institutions like this are always in danger of receiving from good people gifts which are often of no value or benefit to such an institution. Indeed, the very mediocrity of these gifts might in time make us the laughing stock of others.

Hence, we see that with us as with the Greeks, art requires to be beautiful in order to be useful or beneficial.

The same thing was felt by the Council of Bishops in the first centuries of Christianity. They recognized the force and influence of painting, and they desired that the paintings exhibited to the eyes of the faithful should be so many teachers of order, wisdom, and true devotion.

I would suggest, then, that in beginning a collection we should procure a number of plaster-casts from ancient sculpture.

But we have not yet come to this, and this suggestion may, perhaps, better be deferred until we have the means of gratifying our wishes.

The preceding remarks, however, suggest my closing sentiments, which are:—

The habit of observing in art that which forms optical harmony is very likely to make us study it also in all private and social matters. Hence, a lack of harmony in morals will shock us as much as it would in a painting. Harmony and method, and, through these, dignity and purity, will at last become qualities so much the more attractive and dear on account of the pleasure which we experience in tracing and studying them in the beautiful works of art.

MAY 6, 1884—THIRD ANNUAL MEETING.

J. Elmendorf, D.D., president, in the chair; seventeen members present.

One member was elected.

Dr. Stevenson, chairman of the committee on museum and library, rendered an itemized report of the sum expended for the museum and library, amounting to $148.99.

Mr. Pelton, secretary of the board of trustees, gave a general report of the condition of the property of the Institute.

Mr. Elsworth, treasurer, reported in detail the items of receipts and disbursements for the fiscal year ending May 6, 1884, of which the following is an abstract:

Total receipts from all sources	$1,707 33
Balance in treasury May, 1, 1883	462 17
Total credit account May 6, 1884	$2,169 50
Disbursements during year	1,660 34
Balance in treasury, May 6, 1884	$509 16

Three endowment funds have been given by Mr. Vassar, viz:

Repair fund,	$5,000
Museum, library, scientific and publication fund,	10,000
Insurance, light, fuel and general expense fund,	15,000
Total endowment fund,	$30,000

Prof. Dwight, curator of the museum, reported the receipt of 789 specimens for the museum, donated by the following persons: Mr. John Guy Vassar, Mr. C. N. Arnold, Mr. C. J. A. Van Kleeck, Mr. J. W. Adams, Miss M. T. Reynolds, Mr. G. B. Adriance, Mr. Walter Corlies, Jr., John Thompson, Esq., Miss Carpenter, Mr. E. Elsworth, Dr. E. C. Bolton, Mr. J. C. Pumpelly, Mrs. Gilbert E. Hicks, Mr. G. Cornwall, Mr. J. H. Dudley, Prof. W. B. Dwight, Rev. G. C. Berkemeier, Mr. S. Strauss, Mr. A. Innis, Mr. T. J. Woodman, Mrs. W. B. Sinsabaugh, Mr. S. M. Buckingham, Prof. L. C. Cooley, Mr. Frank Adriance, Dr. W. G. Stevenson.

Mr. Moore, librarian, reported the receipt of 109 pamphlets, and 173 bound volumes for the library. The individual contributors are as follows: Mr. John Guy Vassar, John Thompson, Esq., Rev. H. Loomis, Jr., Dr. T. J. Backus, Mr. A. M. Frost, Mr. J. C. Pumpelly, Dr. J. B. Holder, Mr. J. A. Seward, Mr. Jacob Corlies, Mr. John P. Adriance, Mr. T. N. Dale, Mr. C. S. Wilber, Hon. James Bishop, Mr. Charles Grube, Hon. J. H. Ketcham, Mr. E. P. Carpenter. The publications that have been received from various scientific societies, and state departments, will be reported by the secretary.

ANNUAL REPORT OF THE SECRETARY, DR. STEVENSON.

Mr. President and Members of Vassar Brothers Institute: Although no expense arises from any service rendered by the officers or members of the Institute, it was nevertheless apparent, at the time the society came into possession of its valuable building, that an income, in addition to that derived from the annual dues of members, would be needed in order to meet the necessary expenses for insurance, taxes, janitor, fuel, and light, and at the same time successfully prosecute the work for which the Institute was organized.

Your secretary stated the facts as to the financial needs of the Institute to Mr. John Guy Vassar, in the early fall of 1883, with the result of securing from him the generous gift of $25,000 as a permanent endowment fund.

The income of $15,000 is to apply to general expenses, and the income of $10,000 is to apply to library, publication, museum and scientific purposes.

This benefaction, added to the $5,000 which Mr. Vassar had previously given as a repair fund, yields an annual income of $1,550, which secures the society against financial contingencies, and makes possible the more successful prosecution of its work.

The details relating to the finances are given in the treasurer's report, which shows a balance on hand of $509.16.

During the past year eight members have resigned, and one member—Mr. Sidney Putnam—has died.

Twelve gentlemen and two ladies have been elected to membership, of whom seven gentlemen and one lady have duly qualified, and the names of the remainder have been taken from the roll.

The present membership of the Institute is one hundred forty-eight.

The amended by-law of a year ago, which made it the duty of the Institute to hold a public meeting on the first Tuesday of each month, from October to April inclusive, has operated beneficially, because it has given equal advantages to members of the Institute regardless of their affiliation with any Section, and has provided for the introduction of papers and addresses from those who are not members, and who are non-residents of Poughkeepsie.

The following addresses were given before the Institute during the season of 1883–'84:—

October 2, 1883.	Inaugural Address.	J. Elmendorf, D.D., president of the Institute.
October 9, 1883.	"Specialization in Science."	Prof. W. B. Dwight, chairman of the Scientific Section.
October 23, 1883.	"The Work of the Literary Section."	Mr. E. Burgess, chairman of the Literary Section.
December 4, 1883.	"London Stone."	E. J. Miller, Esq., of Albany, N. Y.
January 8, 1884.	"The Eternal Heavens"	J. M. DeGarmo, Ph.D.
February 5, 1884.	"Evolution"	C. B. Warring, Ph.D.
March 4, 1884.	"Education by the State"	Mr. John I. Platt.
April 1, 1884.	"Colorado" (lantern illustrations).	Rev. H. L. Ziegenfuss.

The average number of members present at these meetings was twenty-five, and of guests one hundred sixty.

During the past year the publishing committee issued volume i. of the Transactions and Scientific Papers of the Institute and its Scientific Section, from the date of incorporation, June 13, 1881, to May 1, 1883.

The volume, of one hundred forty-eight pages, contains the following papers:—

Mineral Physiology	T. Sterry Hunt, L.L.D.
Chemistry and the Question of Life, Examination of a Stain on Monumental Marble, The work of the Scientific Section,	L. C. Cooley, Ph.D.
Are other Worlds Inhabited? The Relation of the Chaldean Creation-account to that in the 1st Chap. in Genesis,	C. B. Warring, Ph.D.
The Appearance of the Bean-Weevil (Bruchus fabæ), at Poughkeepsie, Gradation in Animal Life,	Prof. W. B. Dwight.
The Physiological Significance of Vital Force	W. G. Stevenson, M.D.

A copy of this publication has been sent to many scientific and philosophical societies, Government departments, public libraries, journals, and individuals, and it is gratifying to know that in all cases it has been favorably received.

Your secretary is pleased to report that, after due correspondence, the following societies and journals have placed the name of the Institute on their exchange-lists, and have transmitted to us their respective publications, which are valuable acquisitions to our library :—

American Philosophical Society, of Philadelphia.
Albany Institute, of Albany, N. Y.
American Geographical Society, of New York.
American Monthly Microscopical Journal.
Academy of Sciences of St. Louis, Mo.
Academy of Natural Sciences of Philadelphia.
Boston Society of Natural History, Boston, Mass.
Buffalo Society of Natural Science, Buffalo, N. Y.
Bureau of Education, (Department of the Interior).
Bureau of Ethnolgy, (Department of the Interior).
Bureau of U. S. Geological Survey, (Department of the Interior).
Bureau of Statistics of Labor and Industries of New Jersey.
Connecticut Academy of Arts and Sciences, New Haven, Conn.
Cincinnati Society of Natural Science, Cincinnati, Ohio.
Canadian Record and Natural History Society of Montreal.
Davenport Academy of Natural Science, Davenport, Iowa.
Department of the Interior.
Engineer Department of U. S. Army.
Library Company, Philadelphia.
Minnesota Academy of Natural Sciences, Minn.
Middlesex Institute, Mass.
Missouri Historical Society, St. Louis, Mo.
Magazine of American History.
New York Academy of Sciences, New York.
Natural History Society of Glasgow, Scotland.
Nova Scotian Institute of Natural Science, Halifax.
Newport Natural History Society, Newport, R. I.
Portland Society of Natural History, Portland, Me.
Rochester Society of Natural Science, Rochester, N. Y.
Royal Society of Canada.
Sociedad Cientifica Argentina, Buenos Aires.
Société Impériale des Naturalistes de Moscow, Russia.
Smithsonian Institution.
Wisconsin Academy of Sciences, Arts and Letters, Madison, Wis.
Vassar Miscellany, Vassar College.

One hundred seventy-three volumes of books, one hundred nine pamphlets and journals, mostly the transactions of scientific societies, and seven maps, have been received during the past year, making a total of four hundred sixty-one books and five hundred fifty-seven pamphlets in the library.

The large proportion of these books and pamphlets has been received through direct appeals made by your secretary, to institutions and individuals, and he takes pleasure in expressing thanks, in behalf of the Institute, to Hon. John H. Ketcham, Mr. James A. Seward, Hon. James Bishop, Chief of *Bureau of Statistics* of New Jersey, and Protap Chandra Roy, of Calcutta, for the liberal and valuable donations made by them to the library.

Many valuable works have been received from the *Smithsonian Institution*, the *Department of the Interior*, the *Bureau of Ethnology*, *United States Geological Survey*, and the *Engineer Department of United States Army*. *Kant's Infusoria* has been secured by purchase.

The librarian is carefully cataloguing the books by the card system, designating all principal topics. This practically makes a general index of the important subjects contained in each volume—a work which will be greatly appreciated by those who have occasion to use the books.

During the past year the minerals, birds, mammals, marine invertebrata, and archæological specimens, in the museum, have been classified and labeled by your secretary, acting as assistant curator under Prof. Dwight, and seven hundred eighty-nine additional specimens have been received as donations to the society.

Your secretary begs to call the attention of the public and private schools of this city to the advantages this museum offers to those who are studying natural history, and expresses the hope that these advantages may be utilized.

The curator, in his report a year ago, mentioned the fact that certain specimens of birds, mammals, and reptiles, of our local fauna, had been placed in the museum with the expectation that they would become the property of the Institute.

There were, however, at this time, no available funds for such a purpose, and if these specimens were secured it could only be through private subscriptions to the amount of $750.

Your secretary undertook the unpleasant task of securing this sum, and, having made a personal canvass among the members of the Institute, he is pleased to report that $637 of the amount have been subscribed and paid by the following gentlemen:—

John P. Adriance	$100	I. Smith	$5
S. M. Buckingham	50	A. L. Allen	5
C. Van Brunt	50	R. Wilkinson	5
H. L. Young	50	J. P. Atwater	5
T. J. Backus	25	B. Van Vliet	5
E. Elsworth	25	A. M. Frost	5
C. N. Arnold	25	E. S. Atwater	5
W. B. Dwight	25	N. C. Trowbridge	5
W. G. Stevenson	25	H. Van Ingen	5
E. Storm	25	H. S. Wiltsie	5
W. T. Reynolds	25	C. E. Sweet	5
W. C. Smillie	25	Wm. Adriance	5
Herrick & Losey	25	John Sleight	5
A. P. Van Gieson	20	G. E. Cramer	5
C. B. Warring	10	J. R. Reynolds	5
J. M. DeGarmo	10	J. L. Williams	5
Irving Elting	10	J. C. Pumpelly	5
W. A. Davies	10	E. Burgess	5
J. C. Otis	10	J. G. Boyd	2

The subscriptions have been, by your secretary, handed to the treasurer, and by him applied on the account.

Many other members were solicited for contributions, but for various reasons failed to respond to the appeal. The balance due has been paid by the trustees, and the collection is, therefore, the property of the society.

The following papers were read before the Scientific Section during the season of 1883–'84 :—

November 7, 1883.	"The Gyroscope"........ C. B. Warring, Ph.D.
November 21, 1883.	"An Interesting Geological Locality at Cornwall, N. Y. ....Prof. W. B. Dwight.
October 5, 1883.	"Description of two Species of Shark, *Carcharodon carcharias,* and *Odontaspis littoralis,* taken off Nantucket, Mass." W. G. Stevenson, M.D.
December 19, 1883.	"Our Local Mammalian Fauna." W. G. Stevenson, M.D.
January 2, 1884.	"Uniformity of Climate in Past Geological Ages." C. B. Warring, Ph.D.
January 16, 1884.	"Saturn"........ ....Prof. Maria Mitchell.
	"Description of *Cyclopterus lumpus,* the first reported specimen found in the Hudson River." W. G. Stevenson, M.D.
January 30, 1884.	"Laws of the Compressibility of Gases." L. C. Cooley, Ph.D.
February 13, 1884.	"Embryonic Forms of Limulus polyphemus." Prof. W. B. Dwight.
	"Gums and Resins"........Mr. C. N. Arnold.
February 27, 1884.	"Evidence of Intelligence in Butterflies." James M. DeGarmo, Ph.D.
	Papilio turnus (Linn), melanic var. (P. glaucus), taken at Poughkeepsie, N. Y. W. G. Stevenson, M.D.
March 12, 1884.	"On some New Laboratory Appliances."
	"Influence of the Density of a Gas on the Electric Discharge."
	"Notes on the Liquefaction of Gases." L. C. Cooley, Ph.D.
March 26, 1884.	"Report of Progress in Geological Investigation in the Vicinity of Poughkeepsie." Prof. W. B. Dwight.
April 9, 1884.	"List of Birds, (genera and species), belonging to the Vicinity of Poughkeepsie and represented in the museum of the Institute." W. G. Stevenson, M.D.
April 9, 1884.	"Microscopic Study of Rock-Sections ; Crystallization of Gold, and Minute Fresh-Water Crustaceans," exhibited repectively by— Mr. C. N. Arnold, Profs. Cooley and Dwight.

This Section may feel well satisfied with its year's work, for it has made valuable contributions to the sum of scientific knowledge, and its papers and discussions have been exceedingly interesting and instructive.

At the annual meeting of the Scientific Section, held April 23, 1884, Prof. W. B. Dwight was reëlected chairman, and Mr. C. N. Arnold was reëlected recording secretary.

The following papers and discussions were given before the Literary Section during the season of 1883–'84:—

1883—October 30.	"Literary Value of Scientific Knowledge"	Rev. E. A. Lawrence, Jr.
November 13.	"Galileo Galilei"	James Nilan, D.D. Mr. Henry Bartlett.
November 20.	"Chief Justice Marshall"	J. Hervey Cook, Esq.
December 10.	"Poetry of Matthew Arnold."	James M. DeGarmo, Ph.D.
December 18.	"The Scientific Basis of Morals."	Hon. John Thompson.
1884—January 15.	"Communism"— *pro and con.*	Mr. L. F. Gardner. Rev. S. H. Synnott.
January 22.	"John C. Calhoun"	Edward Elsworth, Esq.
January 29.	"Abraham Lincoln" "Aaron Burr"	E. S. Atwater, Esq. S. W. Buck, Esq.
February 12.	"Richelieu"	Rev. C. W. Millard.
February 19.	"Wendell Phillips"	W. G. Stevenson, M.D. James Nilan, D.D. A. P. Van Gieson, D.D.
February 26.	"A Study of the Last Census."	H. V. Pelton, Esq.
March 11.	"Monopolies"	Truman J. Backus, L.L.D.
March 18.	"Daniel Webster"	Mr. Edward Burgess.
March 25.	"Emerson and Carlyle"	Irving Elting, Esq.

These papers were of a high order of excellence, and the work of the Section is commended to the public as worthy of encouragement and support.

At the annual meeting of this Section, Mr. Henry V. Pelton was elected chairman, and Mr. James H. Hamill, recording secretary.

The Art Section has adopted a plan of work and elaborated a systematic course for art-study, which has been approved by the board of trustees, but no further effort has been made to organize the work of the Section.

The work of this Section can only prove successful when members and citizens alike are awakened to the importance of securing systematic and correct instruction in the various departments of art, and are willing to extend a helping hand to the accomplishment of this object. Until such a spirit is made manifest, the Section will be justified in delaying further effort to organize its work.

At the annual meeting of the Art Section, held April 23, 1884, Rev. A. P. Van Gieson was elected chairman, and Mr. A. M. Frost, recording secretary.

In thus closing the third year of its corporate existence, the Institute may justly feel satisfied with the work it has done.

It has established the fact that it is an educational force in the community, and represents, to a large extent, the intellectual life of this city.

It seeks to promote useful knowledge, and invites all who are interested in the object for which it was founded to become its members, and thereby contribute a little towards its maintenance.

True, the funds possessed are sufficient to enable the Institute to hold its meetings, and to continue its general work without further aid; but he who thinks that this alone will suffice, has, indeed, a very inadequate appreciation of the real work there is to be done in order to honestly satisfy the conditions of our charter, or fulfill the expectations and purposes of those who inspired and executed the organization of the society.

Respectfully submitted.

W. G. Stevenson,
Secretary.

The following gentlemen were elected trustees for 1884–'85:

JOHN GUY VASSAR,
S. M. BUCKINGHAM,
JOACHIM ELMENDORF,
WILLIAM B. DWIGHT,
CHARLES N. ARNOLD,
LEROY C. COOLEY,
WILLIAM G. STEVENSON,
EDWARD ELSWORTH,
HENRY V. PELTON,
CHARLES B. HERRICK,
A. P. VAN GIESON,
FRANK L. MOORE.

The following gentlemen were elected officers of the Institute for 1884–'85:

President, - -	LEROY C. COOLEY, PH.D.
Vice President, - -	REV. HENRY L. ZIEGENFUSS.
Secretary, - -	WM. G. STEVENSON, M.D.
Treasurer, - -	EDWARD ELSWORTH, ESQ.
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Art Director, - -	PROF. HENRY VAN INGEN.
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SCIENTIFIC PAPERS

OF

VASSAR BROTHERS INSTITUTE,

AND

TRANSACTIONS

OF ITS

SCIENTIFIC SECTION.

1883–'84.

VOL. II. PART II.

SCIENTIFIC SECTION.

1883–1884.

Prof. William B. Dwight, - - - *Chairman.*
Mr. Charles N. Arnold, - *Recording Secretary.*

SPECIALIZATION IN NATURAL SCIENCE.

AN ADDRESS DELIVERED BEFORE VASSAR BROTHERS INSTITUUE.

OCTOBER 9, 1883.

BY PROF. W. B. DWIGHT, CHAIRMAN OF THE SCIENTIFIC SECTION.

I am called upon officially this evening to say something appropriate to a general audience, and to Vassar Brothers Institute as a whole, while yet addressing myself more especially to the Scientific Section. The subject which I have chosen, as well adapted for this purpose, is "Specialization in Natural Science." I shall endeavor to assist in establishing a clear, popular apprehension as to the character, extent, and necessity of such specialization, and also to show its bearings upon the work of a scientific society.

The work of the specialist in science, as the term is understood to-day, is quite a modern one. During all the earlier ages of history, the divisions of scientific work were mainly the broad, general divisions of science itself, and so few, comparatively, were the facts and principles for a long time recognized in the various sciences, that it was then not difficult for men of strong minds to be masters, not only of a complete grand division of science, but also of several distinct sciences; but we may go beyond this, and say that one or more sciences were often merely appendages to the varied acquisitions of the master-minds of those days.

Thus we recall the names of Pythagoras, Thales of Miletus, Hipparchus and Ptolemy, and, later, Copernicus, and others, as astronomers and physicists, of Geber in the eighth century of the Christian era as chemist, of

Archimedes as physicist. In the immense single department of natural history we find but two prominent persons who had really done anything to the advancement of this science up to as late a period as the close of the middle ages; these were the originial investigator, Aristotle, and the compiler, Pliny. Both of these last illustrious names, however, illustrate the fact above mentioned that there was in those days so little expansion in a department of science that it could be mastered as a concomitant with other great studies. For the great Aristotle, who is called the father of zöology, since he first elaborated its classification, can as truly be called, as indeed he has been, the father of logic and father of psychology; and Pliny only included science as one of the departments of his historical treatises.

Pythagoras also combined with the astronomical studies which made him a leader in that branch, the metaphysical studies of a great philosopher.

In seeking to trace the history of scientific specialization, it is not possible to find any epochs bounded by sharp lines. But the close of the so-called middle ages, or the beginning of the sixteenth century, may fairly be considered as opening a new era of progress, marked distinctly by the development of interest in special minor subdivisions of science. The telescope, and, later, the microscope, were discovered, and concentrated efforts carried them through great strides towards their present career of usefulness. During the two centuries succeeding the middle ages, the astronomers and physicists, Galileo, Kepler, Huygens, Newton, and others, were laying the foundations for the various subdivisions of work in those depatments, while in natural history, Rondelet, Belon and Salviani, applied themselves specially to fishes, Redi and Swammerdam to insects, and Leeuwenhoek to microscopic research; while Ray did illustrious work in classification.

Science went through still more advanced processes of specialization during the eighteenth and the first few decades of the nineteenth century, as it expanded grandly under the imperishable achievements of the great modern masters. Linnaeus, Buffon, Lamarck, and Cuvier, in natural history, developed its leading subdivisions and laid the germs of its biology. At this period, also, under Cuvier and others, geology began to struggle into existence, as the great zöologists began to recognize the life of past ages, and physicists began to study dynamical movements of the earth's crust. Mineralogy also took shape as a science. Chemistry under Lavoisier, Berzelius, Dalton, Sir Humphrey Davy, Priestly, and physics under Count Rumford and others, had begun to assume far-reaching proportions of subdivision.

And now, as we come down to the middle and closing decades of our nineteenth century, through the illustrious labors of Faraday, Wollaston, Naumann, Bunsen, Kirchoff, Tyndall, Huxley, and many others on a glorious list too long to quote, what shall we say in regard to the refinement of specialization to which science has been brought? In these days of the elaborated microscope with its legion of costly accessories, of the spectroscope with its fascinations and its amazing revelations about things far and near, of the telegraph and the telephone and the thousand-and-one applications of electricity, surely the special subdivisions already created, each inviting the scientist to find his sole life-work within its limits, already far exceed in number the hundred arms of Briareus, and make us wonder what the harvest of scientific study will be in the century next to come.

The expansion of one or two scientific departments may suffice to illustrate the work of specialization that all have undergone.

The department of natural history has fallen naturally into one grand division treating of the inorganic portions of the earth's crust, and another treating of its organized life. The first has again ramified into mineralogy and geology, two very distinct branches, connected, however, in an indeterminate way, by the study of rock-masses, called lithology, or petrography. And this, again, gives rise to a most novel, important, and difficult specialty, microscopic petrography, or the making and studying of thin microscopic slices of rocks. In mineralogy, there are the departments of crystallography and crystallogeny, mathematical and theoretical studies of crystals, requiring for their mastery high mathematical training and insight. In geology, we find, as its chief divisions, physiographic geology, or the study of the actual physical characteristics of the earth—the life-study of such masters as Ritter, of Germany, and our own Guyot; palæontology, or the study of the organic remains; historical geology and stratigraphy, or the study of the order of succession in the rocks; dynamical geology, the study of the action of the great natural forces on the earth's crust.

In that branch of natural history which treats of organized beings, our modern subdivision begins with a division which has been but recently generalized into a specialty—if I may use such an expression—out of the two subdivisions of botany and zöology. This is the grand study of biology, or the facts and principles underlying all life. Its two subdivisions are botany and zöology. Botany has naturally resolved itself into its two great branches of phænogamic, or flowering life, and cryptogamic, or flowerless life; while the latter, at least, in its sub-branches of algæ, or sea weeds, fungi, mosses, etc., furnishes several very absorbing and difficult lines of special study.

The ramifications of zöology are almost bewildering. The more important are in two classes.

First, those pertaining to the general philosophy of animal life, such as anatomy, or the study of animal structure ; comparative anatomy, treating of the relations of structure in different types of animals ; physiology, treating of the active functions of animals ; histology, the minute study of tissues ; osteology, the study of bones ; psychology, the study of faculties of mind and instinct ; embryology the study of mode of development from the embryo to maturity ; zöo-geography, the distribution of animals ; microscopic zöology, the adaptation of the microscope to the study of animal life.

Second, those growing out of the classification of the immense number of groups of animals, such as entomology, or study of insects ; herpetology, the study of snakes ; ornithology, the study of birds ; malacology or conchology, the study of mollusks, and the separate studies of fishes, corals, spiders, etc.

Everyone of the these subdivisions, and many others, constitutes an important field which may well engross the life-work of any scientist of the amplest powers.

Other fields of scientific labor would show a similar tendency towards specialization.

Another good method of realizing the intense specialization of to-day, as compared with the past, is to compare the text-books of to-day with those of former days. Let me call your attention to two representative books of scientific instruction in the sixteenth and seventeenth centuries. Specimens of the volumes themselves—the rarest of books in this country, at least—have been kindly loaned to me for this occasion by their distinguished owner, Hon. Henry Barnard, of Hartford, Conn. One is the *Orbis Sensualium Pictus*, (*i. e.*, *The Illustrated World of Material Objects*,) by Comenius, published at Nuremberg, in 1658. The other is the *Philosophica Margarita*, *or*, *Scientific Pearls*, by Reish, published in 1518. Of these two small books, the first was intended to be a pictorial instruction book for elementary schools, and the second as a cyclopedic manual of science—a text-book for the universities of the day. For these purposes they were the standard treatises of those times.

Now set over against these the academic and college text-books of to-day, and mark the difference. On any single topic alone of scientific instruction out of more than a dozen at least, our text-books comprise more information in a very concentrated form than does either of these volumes. But it is by trying to estimate the number and cost of technical works in the various special departments that we begin to realize the extent of our modern special fields of science ; for their literature is enormous in quantity and in expense.

How feeble is the popular apprehension of the latter fact !

This is partially illustrated by the often asked question, "What is a good standard work which I can get to tell me the names of the insects that I collect ?" Such an inquirer has not had even a glimpse into the vastness of the special field of the modern entomologist. For it is now estimated that there are no less than ninety-thousand species of beetles to be described, and twenty-four thousand of two-winged flies, and twenty-five thousand of four-winged flies like the bees, and twenty-five thousand of butterflies and moths, which, with eight hundred species of centipedes and four thousand of spiders, make no less than one hundred ninety thousand species of insects. Even our own North American share of these would fill volumes on volumes of descriptive matter.

It is sufficiently evident that the facts and principles of any one general department of modern science, have been developed to proportions too vast to be easily grasped by one mind, as in former years. The greater part of scientific work must now be done by specialists, or at least by those who combine, with a general zöological knowledge, special study in some limited subdivision ; the more limited the more effectual is the work in most cases. This is so well recognized that there is now a marked tendency in eminent zöologists to deprecate the idea that they are working over a general field ; they assign to themselves, before the public, often, much narrower fields than the large ones they are really filling with honor. The fact that one's scientific responsibilities sometimes assign him to a broad field of multifarious scientific labor is now a thing not to be boasted of, but apologized for. It is only the school-girls just out from a "finishing-school," or flabby amateurs in science, that record a string of sciences among their solid acquirements.

In the present state of science, it is not, among true scientists, considered a matter for congratulation or boasting if one has to spread his labors over several or many broad fields of scientific inquiry.

Hitherto I have spoken of specialization only as a necessary consequence of advanced study. It is not, however, an unfortunate necessity, but brings with it important advantages which it will now be well to consider.

First, it is only by this special study of minute facts, and minute changes in organizations that the true philosophy of life is attained. The keys which, one after another, unlock the great chambers in nature's magnificent palace, are microscopically small. To find them, we must search everywhere, by minute study, the nooks and corners where they may be hid. Yet again, these keys, like some of man's devising, are not simple, but made up of separable combination-slips ; and these slips lie scattered around among the flowers and the insects and the rocks. It is only the minutely special student of nature who can, by long searching and much thinking, find these separated parts, and when he has got them all together, can try their various combinations, until he has found to which one a lock will yield, and a new door will fly open. Now it is a characteristic element of this search, that you can never know beforehand in what minute, obscure, uninteresting little fact of nature you may find the missing link in one of these combination-keys. This is the fundamental principle which makes honorable and worthy of the greatest mind, studies of a host of trivial facts which to the world at large are chaff and straw. The ignorant farmer laughs at the trifling of the geologist who laboriously chisels out a poor little shell from a rock. Yet that shell will whisper to the scientist the history of the birth-throes of a continent, and may point to where its coal-fields lie. Fraunhofer re-discovers and records the shadowy transverse lines in the spectrum which Wollaston had noticed and then forgotten. The great money-kings of his day who would have scorned to waste time on such trifles are now mostly in oblivion; but Fraunhofer's name will honorably travel down the ages with those very lines whose brilliant service to science, and even to the arts to-day, is beyond computation in gold.

Few labors of the modern specialist have been more trying than the studies in embryology, by which the life-histories of many animals have been traced from the egg to maturity. But by no process in zöological study has ever so rich a harvest of results been reached before. They have re-arranged the classification and modified the existing beliefs concerning almost every group of living subjects.

I am happy to quote an instance of the immediate present, where this very study of embryology, though apparently impracticable to the last degree, is achieving results destined, at no distant day, to bring millions in wealth to one of our prominent industries.

The oyster has been yearly demanded by consumers in a rapidly increasing ratio—while its beds are becoming as rapidly denuded. No practical means for its rapid propagation could be discovered, and it was in great danger of becoming extinct.

The chief difficulties in artificial breeding of oysters lay in certain peculiar physiological conditions, made known by the studies of European experts, on European oysters. The most patient investigations made by Brooks, Rider and others into the embryology of the American oyster have, however, recently revealed a most remarkable and unexpected difference in physiological constitution between this and the European mollusk. The nature of this difference is such that, by taking advantage of it, our oysters can be propagated with ease, and the great work of developing the best methods is even now being perfected by the United States Fish Commission at Wood's Holl, Mass. Let no one hereafter laugh at the most trivial labors of the scientific specialist.

Another great advantage of the specialization of scientific studies is that it gives weight and dignity to every field of honest, original, faithful work, however narrow or however situated. Each observer may give the benefit of his labor to science, by studying the special field which his gifts and inclinations suggest to him, and to which circumstances invite him.

Still another advantage is one kindred to that gained in industrial employments by extensive division of labor. As in every great factory, so in science, the maximum of expertness is reached by assigning to one worker a special and narrow field. Yet there is a difference in the two cases, which it would be unfortunate to forget, and which is greatly to the advantage of scientific work. The great evil of division of labor in industries, is the mental and moral depression which it brings upon the workman. He takes hold of his specialty, it may be the straightening of a gun barrel; in a few days he sees quite through all its features, in a few weeks he has attained his maximum of expertness, and that is all of mental zest there is to it. From that time forward it is all a dreary plain of sameness; mental stimulus is gone, and the man has become a spiritless machine.

Far different is it with the scientific specialist; as he attains a high degree of expertness he has only begun to see and to enjoy; at every step he is greeted, not by endless repetitions of the old, but by delightful revelations of the new; nor does he even necessarily reach, at any definite period, the maximum level of expertness; for new situations are ever presenting themselves, demanding new combinations of skillful handling. No amount of magnifying power applied to natural objects reaches the limit of revelations. The specialist is therefore always penetrating unknown lands of discovery; every faculty is awake; his soul is all alive with healthy zeal.

I should not do justice to my subject if I should pass over in silence the fact that there are some positive evils in this attitude of modern science. The first of these evils which I will mention is one which I think has attracted but little attention. It is the fact that the development of special studies in science has greatly increased the difficulty of finding suitable teachers in natural science for academic and collegiate classes. The facts in this connection have been so generally overlooked by scientists as to lead to unfortunate misunderstandings. Men deservedly eminent as specialists are often disappointed and chagrined when they are passed over in the selections of instructors in desirable positions, because they fail to discern the obvious reasons. Some persons are naturally excellent teachers; but many are not. The mere possession of erudition does not make a good teacher. There are certain principles which really constitute a science of teaching. Specialists are under a strong tendency to drift away from the habits of thought and observation of human nature, which can alone bring success in behind a teacher's desk. The prime requisite of a teacher is not only knowledge of a subject, but the ability to adapt its presentation to the mental qualities of his pupils ; a matter of which many specialists are as profoundly ignorant or careless, as they are learned in their specialties.

Another difficulty is that the specialist, by his narrow culture, has in a measure unfitted himself to do the general and elementary work demanded by all schools below those which are strictly professional. It frets him to dissipate his mental powers over broad fields barren of discovery.

There are also other points of culture conducive to eminent success in a teacher, to which the specialist has had no time to give his attention. Of course these statements are only intended to express general tendencies, for there are eminent specialists who are as eminent teachers ; but they are rare exceptions.

A far greater evil, I think, lies in the strong tendency, in narrow special pursuits, of dwarfing the breadth of the mind, while stimulating its acuteness. Some great masters, while following up some special line of research, yet keep themselves well informed on the state of the whole field, and in sympathy with the whole. They can carry on philosophic generalizations as ably and as reliably as minute specializations. So Napoleon Bonaparte could command a knowledge of individual life-histories and characters in the companies of his regiments, calling private soldiers by name, and yet organize the most brilliant manœuvres of a vast battle-field. But it is given to very few men to have such self-training. The tendency among specialists is, first, to neglect to inform themselves even of the general facts in the other fields of science, and, secondly, by their habits of thought to incapacitate themselves for any trustworthy philosophic apprehension of the whole science under which they are working. It is very important that the public should understand this point. The general scientific views and opinions of a great specialist in science are not necessarily equivalent, in relative value, to his eminence in his profession. A man may be so eminent in ornithology that no opinion as to bird-life is more valuable; yet it may be very likely that his opinions on general matters of scientific philosophy may be carelessly formed and of only a moderate value. As this is an important point, let me quote from the words of a prominent scientific authority in Harvard College. He says: "I have known excellent mathematicians and astronomers who had not the first word to say about the nebular hypothesis; they had never felt interested in it, had never studied it, and, consequently, did not understand it, and could hardly state it correctly." Suppose, now, an unprofessional man asks such an "excellent" astronomer about the nebular hypothesis, and receives an answer conveying utter indifference about it or misrepresentation of it; he then receives, and probably promulgates, the false idea that it is thought little of among astronomical authorities.

The writer goes on to say: "It is quite possible for one to study the structure of echinoderms and fishes during a long life, and yet remain unable to offer a satisfactory opinion upon any subject connected with zöology, for the proper treatment of which there are required some power of generalization and some familiarity with large considerations. * * Indeed, there are many admirable experts in natural history, as well as in other studies, who never pay the slightest heed to questions involving wide-reaching considerations."

The truth is, that the philosophy of any science is a specialty by itself. The value of the philosophic opinions, therefore, of any specialist, must be determined, not by the value of his opinions in his specialty, but by his gifts and acquirements as a general philosopher.

This tendency to dwarfing of the mind, in certain directions, by the pursuit of a special line, is sometimes manifested in its leading a scientist to despise other lines of research, even though closely related to his own and every way as important. This charge is not a "man of straw," which I am setting up that I may have a target. It is a sad and undoubted fact, and has its illustrations, though rare, among those of the most eminent scientific attainments. It is not only wrong in sentiment, but, as I could easily show, were it best to bring forward detailed facts, it in some respects works positive evil to science. It is a duty that all specialists owe to the welfare of science, in general, that they should courteously and sincerely interest themselves in the facts of kindred lines of study, at least, and cultivate a close sympathy with their fellow-workers in such branches and in their labors.

Another evil tendency in scientific specialization I bring forward with some diffidence, because, while I am profoundly convinced of its existence and its mischief, I believe it to be little apprehended by scientific men. This evil tendency is, that certain scientific classifications, grounded solely on the convenience of specialization in work, may be, and are, wrongly treated as true classifications in scientific philosophy and in the nature of things. Thus is the truth perverted, and useless disagreements result. The great unseemly, unnatural contentions between science and religion often spring from this error.

I will briefly illustrate this point by a single example, not claiming, however, in this instance, to represent views other than my own.

When the naturalist or physicist tells us that natural philosophy covers the study of material forces alone, that is, of forces commensurable by foot-pounds, there is no fault to be found with this statement in so far as it signifies that these are the proper working limits conventionally and universally assigned by scientists to this department. There are other, subtler, psychological forces permeating and shaping nature, which are conventionally gathered up into another department called psychology, and most effectually studied as a special department by themselves. Confusion would doubtless arise from the promiscuous mingling of these forces in special study. But when the naturalist asserts, as is often done, that this department of natural philosophy is the study of nature, and that natural forces are material forces; when he makes the word "natural" habitually synonymous with the word "material;" when he stubbornly refuses, in his studies of nature, even to recognize the inseparable interweaving effects of psychological forces on the material, he is endangering truth by carrying his provisional working classifications into the higher philosophy of things; he is misleading younger students, and preparing a crop of needless controversies.

The truth is, that the expression "natural philosophy," a term founded on the Latin name for nature, and the term "physics," founded on the Greek word of identical meaning, as now conventionally limited, mean only the study of the objects and material forces of nature and their laws; also that the word "natural" is not really and essentially synonymous with the word "material," since natural forces include the inseparable intermingling of psychological and material forces. Some recognition of these facts by naturalists and physicists in their treatises, would aid, rather than prevent, the truth.

I am happy, in reinforcing my views on this point, to be able to quote words uttered, not long ago, by one of the most advanced and distinguished of scientists and biologists, in which he warns his fellow scientists, in memorable language, against allowing their narrow specialization in work to go beyond its bounds in crowding out the truths of a higher philosophy. These are the words of the learned Dr. William B. Carpenter, in his inaugural address before the British Association for the Advancement of Science, in 1872. They may be found in Appleton's *Popular Science Monthly*, vol. i., for that year. Dr. Carpenter says:

"The science of modern times, however, has taken a more special direction. Fixing its attention exclusively on the order of nature, it has separated itself, wholly from theology, whose function it is to seek after its cause. In this, science is fully justified, alike by the entire independence of its objects, and by the historical fact that it has been continually hampered and impeded in its search for the truth, as it is in nature by the restraints which theologians have attempted to impose upon its inquiries. But when science, passing beyond its own limits, assumes to take the place of theology, and sets up its own conception of the order of nature as a sufficient account of its cause, it is invading a province of thought to which it has no claim, and not unreasonably provokes the hostility of those who ought to be its best friends. For while the deep-seated instincts of humanity, and the profoundest researches of philosophy, alike point to mind as the one and only source of power, it is the prerogative of science to demonstrate the unity of the power which is operating through the limitless extent and variety of the universe, and to trace its continuity through the vast series of ages that have been occupied in its evolution."

I cannot leave this subject, without suggesting, in a few words, some of its manifest applications to the work of our Scientific Section. This is the first year in which we begin our season with the full equipment of a completed building, a museum of very creditable proportions, furnished with many instructive specimens, and a sufficient endowment from our generous founder to keep us from the "carking cares" of debt. It is now an excellent time for those here, who have any scientific tastes, and are willing to give some time to science, to take a new start in some special scientific work. It is especially an appropriate time for the young people of Poughkeepsie to start out on scientific careers, with the prospect of many days and years in which to learn to do accurate and noble work. I am very desirous of seeing such an uprising of scientific spirit among our young people, to which they may contribute a portion of that time which they now give, probably, in some excess, to athletic games. Were I a young man, and I feel as if I were, I would much prefer to acquire some of my athletic power in rambles and climbs of investigation, that would give me a growth of scientific strength, as well as of bodily strength, year by year. But I must also urge those in middle life, or even on its down-hill side, to feel encouraged to take up some scientific specialty, confident of at least a fair measure of success, and at any rate of much mental up-building and enjoyment, if they take hold with zeal. Instances have not been rare of much effective scientific work begun and carried on entirely in the later periods of a long life. I have personal knowledge of one, who, though a clergyman, in active charge of a parish, has recently acquired an honorable reputation as a scientific specialist; yet he did not apply himself to these scientific studies until after the period of gray hairs. And this is a good place to say that the work of an unscientific profession need not necessarily prevent your doing good scientific work. One of the most eminent paleontologists in the United States is a lawyer in practice; quite a number of physicians, and not a few clergymen, doubtless without injury to their other work, have contributed labors of value to science.

Do you ask what scientific specialty you shall select? I reply, first, one suited to your tastes and talents; thus, one having too little mathematical or mechanical skill for the studies of physics or astronomy, might be very successful as an accurate and patient observer of the habits of animals. Again, select a specialty well suited to your circumstances and vicinage; and, yet again, as a third suggestion, as to the choice of a topic for study, let me remind you of a rule that the late Louis Agassiz laid down for himself on this point. He looked through libraries of scientific works, and where he found gaps on the shelves—places where works were lacking on certain topics—those suggested to him his fields of labor. Such gaps are still abundant. Much of cryptogamic life all about us is little understood; the minute organisms that probably cause many blood diseases, are yet to be resolved; troops of undescribed insects run over our hills; there is not yet a single respectable descriptive list of the spiders of a single state of our whole country.

Do not, however, let your scientific aspirations begin and end with the collecting and labelling of specimens. While there is a scientific value in collections, carefully made, yet, after all, there is very little of the scientist about a mere collector. Scientific work requires that, beyond the collecting of specimens, there should be the studying of structure, habits, and principles of classification, the comparison of fauna, the noting of unusual or unrecorded phenomena; and this implies the study of the literature of the subject.

I will close by remarking that there is a special work for science, of which there is much need, for which some residents of this city are well fitted, and to which I earnestly invite their attention. Modern science can do little without its tools; these tools are books, instruments, and collections ; all of these are quite costly. Do you need a fairly complete work on the geological fauna of the world ? You can get one in Germany for between $800 and $900. If you wish a work on shells, comprehensive, and with full and correctly colored plates, you find it in Reeve's *Iconica Conchologica ;* but it costs in England about $1,000. A work giving a descriptive list of diatoms in our waters, will cost, perhaps, $40. One describing the rhizopods, not far from $35. Edwards' standard work on butterflies, in two series, will cost $30 a series. A good library for a working entomologist will cost several hundred dollars. But we are absolutely manacled in scientific work, unless we have such books, if not in our private libraries, at least in those public ones which we can daily consult. It will not answer that they are in a New York or a Philadelphia library. To be of much use, they must be here. Then there are needed instruments, such as telescopes, spectroscopes, microscopes, general and lithological, aquaria, and various physical, chemical and dissecting instruments.

Now, the men who possess the spirit of scientific research are rarely the ones who have also the money to buy freely these important tools. Science cannot flourish unless the means are freely contributed by men of wealth.

May we be cheered in our scientific work by the abundant contributions of those who are able and willing to help science in this special way. And do not wait, men of wealth, to help the cause in your wills. Imitate that noble benefactor of Yale's scientific schools, Joseph E. Sheffield, who for nearly twenty years had the pleasure of looking daily from the portico of his mansion upon the great schools he had founded, partly on his own lawns.

This costly building and these liberal endowments are present testimonials that our generous founder, Mr. John

Guy Vassar, has done himself a pleasure which he can never regret, in doing this society a lasting service. We shall owe him a still greater debt of gratitude if his liberality shall inspire others to come to our aid by their munificence.

NOVEMBER 7, 1883—FOURTEENTH STATED MEETING.

Prof. W. B. Dwight, chairman, presiding; thirteen members and twelve guests present.

The following is an abstract of a paper read, on the

GYROSCOPE.

BY C. B. WARRING, PH.D.

This is a very curious instrument, or rather it is a simple little instrument which behaves in a very curious manner, apparently violating the law of gravitation.

The instrument consists of a small disk, or wheel, moving freely on an axis which itself is supported by a ring going around the disk and axis both. On one side of the ring, close by one end of the axis, is a small projection or lug. The wheel is set going like a top, by a string wound around one arm of the axis, and then pulled as fast as possible. The wheel revolves very rapidly, perhaps thirty times in a second. So far there is nothing strange, but if one takes the thing in his hands and tries to turn it, it seems to be suddenly endowed with remarkable powers of resistance. There seems to be something uncanny about it. If now, while yet rapidly rotating, the lug (in the under side of which, by the way, there is a small round depression) be placed on a pointed standard, the instrument will keep itself out straight (horizontal) in the air and begin to revolve slowly around the point, always going in the opposite direction from that of the upper side of the disk. At the same time it drops very slowly—one-tenth of an inch or less in a second (more or less according to certain circumstances). It seems as if it had lost its weight, or as if gravity no longer acted on it, but if placed on scales while in this condition, it will be found to weigh exactly as much as when not moving.

If a string be attached to the lug, and the Gyroscope lifted off its support, it will go up into the air at right angles to the action of gravity, and still moving slowly horizontally around the end of the string. If it be jerked rapidly up, or dropped down, it continues its motion and position with the most perfect indifference. If another string be attached to the opposite end of the axis, and the thing be lifted by that, gently or roughly, it will instantly begin to rotate (horizontally) in the opposite direction. Everything else will be as before.

It falls so very slowly that this motion seems to be of no consequence, but if it can't fall just as it pleases, it gets the sulks, and falls as if dead; in fact it won't stay up at all. The horizontal motion also seems so small as to be of no account, but if it can't do that, it won't do any thing, and down it falls at once. It is the most contrary piece of mechanism ever invented.

The two questions which most naturally arise when this instrument is exhibited, are first, why does it maintain the horizontal position without apparent support? and, secondly, why does it revolve around the point of support?

There are many other questions which any explanation must meet and answer, but these are enough for the present purpose, and answering them really answers all.

Those who are familiar with the literature of the subject are aware that many attempts have been made to show why the Gyroscope acts in this manner. Some of the explanations are absurd, while others bring in the higher mathematics, and therefore, can be understood by but few.

Some attribute the two effects largely to friction, but this explanation is disproved by the simple fact that the less the friction the better the instrument works. A writer in *Appleton's Encylopedia* says that gravity acts with the motion of the disk on one side and against it on the other; *i. e.*, the side which is going downward is accelerated by gravity, while the other side, moving upward, is retarded. Thus, there is a greater force on one side than on the other, and of course the Gyroscope is pushed around by the greater force. This is sufficiently disproved by placing the instrument so that it is free to move around its support horizontally, but not to fall any. It is found on trial that no matter how fast or how slow the disk revolves on its axis, there is no horizontal motion whatever. Without going any further in the explanations which have been offered, it is enough to say that the problems involved have been regarded as offering very considerable difficulty, and in all school works are passed over without any real solution.

The two questions which have been mentioned I shall endeavor to answer.

First. Why, in apparent defiance of the law of gravitation does the Gyroscope, when supported only at one end, remain in a horizontal position?

Before attempting an explanation, I ask that the following self-evident principles be admitted:

A body set in motion will continue in motion until something stops it. This is a part of Newton's first law of motion. Its best illustration for the present purpose is afforded by the pendulum. When the latter reaches the bottom of its arc it does not stop, but continues on its course up the opposite arc until the continued action of gravitation has produced a counter-force just equal to that caused by the fall, and then it stops. Again gravity draws it down, and again it rises. And so it goes on. Except for outside resistance—that from the air and from friction—it could never cease that up and down movement. In the first part of its swing it accumulates energy, and in the other part spends it. The work and the énergy for each vibration are equal.

Another principle equally important must also be remembered. A body moving in any direction is not retarded by a force exerted at right angles to its direction. The pendulum illustrates this also. The rod which holds up the weight pulls at right angles to the direction of the latter, but does not affect its velocity.

If these two principles are clearly grasped, the explanation of the Gyroscope is simple enough.

We will suppose the ring to be laid aside, since it serves no other purpose than a convenience for holding the disk, and that the disk (or wheel) is cut away until only a narrow strip is left, like two arms extending in opposite directions from the axle. No one who has a Gyroscope will wish to treat it in this manner, and as to conceiving such a thing most people find it too difficult; we will therefore change the Gyroscope for something cheaper and more simple, but which will enable us to show the working of the same principles. We will take a common tee-square, or if we have none, we will nail a small strip of wood, say one inch square and ten inches long, at its middle on the end of another similar strip. This will make a tee-square sufficient for our purpose. Now hold the stem of the square in the left hand close to the end, and make the cross-piece vertical. Hold the left hand still, and let the cross-piece move up or down. Evidently, it will describe part of a circle. If it is held so that the cross is just in front of a plumb line—so that both can be viewed at once—it will be seen that the upper end of the cross moves away from the plumb to the right, while the lower moves away from it also, but to the left. If, while the left hand remained stationary, the cross had been allowed to drop freely, the top and bottom would evidently acquire a certain horizontal motion, one to the right, the other to the left. If now the tee-square be quickly turned over, so that the top and bottom change places, this will not interfere with motion previously acquired. The bottom (which has now become the top) will continue to move to the left, while that which a moment before was the top will move to the right, and, as the motion continues (as in case of a pendulum) the ends of the cross are pushed back to where they were, and the instrument rises to its first position. So long as this continues the instrument will maintain its position, or at least it would if the change were instantaneous. As it is not, it falls slowly.

This answers the first question.

Second. Why does the instrument rotate around the central point, in a direction always the opposite of that of the disk?

Take the tee-square again. Let it fall again a few inches. As in the first experiment, the top, when the tee goes down, gets a motion towards the right—(if held as before)—but, before the instrument can be reversed, it must go half way, and point, instead of up and down, horizontally. Evidently the motion which sends the upper end to the right, will push the instrument (if the top was revolved towards the south) toward the north. Hence we have the horizontal motion.

Another question naturally suggests itself. Why, it may be asked, is the horizontal motion slow in proportion as that of the disk is rapid?

All depends upon the movement of the arms of the tee. If this turns slowly, it has more time to give motion to the ends of its arms, consequently they push it around faster. If the tee turns very quickly, it falls a very short distance, (has so little time), hence the ends of the arms get very little motion, and, of course, can impart but little. Hence a quick motion of the disk makes a slow horizontal movement, and a slow motion of the disk makes a quick horizontal movement.

A careful consideration of the above will render it easy to see why the Gyroscope ceases to maintain itself if the lateral (or horizontal) motion is stopped, for, in order to maintain itself, the motion imparted to the ends of the tee-square, when vertical, must be expended in lifting. If spent in any other way, nothing is left to overcome gravity. Now if, as the square falls, and the tee has become horizontal, some obstacle should prevent its moving still farther to the right, its motion in this direction would cease, and, of course, when it arrived at the lowest point nothing would be left to lift the instrument.

Another paradox is that the instrument must fall some in order to produce any of its peculiar phenomena; but this, too, is easily explained. Everything depends upon the two extremities of the tee getting a motion, one to the right and the other to the left, when the tee is vertical. Now, if the tee does not fall, or if it is not lifted up,—for either movement will do equally well—there will be no such motion: only, if the first sends the instrument north the other will send it south.

This, directly or impliedly, explains all the phenomena of the Gyroscope.

NOVEMBER 21, 1883—FIFTEENTH STATED MEETING.

Prof. W. B. Dwight, chairman, presiding; eight members and twenty-five guests present.

Dr. Stevenson reported five hundred fifty-five specimens that had been received for the museum.

Mr. John I. Platt was elected a member.

The following paper was read:

AN INTERESTING GEOLOGICAL LOCALITY AT CORNWALL, ORANGE COUNTY, N. Y.

BY PROF. W. B. DWIGHT.

My visit to this locality occurred on September 22, 1883, and occupied but a few hours of that day. It was occasioned by information kindly furnished to me by Rev. Alfred Roe, lately residing at Cornwall landing. He informed me that at this spot he had seen fossiliferous limestones, which he was quite sure were higher than the lower Silurian rocks, which are the prevalent ones in that region, and that they were associated with a fine grained red sandstone which so closely resembles the New Jersey triassic sandstone that he thought it most probably of the same age.

From the directions given to me for finding the spot, I was not able by any chart in my possession to locate it, since I was to travel on a railroad constructed since the publication of my charts. I could not therefore, before making the journey, ascertain what investigations might already have been made there, nor what opinions as to its age had been formed. This I consider a fortunate circumstance, since it enabled me to reach an entirely unprejudiced and independent conclusion, founded only on my own observations.

The locality, when reached, proved be the hematite mine of Mr. H. Van Duser, (station-master at that place), and about a quarter of a mile southwesterly from the Cornwall station, on the Erie railroad branch from Newburgh to Turners.

After a careful survey of the positions of the strata, and an examination of the fossils exhibited, I became convinced that the limestones are of the lower Helderberg group, and that the adjoining red sandstone and conglomerate are not of the Triassic, like the New Jersey red sandstone, but are the Oneida conglomerate and the fine grained sandstones of the Medina epoch.

More definite statements as to the reasons for these conclusions, and the fossils which I found, will be postponed until I have given a description of the locality and statements as to the views of previous observers as I ascertained them after returning home.

Van Duser's iron mine is four miles southwest from Cornwall landing, one quarter of a mile westerly from the Cornwall station on the railroad above mentioned, and a half mile from Pine Hill. In this position there is a low northeast and southwest ridge, about ninety feet high above the valley,—called Cold Hill. Its eastern flank, and most of its summit, consists of reddish rock, coarse red and white conglomerates interstratified with fine grained red sandstones and shales; the strike is N. 11° E. to 15° E. (true) and the dip about 75° westerly, or in places more nearly vertical.

The western portion of the summit and the west side of the hill is limestone in well marked beds, cropping out along a line extending at least one thousand feet in length and exhibited on each side of the road which here crosses the ridge. At about eight hundred feet south of this cross-road, the whole hill, as it lowers, becomes a mass of intensely red shale. Under the drift which is heaped up against the western side of this ridge, south of the cross-road, and which extends down into the valley to the west, are the beds of hematite ore. The most conspicuous and complete exhibition of the limestone strata and their fossils is at a small quarry about four hundred feet south of the cross-road, on the west side of the hill a little below its summit. Here the limestone has a strike of N. 19° E. (true) and a dip of 85° westerly. Catskill shaly fossils may also be found in abundance in the small out-crops on the west slope to the north of the road. This road is the one which passes from the railroad station directly towards and over the Cold Hill ridge.

This locality has in former years been observed and reported by Dr. William Horton, Prof. H. D. Rogers, and Prof. W. W. Mather. Dr. Horton made a more thorough examination of that region than was made by any one, unless in recent years. His observations are embodied in a minute and valuable report made to the New York Legislature in 1839. He calls the red conglomerate and grits above described the "millstone grit of Eaton," which is equivalent to the Oneida conglomerate and Medina sandstone of our present system. He shows that the same rock extends to and lies at the base of Round Hill, composes a large part of Skunnemunk Mountain, Bellvale Mountain, and many other localities in this valley; also, that Pine Hill, a three-mile ridge near and parallel to Cold Hill, is of the same red rock, which he says in many places cannot be distinguished in appearance from the New Jersey red sandstone. He remarks: "Its structure varies, in different layers, from fine-grained, nearly compact, to that which is composed of pebbles the size of filberts. Most of the layers are very hard, some are sandy, and others even slaty. Its colors are white gray, grayish and reddish white, and brick red." (Horton's rep., 1839, pp. 152, 153.)

He adds: "The hematite mine of Mr. Thomas Townsend" (now H. Van Duser's) "is connected with this rock two and one-half miles west of Canterbury." There are no fossils, he says, in the red rock.

In describing the other features of this locality, he continues: "A limestone containing an abundance of fossils is found in the town of Cornwall, two and a half miles west of the village of Canterbury, on the road to Salisbury Mills. Its apparent position is between the slate and grit rock, or millstone grit of Professor Eaton. Its dip is to the southeast at a high inclination. Mixed in between the layers of this rock is the hematite or limonite ore on the land of Mr. Thomas Townsend. Where the ore exists the limestone is all more or less decomposed, some parts of the rock and its fossils retaining their form, they but have become white or yellow, and soft; other parts, even the nodules of hornstone are so far changed that they have fallen to fine powder mixed up with the ore in the same condition. The limestone makes but indifferent lime. The distinctive fossil of this rock is the encrinite, although it contains many others." (Horton's Rept., 1839, p. 151.)

Prof. Mather, (Geol. Rept. first district of N. Y., p. 362,) says of the red sandstone of Cold Hill, "Prof. H. D. Rogers is doubtful about the geological age of this formation, but he inclines to the opinion that it is equivalent to the sandstones of the middle secondary, (new red or triassic sandstone) which are associated with the trappean rocks in New Jersey and New York. The observations on the geological survey of the first district of New York do not quite demonstrate the age of this rock, but if the red slates and grits on the east side of the Húdson, which are the same as those of Pine Hill in Cornwall, Orange county, are the same as those of the Bellvale mountain near Long Pond, and the Green Pond mountain, which they strongly resemble, and of which they appear to be an extension, they are older than the middle secondary sandstone (new red sandstone) of New Jersey, to which Prof. Rogers refers them, and are probably the geological equivalents of, and, in fact, identical with, the red rocks overlying and interstratified with the upper part of the Shawangunk grit.

At Townsend's iron mine in Cornwall, the decomposed "delthyris shales," (Catskill shaly limestone,) "with their characteristic fossils, (one of the members of the Helderberg division,) are seen, and the red slates of the formation under consideration adjacent, and a coarse pebble rock, sometimes white, sometimes red like the Shawangunk grit, also near at hand in a nearly vertical position. This locality is a mile or two northeast of the the northeast point of Skúnnemunk mountain in Cornwall, Orange county."

Here Prof. Mather speaks of the uniform, nearly vertical dip of all these red and grit rocks in the counties of

Orange, Dutchess, Columbia, &c., after which he adds, "The association of the Helderberg limestone with these red slates, grits, and red and white conglomerates, may be considered as very strong evidence, almost decisive, that these red rocks are the equivalents of those of the west side of the Shawangunk mountain, and of the central portions of New York (the Medina sandstones, Oneida conglomerate, Onondaga salt group and grey sandstone,) instead of the red sandstones of the middle secondary of Rockland county and New Jersey." He also says, (p. 365,) "Limestone was frequently seen associated with these red rocks in the valley of Smith's Clove in Orange county, and in the counties on the east of the Hudson River; but no fossil remains were observed in it at any other place than Townsend's iron mine in Cornwall."

Prof. Mather (pp. 350 and 351) quotes, and apparently adopts, Horton's description already given of the Townsend mine at Cornwall, finding no fault with the statement about the position of the ore. Again quoting Horton and speaking of the same mine Prof. Mather says, "For years past this ore has been considerably used, and although a lean ore, it makes excellent iron. It is mostly in powder or very small fragments, mixed with balls and pieces of the hematite of a few pounds weight. It lies in limestone rock and between the limestone and the grit rock. * * * This stratum of limestone and hematite can be traced across this town into Monroe, until we reach the beds of magnetic oxide. It is seen a quarter of a mile north of the Clove mine, and at many intermediate places between this and the Townsend mine in Cornwall. The distance between these extreme points is full ten miles." (p. 490.)

Mather considers this ore bed as an anomaly in its geological situation, as being connected with Helderberg limestones with its fossils, and he doubts whether

Dr. Horton is right in supposing this limestone continuous to Monroe. He thinks that the geological relations of the limestone at Warwick and Monroe, are rather those of the calciferous, and that its whole aspect is like that of the Newburgh limestone. I have reason, from my own personal observations in the region, to believe that he is right in these latter opinions. For example, on Andrew Thompson's farm, two miles south of Salisbury Mills, what appears to be a combination of this limestone lies against the gneiss of Woodcock Hill, unless there might be a belt of Potsdam quartzite between, of which, on account of intervening soil, I was not able to make myself certain.

In the light of more recent experience, however, there is nothing anomalous in the occurrence of iron ore beds in connection with lower Helderberg limestones. For instance, in the *Report on Pike Co., Penn. Geol. Survey*, such beds are reported as having been formed in fossiliferous Helderbeg limestone by decomposition of overlying Oriskany beds.

I will now give a more particular description of the strata in Cold Hill and their fossils, as I made them out in my short visit, during which it was impossible to make any very thorough examination.

The red sandstones and conglomerates on the east side and summit had generally a strike of about N. 11° to 16° E. (true) and a dip of about 75° W. with local variations. I do not find any memorandum of the thickness of this stratum as far as visible. Its eastern border is buried in soil—and all the rocks visible in the fields and hills to the eastward are Hudson River shales.

In the little quarry above mentioned near the top, on the western side several hundred feet south of the cross-road, the limestone crops out in a ledge conformable to the red sandstone, though I did not find the line of junction. The inner (eastern) portion of this is evidently the water-lime group, and while about four feet of this formation in thickness is visible, its true width is not apparent, a portion being concealed under the soil to the east. The inner layers showed no fossils, but exhibited the fine grain and drab color so common in the group. The outer (western) layers, for a thickness of two feet, show the characteristic *Leperditia alta* in abundance, with some other fossils, but no tentaculites.

Immediately outside of these layers, and resting conformably upon them, there are visible about twelve feet of limestone of a higher group; but the actual thickness, which is considerably greater, cannot be ascertained, as it is buried in the drift which envelops the hill. Its most striking feature is the presence, in certain layers, of a profusion of sharply defined encrinal columns. Orthocerata and many brachiopods, and corals are also present. The relative position of this rock, and its fossils, appear to characterize it as the lower pentamerus.

In my hasty examination, I did not discover any higher group of the lower Helderberg, at this quarry, though I have no doubt that the Catskill shaly limestone exists there, and if it does not crop out, could easily be uncovered. But on the same side of the hill several hundred feet northerly to the north of the road, there are numerous small outcrops of Catskill shaly with its characteristic fossils, pushing up through the soil.

About five hundred feet southerly from the quarry, as the hill begins to break down in a gentle slope, there is a heavy outcrop on its western side, of a very red, highly ferruginous, exceedingly friable shale, apparently having the same strike and dip as the rocks previously mentioned. These may be a portion of the Hudson River shales, which everywhere surround these ridges, and which in places exceptionally are red. But as they differ in appearance somewhat from the red Hudson River shales, which I have seen elsewhere, and for other reasons, I am strongly impressed with the belief that they may be a layer of the Clinton group—overlying the red conglomerate and sandstones. I was not able to search them for fossiliferous evidence.

There appears to be no foundation whatever for the statements put forth by Horton and Mather, that iron ore is here intercalated between the layers of limestone. There is no trace of any ore in the limestone, but the hematite, as is usual in such cases, lies in loose masses on top of the rock, under and mingled with the drift in the valley and against the western side of the hill. It has evidently been derived, as in many other cases, from the mutual decomposition of the adjoining layers of limestone and the highly ferruginous shales which I have just described.

I now append a list of such fossils as I was able to gather and examine; but it is necessarily a very imperfect representation of the fauna existing in the rocks of the locality. It may be regarded only as a preliminary statement. I hope to make a more thorough investigation of the fossils represented in these interesting limestones hereafter. The bryozoans are especially abundant, and worthy of study.

The only fossils mentioned by previous explorers as far as I can ascertain, are "encrinites" by Horton, and "the characteristic fossils of the delthyris shaly," by Mather.

I. Waterlime group, Tentaculite division.

Leperditia alta, abundant.
Atrypa plicata, one specimen.
Stromatocerium? numerous specimens, two inches in diameter and less.
No tentaculites were found.

II. Lower Pentamerus.

Pentamerus galeatus, one specimen.
Hemipromites radiata, several.
Strophodonta variastriata, two.
Atrypa reticularis, several.
Spirifer perlamellosa.

Tentaculites (elongatus?) several.
Favosites helderbergiæ (?) one.
Favosites small columns, sp. ?
Cyathophylloid coral, sp. ?
Orthoceras longicameratum, several.
Bryozoans in variety, fenestella, stictopora, &c., abundant.
Stromatocerium?

III. Catskill Shaly Limestone.

Strophomena rhomboidalis, several.
Hemipronites radiata.
Spirifer perlamellosa.

I do not find the *Spirifer macropleura* mentioned in my memoranda, but am under the impression that I saw fragments of it, and have no doubt that it can be found there.

DECEMBER 5, 1883—SIXTEENTH STATED MEETING.

Prof. W. B. Dwight, chairman, presiding; ten members and thirty guests present.

Dr. Stevenson presented to the museum a fine specimen of the "man-eater" or white-shark, the only specimen of this species, so far as known, to be found in this country.

The following paper was read:

Carcharodon Carcharias—"MAN-EATER" SHARK.

BY W. G. STEVENSON, M.D.

Carcharodon carcharias, (Jordan & Gilbert) "man-eater shark;" Atwood's shark.

[Syn.—*Squalus carcharias* (Linnæus): *Carcharias lamia* (Cuvier): *Carcharias verus* (Agassiz): *Carcharodon rondeletii* (Müller & Henle): *Carcharias rondeletii* (Gunther): *Carcharondon capensis* (Smith): *Carcharias atwoodi* (Storer): and *Carcharodon atwoodi* (Gill).]

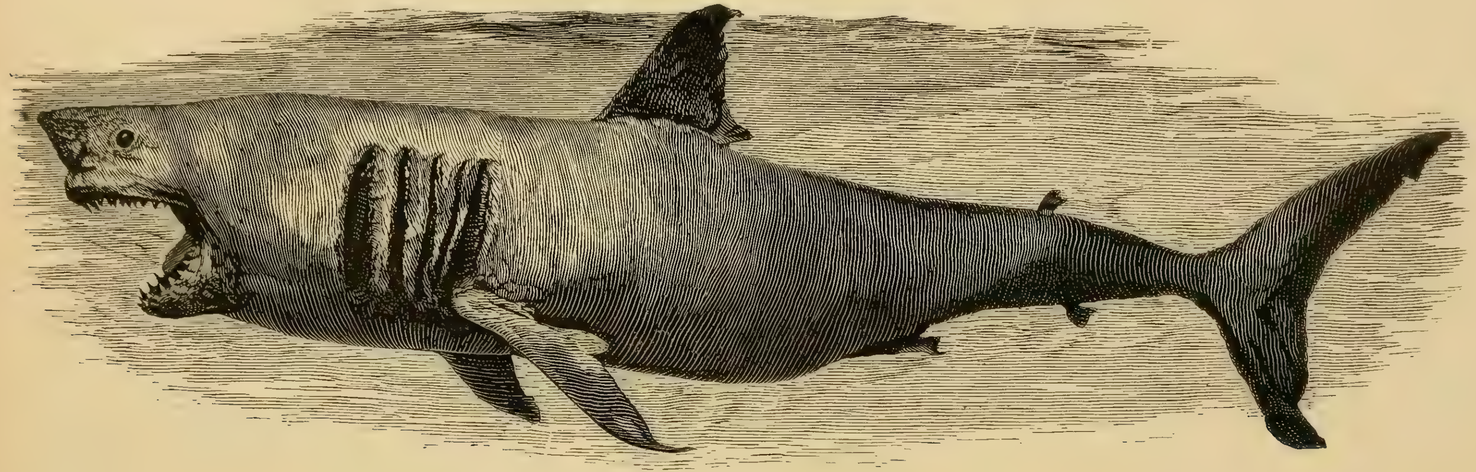
The various descriptions given of this species are so very imperfect and confusing that it is safe to say with Prof. D. S. Jordan, in a recent letter to me, "there is no good description of the animal extant. The earlier writers spoke of it without knowing it, and all had more or less confusion between it and *C. lamia.*"

This shark was taken by C. B. Herrick, Esq., and myself on the fourth day of August, 1883, about two miles off Great Point light-house, Nantucket, Mass.

The experienced fishermen of Nantucket, with all their opportunities to investigate this interesting family of fishes, were ignorant of the correct name of this specimen, though they regarded it as a rare species in the waters of that vicinty. It, therefore, became to me an object of special interest and study.

DESCRIPTION OF EXTERNAL CHARACTERS—GENERAL DIMENSIONS. (PLATE I.)

Length from snout to the end of caudal fin (straight line),	10	feet
Length from snout to the pectoral fins (straight line).....	30	inches
Length from snout to the ventral fins......................	67½	inches
Length from snout to the anal fins.........................	86	inches
Length from snout to the first dorsal fin..................	44	inches
Length from snout to the second dorsal fin.................	82½	inches
Length from snout to the caudal fin........................	98	inches
Length of pectorals, at base...............................	8	inches
Length of first dorsal, at base............................	12	inches
Length of second dorsal, at base...........................	1½	inches
Length of anal, at base....................................	1½	inches
Circumference, anterior to branchial openings..............	56	inches
Circumference, posterior to branchial openings.............	58	inches
Circumference, posterior to pectorals......................	58	inches
Circumference, anterior to first dorsal....................	53	inches
Circumference, posterior to first dorsal...................	48	inches
Circumference, anterior to ventrals........................	42	inches
Circumference, posterior to ventrals.......................	33	inches
Circumference, anterior to anal............................	22	inches
Circumference, of caudal peduncle anterior to caudal fins,	12	inches



CARCHARODON CARCHARIAS. PLATE I.

COLOR.

The color is drab or ashy-gray, lighter on the abdomen; darker or leaden-gray towards the tail and on the borders of the pectoral and caudal fins.

HEAD AND BODY.

The head is short, with snout three inches above the mouth, projecting four and three-quarter inches beyond the jaws. The body is stout, tapering gradually from the pectorals to the tail. The abdomen is somewhat pendant anterior to the ventrals.

IMBRICATED SCALES.

When rubbed in a forward direction the surface feels like minute sharp points or barbules, which, under a lens, are seen to be calcified, imbricated papillæ or shagreen, about one one-hundred-twentieth of an inch in diameter, retrorse, and arranged in irregular rows. These papillæ have their free ends serrated, which give to each papilla three unequal teeth-like points, of which the middle one is generally the longest and sharpest.

LATERAL LINES AND MUCIFEROUS OPENINGS.

The lateral lines of the two sides, united by a transverse line nine and one-half inches from the end of the snout, are distinctly marked on each side of the body from the snout to the caudal peduncle, where they disappear in the keel. The snout is covered with pin-hole like mucus openings, which are more numerous around the nasal apertures, and form five irregular rows on either side of the median line of the head, above the orbits.

EYES.

The eyes are orbicular, without nictitating membranes, one and one-half inches in diameter, seven inches from the end of the snout, three and one-half inches above the mouth, with an inter-orbicular space of nine inches. The irides are dark brown, and the pupillary openings are large and black.

NOSTRILS.

The nostrils are of irregular form, one and one-half inches long and half an inch wide, extending from two and a quarter inches in front of the lower level of the orbits downward and inward. They are not confluent with the mouth, and have a flap-like fold on their external margin.

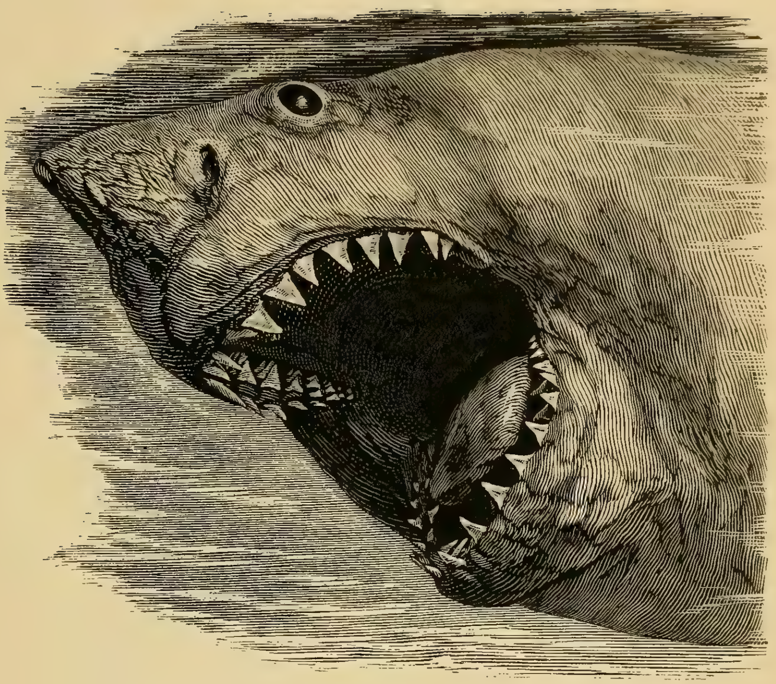
MOUTH AND JAWS.—(PLATE II).

The mouth is large, inferior, and without labial folds. The jaws, narrower at the inner angle, have the shape of a horse-shoe. The upper jaw is ten inches long on the dental margin, seven and one-half inches wide in front, (at the fourth tooth), and six and one-half inches wide behind at the inner angle. The lower jaw is nine inches long, six and one-half inches wide in front (at the fourth tooth), and five and one-half inches wide behind at the last tooth.

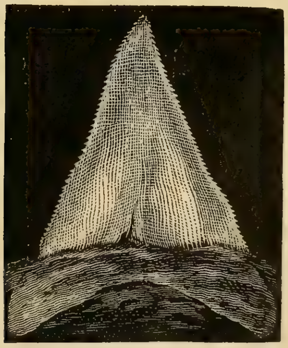
DENTAL FORMULA.

$$R\ \frac{12 \text{ or } 13}{11}.\quad L\ \frac{13}{11} = \frac{25 \text{ or } 26}{22}.$$

The teeth in both jaws have the form of an isosceles triangle, compressed, with the inner surface slightly convex, and the margins rectilinear and markedly serrated. They have no basal cusps, and stand a little obliquely inward. The upper are larger than the lower teeth, and, in both jaws, the largest teeth are in front. In the upper jaw the front teeth measure seven-eighths of an inch at the base, and one and one-quarter inches on each side, and in the lower jaw five-eighths of an inch at the base, and seven-eighths of an inch on each side.



CARCHARODON CARCHARIAS. PLATE II.



TOOTH OF C. CARCHARIAS—(NATURAL SIZE.)

One row of teeth only is fully visible in either jaw, though a second row is partially exposed as it rises above the enclosing tissues, while four rows in the upper and five rows in the lower jaw, overlying each other—the teeth in each succeeding inferior row being smaller and less dense—are entirely concealed in the deep groove of the mucous membrane of the jaws. These concealed rows of rudimentary or non-functional teeth, when exposed by cutting away the enclosing tissues, reveal, even in the smallest and most rudimentary stage, the same triangular form, with serrated margins, as is seen in the fully developed teeth.

FINS.

The pectoral fins, twenty-four inches in length, are large, low, falcate, with anterior margin entire, convex. The posterior margin is twenty inches long, with a large lobe at the base. The pectorals are thirty inches from the end of the snout (straight horizontal line), and have a basal insertion of eight inches, with an antero-posterior diameter, across the basal lobe, of thirteen inches.

The first dorsal fin is forty-four inches behind the snout, and six inches behind the pectorals. It is large, triangular, ten inches high, with a basal insertion of twelve inches. Its anterior margin is entire, convex; its posterior margin is somewhat repand, with a triangular lobe at the base.

The second dorsal fin, twenty-six and one-half inches behind the first dorsal, and fourteen inches in front of the caudal, is a small, somewhat rhomboidal-shaped fin, only two inches high, with an obliquely truncated end, and one and one-half inches wide at base.

The ventral fins, twenty-nine and one-half inches behind the pectorals, are abdominal, horizontal, fan-shaped, and of medium size. No claspers.

The anal fin, two inches behind the second dorsal, is two inches high, one and one-half inches wide at the base, and two inches wide at the free extremity.

The caudal fin is large and strong, lunate. The two lobes are nearly of equal size, the upper lobe being twenty-three inches long, and the lower lobe eighteen inches. The upper lobe has a notch in the posterior edge near its end. The width of the caudal fin, in the median line, is eight inches. Greatest width of lobes, ten inches. Distance between extremities of the two lobes is thirty inches.

The caudal peduncle is ten inches long and carinated on both sides ; the keel is thirteen inches long, extending an inch in front of the anal fin. There is no pit at the root of the caudal.

BRANCHIAL OPENINGS.

The gill-openings, five in number, are lateral, anterior to, and their lower extremities on a level with, the base of the pectorals. The first and second are thirteen inches long, and the other three are eleven and one-half inches long. The last branchia on either side is close to the base of the pectoral, and overlaps it an inch or one-half of the branchial width. Gill-openings occupy a horizontal space of nine and one-half inches above and seven inches below. The inter-branchial space, sub-thoracic, is fifteen inches. No spiracles.

In making a diagnosis of the species here represented, I shall follow the general analysis given by Professors Jordan and Gilbert, in their *Synopsis of the Fishes of North America*, published under the direction of the Smithsonian Institution in 1882.

There are thirteen families in the order *Squali* (the sharks ;) and, by analysis, it is found that the existence of an anal fin, two dorsal fins without spines—the first dorsal being anterior to the ventrals,—a caudal fin lunate and a caudal peduncle carinated, gill-openings of moderate size, and well-developed teeth, are the characteristics which place this shark in the family *Lamnidæ* (the porbeagles), which is thus described: "Large size, with body stout, the mouth wide, with large teeth, and the caudal fin lunate, the two lobes being not very unequal, the upper lobes strongly bent upward; caudal peduncle with a keel on each side; gill-openings wide, all in front of the pectorals, entirely lateral, not extending under the throat; first dorsal large; pectorals large; ventrals moderate; second dorsal and anal very small; pit at the root of the caudal; spiracles minute or absent; genera, three; species, six or more. Those inhabiting our coasts have been much confused by authors."

The specimen which is the subject of this study differs from this family description (1) in the position of the last branchiæ, which partly overlap the pectorals, and (2) in the absence of a pit at the root of the caudal.

This family—*Lamnidæ*—includes three genera, viz:—

Isurus;
Lamia;
Carcharodon.

These are distinguished from each other by the form and construction of their teeth.

The genus *Isurus* has two species, (1) *I. dekayi* (J. & G.)—mackerel shark. [Syn.—Lamna punctata (De Kay), Isuropsis de kayi (Gill), Lamna glauca (Gunther)—]. (2) *I. spallanzanii* (Raf.) [Syn.—Lamna punctata (Storer)—]. Jordan and Gilbert say there is no evidence that this last named species is found in our waters.

Both species of the genus *Isurus* have teeth, "long, lanceolate, with sharp, entire cutting edges and no basal cusps," which excludes the specimen before us from this genus; it is also excluded from the genus *Lamia*, because its only known species—*L. cornubica*—has teeth "triangular, pointed, entire, each one with a small cusp on each side at base." This specimen is therefore not a "mackerel shark." There remains for examination of the family—*Lamnidæ*, only the genus *Carcharodon*—"man-eater" sharks.

"This genus differs from *Isurus* chiefly in the dentition, the teeth being large, flat, erect, regularly triangular, their edges serrated; first dorsal moderate, nearly midway between pectorals and ventrals; second dorsal and anal very small; pectoral large, ventrals moderate, caudal peduncle rather stout; spiracles minute or absent."

The generic characteristics thus given so well agree with the specimen under examination, that I conclude it is, without doubt, a *Carcharodon;* and it only remains to determine its identity with the only known species of this genus, viz., *Carcharodon carcharias* (J. & G.), "man-eater" shark, which is thus described:

"Body stout—depth, $5\frac{1}{2}$ in total length; mouth very large; both jaws with five rows of large, triangular, serrated teeth—those in lower jaw narrower—about $\frac{2}{2}\frac{4}{2}$ in each jaw; first dorsal somewhat behind pectorals; caudal fin large and strong—color, leaden gray; tips and edges of pectorals black." (Storer)—quoted from Jordan & Gilbert, who add: "one of the largest of the sharks, reaching a length of fifteen feet and the weight of nearly a ton. It is found in all temperate and tropical seas, but is rare on our coasts. American specimens have been named *C. atwoodi*, but are probably not distinct from the European."

At the time this was written Professor Jordan had not, as he informs me, seen this species, but quoted from Storer, who had mistaken the genus. Since then, however, Professor Jordan has seen a specimen thirty-two feet long, taken at Monterey Bay, California, the jaws of which only were saved.

The above description, although incomplete, covers so many of the principal characteristics of my specimen that I regard it as identical with the species described, and therefore name it *Carcharodon carcharias*,—"man-eater" shark.

This diagnosis has been confirmed by my friend, Prof. William B. Dwight, of Vassar College, who has examined the specimen, and also by the distinguished naturalist, Prof. David S. Jordan, to whom photographs and measurements of the fish were sent for study, and whose valuable assistance I hereby acknowledge.

There are, however, as before stated, two important discrepancies between the description given by authors and this specimen, viz., (1) the absence in this shark of the caudal pit, which authorities state belong to all lamnoid sharks, and (2) the position of the last branchiæ which, in this specimen, partly overlap the front of the pectorals, but which, according to authorities, should be entirely in front of the pectorals. Professor Jordan says he cannot now explain these differences, which "may change with age."

The expression, as published by Storer and quoted by subsequent writers, "five rows" of teeth is an unhappy one, for it includes the non-functional or rudimentary teeth which are partly or wholly concealed in the groove of the jaws, and which can only be seen when the enclosing tissues are cut away.

The specimen which gives me the data for this report I have placed in the museum of Vassar Brothers Institute in this city, and since it is, so far as I know, the only specimen of this species preserved in this country, it is hoped that it may prove useful in helping to clear away the confusion which has so long existed relative to the lamnoid sharks.

NOTE.—As showing the importance of the specimen above described, I subjoin the following letter from the distinguished zoölogist of the

British museum,—Dr. Gunther,—to whom a description, with photographs of the shark, was sent.—W. G. S.

BRITISH MUSEUM.—(NATURAL HISTORY.)

Cromwell Road, South Kensington, S. W., 15.5. '84.

DEAR SIR: I am truly obliged to you for your kindness in sending me the photographs of the shark which, with your description, leave no doubt that you have had the extraordinary good fortune of obtaining a *Carcharias rondeletii.* It is one of the most interesting discoveries in Atlantic ichthyology. Although I have been endeavoring for years to get a specimen, I have been unsuccessful hitherto.

Believe me, yours very truly,

A. GUNTHER.

Dr. W. G. Stevenson.

On the same evening the following description was given of

Odontaspis littoralis—SAND-SHARK; SHOVEL-NOSE.

BY W. G. STEVENSON, M.D.

Odontaspis littoralis—(MITCH.) J. & G.

[Syn.—Squalus americanus (Mitch). Squalus littoralis (Mitch). Carcharias griseus (Storer). Odontaspis americanus (Gunther). Eugomphodus littoralis (Gill). Carcharias littoralis (De Kay)—].

The second shark which I have the pleasure of presenting to the Institute this evening was also taken, by Mr. C. B. Herrick and myself, on the fourth day of August, 1883, about two miles off Great Point light-house, Nantucket, Mass.

Its perfect skin and large size, for this species, make it desirable to place its description on record.

It is a common species in American waters—at least along the Atlantic sea-board—and is known as

Odontaspis littoralis,—Sand-shark.

This is the only species found along our coasts belonging to the family *Odontaspididæ*, and is the species that was partially described by DeKay, under the name of *Carcharias littoralis*.

DeKay speaks of this species as having a length of from five to eight feet, while Jordan and Gilbert in their *Synopsis of the Fishes of North America* refer to it as from four to six feet in length.

This specimen, when taken from the water, measured eight feet seven inches in length, and may, therefore, be regarded as of full size.

DESCRIPTION OF EXTERNAL CHARACTERS. (PLATE.)

GENERAL DIMENSIONS.

Length from snout to the end of caudal fin (straight line)	8 feet 7 inches
Length from snout to the pectoral fins	26 inches
Length from snout to the first dorsal fin	48 inches
Length from snout to the second dorsal fin	71 inches
Circumference, anterior to pectoral fins	48 inches
Circumference, posterior to pectoral fins	49 inches
Circumference, anterior to first dorsal fin	41½ inches
Circumference, anterior to ventral fins	38½ inches
Circumference, anterior to anal fin	19 inches
Circumference, of caudal peduncle at base of caudal fin	11½ inches

COLOR.

The color is a light-yellowish-brown.

HEAD AND BODY.

The head is short and somewhat flattened on top. The snout is one inch and a half above the mouth, projecting four inches beyond the jaws.

The body is covered with rough tubercle-like scales or papillæ, which give to the surface an appearance and a feeling as if sand had been sprinkled evenly over it.

LATERAL LINES AND MUCIFEROUS OPENINGS.

The lateral lines, united by a transverse line posterior to the orbits, are distinctly marked on each side of the body from the snout to the tail. Pin-hole like mucus openings thickly cover the snout and head and to a less extent the entire surface of the body.

EYES.

The eyes, without nictitating membrane, are small, seven and one half inches from the end of the snout, three inches above the mouth, with an inter-orbicular space of seven inches.

Irides silvery-gray, pupillary openings small and black.

NOSTRILS.

The nostrils, midway between the orbits and the end of the snout, are oblong and not confluent with the mouth.

MOUTH AND JAWS.

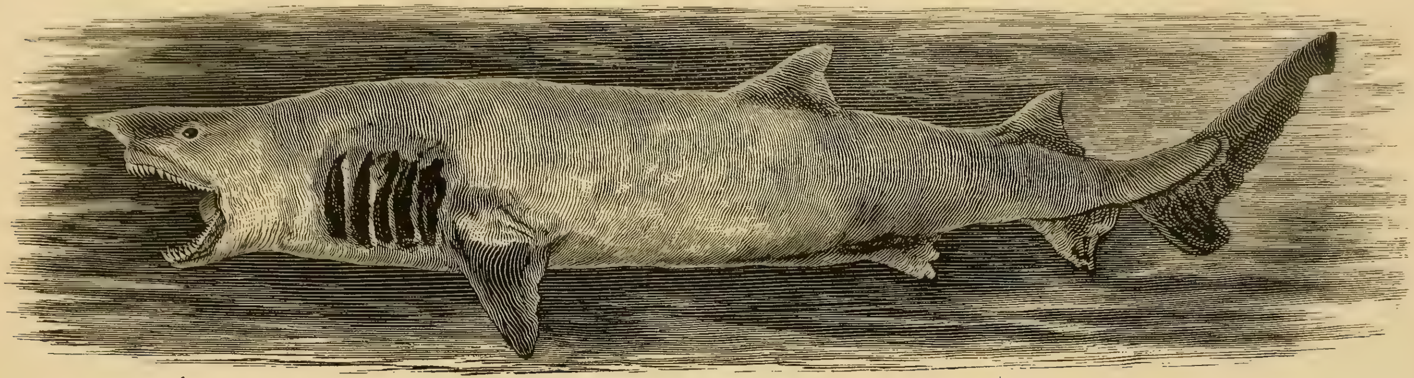
The mouth is inferior, wide, with the shape of the letter U. The upper jaw is eight and one half inches long, on the dental margin, and eight inches wide; the lower jaw is six and one half inches long and seven inches wide.

Dental formula– R $\frac{23}{21}$ L $\frac{23 \text{ or } 24}{20} = \frac{46 \text{ or } 47}{41}$.

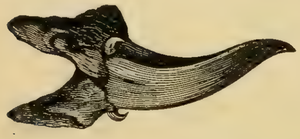
The teeth in front are long, subulate and curved inward, with basal cusps. The first tooth on either side of the median line in the lower jaw, and the fourth tooth on either side in the upper jaw are very small,—projecting sharp points,—without basal cusps.

In the posterior part of each jaw there are six visible rows of teeth, but, the last ten of each row are so small and so crowded together, that they appear like a single tuberculated tooth.

In front two full rows of teeth in each jaw are fully



ODONTASPIS LITTORALIS.



TOOTH—(NATURAL SIZE.)

exposed, and a third row is partially exposed as it rises above the enclosing tissues, of the deep groove in either jaw, which conceal several other rows of rudimentary teeth.

FINS.

The pectorals, twenty-six inches behind the snout, are of medium size, with a basal diameter of six and one half inches, and a posterior basal lobe two and one half inches in anterio-posterior diameter. Their general form is triangular or sub-falcate, with an anterior margin entire, convex, and thirteen inches long, and a posterior margin somewhat repand and ten and one half inches long.

The first dorsal, forty-eight inches from the snout, is five and one half inches high and eight inches long at base.

The second dorsal, fifteen inches behind the first dorsal, is the same form and height as the first dorsal, with a nasal diameter of six and one half inches.

The ventrals are of medium size and anterior to the second dorsal.

The anal is nearly underneath the second dorsal, and is of the same size and form.

The caudal fin has an upper lobe, twenty-three inches long, notched near its top on the posterior border, and a small lobe at the base.

The caudal peduncle has no keel.

BRANCHIAL OPENINGS.

The gill-openings, five in number, are lateral, of moderate size, and entirely anterior to the pectorals. The third or middle branchia is eight and one half inches long, and the other four are each seven and one half inches long.

The inter-branchial space, sub-thoracic, is fourteen inches.

DECEMBER 19, 1883—SEVENTEENTH STATED MEETING.

Prof. W. B. Dwight, chairman, presiding; eight members and seven guests present.

The following report was read:

OUR LOCAL MAMMALIAN FAUNA.

BY W. G. STEVENSON, M.D.

The Institute seeks, through its Scientific Section, to "promote useful knowledge in the departments of natural, physical and biological science," not only by investigating and discussing subjects appertaining thereto, but by collecting, preserving, naming and classifying such specimens as illustrate the biological and physical history of this vicinity.

Already our museum contains many representatives of our fauna, and a complete collection of our flora,—all well preserved, labeled and displayed.

It is my purpose to report from time to time the names of the specimens in our possession that belong to our local fauna and flora, and the hope is expressed that such reports may not only prove interesting items of information to our members and to the public, but that they may encourage many to contribute to our museum until our local natural history collection is complete.

To-night it is my pleasure to report the specimens we have received during the past year belonging to our local mammalian fauna.

Order: *Carnivora.* Family: *Felidæ.*

Lynx rufus—American wildcat.

Two specimens, one old and one young, were taken at Mercer Mountain, Columbia County. This species is practically extinct in this part of the State.

Vulpes vulgaris—red fox.

Two specimens, one old and one young.

Family: *Mustelidæ.*

Putorius vulgaris (*Mustela pusilla*)—least weasel.

One specimen.

Putorius erminea—common weasel, stoat, or ermine. Under this name Dr. Coues includes the various species described by different authors as *Putorius noveborancensis*, *P. fusca*, *P. richardsoni*, *P. kanei*, and *P. cicognani.* Between these various species Dr. Coues, whose authority I accept, says there is no dividing line. He regards the question of size and of color as entirely within the limits of individual variation under external conditions, and not of themselves indicative of specific differences.

Of the six specimens in our collection, four are much smaller than the other two, and by most authors have been described as a distinct species known as *P. cicognanii.* Dr. Coues, however, denies their specific differences. Of the four smaller ones, two are in their summer or brown pelage, and two are in their winter or white pelage, which has a slight yellowish tinge on the abdomen.

The two larger specimens are the same as DeKay described under the name of *P. noveborancensis*,—"New York ermine," or "white weasel"—which, he says, he "had never seen in its summer dress" of brown.

The two specimens in our collection are interesting because, though taken in summer—one in August and one in early September—they have not a single brown hair on their bodies. The upper portions of the head and neck are white, and the rest of their bodies is of the characteristic "sulphury-yellow" color.

Putorius vison—common mink.

Three specimens.

Mephitis mephitica—common skunk.

Three specimens, one of which is entirely black, excepting a small white occipital patch, and the end of the tail.

Family: *Procyonidæ.*

Procyon lotor.—raccoon.

One specimen.

Order: *Chiroptera.* Family: *Vespertilionidæ.*

Vespertilio subulatus—little brown bat.

Two specimens.

Vespertilio noctivagans—silver black bat.

One specimen.

De Kay says the history of this species is incomplete; the largest size attained as reported by him is ten or eleven inches across the wings; the specimen in our collection measures seventeen inches.

Order: *Insectivora.* Family: *Talpidæ.*

Scalops aquaticus—common mole.

One specimen.

Condylura cristata—star-nosed mole.

One specimen.

Family: *Soricidæ.*

Sorex platyrhinus—common shrew.

One specimen.

Order: *Rodentia.* Family: *Sciuridæ.*

Sciuropterus volucella—common flying-squirrel.

Two specimens.

S. niger—fox-squirrel.

Two specimens from northwestern New York (?) no longer found in this vicinity.

S. Carolinensis—gray-squirrel and black-squirrel.

Two specimens of the gray variety, one specimen of the black variety, and one specimen of the rare-white or albino variety of this species.

S. hudsonius—red-squirrel.

Six specimens, three old and three young.

Tamias striatus—chipmunk, or ground-squirrel.

Three specimens.

Spermophilus franklini—gray gopher.

Five specimens, one old, four young.

Arctomys monx—woodchuck or ground-hog.

Three specimens, one old, two young.

Family: *Zapodidæ.*

Zapus hudsonius—jumping mice.

Two specimens.

Family: *Muridæ.*

Mus decumanus—brown or Norway rat.

One specimen.

M. musculus—common house mouse.

One specimen; also, one specimen of the albino variety, and a specimen of a hybrid between common house mouse and albino.

Hesperomys leucopus—deer mouse.

Two specimens.

Fiber zibethicus—muskrat.

Two specimens, one of which is an albino.

Arvicola riparius—American meadow mouse.

One specimen.

Family: *Spalacopodidæ.*

Erithizon dorsatus—white-haired porcupine.

Two specimens, male and female, very fine and large.

JANUARY 2, 1884—EIGHTEENTH STATED MEETING.

Prof. W. B. Dwight, chairman, presiding; fifteen members and guests present.

The following is an abstract of a paper read, on the

UNIFORMITY OF CLIMATE IN PAST GEOLOGICAL AGES.

BY C. B. WARRING, PH.D.

In geological times as late as the miocene and probably the early pliocene, the climate in very high latitudes was about the same as now in our southern states, as is shown by abundant remains of animals and plants identical in species with those of low latitudes.

This condition is so unlike present polar climate that it presents a problem of the greatest interest.

To most persons—and to all writers hitherto—the problem has been summed up in one word, warmth. But there are two other problems involved. Was the climate uniform, or at least approximately so, as now in the tropics? Was the supply of actinic influence subject to extremes? Or, to put the two questions in another form,—do the plants and animals that lived near the pole in those remote times, indicate the presence or the absence of long days and nights such as those of the present period?

I assume that plants and animals were affected by heat and cold, light and darkness, then as now.

If the axis of the earth was inclined at that time $23\frac{1}{2}°$ the days and nights must have varied as they do at present. Hence in Spitzbergen, lat. 80°, and at Captain Naire's winter quarters, 81°-40′ the mid-winter night must have been four months long. Four months of uninterrupted day would tend to raise the temperature very high, while four months with no heat at all from the sun, would make excessive cold. These extremes were undoubtedly greatly modified by the capacity of water to take up and give out heat, and the winters made milder by the inflow of ocean currents. The same capacity, however, exists now, and ocean currents continue to flow, yet in Spitzbergen—one of a group of not large islands surrounded by a broad expanse of water—the cold is very intense. The capacity of water for heat has not changed,—did the Gulf Stream, or the Japan Current, in geological times have a greater flow than at present? The effective cause of these streams is the difference between high and low latitude temperature. If this difference was nothing, there would be no currents, and the less the difference the less the currents. In geological times the difference must have been small for the same plants and animals lived from the tropics, if not from the equator, to as near the pole as has been explored. Hence the flow of these currents must, to say the least, have been no greater than at present.

But it may be said that some change in the arrangement of the land caused a change in the direction of the current. It is now generally admitted that the outlines of the continents are the same as they were from the beginning. If this is true, there has been no great change in the direction of the ocean currents. Moreover, the eastward trend of the Gulf Stream is due to the rotation of the earth on its axis; hence, it would not, in any case, flow up Baffin's Bay; and, therefore, the warmth of Disco Island must be accounted for in some other way. If it be said that the Japan current flowed through a wider and deeper channel into the Arctic Ocean, there must have been some way of keeping it warm while slowly coursing several thousand miles around the northern shores of North America. As the same plants and animals lived in arctic regions, lat. 81° 40′, and well down toward the equator, it would seem that climatic conditions could not have been affected by enormous differences in the length of their days and nights, or, in other words, that the nights there were not as they are now.

The influence of light, or actinic force, on plants is very great. The same species of plants lived all over the world in the earlier geological ages. In view of this fact, any great difference in the mode of the application of that force seems impossible; and, still more, because in more recent times, *i. e.*, in the miocene and pliocene, the very species originated in circumpolar regions, which have since furnished the forests of our southern states.

It seems to me that the fossil plants and animals of polar countries afford the strongest evidence possible in the nature of the case, that down to the pliocene the earth's axis was nearly perpendicular.

To this two serious objections may be made: (1) The stability of the position of the earth's axis, which astronomers assure us cannot be permanently disturbed by any force known to science; (2) the fact, as shown by Meech and repeated by Croll, that, other things remaining as they are, a perpendicular axis would make the circumpolar climate colder even than it now is.

As to the stability of the axis, astronomers prove too much. If the nebular hypothesis be true, the moon and earth should revolve around axes perpendicular to the ecliptic, for no force of avulsion could change their position. They could not revolve around two axes when one body; hence it must have been after they were separate bodies that one or both became tilted.

The moon now is nearly in the normal position; therefore, the great change has been in the earth. Hence, it follows that if our earth was developed mechanically, it somehow, by some "force unknown to science," got into its present position, and the only question that concerns us is that of the date. Astronomers may declare their own ignorance, nevertheless, the event occurred, for we see that the axis is inclined.

The only theory for the formation of our system other than the nebular hypothesis is that which relegates the whole matter to Infinite power. If that is allowable, the case becomes simple enough.

The second objection which was mentioned is a very serious one, and, if it could not be answered, would require us to give up all hope of at present solving the problem of geological climate.

It is true that, under present conditions polar regions would be colder than they now are if the earth's axis was perpendicular, because, as has been shown by Mr. Meech, a smaller number of solar rays would fall during the year upon each unit of polar surface. But temperature depends far more upon the amount of heat retained than upon the amount received. And in this lies the explanation.

Professor Tyndall, in *Heat, a Mode of Motion*, has shown that many gases and vapors permit solar heat to pass freely through them, while they largely intercept heat from bodies of a low temperature; and that some other gases, notably oxygen and nitrogen, whose mixture forms almost all the atmosphere, allow both kinds of heat to pass through them with almost equal freedom. Carbonic acid and aqueous vapor belong to the first class.

All the carbon in the coal, lignite, petroleum, and other animal and vegetable substances in the earth's crust, once existed as carbonic acid, and formed a much larger part than at present of the atmosphere,—and, by retaining the heat, raised the temperature. This, in its turn, increased the capacity of the air for moisture. The aqueous vapor taken up acted in the same sense, and thus the earth was covered from pole to pole by "a warm blanket."

It was also shown by Professor Tyndall that when the amount of CO^2 was large, successive increments produced comparatively little effect upon the diathermanicity; but that when the amount became small, the effect upon heat-transparency was proportional to the decrements. Hence, one would expect a more rapid fall of temperature in the later than in the early geological periods. This is in accord with the facts. The change was very slow during the first half of the geological time, a little more rapid during the next portion,—the mesozoic—more rapid in the tertiary, increasing yet more through its latter part, till, at last, the air becoming probably as pure as now, polar regions ceased to be inhabitable, snow and ice accumulated under the action of a sun that never rose above the horizon at the poles, and, in present temperate latitudes, rose only to its present height at the equinoxes. Under such conditions, aided by high latitude uplifts, it seems not difficult to understand why that time of cold known as the glacial epoch set in, and that it would have continued to the present day had the axis remained perpendicular to the ecliptic and the land retained its elevation. Furthermore, we know that the land in high latitudes was depressed after that until it was much lower than now—sufficiently so to submerge a very large part of what is at present dry land. The effect of this was to hasten the departure of the ice and to soften the climate, making it even warmer than it is now. When the land rose to its present elevation, present temperature set in.

It is believed that this theory, in its entirety, possesses the merit of novelty, whatever that may be. It may be summed up in a few words. The warmth of preglacial climate was due chiefly to the large amount of CO^2 and aqueous vapor in the atmosphere. The evenness of temperature and the uniformity in those biological conditions which depend upon actinic influences were due to the axis being perpendicular. The cold of the glacial epoch was due to the loss of CO^2 and aqueous vapor, and to the perpendicularity of the axis aided by high latitude uplifts. The warmth of the Champlain was due to the axis having become oblique, and to the depression of the land in high latitudes far below its present level. The cooler climate that followed the Champlain was due to an upward movement comparatively local in extent. Subsequent changes have produced the climate of to-day.

I have not thought it best to speak of other theories. Dr. Croll, in his *Climate and Time*, has collected all the most important, and pointed out their absolute failure. As for his own theory, I have shown in an article in *Penn Monthly* what seem to me insuperable objections to it. I add here only this: Dr. Croll utterly ignores the two questions, which, with that of warmth, make up the problem of geological climate, and, consequently, leaves unsolved what seems to me the most perplexing part of the question.

JANUARY 16, 1884—NINETEENTH STATED MEETING.

Prof. W. B. Dwight, chairman, presiding; twenty members and fifty guests present.

Miss Mary W. Whitney, was elected a member.

The following paper was read:

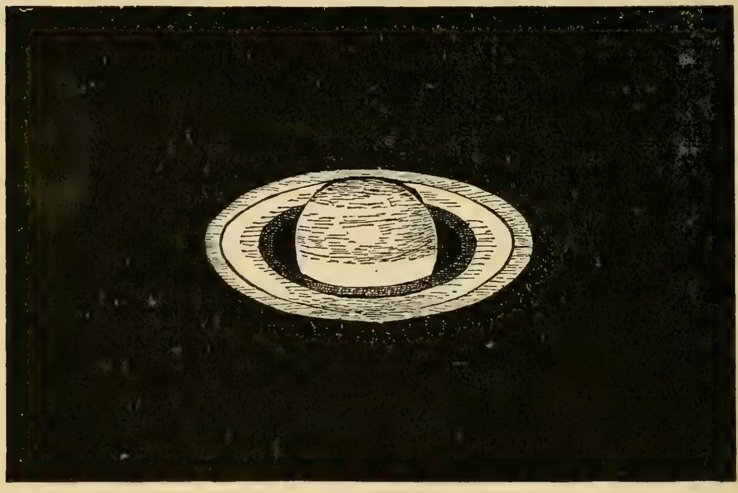
SATURN.

BY PROF. MARIA MITCHELL.

To the eye, Saturn is far less conspicuons than Jupiter. It is farther from us, it is smaller, its color less ruddy. It might easily be taken for one of the countless stars.

The first look at it, with a telescope, is an unexpected delight.

Like Jupiter, it has its moons ; like Jupiter it has bands crossing its disc, nearly parallel to its equator ; unlike every other planet, it is surrounded by a ring, usually so inclined that it stands out in front of the ball of the planet. It is a broad, flat ring ; perhaps we might call



it a bottomless placque. At times, when the edge of the ring is presented to the sun, or, when the plane of the ring passes through the centre of the earth, it appears as a line across the ball, a line so narrow, that it can be seen only by large telescopes.

The thickness of the ring is supposed by some observers to be one hundred miles, by others to be only forty miles. With powerful glasses, the ring is seen to be made up of several rings. When these rings are tipped obliquely to the plane of Saturn's equator, dark open spaces are seen between the ball and the ring ; these are supposed to be the sky ; dark curved lines upon the plane of the rings are supposed to be spaces between the different rings. An inner dusky ring, called the "gauzy ring" stretches toward the ball. Although it is supposed that we see the background of the sky between the rings and the ball, yet there is no record of a star seen in this space. I have seen Saturn in a strong warm twilight, yet the blackness of this space has not been modified by the brilliant background.

In certain positions of the ring, the gauzy, dusky, inner ring is projected upon the ball as a dark band; at times, on the other border of the ring is also a dark band. What can this dark bordering of the outer ring be?

That the ring is of unequal thickness is obvious. When it is seen as a line, this line is broken up into small points, as the coast line is when you leave the shore and go out into full sea.

Spots are seen upon the surface of the ring. We call them shadows. If there are shadows thrown by the ball, the ball must be irregular in shape.

We are so liable to illusions, that an astronomical observer is fortunate if he can call to his aid some novice in astronomy to assist his judgment in regard to the meaning of lights and shades—if possible, an artist. Above all other combats, the old observer has that with his own perceptions and with his favorite hypotheses.

Minute objects, which will bear no illumination of the field of view, but are seen only in intense darkness, cannot be measured; different eyes must do the work of the micrometer; relative size, color, brightness, and motion must be determined by the estimates of unbiased observers.

Saturn is known to have eight moons.

Mimas, the nearest to the planet, is rarely seen. It shoots out quickly from the edge of the ring, rushes quickly back, and is lost in the brilliancy of Saturn.

In years of looking for it, with a glass of more than twelve inches aperture, I have seen it very few times.

Enceladus, the next in distance from Saturn, is a difficult object.

Tethys can be seen with a Clark glass of three inches aperture. It has more sparkle than the others.

Rhea is whitey-blue in color, large, blurry, and shows something of a disc.

Titan could probably be seen with an opera-glass. It is always seen when not behind the planet or in course of transit. It is the Jupiter of the system—readily recognized by its orange color.

The next satellite in the order of distance is Hyperion, which I have never seen. It is too small for the telescope at Vassar College.

Japetus, the farthest of the satellites yet known, is very peculiar in the changes of its light. It is very perceptibly variable. Sweeping around at an enormous distance from Saturn, it is bright when on one side of the planet and pale on the other side.

The grouping of these little moons is very beautiful.

At one time they will arrange themselves in a line; next, they curve above the ball; and, anon, they cling around one of the ansæ, as if the ring had dropped its jewels. When the quickly-moving moons are seen near together, changes of position are noticed in a few minutes.

Although Jupiter is the only satellite spoken of as variable in text-books, I have little doubt of the variability of Rhea and Dione, and a suspicion of changes in Tethys.

Dione is sometimes as bright as Tethys, and I have seen the pale Rhea glowing like Titan.

With the times and the rate of motion, and the angles of inclination of the orbit, the problem of possible combinations must involve an infinite variety of groups.

The possibilities for the observer are the discovery of new satellites if the satellites are thrown from the ring and if the processes continue to go on.

If, as is supposed, the dusky ring tends toward the ball, do the moons lessen in their time of revolution? Are the processes of throwing off and falling back still going on?

Cosmical changes are so slow that we do not expect to meet them in one lifetime. It is the comparison of the records of different ages which shows the order of law.

A general discussion of subjects suggested by the paper followed, and was participated in by Miss Whitney, Professor Dwight, and Doctor Warring.

Dr. W. G. Stevenson exhibited to the society a specimen of

Cyclopterus lumpus—(LINN.)—LUMP-SUCKER; SEA-OWL.

[Syn.—Lumpus anglorum (DeKay)].

This species is found in the North Atlantic, and is common on the coasts of America and Europe.

This specimen is specially interesting, because it was taken in the Hudson River at this city, and is the first reported specimen found in fresh water or inland rivers.

JANUARY 30, 1884—TWENTIETH STATED MEETING.

Prof. W. B. Dwight, chairman, presiding; twenty-one members and guests present.

The following papers were read:

FROM BOYLE TO MENDELEEFF, ON THE COMPRESSIBILITY OF GASES.

BY LE ROY C. COOLEY, PH.D.

What is the law which governs the compressibility of gases and what are its limitations? Experimental investigations to answer these questions have been going on at intervals during the last two hundred years. The literature of the subject is quite extensive and considerably scattered. It is my purpose in this paper to bring together, into a single story, these experimental investigations as far as I have been able to find them, and to embody in it all that has been learned about this subject by experiment down to the present time.

ROBERT BOYLE—1661.

The relation between the volume of air and the pressure it sustains was first experimentally sought by Robert Boyle in 1661[1]. Taking a long glass tube he bent it near one end until the branches were parallel. The end of the shorter branch was closed; that of the other was left open. He fixed this bent tube in a vertical position and alongside of its branches he placed scales to measure their lengths. Pouring a little mercury into the instrument he filled the bend up to the zeros of these scales. By so doing he enclosed in the short branch a portion of air which could neither be augmented nor diminished in quantity during the experiments. The next thing was to bring this mass of air under the influence of various degrees of pressure, and he did this by pouring mercury into the longer branch.

Now Robert Boyle measured the volume and the corresponding pressure, represented by the mercury column,

1 Defensio Doctrinae de Aire Contra Linus.
Encyclopædia Brittanica, 8th Ed.—Pneumatics.

from time to time and tabulated their values. On comparing these numerical values he discovered that any two volumes under pressures greater than that of the atmosphere were inversely proportional to the corresponding pressures.

It then remained for him to determine whether the same relation would exist if the pressure should be diminished more and more below the normal pressure of the atmosphere instead of being raised above it.

Boyle, accordingly, proceeded as follows: Taking a tube closed at one end he enclosed a portion of air within, by nearly filling it with mercury, inverting it in a deep cistern of the same liquid and depressing it until the level was the same in both. At this moment the pressure was that of the atmosphere. On lifting the tube the mercury in it arose also, but more slowly, and the pressure was lessened by an amount always equal to the weight of the column of mercury. As this column lengthened the air above was subjected to pressures less and less. Again the numerical values of the volumes of air and of the corresponding pressures were tabulated, and again it was discovered that the volumes were mathematically proportional inversely to the pressures.

The statement of Boyle's results generalized has come down to us in the form of the well-known "Boyle's law," which says that when all other things remain constant, the volume of a given mass of air varies inversely as the pressure which it sustains.

To-day we find this among the most fundamental principles in the physics of gases, but in 1661 it was the most advanced conception which the human mind had reached. Remember how scanty was the knowledge of nature at that time. The age had scarcely banished the Aristotelian philosophy which attributed all the phenomena of atmospheric pressure to "nature's abhorrence of a vacuum." Indeed twenty-five years had not yet elapsed since the memorable experience of Galileo and the pump-maker, which revealed the fact that this emotion of nature did not extend to a vacuum over water at a height of more than thirty-three feet. Only eighteen years had passed since Torricelli's capital experiment which substituted thirty inches of mercury for thirty-three feet of water, showing that this abhorrence on the part of nature seemed to be of the work to be done rather than of the vacuum which would attend its performance. And finally it was but fourteen years backward from Boyle to Pascal, who, by his famous experiment in which he caused the Torricellian tube to be carried to the top of the Puy de Dome, demonstrated the existence of atmospheric pressure and banished the so called nature's abhorrence of a vacuum from the realms of science. The discovery of Boyle's law which so soon followed was an achievement scarcely less important. Galileo, Torricelli, Pascal and Boyle together laid the foundations of science in the department of gases during the second third of the seventeenth century.

MARRIOTTE[1]—1676.

Several years afterward and without knowledge of Boyle's experiments, but by an identical method and with similar apparatus the Abbe Marriotte in France arrived at the same principle, which is accordingly known by the French to-day as the law of Marriotte.

SULZER[2]—1753.

The experiments of Boyle and Marriotte were reported by several observers in both England and France, without, however, resulting in any marked addition of either fact

1 Encyclopædia Britannica, 8th ed., Pneumatics, vol. xvi.
Essai sur le nature de l'Air, 1679. Œuvres de Marriotte, 1740, tom. 1.

2 Encyclopædia Britannica, 8th ed., Pnuematics, vol. xvi.
Mem. de l'Academie de Berlin, 1753.

or principle. Boyle had himself noticed that the actual results of experiments were not in exact accordance with the law which he had formulated; others had witnessed the same discrepancies, but the deviations, which seemed to increase as the pressure became greater, were by him and them attributed to errors in their experiments. These deviations from the law were exhibited in a marked degree in a more extended series of experiments made by Sulzer in 1753. Nevertheless he also regarded them as effects of imperfect manipulation. It may be said that Sulzer added no new method; that he contributed nothing to the forms of apparatus, and that his experiments are worthy of special notice only because they surpassed those of his predecessors in the amount of pressure applied. In theirs it had not exceeded four atmospheres; in his it was augmented to eight.

ROBINSON.[1]

Sulzer's experiments were afterward repeated by Robinson with precautions against what he regarded as the chief sources of error. These were, first of all, the presence of other gases, notably of the vapor of water in the air operated upon, and then, also, the presence of impurities such as bismuth and tin, together with air in the mercury employed for pressure. He therefore carefully removed the vapor of water from the air by desiccation, and the air from the mercury by boiling, while by using the same mercury for his experiments as that employed in his standard barometer he hoped to eliminate the effects of any baser metals which might be present.

The following table contains the results of his experiments on dry air. The first column gives the densities

1 Encyclopædia Britannica 8th ed., vol. xvi.
Encyclopædia Metropolitana.
System of Mechanical Philosophy, vol. iii., p. 637.

of the air under pressure, while the pressures stated in atmospheres is to be found in the second, and the pressures required by Boyle's law in the third.

1	1	1	5.5	4.930	5.5
2	1.957	2	6	5.342	6.0
3	2.846	3	7.62	6.490	7.62
4	3.737	4			

Robinson also experimented with air containing vapor of water and in another case with air containing the vapor of camphor. In every case his figures indicated marked deviations from those required by the law. But on the other hand the law commended itself by its mathematical simplicity, while the experiments could lay no claim to be considered perfect, and the apparent deviations were small. Hence the experimental results obtained by Sulzer and Robinson failed to seriously impair confidence in it, and Boyle's law was still generally held to be the expression of an absolute truth until 164 years after its discovery.

DESPRETZ[1]—1825.

But in 1825 the problem was stated by Despretz in a novel form and attacked by a method entirely new. All previous experiments had been made on air. Admit that Boyle's law is rigorously true for air, is it likewise true for other gases? This question Despretz seems to have been the first to ask; assuredly he was the first to answer it.

Taking several tubes as nearly alike as possible, and inverting them all in a vessel of mercury, he filled one with air and each of the others with a different gas

1 Bulletin de Sciences, tom. viii.
Annales de Chemie et de Physique, 2d series, tom. xxxiv.

whose compressibility he intended to compare with that of air as a standard. Thus arranged he placed the tubes and cistern in a strong glass cylinder completely filled with water and having a screw piston through the top by means of which pressure could be applied and greatly augmented.

Under these conditions the several gases were simultaneously brought under identical pressures and any difference in behavior could be readily detected. Observing the air and hydrogen tubes, the mercury rose in them equally until the pressure reached fifteen atmospheres, but when it surpassed that amount the mercury rose more slowly in the hydrogen tube, showing that hydrogen is less compressible than air. Sulphuretted hydrogen, ammonia, cyanogen and carbon dioxide, submitted to the same treatment showed still larger variations, and at much lower pressures. But unlike that of hydrogen the compressibility of all these gases was greater than that of air.

In fact each gas at high pressures exhibited a compressibility peculiar to itself. Hence Boyle's law could not be universal in its application. If it be rigorously true for air it must be untrue for all other gases.

POUILLET.[1]

The unequal compressibility of gases was soon afterward verified by Pouillet, with an apparatus which permitted the use of still greater pressures. His gas tubes were about six feet high, one-tenth of an inch internal diameter and carefully calibrated. Their feet were firmly fastened into a cast iron vessel. The bottom of this vessel communicated, by an iron tube, with a cast iron reservoir containing mercury surmounted by oil, which completely filled it. Projecting into the oil through the top

1 Elements de Physique, Pouillet, 5th ed., tom. i.
Deschanel Natural Phil., Everett, p. 173.

of the reservoir was a solid metallic plunger which could be thrust still further by means of a powerful screw.

Equal volumes of two gases, dry and pure, introduced into the tubes could be submitted to enormous pressures by this screw plunger whose descent would drive the mercury against them, while the great lengths and small diameters of the gas columns would permit the changes of volume to be distinctly seen even when the volumes of the gases would be reduced to a small fraction of their original values.

Pouillet's apparatus fully confirmed the results of Despretz's experiments. It showed that no two gases suffered compression exactly alike, and that hydrogen alone was less compressible than air.

DULONG AND ARAGO[1]—1829.

Despretz's experiments did not question the truth of Boyle's law in its application to air. For this substance and for its constituents—nitrogen and oxygen—the law was still supposed to hold good. But when it is remembered that this opinion had no better foundation than the fact that there were obvious sources of error in the experiments which exhibited the deviations of air it will be seen that the attitude of this substance toward the law was still an open question.

Dulong and Arago, in 1829, submitted the question to an experimental test. Their apparatus was essentially the same as that used originally by Boyle, but with such modifications and refinements as would secure greater accuracy and admit the use of vastly greater pressures.

The tube which enclosed the air was about six feet high, an eighth of an inch in diameter inside, and accu-

1 Memoires de l'Academie des Sciences, tom. x.
Annales de Chemie et de Physique, 2d series, tom. xliii.
Ganot's Physics, Atkinson, 8th ed., p. 135.
Cooke's Chem. Physics, p. 293.

rately graduated with the zero at the bottom of the scale. The other tube, destined to hold the pressure-column of mercury, was about seventy feet high. It was built up of successive lengths, joined with the greatest care to avoid leakage, and supported alongside a mast by means of staples, each length being at the same time counterpoised by weights attached and suspended over pulleys. The two tubes were joined together by a cast-iron pipe, which was also in communication with a forcing pump.

Mercury was driven out of this forcing pump in both directions equally, crowding the air in the air-tube and rising freely in the other. To keep the air from being heated by compression, the air tube was enclosed in a jacket through which a stream of water slowly circulated. The mercury rose to greater and greater heights, the air was crowded into smaller and smaller space, while the readings of the scales from time to time gave the numerical values of the volumes, and the corresponding pressures up to twenty-seven atmospheres.

At this pressure the air should by Boyle's law occupy just one twenty-seventh of its original volume. The actual reading of the scale showed it to be somewhat less than this, and air did accordingly seem to be more compressible than the law required that it should be.

Nevertheless, the departures from the law were very small, and, remembering the difficulties they had experienced in their attempts to avoid error, and the slight uncertainty which they could not banish from their judgment in reading the minute changes on the measuring scale, Dulong and Arago decided to regard them as falling within the limits of experimental error. It was, therefore, generally conceded that in the case of air the rigorous truth of Boyle's law had been established by their experiments.

REGNAULT[1]—1841.

Twelve years later this conclusion was overthrown by the classic experiments of Victor Regnault. Regnault's method and apparatus were in principle essentially those of Dulong and Arago, surpassing them and all others, however, in the refinements introduced for the purpose of banishing or correcting those troublesome sources of error which hitherto had perplexed the judgment of all observers. These errors were

First, Moisture in the air operated on, which would cause it to seem more compressible than it really is. Regnault provided an efficient system of absorption tubes by which every trace of vapor could be removed.

Second, Heat generated in the air by its own compression, which would reduce its observed compressibility below the real value. Regnault enclosed his air tube in a jacket, through which a stream of water flowing kept a constant temperature as shown by a delicate thermometer.

Third, Variations in the temperature of the mercury in the pressure-column during the experiments, which would cause the same length of column to contain different weights of mercury, exerting a greater pressure if colder and a lesser pressure if warmer. Regnault placed thermometers at intervals along the pressure column, observed the actual temperature, calculated the error and corrected the observed height of the column accordingly.

Fourth, Compressibility of the mercury itself due to its own weight, which would diminish the height of the pressure column and reduce the observed pressure below the actual value. Regnault calculated this compressibility in every instance, and made the proper corrections for it.

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1 Memoires de l'Academie des Sciences, tom. xxi—(Original.)
Cooke's Chem. Physics, p. 296—(a table.)
Deschanel Natural Phil., Everett—p. 173—(Apparatus.)

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Fifth, Errors in reading very minute changes by scale, which forbids the measurement of volumes with entire exactness and, which, when reduced to their lowest limits, become more serious as the volumes become smaller, since the same error which may be neglected when the volume is very large in comparison will be a hundred fold more serious when the volume is reduced to the hundredth part. Regnault's tubes were gauged with great precision, and by the use of a cathetometer he could read a difference of half a millimeter with considerable exactness, and to forbid the multiplication of the value of the error by small volumes he forced a fresh supply of gas into his apparatus before every observation, until he should have the same large volume to measure at the highest as at the lowest pressures.

Nothing can better illustrate the progress of experimental science during the two centuries than a comparison of this powerful and refined apparatus of Regnault, with the primitive bent tube employed by Boyle and Marriotte. The latter contemplated the action of pressure alone, as if it were an isolated principle in nature, unhindered and unaided by any other, while the former recognizes it as only one of many, each of which asserts itself in determining the result. Seen from the standpoint of Boyle's tube, natural phenomena are separate effects of single causes; there is a subject and a predicate, but no modifiers. Boyle's tube bears a relation to Regnault's apparatus similar to that which the simplest sentence framed by the schoolboy bears to the smooth period of the rhetorician or the well-rounded argument of the skilled logician.

The results of Regnault's experimental logic were at once adopted into science. They may be summarized as follows:

First, That for neither of the gases operated on, viz., air, hydrogen, nitrogen, and carbon dioxide, is Boyle's law exactly true.

Second, That the deviations increase more rapidly than the pressures increase.

Third, That hydrogen is less compressible than the law demands.

Fourth, That other gases are more compressible than they would be if the law were general; and,

Fifth, That both carbon dioxide and air vary less at a higher temperature—the former conforming to the law almost exactly at 100° C.

But even these trustworthy experiments were not destined to long remain the last effort in this direction. It afterwards appeared that they did not reveal the whole truth. In fact, true as Regnault's results might be within the limits of pressure which he employed, the most natural inferences projected beyond those limits could not be verified. The pressures employed ran up to about thirty atmospheres. Air and other gases, except hydrogen, became more and more compressible as this limit was approached,—why should they not continue to do so when this limit was surpassed? Such was generally conceded to be the fact.

NATTERER[1]—1850.

But this inference was contradicted by the investigations of Natterer, who in 1850 experimented with gases under pressures enormously greater than had ever before been reached. By a powerful forcing pump nearly three thousand atmospheres were brought into action. Hydrogen, oxygen, nitrogen, air and nitrous oxide were submitted to these tremendous pressures. Hydrogen alone maintained its behavior the same as when treated

1 Cooke in Chemical Physics, p. 299, gives a table of Natterer's results taken from Leibig and Kopp, Jahresbericht Für 1851, seite 88, to which he refers. For full results the same author refers to Wien Acad. Ber. xii, 199. or Pogg. Ann. xciv, 436.

in Regnault's apparatus. The compressibility of all the others changed sign. Instead of steadily becoming more compressible, as they had done below thirty atmospheres, they became at one hundred less compressible, and their deviations in this direction became larger and larger as the pressure was still further augmented.

This curious change in the sign of the compressibility of a gas at some high pressure has not been left without confirmation. M. Cailletet has shown that, for air at least, Natterer's conclusion is essentially correct. The change took place at about eighty atmospheres, and thence up to six hundred its compressibility grew less and less.

We must now admit that there is one degree of pressure at which air conforms exactly to the requirements of Boyle's law—a pressure of about eighty atmospheres or twelve hundred pounds to the square inch. According to Natterer the same is true for several other gases. Among those tried hydrogen is the only exception.

But what is the effect of low pressures? Regnault's experiments showed that the deviations from the law increased rapidly with the increase of pressure. "Hence we may conclude that as the pressure diminishes and the gas expands, the deviation from the law of Marriotte becomes gradually less, until at an infinite degree of expansion, this law would be the exact expression of the truth."—(*Cooke's Chem. Phys., p. 297*).

This is a most natural inference, and without waiting for experimental confirmation it became the general belief. Indeed an inference so well grounded as this would appear to be, would seem to need no experimental evidence to maintain it, nevertheless the investigation was finally undertaken in Russia by Mendeleef.

MENDELEEF[1]—1872–76.

Briefly described, the apparatus devised by Mendeleef consisted of a reservoir of mercury, in the upper part of which was the air to be submitted to low pressure, communicating by means of a capillary tube with a branch of a siphon barometer. The height of the mercury in this barometer indicated the pressure at work. By withdrawing mercury from the reservoir the pressure was reduced, and the weight of the mercury withdrawn gave the data from which to calculate exactly the volume of the expanded gas.

This method is very simple, but its application demanded the utmost care and skill. Various and nice precautions were needed in order to eliminate sources of error and to reveal minute details in the results.

Among these sources of error are some which even Regnault had neglected. The surface of mercury in any tube is convex. Mendeleef took account of the air which lay below the plane across its summit.

Every change of pressure not only changes the volume of the air, but it changes also the capacity of the vessel which contains it. This compressibility of the reservoir had to be determined and introduced as a correction of the results.

The last traces of air had to be expelled from the mercury and from the barometer. Mendeleef devised a new mode of filling the barometer for this purpose.

The tubes had to be calibrated with the greatest exactness; the joints of the apparatus had to be tight to the last degree of perfection; the gas had to be desiccated with care; and, finally, the temperature of the whole

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1 "On the Elasticity of Gases, (Russian,) Mendeleef.
Russian Journal of Artillery, 1872.
Bulletin St. Petersburg Acad. of Sciences, 1874.
Annales de Chemie de Physique, 1876.
Nature, xv. p. 455.

had to be kept constant, and the readings of volumes and hights had to be taken with extreme precision.

The pressures employed lay between about eighty-five hundredths and twenty-six thousandths of an atmosphere, or more exactly between 650 mm. and 20 mm. of mercury column.

The gases examined were air, hydrogen, carbon dioxide, and sulphurous oxide, with the following results:

Hydrogen, which had proved to be less compressible under great pressures than it should be according to Boyle's law, maintained that characteristic to the end; but, contrary to the prediction, its departures became greater and greater as the pressures diminished. In fact, its deviation from the law was five times greater when the pressure was reduced to 120 mm. than when the greater pressure of 400 mm. was upon it.

Air, as the pressure ran down from one atmosphere to 600 mm., was found to remain more compressible, as it had been at higher pressures. But at about that point the sign of the deviation changed, and, like hydrogen, it became less and less compressible, thenceforth, with increasing deviations from the law.

For the other gases the same change of sign occurred. Carbon dioxide, for example, varies from the law, its compressibility being too great—twenty-nine parts in ten thousand—when the pressure diminishes from 635 mm. to 200 mm., while, carrying the pressure still lower—from 190 mm. to 22 mm.—the same gas departs from the law the other way to the extent of seventeen parts in ten thousand.

At a certain degree of low pressure, all these gases, except hydrogen—which is already so—change from being more compressible to being less compressible than if Boyle's law were rigorously true; and we must admit that at this pressure, determinate for each gas, the law is an exact expression of the truth. When rarefied beyond this point, each gas becomes less submissive to pressure—its behavior towards pressure becomes more and more like that of a liquid or a solid.

These results of Mendeleef are the last words of experimental science in regard to the relation of the volume of a gas to the pressure it sustains.

As the case now stands, the behavior of a gas under varying pressures may be described as follows:

There are two degrees of pressure—one considerably above the normal atmospheric pressure, the other considerably below it—at which the volume of a given mass of gas varies inversely as the pressure upon it, the ratio being exact.

Between these two points all gases, except hydrogen, are more compressible than this ratio indicates.

Outside these limits, whether above the highest or below the lowest, all gases, without exception, are less compressible than this ratio indicates—the rarefaction of the gas as well as its condensation rendering it less compressible.

A NEW APPARATUS FOR BOYLE'S LAW.[1]

BY LE ROY C. COOLEY, PH.D.

This new form of apparatus for experiments on Boyle's law was devised for the following purposes, viz.:

First, To avoid the necessity of adjusting the volume of the air to the zero of the scale.

Second, To secure a quick, easy and certain transition from one definite degree of pressure to another.

Third, To combine in one piece the means of employ-

1 For descriptions of some recent forms of apparatus for the demonstration of this law, see

Weinhold's Experimental Physics, by Loewy—p. 240.

Science, Vol. II—284.

ing pressures both above and below the pressure of an atmosphere.

Fourth, To provide AN APPARATUS FOR PROJECTION wherewith the mathematical relation of volume to pressure may be accurately exhibited to large classes.

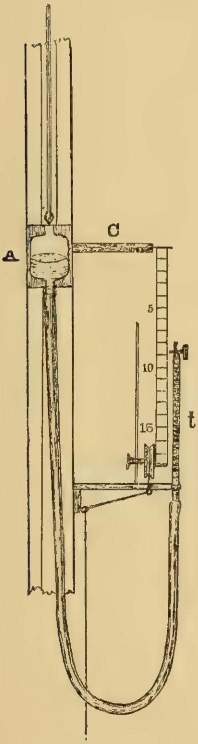


Fig. 1.

A vertical standard made of wood is provided with a groove which extends throughout its length. In this groove a wooden block, A, (fig. 1), moves, with little friction, and carries a glass reservoir of mercury counterpoised by a weight acting over a pulley on the top of the standard. A rubber tube connects the bottom of the reservoir with the lower end of an accurately graduated glass tube, *t*, containing a convenient volume of air. This air-tube is placed at a distance of about six inches from the standard, to which it is attached by means of a metallic arm.

The *zero of the graduation of this air tube is at the top*, and the scale reads downward. The scale reading at the top of the mercury always shows the volume of the air. And since it is the exact measurement of the volume and not any particular quantity that is necessary, this simple artifice obviates the necessity of adjusting the volume for experiment.

The lifting and lowering of the reservoir along the standard, which is easily done by means of the counterpoise, increases and diminishes the pressure upon the air at pleasure, the transition from one degree to another being quick, easy and precise.

Moreover, since the air tube is placed about the midheight of the standard, the reservoir may be raised above it or lowered below it, and thus pressures either above or below an atmosphere may be applied with equal facility.

To measure these pressures, a light scale of inches and tenths is attached to an arm, c, projecting from the block, which carries the reservoir and hangs parallel and alongside of the graduated air-tube. *The zero of this scale is at the top*, and is exactly on a level with the mercury in the reservoir, when this level is the same as that in the air-tube and the air is at the normal pressure of the atmosphere. *It is movable*, rising and falling with the reservoir to which it is firmly attached. Moreover, *it is a flexible scale*, and is kept tense by a spring or a weight which winds it upon a drum, or allows it to unwind, as the motion of the reservoir demands. The division on this scale, which coincides with the top of the mercury in the air-tube, shows the height of the mercury column at any moment.

The reservoir is made large in comparison with the air-tube: on this account the change of level in it is slight. Nevertheless, its sides are made straight—its capacity uniform in order that its rate of change may be determined; after which a correction can be introduced if greater accuracy is desired.

This scale is not only movable and flexible, *it is also transparent*, being made of the finest quality of vegeable tracing paper. Accordingly, the air under experiment and the adjacent part of this scale may together be projected on a screen, when the volume and the corresponding pressure can be read in the image by an audience with even greater accuracy than otherwise, on account of the enlargement. A beam of sunlight from a porte-lumiere may be used, or these parts of the instrument may be placed as an object in front of the condensers of a modern lime-light lantern. With either of these illuminations the opaque divisions of both scales may be distinctly projected.

The grooved standard and the rubber tube are features borrowed from a German apparatus figured in *Weinhold's Physics.*

The following are believed to be novel:

First, The substitution of a counterpoise for clamps in lifting and lowering the mercury-tube.

Second, The placing of the zeros of the scales at the top and reading downward.

Third, The use of an adjustable scale to measure the heights of the mercury column; and,

Fourth, The use of a flexible and transparent scale.

FEBRUARY 13, 1884—TWENTY-FIRST STATED MEETING.

Prof. W. B. Dwight, chairman, presiding; fifteen members and guests present.

Prof. W. B. Dwight gave a description of the

EMBRYONIC FORMS OF *Limulus polyphemus*—KING CRAB.

Specimens of the larvæ of the "king crab" *L. polyphemus* were shown in the stage of development immediately subsequent to their hatching from the egg, which were four millimeters in length. At this stage the abdominal spine is either entirely unformed, or, more generally, barely indicated in its rudimentary condition. Although these larvæ must be in abundance on our shores, for some reason they were rarely seen or collected by scientists. These were discovered in a crowded mass or nest in the sand, on the shore of a lagoon, at Martha's Vineyard, Mass. They were the first he had found on the seashore, and on inquiry, he had ascertained that there were no specimens of them in many of our leading museums.

The larval forms of the *Limulus* bore important relations to the extinct trilobite, the facts pertaining to which were first discovered by Prof. Samuel Lockwood, who reported thereon in a paper before the New York Lyceum in October, 1869, and in a published paper in the *American Naturalist*, vol. iv., July, 1870.

Prof. Dwight discussed the structure and relations of the trilobite, and stated that Burmeister's opinion that it had membranaceous swimmerets instead of stout, chitinous legs, had been, until very recently, the most accepted theory among naturalists. Mr. C. D. Walcott had, however, very lately shown, by comparing many microscopic cross-sections of trilobites, that they probably had spiral gills, and round, strong, and jointed legs. A still more recent discovery of a specimen in Ohio, described in the *American Naturalist*, December, 1883, by J. Mickleborough, which appears to possess legs of this kind, seems to reinforce strongly this theory. This is one of the most interesting points brought out in modern paleontological research.

It has been stated that among thousands of moulted carapaces of the *Limulus*, examined at various stages of growth, not one had been found possessing the peculiar nippers of the male. From this fact, it had been concluded that these male appendages did not exist until after the creature had undergone its last moulting. Prof. Dwight had noticed that the nippers of the male were never to be found on any of the young specimens or moulted carapaces which he had examined, and that he had searched in vain for this distinction between the sexes in hundreds of exquisitely formed larvæ. It therefore seemed to him that the observation was probably correct in so far as regards the earlier stages of the development. That the "king crab" never moults after developing the nipper-claws, is, however, to say the least, not proven. Professor Lockwood has attacked this statement, and shown that such moulting may well occur and yet the rejected carapaces may not be found on our beaches. It was suggested that such maturer moulting occurs only in deep waters, beyond the reach of wave-action.

Mr. C. N. Arnold read some notes on, and exhibited specimens of "Fossil Gums and Resins."

FEBRUARY 27, 1884—TWENTY-SECOND STATED MEETING.

Prof. W. B. Dwight, chairman, presiding; twenty-four members and guests present.

The following paper was read:

SOME EVIDENCE OF INTELLIGENCE IN BUTTERFLIES.

BY J. M. DE GARMO, PH D.

The limits of knowledge among Lepedoptera are soon reached, and are very narrow. To such as hesitate to apply the term "intelligence" to these lower manifestations of the knowing power, we shall offer no objections. For whatever significance may be attached to the extreme phenomena of "instinct" and "intelligence," there is no doubt a border land where these terms seem interchangeable. Some of the phenomena of this disputed region can be readily and reasonably classed under either head. If any prefer to call these facts evidence of instinct rather than of intelligence, they are welcome to the privilege.

The knowledge essential to self-preservation first claims our attention. On slight examination this seems almost entirely limited to a perception of danger arising from motion. They have no knowledge of persons or animals apart from motion. The wildest and most timid will remain at rest if a person approaches them so gently that no movement is perceptible. The *Papilio turnus*, most alert and restless of all our local varieties, will remain perfectly quiet, if the approach be made sufficiently gradual. They can even be picked up with the fingers at times. But the slightest evidence of motion, especially above them, alarms them at once. I have sent a small stone near them, and witnessed every evidence of alarm. When once disturbed, they become more restless and wary. Some, as the *Turnus* and *Troilus*, when rudely disturbed by a stroke of the net, rise high in the air, and immediately seek another resting place, even when on their choicest feeding grounds. Others, as *Papilio asterias*, will make a detour, alighting briefly on some other flower or leaf, and then almost invariably return to the one from which they were frightened.

The *Argynnidæ* are also likely to return again, as is *Nymphalis ephestion.* But the most perverse disregard of all measures of safety is exhibited by the little *Grapta comma.* This little butterfly usually takes his pastime towards sunset, when only now and then a patch of sunlight remains among the shadows of trees, especially upon some gate post, or the trunk of a tree, or a sidewalk. When disturbed very roughly they will take a zigzag trip over a tree, or a house-top, or a fence, and often without lighting anywhere, return to the old spot within six inches. Many times I have put my hands on the coveted spot, and had the little *Grapta* light upon them. Sometimes they will light upon my hat, or the net I hold in my hand, evidently entirely unconscious of danger. But motion, even of a straw, will frighten them away. This peculiarity in their sense of danger is easily explicable. The enemies most deadly to them are the birds. These attack mostly from above, and always on the wing. They use no caution in securing their prey, but swoop down upon them at great velocity. In all my watching, I have never seen a bird take a butterfly from beneath. The pewee will either drop like lightning from its branch upon the prey, or if the prey is above it, will rise to an altitude above the prey and drop down upon it. Hence its knowledge of danger, or if you prefer it, its organized experience of danger, is all from above, and from something in rapid motion.

From beneath, even when in a position on a pendulous flower or leaf to see perfectly, they can be approached with much greater ease and certainty of capture.

Another manifestation of intelligence is in their plain efforts to hide from danger. After pursuing a *Turnus* for some time, and repeatedly starting it from its feeding grounds by ineffectual attempts to capture it, I have often seen it seek the dense foliage of some large-leaved tree, like the maple, hickory, or tulip, and getting itself snugly ensconced on a leaf immediately sheltered by one or more others, it was apparently feeling absolutely safe. Then, any ordinary degree of caution is sure to result in its capture. The *Argynnis aphrodite* once exhibited remarkable knowledge and as remarkable stupidity in this matter. I found quite a number of them feeding on a cluster of thistles in front of a disused barn. Behind the barn was a patch of low sumac bushes, through whose foliage the sunlight filtered in tiny blotches, as from a sieve. The ground underneath was covered with vines of the running blackberry. I came to the barn hurriedly, and when near the butterflies, tripped in the tangled grass and fell, flinging the net into the thistles. When I rose, not a butterfly was to be seen. I went to several adjacent clusters of thistles, but found nothing. I searched all about in vain. Returning in an hour, I found them there again, and caught two in a single cast of the net. But after securing them, I discovered that the rest were all gone again. The next day I came determined to spy out the performance. A companion threw the net at the thistles, and lo! the butterflies all flew round the barn, and lighted under the sumac bushes, each on a blackberry leaf. Now the oddest part of this was, that they had made the circuit of one-half the circumference of the barn to get to the hiding place, when they could have reached it by a short trip directly across the end of the barn. Moreover, part of this route was through the shade, which a butterfly usually shuns. Here was another problem. The short cut was direct and in the sun. Why did they take the roundabout way? The next day solved it, for on coming in sight of the place, I saw three or four small boys approaching the thistle patch, straw-hats in hand, from the end of the barn, and after their onslaught, not a butterfly was to be seen. The boys were communicative, and I found had made many attempts to catch them. They had invariably come up the same way, for they were barefooted, and the tangled grass was full of stones, while the ground at the end of the barn was grazed close or mown. The butterflies had availed themselves of their "organized experience" to dodge the boys.

On following them into their retreat, I found them motionless. Not a wing or an antenna stirred,—they were as "still as mice." But right here their stupidity began, for I caught two of them with my fingers, and could have taken the whole with a little care, had I wanted them. Then I made a grand swing with my net into the sumac bushes, and a more bewildered set of beings it would be difficult to find. They went helter-skelter,—on the barn, on the wall, anywhere and everywhere, without method or sense. On going back again, not a butterfly was to be found. Whether the boys ultimately frightened them away, or whether my inroad upon their harbor of refuge disheartened them, I never ascertained. Similar wisdom and stupidity were exhibited by a *Vanessa antiopa*, in its preparation for winter quarters. It had selected for this purpose the open end of a street drain, built of stone. For two or three days it remained there, but a warm sun called it out, and I tried to catch it. It was very active and alert, but finally went to its hiding place, where it felt so perfectly secure that I took it in my fingers with ease.

Often, in pursuing butterflies, I have seen them show the most perfect stupidity, apparently courting capture, and, then again, exhibiting good sense in evading pursuit. Here, as elsewhere, motion is the main source of their alarm. If the net can be carried after them so as to conceal any motion they will allow it to approach quite close, even to overshadow them while flying.

One of the most curious features of a butterfly's life is its sportive or playful moods and ways. It was some time before I appreciated the fact that they indulged in such moods at all. Seeing them start vigorously after other insects on the wing, I assumed, without investigation, that these were movements in self-defense, till all the facts pointed to them as movements in play. This opened a new and interesting field of observation. The spirit of playfulness I found to prevail more towards sundown than in the morning. Only a very few times have I seen any signs of it in the morning, and never in the absence of sunshine. I found it far more common among the highly developed four-footed butterflies, as the *Graptas*, *Vanessas*, &c., than among the six-footed *Papilios*. Among the *Turnus*, *Troilus* and *Asterias* varieties, as well as the *Ephestions*, I never saw the least spirit of playfulness. These seem to be bent on the earnest business of their lives alone, and especially the *Turnus* and *Troilus* wing their stately flight as if this were not a world where even a butterfly needed play.

But with the smaller varieties this playfulness is quite common. The yellow *Philodice* will often dart from its flower with great velocity, and make quick sallies at another, either of its own species or of a different species. It will fly about the companion, if that one is not disposed to join in the fun,—if it is, away they will go, tumbling over and over in the air, now receding from each other, now approaching. I have never ascertained if they had any playful touches of antennæ, as their motions are too swift for the eye. Often the little *Grapta comma* will follow a much larger butterfly, perhaps the *Aphrodite* or *Idalia*, now under, now over it, in swift zig-zag movements, as if enjoying it hugely, while receiving no attention from the larger specimen. Sometimes the *Grapta* will pursue, as if in sport, a beetle or a wasp,—in such cases keeping a good distance away, but continuing the pursuit for some rods.

Once I saw a *Grapta* and an *Alope* rising high in the air together, going over and over each other in sportive mood, when a pewee bird shot swiftly upon the *Alope*, and bore it off. The little *Grapta* folded its wings back to back, and in half the time I am taking to tell it, liteerally dropped to within two or three feet of the ground, recovered its wing and then hid in a thick evergreen tree close by. On following it, it seemed unhurt, but greatly alarmed, ceaselessly changing its position from limb to limb, and finally getting under a large limb, and remaining very nearly motionless. On another occasion, however, a bird seized a *Turnus*, breaking a portion of its anterior wing, but the butterfly exhibited no alarm and continued steadily on its way, minus a bit of wing. It evidently did not appreciate the fact that it had very nearly lost its life, or else it held life much more cheaply than the ordinary animal.

But the greatest manifestation of fun and frolic was in a group of *Alopes*, some thirty in number, clustered under a tree in the shade. Such wild gambols on the wing I never saw, often in one compact cluster, wings and legs and antennæ in a confused jumble, then off in pairs, then in two crowds, with all the marks of "mirth and jocund din." Such scenes do certainly appear like an intelligent appreciation of fun, as they clearly have no reference to any necessary functions of body, and seem intended only for gratification.

One other class of facts would demand our attention, were it not that they are usually relegated to the domain of instinct. I refer to the selection of proper plants on which to deposit their eggs, so that the larvæ may have appropriate food when hatched. Yet if it be instinct, it is not always unerring, for I have found eggs upon leaves which the larvæ would not eat, but left to seek more palatable supplies. If instinct never errs, then this cannot be instinct,—if it errs at times, then it has a striking resemblance to intelligence.

On the whole, we can safely say that the intelligence exhibited by butterflies is of a very low order, and is mostly confined to the disputed region where it touches the domain of instinct.

MELANIC VARIETY OF *Papilio turnus.*

[Syn.—*Papilio glaucus: Jasoniades glaucus.*]

Dr. W. G. Stevenson reported a specimen of this butterfly taken at Poughkeepsie in August, 1882. It is four and a half inches across the wings, and is a beautiful example of melanic antigeny.

Mr. Scudder in his work on *Butterflies*, states that "the home of this butterfly stretches from Alaska to Florida, but north of the southern boundary of New York or thereabouts not a black female can be found." This specimen is interesting because it is the first one—so far as known—of this variety that has been found in this vicinity.

MARCH 12, 1884—TWENTY-THIRD STATED MEETING.

Prof. W. B. Dwight, chairman, presiding; twenty-five members and guests present.

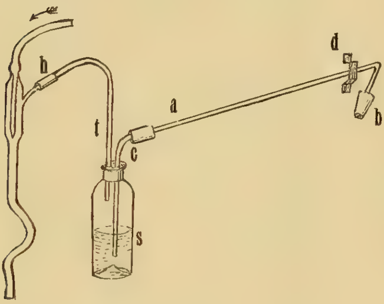
The following papers were read:

VENTILATION FOR THE LABORATORY TABLE.

BY LEROY C. COOLEY, PH.D.

In the Vassar Brothers Laboratory of Vassar College, a Richard's aspirator is placed at every table and provided with the necessary supply and waste pipe. Besides rapid filtration, the usual object sought by the use of this apparatus, the writer has found it to be an admirable means for aspiration in all the usual applications of the process. In addition to these purposes he has also employed the same instrument for carrying off noxious vapors from the laboratory table in the process of evaporation.

To fit the aspirator for general use it is mounted over a small sink at one corner of the work table, with connections shown in Fig. 1. A small glass tube, *t*, joined



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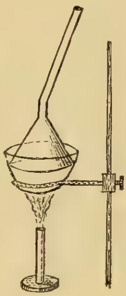

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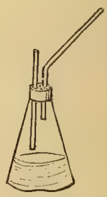

3.

to the exhaust pipe by rubber tubing, *h*, passes through the air tight cork of an eight ounce wide mouth bottle. A larger tube, *c*, reaches nearly to the bottom of this bottle. The end, *a*, of another tube is drawn down to proper size to be thrust into the outer end of this tube, *c*, through a piece of rubber tubing stretched over their junction. By this means an air tight but flexible joint is secured through which fluids may flow without contact with the rubber. This tube is supported against the back of the table by a tin clasp, *d*, through which it passes loosely. The end, *b*, is bent forward and carries a short piece of rubber tube by which connection is made with whatever apparatus is to be exhausted.

Disconnection is made at this point always while the aspirator is still running to prevent the water in the bottle, *s*, from backing over into the vacuum produced in the filter flask or other vessel employed.

For evaporation, a glass funnel is selected whose diameter is a trifle less or a trifle more than that of the evaporating dish, and whose stem is six or eight inches long, and bent at right angles, close to the body. Let this funnel be inverted over the evaporating dish and rest upon it, (fig. 2), and let its stem be connected with the aspirator by being thrust through the rubber tube at *b*; then turn on the water and apply the heat. Air will be drawn into the funnel, entering between its edge and that of the dish and out through the aspirator into the waste-pipe, carrying the corrosive vapors with it.

Since the edge of the funnel may rest either inside or outside that of the dish with the same result, one funnel will fit dishes of different sizes. One of three inches in diameter for evaporating dishes, and another of one and a half inches for crucibles, are in use.

With this ventilating funnel strong nitric acid can be evaporated to dryness on the open work-table without inconvenience from its fumes.

Or a ventilating flask may be used for the same purpose. Close a flask with an air-tight stopper pierced with two glass tubes, one reaching well down toward the surface of the liquid within, the other only through the cork (fig. 3). The latter is to be connected with the aspirator. A rapid current of fresh air will thus be drawn over the surface of the evaporating liquid and with the corrosive vapors off into waste.

Or, let the cork be pierced with a single tube to connect with the aspirator. A partial vacuum will then be formed within, and the evaporation will occur under diminished pressure and at lower temperature.

A LIST OF THE GASES, WITH THE TEMPERATURE AND PRESSURE OF THEIR LIQUEFACTION.

BY LEROY C. COOLEY, PH.D.

TABLE I.

SUBSTANCES WHICH ARE GASEOUS AT 0° C. AT ORDINARY PRESSURE OF THE ATMOSPHERE AND KNOWN TO BE LIQUEFIABLE.

NAME.	FORMULA.	PRESSURE IN ATS.	TEMPER'TURE C.	LIQUEFIED FIRST BY
90 Acetylene	$C_2 H_2$	48	1°	Cailletet, 1877.
		1	Ordinary	Thenard, 1874. By the silent electric discharge.
Ammonia	$H_3 N$	1	— 40°	Faraday.
Bormethyl	$(CH_3)_3 B$	3	10°	
Boron fluoride	$B F_3$	11.5	— 52°.2	
Carbon dioxide	$C O_2$	1	— 78°.2	Faraday.
		53	Ordinary	
Carbon monoxide	$C O$	300	— 29°	Cailletet, (liq. by expansion.)
Chlorine	Cl	1	— 33°.6	Faraday.
		6	10°	
Chlorine monoxide	$Cl_2 O$	1	— 19°	Faraday.
Chlorine trioxide	$Cl_2 O_3$	1	0°	
Cyanogen	$C N$	1	— 20°.7	Faraday.
		2.7	0°	
Ethane	$C_2 H_6$	46	Ordinary	
Ethylene	$C_2 H_4$	46	4°	
Hydrogen	H	300	— 29°	Cailletet, (liq. by expansion.)
		625	—140°	Pictet.

Hydrogen arsenide...........	$H_3 As$	1	— 40°	Stromeyer.
Hydrobromic acid.....	$H Br$	1	— 73°	Faraday.
Hydrochloric acid............	$H Cl$	20	— 16°	Faraday and Davy.
Hydroiodic acid..........	$H I$	1	— 73°	Faraday.
		4	0°	
Hydric phosphide.............	$H_3 P$			
Hydric sulphide........... . ..	$H_2 S$	1	— 70°	Faraday.
Isobutane	$(CH_3)_3 CH$	1	— 17°	
Isobutene	$C_4 H_8$	1	— 7°	
Methane......................	$C H_4$	180	— 11°	Cailletet.
Methyl bromide...............	$CH_3 Br$	1	— 17°	
Methyl chloride........	$CH_3 Cl$	1	— 23°	Vincent and Delachanal.
		2.48	0°	
Methyl ether............. ...	$(CH_3)_2 O$	1	— 21°	Berthelot.
Methyl nitrite.........	$CH_3 NO_2$	1	— 12°	
Methyl phosphine............	$CH_3 H_2 P$	1	— 14°	
91 Nitrogen.............	N	300	— 29°	Cailletet, (liq. by expansion.)
		150	—136°	Wroblewski and Olzewski, 1884.
Nitrogen monoxide...........	$N_2 O$	1	— 87°.9	Faraday.
		30	0°	
Nitrogen dioxide......	$N_2 O_2$	104	— 11°	Cailletet.
Nitrosyl chloride......	N O Cl	1	— 8°	
Oxygen	O	300	— 29°	Cailletet, (mist by expansion.)
		475	—130°	Pictet.
Ozone........................		26.5	—131°.6	Wroblewski and Olzewski, 1884, (by expansion.)
		125	—100°	Hautefeuille and Chappius, 1882.
Propane......................	$C_3 H_8$	1	— 25°	
Propylene........	$C_3 H_6$	1	— 7°.8	
Silicon fluoride...............	$Si F_4$	1	—107°	
		30	Ordinary	
Sulphur dioxide..............	$S O_2$	1.53	0°	Faraday.
		2.54	Ordinary	

TABLE II.

SUBSTANCES WHICH ARE GASEOUS AT ORDINARY TEMPERATURES AND PRESSURES, BUT CONDENSED BY COLD ABOVE 0° C.

NAME.	FORMULA.	TEMP.
Butane	$C_4 H_{10}$	1°
Butylene......... ...	$C_4 H_8$	3°
Chlorine peroxide....	$Cl O_2$	9°
Methylamine.	$CH_3 H_2 N$	
Dimethylamine	$(CH_3)_2 HN$	8° or 9°

TABLE III.

SUBSTANCES GASEOUS AT ORDINARY TEMPERATURES AND PRESSURES, TEMPERATURE AND PRESSURE FOR LIQUEFACTION NOT STATED.

NAME.	FORMULA.
Allylene	$C_3 H_4$
Carbonyl sulphide....	C O S
Hydric selenide......	$H_2 Se$
Methyl fluoride.......	$C H_3 F$
Phosphorus fluoride..	$P F_5$
Silicon hydride.......	$Si H_4$

Total number of gases, 47.

SIMPLE DEVICES FOR LOCKING LABORATORY DRAWERS AND CUPBOARDS.

BY LEROY C. COOLEY, PH.D.

A strong small staple is fixed in the framework between the adjacent corners of four drawers. A disk of heavy sheet brass is provided with a rectangular slit at the centre, only large enough to receive the staple. A small padlock is then applied. The disk projects over the corners of the drawers and effectually fastens them. Those in use are only four and a half inches in diameter; the padlock is one and a-half inches across.

For rows of larger drawers or of cupboard doors, a strong hard wood slat, about one and one-half inches wide, by three-quarters of an inch thick, and long enough to reach the length of from four to six drawers, is hinged to the woodwork, just above their tops. A brass plate projects from behind the middle of the slat, with a slit which fits over a staple, firmly fixed in the wood below. A small padlock secures the whole. The friction on the hinges can be easily made sufficient to keep the slat from falling when lifted.

MARCH 26, 1884—TWENTY-FOURTH STATED MEETING.

Prof. W. B. Dwight, chairman, presiding; eighteen members and guests present.

The following paper was read:

REPORT OF PROGRESS IN GEOLOGICAL INVESTIGATION IN THE VICINITY OF POUGHKEEPSIE.

BY PROF. W. B. DWIGHT.

The two papers on this subject which I have previously presented before Poughkeepsie audiences, were read in the meetings of the Poughkeepsie Society of Natural Science, to which our present society is virtually the successor. The first of these papers was read April 21, 1880, and was published in the proceedings of the society for that year. After giving a *résumé* of former investigations, it took up the more recent ones, describing the finding of numerous Hudson River group fossils in our shales, by Mr. T. N. Dale, the subsequent discoveries of fossils of the Trenton group by Prof. J. D. Dana and myself, and the still later identification by myself, of calciferous fossils at Salt Point and Rochdale.

A second paper was presented in 1881, which, however, was never published, owing to the throes of dissolution into which the P. S. N. S. had already entered. On this occasion was announced the surprising discovery, in what had been already identified as calciferous rock, of a large and remarkable lot of orthoceratites and other fossils of various species hitherto mostly, if not entirely, unknown in that formation, and hardly to be expected there. A large number of these fossils, still in their rough, unstudied condition, were exhibited at that time.

It is the object of the present paper to indicate very concisely the main points of interest in the progress that has been made in this field of research since the date of the last report above mentioned.

My own special explorations have been confined almost entirely to the belt of limestone extending northeasterly and southwesterly through these wide fields of shale. Having had my hands full of work from the limestone, it is only at the junction of the two, that I have given much attention to the shale. The fossils found in the shales by Mr. Dale, both on the east and west side of the Hudson River, were decided by Professor Hall to represent the Hudson River group. The only fossils reported by Professor Mather in the *State Report* forty-one years ago, were Utica slate graptolites on Marlborough Mountain. It now appears that the Utica slate is represented nearer to our city. For Messrs. Henry Booth and C. Lown lately found some graptolites in the shale at Blue Point, opposite our city, which, on being submitted to Mr. E. P. Whitfield, were identified by him as species of the Utica slate formation. They cover the following species :

Diplograptus pristis, *Climacograptus bicornis*, *Dichograptus furcatus*, and perhaps *D. divaricatus*, *Monograptus gracilis*, *M. sagittarius*, *and perhaps Diplograptus marcedus*. A statement of these facts will be found in the *American Journal of Science*, for November, 1883.

My own explorations in the limestones have been continued, as far as my other engagements would permit, without any intermission, to the present time. The results have been, not simply the increase in the number of specimens of the species obtained at the time of the last report, but a very material increase in the number of species and also in the area of fossiliferous rock above that previously discovered. The large collection of fossils thus brought together is of unusual value, for the reason that there is nowhere any known collection of similar species. But the peculiarly imperfect, fragmentary and obscure condition of the specimens makes the work of their study and classification extremely difficult. I speak advisedly when I say that such a task is extremely rare in paleontology. It is doubtful whether there ever has been another instance where so many hundreds of fossils, representing two formations and at the very least over sixty species, many unknown elsewhere, have presented themselves in such fragmentary, metamorphosed and obscure forms.

The case is one much beyond the ordinary requirements of paleontological study. Among the countless numbers of specimens visible in the ledges, I have never yet found a single one weathered out more or less entire, detached, and fallen to the ground, as we commonly find them in geological localities. All are more or less imbedded and amalgamated with the surrounding rock; all have some of their important features altered or obliterated by a partial metamorphic alteration of the rock. In the case of the orthoceratites, in particular, the mode of presentation of the specimen, in the majority of cases, is very embarrassing. It consists usually of a plane longitudinal section of the orthoceratite, in the accidental position caused by the natural abrasion and weathering of the rock, while it is not in many cases possible by use of hammer and chisel to develop any more of the shell.

Such a specimen may show the character and distance of the septa approximately, and give some idea of the curvature, and of the relative size of the chamber of habitation; but unless we can know the exact relative position of the exhibited plane, then the true amount of taper and curvature, the degree of convexity and marginal arching of the septa, the shape of the septal sutures, the position, size, and shape of the siphon, and the shape of the transverse section of the shell are all unrevealed; yet unless a fair number of these elements can be made out, little progress can be made in the specific determination of the fossil. In some cases a more or less longitudinal section of the siphon appears in the section of the shell. This at once reveals the true plane of the section, and becomes the key to many of the specific characters which we desire to know.

Under the difficulties mentioned, it has been necessary to adopt many devices for bringing to view the concealed structure. Grinding and polishing the surface has been of much assistance; but sawing across the fossil at one or more points, followed by a thorough polishing, laborious and time-consuming as it is, has often yielded the most satisfactory and decisive results in determination. It is scarcely necessary to mention that the making of microscopic slices has also proved of invaluable service.

Following the natural division of my subject, I will speak first of the points of progress in the knowledge of the local stratigraphy, and then of those belonging more particularly to paleontology, so far as the latter have not been necessarily brought forward in the stratigraphical discussion.

In regard to the stratigraphy, one point gained is that it proves to be far more complicated than it was at first supposed to be.

In place of the one or two folds of the two limestones, at first made out, there now appear to be several main folds, the relative positions of which are complicated by frequent "faults," while in some places several alternations of the Trenton and calciferous occur within the distance of a few feet. These phenomena occur both at Rochdale and at Cliffdale, (the estate of Mrs. Andrew Boardman), near the barns at the northeast corner of the premises. The estimated width of a single thickness of the Trenton, at Rochdale, is apparently from seventy-five to one hundred feet, while that of the calciferous is estimated to be nearly three times as great. There are probably four main folds of the two combined limestones at the latter place. The narrow alternations above mentioned require some special explanation, and their cause is not to be hastily assumed. I have thought them to be local slips, or "faults" parallel with the "strike." But to others they are strongly suggestive of possible synchronism of the life of the two sets of fauna, in consequence of which, according to varying conditions, alternations of one or the other were possible.

If this latter theory should be the right one, then we have in these phenomena of our vicinity facts of eminent importance in stratigraphical and paleontological philosophy. The more recent and careful investigations which I have made, however, seem to me to favor the former and more commonplace explanation rather than the latter.

There is another feature of much stratigraphic importance revealed by the later explorations. There is to-day no apparent reason for receding from the ground previously taken, that the limestone identified as Trenton and that called provisionally calciferous are entirely and plainly distinct in their fossil fauna, and, as a general rule, in their lithological characters. This is so palpable that experienced geologists who have visited this field have immediately yielded their assent to this fact.

Moreover, they have been able, after a single glance, as it were, at the two kinds of rocks, to assign the successive exposures of ledges, in passing over the fields, at once to their right groups.

Yet it is also beyond question a fact that the Trenton rests directly upon the so-called calciferous, and is at that plane so intimately in union, or amalgamated with it, that it appears to grow out of it solidly, without any definite seam of separation, such as is usually found between different strata. Thus the rock is not a whit more inclined to break under a blow along a plane which would separate between the Trenton and calciferous, than it is in any other direction. It is not therefore uncommon to find in the debris, fragments of homogeneous solidity throughout, which contain portions of both formations. These come from such positions of junction. Where the two formations thus come together, their characteristic fossils are in the closest juxtaposition. There, and there only, the *Ophileta compacta* lies alongside of the *Choetetes compacta.* But more than this: as the surface of the lower rock, the calciferous, was evidently undulating with ridges and hollows, at the time that the Trenton fossils began to be deposited upon it, it follows that, as referred to a horizontal plane, in these places Trenton fossils may lie at a lower level than calciferous ones, and calciferous fossils, in close proximity, may lie in the solid rock at a higher level than their Trenton neighbors. Thus, in a certain sense, but I think not in the full, true sense of the expression, the Trenton and calciferous fossils seem to be intermingled, for a very narrow space, at the line of junction.

Here again questions of general stratigraphical importance are raised. If there is a true and absolute intermingling of the two fauna here, then it follows that for a certain limited transitional period these two distinct systems of life were synchronous. This is a point of so much interest in geological science that it is one of the most prominent features in this local exploration, and deserves the most careful study. Though it would give me much pleasure, if the facts observed should enable me to announce the certainty of synchronism in the two fauna as established at Rochdale, yet, as I have already intimated, there has not yet been evident that true intermingling of fossils which would fairly establish this conclusion. Further observations may modify this view.

Another conclusion desirable from this proximity of the two sets of fossils, is that it shows that no intermediate deposit could have occurred in this vicinity; consequently, if the lower limestone is the calciferous, there must have been quite a suspension of deposits here, (presumably by temporary elevation into dry land,) while the intermediate strata found elsewhere, were being deposited. The facts, however, give additional probability to the theory that the lower limestone is more closely related to the Trenton limestone than the calciferous would be.

This brings me to the last point which I will mention in connection with the stratigraphy, which I will put in the form of a question. Do the investigations of the last two or three years increase or diminish the probability of the view taken in the earlier stages of the work, that the lower limestone belongs to the calciferous group?

The first assignment to the calciferous group was made by myself, in consequence of finding fossils corresponding better to the ordinary calciferous fossils of the United States than to any others. It is true that the list of such fossils in our country is exceedingly meagre, very poorly understood, and very vaguely described. But those at that time found at Rochdale were not of a nature to raise much doubt, or, at least, to give much importance to doubt, as to the correctness of this assignment.

When, about a year later, these numerous orthoceratites were found, a violent shock was thereby given to this original determination of the horizon. The equilibrium, however, was soon restored for awhile by discovering also other fossils corresponding with some described in the Canadian calciferous, notably, *Ophileta compacta*, Salter. This gasteropod is fortunately admirably described and illustrated in Decade i., page 16, *Can. Geol. Survey.* This evidence seemed so conclusive, not only to myself but to several paleontologists of the highest experience, to whom the specimens had been submitted, that these orthoceratites were then accepted as being indeed a new phase of our calciferous.

If, as is undoubtedly to be admitted, there is far more doubt as to the true geological horizon of these fossils to-day, it is not at all because of any weakening of the hitherto accepted evidence as to the presence of characteristic calciferous fossils, but solely to the very remarkable nature and extent of the cephalopods, brachiopods, gasteropods and trilobites, which later explorations have developed. These are so far beyond anything which has been yet known in the so called calciferous of the United States, if not that of Canada, that on this ground alone, we are compelled to revise our earlier views. No real discussion of the question is possible in the limits of this article; nor indeed would any such discussion be profitable at this stage of the investigation. Some of the features of these fossils show close relations to the Trenton group; in other respects they as remarkably and essentially differ from that group, belonging in so far to earlier types of fauna. This question is complicated by the fact that the so-called "calciferous," both of the United States and Canada, is itself seriously in question at the present time. It is very likely that important modifications will soon be made in the nomenclature and classification of much of the rock now called such in the United States; it is not unlikely that the phenomena of our Wappinger limestone, as now developed, will have much to do in determining such a reclassification.

I will close this part of the subject by saying that at the present stage of investigation, (1) this lower limestone still seems to me more properly referable to the so called "calciferous" than to any other formation, and that I will continue for the present to give it that name provisionally; (2) that if not calciferous, it will probably prove to be a member of the Canadian rather than the Trenton period—and may not unlikely prove to be the Chazy group; (3) that any extended discussion of this question is scarcely profitable until these fossils are fully studied and described; (4) that whatever the future decision as to the horizon, the fossils themselves will remain remarkable and important.

Before leaving the stratigraphical questions, it is proper to say a few words as to the relative extent and exposures of the two limestones. The great mass of the limestone along the Wappinger creek, from Willow Brook, at least, to New Hamburgh, appears to be calciferous, and shows its fossils in many places all along this line. On the west side of the Hudson, from Marlborough to three miles southwest of Newburgh, the mass of the rock lithologically appears to be calciferous, though I have entirely failed to find a single calciferous fossil in all that region. The Trenton rock and fossils are much more limited in their exposures, and yet there are long stretches of this formation usually lying on the eastern sides of the limestone ridges. A little Trenton crops out at Wallace's quarry, Salt Point, ten miles northeast of Poughkeepsie. It appears largely at Pleasant Valley, six miles from this city, then at Rochdale, and for about one mile south of that place.

There are no fossils of any kind between this last point and the northeast limits of Cliffdale (the estate of Mrs. Andrew Boardman.) Fossiliferous Trenton forms the eastern edge of the limestone ridge from this point, for at least three miles south, and appears again on the farm of Thomas W. Jaycox, about five miles south of Poughkeepsie. It is doubtless continuous throughout the whole range mentioned, though not always recognizable. It also appears in the parallel ridges to the west of Cliffdale, and further south.

On the west side of the Hudson, it appears three and and a half miles north of Newburgh, on the east face of the ridge, and also at a point from four to five miles southwest of that city.

It remains to make a few brief statements as to the recent progress in that part of the work which is more strictly paleontological.

The development of points of interest as regards the number and character of the fossils in these two limestones has much exceeded anything which I could have anticipated when I last addressed you on this subject. No adequate idea could be given of these facts without going into detailed descriptions, which, when completed, would fill a volume. All that I can say within the remaining limits of this occasion must necessarily be so general that I fear it will hardly secure much interest in the subject.

To the various Trenton fossils previously reported here are now to be added *Strophomena deltoidea*, and an undescribed species of *Triplesia*. The fossil called *Choetetes compacta* has been the subject of controversy as to its true character. Some would assign it to the sponges rather than to the corals. A very careful examination of many microscopic sections, however, seems to prove that one or more corals—one a *Tetradium*—are grouped under this name. I hope to publish before long a full discussion of this very difficult and interesting subject. Microscopic sections have revealed other unsuspected minute corals of various genera, not yet sufficiently examined for description.

In the calciferous group, in addition to the gasteropods, *Holopea* of unknown species, *Ophileta compacta*, *complanata*, and *sordida*, formerly reported, there are several species of *Raphistoma*, one new species of *Bucania*, probably several new species of *Ophileta*, and a large species of what is perhaps *Helicotoma*. Of brachiopods, there are one or more species of *Orthis* and *Leptæna;* also, *Triplesia* (*Camerella*) *calcifera*, a fossil of the Canadian calciferous, in large numbers. Of trilobites, by blasting at Rochdale, I have found a sufficient number to describe two new species provisionally under the genus *Bathyurus*, to which they do not thoroughly conform. One of these species has a smooth and exceedingly convex glabella; the other has a glabella covered with pustules and of very low convexity.

Of the orthoceratites I can only say that after over three years labor on them, I have at last worked them up sufficiently to begin to publish descriptions of some of them. In the April number of the *American Journal of Science*, I have described and illustrated by a plate, six new species of orthoceratites and the two species of trilobites above mentioned, from this limestone. A large and fine cyrtoceras, with an elliptical marginal siphon, which is one of the most abundant, I have named *Cyrtoceras vassarina*. The five other orthoceratites described are named as follows: *Orthoceras spissiseptum*, and *henrietta*, *Cyrtoceras dactyloides*, and *microscopicum* and *Oncoceras vasiforme*. Of the trilobites, the smooth one is named *Bathyurus taurifrons*, and the pustulated one, *B. crotalifrons*. I hope to follow up these descriptions very soon by others. It is as yet impossible to give a very near estimate as to the number of species of orthoceratites present in this limestone, but there are apparently at least from twenty-five to thirty species, mostly new. There are probably over sixty species of fossils in our immediate neighborhood in the Wappinger limestone, hitherto pronounced unfossiliferous.

As a group, it is very probable that the orthoceratites will prove to be of much interest to students of cephalopodic structure.

There is in this group of orthoceratites a predominance (1) of curved forms, (2) of frequent or crowded septa, (averaging, perhaps, eighteen or twenty to the inch), (3) of marginal siphuncles (not a single central siphon has yet appeared in the whole number, so far as I recollect), (4) of proportionately very large siphuncles, generally without any cone, (5) of elliptical or oval cross-sections, (6) of smooth shells.

The facts here developed have already far outgrown the limits of the serial contributions begun in the *American Journal of Science.* It is my present plan, therefore, that this series should be carried to completion by giving general statements, covering the whole ground of the stratigraphy and paleontology, accompanied by illustrated descriptions of some of the more characteristic fossils. The complete details, with copious plates and maps, I hope to be able to present in the form of a book as soon as the task of working up the mass of material on my hands and the notes in my field-books can be completed.

APRIL 9, 1884—TWENTY-FIFTH STATED MEETING.

Prof. W. B. Dwight, chairman, presiding; six members present

Messrs. Arnold, Cooley, and Dwight exhibited, under the microscope, specimens of rock-sections, crystals of gold, and minute fresh water crustaceons, supplementing the views with explanatory remarks.

The following paper was read:

A LIST OF OUR LOCAL BIRDS, REPRESENTED IN THE MUSEUM.

BY W. G. STEVENSON, M.D.

ORDER: *Passeries*—perchers.

FAMILY: *Turdidæ*—thrushes.

Hylocichla (*Turdus*) *pallasi*—hermit thrush.
One specimen.
Hylocichla (*Turdus*) *swainsoni*—olive-backed thrush.
One specimen.
Hylocichla (*Turdus*) *fuscescens*—Wilson's thrush.
One specimen.
Turdus migratorius—American red-breast: robin.
Two specimens.
Harporhynchus rufus—brown thrush: thrasher.
Two specimens.
Mimus polyglottus—mocking-bird.
One specimen.
Galeoscoptes carolinensis—cat-bird.
Two specimens.

FAMILY: *Saxicolidæ*—stonechats.

Sialia sialis—commom blue-bird
Three specimens: two old and one young.

FAMILY: *Paridæ*—titmice.

Lophophanes bicolor—tufted titmouse.
One specimen.
Parus atricapillus var. *carolinensis*—southern chick-adee.
Two specimens.

FAMILY: *Sittidæ*—nuthatches.

Sitta carolinensis—white-bellied nuthatch.
Two specimens.

FAMILY: *Troglodytidæ*—wrens.

Troglodytes ædon—house-wren.
Two specimens.

FAMILY: *Motacillidæ*—wagtails.

Anthus ludovicianus—titlark: brown lark.
Two specimens.

FAMILY: *Sylvicolidæ*—warblers.

Mniotilta varia black-and-white creeping warbler.
Three specimens.

Chloris (*Parula*) *americana*—blue yellow-backed warbler.
Two specimens.

Helminthophaga ruficapilla—Nashville warbler.
Two specimens.

Dendrœca æstiva—summer or golden warbler.
Four specimens.

Dendrœca cærulescens—black-throated blue warbler.
One specimen.

Dendrœca virens—black-throated green warbler.
Two specimens.

Dendrœca coronata—yellow-rumped warbler.
Two specimens.

Dendrœca maculosa—black-and-yellow warbler.
Three specimens.

Dendrœca pennsylvanica—chestnut-sided warbler.
Four specimens.

Dendrœca castanea—bay-breasted warbler.
Two specimens.

Dendrœca blackburniæ—orange-throated or Blackburnian warbler.
Two specimens.

Dendrœca pinus—pine-creeping warbler.
Two specimens.
Siurus auricapillus—golden-crowned thrush or wag-tail.
One specimen.
Siurus nævius—water-thrush.
One specimen.
Wilsonia canadensis—Canada fly-catching warbler.
Two specimens.
Setophaga ruticilla—American redstart.
One specimen.

FAMILY: *Tanagridæ*—tanagers.

Pyranga rubra—scarlet tanager.
Two specimens.

FAMILY: *Hirundinidæ*—swallows.

Hirundo erythrogastra—barn swallow.
Two specimens.
Petrochelidon lunifrons—cliff swallow.
One specimen.

FAMILY: *Ampelidæ*—chatterers.

Ampelis cedrorum—cedar-bird; southern wax-wing.
Three specimens: two old and one young.

FAMILY: *Vireonidæ*—vireos.

Vireosylvia olivacea—red-eyed vireo.
Two specimens.
Vireo noveboracensis—white-eyed vireo.
Two specimens.

FAMILY: *Laniidæ*—shrikes.

Lanius borealis—great northern shrike; butcher-bird.
Two specimens.

FAMILY: *Fringillidæ*—finches.

Pinicola enucleator—pine grosbeak.
Two specimens.

Carpodacus purpureus—purple finch.
Three specimens.

Loxia curvirostra (*Curvirostra americana*)—red cross-bill.
One specimen.

Ægiothus linarius—red poll linnet.
Two specimens.

Chrysomitris tristis—yellow bird; thistle bird.
Two specimens.

Plectrophanes nivalis—snow bunting.
Two specimens.

Passer domesticus—English sparrow.
Four specimens: two old and two young.

Ammodromus passerinus—yellow-winged sparrow.
One specimen.

Zonotrichia leucophrys—white-crowned sparrow.
One specimen.

Zonotrichia albicollis—white-throated sparrow.
Two specimens.

Spizella monticola—tree-sparrow.
Two specimens.

Melospiza melodia—song-sparrow.
Two specimens.

Junco hyemalis (*J. oregonus*)—Oregon or black snow-bird.
Two specimens.

Passerella iliaca—fox sparrow.
Two specimens.

Goniaphea ludoviciana—rose-breasted grosbeak.
One specimen.

Cyanospiza cyanea—idigo bird.
Two specimens.

Pipilo erythrophthalmus—marsh or ground robin; chewink.
Two specimens.

Family: *Icteridæ*—orioles.

Dolichonyx oryzivorus—bobolink: reed-bird.
Four specimens.
Molothrus ater—cowbird.
Two specimens.
Agelæus phœniceus—red-winged blackbird or starling.
Two specimens.
Sturnella magna—meadow lark.
Five specimens: two old and three young.
Icterus baltimore—Baltimore oriole.
Five specimens: two old and three young.
Icterus spurius—orchard oriole.
Two specimens.
Scolecophagus ferrugineus—rusty grackle; rusty black-bird.
Two specimens.
Quiscalus purpureus—crow black-bird; purple grackle.
Two specimens.

Family: *Corvidæ*—crows and jays.

Corvus americanus—common crow.
One specimen.
Cyanurus cristatus—blue-jay.
Two specimens.

Family: *Tyrannidæ*—fly-catchers.

Tyrannus carolinensis—king-bird.
Two specimens.
Myiarchus crinitus—great-crested fly-catcher.
One specimen.

ORDER: *Picariæ*—picarian birds.

FAMILY: *Caprimulgidæ*—goatsuckers.

Antrostomus carolinensis—Chuckwill's widow.
One specimen.
Chordeiles virginianus—night-hawk.
Two specimens.

FAMILY: *Cypselidæ*—swifts.

Chætura pelagica—chimney swift.
Two specimens.

FAMILY: *Alcedinidæ*—king-fishers.

Ceryle alcyon—belted king-fisher.
Four specimens.

FAMILY: *Cuculidæ*—cuckoos.

Coccygus americanus—yellow-billed cuckoo.
One specimen.
Coccygus erythrophthalmus—block-billed cuckoo.
Two specimens.

FAMILY: *Picidæ*—woodpeckers.

Picus villosus—hairy woodpecker.
One specimen.
Picus pubescens—downy woodpecker.
Two specimens.
Sphyrapicus varius—yellow-bellied woodpecker.
Three specimens.
Melanerpes erythrocephalus—red-headed woodpecker.
Two specimens.
Colaptes auratus—golden-winged woodpecker.
Eight specimens—two old and six young.
Centurus aurifrons—yellow-faced woodpecker.
One specimen.

ORDER: *Raptores*—birds of prey.

FAMILY: *Strigidæ*—owls.

Asio otus (*Otus wilsonianus*)—long-eared owl.
One specimen.

Asio brachyotus (*Brachyotus palustris*)—short-eared owl.
One specimen.

Syrnium nebulosum—barred owl.
Four specimens: two old and two young.

Nyctale acadica—saw-whet owl.
One specimen.

Scops asio—screech owl.
Two specimens: one with grey and one with red plumage.

Bubo virginianus—great horned owl.
Four specimens: two old and two young.

FAMILY: *Falconidæ*—falcons.

Falco columbarius—pigeon hawk.
One specimen.

Falco sparverius—sparrow hawk.
One specimen.

Pandion haliætus—osprey: fish hawk.
Two specimens.

Circus cyaneus var. *hudsonius*—marsh hawk or harrier.
Three specimens.

Astur palumbarius var. *atricapillus*—goshawk.
Three specimens.

Accipiter fuscus—sharp-shinned hawk.
Three specimens.

Accipiter cooperi—chicken hawk.
Two specimens.

Buteo borealis—hen hawk: red-tailed buzzard.
Five specimens: three old and two young.

Buteo borealis var. *montanus*—
Four specimens.
Buteo lineatus—red-shouldered buzzard.
Six specimens: three old and three young.
Haliætus leucocephalus—bald eagle.
Three specimens: one old and two young.

ORDER: *Columbæ*—columbine birds.

FAMILY: *Columbidæ*—doves.

Ectopistes migratorius—wild pigeon.
One specimen.
Zenædura carolinensis—mourning dove.
Three specimens.
Chamæpelia passerina—ground dove.
Three specimens.

ORDER: *Gallinæ*—gallinaceous birds.

FAMILY: *Tetraonidæ*—grouse.

Bonasa umbellus—partridge.
Two specimens.

ORDER: *Limicolæ*—shore birds.

FAMILY: *Charadriidæ*—plovers.

Ægialitis melodus--piping plover.
One specimen.

FAMILY: *Scolopacidæ*—snipe.

Philohela minor—American woodcock.
Two specimens.
Gallinago wilsoni—American snipe.
One specimen.
Tringa bairdii—Baird's sandpiper.
One specimen.

Totanus melanoleucus — greater tell-tale : yellow shanks.
Two specimens.
Tringoides macularius—tip-up: spotted sandpiper.
Eight specimens: two old and six young.

ORDER: *Herodiones*—herons and storks.

FAMILY: *Ardeidæ*—herons.

Ardea herodias—great blue heron.
Three specimens.
Butorides virescens—green heron.
Two specimens.
Nyctiardea grisea var. *nævia*—night heron: squawk.
Two specimens.
Botaurus minor—stake driver: bittern.
One specimen.

ORDER: *Alectorides*—cranes and rails.

FAMILY: *Rallidæ*—rails.

Porzana carolina—Carolina rail.
One specimen.
Gallinula galeata—Florida gallinule.
One specimen.

ORDER: *Lamellirostres*—anserine birds.

FAMILY: *Anatidæ*—ducks.

Anas boschas—mallard duck.
One specimen.
Anas obscura—black duck.
Two specimens.
Querquedula discors—blue-winged teal.
One specimen.
Aix sponsa—wood duck.
One specimen.

Bucephala albeola—dipper: butter-ball.
One specimen.
Harelda glacialis—"old wife:" long-tailed duck.
One specimen.
Mergus merganser—shell-drake: goosander.
Two specimens.

ORDER: *Longipennes*—long-winged swimmers.

FAMILY: *Laridæ*—gulls.

Hydrochelidon lariformis (*fissipes*)—black tern.
One specimen.

There are in the museum, in addition to the above-named, two specimens of "bitterns," four specimens of "grebes," of the genus *Podiceps*, and three specimens of the genus *Podilymbus*, all found in this vicinity, whose species have not yet been determined.

From southern localities we have a specimen of the "snake bird," "rosy-spoonbill," "great white egret," and from the west there are specimens of "California quail," pinnated grouse, or, "prairie hen," and "ptarmigans" in summer, fall, and winter plumage.

APRIL 23, 1884—TWENTY-SIXTH STATED MEETING.

Prof. W. B. Dwight, chairman, presiding; ten members present.

The chairman presented the following *Annual Report:*

To the Members of the Scientific Section, Vassar Brothers Institute: The scientific meetings of this Section have been held with unbroken regularity during the present season. As required by our by-laws, I will make the following report of the work that has been done.

Dr. C. B. Warring gave the first paper, on the Gyroscope, to the most lively entertainment of all who listened to it and who watched the illustrative experiments. He presented an analysis of the various problems involved in the subject as they had appeared under his own careful observation, and in a wholesome way taxed the powers of the society in their endeavor to follow his original and exceedingly ingenious explanation of its mysterious motions. He also, on another evening, opened, in a very able and interesting manner, the question of the "Uniformity of Climate in Past Geological Ages," the discussion being subsequently continued at considerable length by other members.

Dr. W. G. Stevenson introduced to the Section a couple of fine sharks, captured by himself and Mr. C. B. Herrick, at Nantucket, Mass., and gave an elaborate and accurate description of their characteristics and relations to other species. This will be one of the most valuable papers in our proceedings for the year. On two other occasions, he also read a paper on "Our Local Mammalian Fauna," and gave a "List of Birds found in this Vicinity, and represented in the Museum," by which he endeavored to increase the interest of the Section in the complete collection and study of the animal forms of this vicinity.

Prof. Maria Mitchell presented, in her usual clear and attractive way, the subject of the planet Saturn, bringing before the society, with the assistance of blackboard illustrations, the results of many careful original observations.

Prof. Cooley discussed, during one evening, with admirable clearness, "The Laws of the Compressibility of Gases," describing the successive systems of experimentation which have been devised to ascertain these laws and the latest conclusions reached. He also exhibited a new, simple, and perfectly effective apparatus, of his own invention, which demonstrates these laws with scientific accuracy, while by the lantern the results are

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shown upon a screen to a large audience. On a subsequent occasion, he presented consecutively these three topics: "On Some New Laboratory Appliances," comprising some ingenious original modifications of Richards' aspirator for the immediate and perfect removal of noxious fumes in a laboratory, and other appliances; also, "Influence of the Density of a Gas on the Electric Discharge," illustrated by some remarkably fine experiments; and, "Notes on the Liquefaction of Gases."

Dr. J. M. DeGarmo occupied an evening, with much acceptation, on "Evidence of Intelligence in Butterflies." Much of the interest and value of this paper was due to the feature that many of the facts from which conclusions were drawn were derived from his own careful and extended observation.

Mr. C. N. Arnold entertained and instructed the society by a full account of "Gums and Resins," in which their origin, nature, and economical value were well described.

The chairman, on three separate evenings, presented the topics, "An Interesting Geological Locality at Cornwall, N. Y.," and "Report of Progress in Geological Investigations in the Vicinity of Poughkeepsie," in both of which the results of original investigation were described, and "Embryonic Forms of *Limulus polyphemus*," in which many interesting facts, as developed by various naturalists, were collated.

The last stated meeting was given up to microscopic work. Professor Cooley showed some rare and beautiful forms of microscopic crystals of gold, and described their artificial formation. Mr. Arnold showed a number of rock sections, and the chairman exhibited some of the minute crustaceans of our ponds.

With this varied list of subjects the evenings have been filled out to their utmost capacity, and profitably filled. It is proper for me to state also that, in addition to the work of the regular Section meetings, the Scientific Section has made valuable contributions on scientific subjects to the course of lectures given before the entire Institute. Thus, besides the address of the chairman on "Specialization in Science," Doctor DeGarmo gave a lecture on "The Eternal Heavens," Doctor Warring one on "Evolution," and Rev. H. L. Zeigenfuss one on "Colorado, Geologically and Industrially Considered," with lantern illustrations.

These exercises have been conducted throughout with an earnest spirit, and with a manifest desire on the part of the members to carry out heartily the work properly belonging to our Section. We cannot but notice with pleasure the large proportion of original work and original thought which has entered into the contributions of our members. This is a most essential feature in the success of a modern scientific society, and as long as it is sustained it will be a guarantee of success.

The exercises have been generally held in the lecture room, but occasionally, for convenience, in the museum. The audiences have generally been larger than could have been expected, and, in many instances, our room has been filled to overflowing. It is evident that among certain classes of your citizens, this honest, earnest, technical scientific work of our Section room is becoming more appreciated. But there is yet need of developing a more thorough and practical interest in this work among the citizens in general. If they can be better informed, month by month, of the work the Section is doing, they may be induced to give us more full expressions than we at present receive of their interest and sympathy in our labors. And such sympathy is never a mere matter of sentiment. It opens the doors to assistance of practical value.

Although the museum and library are not technically the special property of this Section, yet the fact that the former, and the scientific works which form the larger portion of the latter, are collected by, and practically belong to, the work of our Section, justifies me in including a few words in regard to them in this report. A large number of specimens have been acquired in the museum, both by donation and purchase, thus adding much to our opportunities for comparison and study. The most valuable of these is the white shark (*Carcharodon carcharias*), the skin of which, with that of its companion, the sand shark, were presented to the Institute by Doctor Stevenson. Many valuable scientific treatises have been placed on the shelves of our library this year. One of the most valuable of these are the volumes on "Infusoria," by W. Saville Kent. It is an elegant and expensive book, acquired by purchase, and those who possess microscopes will find it to their advantage to consult this book in their examination of infusorial organisms.

In conclusion, I would thank the members of the Section for the most cordial and effectual way in which they have coöperated with their chairman in making the record of the present season one of which we have no reason to be ashamed.

William B. Dwight,
Chairman.

The officers for 1884–'85 were elected, viz.:

Prof. W. B. Dwight, - - *Chairman.*
Mr. C. N. Arnold, - - - *Recording Secretary.*