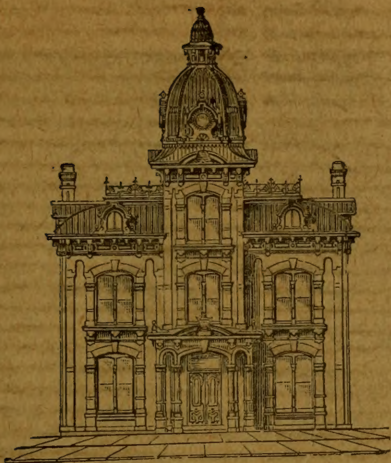


TRANSACTIONS

OF

VASSAR BROTHERS INSTITUTE,

AND ITS

SCIENTIFIC SECTION.

POUGHKEEPSIE, N. Y.

1890-1893.

VOL. 6.

TRANSACTIONS

OF

VASSAR BROTHERS' INSTITUTE,

AND ITS

SCIENTIFIC SECTION.

1891-1893.

VOL. VI.

PART I.—Transactions of the Institute.
PART II.—Transactions of the Scientific Section.

PUBLISHING COMMITTEE:

EDWARD ELSWORTH, HENRY V. PELTON,
W. B. DWIGHT.

POUGHKEEPSIE, N. Y.
PRESS OF A. V. HAIGHT,
12 LIBERTY ST.

CONTENTS OF VOLUME VI.

PART I.

PART II.

VOL. VI.

PART I.

OFFICERS OF THE INSTITUTE.

1890–1891.

Mr. Henry V. Pelton, . .	*President.*
Mr. Chas. B. Herrick, . .	*Vice-President.*
Mr. Edward Burgess, . .	*Secretary.*
Mr. Edward Elsworth, . .	*Treasurer.*

1891–1892.

Mr. Charles B. Herrick, . .	*President.*
Mr. James Winne, . .	*Vice-President.*
Mr. Silas Wodell, . .	*Secretary.*
Mr. Edward Elsworth, . .	*Treasurer.*

1892–1893.

Mr. Charles B. Herrick, . .	*President.*
Mr. James Winne, . .	*Vice-President.*
Mr. Silas Wodell, . .	*Secretary.*
Mr. Edward Elsworth, . .	*Treasurer.*

TRANSACTIONS

OF

VASSAR BROTHERS INSTITUTE,

1890—1893.

NOVEMBER 11, 1890—FIFTY-THIRD REGULAR MEETING.

Henry V. Pelton, president, presented the following paper, entitled

AFRICA AND HER FUTURE.

BY HENRY V. PELTON.

Africa has been marked on the maps of the world for many a century. Its outline has been, in the main, correctly designated since 1600. But little more than its location and its form was known for two and a half centuries later. It lay close to the continents where the dominant civilizations of the world were developing and showing their strength in daring deeds of discovery and conquest, yet beyond the stretch of country which bordered the Mediterranean Sea this discovery and conquest scarcely touched Africa. Distant America and Australia were found, and in these the civilization of Europe was implanted and carried to their farthest limits, but this great continent remained unpenetrated. Even after travelers began to thread their way through its wilds and after the dots of settlement along the coast had revealed something of the value of the country, European nations made little effort to colonize it and to secure empire therein, and until very recent years, its relation with other lands, politically or commercially, have been of little account.

But this indifference and neglect on the part of Europe, after lasting several centuries, suddenly disappeared and in its place has now come great interest and an intense desire to obtain acquisitions therein, and the nations have been eagerly scrambling for that which before they refused to accept.

I do not intend to speak at length of African exploration. The many books of travel, with their exciting stories of adventure and of peril, have made these familiar, and my reference to them will be brief.

African exploration really dates from the formation of the African Association, in 1788. Under its auspices many travelers entered the country, but probably nine-tenths of these lost their lives in the journeys, and African exploration for two and a half centuries was, in great part, a succession of failures and disasters. Indeed, all the expenditure of lives and money before the last half of the present century, had very little result in making the country known, and much less in opening it to civilization.

But one result did come from this continued and persistent entrance of Europeans into Africa; that astonishing and humiliating result which in so many countries and at so many times has come when those whom the world terms barbarous have felt the contact of civilized people, the result of degrading and brutalizing the natives. The history of the intercourse of the white race with the Africans for two hundred years may be indicated by three prominent articles of traffic: slaves, gin, gun powder. Of the slave trade I shall speak again, but the liquor traffic while less noticed and less opposed, is scarcely second to that in its power for evil. In some districts liquor is today the sole currency, and in some factories the entire wages of the black employees are paid in it. Every traveler who compares the coast natives who have been long under the blighting effect of contact with whites, with those of inland districts, finds in the first brutality and viciousness which is shown nowhere else in Africa.

The story of African exploration shows repeated instances of courage undaunted by perils and of patient endurance which no toils or difficulties could exhaust. The long list of names made thus famous begins with Mungo Park, at the close of the last century, and ends with Henry M. Stanley whose enterprises are familiar to us all. His career is an uninterrupted series of successes, beginning with the time when, in 1871, he found Livingston, reduced to a skeleton, in beggary and more broken in spirit than at any other time, and brought to him help and encouragement, down to the time when he carried his column through the equatorial forest and met Emin Pasha on Lake Albert Nyanza. Whether in this last expedition he really succeeded in the main object for which he started, has been questioned. The friends of Emin maintain that the fruit of his years of struggle in the Soudan, during which as Gordon's successor he had striven so manfully and so successfully to redeem and maintain the province, were by his departure wholly lost. But Stanley did succeed in opening a district hitherto unknown and in taking the first step, by contact and treaty with the tribes, to make the district passable for Europeans hereafer.

But the highest place among African explorers belongs to David Livingston. His discoveries need be placed second to those of no other, even if no allowance is made for circumstances. How much more remarkable do they appear when we remember that he made his first and perhaps greatest journey almost unaided; a poor Scotch peasant's son, seeking to carry the gospel to these dark lands, discouraged by both the Missionary Society and by his family, stricken almost continually with fever, most of the time without other white person near him and with no resources by which to secure native help, except his own loving spirit. Even, when afterward he returned as English consul and agent of the Geographical Society, we blush as we read that each gave him £500 salary and a friend added a thousand pounds, thus making barely enough for actual expenses, (Stanley's last trip cost about £400 a day), that he met bitter opposition from the Dutch boers and Portuguese, and that the government in all these difficulties gave him only half-hearted and generally ineffectual support; yet he opened a path across Africa, mostly where no white man had preceded him, and discovered and explored many of the lakes and rivers. We admire his pride and independence when we read that without a murmur he accepted the mean terms offered by his employers, and set about selling the small steamer which he had built for African exploration, to make up the needed amount; and that rather than let the Portuguese in Africa buy her for use in the slave trade, he sailed in her from Mozambique across the Indian Ocean to Bombay, 2,500 miles, with three sailors, himself captain and pilot. When the government afterwards asked what they could do for him, thinking of a pension, he asked, thinking not of rest but of work, that they would by treaty with the Portuguese, secure for him free access to the Shire highlands.

We see him overcoming the opposition of the wild tribes by tact and kindness, building his house with his own hands, noting the habits of birds and beasts, studying astronomy at the Cape, taking observations, so correctly that Sir Thomas Maclear, the astronomer royal could say: "I say what that man has done is unprecedented. You could go to any part across the entire continent along Livingston's track and feel certain of your position. His are the finest specimens of geographical observations I have ever met with."

And what language is too strong in which to depict the greatness of character which was back of all this achievement; a character which rang so true at all times, that even the African tribes recognized its spirit, and wherever he traveled through Africa he is remembered by them with kindness. The lofty spirit which controlled him stood every test, whether of privation and suffering and dire need in the toilsome journeys, or of the adulation of the English public and the most flattering attentions from those highest in station. He kept his promises to his native followers as sacredly as to his noble friends at home, and through every moment of his life shone that high purpose which he held steadfastly, to help upward into civilization and Christianity the barbarous and heathen African. Not glory but love moved him to every enterprise. With him the end of all exploration was only that missionary work might be begun in new areas. The spirit of St. Paul when he said "I am now ready to be offered," rings out in David Livingston's simple words spoken before the Cambridge University, "I beg to direct your attention to Africa. I know that in a few years I shall be cut off in that country which is now open. Do not let it be shut again. I go back to Africa to try to open a path for commerce and Christ. Do you carry out the work which I have begun. I leave it with you."

Until within half a century of the present time, little was known of Africa except along the coasts. This was caused by two peculiarities of the continent itself. First, the climate of the country bordering the coast was very unhealthy, and secondly, the rivers, which were the natural ways of entrance into the country, were generally interrupted by cataracts and rapids. By these the explorers were delayed in the malarious belt along the coast and were often victims of its poisoned air, or, if they escaped this, they generally found the interruptions to navigation too serious for them to overcome. But in later years the increased knowledge and greatly enlarged resources with which the explorers are furnished, have enabled them to overcome such difficulties, and the country has been entered from nearly all quarters and the general characteristics of the continent are now well defined.

These general features are a low, hot coast line, having rank vegetation, from which, on its three sides, the continent rises to two plateaux, the inner and higher one having an elevation of four or five thousand feet. While its waterways are of little use as means of access from the sea, there is, through the most fertile park of the interior, a vast network of rivers and lakes of unsurpassed magnitude. Five great rivers flow into the Atlantic—the Nile, Niger, Ogowai, Congo and Orange; and three, the Juba, Zambezi and Limpopo, into the Indian Ocean. All are interrupted by cataracts, but all except the Orange have long stretches of navigable waters. The size and importance of these waterways is just coming to be recognized and their extent is not yet fully known, for into most of these rivers flow great tributaries, which have been only partially explored. The facts already learned about the Congo will show something of the magnitude of these waterways.

The main river is five thousand miles long, and, though interrupted by cataracts, it has navigable courses between them several hundred miles long and one course of over a thousand miles. Its tributaries are many and large, and though their navigation is also interrupted, yet some of their unbroken courses exceed eight hundred miles. One can sail five thousand miles on the Congo and its tributaries without interruption, and, by passing cataracts, thirteen thousand miles more in different courses. The magnitude is equally astonishing. One of these tributaries, the Mobanzi, pours more water into the Congo than any river in Europe pours into the sea. Twenty-five hundred miles above its mouth the Congo is from twelve to eighteen hundred feet wide, and at its mouth it is fourteen miles in width. At nine miles outside its water is perfectly fresh, and at forty miles distant is only partially mingled with the sea. This great river system is not equalled in other parts, but many of the other rivers have long navigable courses and large tributaries, and when is added to these great rivers the lake system, equal in area to that of North America, and when we realize how these rivers and lakes are interlaced and connected, we see how great an aid to the development of the country is here given.

The partition of Africa has gone forward rapidly. It is only a few years since Europe first manifested its present desire to possess this continent, and a large part of Equatorial Africa is not yet explored, yet nearly the whole of this country has already been parcelled out among the nations. Except the extremities of the continent, Egypt and the other countries on the Mediterranean Sea in the North, and Cape Colony, the Orange Free State, and the Transvaal in the South, both of which sections have been long under settled government; excepting these, no considerable African possessions were well defined and generally acknowledged until very recent years. European proprietorship was confined to small coast settlements and indefinite claims to land in the interior. But several national conferences have resulted in treaties by which the different nations acquire large and well-defined sections of African territory. In some cases this takes the form of direct annexation, in some only of suzerainty, or as being within the sphere of its influence, but the result is that each of these nations has now room for colonies without colliding with each other.

The title of Portugal is recognized to about 700,000 square miles of African territory including nearly one thousand miles of coast line, but Portugal has never been able, and probably will not be able, to colonize or develope its domain. France acquires an unbroken tract from Algeria to the Senegal, also a large section on the west coast in the Congo region, in area over 250,000 square miles (larger than France and England combined), a district with great resources, with eight hundred miles of coast line and eight river basins. Germany has a province in the South West near the Orange river, the Cameroons farther north on the same coast, and a great section on the East coast inland from Zanzibar. All these countries are thus far acting directly through their governments. But in those lands in Central Africa, which are under British influence, action is being taken (and as we recall the history of India we cannot doubt that it is wisely taken) through chartered companies. This movement is now being imitated by Germany. Four great English companies are already in possession. The Royal Niger Co. control, both by governmental concession and by treaties with the natives, an immense tract and large commercial privileges on the lower Niger and the central Soudan. To the British East African Co. was conceded a great district on the East coast, north of Zanzibar, containing 70,000 square miles and extending inland to Lakes Victoria and Albert. The British South African Co. is engaged upon a section of the basin of the Zambezi. The African Lakes Co. have already established twelve trading stations on the Zambezi, Shirè and Lake Nyassa and have steamers plying between them. This Company was not organized for gain and whatever of profits shall accrue are to be re-invested in Africa. Of the African trade at this time probably England controls one-half.

Besides all these corporate and governmental acquisitions, perhaps as important as any of them, is the formation of the Congo Free State. It was organized for the purpose of establishing and maintaining stations through the great Congo basin and extending to Zanzibar on the East Coast. This work was accomplished by peaceful negotiations, though conflicts have since occurred through Arab traders. It has been recognized by all governments and has made numerous treaties with native chiefs, securing their aid to keep the road open and free to all. The Association pays one piece of cloth per month to each chief for his help. The state guarantees to every one equal liberty to trade without imposts or customs.

There is no need to speak at length of the Missionary settlements. Long continued and most noble efforts have been made to carry the Gospel into the interior, and some stations have been established forty years, but the progress is slow and the opposition vigilant and vindictive, for here as nowhere else, Christianity and Mohamedanism are meeting to fight for the mastery. The issue will not seem doubtful to us who believe in a ruling Jehovah but certainly Mohamedanism has in Africa every advantage. It has existed there for at least four centuries. The first Portugese discoverers found Arab traders already established there, and it calls upon the simple Pagan negro for such slight change of life and habit that he finds it in no way irksome.

The most prominent and most serious fact affecting Africa's welfare is the slave trade. It is most abhorent to our sense of justice and our feelings of humanity; it is most pernicious in its influence upon the natives; it is the greatest impediment to the entrance of civilization. African slavery is of two kinds. There is the domestic slavery, that among the Africans themselves, which is mild in character and subject to few hardships. One writer says that every African is a slave holder in will or deed and every slave buys a slave when he can save the money to do so, and a slave's slave has been known to own a slave. And, alas, there is also the foreign slavery which is terribly cruel. It is very old. We know not the time when it did not exist. But it has increased, not only in extent but also in inhumanity, and is now worse than ever before. It has been suppressed on the Western coast, but continues over the Red Sea and Indian Ocean and is entirely carried on by Arabs and their slaves. Their encampments are established over the heart of Africa, and the territory covered by their raids is twice as large as the entire United States and is continually being extended. The districts around these encampments are kept in perpetual war to prevent combination against them, and the traders destroy not only every human being but every hut and plantation as well. The lowest estimate places the number killed at five times the number captured, and it is calculated that slave traders are now destroying more than a thousand persons per day in Africa. We can realize the effect of the trade when we read the descriptions given by travelers. Weisman tells that in 1882 he passed a town on the Lomani River "with well-built huts, gardens of tomatoes, pine apples, potatoes and fields of tobacco and sugar cane, with goats, sheep and fowls in abundance, the town so extensive that their party marched through it from six o'clock till eleven, and still saw the village stretching off at one side." Four years afterward when he passed there was the silence of death; tall grass growing over all; charred poles and bleached skulls. Stanley, in 1883, overtook an Arab slave caravan. "They had been raiding," he says, "a territory covering 3,400 square miles, containing a million of people, and they had only twenty-three hundred captives and not one adult man captive, after raiding through the length and breadth of a country larger than Ireland and burning one hundred and eighteen villages. An entire family had been put to death for one child captive." And in his account of his last journey he thus speaks of the work of a band upon which he came: "They had levelled into ashes every settlement, destroyed every plantain grove, split every canoe, reduced the forest land into a howling wilderness and left scarcely a hut standing over forty-four thousand square miles, and this was but one of a number of bands then operating in such great circles." For every twenty tusks of ivory, a district with all its people, villages and plantations is destroyed.

When we speak of Arabs carrying on this work we bring out the prime cause for the great increase in the traffic. The Arabs are Moslems, and Moslemism, with its harem life, its disregard of the lives of unbelievers, and its practice of proselyting by the sword, finds in slavery one of its chief helps and Moslemism is now extending in Africa more rapidly than ever before. Thus in the conflict for the suppression of the slave trade Christian Europe finds itself face to face with Moslemism and the decision, as to which race and which religion is to rule in Africa, is involved in the struggle.

Of course the elephant with five hundred dollars worth of ivory on his head is a great incentive to the securing of slaves. Mr. Drummond says he will be gone in fifteen or twenty years, and that the sooner he goes the better for his country.

But I hope that Africa will not have to wait for or trust to the extinction of the elephant for the mitigation, if not the suppression of slave raids. No insignificant forces now confront it. All the European nations unitedly oppose it. Cardinal Lavigerie, Archbishop of Algiers, has been preaching a crusade against it throughout Europe, and though Mr. Stanley sneers at this as he does at many another idea, yet the Cardinal has awakened great interest and has raised money with which to equip armed steamboats to patrol Lakes Tanganika and Nyassa. The chartered companies are not only prohibiting it but are also arranging stations that shall be strong enough to protect the surrounding districts; and the international conference held the past summer at Brussels took measures against it, establishing an international office at Zanzibar, organizing an administration to construct roads and to arrange to have the importation of firearms restricted.

If we try to form some estimate of the future of this continent, there are three characteristics of the country to be considered, the climate, the soil and the people.

The country lies mostly in the torrid zone but the records as far as given do not show excessive high temperature throughout most of the interior. In some parts there are high cool plateaux with a temperate climate.

Malaria and consequent fever shows itself in many, perhaps in most parts. Along the coast, especially the western, and extending two or three hundred miles inland, this is excessive, but the interior, several thousand feet higher, is much more healthy. Still, even in this, experience has shown that every European is attacked. Some parts, as the lake shores and river basins, are worse than other parts, but few seem to be wholly free from this scourge. However, Mr. Stanley asserts that in open positions, proper precautions will enable the European to thrive in this climate as well as in any. He adds "there has been remarkable improvement during the last six years in the health of the Europeans who have resided on the Congo." We are also assured, I am not sure it is by Mr. Stanley, that the climate in many places is better than Bengal and that there is less sickness by half in the Congo basin, even in present conditions, than in the bottom lands of Arkansas, and these last have doubled in population in twenty-five years. Of course under European occupancy and the opening of the country to proper agriculture and trade, a marked improvement may be expected. South Africa, especially the Cape Colony, is entirely healthy.

To the productiveness of the soil abundant testimony is given by all travelers. The natural products include most of those peculiar to the tropics and, in nearly all districts, the natives cultivate the soil to some extent, but of course this is done only so far as to satisfy their own simple needs. Of the possibilities of its future productiveness, we have many assurances. Livingston said of the country about the Leambye that it is capable of supporting millions of inhabitants, and would yield grain sufficient to feed vast multitudes. Stanley refers again and again to the quick growing and abundant crops which the country, in most parts, yielded, and to the inexhaustible natural resources of the great river basins. Wheat, tobacco, coffee, sugarcane, rice and cotton may be raised in vast quantities. There is a great equatorial belt of exceeding fertility between fifteen degrees North latitude and fifteen South latitude ; north and south of this, two other belts, with less rain, but enough for crops, and again after passing the Sahara and the Kalahari deserts, there are fertile districts in the extreme North and the extreme South.

The mineral wealth of Africa, while yet undeveloped and known only in part, is unquestionably very great. Gold has been found in many places, copper is abundant in the centre of Southern Africa, and also in the equatorial regions, Iron is reported in quantities in several parts and lead, plumbago and other minerals have already been discovered.

The people are estimated to number about 200 millions which would make the density of population about one-fifth that of Europe. They are divided into almost innumerable tribes, and these are warring with each other with great frequency. When the International Association, by a peaceful expedition, opened the Congo basin, they found it necessary to make four hundred treaties and to obtain two thousand signatures of native chiefs.

On the western shore of Lake Nyassa there are already known fifteen different tribes, speaking as many different languages, each having numerous dialects. This entire absence of homogeneity and the lack of peace among the tribes has undoubtedly been one great cause for their failure to progress. On this account they are suspicious and fearful, being always in danger of being attacked and captured.

They certainly are a people which has not shown any genius for organization, and apparently they are unable to advance by their own unaided efforts. As far as can be judged by appearances or by records, the progress even of centuries is insignificant. There is no large confederation or union among the tribes, and no one tribe has attained to a commanding position so as to dominate any considerable section. Some are more advanced than are others, have some added comforts in their homes, and there are instances where decoration is used in domestic architecture, but among none is there anything like a city or a well organized state. There is mention of the pigmies hundreds of years ago, but they are probably the same now as then. They never leave the forest, and though fond of bananas, which constitute most of the vegetable food there, they never raise them, but obtain them only from the plantations of the larger natives who do cultivate them. But most of the natives do plant gardens and sometimes large plantations; they keep goats and fowls and in a few sections large herds of cattle. Wherever they have been tried they have been found to be willing to work and not wholly lacking in industry.

But they have never been trained to work. They can hunt the elephant and obtain the valuable and easily disposed of ivory and naturally they neglect other and less profitable forms of labor. When they plant, the productive soil gives speedy and abundant returns, their crops never fail, their wants are few, there is no demand for a larger amount of food and thus there is nothing to tempt them to further exertions.

This hasty review of Africa, as it is, while it presents some discouraging and dismal facts, certainly shows us conditions which are not without promise for the future of this great continent. Africa needs outside help to come out of barbarism into civilization but that help being given she is able and ready to repay all efforts on her behalf. Her great needs are two. First trade, which shall offer inducements to the natives to cultivate crops for the markets and thus furnish them with the educational influence of steady and renumerative employment; and second, such stability and strength of government as shall maintain them in security of life and property. The chief obstacle to trade has been the difficulty of transport to the sea.

Railways must be built past the cataracts to connect the great internal water-ways with the ports. Stanley calculates that the four great rivers, the Nile, Congo, Niger and Shirè would need, for this purpose but eight hundred and twenty-seven miles in all, and by these would be opened to the trade of the world twenty-two thousand miles of banks along navigable rivers. The work of supplying railway facilities of transport in Africa is already begun. There are lines in South Africa now running and more are projected. The Portuguese are building one from Benguela into the interior. A line from Mombassa, in the territory of the British East Africa Co., connecting the coast with the lake system inland has been opened this fall. The railway from the mouth of the Congo to its upper basin has been begun. The Germans have projected one over their newly acquired domain, commencing at Bagomoyo and a route has been selected for a line to connect Algiers with Lake Tchad. The natives are generally quite willing to trade, and wherever Europeans have established suitable conditions, they have shown themselves willing to raise crops for market. In Bechuanaland, under British suzerainty, certain amounts of the very fertile grain lands have been reserved for the natives, and already thirty thousand tons per annum are grown there.

But in considering the future of Africa, we are brought face to face with a question which is both serious and difficult to answer. What, in the future, shall be the relations of the white and black races, dwelling together. We are no strangers to that question in our own country. We have seen the blacks in America, increasing year by year more rapidly than were the whites, with no tendency anywhere to the disappearance of the line which separates them, and many of us have been led to ponder unto what that must lead in the coming years. Exactly the same facts confront us in Africa wherever Europeans have long resided, and from such evidence we are led irresistably to the conclusion that these facts will be repeated over the whole continent, when once it is redeemed from its present wild conditions. The aborigines of America and Australia disappeared before the white man and left the country to be occupied by him wholly, but the African shows no such tendency. Cape Colony has been long occupied by Europeans and the country is perfectly healthy for them, yet they fail utterly to maintain their relative numbers. A large proportion of that land is now occupied entirely by aborigines except where missionery stations are established. Fifty years ago the country now constituting Natal and the Transvaal was a wilderness, being kept depopulated by the raids of the surrounding tribes; now under the peace kept by the Europeans, one and a half million blacks are dwelling there and the number is constantly multiplying. When the same strong arm of civilized government shall stop the inter-tribal wars and the still more destructive slave raids, we may expect such a swelling of the numbers of native Africans as shall make white preponderance an utterly hopeless dream. In South Africa, where whites and blacks dwell together, as in America, with the same conditions, the social line of demarkation is never broken. To the whites who dwell there it seems impossible that it ever should be broken.

Here is this great continent, five times as large as Europe, with a soil of boundless fertility, with abundant mineral wealth, and it ought to be contributing of its resources to the world at large. Here is the African himself, a brother-man, making claims upon mankind too strong to be disregarded. Over nearly all rests the pall of barbarism. Civilization, and especially Christian civilization, has felt that it could not leave this land in darkness, and is now, through missionaries, through trading companies, through governmental action, through international conference, sending into it many beams of christianizing light. If these have not yet served to dispel much of the darkness, they have made clear the importance and the magnitude of the work. Many of us have been accustomed to think that to accomplish the redemption of such a people white supremacy was absolutely necessary, but all the evidence before us shows that the number of whites there will be most insignificant. Every step toward peace and order which will make white occupation easier will also add greatly to the numbers of the blacks. The problem must be worked out with the black as the largest factor. He may be taught, and guided and trained by his white brother, but he must, to a great extent, work out his own salvation. In other places and at other times he has not been found equal to this, but surely we may hope that in these new conditions and under pressure of this great demand upon him, he may aspire after and attain into something far higher than he has yet known, and that through him, thus uplifted, upon Africa the day shall dawn and the shadows flee away.

This struggle no one can watch with indifference.

At the business meeting following, Rev. W. Bancroft Hill was proposed for membership by Dr. Van Gieson; John Sutcliffe by Edward Elsworth; Herbert E. Mills by Prof. Dwight.

DECEMBER 2, 1890—FIFTY-FOURTH REGULAR MEETING.

Prof. W. H. Brewer, of Yale University, presented the following paper:

THE GREAT BASIN.

BY WM. H. BREWER.

[This abstract gives the chief points of the lecture, which was illustrated with many views of the scenery and of maps showing the topography.]

The name "The Great Basin" is applied to a portion of the western part of North America, lying between the Wasatch mountains on the east and the Sierra Nevada on the west.

It is a region of interior drainage; that is, none of its rivers flow to the sea. Similar regions lie within each of the continents, and this has no one feature not found in others, yet it has a combination of characters not found elsewhere on the globe. It is the most distinctive geographical feature on the North American continent.

For a proper understanding of its characters it is necessary to consider some elementary facts of physical geography. All the fresh water on the globe comes from the rain and snow that falls upon the land. Water is evaporated everywhere from the surface of the ocean, as well as from the land, is wafted by the winds here and there, and falls in rain or snow. If more falls on the land than can evaporate from its surface, the surplus must flow away in streams to the sea. In New England, New York, and the Eastern Atlantic states, less than half of the total rainfall evaporates from the surface, the remainder, constituting five-eighths, flows to the sea. If there is a depression in the land it fills up with water in time, forming a lake; when full, the depression overflows and a stream runs out of the lake. As rivers are of fresh water, such lakes are always fresh and their outlets are fresh. The many lakes east of the Rocky Mountains are all of this character.

But a region may be so dry that all the water that falls in it evaporates from the surface. In such a region the streams flow from the higher land into depressions, forming lakes, and these lakes become salt. No stream or river has water entirely pure. It dissolves various substances from the soil, which, flowing down into the lakes, is left there by evaporation. Consequently it is the universal rule that lakes without outlets and in dry regions, always become salt. There are but few exceptions on the globe, of which Lake Tschad, in Africa, is the most notable.

Many of these salt lakes, found in the interior of continents, are of great size. Some are in elevated regions, as is the Great Salt Lake in Utah; and others are below the level of the sea, as is the Dead Sea and the Caspian Sea. They vary in size from mere salt marshes or salt pools to great interior seas, like the Caspian Sea.

Bear in mind, that the distinguishing feature of all such regions is that they have a very dry climate. If as much rain fell on every square mile between the Rocky Mountains and the Sierra Nevada as falls in this state, the water could not possibly all evaporate, and some, of necessity, would have to flow away; the hollows would, in time, all fill up with water and overflow, and their outlets would be rivers which would find their way to the sea somewhere, and, moreover, all the lakes would be fresh. As it is now, however, the water that falls al] evaporates, and the air is so dry that much more would evaporate should it fall. As a consequence the depressions never fill up and the lakes are salt. Where there are fresh water lakes, as Lake Tahoe, Lake Utah and numerous small ones near the heads of the streams, their outlets ultimately reach some salt lake, or salt marsh, or salt sink.

This region is traversed with mountains among, which many streams rise, some of considerable size. They run into the lower places where some of them empty into salt lakes; others sink into the sands without making a lake, "sinks" they are called in common language of the country; others form shallow lakes in the winter which dry up in the summer, leaving great mud-plains called "playas." Great stretches are unmitigated deserts. We often hear it said that there is no "American Desert," but there is. Not much actual desert this side of the Rocky Mountains, but in the region under discussion there are certainly deserts enough, as barren and as desolate as any part of the Sahara in Africa; not so large, to be sure, but as truly unmitigated deserts.

Along the eastern side of the Great Basin the Wasatch Mountains rise, abruptly and steep, to the height of 10,000 or 12,000 feet. The Sierra Nevada on the west are still higher, many of the peaks being over 12,000 and some over 14,000 feet high. The early explorers, in crossing the continent, found these great mountain barriers on either side, with rivers draining inland to the salt lakes, so they called this region a "basin." The name was popularly adopted, and is now often used for other regions of interior drainage.

The name basin, however, is a misnomer, and it is unfortunate that it has come to be so generally used because it conveys a very popular error, both as to the causes of the distinctive features of the country and of the structure. I find many intelligent people who have an idea that the causes are in the structure of the country, that there is a veritable basin, a sort of sunken area in the interior of the continent, with a rim around it so that the rivers must run inland, a mountain rim so high that the waters cannot by any possibility get over the edge and flow outward to the great ocean, where most of the rivers of the earth empty. They think that it is the high rim makes the "basin" and turns the waters away from the sea to evaporate from the salt lakes or playas, or sink in the sands of the desert.

This misconception is intensified by the fact, that most of the travelers who see any portion of it at all, cross on some of the routes to California. Going westward, they cross first the great mountain chain, then the Wasatch, then descend into the basin, through which the road runs many hundred miles, and then climb the great and still higher Sierra Nevada which rises like a wall on the western side. These great mountain chains seem barrier enough to hold back the water; they seem sufficient cause why the rivers do not reach the ocean.

But the fact is, it is not a basin of which the rim is the essential feature. In places the rim is very low, merely sandhills, scarcely raised above the level of the ocean; and in many places it is actually on a plain, scarcely discernible to the naked eye. The region is not a basin in any other sense in which we use that word except that the water does not run out of it. The real cause is in the climate and not in the topography of the country or its geological structure. The cause is in the sky above it and not the rocks beneath it. It is the scanty rain and dry air that give it its distinctive character.

I am making a long introduction of elementary physical geography, but this is necessary for an understanding of what I have to say later. If there was rain enough, such an annual rainfall, for example, as we have, no one would speak of the Great Basin. There would then be no salt lakes there, nor salt marshes, nor playas, nor deserts. Where the salt lakes now are and where the worst deserts glimmer with fervent heat, there would then be great fresh water lakes, with rivers flowing into them and out of them, fertile valleys would abound, and the outlets of the many lakes would flow in various directions to the sea. They would overflow the rim in many places. There would be several river systems, and the waters would find their way to the ocean by various routes ; some would pass north into the Columbia River, others find their way to the Pacific through the Klamath River ; possibly other passes in the Sierra Nevada would then be river valleys, while large streams would flow southward and empty into the Gulf of California.

I have plotted this region on a large map, which I show you. It extends over 12 degrees of latitude, or about 900 miles from north to south, and is about 520 miles wide in its widest part. Nearly the whole of it lies within the United States, a little tongue, on its southern portion, extending over the line into Lower California. Its nothern portion is in about the latitude of Portland, Me. ; its southern, about as far south as the northern line of Florida. I estimate that it contains about 217,850 square miles. This is a little larger than Mr. Russell of the U. S. Geological Survey has estimated it.

Let us compare this area with that of some of the Eastern states. It is more than four times as large as the whole state of New York, and just about 45 times as large as the state of Connecticut. The whole state of Nevada and most of Utah lies within it, and it extends into California and Oregon.

The topography of the region is very varied. Indeed, numerous mountain chains traverse it, having mostly a north and south direction ; and between them are valleys, some of great extent; sometimes narrow, at others spreading out in broad plains ; some of them fertile, but the most of them barren: and some of them salt plains or salt marshes.

The mountains themselves are very varied. Some are of volcanic rock, others stratified rock, still other metamorphic ; all of these classes existing in numerous modifications. Some of the chains are isolated so that one can travel entirely around them on comparatively level country; others are joined to each other or to the higher chains on each side. They have every variety of feature, having only one thing in common—all are very dry.

Some of the valleys are narrow canons, some are very deep, and others are high plateaus. Salt Lake Valley is a high plateau, nearly a mile above the level of the sea. West of this lake stretches a great, sandy plain, one of the most unmitigated and dangerous deserts of the United States; the old road across it is strewn with the wrecks of trains and bones of animals that perished there.

Some of these valleys, as before remarked, are very deep. The valley of San Felippe, in the San Bernadino desert and through which the Southern Pacific Railroad passes, lies 200 or 300 feet below the level of the sea. Death Valley, lying northeasterly from this, in California and not far from the Nevada line, is still deeper, probably more than 300 feet below the level of the sea, and probably, next to the valley of the Dead Sea, the lowest spot on the earth's surface.

These facts convey, after all, but a faint idea of the actual variety of feature and of scenery which may be found in this great region. Although very dry, some rain falls on the higher mountains, and portions of the mountains are well watered, and some large rivers form, which flow down and are lost in the hot, desert interior. The upper Truckee, a beautiful stream, flows into Lake

Tahoe, one of the most beautiful mountain lakes of the world. This is of fresh water, very deep, very clear, and situated, amid the most enchanting scenery, over six thousand feet above sea level. The swift and pure Truckee River flows from it, to ultimately disappear in salt lakes and more salt plains.

Being a dry region, it is a region without forests, except in a few places on the mountains. All the plains are treeless, except the narrow fringe of trees along some of the streams. Even the mountains of the interior are without forests, almost naked, supporting only a scanty shrubby vegetation. They stand up from the desert plains, all the topographic features of their naked sides sharply seen, and their ribs standing out with marvelous distinctness against the clear, cloudless sky. From various peaks along the western rim I have looked out over landscapes embracing several thousands of square miles in one view, without a single forest and not a green patch of any kind of more than one or two square miles.

All civilization is founded upon agriculture, and for agriculture there there must be abundant water. A prosperous state must be a state of homes, of which a good proportion are country homes. City life is all very pleasant, but cities cannot make a state nor a prosperous people ; there must be tillable soil to produce food, and water to make it fertile, and country homes. There are few spots in this basin of any extent that are tillable without irrigation, and not water enough to be made available for ever irrigating more than a small fraction of the whole.

I may state here, that all of my own personal exploration in this region was along its western portions. I have only seen the other portions as any traveler might in crossing it and stopping at a few points along the railroad; but with the western portion I am much more familiar. In my explorations nearly thirty years ago, I crossed the great chain of the Sierra Nevada which forms its western rim sixteen times, crossing it in fourteen places. That was before any railroads were built, and with that portion I am somewhat familiar.

The region was not always so dry, so here let me again digress. Just before the present geological age there was one much wetter and colder than the present, called by geologists, the glacial period or ice age. It was a long period of great cold, followed by a very rainy period. We see many evidences of these ancient glaciers in Eastern North America ; they exist also there but not so entirely covering the land there as here. Grand moraines stretch down in great ridges, from the Sierra Nevada into the desert plains below. Large rivers, fed by abundant rains then made that country more like this. Then the depressions were filled with water, and there were numerous lakes, some of them very large. There is abundant evidence of this, and their traces constitute some of the most remarkable natural features of the present country and give a peculiar aspect to the scenery. Fresh water lakes then existed where now are parched deserts. I cannot follow the details of this ; I will only glance at some of them, for there were many such lakes.

Two great lakes in the northern part have attracted the special study of geologists. They were of large size and of fresh water, but are now dried up, the most of their ancient beds existing as desert valleys, in which are salt lakes.

Lake Lahontan was in the western part in the State of Nevada, the grand Sierra Nevada rising from its western shores. It covered 8,400 square miles (considerably larger than Lake Ontario), and was perhaps a more picturesque lake than any now existing on earth. Mountain chains extended down into it, forming high and picturesque promontories; other mountains stood out as islands. The sublime Sierra rose from its western side, and volcanoes rose from its islands or stood near its shores. There were mineral springs also, and some of these have left their traces in more ways than I can describe. I show you a few views of tufas taken about Pyramid Lake, and of crystals that were formed in another of these ancient lakes, and of tufa formations from about Lake Mono, but any representation of them conveys but an inadequate idea of their present aspect, as the traveler sees them standing now in the inhospitable desert or rising from the waters of some dead and salt sea.

The volcanos erupted enormous quantities of ashes, which fell in the lake and were distributed in strata on their bottoms which have since been laid bare by evaporation. Microscopic examination shows that these ancient volcano ashes were much like those which were erupted from Krakatoa, in the great explosive eruption of three years ago. The old lake beds formed of this volcanic dust, are now dry sage brush plains. Lake Lahontan was fresh. If it had an outlet it has not yet been found. It probably flowed northward and found its way to the Pacific through the Columbia River.

Southward from this was another series of lakes. The present Mono Lake is a saturated solution of salt, lying in the desert at an elevation of more than 6,000 feet. Mt. Dana rises from its western shore 7,000 feet higher, its top streaked with eternal snows, the lake itself surrounded by hot, inhospitable deserts. The water is a saturated solution of salt, borax and soda. There are volcanic islands in the lake, with hot springs upon them, the home in the spring time of great flocks of gulls, which come from the distant Pacific to nest there amid these solitudes. I visited these islands with an Indian, who used to go over there to collect eggs, which he cooked for his own use in the hot, boiling springs which issued from the volcanic rocks.

Along the northern shore of this lake there are many curious tufa formations, the pictures of some of which I show you. South of the lake are a number of volcanic cones, the ascent of which, up their steep sides of loose ashes, was one of the most fatiguing trips of my life.

Separate portions of the great basin have their local names. The Mohave Desert, the San Bernadino Desert, and so on, are names well known there.

The atmospheric effects are as wonderful and as striking as the topographic. Week after week, yes, month after month, there is a cloudless sky, the sun blazing through the dry air with an intensity never known in our climate. When I was in Owen's Valley, the rain gauge kept at Camp Independence, showed that there had been but $\frac{3}{4}$ of an inch of rain in the previous 18 months.

You may wonder if any vegetation can withstand such drought. Yes, there are many species adapted to such a climate. Most of them are low shrubs, of which *Sage Brush*, *Greasewood*, and *Creosote Bush* are typical examples. All the shrubs that we know as inhabitants of our climate, if once thoroughly dried are killed. Not so with those. They may dry up as completely as do the mosses or lichens on our rocks; their vegetative functions are suspended for the time being, but when rains come they then put forth their leaves and renew their growth. As a botanist I studied this vegetation with intense interest. I cannot further descant upon it here, than to say that these plants can withstand a drought of several rainless years, suspending their vegetative functions while it lasts, without giving up their life; but when exceptional rains do come they put forth their leaves and flowers and continue their life. There are some small, herbaceous plants which spring up after rainy seasons, their seeds remaining, I know not how many years dormant, until the favorable time shall come for them to start into life. Some of them have flowers of exquisite beauty.

I have alluded to the atmospheric effects. With a cloudless sky there is, nevertheless, a great variety of hue and effect produced by the play of light upon the dust. During midday and in the heat of summer, a dusty haze may prevade the landscape, shutting out distant views. The nights are always cool and clear, and sunrise and sunset are marked by a display of colors in the sky, near the horizon, unlike anything ever seen in moister lands. These are due to the effects of fine dust in the air, scattering or decomposing the light.

But violent storms occur there as elsewhere. There are sometimes fierce water-spouts—cloud-bursts they are called—which are very local and very intense, an enormous volume of water falling in a very short time. This, gathering into the valleys, sometimes produces very destructive torrents. Then, too, there are wind storms, with all of their varied phenomena, sometimes raising clouds of dust and sand, like the sand-storm of the Sahara.

On the broader deserts and during certain seasons of the year, there are numerous small whirlwinds, too mild to be of any danger whatever but carrying up pillars of dust into the air to a great height, which move over the plain, sometimes swiftly but more often slowly, producing a weird, indescribable effect. A dozen are sometimes in sight at once.

In other places, there are winds blowing continually in the same direction, through wind gaps in the mountains along the western side. I show you pictures of dunes of drifting sand, more than 600 feet high. The crossing of these is wearisome beyond description. In other places the driving sand has polished the rocks.

I have said that there were two ancient lakes greater than the others. One in the eastern part has been called Lake Bonneville. It occupied portions of Utah, and the Great Salt Lake is all that is left of it. This was vastly larger than Lake Lahontan, and has been the subject of especial study by the United States Geological Survey. It is estimated that it covered 19,750 square miles, or was nearly twice as large as Lake Erie, but it was so very irregular in shape that it extended a great distance southward. Like Lake Lahontan it had its islands and its promontories, and, what is of even more interest, its outlet. Some of the islands in the lake are now isolated and barren mountains in the dry deserts, the old lake shores marked about them with a vividness that is simply marvelous, as you see from some of the illustrations. These old lake shores form terraces or tables. Salt lake city stands upon such a terrace. These shores can be traced almost as distinctly as if the sea was still there, for more than 150 miles south of Salt Lake City. They constitute a peculiarly distinctive and striking feature in the landscape. The outlet of Lake Bonneville was northward, through Red Rock Pass, at the north end of the present Cashe Creek Valley, in Idaho. This is a small stream which now flows southward to the Bear River. At its head is the Red Rock Pass in a valley, and beyond that to the north is the valley of Marsh Creek, which flows northward to the Snake River. Through this, the old Lake Bonneville emptied, its waters, finding their way to the distant ocean through the Columbia River. The Utah and Northern Railroad now passes through these valleys and over this pass.

I have spent so much time in discussing the scenery and other aspects, that I have but little left for the resources.

First, and most remarkable, are the mines. Those particularly of Nevada have affected commercial values all over the world. Silver and gold bullion have been produced by the hundreds of millions of dollars, produced indeed in such abundance, that since their discovery silver has fallen in value so greatly that it has ceased to be the standard of value in the world. It would take more than one lecture to discuss these various mining regions, which, however important to the world at large, after all give little permanent prosperity to a state.

There are numerous other minerals. I have spoken of salt lakes. I use the word in a chemical sense rather than in the popular sense. The salts are of numerous kinds. Soda Lake furnishes carbonate of soda by the ton. Mono Lake yields both soda and borax. There are borax swamps in various places ; there are valleys with beds of solid rock salts, and there are numerous minerals of commercial value.

But this region is, and ever must be, but a sparsely populated region as a whole. As before said, the basis of a nation's prosperity is in its agriculture, and agriculture is dependent upon water. Water is the great want of this country. Where it can be obtained for irrigation crops grow with a luxuriance Eastern men cannot appreciate, but the supply is limited and we cannot hope it will ever be materially increased. Ultimately, when our whole country becomes more densely populated, then many localities not now occupied will be occupied, and I can imagine that there will be many neighborhoods and districts of great fertility and great production, and of marvelous beauty. The success of the Mormons, in the western part of the basin, gives an indication of what can be done ; and isolated portions here and there, where some enterprising man has gone in and irrigated even on a small scale, give indications of what may be expected sometime in the future ; but at best the population must and will ever remain comparatively sparse.

It is, however, a very healthy region, and I imagine that in the future it will become more and more a resort for people in pursuit of health, particularly those afflicted with lung diseases or with any other ailment for which a dry climate and elevated region are beneficial.

There have of late been many statements made, countenancing the belief that the most of this country will ultimately be occupied. I have no hopes of that whatever. The State of Nevada lies entirely within this basin. It has now been a state more than twenty-five years. It has had the most productive mines of this century. It has an area of over 109,000 square miles, more than twice as large as the whole State of New York, and more than 20 times as large as the State of Connecticut. Yet the population of that large State to-day, as indicated by the recent census, is less than 40,000, less than the population of a fourth rate Eastern town; and not only that, but less than it was ten years ago, and it is probably still declining. Its wealth has been in mines, not in agriculture. While I believe that the population will again increase as irrigation comes into use, I can never believe that any more than a comparatively sparse population will be supported in that State.

In summing up I may say, that while as a whole it must always remain a relatively sparsely settled region, the marvelous variety of scenery, the healthfulness of its climate, the mineral wealth, the picturesque beauty of portions of it, will combine to turn the feet of the traveler in that direction. Persons in search of natural beauties, unfamiliar in aspect and in kind to those of a wetter region, may find there much to interest, the enterprising man will find much to encourage, and the region will always be one of great interest, but a populous region as a whole it can never be.

The following members were elected at the business meeting which followed: W. B. Hill, John Sutcliffe, H. E. Mills.

The following were nominated for membership: J. W. Poucher by Frederick S. Arnold, Dr. C. H. Snedeker by Dr. Van Gieson, and Harris S. Reynolds by H. V. Pelton.

JANUARY 6, 1891—FIFTY-FIFTH REGULAR MEETING.

Prof. Moses C. Tyler, of Cornell University, read a paper entitled "Historic name of our Country." J. W. Poucher, M. D., Rev. C. H. Snedeker, and H. S. Reynolds were elected members at the business meeting which followed. Helmus W. Barratt was named for membership by Edward Elsworth.

FEBRUARY 3, 1891—FIFTY-SIXTH REGULAR MEETING.

Prof. J. J. Stevenson, of the University of New York, read a paper entitled "The Age of Coal," which was illustrated by lantern slides.

Helmus W. Barratt was elected to membership.

MARCH 3, 1891—FIFTY-SEVENTH REGULAR MEETING.

Prof. Burt G. Wilder, of Cornell University, read a paper entitled "The Speech Centers in the Brains of Men and Apes."

MAY 5, 1891—FIFTY-EIGHTH REGULAR MEETING.

Present, H. P. Pelton, Pres., and a quorum of members. The report of the President on the work of the Institute during the past year was read and approved. The report of the Treasurer was read and approved. The report of Prof. Cooley, Chairman of the Board of Trustees, was read and approved.

The following were duly elected Trustees: LeRoy C. Cooley, Charles B. Warring, A. P. Van Gieson, Edward Elsworth, Charles N. Arnold, Evan R. Williams, H. V. Pelton, Charles B. Herrick, Edward Burgess, W. B. Dwight, William T. Reynolds and Irving Elting.

The following were elected officers: President, Charles B. Herrick; Vice-President, Irving Elting; Secretary, Silas Wodell; Treasurer, Edward Elsworth.

NOVEMBER 10, 1891—FIFTY-NINTH REGULAR MEETING.

President Herrick in the chair. The following were proposed for membership: John Williams by E. Elsworth, Edmund Platt by Charles B. Herrick. Charles N. Arnold reported that a flint lock, bayonet, sword, scabbard, and cartridge box, belonging to the period of the Revolution, had been presented to the Institution by Edward Barnes.

DECEMBER 2, 1891—SIXTIETH REGULAR MEETING.

John Williams and Edmund Platt were elected members. Samuel Robinson was nominated for membership.

MAY 3, 1892—SIXTY-FIRST REGULAR MEETING.

President Herrick in the chair. The president reported that the work of the Institute during the past year had been devoted almost entirely to University Extension; a course of lectures on American History having been delivered by Prof. W. A. Mace, of Syracuse University. Chairman Cooley presented the annual report of the Trustees of the Institute, which was accepted. Prof. Dwight as curator of the Museum made his annual report, which was also accepted. Samuel Robinson was elected to membership.

The following Trustees were elected: LeRoy C. Cooley, Charles B. Warring, A. P. Van Gieson, Edward Elsworth, Charles N. Arnold, Evan R. Williams, H. V. Pelton, Charles B. Herrick, Edward Burgess, W. B. Dwight, William T. Reynolds and Irving Elting.

The following were elected officers: President, Charles B. Herrick; Vice-President, James Winne; Secretary, Silas Wodell; Treasurer, Edward Elsworth.

The following resolut on was offered by the Treasurer and unanimously adopted:

Resolved, That the roll of members of this Institute be amended and revised by striking from the present roll in the hands of the Treasurer the names of those who have resigned and of those who have paid no dues or are at least three years in default, and that the Secretary and Treasurer be and they are hereby appointed the Committee to make such revision.

The following proposed amendment to Article 2nd, Sections 4, 5 and 6 of the by-laws of this Society was submitted in writing and read, viz: "That all members on and after the adoption hereof, be elected by the Trustees in such manner as they may prescribe. The affirmative vote of two-thirds of the trustees present at any regular meeting shall be necessary to elect a member, and no person shall be elected a member unless his name is presented to the trustees at a regular meeting preceding the meeting at which his name is to be voted upon."

MAY 2, 1893—SIXTY-SECOND REGULAR MEETING.

In consequence of the occupation of the Auditorium, the meeting was adjourned to May 9, 1893.

MAY 9, 1893—ADJOURNED MEETING.

President Herrick in the chair. The President reported that the work of the Institute during the season of 1892 and 1893 had been devoted exclusively to University Extension; that a course of 10 lectures on Economics had been delivered by Prof. H. E. Mills, of Vassar College.

The standing Committees on Museum and Library and on Publication presented their reports, which were read and accepted.

Chairman Cooley presented the following report of the Trustees which was accepted.

The Trustees beg leave to report in regard to the condition of the property of the Institute:

That the addition of new materials and the construction of some better facilities for displaying specimens, together with the watchful care of all the older collections, have made the Museum more valuable and more attractive than ever before; that important additions by exchange have been made to the library, and the value and usefulness of the whole as a reference collection is secured by the system of classification which has recently been introduced, and by the satisfactory condition in which the books are kept; that the invested funds are under the most careful guardianship, and that the building and grounds have received all needed attention.

The Trustees believe that the property of the Institute as a whole is in satisfactory condition.

The Treasurer made the following report:

Amount of cash on hand per last report		$1,593 81
Amount collected from all sources to date		1,561 00
Total		$3,154 81
Disbursements from the repair fund	$ 81 92	
From the museum fund	181 70	
From the general fund	865 35	
Total disbursements		$1,128 97
Balance		$2,025 84
Cash on hand in special fund May 2, 1893		$3,126 24
Cash receipts from investments		753 47
Total		$3,879 71

Cash invested	$3,092 08
Balance in special fund	787 63
Total cash on hand	$2,813 47

The report of the Treasurer was accepted.

The amendment to the by-laws Article 2, sections 4, 5 and 6, proposed at the regular meeting May 3, 1892, was unanimously adopted.

The following Trustees were elected: LeRoy C. Cooley, Charles B. Warring, A. P. Van Gieson, Edward Elsworth, Chas. N. Arnold, Evan R. Williams, H. V. Pelton, Chas. B. Herrick, Edward Burgess, W. B. Dwight, Wm. T. Reynolds, Irving Elting.

The following officers were elected: President, Rev. W. Bancroft Hill; Vice-President, James Winne; Secretary, John Williams; Treasurer, Edward Elsworth.

SCIENTIFIC PAPERS

OF

VASSAR BROTHERS INSTITUTE,

AND

TRANSACTIONS

OF ITS

SCIENTIFIC SECTION.

1890–1893.

VOL. VI. PART II.

TRANSACTIONS

OF THE

SCIENTIFIC SECTION.

1890–1893.

NOVEMBER 25, 1890—FIRST REGULAR MEETING.

Present Chairman Elsworth; Members Burgess, Cooley, C. N. Arnold, Dwight, Herrick, Pelton, Van Gieson, Warring, Rogers, Neumann, Wodell, F. S. Arnold, and thirty visitors.

After the minutes of the last meeting were read and approved, the chairman officially announced to the section the death of the Curator, Dr. William G. Stevenson. As curator *pro tem.*, the chairman reported progress in the museum and made special mention of a valuable collection of Indian antiquities. The Librarian reported a list of twenty bound volumes and a large number of pamphlets as accessions to the Library since the last meeting, and a recommendation to purchase some additional volumes which the section authorized him to lay before the Trustees.

When the study of specimens was in order, a piece of hematite was presented by Isaac Tompkins and C. N. Arnold exhibited a specimen of aluminum. The Chairman, E. Elsworth, presented a paper entitled "A Question of Professional Ethics" in connection with Dr. Koch's reported discoveries. He made a brief sketch of the life and labor of Dr. Koch, commending his discovery and indefatigable researches in the medical field, but inclined to criticise the secrecy in which his present investigations are hidden, notwithstanding a reported announcement that a cure for Phthisis is perfected. The question was discussed by Members Cooley, Dwight, Van Gieson, Poucher and Burgess, the tenor of the discussion being to explain Dr. Koch's action. The Lymph is not yet perfected nor the investigations completed, and at this early date the yet imperfect results might by stimulating lessable practitioners to do a great deal of harm.

C. C. Gaines was nominated for membership in the section.

Prof. W. B. Dwight was elected Curator with power to appoint an assistant. He subsequently announced the appointment of Dr. Neumann as such assistant.

DECEMBER 9, 1890.—SECOND REGULAR MEETING.

Present Chairman Elsworth; and Members C. N. Arnold, Burgess, Cooley, Dwight, Herrick, Pelton, Tompkins, Van Gieson, Wodell, Warring, Neumann, F. S. Arnold, and a number of visitors.

Mr. Edward Burgess read the following paper entitled:

ANIMAL INTELLIGENCE.

It is my purpose this evening to consider the subject of Animal Intelligence. While it may still be an open question with some whether animals do possess intelligence, the accumulating testimony so strongly tends to establish this, that it seems but a question of time when this belief will be universally held. By intelligence is meant something different from instinct. All animals possess instincts of some kind—that is they have inherited from their ancestors' traits or impulses, to certain fixed modes of action, which they are irresistibly impelled to adopt. Instincts are not exactly automatic like reflex action, because the element of conciousness enters into them. At the same time they are involuntary to this extent, that animals perform them without being taught and always in the same way. The instincts of nest building and migration are something not acquired by experience, but has been transmitted through countless generations of birds, until at the proper time both actions are performed by an impulse, which when the conditions are normal, cannot be controlled. Effort is required in both cases and conscious effort; at the same time it is instinctive, because it is inherited.

Intelligence in animals implies something that is over and above instinct. It is correlated with instinct, and at the same time it indicated a capability on the part of the animal, to adapt itself to new conditions and to meet new and unforeseen emergencies when they arise. An animal guided wholly by instinct must perform all its actions in a fixed and unvarying way. When confronted by any new difficulty, if it depends upon instinct alone, it is at a loss how to proceed, and so is helpless in the presence of it. Here intelligence comes into play, and an animal is rescued from trouble or gains its point by possessing this pliancy of mind, which is of the greatest service to it in the struggle for life.

It is true that instincts have arisen from this necessity of adaptation; but they are gradual acquisitions acquired in the long course of years and are fixed by heredity. They are very wonderful and are admirably fitted to serve the interests of the animals possessing them; but they are not sufficient for sudden emergencies. These can only be provided for by that other faculty of intelligence—that is if you choose to call it another faculty—which animals possess in varying degrees. The action in such cases is neither involuntary nor automatic, but is directed by an intelligent will. Frequent repetition of it eventually converts it into an instinct, but this is obviously not its character in the beginning.

I have said that it is a growing belief that animals do possess this intelligence. I do not, however, intend to take this for granted, for my purpose is to give the ground upon which such a belief rests.

Such a belief must be derived from observing the habits and practices of animals. The difficulties in the way of doing this, especially of animals in the wild state, are very great, for, observation to possess the highest value should be continued, and this is manifestly impossible with those that are feral; and with others that can be controlled and confined by men, the habit of patiently observing them and recording those observations has not been common. But although we possess a body of information upon this subject, small as compared with what will eventually be collected, it is still sufficient to justify the growing belief that animals—employing this word to mean all living things—possess something more than mere instinct, that they enjoy faculty of reason, and that they are frequently able to protect themselves from danger and improve their condition by its exercise. The size of a living creature is no measure of its intelligence. If this were so the ant would be the most insignificant of creatures. As it is, the ant possesses extraordinary instincts and an intelligence that is not less remarkable. Concerning the habits of ants we happen to possess a very large fund of information, collected by a number of pains-taking observers, which can implicitly be relied upon. Huber, MacCook, Belt, Moggridge, Sir John Lubbock and others have made a careful study of their habits and disclose some astonishing things. It is conclusively demonstrated that they have tenacious memories. Huber removed some ants from a nest and kept them in confinement four months, when they were restored to the nest and immediately recognized by the others. Sir John Lubbock extended the time to a year, and with the same result. They stroked the antennæ of the absentees, a mark of ant affection, and gave unmistakable evidence of satisfaction at the return of their missing comrades; whereas a foreigner was instantly attacked and killed. It was supposed that this recognition was due to a sense of smell or to some signs acquired in their earlier acquaintances which they communicated to one another. To test this, Sir John Lubbock, in September separated a colony of ants into two parts, each provided with a queen. There were no pupae or eggs in the nest at the time, nor until the following April. In August the ants were grown and the young members of the separated families were introduced to each other. The recognition was not as immediate as in the former instances—they appeared somewhat perplexed and puzzled, but finally after satisfying themselves of each others identity, fraternized in the friendliest fashion. This put an end to all the explanations which had hitherto been received to account for this wonderful discernment, and it is still unaccounted for. When one considers the number of individuals that compose an ant's nest, this fact of the recognition of relatives is most astonishing. In view of this it is not surprising that they should have an affection for one another and help each other in distress. Mr. Belt fastened one under a stone with its legs projecting. As soon as he was discovered his comrades pulled vigorously at him until he was released. Another was buried under same clay with only his antennæ sticking out. A passing ant noticed him and tried to extricate him but without success. He then went away and it was supposed had deserted his imprisoned relation; but presently he returned, laboring under great excitement, with about twelve others. They all set to work to dig out the prisoner, and in a short time he was free.

Sir John Lubbock's experiments showed indifference to one another when in distress, but this was with another specie of ants. The characters of different varieties are sharply defined, by no means possessing the same traits in common. The incident just narrated shows that they can communicate with one another. This was confirmed in another way. A dead fly was securely fastened with a pin some distance from the nest and an ant conducted to it. After tugging away at it for some time, he found he could make no impression on the fly, and hurried off home for help. In a few moments he emerged from the nest with several others. The re-inforcements seemed only half awake, for they came out rubbing their eyes—so to speak—and wandered aimlessly about, while the scout shot off in the direction of the fly, not looking behind and leaving his sleepy friends out of sight. Finding that they did not appear he went back for others, and brought out eight more drowsy folks. In his impatience and excitement he ran ahead of these also, and they not knowing where to go soon returned to their nest. Meanwhile the first lot, after groping around for about twenty minutes, finally stumbled on the fly, tore it to pieces and brought it home. It would seem from this that the ant could tell his associates that their services were wanted but could not communicate the direction. If he had not been in such a hurry they could and would have followed him, but having no guide they had to wander around until the prey was finally discovered.

It is well known that certain species of ants keep aphides as milch cows. The eggs are first secured and tended as carefully as the eggs of the ants themselves. They are usually hatched in the ants nests, and then taken out and placed on the plants upon which they feed. Sometimes an enclosure is built to confine the aphides, as well as a covered archway leading from the ants nests to them. The aphis secrets a thick sweet juice, which it releases when tickled in the abdomen with the antennæ of the ants. The ants are very fond of it, and protect their aphides with great care. They not only place them on the leaf stalks of plants, but actually plant colonies of them in trees. A gentleman, living in Upper Silesia, noticed that of two weeping ashes, which he set out on his place, one grew vigorously while the other seemed stunted in its growth. This continued for several years, when he carefully examined the backward tree and found it infested with aphides. To remove them, in March, he washed every bough and limb in the most thorough manner. As a result the tree broke out into full leave and sent out strong vigorous shoots. This continued until about the beginning of June, when one morning he noticed a number of ants continually running up and down the tree. He watched them closely and saw that they were carrying aphides up the tree, and on a further examination he found that large numbers had been planted on the upper leaves—in fact that the ants had established a regular colony there.

One of the most extraordinary habits of ants is the practice of making slaves. This scarcely seems credible, but the truth of it is established upon the clearest testimony. There are two principal varieties of slave-making ants—the F. rufescens and the F. sanguinea. Their captives are chiefly made among the F. fusca, a black ant, and inferior in strength to the other. The full grown ants are not carried off into captivity, only the pupæ, which are taken home and cared for until hatched, when they become the milling slaves of their captors, manifesting no desire to leave the nest and fighting in its defense with as much ardor as their masters.

With the F. sanguinea the slaves perform all the household work, which finds them full employment, as they have rather an elaborate system of housekeeping, and seldom leave the nest. When the ants migrate to another spot, which they often do, the slaves are carried in the mouths of the others, as a cat carries her kittens, to the new home. With the F. rufescens the slaves play a much more important part, doing in fact all the work, both outside and in, except the fighting; for apart from defending their nest and attacking others, their masters are entirely helpless. The slaves select the site for the new nest, make all the arrangements, and carry their owners thither instead of being carried by them. They collect the food, milk the aphides, and feed their masters, or otherwise they would die of starvation. Huber shut up twenty of these ants separated from their slaves, with an abundance of their favorite food, and with their own larvæ and pupæ as a stimulant to work. They did nothing and many of them died from hunger. He then admitted one slave, who at once went to work to feed those that were left. These master ants have a long, narrow jaw, well adapted for war, but entirely unfitted for feeding themselves.

Ants pay great regard to cleanliness and this partly accounts for the care which they take of their dead. They are at once removed and carefully buried. The system of caste prevails among them to this extent, that they have separate burial places for their own dead and those of their slaves. It is easy to note this with the F. sanguinea, since they are red and the slaves black. The cemeteries are quite distinct, and each dead body is interred in its own place. Mrs. Hutton, of Sydney, Australia, reports that she once killed a number of soldier ants to see what the others would do with them. Some of the survivors at once went off to the parent nest to report the calamity. A number came hurrying to the spot —two advanced, took up a dead body and moved on, followed by two others empty; then another pair lifted a dead comrade and fell into line, followed by two others carrying nothing, and so on until all the twenty corpses had been collected. The funeral procession moved on, accompanied by an irregular body of about two hundred others. Occasionally the burden would be laid down and taken up by the empty pair behind, and thus relieved they arrived at a sandy spot near the sea. Holes were dug in the ground and the ants buried. Some six or seven attempted to run off without performing their share of the work—they were pursued, brought back, killed and all these recre-ants buried together in a single hole, while the others had been buried in separate graves.

·The different varieties of ants have habits that are peculiar to themselves. Some of these habits are quite extraordinary, and indicate something more than a mere instinct—they indicate a wise adaptation of means to to ends.

The Leaf-cutting Ants of the Amazon cut leaves from trees and carry them home. They make a semi-circular incision on the top of the leaf and tear it off. This they carry over their heads to the nest. As the burden is quite a heavy one for these small creatures, it is essential that they have a good road to travel over; so they make one by cutting down the grass and removing all obstructions. As they are moving in both directions, going to the trees and returning, to avoid confusion, it is necessary that some order should be preserved, so each column keeps to the right. Looking at them from above, each one carrying a leaf over its head, the file looks like a giant snake moving slowly over the ground. The singular thing is that these leaves are not used by the ants themselves. They are cut up in small pieces by the workers at home, and they then support a fungus which the ants do eat, so that they are actual gardeners, raising one vegetable from another for their own use. If they are overtaken in a shower, the leaves, before storing them in the nest, are left outside to dry; if they are excessively wilted by the heat they are likewise left until they harden in the cool evening air, and if the weather is very warm the cutting is discontinued during the day and carried on in the evening and at night.

Still more remarkable are the "Harvesting Ants," which are found scattered in various parts of the world. They clear an ample disk around their houses, removing everything and pack it down hard and smooth. From this several main roads diverge which narrow as they recede. From these main roads are side lanes less carefully constructed which lead into the harvest field. The road broadens as it approaches the house, for the obvious reason that as the ants come pouring in from these side cuts with their freight the numbers continually increase, and a constantly widening avenue is required to accommodate them. These ants lay up stores of seeds in large underground granaries for future use. The most astonishing thing in connection with this habit is that they have found out a way to prevent the germination of the seeds. As they are kept in storehouses under ground and near the surface of the soil, they would inevitably sprout unless prevented. Their germinating powers is not destroyed, for Moggridge planted seeds taken from the nest and produced fall crops with them. If the ants are removed from the nest they will germinate in due time. It was at one time supposed that the ants emitted an odor which checked their growth. To test this some seeds were placed so that the ants could not come in contact with them, although still exposed to their exhalations and the seeds sprouted readily. If they become too damp they are brought to the surface and dried by exposure to the air. If an occasional one does germinate the ants with wonderful intelligence have discovered that the most effectual mode of stopping it is by gnawing off the tips of the radicals. It is still a mystery how they preserve this food without spoiling. I suppose their granaries must be made to keep as dry as possible, and then they must stir the seeds frequently.

I think the ingenuity of man would be taxed to the utmost to accomplish the same result; for you must remember that the seeds are just below the surface, and hence exposed to the heat and moisture incident to warm climates.

Dr. Lincecum further asserts that around these disks the ants plant a grass seed called "ant rice," which germinates in November and is harvested in June. While it is growing all other plants are carefully weeded out from it, and after the crop is gathered the stubble is cleared off and carried away.

Some of these habits and practices may be called instincts, because they are performed by successive generations, but how did the instincts themselves originate? There can be little doubt but that these instincts are the accumulated experiences of generations, that these little creatures have discovered by repeated tests the usefulness of the habits they have adopted, and by continual exercise they have become converted into instincts. But that they could, for example, have thought of utilizing the labor of others for their own benefit by making slaves of them, indicates a capacity to think and to contrive, which scarcely seems possible with such an animal. These diminutive creatures, however, are alive to every new situation, and are ready with some contrivance to meet it. Professor Leuckart reports that to protect a tree that the ants used as a pasture for aphides, he bound around the trunk a cloth soaked in tobacco juice. Those descending from the tree, meeting with this noxious obstruction, returned to the overhanging limbs and dropped from them to the ground; while those who wanted to go up brought pellets of earth and plastered them on to the cloth, until a passage of earth was made.

Another tree, likewise infested with ants and aphides, was encircled with a coating of tar. The descending ants who first approached it stuck fast—the others, seeing their predicament, went back, bringing with them aphides which they kept sticking into the tar until a clear bridge was made, when they passed the obstruction in safety. This indicates that while the ants value their aphides very highly, they will yet part with them, if necessary, for their own safety—as the captain and crew of a vessel in distress will throw over the cargo, to save the ship from sinking.

The "Driver Ants," of South America, display extraordinary intelligence in crossing streams. When one of these is encountered on the march, the column halts and the captains go ahead to explore. If a tree is found whose overhanging boughs arch the stream, they cross over on that, promptly falling into line on the other side. If no such natural bridge is discovered, they will examine the shore until a sandy beach is found, when each ant will seize a piece of wood, mount it, and push out, keeping hold with their feet, and with their paws make fast to the one in front. When this floating bridge becomes so long that they can no longer keep it together, a portion of it breaks away and the little boats drift over to the other shore. New ones are then launched until the entire army has passed over. This story, as well as the others which I have narrated, are vouched for by separate and independent observers, and can be relied upon. They are conclusive, I think, of the fact that ants possess not merely highly endowed instincts, but an intelligence associated with reason, which enables them to adapt themselves to new conditions, when such adaptation is of value to them in the struggle for existence.

The marvelous mechanical ingenuity displayed by bees in the construction of their hives is well known. "The cell of the hive bee," says one, "exhibits the most perfect form of architecture to economize space and material that can be devised. It is built on geometrical principles —the lines at the bottom of each cell converge exactly at the point, which by an elaborate mathematical calculation, has been determined to be that which would require the least material in its construction."

The use to which these cells are put display instincts, quite as remarkable as the construction of them. They are used for storing honey and bee-bread, as well as to receive the eggs deposited by the queen-bee. Honey is the nectar of flowers, while bee-bread is the pollen of flowers. This pollen is collected from different flowers, and each kind is stored in a separate cell or cells. The carriers do not collect indescriminately, first from one flower and then another. They have their own special kinds to forage upon, so that, when they return laden to the hive, the "house bees" know at once the kind that is brought, and store it in its proper cell. There is one kind of pollen, very much more nutritious and stimulating than the others, and this is reserved exclusively for the queen-bees. When a female larva, three days old, is fed upon this food, she develops into a queen. If the larva is older than three days, this striking transformation does not take place. Whenever a queen is desired, a female egg is deposited in one of the large cells—never a small one—which is supplied with this nutritious pollen, the bees knowing that, when fed on this food, she will increase in size beyond the dimensions of an ordinary cell.

The other kinds of pollen are worked up into a sort of chyle by the nurses and fed to the common larvæ. The larvæ require constant attention during the three weeks that intervene between the laying of the egg, and their passing through the last metamorphosis. When this takes place they are washed, fed and caressed by the nurses and so given a fair start in life.

Like ants, bees pay great attention to cleanliness, and otherwise show an anxious care for the welfare of the hive. When the weather is very warm there is danger of the wax in the combs melting. At such a time the bees are very much excited and dangerous to approach. They have been known to crowd together on the top of the hive in a thick cluster to ward off the sun, exposing themselves to its rays to protect their home. The air is kept pure and cool within by an admirable system of ventilation. Bees are regularly stationed off in the corridors of the hive and at the entrance whose business it is to fan their wings and thus keep up a current of air. The motion of the wings is so rapid that it can scarcely be detected with the naked eye, and the current produced so strong that it will extinguish a lighted match at the opening. They have been observed keeping up this motion continuously for twenty or twenty-five minutes—they are then relieved by others. It is said, and upon good authority, that when bees are transferred from a cold to a warm climate, where food is to be obtained throughout the year, in a few years they cease to lay up honey and become idle and shiftless creatures. They live from hand to mouth and take no thought for the morrow, for they have found that the morrow will take care of itself.

There is one thing in which the otherwise unerring instinct of bees seems to be somewhat at fault, and that is in the management of the drones. A few drones are all that are required in a hive, and yet they number sometime as high as a thousand. After the young bees are hatched and the numbers for the future welfare of the colony are thus secured, these drones are ruthlessly killed off, as upon principles of thrift and economy they should be, since they are great consumers and produce nothing. But upon the same principles of thrift, the great majority should never have been permitted to exist at all. They could easily be destroyed in the larval state and the expense of rearing them would thus be avoided. Romanes touches upon this deficiency of instinct and says that no satisfactory explanation can be given for it. The only one that he offers is that at some time the drones may have been useful members of the community and were therefore preserved, and that now, though they are no longer useful, they are still permitted to live for a time from the force of the earlier habit. But then the law of natural selection and the survival of the fittest should have long since weeded them out. This *apparently* seems to be a case where that law is not stringently operative. It is possible that some solution may yet be found for it.

Even in this incomplete enumeration of their habits, it is clear that bees possess remarkable instincts, and that these instincts like those of the ants, are closely associated with intelligence. The construction of their combs, and the repairing them when injured, putting in temporary supports to prop them up, until permanent repairs can be made, another removing the scaffolding as no longer needed; "the rearing of the queen bees, selecting and setting apart for them a food which can alone develop them"; the intelligent care bestowed upon the young, the ventilation of their hives, ceasing to store honey when removed to a warmer climate, and many other habits, attest a mental power that justly entitles them to a high rank in the scale of intelligence.

The instincts and habits of birds afford an interesting field of inquiry. The affection and sympathy which they show for one another is well known. Some birds are inconsolable in the loss of their mates and often sacrifice their own lives in the defense of their young. Jesse tells of a male pigeon, that had for some time committed serious depredations in a corn-field, and was shot by one of the men on the farm. His mate at once flew down to the ground beside him, and stood over him, showing the most unmistakable signs of grief. His body was hung upon a stick to frighten away others, but was unheeded by his mate. She remained there, continually walking around the stake in a circle, making now and then a little spring towards him, so that the ground was beaten hard by her tracks. This continued several days, until the kind-hearted wife of the farmer hearing of her actions, went to the field and removed the dead bird, when the other, in a very weak and emaciated condition, flew off to the dovecote.

Edward, the celebrated naturalist, shot a tern; it fell wounded in the water, and was drifting towards him by the wind. To his astonishment, he saw two other birds fly down to their companion, lift him by his wings—one on each side—carry him six or seven yards, and then set him down gently in the water; two others then picked him up and carried him another stage, and in this way they conveyed him to a rock some distance off. Not wishing to lose the bird, he went around to secure it, when not merely a few but the whole flock gathered around him, uttering their piercing cries. He had very nearly reached him, when two birds again picked up the wounded tern, and carried him safely out to sea.

In both these cases the birds risked their lives for one another. The pigeon certainly had intelligence enough to know that it was unsafe for her to remain upon the spot where her mate was killed. Yet in spite of it, perhaps unconscious of it in her grief, she exposed herself for several days to the same fate. And the terns plainly knew who was their enemy, since they came forward so gallantly to carry away their wounded comrade as it was drifting towards him. He could have killed them as easily as the first, and they must have known it, "not perhaps with the same vividness as we would have realized it, but sufficiently to make them aware that they were incurring danger for another," and yet they encountered it without hesitation.

Among men it is considered the highest form of heroism to risk one's life for another and the small meed of praise ought not to be withheld from those animals that show equal courage. Birds show resentment as well as affection. Swallows and martins retain distinct recollection of injuries and avenge them. Linnaeus says that when martins build under the eaves of houses they are sometimes molested by the sparrows, who take possession of their nest. If they are not strong enough to dislodge the intruders, he has known them to call in the aid of their companions and plaster up the entrance with mud, thus imprisoning the sparrow and killing him by starvation. Jesse reports the same thing, though he knew nothing of Linnaeus's observations.

On another occasion some swallows, who were driven from their nest by sparrows, submitted quietly to their loss until the young sparrows were hatched. The swallows then watched their opportunity, and when the mother left her nest for food they tore the nest down, throwing the young birds to the ground and killing them.

The sagacity and cunning of crows are notorious. Miss Bird, in her work on Japan, relates an instance of which she was a witness that is quite amusing. A dog was eating a piece of carrion in the presence of several of these birds. They tried to pull the meat away from him, and after several trials, intermingled with a good deal of crow talk, succeeded, though with considerable danger, in securing a piece. They then flew upon a limb and held a very earnest consultation. A little stratagem was then planned, which they proceeded at once to put into execution. They flew down upon the ground again and approached the dog as near as they dared, with the exception of the big crow with the piece of meat. He remained upon the limb and when all was ready flew over the dog with the stolen property in his bill. He dropped it, the dog let go the large piece to secure this fragment also, and as he did so the other crows seized it and flew off triumphantly to the tree, where they ate it amid great hilarity. The dog looked vacant and bewildered for a moment, after which, so says the account, he sat under the tree beneath the thieves and barked inanely. If such a performance as this does not indicate free thought and concerted action, quite independent of instinct, to secure a given object, I am at a loss to understand in what other terms to describe it.

Thomas Guring writes to the "Gardener's Chronicle", England, 1878, an account, which the editor of that paper vouches for, as coming from a perfectly trustworthy man, that a number of years ago market day was held every fortnight in the town near which he lived. The town itself was skirted by a "Common" on which fed large flocks of geese. In showing samples of grain and in otherwise handling it, a good deal was scattered about and lay on the ground, affording good picking for poultry. Somehow the geese discovered this, and thereafter every two weeks, as regular as the recurrence of the market day, these geese would appear and at no other time. How they contrived to hit upon the right time, with so long an interval between, was most surprising. They could not see the market place from the "Common," for it was in the center of the town, and they had to pass through the streets to reach it. It might be supposed that the unusual number of wagons coming to town on that day, or the smell of the grain, may have guided them; but that this was not so, was demonstrated in the clearest manner. For on one occasion market day occurred on a holiday, and no market was held. The town was as still as Sunday—no wagons came in and there was no smell of grain, yet the geese appeared as usual, and not finding their usual forage, appeared very much puzzled. I can see no explanation of this, excepting that somehow they could note the recurrence of every fourteenth day, and to do this they must have had some idea of time.

The instinct of nest building is very curious, not the mere fact of building a nest, but that the different kinds of birds should have such different ways of doing this. Wallace says that nest building is not an inherited instinct but comes from imitation. The young birds observe the nest in which they are reared, and after they have left it, construct one like it when the proper time comes around. But Romanes very truly says that if this were so, nests of the same varieties would differ widely, since, if they were reproduced by imitation alone, there would be continual variations, which if copied in turn, would eventually quite alter the style of the nest. It is well-known that the nests of each variety remain substantially the same, although it is perfectly true that birds do profit by experience in this, and that the nests of older birds are much better made than those of younger ones. No! nest building is in the main an inherited instinct, but capable of being improved upon by experience. But why they should vary so with the different kinds of birds is quite curious.

The petrel, kingfisher and land marten, make their nests in burrows in the earth. Gulls, sand-pipers and plovers lay their eggs in shallow pits, excavated in the soil; partridge and quail build upon the ground also. The house martin builds its nest of clay, which it fastens to the side of the wall; only the forenoon is devoted to this work, for the reason that if the nest is built too fast, being made of soft material, it would crumble with its own weight, unless it were allowed to harden. The woodpecker and tom-tit dig a hole in a tree, and carefully carry away the chips to conceal their home. The woodpecker's hole is sometimes five feet deep and of a tortuous form to keep out the wind and rain.

The baya bird of India, like our oriole, suspend their nests from a projecting bough, with the entrance downwards. This is done to prevent their enemies, mice and snakes, from entering them. It is also said that they fasten fire-flies to the outside to frighten off invaders. The tailor bird sew leaves together, using artificial cotton when they can find it, and if not, natural vegetable fibers that are suited to the purpose. The beak is used for a needle, or rather an awl. Certain hawks lay their eggs on the bare rock, while the curlew and goat-sucker deposit theirs in the soil. These and other birds will readily use artificial houses, showing that they can change their habits easily, if they can save trouble and better themselves by so doing. Certain varieties of swallows build in chimneys. How these habits were acquired in the first place cannot now be known, and why they should vary so is not always easy to understand. That many of these nests display great skill in their construction will not be disputed, while others are such simple devices that they cannot be termed nests at all. They are, no doubt, reasonably wise adaptations to the needs of each bird—liable to be changed, if altered surroundings make change necessary for the welfare of the bird.

When we come to consider the habits and characteristics of quadrupeds, we find a mass of evidence, confirming in the strongest way, the existence of intelligence in animals. There is such a variety here to choose from that it is difficult to make suitable selections.

The beaver, perhaps more than any other undomesticated animal—possibly not making even this distinction—gives evidence of possessing the greatest mental power. His habits have been carefully studied by an accurate and scientific observer, Mr. Lewis H. Morgan, an American, who has published an interesting volume on this subject. What he there tells of these animals cannot but excite the highest admiration for their industry and skill.

Their "lodge" or "burrow," is built sometimes upon an island and sometimes on the shore. The floor is placed a few inches above water level and has two entrances, both under water. One may be called the "wood" entrance, and descends in a straight line, but on an inclined plane to the bottom of the pond. This is used for carrying to the "lodge" the wood upon which they feed during the winter. The other is nearly perpendicular, somewhat tortuous in shape, and like the first descends to the bottom ; this is their ordinary rear way for their exit and entrance. In addition to this they always have an underground burrow upon the main land, with an entrance under water, as a place of refuge if hard pressed by their enemies. Unlike the "lodges" which are conspicuous huts, sometimes eight feet in diameter and correspondingly high, these burrows have no outward sign to indicate their existence.

During the long winters of the northern latitudes which they chiefly inhabit, they live upon the bark of trees which is stored under water. The tree is cut so that it will always fall in the direction of the water, and thus save labor in carrying. Just before it falls they scramble off to the pond and remain hidden for some time after the crash, evidently thinking that the noise may attract their enemies to the spot, and that they must secrete themselves until the danger is over. After it is felled, the smaller branches, from two to six inches in diameter, are cut into suitable lengths, stripped of the twigs and smaller sprouts and taken to the "lodge." They are then sunk to the bottom of the pond and fastened there in brushwood, the butt-ends of which are driven into the mud and the sticks are then put through the branches.

It is in the construction of the dams that the beaver has acquired his greatest reputation. These dams are built chiefly to maintain the water in the pond at a fixed level, and that is from one to three feet above the entrance to their "lodges" or "burrows." They are of two kinds—the "stick dam" and the "solid bank dam." The "stick dam" is made of poles and sticks interlaced together, through which the water percolates throughout its entire length. This is of comparatively easy construction and is used in those ponds or streams where the flow is sluggish and the pressure such that a solid earthwork is not required.

The "solid bank dam" is a much more elaborate and difficult piece of engineering, and is used when these conditions are reversed. It is made of sticks and brush, cemented with mud and often weighted with stones. A regular opening or trough is made in the top to provide for the overflow. This trough is enlarged or contracted according to the varying amount of water that must be drawn off to keep the pond at the proper level. This dam is a solid structure capable of supporting the weight of a horse, is from two to six feet high and from six to eighteen feet broad at the base, with sloping sides narrowing at the top. Some of these dams attain an extraordinary length. There is a remarkable one on the tributary of the Esconauba River. The beavers first built a dam across the channel about 20 feet in length. The water backed up, of course, and flowed around to the left. To shut this in the dam was extended about 90 feet. The shore end of this abutted against a natural bank, which extended back along the border of the pond for about 1,000 feet, nearly at right angles to the artificial dam, with an occasional break which the beavers filled in. Around the open end of this natural bank the water again overflowed, running down the land side of it and emptying into the outlet at the foot of the dam. This had to be stopped, so another earthwork 420 feet long was constructed which effectually shut in the waters so as to maintain them at the proper elevation. The entire dam, including the natural barriers which had to be filled in in places, was 1,530 feet long.

It often happens that the pressure of water against a dam is so great as to endanger its stability. To obviate this, the beavers build another dam, a short distance below the main one, raising the water a foot or a foot and a half, which backing up against the larger one, diminishes to this extent the differences in the level above and below, and thus neutralizes the pressure of the water against the main structure. They have been known also to build a dam *above* the main one, for the purpose of keeping back the water in time of freshet, which but for this, the main outlet could not safely carry off.

These dams serve another and very important purpose, beside keeping the water at a certain level for the "lodges" and "burrows," and that is by flooding the surrounding area, bring the water line up to the hard wood trees, upon which they feed, so that these can be carried to their lodges by water transportation. This is a very important consideration, for the labor of dragging the wood over the ground is very great, and when there is no incline and the ground rough, almost impossible. But even this raised area becomes denuded in time, and then to save land carriage, the beaver resorts to the extraordinary device of digging canals, which penetrate into the hard wood region, affording a water way for bringing out the wood. These canals are from three to five feet wide, about three feet deep and hundreds of feet long, and are made by excavation. All roots and stumps of trees are carefully removed, so as to form a free and unobstructed way.

Mr. Morgan observed one that extended 450 feet on a level with the pond that supplied it with water. Here the ground rose so that the excavation could not be continued without cutting very deep, involving great labor. The beavers surmounted this difficulty by building a dam about a foot high and then excavating at this higher level for a distance of about 25 feet. Here another rise took place, and another dam was built about a foot high, and the canal continued for another length of 47 feet. In every case where these dams were placed, earthworks were thrown out in a lateral direction for the purpose of collecting the water and draining it into the canals. Here then was a perfect system of locks, which the beavers had wrought out in order to supply themselves with their winter's supply of food. These dams were worn smooth and rounded at the top where the logs had passed over them. If engineering attainments like these do not indicate the possession of reason, it would be difficult to understand in what reason consists. It is beyond belief that any instinct could have taught them that the strain on their dam could be relieved by throwing up another below it, causing the water to back up against it and thus equalize the pressure. And then to alter the size of the trough on the top, as they do, to regulate the overflow, plainly indicates something more than instinct, since instinct applies only to those situations or conditions that are regular and uniform in their recurrence. But this is an emergency liable to arise at any time, the existence of which the beavers must learn from observation, and to which they must apply the proper remedy in order to preserve their homes from injury. Think, too, of an animal having found out how to save labor in transporting his goods by running a canal into the country, building it so as to keep the water at the proper level and overcoming the difficulties of a rise in the ground by throwing up a dam and then excavating at the higher elevation, supplying these channels with water by building earthworks on either side so as to collect and drain the water into them. There are many tribes of savages quite unequal to an achievement like this, who could neither devise such plans, nor having devised them, exercise the patience and industry necessary to put them into execution.

The cunning of the fox is notorious and I am inclined to think that common report has not overdrawn it. Jesse tells an incident showing how foxes work together. A sportsman and his attendant were watching for hares. They had stationed themselves near a gully on a rocky, sloping piece of ground, when they saw two foxes approach. After playing with each other for a few moments, one secreted himself behind a rock, while the other disappeared up the gully. Presently he reappeared, driving a hare before him. The concealed fox made a spring for the hare, but missed him. The other was so enraged at the loss, owing to his partner's want of skill, that he flew at him and fought with such fury, that the men came up and easily killed them both. This incident is not so remarkable, excepting as showing how foxes can act together for a common end, and what resentment they can feel, if one fails properly to perform his part. The other incident that I shall narrate is remarkable, and could scarcely be credited, unless it was supported by the most undoubted testimony. Dr. Rae, the celebrated Arctic explorer, while in the Polar regions, was desirous of securing some specimens of Arctic foxes. He tried the ordinary traps, but without any success. He then set a trap with which the foxes in that part of the country were not acquainted. To a piece of bait a string was attached, which was connected with the hammer of a gun, mounted about 31 yards off. The fox would seize the bait, pull the strong and discharge the gun, thus killing himself. By this device, he secured one, but could never get another. The bait disappeared, and nothing but the tracks of the foxes could be found.

Foxes usually travel in pairs, and the survivor of the one that was killed, was warned by the fate of his comrade, that extra care must be used to secure the coveted bait with safety. So these cunning creatures practised two ways of doing this. They would approach the gun from behind, cut the string back of the muzzle, and then carry off the bait at their leisure, or else employ this more daring expedient. When these traps were set, the ground was usually covered with a thick depth of snow. The foxes took advantage of this, and would work up to the bait in a lateral direction, by digging out a track in the snow below the surface, reach up and seize the bait, which would of course discharge the gun, but would leave them unharmed, as they were underneath the line of fire. This stratagem was so extraordinary and so audacious, that Dr. Rae could not believe that it was deliberately done, until it had been verified by repeated trials. The foxes never dug out their track in the snow in the line of fire, but always at right angles to it, as that was clearly the safest direction in which to approach it. I should say that in adjusting the string it was necessary to leave about four inches of slack, to provide for its contraction with the varying humidity of the air, so that the fox could pull it down that distance before the gun went off. In order to deceive them as much as possible, the string connecting the bait with the gun was buried under the snow along its entire length, excepting at the two ends, where it necessarily came to the surface to connect with the bait and the gun. The fox had evidently reasoned out that that strange looking object 30 yards off, had been the cause of his companion's death, and that it must be circumvented in some way in order to secure the food, and circumvent it he certainly did. I doubt whether any of us would care to get a dinner on such risky terms—deliberately to provoke a rattling fire of shot a few inches above our heads, in order to secure a piece of meat. Dr. Rae vouches, under his own signature, for the absolute accuracy of this story. That part of it relating to the cutting of the string is confirmed by an entirely independent authority. In a monograph of the North American Mustelidæ, by Captian Elliot Cones, contained in the miscellaneous publications of the United States Geological Survey, 1877, the writer gives a similar instance to illustrate the sagacity of the wolverine. A trapper found a wolverine at work on his marten traps, of which he had from a hundred to a hundred and fifty. The animal approached the traps from behind, ate the bait, and even carried off the sticks and buried them, for the wolverine has a great propensity to steal everything he can carry off, whether it is useful to him or not. The trapper made up his mind that he must either kill that wolverine or quit trapping in that section of the country, so he set six strong wooden traps and four steel ones, but all to no purpose. The creature secured the bait and broke the traps to pieces without being injured himself. He then placed some bait with a string attached to the hammer of a gun, the same sort of a contrivance which Dr. Rae used, and with the same result. The wolverine went back of the gun, cut the string with his teeth just behind the muzzle, carried off the bait, and ate it at his leisure on the frozen lake below as his tracks showed. He tried it again, thinking it impossible that this could have been intentionally done, and with the same result—with this difference only, that each time, the animal cut the line behind the knot, evidently suspecting some danger in the knot itself. After repeating the experiment a number of times, the hunter gave up the contest and moved away with his traps. Outwitting their enemies, in this triumphant fashion, it is plain could never have been accomplished by inherited instinct. Instinct had made no provision to teach them the mysteries of a gun-trap. Dr. Rae says that their tracks showed they had made a most careful examination of the whole contrivance before proceeding to work. They had then reasoned out, as I have said, that that object 31 yards off, had been the cause of their comrade's death, and that it would be rendered harmless if the string that was fastened to it was cut. Or in the other case, they could leave the string undisturbed if they could approach the bait from below, knowing that the barrier of the snow protected them from any injury in the discharge of the gun. This certainly was a case of profound and accurate reasoning, and more than justifying the fox's reputation as a cunning animal.

There are numberless stories illustrating the intelligence of the dog and the elephant, as these animals have been for many centuries the companions of man and thus affording numerous facilities for observing them. Tame elephants are indispensable in reducing to submission the wild ones that are captured. They seem to take great pleasure in acting as decoys, showing extraordinary intelligence in securing a struggling wild comrade and protecting the men from injury. Sir E. Tennant, in his Natural History of Ceylon, tells of two female elephants who were famous for their skill as decoys. One was of very great age and had been in the employ of the Dutch and English governments for upwards of a century; the other, named "Siribeddi," was about fifty years old and remarkable for her gentleness and docility. The decoys entered the "corral" in which the wild ones were confined, the "mahout" or keeper, and the one carrying the rope, called the "nooser," mounted on Siribeddi's neck. She moved along leisurely, stopping every now and then to pick up a tuft of grass, and with an air of careless indifference approached the captive animals, who were nervously watching her. The leader of the herd came out to receive her, and having twined his trunk around hers, returned to his place. She followed him and placed herself alongside in such a position that the nooser could run underneath her and slip the rope over the elephant's hind foot. The wild elephant at once perceived his danger, shook it off, and would have taken summary vengeance on the man had not Siribeddi interposed and prevented his following him. The nooser ran out slightly injured and another took his place. This time both decoys placed themselves alongside of the other and the nooser succeeded in slipping the rope around his hind leg and securing it. He then ran out. The other end of the rope was fastened to the collar on Siribeddi's neck, who at once commenced to drag the captive out to the nearest tree. The wild one made an active resistance, kicking and bellowing all the time. Siribeddi reached the tree and made a turn around it with the rope, but was unable to get her victim any closer. The other decoy, seeing the situation, came forward to help, and putting her shoulder and head alternately against her struggling brother, slowly pushed him back to the tree. Here the other hind leg was fastened. It was now necessary to secure the front ones. The two decoys again stood on either side of the frightened captive, the rope was adjusted, but the elephant seized it in his mouth and would have bitten it in two in a few moments but for the decoy, who stepped upon it with her foot and brought it to the ground again. The decoys seemed to understand what was needed in every emergency and always did the right thing at the right time without being told and without any flurry or excitement. Thus, when one of the elephants had wound the rope around the tree several times before he had been brought close to it, Siribeddi, perceiving the situation, began pushing against the side and head of the captive until he had unwound himself. The decoys seemed to enjoy the sport keenly, not inflicting any needless injuries on their luckless comrades, but evidently witnessing their struggles and terror with a great deal of amusement. While these operations were going on and when their services were not required, they would fan themselves with a bunch of leaves, which they would swing backwards and forwards in the most graceful fashion.

Of all animals the dog affords the most remarkable example of the modification of natural instincts by association with man. He shows in the most conspicuous manner the passions and traits that belong to us. Dogs who have been well brought up and of good lineage exhibit pride, self-respect and dignity. They are hurt by a kick or a blow, not because it gives physical pain, but because their feelings are wounded or outraged ; whereas dogs of mean conditions, like children who have lived in squalor, are affected by a blow only because it hurts. Romanes had a skye terrier, which he entrusted to the care of his brother during the absence of himself and family. He went out with this gentlemen every day for a walk, which the dog seemed to enjoy very much. One day the skye was amusing himself with another dog and lingered too far behind. His master struck him with a glove to make him follow him. The dog gave him an indignant look, turned around and trotted home. The next day the dog started out as usual, but after going a short distance looked up in his face significantly, so that their could be no mistaking what he meant, and with a dignified air went back and never could be induced to accompany him again. Dogs exhibit plainly emulation and jealousy. Romanes had a terrier, which took great pains to teach a puppy how to hunt rabbits. In time the son outstripped in speed the father. It then became the paternal practice to seize hold of his boy's tail and hold him back whenever he was outrunning him, even if the rabbit was just before them. This exercise of parental authority the son never resented. Mr. Oldham had a dog which had grown old and decrepit and led a very inactive life. He bought a Scotch terrier which became quite a favorite. All of Charlie's old vigor revived upon the advent of this rival. He exhibited agonies of jealousy and spent the rest of his life in following, watching and imitating him. He had given up walking but now went out whenever Jack did. He had been very particular about his food ; would eat nothing but meat, but now ate the same food as Jack. If Jack was caressed he would stand it as long as he could and then set up a piteous whining. He would plunge into cold water after sticks and do many other disagreeable things, not to secure any material benefits, but simply that he might receive the same attentions as another dog.

Dogs are deceitful and do not like to be laughed at. A terrier was very fond of catching flies on the window pane. Sometimes he would miss them and then his owner would laugh at him, in fact took pains to laugh immoderately at each failure to see what the dog would do. The dog was very much annoyed at this and as he could not give up the habit, when he failed, he pretended to succeed in catching the fly—would go through all the motions, rubbing with his neck upon the ground and stamping with his feet as if killing his victim ; he would then look up at his master with an air of triumph. The fly was not caught for it was still upon the window pane. He would then let the dog know that he saw through his trick by pointing to the fly, upon which the dog would slink off and hide under the furniture.

A clergyman writing to Mr. Romanes, the author of the work on "Animal Intelligence," and to whose work I am indebted for many of the incidents I have narrated, says of a favorite retriever, that he was one day lying in the kitchen while a turkey was being roasted before the fire.

The cook had to leave the room for a few moments, when the dog quickly seized the turkey, ran out and placed it in a cleft in a tree. He returned before the cook got back and placed himself before the fire in the same position in which the cook had left him, looking perfectly innocent and unconscious. Unfortunately for for him a man outside had seen the whole proceeding and exposed him. The clergyman writes that the dog evidently intended to establish his innocence by proving an alibi. Here was an example of pure reasoning, instinct played no part in this performance. The dog wanted the turkey, but knew that if he stole it and ran off with it in the ordinary fashion, he would be detected and punished. He must secure it without being seen or even suspected. The temporary absence of the cook from the kitchen gave him his opportunity. He caught up the prize, ran out, concealed it in a tree near by, and hurried back to be in his usual place before the cook returned. He fully realized if he was absent when the cook got back, that he would be suspected of the robbery, and to disarm all suspicion he must be found in the same position in which the cook last saw him. But for the unlucky presence of a spectator outside his plan would no doubt have succeeded, and when the fitting opportunity came could have carried off and eaten the turkey at his leisure. This defeated his scheme, but that it was well planned and showed admirable reasoning power will not be denied.

One of the most extraordinary instances of reasoning, shown by a hunting dog, is that related of another retriever, belonging to Mr. Arthur Nichols, who relates the incident in "Nature." He had been out snipe shooting and the party were returning home, when the dog "flushed" a widgeon. He shot and the duck instantly dived. The dog did not plunge in after it, but ran rapidly down the shore of the narrow stream some fifty yards, then entered it and swam up, dashing from side to side and making a great commotion in the water. He then landed near where the men stood and where the bird was shot, and explored diligently for a short distance up and down the reedy bank. Finding nothing, he crossed over, soon struck the trail, disappeared among the rushes, and in a few moments reappeared with the bird.

It seems that the dog had learned in Australia—from which place he had been sent to his present owner—that a wounded duck, after diving, always goes down stream, swimming a considerable distance under water before making for the shore, when he will steal out and hide in the bank. To prevent this the dog had run down, entered the stream below, and thrashed it up so as to drive out the duck nearly at the point where he dived, knowing that he would not swim up stream but take to the shore. This would make it easy to find the trail, as only a short distance on either side would have to be tracked; whereas, had the bird swam down stream thirty yards or more, as he might have done, or landed immediately, as he might have done also, that whole distance must have been covered by the dog with much greater chance of the game escaping him. Instinct had nothing to do with this—it was an elaborate and invalued piece of reasoning, acquired of course by experience.

Of the affection and tender solicitude which dogs display for those to whom they are attached or who are entrusted to their care, there are numerous stories. I can only quote one. This relates to a Newfoundland dog belonging to a Mr. W. F. Hooper. One day, as usual, he went out with the nursemaid, who was carrying the baby in her arms. The wind beginning to blow she turned back to return, wrapping the shawl around the baby to protect it from the air. Presently the dog placed himself across her path, and would not let her advance. His hair stood up, he showed his teeth, and displayed an ugliness of temper that greatly alarmed her. He had never acted so before and no amount of coaxing or soft words made the slightest impression upon him. She was in despair what to do, when suddenly it occurred to her, as a last resource, to show Leo the baby. She unwound the shawl and held the baby out at arm's length to the dog. The dog's manner changed at once—he removed himself from the path, began to frolic and caper about in great glee, and the nursemaid with her precious charge passed on. The explanation of his conduct was this: Leo had constituted himself a guard when the baby went out, and when the maid turned about to come home, having wrapped and so hidden the child in the shawl, the dog supposed the baby had been left behind and would not let the girl advance until she had produced it.

It is needless to enumerate more cases in evidence of the existence of something more than mere instinct in animals. Most of the incidents which I have narrated cannot be explained upon the theory of instinct; for instructive actions are actions performed by successive generations, in obedience to hereditary impulses which cannot be controlled. They are involuntary to this extent that while the animal knowingly performs them, he is urged on to their performance by transmitted tendencies which his will has not set in motion, and which when his environment is unchanged remain the same. That with an altered environment or sudden emergencies they can and do change, evidences the possession of that intelligence which is claimed for them. If they did not possess this power they would not infrequently be placed in situations, when a rigid adherence to inherited practices would result in their destruction. It is because they are able with more or less facility to adapt themselves to altered conditions that they survive. This adaptation is usually gradual and inevitably follows from the law of natural selection. But even if self-preservation depends upon it, it implies variability, the power to change when circumstances require it, and it is this power which has diversified the earth with such varied forms of animal life. Inability to do this explains why so many species of animals have become extinct. Very few owe their disappearance from the earth to the destructive hand of man. Their extinction has resulted from their incompetency to alter their modes of life so as to harmonize them with their constantly changing surroundings. Others better adapted to the new conditions have taken their place. And in this way nature offers a perpetual premium upon intelligence —the least intelligent unequal to the severe competition disappear—the more intelligent survive. It is not then so extraordinary that this sifting process which has continued through countless generations should not only have developed such wonderful instincts which primarily owe their origin to intelligent adaptations, but should also have developed that very faculty which makes a new instinct possible. In obedience then to the law of national selection and an inevitable consequence of it, this intelligence has arisen. It is such an irresistible logical deduction from that law that its absence would be the startling thing. What is it that gives to man his superiority as a member of this material world? What but this very intelligence—this power of reason—this capacity to think and to contrive and so make this material world serve his purposes. He has developed in this direction to such an extent and has so far outstripped every other organic form, that in the pride of conscious superiority, he has come to think that intelligence is his exclusive possession; that while animals possess instincts that are inherited and upon which they are dependent, he alone is independent of instincts and can protect himself and provide for himself without its aid. He forgets that his own supreme intelligence is not of his own creation—that it is the slow growth of centuries and that he can no more rightfully repudiate the debt which he owes to those who have gone before him, than an animal can ignore the qualities and habits of his ancestors. Man can alter, change, vary, more quickly than the lower forms of animal life, for the reason that his intelligence is so much greater. But when animals show this adaptability also there is no reason why we should deny them the possession of that intelligence which makes adaptability possible in us, simply because they exhibit it in a less degree. The kind is the same—it is the proportions that are unequal.

I do not think that this admission will, in the least, alter the supremacy of man—a supremacy so unquestioned—that one of the few things to make us doubt it is when he either lacks the generosity or the courage to do justice to those creatures that are so far below him.

If this admission will cause us to look more kindly upon these humble creatures, to remember that ill-usage whether by word or deed, hurts them as well as ourselves, and to do away in any degree with their wanton and cruel destruction, simply for the sake of killing, some good will then have been accomplished and a step taken towards a truer appreciation of these dumb friends of ours.

At the conclusion of the paper it was discussed by Members Dwight, Pelton, Cooley, C. N. and F. S. Arnold. C. C. Gaines was elected an active member of the section.

JANUARY 20, 1891—THIRD REGULAR MEETING.

Present, Chairman Elsworth; Members Warring, Neumann and F. S. Arnold and a number of visitors.

The Chairman presented for discussion a few informal remarks about the Sun, the little that is known about it, and reviewed and criticised several theories concerning it. The subject was discussed by Members Warring and Neumann.

FEBRUARY 10, 1891—FOURTH REGULAR MEETING.

Present, Chairman Elsworth, and Members C. N. Arnold, Cooley, Dwight, Herrick, Tompkins, Warring, Ward and F. S. Arnold and visitors.

Prof. W. B. Dwight presented a fossil shark's tooth from Gay Head, Martha's Vineyard, and made some remarks on that locality. It is the miocene and pliocene formation and very rich in fossils—sharks' teeth, whale bones, amber, etc.—the Isle of Wight of America, but it has never yet been thoroughly explored.

Prof. C. B. Warring read a paper on the Geology of of Montgomery County, Illinois, which had been written by George H. Richards, of Pillsbury, Illinois. The formation of Montgomery County, Mr. Richards represents as carboniferous with numerous shales, sand and limestones, and with bituminous coal. The deposits are mostly in place not yet contorted and not very fossiliferous. The lime stone is crystalline. Natural gas is found co-incident with a fault in the formation, the heat displaying the strata, having probably distilled the coal.

The writer observed the somewhat singular fact that the coal layers, instead of lying as usual between two layers of shale, may lie beneath sandstone or shale indifferently. The writer considers the region as interesting as being at the end of the Continental Glaciers, but as surprised to report that there are no morains in the vicinity. He finds also above the glacial deposits, mounds which he can only account for as lake debris.

He also incidentally observes a curious fact in relation to the geological changes which man effects. When fifty years ago, he entered the region among the first settlers, there were a number of lakes in the prairie with, it would seem, no regular drainage. The settlers settling in the brush along the creeks and turned their cattle into the prairie and these in the summer would go to the lakes to drink, and in so doing wore paths through the fields from the lakes to the bush and the stream. During times of high water the lakes would overflow into these paths and as the grass roots, which hold the earth firm, were killed by the cattle, it would wash them until a little gully was started from them into the creek, and this went on increasing until the gullies became quite large and the lakes were drained.

The paper was discussed by Members Dwight, Cooley and Sutcliffe ; the former calling special attention to the fact that moraines are not necessary companions of of a glacier, unless it passes under overhanging crags.

Mr. John Sutcliffe and Dr. J. W. Poucher were elected active members of the section.

FEBRUARY 24, 1891—FIFTH REGULAR MEETING.

Present, Chairman Edward Elsworth, and Members C. N. Arnold, Bolton, Cooley, G. Van Ingen, Warring, Frost, Sutcliffe, F. S. Arnold, and visitors.

The curator reported a gift to the Museum of Marine specimens by Miss Anna Goodsell. A paper was read by Mr. C. N. Arnold on the "Deforestation of America," which was discussed by Messrs. Cooley, Sutcliffe and Hill.

Prof. L. C. Cooley also offered a note on the preparation of artificial sugars, wherein he referred to the work of Prof. Fisher, of Berlin, in composing artificial sugars by artificial synthetic methods and stated that, since 1887, fourteen new artificial sugars had been discovered.

MARCH 10, 1891—SIXTH REGULAR MEETING.

Present, Chairman Edward Elsworth, and Members Bolton, Gardner, Pelton, Van Ingen, Ward, Neumann, Sutcliffe, C. N. Arnold and visitors.

A paper was read by Mr. Gilbert Van Ingen on the Geology of Ithaca, N. Y., and the speaker gave an interesting sketch of the formation and fossils found in this locality, which he stated to be rather rich in fossiliferous remains.

MARCH 24, 1891—SEVENTH REGULAR MEETING.

Present, Chairman Edward Elsworth, and Members Nilan, Van Gieson, Ward, Sutcliffe, C. N. Arnold, Bolton, Cooley, Elting, Gardner, Warring, Neumann and visitors.

A paper was read by Mr. Prof. L. C. Cooley on the "Lowest Forms of Life," in which he reviewed the history of microscopic organisms, the controversy as to their spontaneous generation versus germ-evolution, and enlarged on recent investigations in this department especially as regards the future possibilities of successfully treating many germ diseases. The paper was discussed by Members Warring and Van Gieson.

APRIL 21, 1891—EIGHTH REGULAR MEETING.

Present, Chairman Edward Elsworth, and twenty-five members and visitors. The following paper on "Poisonous Snakes and Snake Poisons" was presented by Dr.

Theo. Neumann, who also exhibited an interesting collection of serpents preserved in alcohol.

POISONOUS SNAKES AND SNAKE POISONS.

BY DR. TH. NEUMANN.

In all times and amongst almost all nations, snakes have fixed the attention of the human race, and it is conceivable that they have played an important roll from times immemorial in the tales as well as in the belief of people. Snakes are mentioned in the earliest chapters of the Old Testament, as comtemporaries of the first men; the great tempter of mankind assumed the form of such a creature and under this disguise crept into paradise. When in the wilderness, the Jews were troubled by fiery flying snakes, and Moses himself made, after the command of God, a brazen serpent which he placed on a pole so that those who saw it might live. Many of the ancient nations, notably the Egyptians and Babylonians, considered snakes sacred and worshipped them; while in Hindoo mythology they are believed to be evil spirits. History teaches us that the Old Greeks and Romans bestowed godlike honors on snakes; the latter consecrated them to the god Æsculapius, and he himself was worshipped in his temple in the form of a snake.

Such views, however, are not reserved for ancient times only. When Cortez conquered Mexico, he found that the inhabitants adored snakes as their gods, and the very same thing can be seen still now a days among many barbarous tribes of Africa, Asia and America. The Galla in Africa look upon snakes as the originators of the human race and pay them respects due a god. When Huglin, a traveler through Africa, had killed an African python within the territory of the Dinka negroes, those people were very much disturbed, and complained that the death of this, their ancestor, who had lived with them such a long time in peace would surely bring them mischief. The same negroes call other snakes their brothers and punish every body severely who kills or hurts any such animal. Even in comparatively highly civilized countries, as in some provinces of Italy, Sardinia for instance, the peasants tell strange stories about the power of speech and the gift of foretelling the future which certain snakes possess. Consequently, whenever one appears in the hut of a farmer or a shepherd, these good people believe that they may expect great fortune which the snake has come to announce to them. They pet them, talk to them, invite them to stay, bring all kinds of delicacies to induce this strange visitor to tarry, and are disconsolate if the snake goes away. Among Russian and even Thuringian peasants the same belief can be found : for them a snake is a messenger of coming wealth and fortune.

Our own Indians, the Sioux, Dacotas and other tribes, consider snakes worthy of their reverence, and whenever they meet one they believe that the matter they have on hand, be it a battle or a hunting expedition, or the election of a new chief, will come to a favorable end.

No wonder that such views from the earliest times tended to strengthen the belief that snakes must be beings quite different from what they seem. People might indeed be justified to a certain extent when they surrounded with mystery these animals, which apparently were nothing but tail and head, which crept on the ground like worms, which seemed to prefer abodes that no other living being would like to choose, and which in so many cases were able to inflict deadly wounds. What else could they be but examples of a deviation from the straight ways of nature, as the enemies of progress, lurking in the dark, always ready to do mischief? Much oftener than gods or good spirits they were pointed out as children or servants of the Evil One, and the latter himself appeared in this disguise whenever he aimed at misleading a poor soul or at creating destruction in the world.

Imagination, ever ready to soar beyond the reach of reality, ascribed to them wings, feet and other limbs, golden crowns on their heads and—as pointed out before—the gift of speech and reason. Priests and physicians were eager—here is a temptation to say, of course—to support all this belief and to point out other supernatural qualities, which were apt to increase the awe of nations. What shall we say when we learn what Egyptian priests teach: that whoever kills an asp is persecuted by its spirit with terrible cruelty; the murderer is found out even in the greatest crowd, is followed beyond mountains and rivers, until the thirst for revenge is quenched? And physicians of ancient times and of the middle ages were not far behind the slyness of their colleagues, the priests, when they ascribed powerful, invigorative and restorative virtues to the broth of snakes, to their fat, to their flesh. Lucrezia Borgia, that famous Italian lady, whose wonderful beauty set so many hearts on fire, is said to have washed her face with snake fat, and Sir Kenelen Digby's beautiful wife loved to eat capons, which were fattened by means of snakes.

Nowadays advancing civilization has broken the power of such superstition, nobody believes any more in the "theriac" and others of those famous drugs made of the heart and liver of snakes powdered, which were found during the last and until the beginning of this century in all apothecaries' stores, and believed to cure fever, smallpox, apoplexy, paralysis, leprosy, consumption, blindness, etc. Science has advanced rapidly, and before its lifted torch of knowledge, enlightening a world of darkness, superstition and unbelief, all these dismal notions have taken their flight.

So much the more it seems reasonable to look a little more closely into the natural history of those ill-famed animals, to throw a little more light upon their anatomy and strange habits, and in this way to find some reasons for many of the above mentioned prejudices and opinions so inexplicable to our forefathers.

It would take up far more time, however, than is at my disposal to-night to take the entire order of snakes into consideration; I should be obliged to lecture several days and should then not yet have exhausted the subject. Allow me, therefore, to draw the line and to restrict myself to that department of Snakedom which has been exposed to grossest misrepresentation, which has given vent to most unheard of stories, and about which still so little of the real truth is known, the department of the Poisonous Snakes.

Many things, which must be said about these, hold good for both poisonous and innocuous snakes, so that it will not be necessary to dwell at length upon their position in the Animal Kingdom, their general anatomy or their manner of life. Suffice it here to state that snakes belong to the class of Reptiles, the third class of the sub-kingdom of Vertebrates, and that they are characterized by the absence of extremities and breast bone, by their cylindrical, elongated bodies, by their tapering tails and the ability of widening or expanding their mouths. Snakes are covered with flat, imbricate, horny scales which in several instances extend as a transparent film over the eyes, and which are thrown off either as a whole or in parts at least once a year.

The vertebræ in snakes are exceedingly numerous (a skeleton of a python in the British Museum has 422); they articulate with each other not only by a cup and ball on the central portion of the vertebæ—that is, on the centrum—but also by eight joints in addition to these, which interlock by parts reciprocally receiving and entering into one another; and thus the vertebral column is very strong, while at the same time it has great freedom of motion. It must be added, however, that, in accordance with this structure, there is little or no natural upward and downward undulation of the body as the apophyses prevent that; all the undulations are from side to side. Nearly each of the vertebræ has a pair of ribs which serve not only to give the body its form, but help in breathing and in locomotion.

Also the ribs are extremely movable; their free ends, in fact, being simply attached by muscular fibres to the scales or "scutes," which cover the lower or abdominal surface of the animal, so that they can easily be drawn backward and forward. By means of this arrangement, snakes are able to progress rapidly, walking, as it were, upon the ends of the ribs, just as other animals get along on their feet.

It is impossible for them, however, to jump great distances, nor are they able to erect more than the first third of their body; so that all reports telling us about the terrible speed which snakes attained while pursuing other animals or human beings, as well as accounts of enormous heights which snakes jumped in order to reach their victims, may safely be rejected as fairy tales. We know positively that no snake can run so swiftly that a man could not, without running, walk along side of it with long steps, but we may account for the frequent exaggerations by the circumstance that the winding, wriggling motion of a snake offers a rather unsteady picture to the human eye, and as, moreover, very few people really take pains to observe the speed of snakes carefully, everybody is convinced that it must be very great. The same reason may be given when we hear from otherwise quite reliable persons that they saw snakes jumping to an utterly imposible height. Most snakes are scarcely able to raise their heads more than one or two feet above the ground, a few only, the cobra for instance, being an exception: many others, when grasped by the tail and allowed to hang free, cannot even bend their bodies so that they reach the holding hand or the arm with their heads.

The bones of the jaws and mouth, which in the higher animals are more or less firmly united, are connected in snakes by extensible ligaments only, and the lower jaw articulates with the skull by means of a quadrate bone which in turn is movably jointed to the cranium. As the two halves of the lower jaw are also merely united loosely in front by ligaments and muscles, the snakes have, in consequence of this peculiar arrangement of parts, the power of opening the mouth to an extraordinary width, and they can perform the most astonishing feats in the way of swallowing, although here more than elsewhere great caution is to be exercised in believing the accounts given by travelers who claim to have seen giant snakes swallow whole buffalos and horses.

As regards this process it is to be noticed that the snakes are not in the habit of chewing their prey, but of swallowing it whole, aud it is surely very interesting to observe them in performing the act. With rare exceptions they seize their prey by the head, hold it firmly with their teeth, push forth one side of the upper and lower jaws, hook in their teeth, push the other side after and in this way go on pushing first one side then the other of the head over the prey until the latter disappears entirely inside the mouth. During this act the head appears twitched entirely out of shape and every bone of the jaws out of joint; but as soon as the heavy pressure is over, the sinews and ligatures resume their former natural position and size, while the morsel which may have a diameter greater than the snake itself, is seen like a knot in the long and slender body of the animal, slowly moving down through the alimentary canal until digestion disposes of it.

Of the other general characteristics of the snake, a few words may be said as to the teeth and to the tongue. Snakes have literally a whole mouthful of teeth, for these are found not only on the upper and lower jaws, but on nearly all the visceral bones ; they may, however, be also entirely absent. Their teeth are usually pointed, smooth, arched toward the throat, fitted only for seizing and holding the prey, but not in any way for chewing or dividing it. In the harmless snakes the teeth have the form of solid cones which are arranged in rows round the whole of the upper and lower jaws, a double row existing on the palate as well. In the venomous snakes, on the other hand, the ordinary teeth are usually wanting upon the upper jaws, and these bones are themselves much reduced in size. In place of the ordinary teeth the upper jaws carry the so-called poison fangs of which more will be said as soon as we examine the poisoning apparatus.

The tongue in serpents is probably more an organ of touch than of taste. It is long, wormlike, and consists of two muscular cylinders, which are united toward their bases. The organ thus formed has two long, very slender, points ; it appears like a fork, and can be protruded and retracted at will, as it runs in a kind of sheath which by its secretion keeps it wet, slimy and flexible. The tongue is very movable and in constant vibration when protruded, the snake apparently feeling its way and reconnoitring the surrounding territory. It can even be pushed forward when the mouth is closed, and appears also when the animal is in fear or in anger. At all events this organ has no harmful qualities, though people usually dread it as the frightful weapon with which the snakes are said to inflict death. That this is not the case we shall see presently.

A few words only, before I speak of poisonous snakes in particular, about the occurrence of snakes on the earth. We find them most frequently in the tropics, where the largest and most poisonous snakes appear. They prefer in general a well watered territory with shady places and with abundance of food. Each locality has its peculiar kind of snakes, so that we may speak appropriately of tree-snakes, water snakes, sea-snakes, ground-snakes and even desert-snakes, all of which have their peculiar organization and habits. Most of the non-venomous snakes are of diurnal habits, nearly all poisonous snakes, however, prefer the night for their excursions. The former usually withdraw to their hiding places when darkness sets in, there they spend the night in lazy restfulness and reappear some time after sunrise; the other group, the poisonous snakes, may indeed be found during the day-time, but nearly always in a state of drowsiness which disappears after dusk. Then they pursue their principal business, the catching of prey, and fires lighted by travelers in the forests are particularly apt to attract such unwelcome visitors, much to the disgust and dismay of the weary hunters whose night's rest is gone.

"You must know what it means," writes one, "to have finished such a day of travel through the desert or the prairie. From early morning until sunset we have been riding and balancing on the backs of our camels and endured the heat of the scorching sun; everybody anticipates the pleasures of the night's rest. At last we arrive at the place where the camp is to be staked. The baggage is taken down from the mules, carpets are spread out on the ground, pipes are being lighted and a fire started. An indescribably comfortable disposition overcomes everybody, even the African cook who prepares a very frugal supper, hums some native songs. Suddenly he stops, and instead of words singing of sweet love and charming spring time, he utters a loud curse. 'What's the matter, my boy?' 'O,' comes out the answer between his teeth, 'may the Lord curse her and her father and her mother and all her relatives, may he banish them into the abyss of hell! A snake, massa, but she roasts already in the fire!' Gone is our peaceful situation, everybody jumps up, the whole camp becomes lively, and all arm themselves with tongs, pinchers or forks, take their seats on high boxes or bales of wool and wait anxiously what the following hours will bring. There they sneak in, by the dozen, the vipers—where in the world do they come from? Cautiously everybody reaches down from his elevated seat, pinches the ugly beast firmly immediately behind the head so that it cannot bite and flings it amidst the blazing flames, watching its destruction with malignant joy. Instead of having sweet, refreshing sleep we must sit up all night and defend our camp against those detestable intruders which, attracted by the camp fire, crawl and hiss around till the sun rises and we mount our animals again."

By far the greater number of reliable travelers, however, tell us that snakes are by no means abundant. It is true some of these animals are rather obtrusive and become troublesome, as the water moccasin, which lays in the sunshine on trees overhanging rivers and drops without ceremony on the heads of people in boats going under them, and in some districts of India snakes are found on the roofs of houses, even in chairs and in beds, so that a special inspection is needed before one can sit down or go to rest.

But this state of things is apparently an exception, as we may infer from the reports of gentlemen who lived a long time in countries that are considered by people as swarming with most dangerous snakes. Dr. Davy, who spent many years in Ceylon, says that he has seen more monkeys there in one day than snakes during the whole time of his stay. He speaks of the common belief that

Ceylon abounds with snakes, that they are very dangerous, and that one cannot be too careful in avoiding them. "All that," he says, "is exaggerated. Where fear is in play, reason is usually very weak, and snakes have from times immemorial with all men and all nations been the subject of aversion and fear, and objects of superstition and fables. Snakes are neither numerous there nor to be feared. Those men who possess the greatest experience have also the greatest confidence. Old sportsmen rush fearlessly into the thickest shrubs and underwoods, while the new-comer from Europe does not dare to cross the lawn before his hotel, trembling and afraid of the snakes in the grass. The latter is full of imaginary fear, the former fearless by experience. This fear sometimes causes most ridiculous, though often sad scenes, and makes the life of many people a burden, a torment."

If we look over the reports issued by the medical officers of the Federal armies during the Civil War, we find very few cases of men injured by the bites of snakes. This is so much the more remarkable as our troops must have tramped through countless miles of woods and wilderness often for weeks and months, and we ought not to be surprised to learn that they had a good deal to suffer from encounters with those apparently obnoxious animals.

The reason for this is very simple ; snakes very seldom attack men unless they are irritated or in some way excited ; even the most dangerous prefer to steal away as soon as they hear the lord of creation come near, and they will bite only in extreme necessity when trodden upon or otherwise irritated. There is only one snake, the bushmaster (*Lachesis muta*), in Brazil, which is said to attack men without provocation, but this is an exceptional case. We may still hold that in general no snake will molest a man ; on the contrary, it will be glad to be left alone and hide or crawl away in order to avoid an encounter. Singhalese people make use of this fact, for whenever they have to go out in the night, they take with them a stick that has a loose ring fixed to it. They strike it against the ground so that a loud rattling noise is made ; the snakes which may be near will hear it and take care to get out of the way.

The danger of meeting with poisonous snakes is much less in civilized countries, for they are not only killed by farmers and other pioneers of civilization who take special care to annihilate them whenever and where-ever they see them in order not to be molested, but they have also numerous enemies among the domestic animals, which make short work with them. Cats and pigs are prominent as destroyers of snakes, but also an army of beasts of prey, foxes, weasels, martens, many birds, falcons, buzzards, vultures, owls, storks, etc., are very effective in their work of exterminating those disagreeable animals. Even if this were not the case, careful observers have found out that snakes seem to leave those places where they are liable to be disturbed by man. It is nearly impossible, for instance, to find a rattlesnake in any one of the more highly cultivated agricultural districts of the eastern United States, and if we want to catch one, we must repair to desolate places, stony, rocky or sandy territories, which furnish them numerous hiding places and all the commodities of life, water, sunshine and sufficient food without obliging them to constantly endanger their lives into the bargain.

In connection with this point, the annihilation of snakes, the question arises very naturally which are the harmless or even useful ones, and which must be mercilessly pursued and killed whenever we see them. Not considering those snakes which grow dangerous or at least obnoxious through their size or their voracity only, and keeping in mind that danger will then come only from the poisonous snakes, we may ask the question now whether there are any characteristic signs by which we can find at a glance the difference between a poisonous and an innocuous snake, so that we know at once whether it is safer to keep away from it or to handle it with impunity, whether it is more advisable to kill it or spare its life.

Be it said right here what cannot be repeated often and emphatically enough, that the external differences between both kinds of snakes are extremely insignificant, that it is impossible often even for a very well trained eye, to recognize a poisonous snake as such by merely looking at it, and that many scientists have imperiled their lives more than once by disregarding this precaution, by getting too confident in their experience and finding out too late that they had deceived themselves. In more than one case such men have paid for their temerity with their lives.

In some text-books of Zoology so-called characteristic signs of venomous snakes are set forth with really incredible levity. It is true that certain kinds of poisonous snakes possess a short body, which is very much thicker in the middle than at the ends, that they have also a short and rapidly tapering tail, and that they have a very thin neck with a triangular head which is connected with the neck by one of its broad sides. We may also admit that the construction of their scales differ often from that of the innocuous snakes, but most of these marks hold good only for a limited group of poisonous snakes, not for other groups, and—what makes things worse—may also be found in harmless snakes, so that this method of getting at the truth is a very treacherous one. There are species of sea-serpents, some of the most dangerous imaginable, which look as harmless and innocent as any other snake, and a numerous group of cobras whose virulence is well-known, has externally so many attractive qualities and seems to be so good-natured that the most reliable investigators have pledged themselves for their harmlessness, and in one case recommended them even as playthings for ladies and children. Nothing has proved to be more pernicious than this unheard of credulity.

Other scientists pointed out as a sign of distinction their peculiar, danger-signaling, awe-inspiring look, their fiery-red, malicious-looking eye with the oblong or slit-like pupil, and their dull and heavy disposition. Not to speak of the fact that nobody will be inclined to examine quietly and carefully the pupil of a snake which is about to bite, and also not mentioning the circumstance that any snake, poisonous or innocuous, dull of disposition or not, invariably becomes very lively as soon as it is going to attack somebody, all those marks are likewise very uncertain and can in no way be depended upon as long as our life and health is at stake by some slight misunderstanding or misrepresentation of the facts.

Much has been said, indeed, by trustworthy travelers on the peculiar enchanting power of the eyes of poisonous snakes ; others have denied it just as positively. It will be safe, therefore, to conclude that the truth lies in the middle. There is no doubt that the eyes of serpents, not being protected by any eyelids, show that strange, stony and unwinking stare for which these reptiles are celebrated, and there is just as little doubt about cases when squirrels or birds, merrily playing in the woods and suddenly preceiving a poisonous snake, are terrified to the utmost, so that they are unable to move, and thus become an easy victim of their enemy. They seem to be paralyzed, and, far from trying to flee away, fall from the tree or from the shrubs, often right into the wide-open jaws of the luring animal. Nobody will consider such an event as anything strange or doubtful.

What is more remarkable and less explicable, however, is the often noted fact that under certain circumstances small quadrupeds and birds, when seeing a dangerous snake, are not only unable to withdraw from it, but are apparently tempted to get nearer and nearer from a place of comparative safety into imminent danger. Should we blame observers who happening to look upon such scenes have ascribed the mysterous behavior of those little animals to some peculiar power or influence emanating from the eye of the lurking enemy and forcing the poor victim to rush literally into the jaws of death? But even such an occurrence may be explained without referring it to supernatural powers. We know that birds have often sacrificed their own lives in order to save their young—why could we not assume such a case? The mother may have tried to attract the attention of the poisonous reptile and fallen a prey to its self-sacrificing love. We may also assume that the animal acting so strangely has already been wounded and becoming weak, falls down; meanwhile eagerly watched, by the greedy eye of its murderer. In most cases, however, even when such explanations cannot be given, we may take it for granted that any animal suddenly finding itself within the reach of a deadly foe, seeing no hope of escape, will be paralyzed, will loose all its energy and be in many cases unable to do what it would have done if it had had time for consideration. I myself have gone through such an experience more than once when, while rambling over mountains and hills, or while lying down in the grass for a little rest, I saw unexpectedly a viper close by on the ground very near my face, watching me with seemingly intense interest, ready to strike at the least motion I should make. I must declare plainly that I felt rather uncomfortable. I knew that the slightest provocation would induce the animal to inflict its blow, and yet I felt that I could not stand that immense strain on my mind very long without moving involuntarily one or the other way. Something had to be done—while I kept my eyes fixed on the ugly reptile beside me, I began to move away from it, very, very slowly, until I was beyond immediate reach of a bite, then I quickly jumped up, grasped my forked stick and pinned Mr. Snake to the ground, despite his desperate wriggling and kicking. It ceased soon, whereupon I put him into the box which I always carried with me when out snake hunting.

So we see that without falling back on a special mysterious power of the eye of a snake, we may suppose that its strange looks, combined with the fear of disaster which the presence of so wicked an animal must produce, can exert influence enough to deprive any creature of its usual agility and to cause it to behave as under ordinary circumstances it would not have done.

We know, moreover, that numerous animals such as mice and rats, do not mind the presence of poisonous snakes. They may be curious to find out what is near them, but are never afraid of running over or otherwise touching vipers that occupy the same cage. Nay, there are well authenticated instances when after all the snake, instead of killing the rats that were put into its cage as food, was rather bitten by the rodents and finally devoured without injury to them. Other animals, for instance cats, when attacked by poisonous snakes, have defended themselves bravely, and either sold their lives as dearly as possible, or in not a few cases even triumphed over their adversary.

At all events we see that the bad eye ascribed to poisonous snakes cannot serve as a distinguishing feature. There is only one fully reliable criterion left, their teeth or "poison fangs." We find the latter in venomous serpents only, so that their presence or absence alone decides the character of the reptile.

However different in their size and shape of the body, however different in their manners of life, in the poisoning apparatus the venomous snakes possess a sign which distinguishes them at once with certainty from the innocuous ; it is deplorable, indeed, that one cannot look with ease and impunity at this infallible sign, but one learns soon to some extent by careful observation how to tell one from the other, even without opening their mouths by force and searching for the "fangs."

Thus they form a natural subdivision (*Toxicophidia*) that needs no other characteristic except that they have perforated or grooved teeth in the upper jaws besides their solid ones. This subdivision possesses again two distinct groups, the "Solenoglypha" (*Vipera*, *Pelias*, *Crotalus*) with their fangs pierced by a regular tube, and the "Proteroglypha" (*Elaps*, *Naja*, *Hydrophis*), whose fangs show only a groove or a canal instead of an internal tube.

Let us now look a little more closely at this poisoning apparatus. One of the strangest ideas concerning it was that of the Ancients, who believed that the end of the tail was the seat of danger, while during the Middle Ages many learned people maintained that the poison of vipers was stored up in their teeth ; others said that not the teeth themselves were injurious, but the liquid contained in the sheaths of the teeth ; still others were of the opinion that the gum, the saliva, or the gall-bladder ought to be considered as the producers of the poison. Redi, a celebrated physician living at the court of Ferdinand II, grand-duke of Toscana in Italy, during the 17th century, examined all these parts without being able to confirm what had been the unshakable belief of generations, that the above named parts of the body of a snake contained poison.

A wide spread opinion may still be found among a good many people that the tongue of a snake is the death-inflicting weapon, hence the expression that the snake "stings," which is not correct, as it really bites with its teeth. Shakespeare even has embodied this idea several times in his works, for instance in "King Lear," who, when suffering from the wrong done him by his daughter Goneril, exclaims:

> "She has abated me of half my train,
> Looked black upon me, struck me with her tongue
> Most serpent like, upon the very heart."

In the "Midsummer Night's Dream" Hermia, who accuses Demetrius for having murdered Lysander, says:

> "And hast thou killed him sleeping? O brave touch!
> Could not a worm, an adder do so much?
> An adder did it; for with doubler tongue
> Than thine, thou serpent, never adder stung!"

We may easily account for this strange belief, as the tongue, this ever movable, slender, forked part, gives to the snake a mysterious, even malignant look, hence the repeated statement that it is the animal's "dart" with which it kills. David, the royal harp-player, who is otherwise a good observer, says in his prayer for Saul, Psalm 140:

> "Deliver me, O God, from the evil men, preserve me from the violent men, which imagine mischiefs in their heart; they have sharpened their tongues like a serpent; adder's poison is under their lips."

It is confirmed now beyond doubt that the tongue can do no harm, and that the poison-fangs alone must be considered as the deadly weapon which condemns the whole family to hatred and aversion. There are usually two, one on each maxilla or upper jaw-bone, which when they are not in use, point backward. They are concealed in a fold or a slight groove of the gum, but can be raised as soon as the mouth opens. Each tooth is either perforated by a fine tube which opens by a distinct aperture at the point of the fang, or it has a shallow longitudinal canal on its surface. Usually only one tooth is found perfectly developed on each side ; but on a more careful inspection one may discover two or more reserve teeth of smaller size and less developed behind the principal one which sit very loosely on the jaw-bones and are destined to move forward and to serve as substitutes in case the first should be lost. Consequently, the one nearest in front is the most highly developed.

These teeth are distinguished always by their great length and their peculiar curved shape. They are as hard as glass and brittle, but possess an extremely fine point so that they penetrate easily even things of comparative resistance, as leather, while, on the other hand, they slip off hard ones or even break into small pieces if the blow of the snake is a very violent one. If one is lost, the one following behind will take its place. With some groups such a change is going on with a certain regularity without any reason or provocation from outside, perhaps once a year or oftener.

The development of such poison-fangs proceeds with marvelous rapidity ; investigators have found out that embryos which had apparently been born within five or six days had none at all yet, while others only one or two days before their leaving the egg had them in perfect working order. Each tooth is in its first state a sheet only with edges rolled up so that it shows the groove, beyond which the development does not go in certain groups, in the Proteroglypha, which take their name from this very circumstance.

In the Solenoglypha the sides of this groove approach each other and finally grow together, thus forming a tube which is entirely closed and forms a higher state of development.

In either case the canal or the tube is connected with the duct of the "poison-gland." This is a gland, situated under and behind the eye, secreting the poisonous fluid which renders the bites of these snakes dangerous or fatal. When the serpent strikes at an animal, the poison is forced through the poison-fang into the wound, partly by the contractions of the muscular walls of the gland, and partly by the compressive action of the muscles of the jaws, perhaps also simply by the repulsion of the tooth which when forcing its way into the wound is pressed backward to a certain extent and squeezes the gland.

The act of biting is the work of one single moment. The snake coils up into a spiral, and about one-third of its length, carrying the head, rises from the coil and stands upright, waiting.

Then its head and neck are thrown far back, its mouth is opened very wide, the fangs, held firmly erect, and with an abrupt swiftness, for which its ordinary motions prepare one but little, and with extreme force it thrusts its head forward and plunges the fangs into the flesh of the victim, striking once, scarcely ever a second time, and immediately after being on guard again. The blow may be called a stab, given by throwing the head forward, while the half coils below it are straigthened out to lengthen the neck and give power to the motions which drive the fangs into the opponent; as they enter, the temporal muscle closes the lower jaw on the part struck and thus forces the sharp fangs deeper in. It is a thrust aided by a bite. At this moment the poison duct is opened by the relaxation of the muscle which surrounds it, and the same muscle which shuts the jaw squeezes the gland and drives its venom through the duct and the hollow fang into the bitten part. In so complicated a series of acts there is often failure. The tooth strikes on tough skin and doubles back or fails to enter, or the serpent misjudges the distance, falls short and may squirt the poison several feet in the air, where it does no harm. A snake in South Africa, the spitting snake (*Serpedon hæmachates*), has its name from the capability of hurling the poison towards its enemy.

A snake will turn and strike from any posture, but the coil is the attitude always assumed when possible. The coil acts as an anchor and enables the animal to shake its fangs free from the wound. A snake can rarely strike beyond half its length. There may be cases when it throws its whole body forward or actually jumps at the victim, but this does not happen very often. The nervous mechanism, which controls the act of striking, seems to be in the spinal cord, for if we cut off a snake's head and then pinch its tail, the stump of the neck returns and with some accuracy hits the hand of the experimenter, if he has the nerve to hold on.

The poison gland is probably a modification of a saliva gland. It secretes a comparatively small quantity of fluid, a rattlesnake six feet in length surely not more than five or six drops, but a small fraction of such a drop is sufficient to create fatal changes in the blood of any big mammal or bird. If the snake has not bitten for a long time the gland is brimful of it, and the poison itself seems then to be more effective, but the regeneration of the lost secretion occurs very rapidly, and also the recently produced liquid is very quick in its action.

The snake poison may be compared to saliva, or rather it is a kind of saliva, which has by degrees assumed its dangerous qualities. Not all poisonous snakes inflict death by means of their bites; there are species whose bites, though disagreeable and painful, do not do more harm than the sting of a scorpion or a big wasp, and there is some probability that the liquid in all cases is nearly the same, only different in the degree of its effectiveness. The poison of snakes is nearly always very innocent looking; it appears in most cases as a clear, thin, light yellow or greenish liquid, without smell or taste; it sinks in water, dissolves in it with very light clouding, reddens litmus paper and thus betrays its acid character, although other researches have proven it to be neutral or even somewhat basic.

The easiest way to collect venom is by means of the snake loop. With it the animal is caught by the neck, lifted out of its cage and then the lip of a saucer slipped into the snake's mouth. Angry at this liberty, it lifts its fangs ; they catch on the inner edge of the saucer, against which the reptile bites furiously again and again. As it does so, that thin yellow fluid squirts out of the tube or the canal near the end of the fangs and is collected in the saucer. The operation may be repeated with a second or a third snake, until a quantity of the venom desired is at hand. It easily dries up if spread out on a plane surface, and then appears shining white like the white of eggs or like some brilliant varnish. It also keeps well in glycerine or alcohol.

All investigators now agree that it is albuminous in its nature. As such it had always been regarded since it had been proved by Prince Bonaparte to belong to the albumens ; it was not yet certain, however, whether we should consider it as a single body or compound. The extensive and careful researches of Dr. Weir Mitchell in connection with Prof. Reichert, continued for a number of years at the Smithsonian Institution, have thrown more light on this hitherto obscure question and enabled us to see more clearly of what ingredients the different kinds of snake poison are composed.

If a little of the venom is placed in sufficient water, it dissolves readily. If then the solution is heated, a coagulation takes place, just such as happens when white of egg hardens on boiling. If by means of a filter this clotted substance is separated, we find it innocuous. The clear fluid, however, which passes through the filter, is poisonous; but does not produce any local effects as the intact substance. This means that heat has damaged its dangerous properties ; one or more of its ingredients have been injured by heat. The next step would be to learn if the substance made solid and inert by boiling cannot be separated in some other way and in such a form as will leave it also poisonous.

All soluble substances are divisible into two classes, one of which will pass through an animal membrane into a current of pure water, and one of which will not. Those which can so pass are said to be dialysable; the filter is known as a dialyser, and the process is called dialysis. If some of the poison is dissolved in water, put in an inverted funnel, the wide mouth of which is covered with a thin animal membrane, and placed in distilled water, the latter will under these circumstances go through the membrane and dilute the fluid above it while certain substances pass out to the water.

The matter which thus finds its way out to the water is said to be dialysable. When examined, it proves to be poisonous, to be uncoagulable by heat, and to be the same as the matter left unaltered when we boil the diluted poison for a few moments. On account of its similarity with peptone it is called "*venom peptone.*"

Within the dialyser a white substance falls down, which is easily redissolved if we add a little common salt. It has a certain likeness to the albuminous body known as globulin, and is therefore called "*venom globulin.*" Other substances of like nature but less important are found in some snake venoms, but essentially all examined contain at least two albuminous substances. If we mix them, we practically reconstruct the snake venom.

Let us see now what effect this poison has upon a living organism. We all know that the result of a snake bite may be death or a long painful sickness, at all events there is danger to life and health to any one who has unfortunately been struck by a poisonous snake. We cannot deny, however, that such results have often been grossly and even ridiculously exaggerated. Allow me to read to you a report of the Roman author, Lucanus, who describes Cato's expedition through the African deserts after the battle of Pharsalus. He first mentions the legend how poisonous snakes originated from the drops of blood which fell from the head of Medusa, and then he proceeds:

"Right through these horrid monsters Cato led his veteran army, and many of his men he saw miserably dying of insignificant wounds. The color-bearer Aulus stepped on a Dipsas: it bent back its head and bit him. He scarcely felt the sting of the animal, and the wound itself seemed entirely harmless. Soon however the pain penetrated his whole body, even to the marrow of the bones; mouth and tongue became parched, and his skin dried up. The unfortunate man threw away the colors and sought water, crazy and tormented by horrible thirst. He drank and drank, and became more and more thirsty; at last he tore open his veins and sucked his own blood, but was not able to quench his terrible thirst. Exceedingly frightened Cato ordered the army hastily to continue their march, but soon death was to be seen in still more horrible form. The leg of one of the officers, Sabellus, was bitten by a little Seps. With his hand he tore the snake away from the wound and killed it with his sword; it was only a small animal, but round about the bitten spot the flesh began at once to fall off in rags, so that one could see the bare bones. Rising higher and higher, the disease spread throughout his whole body which was gradually changed into a filthy, stinking liquid; and when the flesh had disappeared from his head, the very bones were dissolved so that not even the corpse of the man could be found, but instead of it, an ugly spot colored by that filthy liquid."

"The Marsian warrior, Nasidius, was bitten by an adder. His face became at once fiery red, and the body began to swell. The swelling went on until the shape of a human being had entirely disappeared, and only an immense ball or lump of hideous color presented itself to the astonished eyes of the frightened bystanders. Nobody ventured to put this mass, which went on increasing in size, on the funeral-pyre, and every one made his salute in the flight."

We need not emphasize that such stories cannot possibly be true at least as they are reported; the accidents themselves may have been true, but the author may, just according to the fashion in which writers indulge nowadays, have exaggerated them in order to make a greater impression on his readers.

To-day we know better what happens when somebody is bitten by a poisonous snake; we know not only the incidents of such a dire occurence, but also the feelings and sentiments of the wounded, and we are able to give a reliable explanation of nearly every phase of the event. Before investigating the effect of snake poison as it is coming out of the poison-gland and injected by means of a bite, or injected into the blood artificially, it would be well to consider at first the effect of its components, the venom peptone and the venom globulin, as we shall be able then to account much better for the effect of both combined, *i. e.* of the unaltered poison.

Venom peptone alone put under the skin of a living animal causes only slight local injury; after some time, however, the tissues soften as if they were melted or dissolved, a horribly swift putrefaction occurs, and at the same time the breath sustaining nerve-centres become weak, the muscles which move the chest cease to work, the animal dies from failure to breathe; while the changes in the blood are by no means remarkable.

Venom globulin has an entirely different effect. At the spot where we inject it, the vessels give way and pour out blood which cannot clot, and this change by and by occurs here and there throughout any or every organ of the body, so that at last the blood becomes what physicians call "diffluent," and may remain until it decays, free from the clots usually seen in the healthy fluids when drawn and allowed to stand. In other words, the brain, the spinal column, the lungs, the intestines, all are filled with blood; with blood, however, whose coagulability is destroyed. What fatal influence that has on any living organism can readily be seen. There is really no other poison known except snake poison, which has the *ability to ruin in a few minutes the capacity of the lesser blood vessels to keep the moving blood within their guarding walls.* Our every function—nay, life itself—depends on the blood being so restrained. If by accident a drop or two of normal blood escapes from a small vessel, instantly the blood clots and tends to cork up the tiny hole through which it came. Venom not only seems to rot the vessels, but it also makes the blood fluid and so facilitates the hemorrhages, of which it is the primary cause. Such hemorrhages can even be followed under the microscope. The peritoneum of a rabbit is laid open and examined under the magnifying glass. The spectacle of the blood globules driven swiftly through transparent capillaries, the smallest of vessels, is a constant source of delight for every one who sees it. Venom peptone scarcely disturbs this local stream; if, however, we touch the thin membrane with fresh rattlesnake poison, which has a great per centage of venom globulin, in a few minutes the delicate little cells, which are like a thatch on the inside of the capillary vessels, seem to be roughened and become less transparent. Then, abruptly, here and there a drop of blood oozes out; these tiny blood points increase in size and number, until at last the whole field of view is covered with escaped blood.

It is then only a question of time, as to how long it will be before the same disintegration of vessels, and the same loss of power in the blood to clot, occurs in hundreds of places remote from the spot first poisoned.

Now as bacteria are always present in fresh poison, enough enter a wound to account for the fact that animals envenomed swarm within an hour or two with these organisms which cause putrefaction. The rate of increase is inconceivably great, and seems to be favored by the poison which provides them with some mysterious conditions of growth. Thus it is that the blood, the nerve centers, the vessels, are all in turn attacked by these fearfully destructive poisons, that the blood itself thus infected becomes poisonous, that the venom does not loose its fatal properties after the death of the snake or even after a number of years, that the careless handling of alcohol for instance, in which poisonous snakes were preserved, may prove disastrous.

Now, cobra poison contains about 98 per cent. of peptone, rattlesnake poison about five per cent., the remaining percentage in either case being the other component in question. Thus it is that the local appearances of the bite in either case are readily recognizable, and that in most cases the general phenomena would enable us to say which snake had bitten. Likewise, as venom peptone passes with ease through membranes, we understand readily why cobra poison may not be swallowed with impunity, whereas it is possible to feed animals on rattlesnake poison day after day and see them live and be happy and comfortable.

These two components mixed together, or in other words, the real snake poison, will of course work far more disastrously than one by itself, neither alone produces the tremendous and perfect effects seen when both are combined by mischievous nature in a suitable solution.

The effects of a snake bite depend, however, also on different outside reasons, as on the size of the snake, or on the quantity of poison entered into the wound, so that a bite when the gland is empty or the snake had bitten several times recently, is not so dangerous as when inflicted by a snake which has the gland brimful of the horrible liquid. Then, too, the effect depends more or less on the weather, bites in very hot weather apparently being more dangerous than others in colder seasons. Then, the constitution of the man or the animal bitten will be an important, or rather the decisive, factor in determining the result of the bite; feeble, timid, weak-minded people seem to succumb more easily than courageous, strong men; a bite seems to influence lean men more than fat ones; it is more destructive for white men than for Indians, and generally more for foreigners than for natives.

Last not least the *situation and the depth of the wound* is to be considered. If the bite is only a superficial scratch on a nearly bloodless tissue, the victim may easily recover, while striking a large blood vessel will cause instantaneous fatal results.

We must not forget that *mere fright sometimes has caused death*, especially to nervous, easily frightened people, while the snake which had bitten was utterly harmless. On other occasions the bite of an innocuous snake has actually had fatal results, as it infected the blood of the bitten person with bacteria that were in the saliva.

People who are bitten usually feel immediately after, a violent pain, a pain which cannot be compared with anything else, and which goes like an electric shock through the whole body. In other cases the contrary takes place, the one bitten believes himself to have been scratched only by a thorn and does not think much of the ache. Soon, however, he will feel tired, strength will leave him rapidly, he faints, he begins to vomit, to discharge blood, hemorrhage and diarrhea set in, the nerve centres cease to work, breathing becomes difficult, the muscles relax, the skin becomes insensible, blindness, deafness may occur, and during the last stages no pain at all may be felt. Other snake bites cause the most terrible pain, men moan most pitifully, and dogs howl dismally for hours together until death comes as an ardently longed for deliverer. This is *usually brought on by suffocation*, as in every case the mechanism of respiration is put out of order; as with cobra poison, the motoric centres sustaining the breathing cease to work, and as after a rattlesnake bite, the lungs are filled with blood that has oozed out through the capillaries, and prevents the proper action of the respiratory organs. If, therefore, artificial breathing can be maintained sufficiently long, recovery may be hoped for. At all events, however, even if death is not the result, long sickness follows, and very often it happens that if a man does overcome the dreadful blow, he must suffer a very long time, maybe to the end of his years, from the consequences of a snake bite, and literally his whole life has been poisoned by a single little drop of this terrible liquid.

The number of antidotes is legion. From oldest times until nowadays the mineral, vegetable and animal kingdoms have been searched for remedies for the horrible effects of snake bites; unfortunately, however, superstition had a good deal to do with all of them. There are people to-day who are earnest believers in the power of reciting a dozen or two of "Pater Nosters" or "Ave Marias;" and juices of plants, hot olive oil, ammonia, chlorine, arsenic, silver nitrate, nitric acid, and other caustic substances, have been recommended, but until today we must confess that *we do not know of any trustworthy remedy.*

There are indeed many chemicals which destroy the *power of snake poison to kill*, for instance a strong enough solution of potassa or soda, or codine or perchloride of iron, bromohydric acid has the same capacity, but by far the best of all is permanganate of potash. *Two circumstances, however, make such welcome remedy useless*, as the bites usually occur when *man is far from help, and when one has neither the remedy nor the instruments to apply it.* All such remedies are too often futile. Moreover, even if the remedy and a skillful assistant could be at hand, the poison has begun to travel through the body at a much quicker rate and is beyond reach when the injection is made. Then let us consider that *all those recommended chemicals indeed destroy the poison, but at the same time the tissues*, and where is the gain then? Such agents are worse than valueless.

Recently alcohol in great quantities, externally and internally, has been recommended by physicians as well as laymen, and even many savage tribes consider themselves safe when they, having been bitten, have enough brandy at their disposal. They drink as much of it as they can, become utterly intoxicated, fall asleep, and when they wake up again after a number of hours, feel no more unfavorable consequences. Drunken people have sometimes been bitten by a poisonous snake without encountering any harm, though others under like circumstances have died. To explain this we must remember that *alcohol does really not serve as an antidote*, that it does not destroy nor act directly on the snake poison, *but it stimulates the activity of the nerves*, which have been weakened and are usually on the point of stopping work entirely. Therefore alcohol is so much the more to be recommended as it can generally be had in every village. On the other side we must be mindful that many men have been killed by the alcohol given to relieve them from the effects of the snake bite.

For the effects on the blood and on the nerve centres *themselves, which follow an injection of snake venom there is no antidote.* We may hope to find remedies which will stimulate and excite the vital organs enfeebled by the venom, and in this direction lie our hopes for future help. At present we might formulate the treatment for poison of a venomous snake as follows: Above all we must consider that when a bite has occurred no hesitation is allowable, a few seconds are sometimes sufficient to decide the question of life or death. If posslbie, if the wound be at the tip of a finger or somewhere else in the extremeties, one ought to get rid of the part by such prompt auto-surgical means as a knife or a burning hot iron affords. If such a self-amputation is not convenient, free incisions to the bottom of the wound and immediate cauterization are necessary, or if these also be not practicable, sucking of the wound either by mouth or cupping glasses should be resorted to. It is also wise to quarantine the poison by two ligatures drawn tight enough to stop all circulation of the blood. The heart-weakness is made worse by emotion, and at this time a man may need stimulus to enable him to walk home; the free administration of alcohol or carbonate of ammonium is therefore recommended. This might be termed the urgency treatment of snake bite poisoning. The curative treatment requires free incisions into all portions of the inflamed tissues, and the thorough kneading into these incisions of a fifteen per cent solution of permanganate of potassium. By working and kneading the tissues the venom and the antidote may be made to come into contact, and the former be so far destroyed. Multiple injections of the same solution into all of the inflamed regions, but particularly into the region of the wound must then follow, which seem to exert no deleterious effect, either locally or generally. The involved area should be dressed by means of lint saturated with a fifteen per cent permanganate of potassium solution. Stimulants should be given according to indications—*i. e.*, the condition of the pulse. Laxatives, diuretics, and diaphoretics should be administered to aid in the elimination of the poison. The diet should be as nutritious as the stomach can digest. Care must also be taken to relax the ligatures from time to time to escape gangrene. This relaxation of course lets some poison into the circulating blood, but in a few moments it is possible again to tighten the ligatures, and again to inject the local antidote. If the dose of venom be large and the distance from help great, except the knife or cautery immediately applied, little is to be done that is of value.

In consideration of the dangerous character of poisonous snakes, the question arises what we must do when we see one. If the Buddhists whose religious belief forbids them to kill any living animal, find a poisonous snake inside their houses or on the road, they put it into a basket and throw that into the river. There are people also among us who protest against killing a poisonous snake and call it an unnecessary cruelty, but there is no need of arguing with such people, they have no idea of what they say. What does Virgil advise? "Come on, grasp your stick firmly, lift up stones and strike bravely at the brood of vipers however they may raise their fangs threatening, and however they may hiss with expanded chest." And we follow his advice. We cannot yet boast of having gained the victory over these dangerous reptiles, and as long as the war against them is lasting it would out of place to spare one. We kill them and are right in doing so, for merciless annihilation only will be beneficial to the human race. We may never extinguish them entirely, but we can diminish their number as has been proved in all those countries where agriculture has reached a high state of development, for instance in the United States and in Brazil, where snakes are very rare in comparison with their number only half a century ago.

I am now at the end. I shall be very happy if I have succeeded in giving you a few ideas about these strange animals. I should be very glad if some of you would feel now differently toward these creatures, if you would not look upon all of them with contempt and hatred, but consider them, though not so charming and agreeable as many other animals, just as wonderful creatures of the all-wise Maker of the Universe, creatures which fill their peculiar place in nature, which enjoy their lives in their own peculiar way, and which announce just as eloquently if we only stoop to understand their language, the love and the wisdom of the Lord Almighty who made us all.

ANNUAL MEETING.

The annual meeting was called for April 28, 1891, but as there was no quorum present, the meeting was adjourned to Tuesday evening, May 5, 1891.

MAY 5, 1891—NINTH REGULAR MEETING.

Present, Chairman Edward Elsworth, presiding, and Members Herrick, Williams, Van Gieson, Sutcliffe, Warring, Reynolds, Dwight, Neumann, Pelton, Cooley, Burgess, Wodell and C. N. Arnold.

The following were chosen officers for the ensuing year: Chairman, Edward Burgess; Secretary, F. S. Arnold; Curator, William B. Dwight; Librarian, C. N. Arnold.

NOVEMBER 24, 1891—FIRST REGULAR MEETING.

Present, Chairman Burgess, and Messrs. Elsworth, Warring, Cooley, Neumann, Elting, Albro, Pelton, Sutcliffe, Boyd, C. N. Arnold and visitors.

The report of the librarian was received and approved.

Mr. John Williams was nominated for membership.

The Chairman, Mr. Burgess, read the following paper on

SOME THOUGHTS ABOUT SCIENCE AND LIFE.

My subject I fear, is a pretentious one, but I could not think of a better one for what I had or wished to say, and so pretentious though it were, I had to take it. It has this merit, however, that at least one word in it indicates its fitness for this place. My subject is "Some Thoughts about Science and Life." You will agree with me that this is wide enough and vague enough, and these qualities were among its special recommendations.

What is the advantage of scientific or any other kind of knowledge? Why do we seek after it and extol it so highly? The mere acquisition of knowledge of any sort, if it be simply put away in bottles and labeled, has no especial merit or advantage, if, after it is attained, the process of attainment and the thing itself may be entirely eliminated from us. Of what advantage are studies in geology, or chemistry, or natural philosophy, or biology, unless this knowledge and the exertion by which it is secured, are in some way useful to us?

We seek to know these things, it is true, from that insatiable curiosity *to know*, that seems to inhere in the human mind. We wish *to know*, it is said, from the pure love of knowledge, to gratify an irresistible longing, quite apart from any apparent use that the knowledge will be to us. This may all be true, and yet we come back to the inquiry, why does this curiosity exist? Why is there within us such an impelling force that pushes us into these unknown fields to search for hidden things, that when found, can afford us no profit? Surely, so strong a desire would not exist if it were useless to us; since if it were, its gratification could afford us no satisfaction, and therefore it would not be sought.

The desire for knowledge must co-exist with some benefit to be derived from its aquisition, even of that kind of knowledge that seems to be most completely dissociated from the affairs of life, as is the case with many subjects of scientific inquiry.

What, then, is this benefit? It may be very briefly stated. The inestimable advantage of knowledge and the seeking it is, that it teaches us the better how to live. It is for this reason that we seek knowledge, whether that purpose be distinctly formulated in our minds or not. It is for this reason that the mind seeks to know. The existence of this desire is proof of its truth. Surely, in a world in which the struggle for existence is such a manifest fact and where the weakly endowed must go to the wall, the continuance of such a desire and its continuance with an ever increasing intensity, could not be accounted for, except by some such explanation as this.

If knowledge and the desire to obtain it, could only be secured at the expense of retarding our efforts to live and to live better, it would long since have disappeared from the desires of men; in fact it would never have originated. It has come into existence and has perpetuated itself for the reason, that knowledge and the seeking of it, no matter what kind it may be, is an advantage to man; that by means of it his own development is the more complete, and he is therefore the better fitted for the performance of life's duties.

This is true of all kinds of knowledge, and it is especially true of what we call scientific knowledge—that kind of knowledge that this society seeks to disseminate. This may not seem perfectly obvious at first, but a little reflection will, I think, reveal its truth.

Now what is right living? This, I know, is an immense theme, and I am sure that you will not expect from me any elaborate treatment of it, even if I felt qualified to enter into its analytic examination. We may, however, for the purpose of this inquiry, arrive at some conclusion about it without such an examination. Right living, may then be said to consist in living in the most perfect accord with natural and moral law. With natural law, because this globe that we inhabit and that supports our life, is governed by natural laws; with moral law, because by means of moral law, it is possible for men to live together in society, and by this living together in society, the highest development of man becomes possible. In other words, the completest living comes from man being in the completest accord with his environment—an environment that is both physical and moral.

If we try to ignore the law of gravitation and jump to to the ground from the top of the house, we shall certainly suffer serious physical and probably mental injury also, if we do not lose life itself. If we pretend that fire does not burn, or if we are ignorant of this property of fire, and thrust our hand into the flame, we shall certainly be burned. If we grossly or only slightly violate the laws of health, the certain punishment of violation will follow.

And equally so, if we pay no heed to the rights of others; if we take what does not belong to us; if we pay no regard to truth; if we are selfishly self-seeking and unsympathic, retribution of some sort will follow—a retribution that will interfere with the satisfaction of living, and in so far, will make life incomplete and stunted. These things, when once stated, are obvious enough. We cannot expect to live a full and well-rounded life if we are out of accord with our environment; and in proportion to the deficiency and disagreement, is the measure of our life's incompleteness.

It is important then, nay, it is essential, in order that we may live a perfect life that we should be in perfect accord with our environment—that we should be in perfect accord with the physical laws of the universe and with moral law. It is in this complete adoption that perfection consists. Of course, in the present condition of things, this perfection is an ideal rather than an actual state; but although it be an ideal state, we may and do approach it as we understand more clearly and correctly these physical and moral laws, and thus diminish the possibilities of disagreement between ourselves and them. Whatever gain therefore, is made in a more accurate understanding of these laws, is a help towards right living; and as every contribution to the stock of knowledge does aid to the more accurate understanding of these laws, we may truthfully affirm that all such contributions do teach us, in some measure, the better how to live.

This object of purpose, as I have said, may not be present to the mind of the one who is seeking to extend his knowledge. He is stimulated by what seems, the pure love of knowledge itself. This is a sufficient incentive to exertion ; and this ulterior result may never occur to him; but nevertheless, at the bottom of all, lies this foundation impulse. The pursuit of knowledge is arduous and fatiguing. It is hard to think and hard to deviate from the paths of our predecessors, and unless some great advantage were to be gained by this labor and this deviation, they would, by the law of natural selection, have disappeared from the earth. The mere love of knowledge, without any results flowing from it, would have been insufficient to have preserved any ardor in its pursuit.

Unless this fact be clearly recognized, it is not easy to understand the value or the worth of many kinds of scientific research. We often hear people ask, "of what good is it to study such dry, uninteresting things? Of what value is it to the investigator himself or any one else?" One may be studying mosses ; another hammering away at some old rocks; another impaling butterflies or beetles, and the thought often arises in the minds of some—what benefit is there in spending one's time in such pursuits?

There are indeed many branches of scientific research, of which the immediate or the not remote advantages, are clear enough. The investigation of heat, and light, chemical composition, and of animalculæ as sources of disease, yield practical results of very great value and of the worth of which our own age certainly is not all sceptical. But there are many other branches of scientific investigation, so remotely allied to utility, that their pursuit cannot easily be explained on other grounds than those that we have named.

The instinct of self-preservation and the desire to better ourselves, stimulates researches in these seemingly uninviting fields, because extension of our knowledge in any direction, does help us to adjust ourselves more harmoniously with the environment that surrounds us. The more we know of this physical universe, the more perfectly can we make it serviceable to us, and therefore the better ordered our lives may be, in so far as we are more completely in accord with physical conditions, from which we cannot by any possibility escape.

When looked at in this light, the value of scientific knowledge is of the most solid kind. Each may be pursuing his own special line, never giving a thought to the basal motive that is quickening his energy; and yet every discovery that he makes, every addition to the stock of knowledge that he contributes, is a gift to the race, that by enriching it, helps the race forward. But in addition to this general result that follows from any extension of our knowledge, and which is the real reason why we seek knowledge, there are to the individual, collateral advantages of no small moment, that accompany its pursuit. I refer now more particularly to that knowledge that we term scientific.

A person cannot expect much success here unless he is thorough and possesses the power of patient, persevering investigation. It is useless for one to engage in this kind of work if he be easily discouraged and disheartened. The habit of persevering effort is essential if any real achievement be expected. It is only by slow accretions and from close and continuous observations that any real advance may be made. Labors of this sort must develop the mental qualities of thoroughness, persistence, and the power of close and prolonged application.

No one will question the great value of such mental traits. Their value is not only manifest in the special line of work in which they are acquired, but their influence is diffused over everything that we do. One is not content to do anything carelessly and incompletely, if painstaking and thoroughness have been directed to the doing of any one thing. In a world where a great deal of careless, hurried, superficial work is being done; where the training to fit one to do work is often so entirely inadequate, the dissemination of the traits of which we are speaking is a public benefit.

There is also developed an analytic power, the power of comparison, the power to distingush between real and false resemblances, to look behind the appearance of things and to discern the realities that belong to them. To this is allied the power of logical reasoning, by which irrelevant things may be cast aside, and the reaching of correct conclusions facilitated.

The worth of these mental traits is apparent. They are a safeguard against forming opinions from superficial data. A mind distingushed by these traits instinctively refuses to be influenced by appearances, and must, in order to satisfy its natural longings, analyze and examine. This deliberation and investigation, justly presumes the more certain avoidance of error, in whatever opinions or conclusions we may reach. That impulsiveness, so common to men, and which is still so strong notwithstanding the restraining influences of centuries of civilization, because it was one of the strongest traits of our early ancestors, is thereby checked, and the calm and surer, because slower conviction is secured. This judicial quality of mind is essential to a people living under a self-government, and in proportion to its more or less complete possession by that people, is the stability of the government measured.

There is also another and a very great advantage from scientific study, and that is a regard for truth, irrespective of any consequences that may follow its establishment. A person engaged in this study is engaged in a search for truth. The objects of his investigation are as a rule, though not always, dissociated from those things about which social, or partisan, or theologic controversy rages. He is prying into some portion of the world of nature about which the opinions and passions of men are not engaged. He is really occupied in a voyage of discovery, and generally speaking, he has a fair field.

There are, I know, some great subjects that excite bitter controversy. There were the Ptolemaians and the Copernicans; the cataclysts and the ants-cataclysts; the Darwinians and the special-creationists; and no one can deny, but that the subjects which gave rise to these opposing forces, fiercely aroused the passions of men. They aroused the passions of men, because they came in direct collision with established and cherished modes of thought, and beliefs; and when these are touched, the passions are at once kindled. But even when these controversies have arisen, the provocation from the scientific side has often been not a direct one.

The unsuspecting and careless reader of Darwin's first book, "The Origin of Species"—the book that precipitated the great ninteenth century revolution—would have discovered no cause of offense in it. It simply was, what is purported to be, a conscientious inquiry into the origin of species made by one who possessed in extraordinary measure, the power of patient, prolonged and accurate observation, united to a power of generalization seldom granted to the sons of men. No more calm or dispassionate scientific work was ever written on such a subject. It was a collection of facts accumulated during a quarter of a century, which led logically to the conclusion that the different specie of animals and plants had been developed from one another ; and the operation of certain laws that he named, accounted for or explained the wide variations. Man was not mentioned in the whole book. But many persons at once saw, that if the various kinds of animals, so strikingly different from one another, had arisen from some common progenitor, the logical inference must include within the operation of this law, even the highest mammal—man himself ; and hence the tumult.

I mention this not to give an exposition of the Darwinian theory, but to show that Mr. Darwin, when he wrote his celebrated book, was engaged in a disinterested search for truth. He was not assailing and he did not assail any existing beliefs. He was following a line of scientific research which he had fortunately discovered, the observed facts of which led him irresistibly to certain very important conclusions. But you see, that even in this extreme case, in which science stirred up a momentous agitation, the provocation was not direct, but indirect. In the great majority of cases, the search and the discovery of new truth in the fields of science, arouses no malignant passion, but only pleasure and gratification that an addition has been made to the stock of human knowledge.

Therefore I say, that the scientific investigator usually has a fair field ; he can pursue his researches undeterred by fear of consequences, for the more discoveries he makes the greater his fame and his reward. He and his fellow-laborers, if they are worthy members of the order, are trying to find out things as they are; and if one supposed scientific fact after another tumbles down as new revelations come out, why, this only causes general exultation and not persecution and abuse. Scientific research then does kindle this love of truth—of truth for its own sake; and this openness of mind is an admirable thing to possess and deserving of the widest encouragement.

Now these and other benefits that accrue to the individual engaged in scientific investigation—thoroughness, application, the power of discrimination, and of logical reasoning, and a love for truth for its own sake—are benefits—why? Why are they extolled and why do *we* extol them? Why are not slovenliness of work, inattention of mind, want of discrimination, inability to reason and indifference to truth, objects of eulogium, instead of their opposites?

There can be but one answer to this question. These qualities enable man to fulfill more completely the purposes of his being, they teach him the better how to live, by drawing out and developing those qualities within him which have caused his ascendency in the past and which must be retained and enlarged for his increased development in the future. It is this fact that gives to these attributes the merit that they possess. They are useful because they aid him to fit in more harmoniously with the world in which he lives, to adapt himself more intelligently to his environment, and this makes possible the higher development of himself.

These qualities of mind that are fostered by scientific study are valuable not only to the scientist, but they are of equal value to those in every other walk in life. In every occupation in which men engage they are useful;

but in none are they of greater importance than to aid in the proper discharge of the duties that devolve upon the citizens of a great republic. These duties, that are both political and social, cannot be indifferently done, without imperiling those favorable conditions that now make scientific research so easy and inviting.

The inevitable and unavoidable condition of man's advance, seems to be an ever increasing complexity. This conclusion may be drawn from a study of the phenomena themselves but not less truly than from the analogy of the world of nature. As you advance in the scale of intelligence, the more complex becomes the physical structure ; so that complexity and capacity seem to be indissolubly related to one another. The same law governs man's social advance. As a nation rises higher in the scale of civilization, the social and political structure become more complex ; indeed this very complexity is the evidence and test of an increasing perfection.

Now the maintenance of such a society presents ever increasing difficulties. The demands made upon civilized man to keep this subtle and nicely balanced framework together are continually greater. Every resource that he can lay hold of is therefore needed that he may fulfil the most important obligation.

Everything else is subordinate to this imperious necessity. In the earthly affairs of men, nothing rises higher than government, for government is essential that we may pursue our several callings, whatever they may be, in peace and security. The creation and maintenance of a stable society is the indispensible pre-requisite both for man's happiness and man's development.

Now as man rises higher in civilization, and as the social structure becomes more and more complex, it is seen with an ever increasing clearness, that on nothing does the stability of that society so much depend as upon the existence and extension of justice. This is not merely applicable to those forms of government that are called free, but to all forms of government. More than ever, no matter by what name it may be called, government rests upon the consent of the governed; and the willing and hearty consent of the governed cannot be obtained, if the government that seeks it, is in league with injustice.

Justice means that kind of legislation that recognizes and provides for the equal rights of all; not legislation for privileged classes, by which a few are benefited at the expense of the many; but a legislation that makes no envious distinctions and that therefore can excite neither envy nor hatred among those who are affected by it. This is the direction that governments must take, if they approach nearer and nearer to perfection.

A great self-governing society can have no other secure foundation than this; since in it there is no central, disciplined, irresistible force that can compel obedience. The obedience is voluntary and is based upon mutual benefit. If, by sinister influences, those benefits are unequally distributed, if they foster a selfish greed, whether of money or power or anything else, then injustice becomes predominate and the cohesion of that society is inevitably loosened.

Now this establishment of justice is a difficult thing. The selfish passions of men are strong—strong even in their gradual decline. And since the gratification of our selfish instincts, if freely indulged in, must often run counter to justice, every agency should be encouraged to repress their gratification, when this gratification is at variance with the public good.

There are no qualities of mind or of character more sure to aid in accomplishing this desired result than those that are fostered by the spirit of science. Candor, openness of mind, reverence for truth, discernment, the power of application and of logical reasoning, must certainly aid the possessor of them to understand what justice is, and with the knowledge of it, the disposition to practice it.

I do not mean by this that the absorbed student of science will necessarily have a juster political instinct than one who is not so occupied. A complete absorption in this or in any other pursuit, to the exclusion of everything else, may impair the judgment in matters outside of one's own special field ; matters that, for their proper understanding, require something more than a just instinct, but in addition an actual knowledge of the thing itself.

What I mean is, that the true spirit of science is in complete sympathy with honesty of mind, disinterestedness, fearlessness in the search for truth and in the utterance of it, an unquenchable desire to find out things as they are, no matter whether they accord with long existing practices and prejudices or not.

It is this very spirit that has already made this nineteenth century, and especially this latter half of it, a memorable one ; for it is a century of revolution. Revolution not less, but even more pronounced and real, than those revolutions that have made themselves memoriable by the shedding of blood. More than anything else in this result owing to the presence of the scientific spirit, which, having dared to pry into everything and having made some astonishing discoveries because of this courageous curiosity, has diffused itself throughout the community at large, and developed a tolerance and candor unknown to former ages.

This spirit is absolutely essential to the continued growth of man in the future. The theory of evolution has made it clear that there is no known limit to man's development. To establish this truth was a matter of supreme importance. This, once made clear, the direction in which to look for perfection was immediately changed. Formerly it was behind—but now it is before. The desire for perfection now lures us on, not back. Hence the importance of this disposition and this power to throw off any clogs that may hinder that advance.

What has existed and does exist, is no prima facie reason for its continued preservation. Its usefulness in the past does not of itself entitle it to an indefinite existence in the future. The importance of the theory of evolution as effecting human life is, that it gives us a reason for abandoning past usages without any offensive disrespect to the usages themselves. According to the laws of life they have served their functions—they have rendered useful aid to man at one stage of his growth; but through their help he has advanced beyond them, and they must honorably give way to their successors, whom they have as much called into being, as a father his children.

But though this be true, we all know perfectly well that it is not an easy thing to get rid of old ideas, practices, prejudices. They are never surrendered without a struggle and often a struggle so convulsive as to threaten the existence of society itself. And yet, if the law of evolution be true and we are to avail ourselves of it, these things must be parted with. If society have not vitality enough to get rid of them, when they have served their purpose, it is certain that such a society will decline. Revolution is preferable to death, no matter how much blood may be shed in it.

Fortunately these are not the only alternatives, there can be and there is the peaceful revolution of opinion, and to give strength to this should be the desire of every good citizen and every lover of his kind.

There are problems pressing on us for settlement today, that require all the openness of mind, discernment and patient attention that men are capable of, in order to solve them. The past cannot give us much help in their solution. The conditions are so unlike anything that have hitherto existed, that not by looking backward can we successfully cope with them; but rather by patient, frank, honest and thorough examination, putting selfishness and prejudice more and more in the back ground, and cultivating a disinterestedness of mind that will cause us to seek and to accept whatever determination seems best fitted for the public good.

Public questions must be looked at more and more in this way, if we hope to settle them on the basis of justice; and it is only by this settlement of them, that the increasing complicated structure of modern society may be expected to endure. The equality of human rights was never less of a theory and never more of an ardent, burning desire to make this theory a reality than to day. To make it a reality without endangering the structure of society, will demand the highest wisdom that man has yet been called upon to exhibit; and we may safely say, that the attainment of this wisdom will be greatly aided by the cultivation and diffusion of the true scientific spirit—a spirit that seeks above all, the light, and will follow wherever it leads.

At the conclusion of the paper, Prof. Cooley added some notes suggested by the subject. Donations were made to the Museum of one pair of Indian moccasins, from the Lake Superior region in 1842, by Mrs. Levi M. Arnold; and a portfolio of photographs by Mr. Benj. Fowler.

DECEMBER 15, 1891—SECOND REGULAR MEETING.

Present, Chairman Edward Burgess, and Members Elsworth, Cooley, Neumann, Van Gieson, Warring, Sutcliffe, Mosely, Bolton, C. N. Arnold, and visitors.

JANUARY 26, 1892—FIFTH REGULAR MEETING.

Present, Chairman Burgess, and Members Van Gieson, Cooley, Elsworth, Neumann, Sutcliffe, Albro, Elting, C. N. Arnold, and a large number of visitors.

Dr. Theo. Neumann presented the following paper, entitled :

UNIVERSAL LANGUAGES.

The more commerce and international relations have increased on earth, the greater has become the necessity for all nations to find a means of mutual understanding by virtue of a common language.

A few words about the origin of language will perhaps not be out of place. Is language anything new, belonging to man alone during our cosmic development, or are we allowed to speak of the language of animals? Savage tribes consider the existence of such animal language as evident, and numberless fairy tales give us account of magic means through which man may be enabled to understand the language of animals, as Melampus, the Greek, who is said to have spoken the tongue of the wood-beetles, or the Nordic Sigurd, who could understand the talk of the birds.

A difference must be made, however, between "language" and "ability to communicate." The latter is surely developed more or less in nearly all animals which live sociably, and we may then distinguish three forms, the language of sign, or gestures, communicated through the sense of sight, the language of sound, affecting the sense of hearing, and finally the language of touch, which can be used only in immediate contact, as ants are said to have worked it out to a very high degree of perfection.

Man himself makes use of the latter, the language of touch, in a few cases, for instance in shaking hands, which may be done to indicate friendship, love, as well as any other emotion, but only two, the languages of gesture and of sound, have been developed by the human race to any higher extent, and we notice without difficulty, that the latter is gradually suppressing the former, as the point of culture and civilization becomes higher and higher.

In general, the languages of sound with animals, are mostly languages of interjections, *i. e.*, they consist of single exclamations expressing a certain state of mind, and are used by more highly developed creatures, to give signs of warning, to cry for help, to express joy or grief, etc., and as such they may be termed universal languages, as they are, on account of their very simplicity, understood everywhere.

The barking of a dog is unusually rich in such different sounds, and the language in which man must speak to such an animal as well as to very young children, is essentially such a language of gesture and interjections. Such creatures, whose organs of speech and intellect have not yet reached any higher development, would understand no other. Doubtless the language of primeval man was of the same character; the language of gesture must have formerly served as a far more important means of communication than it does now when an educated man scarcely moves his facial muscles while speaking. But if we go down to the lower classes of any nation, we find in the conversation very expressive pantomime, so much the more expressive, the more lively the temper and the less accomplished and the poorer in words the language of those who want to converse. With many wild tribes the few words which their language possesses receive their necessary explanation only by means of pantomimes and gestures. We are able to know from the latter only if the individuals speak of themselves, or in the second or third person. In the Turkish language a certain word means "no" when accompanied by a backward moving of the head, while the same word means "yes" when the head is shaken just as we shake it when emphasizing our "no." The old Mexicans flapped their ears in different directions and thus added many meanings to different words, while the Peshera in South Africa have their name from this very word "Peshera," the only articulate sound they are able to pronounce, to which they give various meanings by gestures, distortions of their facial muscles, etc.

Nowadays we can see how any uneducated, ignorant sailor knows how to get along with representatives of nearly every nation on earth by means of mimicry and gestures, and a visit to South Street, in New York, well rewards any observer who keeps his eyes open. The same often exceedingly ludicrous performances take place on board of any transatlantic steamer, whose steerage passengers hail from every corner of the globe.

All these so-called languages are, however, an inferior way of communication, and when we speak of universal languages, we must think of such as are actually spoken by more than one whole nation. A universal language must serve as a means of intercourse, commercial, scientific, social intercourse, between several nations of the globe; it must bring them nearer together, must establish closer ties than any other thing would do; it must cause them to understand each other better, affect their respective way of thinking, doing and living; in short, it must act as a spirtual link from mind to mind in the highest sense of the word.

Of such languages we find several, not only during the present period of history, but also in times long past, when neither commercial nor scientific nor social bonds united the nations so closely as we find them now.

There is indeed a marked difference between the ways in which the universal languages of ages past were spread out. International commerce, a factor very peaceful indeed, obliges nations to-day to seek a means of mutual intercourse, while during the ages of antiquity conquerors marched out in order to subdue whole continents and to force their language upon the nations who yielded to their swords. This is the case with Alexander, the Great, who carried Greek culture and civilization across the whole Orient far into Asia and to North Africa ; the same holds good of the Romans, who spread out their power at first by means of the sword, but then sent peaceful colonists after their victorious eagles who gave Roman language, Roman manners and customs to the subdued nations.

Thus the ancients possessed two universal languages, the Greek in the East, the Latin in the West. But the Greek had gained greater importance than being only a means of intercourse in a great territory ; it was the language of philosophy, which for the first time was treated as a separa'e science by the learned Greeks. The young Roman nobleman, who sought finer education, went to Greece in order to visit the schools of the philosophers there, and if we want to give the name philosophers to the Roman Eclectics, we must keep in mind that they were pupils of Greek philosophy, which had come to the very gates of the Roman capital, conquering the minds by the superior power of its intellect and art. So we have the strange spectacle of a mutual conquest, for while the Romans carried their victorious eagles to the South of Italy, which was then occupied by Greek settlers and only a Greek colony, while they went across the Adriatic and subdued the Hellenic peninsula, Greek art, Greek science, Greek intellect, gained a decisive stronghold in the very heart of the Roman empire, even to the neglect of the Roman language, for often it happened that young nobleman, educated by

Greek slaves acting as masters, spoke Greek better than their Latin mother tongue. Cicero went to Athens in order to study, others sent their sons there just as we now send our sons and daughters to Paris and Berlin to be educated, and learned men in Rome preferred to speak Greek just as we find similar conditions on the European continent now where we may find whole nations, or at least whole classes of them, that speak an adopted language, not their mother tongue.

Thus Greek became the language, not only of commercial intercourse in the Orient, all over the Adriatic, in Spain and Southern France, everywhere where Greek colonies had made their appearance, but it had developed as the language of all the thinkers of the world. So it is clear that it became by necessity the language of the world-moving doctrine of Jesus of Nazareth. Indeed, the latter did *not* teach in the Greek language, although he knew it, but being obliged to address the humbler class of the people, spoke Aramäic, then the principal language in Palestine. But those who spread his doctrine by writing as well as by oral teaching and preaching, could necessarily use only the finely developed Greek language, and wrote their epistles in it. So the New Testament has, with a few exceptions, come down to us in Greek from beginning to end, and most of its parts, to the writing of St. Paul, are preserved with their original features. Could it be otherwise? A universal religion, for as such Christianity appeared at once in opposition to Judaism, was obliged to use a universal tongue, and that was the Greek.

Meanwhile the Romans had conquered nearly the whole Orient, and they were nearing the time when they could justly consider themselves as masters of the whole world (then known.) Palestine was a Roman province when Christ was born, and when the Roman Emperors had embraced the Christian religion themselves, and declared it the official religion of the empire, it soon conquered all the other nations, even those who had not accepted the Latin language in exchange for their own. Especially in the West and the North of their vast territory Christianity made rapid progress, in many cases reversing the order of adoption, for the Latin language was not always the means of carrying Christianity; on the contrary the latter helped to spread the Latin language, so that toward the fifth or sixth century it was just as much a universal language as the Greek had been before. This importance increased until the tenth century; wherever Roman Christianity penetrated it brought with it the Latin language, the authority of the Bishop of Rome (the Pope), the church fathers, and above all the Latin Bible, the Vulgate. We know that in the eleventh century in Ireland and in Greenland even Mass was read in Latin, just as well as in Italy, or France, or Germany. The expansion, however, of the language went further still. In consequence of the close connection of clergy and throne the emperors and kings used Latin in communicating with each other, and since the times of Louis XI, of France, when regular diplomatic intercourse was established between the different governments, Latin became the language of diplomats all over the civilized world.

The Latin language gained its greatest splendor in the time of the Renascence, that revival of the classical antiquity in science and art since the fifteenth century. Just at that time when the victory of the Roman or Justinian law over the individual laws of the different nations was completed, the Corpus Tunis became the sole resource whenever questions and doubts concerning law had to be settled. It was the "written reason," and has been considered as such up to date in nearly all civilized countries. The Renascence added its influence to this. It stirred up the whole intellectual world of Europe in another direction, for originating in Rome, a flood of learned men swept over the continent, whose common language was classical Latin, and the emotion caused by that rush has not yet subsided to the present day. For several centuries the lectures at the universities were delivered in Latin. They were bold, audacious steps when Chr. Thomasius, in 1687, delivered the first lecture in German at the University of Leipzig, when Chr. Wolf, in Halle, wrote his philosophical works in the same language, and when, after all, a whole university, Göttingen in Germany, after long and fierce struggles, resolved that all professors should deliver their lectures in German. Still to-day we can find many colleges and universities on the European continent where Latin is the official language of intercourse between officers and professors of the school and the students, and the lectures of most theological seminaries are still delivered in Latin.

Another lasting sign of the powerful influence of Latin is found in the circumstance that the prayer-books of the Roman Catholic Church are still in that language. While evangelical churches claim that prayers, hymns and church songs must be written in the languages understood by the communities in order to be sung cheerfully and with enthusiasm, the Roman Catholic Church points out that wherever a member of the church may go, either in his own or to a far distant country, he will always find the same Latin liturgy of the service, and the same hymns, facts which must bind the members of the church far closer together, however widely they may be scattered.

Meanwhile the Modern Spirit moved and developed powerfully, and even the universal Latin language was not sufficient to express those world-moving new ideas, those powerful new thoughts, those new facts which marked so decisively the beginning of a new era. The first European language which gained prominence by this natural process of development was *French.* Many reasons account for this. When Latin still was the language of diplomats, there was one group of society which kept itself exclusive, the knighthood. The knights, especially the French-Provincial knights, formed a state of their own with distinctly fixed ceremonies, with distinct ways of thinking and living, distinct aims, intentions and occupations. Knighthood furnished the material for chivalrous poetry and shaped it, and the German, English, Italian and Spanish knights were obliged to learn French and Provincial in order to be able to understand and to perform that wonderful art of minstrelsy, whose cradle was in Southern France, where it also matured its tenderest, most brilliant, most exquisite blossoms. What a power that chivalrous French possessed may be seen from the fact that certain poetical subjects, such as the story of King Arthur and his knights, went from Great Britian to France and returned to their mother-country in foreign, in French garment. Here, in this circumstance, the French knights protecting and developing their own language, we find sufficient reasons for the dominating position of the French language, and this position was moreover splendidly maintained by William of Normandy when he conquered England. The wars of the French kings in Italy, which followed then, and which lasted many centuries, the close relation between France and England extended also over many generations, did more to establish and to strenghten the universal dominion of the French language. We must keep in mind, moreover, that the political preponderance of France during the the 15th, 16th and 17th centuries forced the other nations who sought intercourse with her, to learn that language. French became the universal language of diplomacy, and it has retained this position up to date. And truly, few other languages offer equal advantages in beauty, simplicity and precision of expression. One of the statesmen of France is reported to have said: "God has given us the power of speech so that we are able to hide our thoughts." This will not hold good for the French language. On the contrary, for all negotiations and treaties, shortness, clearness, precision is wanted, no doubt must be left, no uncertainty must arise as to the meaning of a word or a whole sentence, so that all future explanations and arguments may be unnecessary—and these advantages the French language offers in a very high degree, so that it takes its place rightly as one of the universal languages of the world. Another reason for the spread of the French language was the florescence of French literature during the 17th and 18th centuries, and its influence upon the educated classes of all nations. This influence was so powerful that in Poland, for instance, a danger was threatening that their own language would give way entirely to the new comer, and to-day we still consider Poland as the second home of the French language.

Yet in spite of these mighty factors its reign could not last forever, it did not stand upon the foundation which alone in modern times can grant supremacy. French may be the language of society, of the men of science and art, but the moving spirit of our times is commerce and international intercourse.

Since the discovery of the New World the fetters, which limited the free intercourse of the nations of the globe, were one by one broken down, until even the remotest parts of the earth participated in the blessings of a free and easy communication. Even before the event just named, the discovery of America, the Portuguese had set out to circumnavigate Africa and had brought their language to all African shores and even to East India. Yet it was another sea-faring nation, kindred to them, who founded a world-embracing empire, on which, as their kings proudly used to say, the sun never went down. It was the Spanish nation, whose language became then and is still a universal language in many parts of our planet. Nearly the whole continent of South America, the Antilles and Central America became Spanish, as well as the Philippines in the far East and other islands in the Pacific. The great difference between Portuguese and Spanish colonization, and therefore the simple explanation of the better success of the latter, was the circumstance that the Portuguese settled only along the coasts of the countries they occupied, in Africa as well as in India, partly yielding to the power of adverse events, partly on account of their near-sightedness and carelessness ; the Spaniards, however, at once endeavored and succeeded in penetrating the whole interior of their colonies, thus gaining a territory many times greater than the small coast strips the Portuguese inhabited. In consequence of this, Spanish has become a universal language which we hear on all the oceans ; a whole continent has taken up the Spanish language, besides numerous groups of islands and smaller colonies, and a rich and highly developed literature forms the intellectual background, without which no universal language can be imagined. The great ease with which other Romance nations, such as Italians, French, Portuguese, are able to acquire a knowledge of Spanish, has contributed not a little to its dominating position. It is a universal language in the highest sense, and its powerful influence in South America is so great that the very Indians have learned it and use it sometimes exclusively, or at least in connection with their own tongues.

Yet Spanish is not the language to which the palm must be attributed. As rulers of the Universe the Spaniards have been followed by the English. It is but fair to state that there was another nation which for a short time during the seventeenth century had gained a brilliant development of commercical and intellectual life, the Dutch or Netherlandish nation, whose language might just as well have gained a universal position, not only on account of its simple construction, but also especially because it holds an intermediate place between English, German and the languages of the North of Europe, Swedish, Danish and Norwegian. It would consequently have well been adapted for a wide circulation, and as moreover just at the time mentioned, Dutch literature, art and culture had gained a very prominent position, all conditions were given to develop it into a universal tongue. But the florescence of the Dutch nation was of a comparatively short duration only, too short for giving it time to gain root among other nations and to spread. The astonishingly rapid development of the English nation pushed the Dutch back and placed the language of the former in the foreground.

The defeat of the Armada, the deliverance from Catholicism and Spain, marked the political and intellectual development of Great Britian, and hand in hand with this went the exceedingly rapid spread of the Anglo-Saxon race which, carried by an unsually high self-consciousness, forced other nations in a way never experienced before to adopt the English idiom. In more than one case it was actually a struggle for life: adopt our language or go down, and nowadays we can witness all over the earth that wherever the English establish their rule, they bring their language with them; not contented to use it among themselves, they force it upon the natives who have no chance whatever to choose. Thus Anglo-Saxon culture and English language emigrated into its second great realm, North America, with those stout-hearted men, the Puritans, who left England after the revolution; in English ships their language came to the Cape Colony; English seamen transplanted it to Australia, and to East India, the possession of which makes Great Britian the ruler of the waves and elevates it to one of the first powers on both hemispheres. In East India where we find only about 150,000 English to two hundred million native inhabitants, the official language of government, administration, commerce and intercourse is English. Anglicized are the members of *all* nations that emigrate to North America or Australia, and with *great difficulty* only foreign idioms are preserved here and there in small spots within *one* household, while the settlers are forced to use English as soon as they step outside their threshold. And even inside the house we do not find the other idioms kept pure and unchanged—proof enough for instance, the Pennsylvania German, the French in the South and the Swedish in the Northwest: "Putten sie das noch a minute in die Eis-box"—"feeder les chickens," etc.—what a mixture! All over the world English is now the key-stone of mutual understanding, and even such nations as the Germans, who have now colonies of their own, are obligedto learn English in order to speak with the natives, who, if they know any but their own, know only the English language.

But is it deplorable that the foreigners must learn English. In their literary inheritance the readers of the English language are among the richest people that the sun shines on. Their novelists paint the finest portraits of human character, their historians know the secrets of entrancing description and of philosophical narration, their critics have acumen, their philosophers probe far into the philosophy of mind, their poets sing the sweetest songs. And as to Shakespeare, is not his name the greatest in English literature, perhaps the greatest in all literature? No man ever came near him in the creative powers of the mind; no man ever had at once such strength and such variety of imagination. Are not the works of our immortal William alone worth the study of the English tongue?

We must not believe, however, that English is *the* universal language now, although the two or three others which must be mentioned, have either not yet attained their highest development or lie so entirely outside of our sphere, that we need but consider them in passing.

A careful observer must have noticed that in Asia, especially in the interior of its northern parts, Russian is on the best way to become a universal language. In fact, we do not very well know what is going on there now, thanks to the excellent work of exclusion towards outsiders which the Russians have been establishing for some time, and so whatever events and occurrences happen there they are hidden from the observing eyes of the rest of the world. This much is sure, however, that the Russians with their rule also bring with them their language. Thus the subdued tribes, at least those who want to have any commercial intercourse with Russian merchants, or such as must communicate with the authorities, must learn Russian, and the Russian garrisons spread all over the vast country where their eagles dominate, contribute a good deal to the further extension of this most important Slavic idiom. We may think whatever we please, little or much, about Russian literature, which is only beginning to grow and to develop its peculiar features, but it cannot be denied that it presents already works of great and wonderful poetic power, and the facts that the writings of Turgenieff and Tolstoi are being translated into all the languages of the civilized world, are proof enough that the Russian language occupies already a prominent position among others. As far as we can say, that language will soon be one of the most important and far-reaching languages of the globe. It may be surprising for many to hear another language mentioned, of which nothing but its name may have been heard, and which is indeed so very much outside of our sphere that ignorance concerning it is not only pardonable but a matter of course. It is the *Arabian* language. That tongue is, and has been since the seventh century, when the Arabians began to develop their own peculiar ways of culture and civilization, one of the, or rather *the* universal tongue of the Orient. Arabian science, especially mathematics, poetry and historiography, and above all, their religion, Mohammedanism, showed forth such an innate power that their language also soon became universal, and this position it maintained and confirmed during the middle ages. It penetrated as far as Persia and India, along the south coast of the Mediterranean into North Africa until it reached Spain, and on the northern coast of the same water over Syria to the Balkan Peninsula. Arabian influence was felt even in Rome, and for several centuries the learned men of the Orient and such as wanted to study the deepest problems of Philosophy, Geometry, Algebra, Astronomy, Anatomy, Hygiene, went to the seats of Arabian universities where the stream of knowledge issued forth in pure, strong, unadulterated, uninterrupted flow. To-day Arabian is one of the most important universal languages, just as Islam is one of the great religions of the world, one supported by the other, and supporting it in its turn just as Christianity and Greek belonged to each other. The Koran is written in Arabian, and other documents of Arabian literature have been of the greatest significance for the study of mankind and universal literature. It reached its highest development after Mohammed, and those scholars of our days who succeed in mastering that language, cannot tell us in words enthusiastic enough what splendor, what delicacy, what tenderness, what strength is put down in all those love songs, those heroic melodies, and in those hymns which sing of spring and youth.

Besides these universal languages, spoken by entire nations and showing a gradual development in form, sometimes reaching back many centuries, we find during the last two or three hundred years several attempts of learned men to create an artificial universal language. It is apparent that the problem of universal speech, the importance of possessing a language for international use occupied the minds of many eminent philosophers, and numberless are the efforts to produce such a language as might be acquired and understood by all the nations on earth. The desirability of such a means of international communication, and the actual need of it became more apparent during the nineteenth century, in which so many barriers of time and space were thrown down, in which many marvelous inventions brought together the remotest peoples of the globe, and in which the international intercourse in commerce, scientific interchange of thought, travel and many other relations in which language is an essential factor of convenience and benefit were raised to such unexpected height. The objections to natural languages, for the purposes indicated, were manifold and insuperable—inherent difficulty and national rivalry being the prominent objections. Thus, the immense advantage that would follow the general adoption of an artificial universal language was readily seen. Not a single one, however, of the numerous inventions had any practical value in the direction of solving the vexatious problem, until Johann Martin Schleyer, a German clergyman, conceived the thought that to be practicable a world language must be easy of acquirement in its pronunciation, simple in its construction, regular in inflection, comparison and conjugation, logical and expansive in its derivation, and must embody in its method the best feature of synthesis and analysis. His quick perception, his retentive memory, and his untiring industry had enabled him, during thirty years of study, to master the grammatical structure of sixty-two languages and dialects, and his analytical mind was ever busy with the assortment of these languages into relations of correspondence. This knowledge enabled him at the same time to prove the often heard statement that the purpose of a universal language is to supplant all existing languages, to be the outcome of a misconception. He saw and knew clearly that no artificial language will ever supersede the languages of the earth, nor even a single one of them. Its aim can never be to supersede, but to supplement, to provide a means by which the races of mankind may become intelligible to each other *while retaining their mother tongues.* After years of wearisome work, often disgusted and discouraged, and many a time nearly giving up, Pastor Schleyer presented to the world in 1879 his new language, Volapük. But even then he was not favored with immediate success. The influence of many previous abortive attempts was felt in preventing an impartial investigation of its merits, and for several years it was either ignored by the world of learning or spoken of with ridicule. Slowly only it made its way, it gained strongholds here and there, found the approval of eminent philologists who commenced its propagation, until in 1889 Professor Ellis, president of the London Philological Society, was justified in saying: "Volapük is no longer an experiment; it is a living, spoken tongue!"

It spread rapidly to nearly all the countries of Europe, crossed continents and oceans, and set up its standard in China and Japan, and within a few years from the first impulse given it, every civilized nation of the globe had accepted Volapük. In 1885 an academy was founded to supervise the interests of the language and this academy was made international in 1887. The capability of Volapük to express ideas has been demonstrated variously. One of the most significant experiments was made by Dr. Böger, of Hamburgh. He requested the Echo, a journal published in Hamburg, to select an article from its columns. This he translated into Volapük, and sent the translation to a Volapükist in each of sixteen countries, and each made a translation into his own language. Each of these translations, without its Volapük equivalent, was then sent to a native of the country in whose language it was written, and was rendered by him into Volapük. These sixteen Volapük translations were then compared by Dr. Böger with his own Volapük rendering and were found to be almost identical with it, in no instance showing the slightest difference in sense. It is doubtful if such a test with any other language would show a similar result.

There remains one thought to be presented, a thought that was prominent in the mind of the inventor of Volapük, and which those who have the fraternity of mankind at heart, never place in the background when discussing Volapük. If it is time that English unites the English, German the Germans, and each language those who use that language, the legitimate influence of Volapük is to bind all the nations together in common brotherhood; and already that influence has been felt in significant measure in the international correspondence which, as a means of practice of the language, has been availed of, with the result of bringing into amicable association millions of people of every race and clime.

FEBRUARY 9, 1892—SIXTH REGULAR MEETING.

Present Chairman Burgess; Members Elsworth, Cooley, Reynolds, Sutcliffe, Winne, R. E. Taylor, Warring, Dwight, Van Gieson, Herrick, Ward, Bolton, C. N. Arnold and a large number of visitors.

Mr. John Sutcliffe presented an interesting paper on "Mining", as follows:

MINING.

In presenting the subject of mining before you this evening, I shall not attempt a general historical or scientific discourse upon this ancient and important department of human industry, nor attempt to show the leading part it has played in the discoveries, development and progress of this world. The subject (like the business itself) would be *too deep*, too extensive, and too intricate and too intimately connected with the very formations of the crust of the earth upon which we live, and the wants, conveniences and luxuries of mankind in all ages. It would require more time and a greater knowledge of history, science and philosophy than is at my command, to enable any one to do justice to the theme as a whole—therefore the subject of mining presented this evening will be simply treated from a business point of view, and will consist of a brief description of operations and incidents which have come under my personal observation during the past thirty years of actual business, as mining engineer and manager in various parts of this Continent, with such remarks and rules of business deduced therefrom as may occur to me.

In undertaking the task, at the request of our worthy President, only a deep sense of duty, as a member of this society, impels me to its performance, trusting the members and friends present will have patience and charity, if the subject is treated in too personal and crude a manner.

Mining life is not well adapted for the cultivation of rhetoric or belles lettres. The language of mining communities is generally more forcible than refined, and of few words, and a residence of thirty years principally among such people, ten years of the time among people who did not even speak our language, prevents me from being able to clothe my ideas with words which clearly express my meaning and at the same time please the taste of an audience in this City of Schools and Colleges; especially is this so, when the technical names of Science are required. In pleading the baby act, there is no desire to prevent criticism or discussion, as that is the very thing to be desired in a society of this kind, and on occasions like this.

Truth is what we are seeking for, and it is your right and duty to examine every phase of the subjects presented before you with impartial and unbiased minds, keeping the truth always in view as the objective point of all endeavor.

Such a state of mind must exist in the management of all operations of life in order to win success; bias personal feelings, and pet theories must be controlled and only actual facts *govern us.* The inability to act upon this vital principle has been the ruin of countless projects in every department of life, and calls for especial care in the management of all mining operations.

The main object of mining is the pursuit of wealth—money making.

All kinds of occupations have some end in view and to insure success the objective point must never be lost sight of, and everything must be used and subordinated for that one object. This principle object must never be lost sight of in the mining business.

In the practical operations necessary for locating, opening and managing mines, more general knowledge of the various trades and professions is required than for any other business, and those who undertake the management ought to be well informed, theoretically and practically, in everything relating to or affecting the business in any way, in order to be able promptly to use every possible means in nature, mechanics, science or government, necessary to meet and overcome emergencies and difficulties of all kinds to which this business is always liable.

The mining business requires a great many trades and occupations in its operation, and mines are so situated that all have to be under the control of the manager, and ready for immediate use, and in the nature of the situation this can only be accomplished, in many cases, by having a manager who embodies in himself a general knowledge of all these necessary qualifications. This important fact is often overlooked or set aside in appointing managers, and when difficulties arise the enterprise suffers great loss, or perishes from want of prompt means for overcoming them. A man may be a good practical miner, a good mechanic, metallurgist or mineralogist; may have graduated with the highest honors from one of our many invaluable mining schools or colleges, or may have had long experience in actual mining operations, and yet be unfit to manage and control an extensive mining enterprise, owing to lack of indispensable business qualifications, the ability to control himself, his own feelings and inclinations, to keep always before his mind the sole object of the business as far as he is concerned as manager, and to utilize everybody and everything and direct all to the end in view. A specialist never makes a good manager. A good manager requires to pick out specialists to fill positions in the various branches of the business and only requires general but correct ideas and general knowledge of all branches, and of human nature, in order to pick out the most suitable person to fill the special positions fully, so that the manager can always be at liberty to devote his attention to every part without being trammelled by the detailed duties, which would prevent that freedom of mind and body which "eternal vigilance"—the price of business success as well as the price of liberty—requires.

When mining operations are conducted upon sound business principles, they are as safe and free from great risks as most other manufacturing, mercantile or commercial businesses, if undertaken in good faith and carried on in a legitimate manner. The choice of location, mode of development and prosecution of the work, choice of officials and employees, processes, machinery, tools, etc., all are of great importance in starting, carrying on and organizing the business, and ought to be decided upon only after carefully examining and looking over the whole situation and taking into consideration all surrounding circumstances affecting the business generally, especially the particular mine or mining location under consideration.

Every mining operation requires special treatment of its own, even when in the same district and when the same kind of mineral is being mined and reduced by adjoining mines. The same course of working, or treatment, may not even be suitable for different parts of the same mine to obtain the best results, and different localities may require different methods entirely for carrying on the business, even when the mineral and general character of the mines may be the same. Fuel, water, climate, transportation, market, labor and government, are all important factors and must be taken into consideration in making up the plans of operation. Many good mines have been ruined by management which failed to comprehend and apply the necessary means suitable to its own surrounding circumstances. Of course all mines cannot be worked at a profit, no matter how well managed, but all mining enterprises can be so entered upon and conducted that the losses can be kept entirely under control, and the risks very correctly estimated before hand, unless in case of accidents or outside causes, to which all other businesses are subject, and over which no manager has any control.

One of the great mistakes of the mining business lies in taking for granted all the possibilities or probabilities of the future development of the mines, and spending large sums of money upon permanent improvements, before actually exploring and developing the mine, for with all the skill and experience the best mining experts possess, it is impossible, at the present time, to determine, definitely and surely, what is contained beneath any part of the crust of this earth before piercing it, and actually seeing it. It can be estimated with more or less confidence by the intelligent and experienced mining engineer, but the only safe and sure way is to open up the ground by uncovering to the solid rock, by sinking shafts and driving tunnels, or in some cases by using the diamond drill.

Even with all these necessary precautions it is best to proceed with care and use the old proverb: "Time is money," as the Mexicans understand it—which, like a great many other things one finds in Mexico, is diametrically opposite to our ideas; the proverb as understood in Spanish is that by taking plenty of time, money is made or saved, and really means "waiting is money." The mining business turns a great many of our old proverbs upside down.

Thus we say "Get a cage before a bird"; but in mining the great thing to be secured is the bird, the cage can be got at any time; and one of the great causes for mining companies' failures lies in getting great cages before having anything to put into them.

A few hundred dollars judiciously expended and a few weeks waiting for results would save both time and money under the best conditions and often save the enterprise itself, for very many really valuable little mines that could be worked at a nice profit in a small way, are swamped by excessive expenses occasioned by too large a plan of operations, and sometimes large mines are worked at a loss, and finally abandoned by not having a plan of operations large enough to develop and utilize their large resources. Some actual mining operations will be described later on to illustrate what is meant by these statements.

The obscurity and uncertainty attending mining operations, owing mostly to the out-of-the-way places in which mines are located, have always given to the mining business a sort of gambling character that has attracted the venturesome and reckless classes of mankind. This has had a corresponding effect upon the whole business in all ages, never more noticeable than in our own times, since the discovery of gold in California. This gambling element has been the cause and means of the great growth of the mining business in this country, with all its attending circumstances of good and evil. It was the prime cause of the Spanish discoveries and conquests on this hemisphere, but is the bane of all real legitimate mining operations to-day.

Mine gambling requires different qualifications for its operations than real mine working, in fact it is gambling of the worst kind. Success is not left even to chance and the very worst side of the gambler's character is required for successfully managing the mine gambler's business.

The Gambling Mining Company organizers and managers do not require real mines. Mining *prospects* are of far more use, especially if in the neighborhood or adjacent to some well paying mine. They are gamblers and require all the qualities of heart and mind of gamblers, and more too, for a gambler may deal fairly and honorably with his associates, or even with the public at large, in order to be successful in his profession and enjoy an honorable reputation ; but of all the ways that are dark, that of the dishonest mining manipulator is the darkest, and those who enter his net may well leave hope behind.

A knowledge of human nature and the science of gulling the public are the great requisites for managing this deplorable branch of the mining business, whose object is the obtaining of wealth for themselves, not by abstracting it from the pockets of a mine, but from the pockets of the public, using the mining operations only as a blind to attain the ends desired ; and it is a sad fact, that many highly respectable and apparently honorable men, occupying high positions in public, professional or private life, lend their names to be used in such enterprises to assist in this *confidence game.*

The character of the mining business and the surrounding conditions under which its operations are carried on also enables it to be used for speculative and fraudulent purposes, and its loss or gain to be kept secret more than most other public businesses.

This is a great temptation to those in immediate control of the management and operations to take advantage and rob their co-partners or the public generally, even when such operations have been started and operated in good faith.

Especially is this true where largely stocked companies and unknown stockholders are concerned, and in the present state of the public conscience as represented by expressions of public opinion in society, the newspapers, the verdicts of juries and the acts of legislatures, and even of our courts of justice, such acts of theft, or in polite language, *breaches of trust*, are not looked down upon as they ought to be, but on the contrary the successful scoundrel is worshipped and applauded like any other hero, and really looks down upon and despises less wealthy persons who have not taken advantage of their position to obtain wealth at the expense of honesty. It is an old saying that corporations have no souls, and are they not generally treated as if they had no rights ? Not alone is everything considered fair in love or war and politics, but also in dealing with the public in any corporate capacity, whether for business or for government. This is all wrong and will ruin the strict sense of honesty in any people, and destroy business and government as well, and is especially bad for the mining business on account of the impossibility of seeing what is being done under ground, or judging of the conditions of the mine at any time except through the reports of the manager in charge. All mining operations, especially below ground, have to be entrusted to the honesty of employees, and when dishonesty rules the head the rest of the members are apt to follow the lead, and distrust takes the place of confidence throughout and ruin must follow, sooner or later, as a matter of course.

Mining populations are generally very cosmopolitan, and possessed of great individuality. Human nature is met, stripped of its covering of polite and cultivated attempts to appear in the reigning moral fashion—human nature is seen in the rough—men and women are generally known and taken for what they are worth, and their characters are very clearly defined. A keen insight into human actions is the natural result of mining experiences. There is no use in putting on airs or pretending to know more than you really do or to hide your real character, for it will all come out in a very short time, and you are named, classified and weighed up so quickly that it is astonishing to the *tenderfoot*. The unassuming man is the most deceptive man in such a community. There are found some of nature's noblemen, real self-made, honest and sympathizing men, educated by contact with nature and their fellowmen. Again, some have had college educations or have been raised in the lap of luxury and refinment, others have been dissatisfied or unfortunate in other walks of life, but all have drifted to the mines in search of fortune, adventure or seclusion, and becoming infatuated with the free, wild life of the mining regions, have followed the bent of their own inclinations or given themselves up to the current until they are uncomfortable anywhere else, and so drift about from one camp to another as agents for good or evil, making up the well known characters of mining regions and crystallizing into rich mine owners, ranch owners, mine managers, mining cranks, prospectors, saloon keepers, stage drivers, gamblers, sharpers, desperadoes and bummers; all are known, and strangers are soon sized up and take their places among their class, and are generally well known for all they are worth. Now among these denizens of the mining regions the moral law is quoted in many ways to suit the requirements of different communities and to ease individual consciences—hypocrisy being generally looked upon as one of the worst sins known, in fact, as the unpardonable sin. Principles are flung out to public view like flags (à la Bob Ingersoll), and then the followers of the flag or principles are easy in mind and conscience, and at least fully represent all they profess. As an example of this assertion, I beg to mention some of the versions of the golden rule as used in this manner, which I have named and described, thus:

1st—The Christian version, representing the era of spiritual manhood, the pure gold lying in the bed-rock of christianity: "Do unto others as you would they should do unto you."

2d—The old law—the animal representing the era of mammals: "Do unto others as they do unto you."

3d—The survival of the fittest—representing the reptilian age: "Do others or they'll do you."

There are followers and representatives of all these versions in all mining communities (even if nowhere else), and they are easily known by their fruits, and their works follow them.

I have mentioned all these surrounding conditions of the mining business because all those conditions must be known to the mine manager, and call attention to them as briefly as possible ; but as time is short and the subject long, I will stop *theorizing* and *moralizing*, or as some of you may think "*dogmatizing*," and give you some examples from actual life to illustrate and prove my theories—and the first shall be last and the last first.

On my return from Arizona in 1880, before railroads were in operation, there were five men and one woman in a stage coach coming north to Santa Fé, New Mexico. It was slow, tiresome business, and sleeping and meals were very uncertain and very uncomfortable. One night after a dark and long ride, with a long time between meals, we came to a changing place for the horses and were informed by the driver that we could get something to eat. Of course we were hungry, and all the men went at once to the stable where the stableman had some bacon, beans, and black coffee and fresh biscuits, which he would let us have at seventy-five cents each, and notwithstanding the surroundings and the appearance of the food and the men who had prepared it, we were all ready for supper, but thought of the woman in the stage who did not want anything ; but some kind-hearted man said he wanted a cup of coffee for her anyway, and (being no chicken) asked what the price of a cup of coffee would be. The proprietor of the food said seventy-five cents, the same as a meal. Upon the man expostulating and saying it was for a poor woman who could eat nothing, this thorough representative of the doctrine of the survival of the fittest said, "I don't sell coffee by the cup, but will tell you where you can get it." "Why, where?" asked the man. "In Saint Louis, Missouri," answered this thing, followed by the question, "what do you think I am here for?" Such an occurrence in a populated part of the country might have caused a row, but as all the passengers knew, it was *put up* or *shut up* in such a place as that. They all shut up not only their mouths, but their pocketbooks, and every one, to their credit be it said, lost his appetite, and although nothing was said, no one wanted any supper at all, and the miserable fellow's stock in trade was left all on hand except what the driver ate, and that was free, for the drivers share with the stablemen in the profits derived from feeding the passengers. Well, when all was ready to proceed on our journey, the driver showed his colors by ordering all the passengers inside the stage. Six people could be crowded inside, but as there was a woman and one of the passengers had a boil which made it almost impossible for him to bear the crowding, two of the passengers had ridden outside with the driver; but the driver was angry because there was no profit and resolved to make the passengers suffer for it. He belonged to the same class as the stableman, and the passengers all proceeded to get in the stage, but one who had ridden inside got out, and speaking quietly and cheerfully to the driver, said, "I think I'll ride with you anyway." The driver seemed surprised and looked although not daggers, yet pistols surely; but the little man looked childlike and bland, and at once mounted the seat. The eyes of the two met, the driver quailed, and not a word more was said until the stage started, and the driver tried to take all the room possible for himself; then the passenger said, "Being you have not much mail or express under the seat, a good bed can be rigged up and I will turn in and be out of your way entirely and have a good sleep until morning," and it was so, and all went quietly along without a word of complaint or anger for the rest of the journey. Such events are living sermons that never fail to show up the real characters of men stripped bare of all conventionalities.

The story of a wealthy ranchman which I also heard during my Arizona trip, will show another phase of mining character and one of the tricks often played upon the innocent public by mining sharpers, and the way wealth is obtained by such operations.

The hero in question had spent many years in search of fortune by mining and prospecting in an honest manner, and failed of success. He saw others passing him in the race for wealth by using their wits and *doing* others, so he got discouraged with regular mining ways and formed a plan to obtain his desires in ways that were dark. He picked out a section of country suitable for his purpose, and commenced sinking a regular mining shaft. In a short time his mysterious actions attracted the attention of experienced miners, who found out what he was doing and visited the scene of his work, and thought he must have gone daft, as there were no signs of any mineral where the old man was sinking the shaft; but the work went on with a couple of miners devoted to his interests, who got their wages and asked no questions. In course of time a deep shaft was sunk, water was struck, a cross cut driven and, behold, signs of mineral began to appear in the broken rock hoisted from the shaft, and one day work was suspended in the shaft. The water accumulated in it so that nothing could be seen of the lower part or cross cut. The old man gave up just when every indication, judging from the waste material lying about the shaft mouth, gave hopeful signs of a rich vein of mineral. The old man disappeared from his old haunts. Shortly after this an honest looking, but ignorant old miner, was seen in New York City with specimens of ore which he wished to find out the value of, as he knew a place where he had been prospecting, where a large vein of such ore was to be found. Of course the ore was so rich there was soon a lively interest taken in the old man and he was well treated in order to obtain his sercet, but the old man would neither give it away nor sell it, but wanted it all for himself if it was worth anything, but at last was prevailed upon to sell part of his claim to a mining company, of which he would own the controlling interest or at least half; and at last this was arranged by some expert mining company organizer, who agreed to pay $50,000 for a half interest, if the mine turned out as the old man stated, upon being examined by a mining expert who would accompany the old man to the claim, from New York, and report on the property.

So the innocent old man and the smart young mining expert went together to visit the shaft, where everything was found exactly as had been described by the old man. Small pieces of vein material and of the ore itself could be seen mixed in the debris lying about the mouth of the shaft, but owing to the water in the shaft it was necessary to get some miners to hoist it out to enable the expert to see the vein itself in its natural state. This would require a few days work, so a couple of miners are found and hired; of course the old man didn't know them nor did they know the old man, but they knew their business as miners. They rig up the old windlass and with an old rope and couple of buckets commence hoisting out the water. This is a slow job, but it cannot be helped, so the expert feels inclined to look about the country and amuse himself by hunting or prospecting until the shaft is clear, which will be in the course of two or three days. All is ready for the expert's inspection—in fact the miners are at work drilling and blasting out some of the vein material when the expert comes to see the bottom of the shaft, and some of the newly removed vein material is hoisted up with the poor looking arrangement of rope and windlass, and all looks very well, only the expert does not like the idea of trusting his life to the poor old rope, which he will have to do in being lowered into and hoisted up from the deep shaft. The old man won't venture himself anyway, and the men won't continue work with such a dangerous rope, and it will take a week or more to get a new one, but the men will put in another hole or two and measure the lines of the vein, and so the expert can get all the information necessary without risking his precious life in going below. The young man is only too glad to get out of the difficulty, and the honesty of the old man, who has half interest in the enterprise anyway, and the simplicity of the miners, who have no interest in the business at all, all tend to allay any suspicions that might arise. So another hole is drilled while the expert is at the mouth of the shaft, and it is fired off and the loosened material sent up, but the old man still insists upon having still another hole put in and fired off so the young man can be fully satisfied, and the material loosened by the shot is sent up. The young man fully satisfied, goes back to New York, gives in his report and the old man get his $50,000 for half of the mine. The company is being formed, arrangements made for immediate and energetic work, contracts for machinery and supplies entered into, and the fortunate organizers take a trip out to the place themselves along with the first employees, who are sent out to begin work; but when actual work begins nothing can be found of any mineral vein whatever in the shaft, all is simply country rock. The new comers did not understand the way the old man had mined rich mineral from that shaft until after the first effects of the disappointment had passed away in bad language and abuse of the same honest, simple, old man. Then when the old man could get a word in, he simply said in the language of the immoral Tweed, "What yer going to do about it?" and what could they do about it in the wilds of Arizona, where the law of the survival of the fittest reigned, and the fittest was the one who had the best arms and could handle them the quickest and with certain aim. When they called the old man a cheat and threatened the law, he simply said as quietly as ever, "Don't make d——d fools of yourselves. I have the money and have put it where it will stay put. What do you think I am living here for anyway? Now take my advice; you are in it, and the only way to get out is to keep the matter quiet and unload on others." This was the only way left to get anything out of their speculation, so they returned to New York wiser, and if possible worse men than they were before, and they put their wits to work to sell out and in a short time had arrangments nearly completed with parties who were willing to purchase their half interest in the rich mine; but about that time business called the simple old man again to New York, and he got acquainted with the parties who were arranging to buy out his partners, and felt so disappointed and angry at the action of his partners in selling out, that he offered his half interest at a less price than his partners were selling for—and of course it was worth just as much—and secured the deal, got the money and returned to his valuable shaft, which he used for a well ever afterwards for watering his stock, for he secured a large tract of land surrounding his mining claim and now enjoys his well earned wealth, and lives over and over again his smart business trick by telling the story to all strangers who fall into his company, and fully explains the method used for producing mineral from the barren rock in the shaft. He had gotten a liberal supply of good mineral and vein matter from a good mine and had it conveyed into his shaft when all was ready, and then by aid of a double barreled gun could easily fire off a couple of blasts in the shaft, and send up a corresponding sample of mineral from the supply on hand. This is a well known business method among miners with many variations, and is called salting a mine. I have had cases of salting in my own experience as an expert and even in this very country, but so far have never been deceived, although it is often more healthy not to notice such things until one gets away from the mining locality under examination. A human life is not allowed to block the way to success.

The Homestake mines of the Black Hills in Dakota are an example of real mining operations. I was acquainted with the mining expert who visited this mine when first discovered. He was sent out by California parties, who purchased it on his report, and when they first began work were so disappointed with the first result that they accused the expert of selling them out; but he showed them that he was right if they would work the mine as he had recommended, which was with not less than one hundred stamps and as many more as they could handle. The mineral was of very low grade, only running from $5 to $10 per ton, but it was in immense quantities and very easily mined, and free milling. The actual cost for machinery, material and labor, for mining and milling a ton of this mineral, was only about $3.00 per ton outside of management, interest and general expenses, and counting two tons per day for each stamp it was easily figured out how many stamps would be required to pay expenses, and what profit could be turned out, and as there were endless quantities of the ore, it was simply a matter of capital and management. So the enterprise was stocked for $12,500,000.00 and has only called but for $200,000.00 assessments in all. That was July, 1878, and has turned out dividends regularly, and it has actually paid up to this date, Jan. 1892, when the last dividend of 10 cts. per share was declared—$4,793,750 in all. This is a well conducted business so far as the mines are concerned, but it is very much over capitalized and its stock, each share of which represents $100.00, sells for $12.00 to $13.00 per share on the market to-day. Thus the dividends net about 3½ per cent. to the actual purchaser for money now invested, by which you will see that the great profit in mining accrues generally to those who enter *on the ground floor*, and share in the great profit of selling the *public*, or I ought to say the stock—but it all means the same.

You have all doubtless heard of Mackay, Flood, O'Brien and Fair, the great mining kings of California, and of the great Comstock mines, which made them all so suddenly rich. They were all poor adventurers in the mining regions, without anything remarkable to distinguish them from other characters ; but they struck a streak of luck, took advantage of everybody and every opportunity, and finally when the great bonanza was struck in the Comstock mines, laid the foundations of their enormous wealth by keeping the discovery secret until they got control of the stock and of the mines, thus manipulating the mines and stock to suit their own selfish interests.

A miner, who had charge of the underground working as mine captain in a mine under my management, told me he was employed as a miner in the Comstock mine when the great bonanza was struck, and as soon as the discovery was made, the entrance to the mine was guarded and no one was allowed to enter or depart for several days, so no information could possibly get to outside parties before all the stock was secured that could be bought in the market.

The miners were really prisoners and could not help themselves, but they were fed on the fat of the land and given everything they desired to drink until things had been made right. Then the gold was taken out in quantities never before heard of, and people went crazy with excitement, and speculation became the order of the day. Meanwhile those in control could move the market up or down to suit their own purposes and they did so. They got their share of the great profit from the actual find, and besides sold and bought stocks, and by that means obtained a great part of the profits that had got into the hands of the public. Previous to 1884 the consolidated Virginia and the "California" had paid over $70,000,000 in dividends. They were then consolidated with capital of $21,000,000, and since that time have paid small dividends occasionally, some $3,500,000 in all to this time, but the persons in control have made a great deal more by stock operations and by the mills, which were owned by separate organizations, but controlled by the same unscrupulous ring, and the power of this ring of mining kings of California and Nevada has never been fully realized outside of the people immediately concerned. They have influenced the whole country and its legislation, and the stupendous operations carried on at the mines are a wonder in the engineering and mining profession.

I could give you many more examples of the many phases of this great business, especially of its bad side, as that attracts the most attention. Legitimate mining makes no great newspaper excitement, and takes its losses and gains quietly as other businesses do, and little is heard of it outside of its immediate neighborhood.

Gold and silver mining has caused the greatest interest in mine gambling. Copper, as being next in value, has caused some large operations, and some of the largest and best paying mining operations in this country are the copper mines of Lake Superior. The Calumet and Heckla mine has made more money for its owners from actual mining operations than any other mine in this country and is a great example of good management. Some of our iron and coal mines are fountains of wealth to their owners, and far more valuable and reliable business enterprises than the mining of gold or silver—in fact, the more useful and less valuable minerals receive better management as a general thing, and do not offer such great chances for luck as the more precious minerals do.

A visit to any of our leading coal mines or iron mines, and a study of the great amount of work done and the way everything is managed, will convince any person of intelligence that their success depends almost, if not entirely, on the management.

The St. Jo Lead Company, of Missouri, is one of the best managed works I have ever visited. It is wonderful to see the way the ore is mined, crushed and pulverized, and a profit obtained from lead, containing no silver, in these days of cheap lead. Every use is made of science and invention up to date.

Electricity, diamond drills, improved machinery, and men of brains with only one object in view tell the whole story.

Rock mixed with galena and so poor that no other concern in the world could work it without loss, is mined, hoisted out, dumped into crushers and scarcely touched by human hands until it has passed through the various operations of the mill and comes out separated into two substances fine as meal; one is galena and the other rock. Brains and machinery, driven by the skill and energy of a ruling mind, do the whole business.

The very men who invented and built the machines could not run them as successfully as is being done at this place. Other mines have tried it and failed. I have known one of the leading mineralogists of Europe, Dr. Stapf, of Sweden, who came to this country twenty years ago to take charge of some mines in Mexico for a New York company. He built a concentrating machine at Bethlehem, Pa., which was spoken of very highly by the U. S. mining reports, and published drawings made of it and a long account of its performance during a trial at Bethlehem, and it was undoubtedly a perfect machine for its work, which was to separate galena, zinc blend and rock at one operation and deposit each material in separate receptacles; but when the Dr. went to Mexico he could do nothing with the machine as there was not water enough in that part of the country to supply it, although the mine had to be pumped night and day to keep the water down, by a Cornish pump, 9 inch bore and 6 foot stroke, running 10 strokes a minute. So Dr. Stapf ordered great tanks to be dug in order to retain the water from the mine pumps for the use of this machine, and ordered two large Knowles steam pumps from New York, at a cost of $3,000, to supply the water from these tanks when dug. All Dr. Stapf's operations cost over $30,000, and then when the tanks were completed and walled up they could not be made to hold the water, for the tanks were built over the mine and the rock was stratified limestone, all the water ran back into the mine and blocked the mine pumps, so this plan had to be abandoned. Then Dr. Stapf was not satisfied with the way the galena was smelted, and built large, high stack smelting furnaces, capable of smelting all the ore raised from the mine in a year in less than a month; but here again this distinguished scientist made a sad mistake, because there was no chance to get fuel in Mexico to run such furnaces. Then he could not get along with the workmen, who knew more than he did of practical life, and so made fun of him and the great airs he put on, and he left the place in disgust, and other noted metallurgists came there and did no better, and the company sunk a half million dollars in that mine. At last a manager went out who knew nothing of this particular business, either theoretically or practically, but did understand mechanics and the laws of nature, and with common sense and business principles looked over the business, studied its surroundings and the business itself, made a slight change in Dr. Stapf's machine to suit the water scarcity, so the machine really used its own water over again, filled up Dr. Stapf's tanks, and as the ground was nearly level, formed a tank on the surface of the ground by making a light embankment, requiring an expense not exceeding $5.00, which would hold all the water it received, and the machine went to work without any trouble after lying several years idle because no one could make the egg stand on end.

In fact an inch stream of water constantly running into the machine kept it fully supplied. I could bring out hundreds of similar instances in my own experience, where men, superior in learning and special skill, failed entirely as managers and mining engineers in charge, because they could not free themselves from the rut they had been trained in and take an impartial and comprehensive view of every question that came up and use the resources of the surrounding country and the combined brains and energies of all interested in the business to carry it on successfully.

I will now call your attention to an article in this week's *E. & M. Journal*, and to some figures showing the state of the mining stock market, and point out some stocks to illustrate the business financially, and then leave the subject open to the society.

MARCH 8, 1892—EIGHTH REGULAR MEETING.

Present, Chairman Burgess; Members Elsworth, Cooley, Reynolds, Sutcliffe, Winne, R. E. Taylor, Neumann, Warring, C. N. Arnold.

Mr. Edward Elsworth read a paper on "Color Photography," of which the following is an summary:

The discoveries in science and great improvements in many methods of mechanical appliances have been so great during the past quarter of a century, and popular credulity has been developed to such an extent, that no announcement of present or future discovery, even though the laws of Nature as at present interpreted, be transcended, but finds a host of advocates and believers.

The Keely motor, perpetual motion and aerial navigation, all have found many votaries. So rapid and amazing have been the developments in photography since Daguerre and Neipce's crude experiments that no one seriously thinks of questioning the announcement, that we are upon the eve of the discovery of a process by which the colors of Nature may be successfully transferred to the photographic plate.

Within a year past a charlatan has successfully canvassed this city and vicinity for orders for color photographs, based upon the assertion that Nature's colors are latent in the photographic image which is impressed upon a silvered plate, and that his process simply develops them in the printed picture.

Of course no one, who has the most rudimentary knowledge of the action of light upon a silvered plate, would be deceived by such an arrant imposter, but the fact of his success demonstrates the truth of the statement that the public is not disposed to doubt any claim of discovery which is plausibly made at the present day.

I propose to submit a brief examination of what has been accomplished in the way of so-called color photography up to the close of 1892.

To appreciate what has been thus accomplished presupposes a knowledge of the process by which a photographic image is secured upon a sensitized gelatine plate; suffice it for the present purpose to say, that such an image is the result of a molecular change in the body of the sensitizing medium, caused by the action of light, and varies according to the duration of the exposure.

Light is described as an undulatory movement in a highly elastic medium—ether.

Ether pervades all space not occupied by matter. The disturbance of this ether caused by the appearance of such a body as the sun for instance, propagates a rapid series of undulations or vibrations in every direction at a velocity of 186,000 miles per second. Some of these vibrations are too rapid for the eye, such as the vibrations of heat. Some on the other hand are too slow and cannot be detected by the unaided human eye.

"Color," says Meldola, "is the visual impression corresponding to oscillation frequency."

If a series of ether waves were all of one definite rate of oscillation, we would have a pure monochromatic light.

White light is polychromatic, *i. e.*, it is a mixture of ether waves of different periods and wave lengths. Passing a thin slice of this light through a prism simply sorts out the waves of different length, the shortest apparent waves producing upon the eye the sensation of violet, the longest, red. They increase upward from red to violet. Beyond these, *i. e.*, beyond the red waves we have radiant heat, and beyond the violet nothing visible to the human eye, yet waves which do exert an influence photographically and can be measured. Hence we say that there is a photographic sensitiveness far beyond the sensibility of the human vision.

This is illustrated by the photography of the firmament, which discloses many stars not discernible to human vision.

The intensity of these color waves differ. To the human eye the yellow is the most intense; photographically, the most intense wave is violet.

So if we looked upon Nature with a photographic eye, violets would appear more brilliant than buttercups.

Every practical photographer has discovered this. Reds and yellows impress feebly and require longer exposure, while violets and blues impress strongly.

Again the color of no natural object is ever pure. Analyzed, some rays of the spectrum are absorbed, some reflected ; besides a certain amount of white light is reflected from all surfaces except dead black. Were it not for this, all ordinary photographs would present more striking contrasts than now.

Now in exposing a sensitizing plate, we have all parts acted upon by the white light according to length of exposure: certain molecules specifically decomposed according to the colors of the object focused upon the plate.

As it is a property of the silver salt under these conditions to darken, the molecular changes affected correspond to the impact or impression of the light waves striking it, we have as a result of "development," which is a dissolution of the silver salt which has not been acted upon by the light, and the subsequent fixation or rendering permanent by the application of certain chemicals to the plate, a picture presenting simply contrasts.

Every one who has looked upon the reflection of a landscape in a Claude Lorraine mirror, or who has merely focussed an ordinary landscape upon a camera ground glass, must have given expression to a longing that some process would be discovered whereby the beautiful reflected picture could be reproduced in the finished photograph.

The distortions of optics and the unvarying laws of chemical action have discouraged the efforts of many a would-be photographic artist.

From the very earliest date of photographic printing, long before the discovery and perfection of the present methods of photography, long before Daguerre's great discovery, efforts were made by distinguished scientists to reproduce the colors of the spectrum in a photographic picture. Seebeck, of Jena, in 1810 discovered that chloride of silver, after a preliminary exposure to white light, was by prolonged exposure to the red end of the spectrum colored a brick red, and by a similar exposure to the blue end colored a metallic blue. Eighty years experimenting with this phenomenon, however, produced no practical results.

In 1865 a series of experiments along another line were commenced by Henry Collen, of England, which have, through the scientific investigation of several French and German chemists and physicists, and also by Mr. F. E. Ives of Philadelphia, yielded the only approximately satisfactory solution of the problem under discussion. The result of the last named investigator's experiments I shall present later as Mr. Ives' process.

In mentioning other processes, it may be well to state that Dr. R. Kopp, a Swiss photographer, claims to have discovered a process whereby all the colors of nature may be impressed upon a single film, which is simple, practicable and permanent.

As the samples of his work furnished, so far as I can learn, do not sustain his claim, and as he declines to reveal the process whereby he accomplishes his alleged results, he may be dismissed for all present purposes.

Various other processes for the purpose of reproducing pictures have been published from time to time, but these are all more or less mechanical in their nature, depending upon the application of pigments at some stage of the process and do not properly belong to this subject.

A little more than a year ago the photographic world was startled by the announcement that Mr. Gabriel Lippman, a distinguished physicist of Paris, had succeeded in photographing the colors of the spectrum. His process, which was based upon well known physical laws, has not so far justified the pretentious claims at first announced and bears about the same practical relation to the subject as the earlier experiments of Neipce and Daguerre do to the more advanced processes of photography.

In the first place, he uses a very thin glass plate, coated with such a thin emulsion as to be practically transparent. This sensitized emulsion is so compounded as to be perfectly homogeneous, presenting no discontinuance in the film. This plate is placed in a glass box or camera, so constructed that the plate placed film inward forms the front thereof. The interior is filled with mercury so that the sensitized plate comes in immediate contact with the mercury.

Thus prepared there are thrown upon the outer surface of the sensitized plate the rays of the solar spectrum. After long exposure, varying from 30 minutes to 2 hours, time to allow the perfect impression of the red rays or waves, the picture is completed and the plate is removed, developed and fixed in the ordinary manner.

The plate thus developed dried, and viewed by transmitted light is said to give a duplication of the solar spectrum.

There is a conflict of opinion as to the success of Lippman's experiment.

The theory of the method is this: the plate and its sensitive surface being transparent, the mercury forms a mirror before the film and reflects the rays of light upon themselves. There is, as physicists say, an interference between the incidental and the reflected rays. There follows in the interior of the sensitive film a series of positions of interference and each of these is marked by its particular deposit of silver. The result is that the sensitive film, after the photographical operations are completed, is subdivided by the deposit of silver into a series of thin sheets. These sheets are precisely of the thickness necessary to produce by reflection the incidental color which gave them birth; for instance, the mercurial mirror behind the plate has caused the red light to deposit the silver in layers corresponding to the length of a red wave, etc. These layers coinciding exactly with the length of a certain wave of light, can only let pass the same light which originated them.

It is the principle of the phonograph applied to light waves instead of sound waves.

So far as any practical use that can be made of Lippman's process is concerned, it may be said that it is merely suggestive. As a scientific experiment it is interesting and some future explorer may, through its channels, develop a process of color photography.

Up to this date it has been used only to record the colors of the spectrum, as represented by rays of light passing through stained glasses.

It might produce a negative plate for lantern projection, but at best the process is inconvenient for practical use.

To my mind one great objection to the process is the time of exposure necessary ; the period required for the impression of the red waves must certainly obliterate the blue, resulting in contrasts which must yield a bad positive.

In short the achievement of Lippman, which so excited our Parisian and English photographers last year, is little more than was accomplished by Ritter in 1801, by Seebeck in 1810, and by Herschel in 1839, even before the present art of photography was known.

Speaking of these experiments the late Mr. D. Wistanley, in an article published in a recent number of "Photography," an English magazine, said "I think that all these experiments with the solar spectrum are experiments in the wrong direction, for in making photographs of such objects as we see around us, we very seldom indeed have pure spectrum colors with which to deal. The thing which looks red only does so because it reflects more of the red rays than of the rays of other colors. The thing which looks green because it reflects more of the green rays, etc.

I know of no substance whatever, which does not reflect white light—black velvet even—and we may take it that the rays proceedings from any object by reflection, whatever the seeming color of the object, are in part composed of pure white light which dilutes and brightens the preponderating ray. To be able to take photographs in natural colors, that is photographs of anything we see, we must be able to do so by means of the preponderating ray even in the presence of all others. Hence though photographs of the spectrum have (to my thinking) demonstrated the possibility of making photographs in colors, it is perhaps useless to pursue the subject further in that direction.

At first sight it seems quite hopeless to expect that we shall ever be able to eliminate the results of all those colors which are not evident to the eye, but I hope to show that it is not merely otherwise than hopeless, but that it is actually easy."

Unfortunately Mr. Wistanley died shortly after making this hopeful prediction, without leaving any tangible clue to the method by which he thought he had found the philosopher's stone.

His experiments so far as we have any record of them do not appear to open any original avenues of research.

Dr. R. Kopp, of Munster, Switzerland, succeeded in making positive prints in colors, which were sent to Dr. Lesgang, but as they did not stand exposure to sunlight, they were worthless, and as Dr. Kopp declined to give the secret of his process, it may be suspected that the prints themselves were the result of mechanical manipulation.

I now revert to the experiments of Mr. F. E. Ives, of Philadelphia, which may be considered the most successful solution of the question of color photography, up to date, and which differs entirely from all the processes which I have mentioned.

The first practical suggestion of this process was made in 1865 by Mr. Henry Collen, a painting teacher, employed in the household of Queen Victoria. His idea was to make three photographs of an object, one by the action of red, one by yellow and one by blue, and to print from each pair of these negatives superposed as one a transparent positive having the color represented by the third negative, and to superpose on a white surface the three prints thus obtained.

The obstacles in the way of Collen's theory were that there was no known process at that time by which plates could be prepared, which were sensitive to single colors only, and no photographic plates were sensitive enough to red and yellow to admit the production of such negatives by exposure through color screens. The result too, says Mr. Ives, would have been very imperfect in any event.

In 1868, Ducos Duhauron, of Paris, attempted to carry out Collen's theory in a slightly different manner, with precisely the result which Mr. Ives suggests. Charles Cros, of Paris, followed Duhauron with some further modifications of the same process, but with no more successful result.

These two men continued their experiments until 1880 without solving the problem.

I will not take up time with examination of the theories of Drs. Stolze and Vogel, of Berlin, except to say that the efforts of these distinguished physicists and chemists, while they did not solve the problem of color photography, undoubtedly incited the invention of what are known as orthochromatic or Isochromatic plates. These are now made by all of the principal manufacturers of dry plates, and are simply plates which render the colors of the spectrum at their true color value in monochrome.

This is accomplished by combining with the emulsion with which plates are coated certain dyes, which render it more sensitive to the yellow, yellow green, and even red rays, than they would be normally.

In November, 1888, Mr. Ives communicated to the Franklin Institute, of Philadelphia, that he had demonstrated a procedure based upon the assumption that although there are more than 3 or 5 or 7 primary spectrum colors, all of them and in fact all the colors of Nature could be counterfeited to the eye by three type colors and mixtures thereof.

He proved his process by photographing the spectrum itself, employing compound color screens carefully adjusted to secure definite intensity curves in the spectrum negatives, so that they would make color prints which counterfeited the color effect of the spectrum when superposed.

Promising results, he says, were obtained by this process, but he soon found that a process might reproduce the color effect of the spectrum and yet not be able of reproducing perfectly the compound colors.

It was necessary to discover a new process by which not only the spectrum would be reproduced but also all the hues of Nature.

This he discovered to be the making of sets of negatives by the action of light rays in proportion as they excite primary color sensations and images or prints from such negatives with colors which represent primary color sensations.

In order to illustrate this principle he explains that although the spectrum is not made up of three kinds of color rays and mixtures thereof, the eye is only capable of three primary color sensations. A distinction he says of the utmost importance, for the reason that the spectrum rays which most powerfully excite a primary color sensation are not the ones which represent the character of that sensation. The primary sensations are red, green and blue (violet), but it is not the red, green and violet spectrum rays which most powerfully excite these sensations. The orange spectrum rays excite the red sensation more strongly than the brightest red rays, but also excite the green sensation. The greenish yellow rays excite the green sensation more strongly than the purest green rays, but also excite the red sensation.

The yellow rays excite the red sensation as intensely as the brightest red rays, and the green sensation as intensely as the purest green rays.

Acting upon these principles Ives produced one negative by the joint action of the orange, red, yellow, and yellow green rays in definite proportions to represent the red sensation. One by the joint action of the orange, yellow, green and green blue rays in definite proportions to represent the green sensation, and one by the joint action of the blue green, blue and violet rays in definite proportions to represent the blue sensation.

Lantern slide positives are made from these negatives and by exactly reversing their light and shade the plates must also represent the effect of the photographic object upon the respective color sensations.

One lantern positive when seen by transparency in red light produces the effect of the object upon the primary red sensation.

Another view in the same manner by green light reproduces the effect of the object upon the green sensation.

The third viewed by blue violet light reproduces the effect upon the blue sensation.

The combination of these three images into one must form a reproduction of the object as seen by the eye, correct in form, color, light and shade.

This effect is produced mechanically by a triple optical lantern in such a way that the three projected pictures exactly coincide upon the screen.

The lantern front used for these new projections consists of three prisms converging light from a single condenser, and radient to three small projectory lenses ; the necessary color screens being located just behind the objectives, (so after all mechanical).

Various improvements have been made from time to time, the chief of which has been the construction of a camera by which the three negatives representing the effect of the object photographed upon the three fundamental color sensations, may be made from one point of view by a simultaneous and equal exposure upon a single sensitive plate.

The value of Ives discovery, from a practical point of view, is yet to be determined. From a purely scientific standpoint, his process cannot be compared with that of Lippman. Of both it may be said that they will be sure to stimulate further investigation, and he is a rash man who will positively assert that out of such investigations a simple practical process of reproducing the colors of Nature in a photographic image may not be evolved.

The subject was further discussed by LeRoy C. Cooley, Ph. D., who strongly endorsed the scientific character of Lippman's experiments and predicted that final success would come along that line, if at all.

APRIL 5, 1892—NINTH REGULAR MEETING.

Present Chairman Burgess, and Members Elting, Gardner, Sutcliffe, Van Gieson, Neumann, Winne, C. N. Arnold and visitors. Rev. A. H. Huizinga of New Paltz, N. Y., read avery interesting paper on "Assyriology."

MAY 10, 1892—TENTH REGULAR MEETING.

Present Chairman Burgess, Members C. N. Arnold, Dwight, Elsworth, Elting, Herrick, Nilan, Pelton, Warring, Williams, Rogers and F. S. Arnold.

Chairman Burgess reported to the Section in writing on the progress of the Section during the past year. His report was accepted.

The Curator, Prof. W. B. Dwight, reported the purchase of a valuable collection of corals costing $533, from H. F. Woodman, Esq. The collection consists of 266 specimens and 100 duplicate specimens of corals ; 170 trays of shells, 100 large shells, and 5 porcupine fish, together with a few starfish and other marine specimens. The collection is rare, beautifully preserved and worth much more than was paid for it, the corals especially being remarkably valuable. Thanks are due to Mr. Woodman and Mr. C. N. Arnold for arranging the specimens, the former of whom did a great deal of work in putting the collection in order without extra compensation.

It was also suggested that the Museum is too crowded and that some enlargement is desirable. The report was accepted.

The Librarian, Mr. C. N. Arnold, reported in writing. The Library at present possess 1,033 bound books, 27 paper books and 355 miscellaneous pamphlets, 775 copies of transactions, etc., from learned societies, 17 atlases and 51 atlases and maps. The work of cataloguing is proceeding satisfactorily. The report was accepted.

The following were elected officers for the ensuing year : Chairman, Edward Burgess ; Secretary, F. S. Arnold ; Curator, Prof. W. B. Dwight ; Librarian, Charles N. Arnold. The Curator announced the appointment of C. N. Arnold as assistant curator. Mr. S. J. Robinson was nominated for active membership.

DECEMBER 6, 1892—FIRST REGULAR MEETING.

Present, Chairman Burgess, and 70 members and visitors. The Curator reported as gifts to the Museum 30 specimens of birds' eggs from Fred. W. Stack, and about 50 specimens from Florida from Mr. E. R. Williams.

Dr. Theo. Neumann presented the following paper on

THE SPEECH OF MONKEYS IN THE LIGHT OF DARWINISM.

By universal consent we see in the monkey tribe a caricature of humanity. Their faces, their hands, their actions and expressions present ludicrous resemblances to our own. Indeed, since times immemorial these similarities have struck the eyes of all thinking and observing friends of Nature as something very remarkable, and poets as well as writers of scientific works have, for many centuries, dwelt at length on that fact.

It is, therefore, easily conceivable that efforts were made from time to time to deny such similarities, because that resemblance was always more or less a disagreeable one, humiliating and annoying, so that we need not wonder that man, the more he felt his superiority over the surrounding animals, tried to deny his relations to those creatures, to prove that such relations could not possibly exist, nay, that he was of quite a different, of a divine, origin.

Very instructive is, concerning this question, the demeanor of the different states of culture of mankind. Originally, *i. e.*, nearer to the natural state, man feels usually a member of the great whole, he does not consider animals and plants around him as beings created only for his entertainment and for his convenience, but as his equals as to the right to live and to enjoy life, sometimes even as his superiors which he must worship and respect. In all the countries where there are anthropoid apes we find the belief that the latter are the forefathers of the human race. Some Indian tribes trace their origin back to the ape god Hanuman and prove their statement by pointing out that tail-like prolongation of the back-bone which, as they say, the princes only had preserved as an unmistakable sign of their origin. Similar traditions are found among the wild tribes of the Malay Archipelago and on the Sunda Islands, where we are told that the offspring of two apes were sent down into the plains, where they learned to till the soil, to raise corn and rice, and to eat, that then their tails and the hair which covered their whole bodies disappeared gradually, that they began to speak and to people the earth.

On the other side, it is amusing to study the continuous but ever failing efforts of scientists to find decisive differences in the constitution of man and ape. Old faithful Linnæus, although thoroughly believing and scripture-proof, was honest enough to give evidence to the utter failure in his efforts to find any marked and decisive differences between the two. When he arranged his system of the Animal Kingdom, he was bound to place man in the very same group with the anthropoid or man-like apes, and called this group then Primates, the first or the princes of the animal realm.

Later other anatomists were convinced that they had found something which would really draw a dividing line. They pointed out the so-called four-handedness of the apes in opposition to two-handed man. This characteristic seemed indeed to stand, and for some time the natural histories taught us that apes had four hands, man only two, and that both groups had consequently to be kept apart. It came from the fact that apes are able to use their big toes as we do our thumbs, as grasping organs, and that indeed they scarcely make any difference in the use of either.

Even this small difference, however, did not stand any farther or more careful examination. Huxley, one of our greatest living zoologists, gave full evidence that there is really no difference at all between these two, that, on the contrary, apes are just as much two handed creatures as man. The hind foot, or if we want to use the old expression, the hind hand, is really no hand but a regular foot, whose toe can be moved freely, and thus enables the foot to grasp things as we do with our hands. The same thing we find with negroes and other uncivilized tribes who use their big toes as well as their thumbs just like apes, nay, in the young child of the most civilized white race we find the ability of moving the big toe as well as the fore-hand thumb. It is only through want of exercise, bad treatment, tight shoes, and leather-covered boots, that we lose the movability of our toes, while all wild tribes who never use any foot-wear are able to do things with their feet which no European could ever accomplish.

Still more, Huxley gave proof that there are real anatomical differences between hand and foot, which means, that we find the same differences between the foot and the hand of the apes as between the corresponding members of man. The arrangement, size, shape of the bones, the quantity and the fixation of the muscles is the same in both, and,to state a small item which is convincing, however, the foot of ape possesses three more muscles than the hand, and the very same difference is found in man's foot and hand.

So we see that this very characteristic, pointed out as a decisive evidence of the great difference between man and ape proves just the contrary, the zoological inseparability of the two. The utter failure, of proving the former, is so much the more striking, as it was the apes and not man who introduced two-handedness and began to walk on their hind feet only. In many natural histories we find it stated as something remarkable that while animals walk on all fours and are forced to look down to the earth, man alone is able to walk erect and to look toward heaven. Let us consider apes—more or less all anthropoid apes, Gibbon, Orang, Chimpanzee, Gorilla give up walking on all fours and move around on their hind feet only. This was only a consequence of the struggle for life. The apes were rather badly off in it, not only on account of their teeth, but also for the want of any claws, so they rose up on their hind feet whenever attacked and when they wanted to fight, because then they were able to use their arms better than when approaching the adversary on all fours. The advantages resulting from this upright position were so many that this way of going and standing soon grew into a regular habit, just as man begins his career of life as a quadruped and does not learn the erect walk until some time has passed.

Another fact on which a good deal of hope of marking a difference had been placed, has been disproved by close examination. Whenever we look at a represenative of a lower species of monkeys, we find a more or less extensive tail, and more than one philosopher has pointed out with immense satisfaction that apes have tails while man has none. Not to speak of the fact that there are many tailless apes, especially those which are nearest to man in their anatomical build, man himself shows rudiments of that organ which in his earliest stage is even of a very marked development.

It afterwards turns inward, instead of reaching to the outside, as may be seen in the picture of the human skeleton, and this is the case also in the higher apes.

The same striking conformity we find in no less degree in all the other essential parts of the bodies of men and of the highest apes. We find such a great harmony in every part that Huxley, after a most careful and often repeated examination, said: We may take whatever system of organs we want, the anatomical differences which separate man from the highest apes of the Old World are smaller than those which are to be found between higher and lower apes. No wonder that all honest zoologists have long ago given up the hope of finding a true characteristic in order to separate *Homo sapiens*, from *Homo Satyrus* and *Homo Lar*.

During the last ten or twenty years some more endeavors have been made to establish a final separation by means of the differences in the construction of the brain. It seemed only natural that this seat of all the higher qualities, the seat of intelligence and of the most eminent "human" attributes, morality, love, etc., should be more fully developed than in any animal, or that it should possess parts or specifications not found elsewhere. An English zoologist, Owen, was especially obstinate in pointing out one particular place of the brain which has been proved to be the seat of speech, and which he could not find in any ape. This effort has also failed, for all these parts have recently, after more careful investigation, been found, in rudiments only, in the lower tribes of monkeys, better developed and plainly visible in the higher groups. This fact will be of some importance in the course of this lecture as soon as I shall mention the ability of monkeys to speak. Huxley again, who was an enthusiastic partisan of the theory that men could not claim any anatomical superiority over the highest animals, formulated the following sentence, which up to the present date has not been contradicted: As if Nature wanted to show the impossibility of establishing in the most prominent organ a dividing line between man and apes, it has given to the latter animals a nearly complete series of gradations in the forms and sizes of the brains, beginning with specimens which are little higher than those of a rodent up to such as are scarcely different from the brain of man. And it is a remarkable circumstance that, although there is a dividing line between the brains of the different groups, we do not find the gap between man and ape, but between higher and lower monkeys, so that we should have a series as follows: Man, Orang, Gorilla, Chimpanzee, Gibbon, Pavian—half-apes, the series being uninterrupted up to the hyphen which inticates the gap or the dividing line. To state it again, the very organ which in the first place ought to furnish anatomical distinctions of weight and importance, forsakes us when we require more than Nature can evince.

When thus the adversaries of the theory of relationship between man and ape, or more generally between man and animal, had failed in their efforts, when they were forced by countless facts to admit that not a single anatomical distinction could be found which gave us a right to form a separate class for the human race, or to believe even that man had been created by a special divine act of the Creator, the psychologists stepped to the front, ready to take up the fight and carry it to a victorious end, after their colleagues, the anatomists, had met with such a serious and everlasting defeat. They admitted, indeed, that there might be many similarities in the anatomical construction of the bodies, and that it was impossible to establish a dividing line between man and ape on the strength of their anatomy, but that the whole weight of argument should be taken from the psychological, the intellectual and moral side of the question. Many an eminent scientist produced the statement that animals, and with them monkeys, were destitute of any logical apprehension and power of abstraction; that man alone could count, that man alone fabricated weapons and tools, kindled fire, planted seeds in the earth, and was alone capable of self-renunciation and suicide.

The weak point of these speculations concerning the mental powers of animals is that they are too exclusively metaphysical, constituting a logical and systematic exposition of conceptions or notions without that accurate and exhaustive observation of facts which no acuteness of analysis and no vigorous process of thinking can supply. Those investigators who denied the fact that animals were unable to reason, were surely ignorant of the habits and aptitudes of animals, and at the same time they were liable to an opposite error, equally fatal to their theories, in their tendency to ascribe to the human race as a whole faculties which are characteristic of man only in a high state of civilization. They ignore the savage and the boor, and compare beasts with the most cultivated and most highly developed beings, overlooking the period during which man existed on the earth before he even learned how to chip flints.

These are savage tribes in which that "ideal-sense" upon which peculiar stress was laid by those scientists who wanted to find a psychological dividing line between man and the brute, is wholly wanting, and which are as destitute of historical annals as any herd of apes. Nor is there any reason to believe that animals cannot comprehend facts and draw logical conclusions. Such low animals as ants have been observed bringing straws from a distance for the express purpose of bridging chasms that separated them from a desirable article of food. A striking example of this kind is related by a monk who lives in a monastery in Botzen in the Tyrol. He had put some pounded sugar, together with a few ants taken from an ant hill in the garden, into an old inkstand, which he suspended by a string from the cross-piece of his window. Very soon the ants began to carry the sugar along the string to their home in the garden, and returned with many others which went to work in the same way. After two days, although the greater part of the sugar was still in the ink-stand, no ants were seen on

144

the string; and, on closer examination, it was found that about a dozen of them were in the inkstand, busily engaged in throwing the sugar down upon the window-sill below, where others were carrying it off to the hill. They thus saved themselves the trouble of climbing the whole length of the window and down the string into the inkstand and back again with their burdens, and avoided by this means an immense expenditure of strength and loss of time. This change in the plan of operations shows remarkable powers of observation and reflection, and was doubtless suggested by some of the more thoughtful and practical members of the community, and, after being communicated to the others, was adopted by them.

Time-sense is very highly developed in domestic fowls and many wild birds, as well as in dogs, horses and other mammals, which keep an accurate account of days of the week and hours of the day, and have, at least, a limited idea of numerical successions. Experiments have been made with different classes of animals, high as well as low ones, to ascertain their power of counting numbers, and the results have been greatly in favor of the statement that animals can count, sometimes even better than man.

Again, the ability to use tools and to wield weapons is not exclusively human. From the ants which make a clever and effective use of implements for their domestic, social and military life, up to the apes and elephants, we find tool-using animals nearly everywhere; not to speak of the flash of water which certain snails and fishes send toward their enemy with calculated exactness, not to speak of the dexterity with which birds open oysters and fishes with hard shells by means of dropping them on the rocks so that they break, let us point out only how cats and dogs open doors by pressing the latch-key, or how they cause them to be opened by pulling the bell-cord or lifting the knocker, or how readily cows familiarize themselves with the mechanism of gates, to the frequent vexation of farmers. It is well known that monkeys living near the seashore evince extraordinary expertness in opening oysters with sharp stones. It would require only a very slight increase of intelligence to learn to break a stone into proper shape, and thus by fabricating a tool to bring himself abreast, intellectually, with the flint-chipping man of the early stone age. Monkeys use stones as hammers and sticks as levers, and appreciate the advantage to be derived from this simplest of the mechanical powers. With them, as with primitive or uneducated men, this knowledge is purely empirical, a product of experience, and does not imply a perception of mathematical truths.

Another characteristic claimed to prove the superiority of man, the use of fire, is by no means common to mankind alone, and on the other side, not common to all mankind. *Homo sapiens* inhabited the earth for ages before he discovered methods of generating this element and making it subservient to his interests. The habitual use of fire is the sign of a very considerable advancement towards civilization, and marks an important epoch in the evolution of the race. Chimpanzees, gorillas, and orang-outangs, have repeatedly been seen bringing brushwood and throwing it on the camp-fires, which travelers travelers had left burning, while we know from different that there are savage tribes of men who did not know a fire, and who were very much frightened when they saw it for the first time, while others came near, trying to touch it and to carry the flame away, and when they were burnt, thought that a wild animal had bitten them.

The assertion that animals do not plant seeds in the earth and raise crops is proved to be wrong, as it has now been ascertained beyond a doubt that in Texas and South America, as well as in Southern Europe, India, and Africa, there are ants which not only have a military organization and wage systematic warfare, but also keep slaves and carry on agricultural pursuits. As to the higher moral qualities, we know that love, gratitude, devotion, the sense of duty and the spirit of self-sacrifice, are proverbially strong in dogs, and nobody who is able to observe would venture to assert that they are governed solely by a regard for their own individual well-being. There are also many apparently well-authenticated instances of animals deliberately taking their own lives; and without too credulously accepting anecdotes of this sort, there is no psychological reason for rejecting them as grandmothers' stories. The mandarin duck is proverbial for conjugal faithfulness, and jealousy is a virtue (or shall we say a vice) quite sure to arise in certain birds whenever the male shows a preference for one of his mates. The instances recorded of animals holding courts of justice and laying penalties upon offenders are too numerous and well authenticated to admit of any doubt. It is as clearly established as human testimony can establish anything that these creatures, especially birds, have a lively sense of what is lawful or allowable in the conduct of the individual, so far as it may affect the character of the flock or herd, and they are quick to resent and punish any act of a single member that may disgrace or injure the community to which it belongs.

The conduct of monkeys shows us remarkably well that they are endowed with a moral sense and a logical faculty, implying a clear perception of right and wrong, and a consciousness of guilt. The following incident, related by Dr. Schomburgsk, director of the zoological garden at Adelaide, in South Australia, would prove this statement. An old monkey of the genus *Macacus sinicus*, which was confined in a cage with two younger ones, flew at the keeper one day as he was supplying them with fresh water, and bit him so severely as to endanger his life. Schomburgsk ordered the animal to be shot, but as an attendant approached the cage with a gun, the culprit showed the greatest consternation, fled into the sleeping apartment of the cage, and could not be induced by any offer of tempting food to come out of this place of refuge. It must be added that the monkeys were perfectly accustomed to fire-arms, which had been frequently used for killing rats near the cage, and that they had never manifested the slightest fear of them. Even now the other monkeys ate their food as usual, with a conscience void of offense. No sooner had the man with the gun withdrawn and concealed himself than the old monkey sneaked out, and snatching some of the food, rushed back into his asylum, but when he tried to repeat this experiment, a keeper closed the door from without, and thus cut off his retreat. As the man with the gun drew near again, the poor monkey seemed quite beside himself with terror. He first tried to open the sliding-door, then ran into every nook and corner of the cage in search of some way of escape, and finally, in despair, threw himself flat on the floor and awaited his fate, which soon overtook him.

Let us compare with such facts the statement for instance of one of the ablest and most devoted missionaries, Morlang, who without any success at all worked for many years among the ape-like negro tribes along the upper Nile. He said: "Among such savages every mission is utterly useless. They stand far below brutes, as the latter show at least signs of affection towards those who are kind to them, while those beastly natives are totally devoid of any feelings of gratitude." Other travelers have expressed their opinion in similar ways and even stated that if a dividing line must be drawn, it ought to be established between the most highly civilized portion of mankind on one side, and those savage tribes on the other, so that the latter would be, and not unjustly, reckoned among the animals. To say the least, here, too, we find an uninterrupted gradual development from the lowest state of conscience and the total absence of clear conceptions to the highest intellectual and moral properties, so that it is impossible to find any qualitative difference, and perhaps only a very slight quantitative difference in the functions of the mind.

Thus another stronghold of the opponents of the theory of evolution had been completely destroyed, and not few of them began to doubt if it were possible to maintain their opposition very much longer. One strong argument, however, remained in their favor, and for a long time it seemed as if they should carry the day. Let it be true, said they, that there are no essential differences between the anatomical construction of man and apes, let it even be granted that monkeys can reason, that they possess intelligence and that they have a conception of high moral sentiment, one thing stands undisputed and will never be doubted, namely, that man has the power of articulate language, man has the power of speech, while monkeys, and with them the whole wide kingdom of animals, are denied it. The Darwinists freely admitted that this statement could be used as a powerful weapon against their theory, and that the prospects did not seem very bright for ever removing this obstacle, although they knew that the throat of monkeys shows by laryngeal adaptation capabilities for sound vibration, and even for singing, not to speak of the fact that many animals use certain sounds for expressing certain emotions, as danger signals, as calls from one member of a troop to another, or from the mother to her lost young, or from the latter to their mother.

It was a profound emotion, therefore, which went through the scientific world when an American professor, Mr. R. L. Garner, announced that he had discovered the language of monkeys. The news spread lightning-like throughout the whole world, and everybody seemed to ask: Is it true? What now? At first everybody seemed convinced that the whole thing was a good joke, while others very promptly declared Mr. Garner a crank, a fool, an idiot. Soon they found out, however, that there was nothing cranky about Mr. Garner's statements, and now he was besieged by scientific societies to lecture before them on this extremely interesting and important subject; magazines and journals applied to him for articles on his discovery, and an army of reporters constantly besieged his office door in order to interview him and get exhaustively the latest facts, the latest phases of development of his work.

Mr. Garner was by no means reluctant to give the history of his discovery and the present results of his researches. Indeed, his approaches were slowly made, and his self-preparation long. During his hard work for years as a village schoolmaster he had paid most attention to the study of phonetics and investigated the development of human expression. Early in life, having been bred on a stock farm, he conceived the childish idea that horses had a language, that he could converse with them, and that it was possible to exchange thoughts with them, that they could understand each other.

Why should it, therefore, be regarded as strange that monkeys talk?

Some ten years ago Mr. Garner sat one morning in the Cincinnati Zoological Garden, before a cage containing a mandrill and several smaller monkeys. The former, the most disagreeable creature of his kind, was the bully and torment of the smaller monkeys. The cage had a partition with an opening through which the smaller monkeys could escape, and a box into which they could withdraw. Tired of bothering the little monkeys, every now and then the mandrill would be quiet. Then a little monkey would peep out, give a certain cry, as much as to say: "The big brute is asleep now, come along, you fellows," and out would troop the small ones. The instant the mandrill began to annoy one of them, another and a different cry would be heard, and away would scamper the whole party out of his reach. But that was not all. There came suppressed cries from the hidden chamber where the monkeys were huddled and then no one budged.

"I sat hours by that cage," said Mr. Garner, "revolving that scene in my mind—the fright of the monkeys, their signalling, the difference of the vocal sounds. I was lost in a daze of thought. Had those monkeys language? Why should it be regarded as strange that they could talk? Do they not enjoy the senses and faculties of man in all things else? Then why should speech be the one faculty withheld from them? If the voluntary sounds they make do not mean anything, why may those creatures not as well be dumb? If they do mean anything, let us determine what the meaning is. My mission was to find out, and from that hour and day began my particular study."

The first effort made by Mr. Garner was to produce by our alphabet the sounds he heard, and to memorize them. The difficulties were immense. The subjects themselves were not ready at hand. The toil was constant. He visited all zoological collections, and as he expressed himself: "I am on speaking acquaintance with every monkey in the United States." Superintendents of zoological gardens or keepers were not always courteous. For him to say, "I want to hear your monkeys talk," was sure to be met with a rebuff. Evidently the supposition was entertained that it was not safe to allow a man bent on such an errand in too close proximity with monkeys.

The monkeys themselves, moreover, were not always inclined to give utterance to any sound. One cannot go into a menagerie, and select and interview a monkey, and discover new words or interpret new sounds at will. Monkeys are not loquacious, and if the investigator succeeds in making them talk, he cannot have an expression of general well-being, or of anger or of joy, made to order. And if after all success had been gained, if one of the monkeys had condescended to utter a sound, it was often, or rather nearly always impossible to fix it by means of letters, so that they could be recalled and compared with other sounds. We must admit that many of our own sounds are not expressed by the letters of the alphabet, and many of them are not reducible to any literal expression, as for instance the sound very poorly represented by "umph—humph," or any utterance of an infant's voice which we might vainly try to express in letters. And yet this is, by comparison, one of the easiest things to bring within the reach of the alphabet, being made by human vocal organs with all the advantages of heredity.

Is it any wonder that progress of Mr. Garner's researches was very slow, that results were often barely appreciable, even to a trained ear? Should we be astonished if we learned that he gave up his investigations in despair and in disgust, as no man's patience could stand that permanent, heavy pressure and that humiliating and depressing feeling of constant failures? Indeed, he was about being shipwrecked, when the Edison phonograph made its appearance. Do we wonder when we hear that Mr. Garner spent a sleepless night, thinking over the possibilities of such a recording instrument? He made use of it at once. It simplified matters, for the only thing for him to do now was to receive the sounds which monkeys make, on a cylinder and, having obtained a good record, to take it home and study it.

Dozens of cylinders might be used this way, and only one of them be found worthy of preservation, but even then an ample reward for days and weeks of work was to be expected.

Very interesting, indeed, is the method of obtaining a record of these sounds. Acting on the general broad principle that a bird who will not sing must be made to sing, we may safely state that hungry monkeys, impatient for breakfast, are the most likely to say something equivalent to "Hurry up them cakes." An apple is shown them, and as soon as their appetites are whetted and the monkeys begin to cry and make remarks, the phonograph is brought into play. They do not seem to mind the apparatus with its brass funnel and its open mouth, so that their expressions, directly over the big receiver of the phonograph, may be recorded on the revolving cylinder with the greatest ease.

In a similar way the record of the monkey sound for thirst may be taken down. The keeper pours out milk into the pan in a niggardly manner, and when the poor little chaps discover that there is barely enough for one, they cry for "more." At once the phonograph is put in position, and a second page in the simian vocabulary set up in sounding type. Likewise we may send a monkey or a whole cage full of them into an ecstasy of passion; we may let them screech, rave, scold, bounce about, have paroxisms of anger, the revolving cylinder will take in all the clamor in an unruffled manner.

Another way of obtaining records is to hang a mirror on the horn of the phonograph, which induces the monkey to believe that another monkey is present and to talk to him. If, moreover, the phonograph utters sounds, the monkey, perhaps after some disconcert and perplexity, as he does not know where to look for his new friend, will begin to chatter with the monkey in the looking glass, and to lavish caresses on him. If anything suspicious occurs, the monkey will warn his friend in the mirror; he may also listen to the tales of woe uttered by the phonongraph and try to return some words of consolation, or be on the lookout if the voice from the horn gives a sound of alarm.

On every cylinder Mr. Garner carefully marked the accompanying circumstances, date, place, kind of the experiment and so on, for instance: New York, Dec. 16, 1891. Central Park collection. Cage of Rhesus, Capucin monkeys; cries of temper.

After having got a number of good records Mr. Garner took them to the labratory or study and carefully examined them. Then at night, when all was still and quiet, he listened to the sounds. Often it was necessary to turn the same cylinder for hours on a stretch. He could not always isolate one monkey, as often many sounds are imparted to the same cylinder, but every sound was analyzed. The ingenious construction of the phonograph allowed him to do so in the easiest manner. If he had a good clear record of some sound while the cylinder of the phonograph had been revolving at its highest speed, it was only necessary when reproducing the sound, to reduce that speed to the slowest rate at which he could obtain an audible vibration. Thus he lengthened the sound waves until he could get a very correct idea of the fundamental sound, and could finally detect the slightest shades of variation in them. Thus Mr. Garner was rewarded with an almost faultless analysis of the sound; at the same time he could trace out the defects in his own efforts to imitate them. For this was his final purpose, not only to understand that language, but also to acquire it himself so as to be able to talk to the monkeys and to be understood by them. So this never-tiring investigator went to work to learn himself what sounds the phonograph presented to him, in the beginning with failures only, of course, as the same difficulty as pointed out before presented itself: those sounds cannot be reduced to letters and thus anchored in the mind in such a way that one could recall them at leisure and compare them with others; they can be grasped only by an arbitrary effort of the memory, and that is indeed overtaxing the faculties of nearly any human being.

Nevertheless, Mr. Garner could not be discouraged so easily. Slowly, very slowly, he went on talking into the funnel what he had heard either from the monkeys themselves or from their phonographic records, over and over again comparing the result of his own efforts with the original sounds, until after many months of hard, patient work, he found that he was able to pronounce about twenty words of all those which he had recorded.

His disappointments, however, were not yet to be at an end, for when he with beating heart, tried his carefully learned words for the first time on the monkeys themselves, they did not pay the slightest attention to him, or behaved at least quite different from what he had a right to expect. When his ear had not been able to discover any differences between the sounds uttered by the monkeys and his own, those creatures were sensitive to those most subtle distinctions and could consequently not reply in the expected way.

Another series of trials was begun. Mr. Garner paid still more attention to the most minute deviation of the the sound-waves; he watched still more carefully his own progress in uttering the words which he wanted to master, he trained his ear better than before in order to detect the slightest differences between the sounds—and thus, owing to his unceasing, heroic efforts, found himself at last successful.

He had positive proof that each sound had a meaning, that with few exceptions monkeys talk with each other just as men do, not on many subjects nor in many words, but with a language of sounds, and that he, Mr. Garner, himself, was able to talk with many monkeys which understood him and gave answers. We must not suppose, of course, that such a conversation was a connected one, such as could be carried on with a man; but he could ascertain from them that they wanted food or drink; he was warned by them of the approach of danger, and often the monkeys did not hesitate to tell him that they liked or disliked him. "In many of these cases," says Mr. Garner, "my knowledge of the desire of my subject was as perfect as could have been conveyed to me by any vehicle of human thought, and since these sounds discharge every function of speech, I cannot see wherein they are not speech."

The most powerful, the most convenient agent for those proofs was again the phonograph. As mentioned before, we can get a perfect imitation of the original sound by turning the cylinder backward. To begin with an amusing experiment, Mr. Garner tried one record of monkeys, which evidently had been in a great fury, on an Italian who happened to enter his office in search of a little monkey for the organ-grinding business. As soon as those sounds came out, the Italian's eyes sparkled, his big mouth, his square white teeth were disclosed, he looked amazed, and from his tightly squeezed lips came the word in the best English he could afford, "Monk he mad."

Much more striking it is, however, to play the phonograph sounds on the monkeys themselves, as in this case we get sure proof that the sound means something, that they understand it and act accordingly. So one day a batch of brand new monkeys had been bought, however, not yet put in their regular quarters, but into another room. Mr. Garner went to them with his phonograph in which he had the record of the hunger cry of other monkeys that belonged to the same species. As soon as the cylinder was turned, all the strangers seemed to understand it, for they began to beg in their turn, making all the sounds and gestures of famine, and when these latter sounds were taken and compared with the former, they resembled each other in every respect.

In quite the same way the sound for "drinking" was uttered by the phonograph. Mr. Garner who tried the experiment on a capuchin monkey, reports that that monkey looked at him at first frowning as if he were startled to find that such a human being could have learned his language. Then he rose from his seat in the cage, answered with the same word and came forward out of the farthest corner toward the spot where Mr. Garner stood. As he still looked doubtful, the latter repeated the word, whereupon the monkey replied again with the identical word and brought him a little dish which was in the cage, and into which water was usually poured for drinking purposes. Mr. Garner put some water into it, whereupon the monkey seemed satisfied.

On many other occasions monkeys which are treated to such phonographic recitals, show through their actions that they recognize the sounds as the voices of one of their tribe. They look at the horn in surprise, speak a sound or two to it, glance around the room, and again utter a couple of sounds, often apparently afraid. They cautiously advance or retire, show grave suspicions about the things they hear from the horn, and finally try to keep away entirely, sometimes acting as though they do not know whether to regard the whole performance as a joke, or treat it as a grim and scientific fact. Their utterances and actions are then exactly like those of a child declaring with its voice that it is not afraid at all, and yet betraying fear in every act.

Several of Mr. Garner's experiments really sound like fairy-tales, nevertheless they have been witnessed by men of the highest scientific standing and greatest reliability. One day when it was very stormy and the rain was dashing against the windows, Mr. Garner took a record of a monkey who evidently suffered a great deal from the cold and unpleasant weather and tried apparently to tell his human friend, who was then on very good terms with him, how very uncomfortable he felt. Whenever a hard gust of wind and rain dashed against the windows, the monkey would leave him, rush to the window, look out and utter a distinct sound, doubtless addressed to the gentleman before the cage, and then, returning near him, would renew his plaintive speech with great earnestness. This he continued until another gust called him to the window. Each time he went he used the same sound, and sometimes stood an instant at the window, turning his head toward Mr. Garner and repeating the sound. A fine record was secured of this conversation and laid aside for future reference. Some time after, when the day was very fine, the weather most pleasant and the monkey very cheerful, this record was repeated to him from the phonograph. As soon as he heard those parts of his speech which he had uttered at the window, he, in nearly every instance, would go and look out as if he wanted to ascertain what the phonograph told him.

Now, after having proved that each sound uttered by a monkey is a real word with a definite meaning, Mr. Garner went to work to classify his collection of talks. He was sure, of course, that not too much was to be expected of a monkey—we cannot create what does not exist. The expressions he uses, indicative of his wants or his emotions, are but few. He has no ideas on the McKinley Bill, or the Silver Question, or the Princeton and Yale foot ball match. What he says may be equivalent to such expressions as: "I am hungry," "I am thirsty," "watch out, now," "I am frightened," "I would tear you to pieces if I could."

We must not even expect that their language is capable of shading sentences into narrative or giving a complaint in detail, but we are justified to think that their present form of speech is developed far above a mere series of grunts and groans, and that some species among them have a more copious and expressive speech or higher phonetic types than others.

Surely such language will be exceedingly simple, as one certain sound alone expressing something may be sufficient for the monkey, which, in his simple life, has not many wants, not many and great emotions, and as moreover there may be three or four inflections to the same sound, each with a meaning of its own. Mr. Garner makes no claim that monkeys or other animals have different sounds for the kinds of food, as bread, apple, milk, etc. ; in some instances, however, he had some cause to believe that simians use a few specific terms in their vocabulary, such as a word for monkey, and another for banana. He has experimented with these sounds and found out that the monkey uniformly uses a certain word on seeing another monkey or his own image in the looking-glass, especially if he has been kept away from other monkeys for a long time. In the same way Mr. Garner has noticed that if a monkey is fed upon milk and bread for some time without receiving any bananas, when a banana is shown him, he seems to use a sound which is slightly different from the common sound of food.

One thing, however, is by far more certain, namely that monkeys of the same species in London or New York, say precisely the same things over and over again when they are hungry, or thirsty, or afraid. This fact, at least, lays a foundation for future study. We have the same differences in languages and dialects among monkeys as among men, and the mental development of the different tribes plays an important part, or rather is the only decisive factor in fixing the degree of development for the respective languages. The capuchin monkeys for instance have their own vocabulary, likewise the white faces and the mangabi. The latter speak very little, are rather ugly in communication with other individuals of their own tribe, and have an outspoken shyness for the phonograph. The rhesus may be the bushman of their race, while we might find in the chimpanzee the Aryan, the highest development.

The most important and most frequent word in the little vocabulary of any monkey will evidently be that for "food." After a long and careful study of the word used by the capuchin, Mr. Garner landed on the formula wh-oo-w to represent it. He hesitated for a long time before committing himself, as he was fully aware of the difficulty of spelling a word with letters when the sound itself was almost like the note of a flute. Since that time he has been able to test the correctness of that formula by means of the phonograph and succeeded in doing so. The record of the sound which probably means "drink" may be expressed by the letters ch-eu w, giving the ch a guttural value as in the German word "ich," blending the eu somewhat like the same letters in French, and closing with a vanishing w as in the first word described above. The rhesus monkey's word, for food may be represented by the letters nqu-u-uw. Also this formula has been subjected to phonographic tests, and been found to be about the best literal formula that our alphabet can furnish. But many of the sounds of these little creatures cannot be represented by letters found in any alphabet. So it has been impossible yet to record the sound which means food in the dialect of the sooty mangaby monkey. It is very nearly represented by wuh-uh-uh, uttered as a guttural and with a marked tremolo. The sound is low in pitch, and the syllables are uttered in rapid succession. When this monkey is disturbed, the sound seems to be about an octave higher, but the same in form. The spider monkeys make a sound somewhat resembling that of the sooty mangaby, but much less distinct. Moreover, there is some uncertainty still about its meaning, as, although the sound, when uttered to them, attracts their attention, yet further researches indicate that it may also be a term of friendship or endearment, as the spider monkeys occasionally utter it to their images in the mirror.

One most unmistakable expression in the simian speech is the negative sign of shaking the head from side to side. It has been subjected to many tests which have met with uniform, confirming results. Seeking a source from which this sign may have originated, we conclude that it arises from an effort to turn the head away from something *not* desired, and that it has gradually crystallized into an instinctive expression of negation or refusal; while the nod of approval or affirmation may have grown out of the instinctive lowering of the head as an act of submission or acquiescence, or from reaching the head forward to receive or procure something desired, or conjointly from these two causes. Anyhow, when a monkey shakes his head in this way and utters a faint sound at the same time, and always does it in the same way and confirms the sign by a positive act of refusal, he means "no."

One more striking resemblance to human speech is found in the word which is expressed by the formula "egck," used by the capuchin as a warning of the approach of some person or something which he fears or dislikes. As the capuchin uses it, it seems to have a tincture of defiance, something like a "beware," and its equivalent in human speech is very nearly expressed by the sound "ah, ah!" or "ughn, ughn," uttered with a strong staccato effect, as is often used by man in warning or forbidding, and especially in addressing young children. So Mr. Garner tied a long thread to a glove, and placed it in a corner of the room at a distance of several feet from him, but without letting the capuchin monkey which was there see it. Holding the end of the string in his hand, he drew the glove obliquely across the room toward the cage. Quickly the monkey observed the first motion, and began to warn his master. Standing almost on tiptoe, mouth half open, he peeped cautiously, and then in a low whisper said "egck," and every few seconds repeated it, at the same time glancing at Mr. Garner to see whether he was aware of the approach of this goblin. His actions were almost human, while his movements were as stealthy as those of a cat. As the glove came closer and closer, he was more and more demonstrative, and when at last he saw the monster climbing up the leg of Mr. Garner's trousers, the monkey uttered the sound aloud, and tried to get to the enemy. Having done this a few times with about the same results, Mr. Garner relieved the little urchin's fright and anxiety by letting him examine the glove, which he did with deep interest for a moment, and then turned away disgusted. When afterward Mr. Garner repeatedly tried the same thing, he failed to elicit the slightest interest from his pet.

Many times monkeys, when very good humored, utter sounds for which no satisfactory explanation could be found, until Mr. Garner by means of phonographic experiments found out that they were real loud laughter. Some people said that it was not really laughter, but only a good natured growling, but if this is correct, the same is true of human laughter, for Mr. Garner succeeded in converting one into the other, and thus deceived the very elect of musicians and philologists. He simply took a record of a monkey laughing while the cylinder was revolving at the highest rate of speed he could obtain, and by reducing it to a very low rate he lengthened the sound waves and lowered the pitch to that of human laughter, and found both to be identical in all respects except volume. Then by taking a record of human laughter at a very low rate of speed and increasing it to a very high one, he simply shortened the sound-waves and raised the pitch to that of the monkey, and found that it was identical except in volume.

A still more remarkable feat is the fact that a monkey has learned the language of another tribe, as for instance a capuchin acquiring two sounds which strictly belonged to the tongue of the white-face, and another instance in which a young white-face cebus acquired the capuchin sound for food. The former simian, the white-face, of rather more than average intelligence, lived in a cage which stood on the same shelf and not far from another one containing a little capuchin. Mr. Garner visited the latter for many weeks, almost daily, and always supplied him with food after requiring him to ask for it in his own language. Having but little interest in the white-face who was very shy, Mr. Garner rarely showed him the slightest attention, until he observed that the monkey, which could easily see through the open wire partition between the two cages, tried to utter the capuchin sound for food which always secured for the other one a banana or some nuts. Seeing that the capuchin was always rewarded for uttering this sound, the little white-face began to try it, and as soon as Mr. Garner discovered his purpose, he began to reward him in the same way, and thus saw one step taken by a monkey in the mastery of another tongue. At first the little creature's effort was quite poor, and nobody could decide what he meant, but practice soon developed in him great proficiency, and now he speaks it almost as plainly as the capuchin himself.

On another occasion Mr. Garner was surprised to hear a capuchin utter a sound which, to his knowledge, belonged to the white-face tongue, and on investigation found out that he had occupied a room with a white-face for about four years.

So far we must admit that there is no intrinsic difference between the vocal sounds of man and simian. Their voices differ in compass, pitch and flexion, but not in their mode of producing sound. In fact, there is no doubt that if human speech were divested of the accretions of social culture and contact, it would not be so unlike the simian speech as popular belief regards it.

In order to find out particulars about that, Mr. Garner has proposed to go, or rather has gone to Africa, to study the language of the more distinguished of the simian race, the gorilla, also to take down the speech of the lowest specimens of the human tribe, the bushmen, and to compare results. If there be family resemblance, and structural relationship, between the rhesus monkey, the chimpanzee, and the lower grades of humanity, there may be correlation of speech, philological kinship, and then—and then the origin of man's talk may be found.

As a detailed description of this trip does not really belong within the realm of this paper, it may be said only that Mr. Garner has taken with him to the Gaboon country at the west shore of Africa, a large iron cage constructed in sections so as to be readily transported. This cage is not intended to catch gorillas in, on the contrary it is meant to keep them out. Prof. Garner proposes to occupy it himself, having set it up in the midst of the forest. His idea is to lure (if he can) a gorilla in the proximity of the phonograph, and to get him, without knowing it, to talk into the funnel. At the same time he will try to catch by ear a few suggestions of the language employed by these wild creatures in shouting to one another, and then, as the study he has already made of monkey talk will be a help, he proposes to make use of the words he has acquired and take part in the conversation. Thus he may attract certain individuals, especially females, about him; presumably they will be favorably prepossessed with so agreeable an anthropoid as the professor, and intimacies may result which will afford most profitable opportunities for conversation. He will not venture out of the cage, however.

A great number of phonographs will be placed around the inside of the cage, with large trumpets fixed to their diaphragms and pointing outward. If any gorillas approach the barred inclosure and have any remarks to make of a hostile or amatory nature, the electric batteries controlling the phonographs can be turned on at a moment's notice, and the words uttered will be indelibly recorded for future study. More than that, with the actual scientific apparatus which Prof. Garner has taken with him, he will not only record voices, but will by means of electric communication snap a camera on him. The visitor will be photographed just as he is, never having been cramped by confinement, and will only be captured afterwards, if possible. For should the gorilla ever touch the iron bars of the cage, either in a playful way or in order to get more intimate with its inmate, a mighty electric shock will be given him, making him helpless and leaving him at the mercy of the captor.

All this seems like a Jules Verne excursion into Fairy Land, but with a man as a directing spirit, who will go to Africa, taking with him all those implements which have positive and practical effectiveness, much may be expected. No one can know what Mr. Garner may accomplish, but even now we know that his discovery is a most important, a most striking one. We need not yet think of those propositions which the ever-ready funny papers have made, to send out missionaries among the monkeys and to civilize them; we need not think of learning ourselves their language in order to be able to converse with them. It is even premature to point out the possibility that monkeys may be educated to a limited extent. Moreover, all these considerations lie outside of the territory of this paper, and I will not dwell on them at length, nor on their importance for linguists.

What I wanted to emphasize here is that we consider in Mr. Garner's discovery one of the most powerful and most convincing links for the chain of proofs that establish evolution. Indeed, we are allowed to say that any one who is still contesting the animal descent of man exposes himself to the suspicion that he cannot make a simple conclusion. There are few scientific hypotheses which can be raised to an equally high degree of probability, a probability which comes as near certainty as is possible, with a fact which cannot be observed with our own eyes.

It is true that no other doctrine, with the exception perhaps of Copernicus' new planetary system, has interfered so much with our innermost convictions. For it tries to solve "the question of questions," the fundamental question of the position of man in nature, and this had hitherto been quite different from what the theory of evolution teaches. Just as man is the measure of all things, so also the last fundamental questions and the highest principles of all science must depend upon the position which our advanced natural science gives to man himself in nature. Evolution has for the first time since times immemorial tried to solve the question of the origin of man in a scientific way. It is a common error, however, that Darwin's theory teaches a descent of man from the apes which live nowadays. Darwin's idea has quite a different root and direction, and its application to the human race is only one of the last consequences, but does not at all represent the whole theory. He tells us that all living beings originate from one organism or from a few very simple organisms, and that they have developed in the natural way of gradual changes. It is, as already stated, only on the last conclusions of this theory, applied to mankind, that we must trace our origin back to the highest mammals, to the apes.

This fact seems to be horrid and ugly at the first glance, not only as the fact itself, but much more in its consequences upon our thinking and feeling, upon our whole intellectual and moral life. We have been told that this scientific statement destroys not only every religion, but also morality and all the highest properties of our human and of our divine life. It has been said that such science must bring about the state of anarchy in every country, and the ruin of all laws of civilization and society. We do not think so, however. Just as in the sixteenth century, the new doctrine of the revolution of the planets around the sun became the powerful agent of an unheard of progress in the true knowledge of nature and consequently in all civilization, so also Darwin's theory must be hailed as the morning star of a new period in the history of man ; and far from being the cause of a deterioration and humiliation of our race, the knowledge of our animal origin will serve only to better our faculties, to improve our minds, souls and hearts, and to rapidly increase our intellectual development. And aside from these consequences, is it really so humiliating to know that we have worked our way up through a long and slow process of differentiation and perfection to the state in which we are now? The theory of evolution does not only explain the origin of man and the course of his historical development in the most natural way, it gives us also the right to feel proud of ourselves, to look upon our development as the highest triumph of our own over the whole remaining nature, and to feel confident that also in future the human race will proceed on its glorious course of development and reach higher and higher stages of intellectual perfection. In this sense, Darwin's theory gives us the most cheerful prospect for the future and invalidates all fears which have been obstacles to its extension. Instead of that relentless cruelty and that unavoidable depression which seems to result from that terrible theory of the "struggle for life" and the "survival only of the fittest," which mercilessly sacrifices all the weak and those unfit for given conditions of life, we must consider that we are now the fittest, and that it is a necessary consequence for us to perfect ourselves more and more. Therein lies an immense comfort, and therein lies the boundless moral significance of Darwin's theory, which only short-sighted or obstinate people cannot see. Or is there anyone who will deny in earnest that there is in the supposition of an incessant development of mankind an extraordinarily comforting assurance? The brutal struggle for life will take the form of a noble contest in perfecting our intelligence and our humanity, our virtues and our morals. But even if this were not the case, we ought not to hesitate one moment to state the results of our scientific researches, no matter if they are agreeable or disagreeable to our feelings, desires and inclinations. What we strive at is truth, nothing but truth, no matter how we find it, and how it presents itself. We do not hesitate a moment to tear down old systems and doctrines if they should prevent the truth from coming forward and spreading out among all people. Does that necessarily mean that we destroy religion? On the contrary, we are firm believers in the statement of the old philosopher: "Only he who seeks truth seeks God."

This brings up a question, the last one I shall touch to-night, which in the opinion of many present, does not belong here at all, and yet which stands in close relation to this subject under discussion. It is the often repeated reproach that the Darwinists have no religion at all, that they do not believe in a divine Creator, and that they want to remove religion entirely from the earth. This idea is so wide spread, and it is so extremely hard to succeed in convincing people of the contrary, that I for a long time hesitated whether it would be advisable for me to choose this subject for my lecture. No, I act in self-defense only when I say emphatically that nothing is less grounded than such a reproach. There is no Darwinist in the whole wide world who does not believe in God, who is not through his very studies more convinced than many other people that there must be an almighty, all-wise and all-kind Creator, who made this beautiful world and governs it according to his power and wisdom. There is no scientist who ever looked up to the starry heavens or investigated the wonderful construction of a flower, of a leaf, or who examined the magnificent frame of our own body with its numberless fine and splendid properties, there is no one, I say, who is not much more inclined to fold his hands in prayer and cry out full of devotion: O Lord, how wonderful are Thy works! Nature alone tells us much more plainly and better than any other source that there must be an almighty Creator of the Universe, and I myself have never felt that more distinctly than when I had taken a look into the workshop of the Almighty wherein he has arranged everything so beautifully according to number, measure and weight. Only a fool can say that there is no God.

There is only one thing which we fight against, and that is the idea that we, Man, are the centre of all life on earth; that we are of a special divine origin created by a special act of our Creator, and that all the rest of creation, animals, plants and stones, are made only to serve man; that we are the last end and the highest purpose of all creation; that we are the crown of the whole universe, just as the earth is the centre and the principal part of the world.

Such ideas are contradictory to every scientific fact, and contain therefore much more danger for the development of our intelligence, which will not and cannot be stopped at all. The idea that the world was good in the beginning, that the man of to-day is a degenerated being, sunk down from his former perfection and godlikeness and perished through sin; this idea is a phantom, such as only priests could invent and philosophers defend. But even if the balance were wavering, we may boldly put the question: Which turns to the greater honor of our race, having sunk down into sin, or having worked up through our own force to the wonderful being which has bridged time and space, which climbs the heavens, which measures the universe, and which begins to conceive himself?

At the conclusion of the paper it was discussed by Dr. C. B. Warring and Mr. Edward Burgess.

Mr. S. J. Robinson was elected to membership in the Section.

JANUARY 17, 1893—SECOND REGULAR MEETING.

Dr. Warring read a very interesting paper entitled:

FACTS AND THEORIES.

BY CHARLES B. WARRING, PH.D.

Perhaps nothing marks more clearly the change—shall I say progress? in the public mind, than its attitude towards science. Not many years ago, scientist was to most people synonymous with infidel, and infidel meant atheist, and the fate of our first parents was gravely held up as a warning to those who would pry too deeply into the mysteries of nature. To-day the pendulum has swung to the opposite end of the arc, and the same persons, or rather their successors, now stand more than ready to accept all that is offered in the name of science.

Then, whatever did not agree with the current theology was deemed unworthy of belief; now it is the fashion to regard anything which does not agree with what somebody has labeled "scientific" as, *ipso facto*, untrue. Once science was a bogie to frighten grayheaded children and pantalooned women. Now they find it a fetich to be worshipped. This is not greatly to be wondered at, for the world has seen astronomers predict eclipses, and transits, and conjunctions, and at the appointed hour the predictions were fulfilled more exactly than a time-table predicts the arrival of cars. They have read that mathematicians map out the paths of comets, calculate the delay that must come from the interfering attraction of the planets, and announce how many hours late these travelers from afar will arrive at perihelion — the grand station at which their sunward journey ends. They have learned that science has weighed the earth, its sister planets and the sun, to say nothing of moons and comets. They are told that this weighing is not a matter of guessing, but is accomplished with a less percentage of error than grocers weigh out their sugars. Then, too, there is the outreach of science into the abyss of space about us. It takes the distance from here to the sun, measures it, takes that as its unit—its yardstick, some 93,000,000 miles long—and then tells with almost absolute accuracy how many such "yards" it is from the sun to each planet, how far the comets go before they begin to return, or whether they are strangers in our system, looking in upon us for a few days, and then speeding away, circling by sun after sun, until, having completed the circuit of the universe in years too infinite to number, they shall return to the spot where our system once was, and find our earth with its sister planets and all their satellites motionless and dead, buried in the cold and dark sun.

They read that the velocity of light, to conceive of which paralyzes the imagination, has been measured in ways independent of each other, and that the result, marvelously agree. They have heard that physicists are able with help of the specstroscope, to tell what the stars are made of, and that invisible stars have been detected by the perturbations which they produce in the movements of stars that are visible. They have seen the geologists overthrow the traditional belief that, till some 6,000 years ago, there was neither plant nor animal on our globe, nor globe for them to inhabit.

Then there is the wonderful array of discoveries and inventions which distinguish the present half century. Light made to do our printing. Steam made to do our work. Electricity made to give us light and heat, and to carry our messages, reproducing even the tones of our voices. Without geering or belts, it mysteriously and silently transports energy from the waterfall, or the steam engine, to distant points, and there delivers it to do man's will.

I do not wonder that plain men give to science attributes little short of omniscience, and, with a faith that is really touching in its unquestioning simplicity, drink in the words of those who are supposed to be its high priests. But they soon find themselves disappointed and perplexed. Science, they imagine, is but another name for truth, and truth, they know, never becomes falsehood. It may increase, but never grows less, never denies itself. But they read in some standard work on optics, that light, according to Sir Isaac Newton, consists of little particles of matter shot out from the sun, and then, a few paragraphs farther on, that light is not particles of matter at all, and that nothing is shot out from the sun except an intangible, invisible, imponderable something called energy, and that it is this which causes undulations in an interplanetary substance (?) styled ether, and that these excite the sensation of seeing. And then they read a little further, and find that to-day most scientists think the undulatory theory is about to follow the corpuscular, being on the verge of being supplanted by a new hypothesis, and that it now seems most probable, that light is only a mode of electrical action.

And then if these innocents in science turn to read about electricity, they find in one place that it is a single fluid whose excess or deficiency, makes bodies positive or negative; in another, that it consists of two fluids which separate possess most remarkable powers, but united have none, reversing the old motto, "In union is strength." Later, another scientist tells them that that electricity is not one, nor two, nor any kind of fluid, or substance at all, but only a mode of energy. And then this is denied, and electricity is again a fluid but whether it is one, or two, is uncertain, but however that may be, it is no more a form of energy than is running water.

These seekers for knowledge by short roads, these reverent accepters of all that is said to be science, read that the planetary system was evolved from the sun, the planets having flown off from it under centrifugal action as water flies from a rapidly revolving grindstone. They meditate on this interesting operation, think how nicely it accounts for the orbits all lying pretty nearly in one plane, for the orbital and axial motions being pretty nearly in one direction, and for all the axes being pretty nearly parallel. They get their mental operations adjusted to such a scheme, and settle down in comfort, satisfied that Laplace was not so much out of the way when he told Napoleon that God in creation was an unnecessary hypothesis. But alas for the instability of all things earthly! A few years later this quiet was disturbed by a parcel of iconoclastic philosophers who recklessly proved that the planets could not have been thrown off from the sun, and that, on the contrary, no planet was ever before as near the sun as it now is ; that, at first, all the planets and the sun constituted one mass of highly attenuated matter extending beyond the orbit of Neptune ; that this matter was drawn centreward, condensing more and more, and somehow getting itself into a rotation around its centre of gravity, with ever increasing speed, until the centrifugal force became sufficiently great to stop the inward movement of the external portion ; that the central part continued to condense, but the ring left behind, broken to pieces by the mutual attraction of its parts, was gradually gathered up into a sphere, the first of planets, now known as Neptune ; that Uranus, Saturn, Jupiter, Mars and their sister planets were formed in the same way. And now, along comes another scientist and says : This won't do, this theory needs emendation. There are those fragmentary bodies in inter-planetary space, once probably far more nunerous than now. They must have played an important part in world-making. The planets at their first condensation from nebulous matter were very small, perhaps smaller than the least of the asteroids, but for all that immensely larger than these little bodies, and hence by their superior attraction, drew to themselves infinite numbers of them, and so, through countless ages, the planets grew to their present size.

Fifty years ago it was taught that the sun was a magnificent world inhabited by beings more favored than the denizens of earth. Shielded by a canopy of phosphorescent clouds, they dwelt in perpetual spring and endless day. Poet-philosophers exhausted their imaginations depicting the beauties of the solar landscape. To them it was the region of the blessed, for do we not read : "There shall be no night there?" and where else could that promise be realized ? But now philosophers tell a very different story. The sun, they say, is a collection of inconceivably hot vapors and gases. If inhabited, it is by beings able to endure a heat many hundred times greater than that of any earthly fire, a heat in which substances which remain solid before the oxy-hydrogen blowpipe, would be instantly dissipated in vapor. Instead of perpetual peace, violence reigns. Through the spectro-telescope cyclones are constantly seen sweeping over its surface, not as on the earth, a hundred miles or so in an hour, but hundreds of miles in a second. Fire-spouts, millions of square miles in sectional area, burst at frequent intervals from its interior and rise thousands of miles into its atmosphere. Huge vortices, veritable maelstroms, are in almost constant action, down whose throats hundreds of worlds as large as ours could be drawn without crowding or jostling. It is a world of fiery wonders. We read in ancient story of Phlegethon, a river of fire flowing around the realms of Pluto; but, in the sun, astronomers tell us, is a real river of fire infinitely surpassing the wildest fiction. A stream more than 300,000 miles wide—a distance far greater than from here to the moon—girdles the sun. Unlike rivers on the earth, it has neither head nor mouth, its width is everywhere the same. It is a broad belt of hot matter more than 2,750,000 miles long, flowing eastward, not as our Gulf Stream, at the rate at most of five or six miles an hour, but of five or six miles a second, three hundred miles an hours. What a world! How different from the fancies of a few years ago!

Time would fail me to recount the theories whose remains thickly strow the shores of the stream of time. Most of them—all the most important ones—were, in their day, accepted as more than probable by the great philosophers, and by others as final truths. John Leslie, a physicist of no mean rank, was selected to write an introductory essay to the eighth edition of the Encyclopedia Britannica, not so very many years ago, and in it tells his readers of the sad catastrophe that would have occurred, had the sun been made a few times more massive than it is, for that would have so increased its attractive power that the luminous corpuscles shot forth from its surface, would have been drawn back before they reached the planet Mercury, just as the earth draws back a stone before it reaches the clouds. And so, all the planets, our own included, would have remained forever in darkness.

At no time has theory-making gone on more largely than now. At no time have theories influenced more profoundly the currents of thought than to-day. Yet every thinking man knows, partly from the large proportion of once fair and flourishing theories that have perished, and partly from the enormous load of hypothesis that many theories carry, that our children will wonder how the present generation could believe many things which now seem indisputable.

Plain men who make no pretention to be philosophers, but desire to learn all they can from those who they think know so much, may well be perplexed, and exclaim: "Is there nothing settled in science? Is there nothing real? Nothing that one can tie to, and be sure that it will always be there?"

Yes, there is much that is permanent. All science consists of two very distinct catagories, facts and theories. The latter attract the public eye and are apparently much the more important, but the former alone have self-contained value. Facts are true now and always; all else may change, they never do. Theories may come, and theories may go, but a fact is a fact forever. We may, indeed, be mistaken, and regard something as a fact which is not one. But the fault is in ourselves. We have not been careful enough. We have seen incorrectly, or our ears have deceived us, or in some way we have misunderstood. Facts never contradict one another. If they seem to do so, we know that the contradiction is only apparent. In some way it can be explained. A cork in water goes up, and a stone goes down, an apparent contradiction which the schoolmen sought to reconcile by saying that the cork had an inherent principle of levity, while the stone had a natural downward tendency, we now explain it very differently, but the facts remain and the contradiction has ceased.

Facts are stubborn things; nothing can make them give way. The best made theory goes down when squarely contradicted by a single one. The phlogistic theory of combustion, apparently so sensible, for everybody could see that the fire came out of the burning body, was refuted by the fact, which was at length discovered, that the products of combustion weighed more than the substance burned. Not very long ago, everybody—everybody who desired to have any standing, as a man of scientific knowledge—believed that heat, or caloric, as it was called, was an imponderable fluid residing in the space between the molecules of bodies, which, when by any means it was forced out, caused a rise in temperature. If so, it was readily seen that the amount of caloric in a body was limited, because the vacant space or interstices, were limited in size. When Count Rumford showed by his celebrated but long undervalued experiment of rubbing two bodies together, that the amount of heat produced has no limits, but continues to come in undiminished quantities, so long as the friction continues, the theory met a fact that could not be got out of its way, and the theory, though tenacious of life, was obliged to succumb.

In all cases it is only the theory that comes to grief. Every fact remains as it was. Some supposed facts perhaps have been shown not to be facts; some new ones have been added, but as to all that was fact before, everything in them and in their relation to each other, and to other facts, remains unaffected. As when one passes through a mountainous region, he sees new peaks and crests, and every thing seems to change as he advances, yet every peak and crest was just as high, as steep, as long and as broad, before he came. Whichever theory as to the formation of the solar system prevails, or if hereafter a better one shall be devised, every fact now known as to the position of the orbits, and the direction of the rotation of the planets, or as to fluid bodies becoming spheroidal, or as to the internal heat of the earth, or the condition of the planets and the sun, or as to the spectroscopic lines in certain nebulæ, will be unaffected, and must have due consideration in every future theory.

So, too, in regard to light. The corpuscular theory has come and gone; the undulatory bids fair to follow it; but if it does, not one particle of knowledge will be lost. The laws of optics now known will not be affected. The angle of incidence will still be equal to the angle of reflection. The index of refraction for all known bodies will still be found by dividing the sine of the angle of incidence by that of refraction. Convex lenses and concave mirrors will continue to magnify. The prism will continue to give the bright colors, and the spectroscope to give the black lines in the solar spectrum with entire indifference to Newton's corpuscules or Huyghen's undulations.

Every fact now known in regard to electricity will be unaffected, though all present theories should be supplanted by one not yet thought of. Everything true now will be true then, and must find its place and weight in any satisfactory theory.

The point I wish to emphasize is this: The destruction of a theory is never a loss to science. On the contrary, it is a gain. If to-day an angel should come to our planet, and calling together the students of science in every department; should demonstrate to them the errors in present theories, they would be dazed by the greatness of the catastrophe. Few, indeed, would be the theories that would survive. Probably not one would escape serious damage, except that which pertains to the mechanism of the heavens, explaining all astronomical movements by an original impulse affected by a centreward stress varying inversely as the square of the distance, and directly as the masses. And yet, by the irony of fate, this theory, so perfect that it is the pride and boast of the human intellect, rests upon the existence of an attraction, an impulse, a stress or whatever it is—we call it gravitation—which in defiance of every effort, refuses to be brought into any theory.

The layman in science, the man who would have general conclusions and short explanations, and who dotes on theories, would stand aghast at such wholesale destruction, and imagine the dark ages were about to return, yet not one fact would be lost, and only an immense amount of rubbish would be cleared away. After such a purifiying, science would bound forward with an energy and success, far surpassing all that it had done before.

I trust I have made clear the enormous difference in vitality and importance between facts and theories. But do not underrate the latter. Only He who knows all things has no need of their assistance. We mortals remain forever learners. We need them as aids to memory. In every department of knowledge, the number of facts is so large that to hold them in mind without the mnemotechny of a theory, which fits places for them, and puts them there, would be impossible. The atomic theory is indispensable to the chemist, although his atoms differ from those of all other physicians in that they are of various weights, and have various qualities. He finds it, too, an exceedingly useful thing to hold that changes of atomic position may result in change of every property but mass. The lay mind finds it impossible to conceive how a thing apparently so unimportant as a mere change in the position of the same atoms should result in the exhibition of qualities so different. The chemist, I suspect, is in the same predicament, but he knows that something has occurred, he can think of nothing better than a change of position, a change in atomic arrangement, and that must do service until he can think of something more satisfactory.

Another important office of theory is to aid in the discovery of truth. Nature is a dumb oracle to all who do not rightly question it, and to them its answers are only monosyllabic, a yes or a no. But such answers given to questions judiciously put may give an amount of information limited only by the skill and knowledge of the questioner.

We have all played a parlor game in which one is required to discover something thought of by the rest of the company. He is to ask twenty questions which must each be answered by yes, or no. One who plays the game well, will quickly succeed, while a novice will often fail. The former selects his questions so that every time he asks one he narrows the field.

"Is it on our planet?"

"Yes," tells him the thing thought of is not a heavenly body.

"Is it found in the Eastern Hemisphere?" "No," confines him to the Western.

"Is it in the Northern Hemisphere?" "No," tells him not to look for it in North America.

"Is it an organism of any kind?" "No," throws out all plants and animals.

"Is it a solid?" "No." Then it must be a fluid.

"Is it water?" "Yes." But water is found everywhere. It must be some special form of water, probably some body of water not extending to the Eastern, or the Northern Hemisphere.

"Is it salt water?" "No," limits the inquiry to rivers and fresh water lakes.

"Is it a lake?" "No," tells him that it is a river.

"Is it very large?" "Yes," confines his next question within narrow limits.

"Is it the Amazon?" "No," it is not the Amazon.

"Is it north of it?" "Yes." Then it must be the Oronoco.

This well illustrates his method who would learn from Nature. He must have a well defined plan, and let question follow questions in a carefully prepared order, gradually forcing from the oracle the desired answer. He must therefore arrange his facts, examine the relations between them, and fix upon what he thinks the true explanation of the phenomena which they present. In other words, he must make a theory. Now he has something which he can mentally handle. He can decide what questions to ask, and in what order to put them. Without this, all would have been in confusion, and the oracle's answers of little value. His theory may be simple, or it may be complex. For the former, the crucial question is easily formed, and one may suffice. For the latter, many questions may be necessary. The theories that have prevailed as to the shape of the earth, illustrate the first.

It was long the consensus of scientists that the earth was flat. One, esteemed a crank by the wise men of his day, thought it was round. The question, which with the assistance of Isabella and the permission of Ferdinand, he put to nature, was this. Can one sail west to India? It was only partially put at first, but the answer so far as it went, was an affirmative. Later on, Magellan put the question fully, and got a full answer, Yes. Men then settled into the belief, another name for theory, that the world was a true sphere with diameters all equal. But was it so?

Scientists differed. All agreed that if it was a sphere, degrees of latitude everywhere would be of the same length, and, if it was an oblate spheroid, as seemed to be indicated by the shortening of the pendulum near the equator, and by the necessary effect of centrifugal action, a degree of latitude measured to the far north, ought to be longer than one measured near the equator. The question was put, two such degrees were measured with all the care possible, and the polar degree was found to be the longer. The earth therefore, is a sphere flattened at the poles.

More complex theories present greater difficulty in properly framing the questions. The principle, however, and the method are substantially the same.

A third office of theories is to serve as hypothetical foundations on which to build logical structures, which have sometimes led to discoveries of great importance. A theory as to the perturbations of Uranus led Leverrier to the discovery of Neptune.

Lastly, theories serve as a scaffolding on which to stand while the work is going on, and, like other scaffolding, are destined to be removed when the structure is completed.

What I have said, will I hope, convince those who are not scientists—scientists know it now—that theories are in their nature only tentative, temporary expedients, helps to be used until replaced by something better. In their place they are very important, so much so that without their assistance very little progress would be possible. But woe to the man who builds on them, thinking he has bed-rock under him. Some morning he will wake up, and find his foundation gone, and his superstructure, reared with so much logic, vanished.

Theories may become dangerous. Not as in the past when scientists could burn Bruno, and imprison Galilleo, for holding theories contrary to their own, for it was for this and not for contradicting Bible theories—the Bible has no theories—that those men and others were persecuted.

The danger now is of a very different character. Sometimes they retard the progress of science, by belittling new discoveries. It is said that no physician over forty years of age, contemporary with Harvey, adopted his views as to the circulation of the blood. It is said, too, that Newton refused to look into Huyghens' invention of the achromatic telescope, because his theory of refraction said that achromatism was impossible. And, saddest of all, Solomon Caus, a Frenchman, who believed that steam could be made to drive machinery, and insisted on talking and writing about it, was thought insane. For years he was shut up in a madhouse, where at last his reason gave way, and he died a raving maniac. Count Rumford's famous experiment, the foundation of the modern theory of heat, received little attention until long after his death.

Another danger comes from too great readiness to accept theories—or even mere hypotheses—as tests of truth. This is especially apt to occur in the border land of science—in that broad and undefined region living between physics and metaphysics. Here we find discussions of space of more than three dimensions, of the nature of atoms, of the kinetic theory of gases, of the origin of axioms, and the like. Here is much that is assumed as known in biology, and notably in the department of biology which treats of the origin of species.

These dangers are comparatively harmless, for the truth will always prevail, although its triumph may long be delayed. A third danger may result in more serious consequences. I refer to the use to which theories are sometimes put, especially those which really, or, as is more often the case, which seem to oppose revelation. To many minds a flavor of heresy gives piquancy to what might otherwise pass unnoticed. That this is true, whatever its explanation, few will deny. Do philosophers prove that our world is round, and that it revolves around the sun? "That overthrows the Bible." Do they say that our earth is one of the smallest members of the solar system, and that the innumerable fixed stars are suns? and that those worlds are inhabited? "That overthrows the Bible estimate of man's importance, and consequently disproves the Bible's teachings as to the infinite sacrifice necessary for man's redemption." Is it shown that the earth is many times 6,000 years old? "That overthrows the Bible!"

A few years ago, it was most confidently said that under proper conditions of temperature, certain inorganic substances produced living creatures by mere chemical action, spontaneous generation it is called. At once it was loudly proclaimed, "This overthrows the Bible doctrine of creation by act of the Almighty."

We all remember the announcement that Col. Ledyard and others had found in the ruins of ancient Nineveh, tablets on which were the originals from which Moses obtained the first part of Genesis. There we were told, he got the story of Creation, the temptation and fall, the tree of life, the expulsion from the garden, the flaming sword of the cherubim, forbidding all return, as well as the story of Noah, the ark and the deluge. Again the cry went forth, "The Bible is overthrown. In this part at least, it is proved to be only a collection of Chaldean Myths, and probably the rest is no better."

I might extend this list indefinitely and show how almost every discovery which could be made to have any bearing on the subject, has been claimed as overthrowing something in the Bible. Never is the claim more loudly put than when the discovery is new, with neither time nor opportunity for examination. Then it is pressed for all that it is worth—and a great deal more. The opponents of revelation advance like an army with banners, in strange contrast with the silence with which they accept defeat.

A brief review will suffice to show that in none of these instances said to be so damaging, has any harm come to our faith in revelation. The Bible nowhere says the earth is flat, hence it is not contradicted by its being round.

Man's place in the universe is one of solitary grandeur, and the Bible does not overrate his relative importance, for science has at last discovered that neither sun nor planet can be inhabited on account of their intense heat, unless the little planet Mars be an exception, and there the lack of color changes, as its spring comes on, renders improbable the presence of vegetation, and therefore, of animals. As to the moon, it is known that it possesses neither air nor water, and this, together with the extremes of heat and cold coming every two weeks, forbids its being inhabited.

As to the age of the world, the Bible says nothing about it, and hence cannot be contradicted by the geologists. Spontaneous generation has been disproved by Prof. Tyndall's exhaustive experiments. Nothing more is heard about it. The claims made for the Chaldean records have wonderfully dwindled. It is now admitted by Prof. Sayce and other Assyriologists, that the tablets say nothing as to the temptation and fall, or the tree of life, or the expulsion from the garden, or the cherubim with flaming sword. There is indeed the story of a flood which agrees in important particulars with the Noachian —and no wonder, for it was written so near the deluge that tradition could easily preserve an account of it. In fact, the story of an universal deluge has survived in some of its most important particulars, among nearly all nations to the present day.

As to the so called story of the creation found on the Chaldean tablets, it is difficult to see how any person with his mind free from bias, could imagine it the original of the Mosaic account. For example the myth begins with the heavens and earth as in existence before any god, "before the great gods were made any one of them. The sea was the mother of them all." On the contrary the Bible represents God as before all, and as the creator of heaven, earth and sea. Equal divergence and positive contradiction run through the whole of the myth.

To nothing has the opposition of a certain class of scientists been more pronounced, on nothing have their attacks been more frequent, or their paens of victory more loud than in reference to that brief chapter which contains the Bible Annals of Creation. Again and again, they have said that its statements are false and their order wrong. And even to-day "liberal" theologians are so impressed by these positive and oft-repeated assertions, that they accept them as true, and point to that chapter as glaring proof of the errancy of the Bible, or, as others say, of its human origin.

I do not propose now to discuss that "grand old chapter," I have done that elsewhere, I would only point out the fact that it is the traditional teachings—the glosses of a more or less ancient "science," and not the account itself, its *verba ipsissima*, that is in error. All I can now do is to name briefly as possible certain facts in our world's ante-human history on which all scientists are agreed, leaving the reader if so inclined to collate them, not with what Milton, or what the commentators have said, but with the story itself in its own words, and above all to compare the order as given by Genesis with that of the most advanced science, agnostic or not.

Through centuries of observation and study, with many mistakes and corrections, some solid results have been secured, facts which it is safe to tie to. And these are some of them.

The earth and heavens had a beginning.

The earth was at first an integral part of an immense nebulous mass, and consequently, literally without form, and void of land, water, plants and animals.

Prior to motion, the earth was enveloped in darkness.

Light, which began in that nebulous mass with little color-giving power, became more and more like present light as the condensation of the nebulous matter went on, until it obtained the full richness of present solar rays, *i. e.*, was good for all its present uses. This completion, or "goodness," was attained before that division between light and darkness, which we call Day and Night, was made.

Subsequent to this, the earth was enveloped in dense vapor of water forming clouds of enormous thickness, in which a process of condensation went on, making them thinner and thinner, until through their rifts the heavens were visible.

This vast expanse was filled with an atmosphere so loaded with carbonic acid and other poisonous gases that animal or plant life was impossible for other than the lowest types; hence it was not yet "good."

The present dry land was once under the water.

Of present living organisms, at least as to the higher forms, the vegetable kingdom attained its present state, its culmination in grasses, herbs and trees of to-day before the animal kingdom reached its final development in present living species.

After the plant world had arrived at its present goal, but with a very considerable geological period between, the water and the air divisions of the animal kingdom reached their present development in the living species of whales and other great water vertebrates, and other water creatures which the waters brought forth abundantly, and also in an abundance of birds, those of to-day.

Notice, it is not water creatures in one period, and in another birds, but both at once.

That division of the animal kingdom which includes present cattle and wild beasts and other land creatures, came last of all.

These are facts, not theories. They are the teachings of science, and not that of man in the infancy of the race, not that of Egypt, nor of Assyria, nor of Rome, nor of the last century, nor of fifty years ago, but of the latter part of the nineteenth century. Yet, so far as it goes, it is a paraphrase of the first chapter of Genesis without changing the order of a single item. Nor is it any answer to say what everybody knows, that the geological plants and animals long preceded living species, for it was impossible for Moses to have alluded to them, since Geology was not then dreamed of, and if God was the author of the account, which our agnostic friends so strenuously deny, He could not have referred to the first vegetation as including grass or fruit trees, for He knew better. For like reasons, it is, I think, evident that the account has no reference to the extinct fossil animals. Moses knew nothing of them and God knew infinitely too much to include cattle among the first land animals.

I submit that this more than counterbalances the opposition of immature theories which have yet to establish their own right to be. It justifies the claim that established science is not hostile to that epitome of the pre-Adamic history of our world which is found in our bibles. Only when in the stage of callow theory, or when it substitutes Miiton for Moses, does science show such tendencies.

What lesson would I have the reader draw from this discussion ?

I would have him keep theories in their proper place, servants of science, and not its master.

I would have him always remember that theories are subject to change, sometimes very sudden and extraordinary, and that, with so few exceptions that they can be counted on the fingers of one hand, probably with three fingers to spare, all scientific theories are largely in error either from truths omitted, or from falsehoods mistaken for truth.

I would have him beware of reasoning from theories as from axioms, in geometry. They will disappoint him if he does.

I would say to him, don't give up your faith in that book which has come down through the ages, because some one high in the hierarchy of science, says science has disapproved it. So called insurmountable obstacles have so often vanished with increased knowledge that you may well be incredulous as to new ones. If you can't see through the difficulty, wait.

The subject was discussed by Members Cooley, Dwight, Winne, Neumann and Burgess.

JANUARY 24, 1893—THIRD REGULAR MEETING.

Present Chairman Burgess, and 40 members and visitors.

A paper was presented by Mr. Wm. C. Albro on the "Scientific Limitations of Government in Business."

The paper was discussed by Prof. H. E. Mills of Vassar College, and Mr. F. S. Arnold.

FEBRUARY 21, 1893—FOURTH REGULAR MEETING.

Present Chairman Burgess, and 30 members and visitors.

The following paper was presented by Mr. Edward Elsworth, entitled:

DUST AND WATER.

I have adopted this subject, not because I have anything new or original concerning it to offer, but principally because it may direct our thoughts towards some sanitary questions that are of the utmost importance to us as dwellers in a populous community. When I was reminded of my promise to our chairman, to address the Section on some evening in February, '93, clouds of dust were rising in the wind swept streets, impressing its disagreeable presence upon all the senses, and suggesting the absence of the grateful andidote, water, so I decided to make the subject of my remarks "Dust and Water."

A gentle critic of my own household insinuated, "Why not call it mud?" But I do not propose to speak of water and dust compounded, although I may say something concerning their relation to each other. What I particularly desire to call your attention to, is some sanitary observations in connection with each. It is safe to say that if it were not for dust—if it could be eliminated—kept under or otherwise disposed of, the health of the human race would be improved 75 per cent. It is however in its baleful aspect, the product of civilization, and the attendant of barbarism. The very air is laden with it, and nothing short of a vacuum may be entirely free from it.

What is dust? A suggestive and quite comprehensive answer to this question may be quoted from Dr. Prudden's book "Dust and its Dangers"—of which I shall make free use.

"The coarser particles of dust, such as are usually swept into our faces whenever we go upon the streets, in dry and windy weather, consist largely of small fragments of sand, broken fibres of plants, pollen, fine hairs, the pulverized excreta of various domestic animals, ashes, fibres of clothing and other fabrics, particles of lime or plaster or soot, parts of seeds of plants, masses and clusters of various kinds of micro organisms, and partially ground up materials of kinds too numerous to mention."

Within this latter category I ought to include specifically a new form of dust which has made its appearance in the city of New York since the advent of the elevated railway system—viz., a vast amount of minute metallic dust which has been liberated by the constant friction of the car wheels over and against the rails, and the ceaseless jar of the whole iron structure. Oculists aver that there has been a marked increase in the number of cases of diseases of the eye since the building of these railways, and of external injury to the eyes, which may be attributed directly to this cause.

"The finer dust particles consist of fragments of fine vegetable or animal fibres, such as cotten or woolen or other light material, and of the greatest variety of micro organisms either singly or in masses, such as bacteria and mould spore."

These latter forms are mostly invisible, except in a beam of sunlight which streams into some darkened room or corner.

It is with these that Dr. Prudden chiefly deals, as these insidious messengers of evil are the ones most dangerous to human life.

They are by no means confined to the highways and market places, but are uninvited guests in all our dwellings, and interior places of congregation. They come in through many avenues, and fortunate is he who studies best how to reduce their presence to the minimum.

There is another danger from dust in some of our dwellings which has not received the attention from those having charge of sanitary supervision, which its presence suggests, and that is contamination of the air we breathe by the liberation of posionous dust particles from various hangings, and other decorative articles which are freely used to beautify our homes. Many cases of serious illness have been traced to the posionous coloring matter used in certain wall papers, and I have no doubt the dyes used in many tapestries, hangings and other articles of upholstery, so common in domestic use, are responsible for many more.

Of course the quantity of dust in the air, whether out of doors or in our houses and places of assembly, differs very much according to different conditions. While there is always a certain quantity of suspended matter in the air, the general tendency of dust is to settle. Hence disturbance by atmospheric currents, or mechanical means, always increases the amount which we are forced to inhale wherever we may be. Careful investigation has shown that under ordinary conditions the dust laden air, in the streets of a city, on a moderately breezy day, contains far more living germs to the cubic inch than the air within what we would designate a well kept dwelling. In April, 1890, a biological examination of the dust, which was allowed to settle upon the bottom of a round dish 3¾ in diameter, at several localities in the City of New York, exhibited the following startling result:

At Central Park, 499. Ball ground.

Union Square, edge of fountain basin, 214.

Library of private house near 34th street and Broadway, 34.

Large retail dry good store, 199.

Railing of small park, Broadway and 35th street, 941.

Cross street, through which carts of sweeping department were passing, collecting dry heaps of street dirt, 5,810.

Various experiments, in hospitals, in tenements and private dwellings, show that no ordinary system of ventilation serves to materially diminish the number of dust germs, but that absolute quiet does tend to free the air almost entirely. Thus in the Boston City Hospital, at midnight the number of living bacteria in 600 cubic inches of air was found to vary from 0 to 13, while during the day time the number varied from 1 to 477. The number was always largely increased by sweeping, bed making, etc.

In a carpeted living room in a 10th avenue tenement, New York, 75 bacteria five minutes before sweeping were increased immediately after sweeping to 2,700.

It seems reasonably certain then, that whether we remain at home, or walk abroad, we are constantly exposed to the danger of inhaling a certain quantity of dust, which may, and pretty surely does, contain a varying number of living organisms. It is certainly best to avoid the danger as far as possible, and the co-operation of government and individuals would reduce the danger to a minimum. For the comfort of the race, our intelligent investigators have determined certain facts, which make it possible yet to enjoy life, in spite of the disagreeable results which have been spread before us. In the first place, only a small portion of the dust inhaled goes into the lungs. Nature seems to have considered the environment of man, and anticipated the dangers to which he would, as an air-breathing animal, be exposed. A considerable portion of the foreign matter inhaled lodges and is retained on the moist surfaces of the nose, the upper throat, the mouth, the windpipe and the bronchial tubes.

Of course the dust particles which are lodged in the nose, upper throat or mouth, may be disposed of by swallowing or ejection; but how about that which has found its way into the windpipe and bronchial tubes?

The speaker here read from Dr. Prudden's book: "Dust and its Dangers," passages descriptive of the safeguards with which nature has provided the human body against the inhalation of dust, and also the means for its elimination. All this, however, refers to the disposition of the inorganic matter which under the general form of dust, may be inhaled.

The living germs with which we have seen dust is generally laden, are for the most part harmless to the human organism. They are destroyed by the digestive fluids, or they perish for lack of nutriment.

Here again nature has fortified us with the weapons of effective defence; but there are germs which, under certain conditions, find in the human organism a place where they may develop and become the propagators of most dangerous disease. That these germs or bacteria, by which name they are now known, are scattered with the dust which we are apt to inhale in public places, and even in the streets, is a fact too well established. The study of bacteriology which has occupied the attention of the scientific physicians during recent years, has developed the fact that every infectious disease is caused by the agency of some form of bacteria. This knowledge has already been of great service to mankind in preventing the spread of infectious disease, and doubtless if, by some wide-spread scheme of co-operation, every one of such cases of disease could be isolated and the bacteria destroyed, by fire and disinfection, those diseases might be expected to disappear from the face of the earth. This, of course, cannot be accomplished, but each locality can do much in reducing the danger from this source to the minimum. So long, however, as people are indifferent, careless and ignorant, these minute organisms, visible only to the eye of the skilled microscopist, will continue to mingle with the dust which whirls through our thoroughfares, and become the veritable pestilence which walketh in darkness.

It is only within a very few years that it has been absolutely demonstrated that tuberculosis, or consumption, is a bacterial disease. It has long been the scourge of the human race, and yet most of us regard it as a disease which is one of the inevitable ills of life. If a single case of cholera appears upon our shores, the whole nation is thrown into a spasm of excitement; yet we regard the universal presence of consumption without alarm, and have not yet awakened to the necessity or the possibility of greatly lessening its ravages by proper sanitary regulations.

While it may be true that many cases of consumption depend upon a predisposition, caused by heredity, it may be also regarded as true that nearly every case has been caused by inhalation of the bacteria into the lungs.

Some idea of the ravages of this dreadful disease may be obtained from a glance at the statistics of cases in the various cities, etc., enumerated below.

In New York State, in 1887, out of 96,453 deaths, 11,609 were caused by consumption.

In New York City, in 1890, in one week in March, the number was 121, out of 772.

In Chicago, 178 out of 2,072.

In St. Petersburgh, 128 out of 617.

In Paris, 248 out of 1,214.

In London, 206 out of 1,889.

In Vienna, 116 out of 470.

In Berlin, 96 out of 650.

The relation of these appalling facts to the question of dust, lies in the fact that the tubercle bacilli mingles with the dust which may adhere to the walls of the consumptive's room and house, to the hangings and carpets and upholstery thereof. It is found in the dust cloud of the street, in the dust which rises from the floors of theatres and other public places, and from the floors and furnishings of public vehicles.

Wherever the expectorated matter from a consumptive's lungs is allowed to dry and become pulverized and mingled with the dust, you have the fruitful source of contamination. The danger is enhanced ten thousand fold by the fact that consumption is a slowly progressing disease, and afflicted persons are suffered to mingle with society, to frequent all public places, inhabit hotels, occupy sleeping cars and steamboats, without any limitation.

Whenever any considerable proportion of the consumptives in the world can be aroused to a realizing sense of the fact that the safety of their kinsfolk, and of the other well people in the world, depends largely upon themselves, we may expect to see a material decline of the ravages of this dreadful disease.

One other serious ailment which so far has been traced to dust, deserves a brief notice—I refer to the form of catarrh known as "*hay fever*" and its twin brother "*rose cold.*"

Both of these diseases are somewhat obscure, but we do know that if they are not actually caused by the inhalation of dust-laden germs, they are rendered active and greatly aggravated by the pollen of certain plants which enters largely into the composition of the dust which covers road, roadside and meadow during certain seasons of the year.

The question we have to ask is: How may the dangers of dust be prevented or mitigated?

Briefly I answer; first, by keeping our streets clean by a liberal use of water.

Second, by exercising greater precautions in our dwellings by keeping dust *out* as far as possible; by the use of bare floors, covered with rugs which may frequently be removed and shaken; by the use of moist dusting cloths, and such articles as salt or moist bran to keep down the dust during sweeping time. In a word by the encouragement of cleanliness, in the removal of dust, and not its redistribution.

Next to the air we breathe, nothing more interests the welfare of the human race than the water we drink. The sources from which it is derived, the possible causes of contamination—all should be studied and guarded with the utmost vigilance and intelligence. It is to the credit of the race that much more attention is paid to these matters than there used to be even twenty-five years ago. This branch of the subject is suggested because water is the natural enemy and antidote of dust, but I propose to speak of *it* also from a sanitary standpoint, and that will limit the discussion to the subject of drinking water. Let us commence with our own city, and examine the different sources of water supply which are available. First, we have the rain water from our roofs; second, the ground water, which may be obtained by sinking ordinary shallow wells; third, the water which may be obtained from those deep currents, under lying the strata of clay and rock, upon which the city rests (by artesian wells); fourth, we have the waters of the Fallkill creek; and lastly, the Hudson River. It is the common opinion that rain water is the purest of all water. Theoretically, this is true. If we could tap a cloud and draw thence our supply through clean conduits, nothing could be purer. It would rival the distilled water of the laboratory. But few reflect that the rain drops passing through the lower air, act as scavengers and carry many germs and other impurities with them. Then, the roofs and gutters of houses, especially in cities, are depositors of street dust, which nine times out of ten is washed into the cistern with the water. The family using cistern water, should see to it that every precaution is used to prevent impurities from entering the cistern, and also see that the water is properly filtered before using.

The purity of ground water depends entirely upon where it comes from and upon its environment. Being the water which is held by the impervious stratum of clay or rock immediately below the earth's surface, it may form the source of our purest springs, and it may in certain localities and under certain conditions become dangerously contaminated. It should never be used for drinking, in closely settled communities, or when drawn from wells which have been sunk near cesspools, stables or closets. I think that the liability of ground water wells to contamination, may be illustrated by the effect which the construction of the sewer system of the city of Poughkeepsie had upon them. They were invariably drained, and rendered useless as sources of water supply. Thus the construction of the sewers conferred a benefit upon the city, not originally contemplated. The water of the Fallkill may be classed as surface water, or as ground water which has not been filtered; and may not be regarded as a strictly pure water, inasmuch as it receives a great deal of questionable drainage during its course. It is however a swiftly flowing stream, and the constant aeration which its water receives, tends strongly to purify it. Its uncertain and inadequate quantity even in rainy seasons, makes it unreliable as a source of general supply for the city.

Artesian Wells.—In the wonderful construction of the earth's crust there are below the depressions and *subterranean* water courses formed by the upper strata of clay and rock, other and deeper recesses, where flowing streams and lakes of water abound—all more or less pure, according to the environment.

These are reached by deep wells reaching thousands of feet sometimes and known as artesian wells. They are not always successful in producing pure water, although they are frequently very successful—producing without pumping a large quantity of excellent water. The cost of sinking these wells was formerly a great obstacle to their employment, but with the new machinery, and boring implements developed by the growth of the petroleum industry in this country, the cost of sinking an artesian well has been greatly reduced, and can be calculated to a nicety.

The failure of an artesian well generally results in striking water which is unfit for domestic use—water impregnated with some chemical or mineral substance. In our Southern Atlantic and Gulf states, in those portions where the surface and ground waters are generally unfit for use, large sums have been expended in sinking Artesian wells, but I do not recall an instance where satisfactory drinking water has been obtained. Reliance has to be placed upon river water and careful filtration of the ground and surface waters.

Whether our own city could obtain a satisfactory supply of water from such a source is a question which has often been asked. And I see no reason why the question may not be answered affirmatively.

So far as I know, but one attempt to secure such a supply of water has ever been made, viz., at the Vassar Brewery, within a few years. That well was sunk to the depth of about 500 feet, and yields to-day a supply of pure water, sufficient for the manufacturing purposes of the brewery.

Lastly we come to the river supply.

Why was the Hudson River selected as the source of supply for our city ?

This question, in view of recent criticism, deserves perhaps more careful consideration than can be given in the brief time remaining to me. Suffice it to say generally, that the Hudson River was selected as the best available source, after careful, long continued examination and test of every other source within reach of the city. I have already stated why the Fallkill creek was not selected. The same reasons apply with greater or less force to every other available stream.

The objection to the Hudson River supply is that there is liability to sewage contamination, but to obviate that the supply is taken at a considerable distance above the city, and before delivery to consumers, the water is subjected to filtration by passing the same through successive layers of sand, which is subjected to constant cleansing, and frequent renewals.

It is well known that a chemical analysis of water does not reveal the presence of bacteria, but merely determines the quantity and quality of organic matter. The latter, of course, may suggest sewage pollution, and *that* we may assume means possibly, dangerous bacteria. So far as we can be certain, the numerous bacteria found in the water of the Hudson River are harmless. The vital question is not how many bacteria, but *what kind*, and if we assume that Hudson river water shows upon bacteriological examination, that their are neither the bacilli of cholera, or typhoid fever, we may be reasonably sure that the water is not unfit for use.

Of course in the absence of a cholera epidemic in this Hudson Valley, there is no danger of river contamination from that source. And so far as statistics go, they certainly sustain the results of bacteriological examination, for the relative number of cases of typhoid fever to the population, has declined since the introduction of river water in the city of Poughkeepsie. The danger in country places from contaminated wells is greater than it is in this city.

Even under the most adverse circumstances there is some consolation in the fact that the bacillus typhosus, while exceedingly tenacious of life in water, under isolated conditions, does not thrive in the presence of other bacteria. Then there is the uncertainty whether in order to communicate typhoid fever, it is not necessary that certain predisposing conditions should exist in the human subject. So far I have been speaking of the river water unfiltered ; but our City Fathers took into consideration all the circumstances and possibilities, and notwithstanding the comparative purity of the river water, they provided for the future by the system of filtration, to which I have alluded.

This system consists of a series of sand-beds, through which the water percolates into a clear water basin, whence it is pumped into the upper reservoir for distribution. It is, in fact, a perfect simulation of the processes of nature.

The results vindicate the system. During the summer and autumn of 1891, and continuing down to the present year, a series of chemical and bacteriological test examinations of the river water, both filtered and unfiltered, have been made at frequent intervals, and under the various conditions of tides, currents and temperature, under the direction of Mr. Chas. E. Fowler, our efficient superintendent, and while the difference is enormously in favor of the filtered water, these examinations show conclusively that at the present time our filtered water compares favorably with the water supply of any other city in the country, and is much superior to that of many of our larger cities.

Reference is made to the report of Prof. Drown, of the Boston Institute of Technology, and to the special report of Supt. Fowler, both of which are embodied in the report of the Water Commissioners of the City of Poughkeepsie to the Common Council, for the year 1892.

The speaker explained at length the system of water purification by means of the "Anderson Revolving Purifier," which being used in connection with sand filter beds, is susceptible of easy and economical application to the filter system in Poughkeepsie.

An arrangement has been entered into between the

Water Commissioners and the Anderson Co., for the addition of this purifier to the filter plant, but mechanical difficulties and unavoidable delays have, up to the present, prevented the completion of the work. The successful operation of this system in such cities of the Old World as Antwerp, Dordrecht, etc., encourages us to believe that when the work is perfected here, Poughkeepsie may boast of a supply of water unsurpassed in any other city in the United States.

The paper was discussed by Members Van Gieson, Elting, Ward, Sutcliffe, and C. N. Arnold.

FEBRUARY 28, 1893—FIFTH REGULAR MEETING.

Present Chairman Burgess, and 30 members and visitors.

A paper was presented by Mr. John Sutcliffe on "Mining."

Mr. Sutcliffe described mining for slates in Vermont and for silver in Mexico, pointed out the necessity of conducting mining operations on strictly business principles, and gave a great variety of very interesting facts from his own personal experience. He illustrated the lecture by drawings and specimens.

MARCH 28, 1893—SIXTH REGULAR MEETING.

Present Chairman Burgess, and 30 members and visitors.

The curator's and librarian's reports were read and approved.

A paper was read by Mr. John A. Williams, as follows:

METHODS OF GLASS MANUFACTURING.

The credit of the discovery of glass has been given to some Phœnician merchants, who were preparing a meal on a sandy beach, supporting their cooking utensils on blocks of soda, which were part of their cargo. The heat melting the soda, it united with the sand and it is said a glassy mass was discovered.

This seems very improbable, as the amount of heat that was available was far less than that necessary to effect the union between sand and soda under far more favorable circumstances.

Glassy masses are produced in many of the metallurgical operations, silica being present with certain bases to play the part of the alkali. It is more than probable that glass was first discovered in this manner.

The earliest authentic date that can be given to the manufacturing of glass is in the neighborhood of 3900 B. C. In the metropolis of Sakara, in ancient Memphis, a mortuary chapel has been discovered, sculptured with designs representing glass blowers at work. The Egyptians made great progress in this art, producing the most remarkable varieties of ornamental vases, etc.

The seat of the glass industry was transferred to Rome at the time of the Roman Conquests, and prospered under the reigns of Cæsar Augustus and Nero. From Rome it spread to France, Spain, Germany, Bohemia, and somewhat later to England. Each country soon began to excel in certain specialties, owing largely to the different tastes of its inhabitants, and also to the fact that much purer materials were available in some countries than in others. For many years Venice held the highest place as a glass manufacturing center, but Bohemia soon became her greatest rival in the art, as the Bohemian glass was much whiter and clearer, which was due to the fact that the Bohemians used a sand, which was much purer than any that could be obtained near Venice.

In the 17th century, England made rapid progress in the development of the industry, and it was due to chance that she soon led the world in this branch of manufacturing. The furnaces used at that time for melting glass were heated with wood, and on account of the growing scarcity of this fuel, it was decreed that only two of the fifteen glass houses then in operation, would be permitted to continue. Soon after coal was used as fuel, but this presented new difficulties to overcome. The glass being melted in uncovered crucibles or pots, was colored by smoke and soot, thereby largely destroying the value of the product; to overcome this, covered pots were employed, but the amount of heat which had formerly melted the batch, was found to be insufficient now, and as no greater amount of heat could be obtained the only relief was to use more powerful fluxes. Amongst many which were tried was litharge or oxide of lead. The result was that glass so produced was far superior in color, transparency and brilliancy to any manufactured in ancient Rome or modern Venice and Bohemia, and was called flint glass or crystal.

During the 18th and 19th centuries there was little progress made in improving the quality of the glass produced, the principal advancement in the industry having been made in developing cheaper methods of manufacturing.

Glass is a transparent compound, produced by the fusion, at a high temperature, of silica and various metallic bases. The bases employed, regulating the solubility, density, color, &c.

True glass is a mixture of soda or potassium silicate, and one or more insoluble silicates such as barium, stronsium, calcium, magnesium, aluminium, manganese, iron or lead. While the silicate of soda or potassium, or the double silicate, are soluble in water, the addition of one or more of the insoluble silicates renders the glass practicably insoluble.

For convenience the several varieties of glass may be classified, as follows:

1. Flint glass or crystal. Silicate of potassium and lead. Example, lamp chimneys and tableware.

2. Common window and plate glass. Silicate of sodium and calcium or silicate of potassium and calcium.

3. Refractory Bohemian glass. Silicate of potassium and calcium.

4. Coarse green bottle glass. Silicate of sodium, calcium, iron and aluminium. Example, champagne bottles.

5. Ordinary bottle glass. Silicate of sodium, calcium, iron and aluminium; the quality of the product depending upon the purity of the materials used.

Glass is a compound in which the constituents are chemically united, but the elements may be present in various proportions, and they may be changed at will. This table shows how the proportions may vary in several varieties of calcium soda glass:

CaO.	Na_2O.	SiO_2.			
11.7	13.	75.3	Na_2O.	CaO.	6 SiO_2.
13.7	10.8	75.5	5 Na_2O.	7 CaO.	36 SiO_2.
12.8	11.8	75.4	5 Na_2O.	6 CaO.	33 SiO_2.

Under the influence of a cherry red heat and upwards all glasses are capable of being first softened and afterwards undergoing complete fusion. Glasses in which silicic acid predominates being fused with much greater difficulty than those in which it is present in normal quantities. Silicic acid is in itself infusible, but in combination with the metallic oxides its fusibility depends upon the nature and quantity of the oxides present. All the bases employed in the manufacture of glass, being considered fluxes, since they aid fusion, the greater the proportion of these bases present, the less heat and time are required to make the fusion complete. An abnormal amount of bases present is detrimental to the quality of the glass, as reagents react readily upon it, removing the metal and leaving silicic acid deposited.

At an intense heat pure glass is tolerably fluid, while at a brisk red heat it is in a semi-fluid condition, and it is due to this property that it can be worked into forms so commonly seen.

The chemical properties of glass are various, depending entirely upon its chemical constitution. Dry air or oxygen exert no action whatever. Deoxidizing bodies, by aid of heat, reduce the oxides of lead, manganese and iron if present.

Water acts on all glasses to a greater or less extent, particularly on those rich in alkalies. Alkaline solutions and acids exert a decided action, decomposing it, in the first case by forming soluble silicates, in the latter case by combining with the metal and leaving silicic acid free.

Glasses which may be called normal, that is those in which the amount of silicic acid present is approximately that required to form definite compounds with the bases present, are scarcely acted on by water, alkaline solutions or acids.

As the quality of glass depends on the purity of the ingredients employed, great care must be taken in their selection, if glass of a fine quality is to be manufactured. The principal ingredients employed are sand, lime, and soda ash, or carbonate of soda.

Sand and quartz rock are the chief sources from which is obtained the silicic acid required for the operation. Sand is usually used in the manufacture of window and ordinary light green bottle glass. A sand should be selected which is comparatively free of oxide of iron and also one, the grains of which are not too hard or flinty.

Such a sand is found in New Jersey and is the chief source of supply of the Eastern glass manufacturers.

Ground quartz rock is largely used in the manufacture of flint glass or crystal, its purity causing it to be the best source of supply. Lime may be used either as slaked, burned or carbonate. If the limestone is comparatively pure, it may be used as carbonate to great advantage, however, when impurities are present it should be burned, and if a fine quality of glass is desired it is preferable to slake and sift it.

Carbonate of soda is the chief alkali employed and is obtained principally from England, although a small proportion of the amount consumed in this country is produced at Syracuse, N. Y. The sulphate of soda is largely substituted for the carbonate when pots are used for melting the batch, since it is much cheaper. The disadvantage to its use, is that it acts very powerfully on the fire clay of which the pots are made, but as the durability of a glass melting pot is limited at the best, its life being from four to eight weeks, it is probably more economical to use a greater number of pots per year, and the sulphate of soda as the flux. In tank furnaces it has been found more advantageous to use the carbonate of soda.

Iron and aluminum are present in all glasses which have been manufactured from impure materials. They impart a bluish tint to the glass, which is very undesirable in most cases, as the higher oxides of iron forms an almost colorless silicate, by the aid of such oxidizing agents as $Mn0^2$, $NaNo^3$ and As^20^3, it is possible to reach such a result.

The materials used are all carefully weighed so that each batch is a duplicate of the preceding one, and it is then thoroughly mixed by being turned over several times, or by passing through a machine constructed especially for this purpose ; after the mixing is completed, it is then screened, mixed with a certain proportion of broken glass, and is then ready to be melted.

It is impossible to state what were the exact methods employed by the ancients in melting the batch. The first descriptions of the art and the plans of furnaces and methods of working lead us to think that the general style of pot furnaces now in use is only a slight modification of those used many hundred years ago. These furnaces are usually built in the form of a truncated cone, from 40 to 80 ft. in height and 25 to 50 ft. diam. at the base. In the center of the area is situated the melting furnace, which may contain, according to its sizes, from five to fifteen pots or crucibles, in which the materials are melted. These pots are supported on benches on each side of the fire pot. The grate of the furnace is nearly on a level with the floor of the glass house, and the ash pit or cave is built under ground and extends from one side of the building to the other, opening on the outside, so that a draft may be secured from as many quarters as possible. Slack coal is usually employed as the fuel. On each side of the pots or crucibles there is a flue, which connects the inside of the furnace with the stack. The arch or dome is built as low as possible, consistent with strength and durability. Owing to the location of the flues, the pots are nearly surrounded by the flame, thus heating the charges contained. Between the flues is an opening called the working-hole, which is used for the introduction of the batch into the pots, also for working out the glass when it is prepared for use. The operation of working out the glass in this style of furnace is carried on in the day time, while the batch is melted at night. Up to 1860 this style of furnace was in general use in this industry. In 1860 glass making made rapid advancement, when the Siemens regenerative principal was applied to this industry. The source of heat is not by burning coal direct, but converting it into carbonic oxide by burning coal with a limited supply of air. The gas so produced passes through retorts into the regenerative chambers of the melting furnace. At first this regenerative gas principle was applied to the pot furnace then in use, but soon furnaces of far different construction were employed. The general plan of construction was in the form of a basin or tank, covered with a low arch. The length is usually about 30 ft., width 15 ft. and depth 3 ft. The tank is divided into one or more compartments either by floating or stationary bridges. At one end of the furnace is an opening for feeding in the batch, and at the opposite end are a number of openings called working holes, through which the molten glass is extracted. The flues through which the air and gas enter the furnace, are located at the sides. Underneath this furnace are situated the regenerative chambers, which are built up with brick in the form of checker work, so arranged that there is sufficient space between the brick for easy access of the gas and air.

These chambers are arranged in sets on each side of the furnace, one part of each set being used for the supply of air, the other for the supply of gas. By means of valves it is possible to connect either set of chambers either to the gas retorts, or to the flue leading to the chimney stack. When the gas from the producer enters one of the regenerative chambers it is forced through by the pressure of gas behind it, and at the entrance to the furnace it comes in contact with a volume of air which has been forced through the corresponding chamber of this set. Combustion then takes place, and the flame spreads across the furnace over the batch, and escapes through corresponding flues on the opposite side of the furnace, which lead to the second set of regenerative chambers, at this time in connection with the chimney flue. The escaping gases impart to the brick checker work of the regenerative chamber a great amount of heat. As highly heated gases are capable of producing a greater amount of heat on combustion than cold or only moderately heated gases, it was to this end that Dr. Siemans made this application. If the process of supplying the gas to the furnace be reversed, that is by regulating the chamber valves, so that the gas and air which unites with it at the opening of the flues into the furnace, will enter into the furnace through the regenerative chambers which have been heated to a high temperature by the escaping gases, the gas and air will become highly heated, and their combustibility greatly increased.

This reversal of the supply of gas should take place every 20 to 30 minutes, or as often as necessary, so as not to allow the receiving chambers to grow absolutely cold. In this manner it is possible to obtain a far greater efficiency from a ton of coal than by any known process. The operation of this style of furnace is continuous, the batch being supplied at one end, while the pure metal is worked out at the other. The purpose of the bridges is to prevent imperfectly melted material reaching the working-out end. These are constructed with openings near the bottom through which the glass must pass to go from one compartment to another. As the Sp. Gr. of pure glass is greater than that of the imperfectly melted material, it follows that it is only the pure glass that is admitted into the working-out compartment, and the imperfectly melted material is obliged to remain in the heating compartment until it becomes perfectly fused.

The principal advantages of the tank furnace over pots may be classified as follows :

Increased production, it being possible to work several gangs of workmen, so that the glass may be blown at night as well as by day.

Greater economy in working, as the extra cost of melting the batch for continuous working is less than the average cost per ton for melting the batch which is worked out in 6 to 10 hours, as is the case in pot furnaces. There is no necessity for lost time, as the pure glass is always ready for use and the delays occurring in pot furnaces due to broken pots and imperfect melts are unknown.

Greater economy in repairs, owing to the fact that in tank furnaces an almost constant heat is employed, thereby not subjecting the furnace to such changes of temperature as are necessary in running pot furnaces.

The greater durability of the tank furnace is largely due to the fact that the batch is filled in, in such quantities, as not to come in contact with the sides of the furnace, thereby not subjecting them to the action of the free alkali contained in the batch.

The construction of a glass furnace is attended with many difficulties, owing to the great heat required, ranging from 2,500 to 3,000° Fahr., and to the destructive action of the alkali on the pots or tanks employed.

It is necessary to select the most refractory fire clays possible, and for those portions which come in direct contact with the glass, clays especially free of iron and alkalies are selected. The walls of the furnace are built of fire-clay blocks, molded into special shapes as required, and the dome is usually built of silica fire-brick.

The most important process in the manufacture of glass is the annealing, and unless this is well performed the goods manufactured are absolutely worthless.

The process of annealing consists in allowing the manufactured goods to cool gradually, so that the particles may so arrange themselves that they will all be in a state of uniform attraction to each other.

When glass has been heated to the melting point and allowed to cool rapidly it is very brittle ; when allowed to cool gradually it is capable of resisting severe shocks and sudden changes of temperature. When cooled gradually, the particles arrange themselves in a regular manner, or in a crystalline form. When cooled quickly there is not time allowed for this regular formation and the particles are forced to remain in that relative position which they assume during the working, and form an amorphous mass. Where the particles have cooled most rapidly, this forced relative position is greater while the interior of the mass is not so subject to it as the exterior and the later contracts in a greater degree. The exterior layers are in a state of tension compared with those of the interior and there exists a lack of uniformity in the attraction of the particles for each other.

The customary form of the appliance in which the annealing is done, is a brick lined oven, about 6 ft. high, 12 ft. wide by 10 to 12 ft. deep. After the temperature of the oven has been raised to about 1,200° F., just below a melting heat, the manufactured articles are piled up in rows, as fast as they come from the blowers, and when the oven is filled, the fires are banked, all openings are closed and the contents allowed to cool. The time required is from three to four days. A more rapid and modern method is in the use of Leers, which are built of brick and covered with a low arch. The length may vary according to the amount of work to be done, but they are usually constructed of such length and width that the operation will be completed in from ten to twenty-four hours. A not unusual size is width from 6 to 8 ft., and length 70 to 80 ft.

At each side of the entrance the heat is applied, the source being fuel oil, coke, coal or wood. Fuel oil gives the best results as the heat is more uniform than can be obtained from any other sources. The temperature employed is the same as is used in the ovens, about 1,200° Fahr. The articles to be annealed are piled on iron pans, which are about 2½ ft. long and a trifle less in width than the leer. The pans are provided with wheels which run on tracks extending the length of the leer. They are attached to each other, and the whole train of twenty to forty pans is propelled by means of a winch located at the exit end. As a pan is filled with ware, the whole train is pulled down about 2½ ft. so as to make room for another pan, which in turn is loaded and and the train again moved toward the exit end. Thus the contents of each pan are gradually removed to a locality of less temperature, thereby effecting the cooling in a gradual manner. The results obtained by this process of annealing are fully equal in most cases to those obtained by the longer process. However, where some of the ware is very heavy and some of much less weight, the heat employed is liable to be either too little for the one or too great for the other.

The moulds generally employed, in which the glass is shaped, are made of a fine grade of cast iron. They usually are made in halves, which work on a hinge, and are so arranged that they may be opened or closed by the blower at will. Such lettering or designs as are to appear on the glass bottle are cut into the mould. Considerable skill and dexterity are shown in the operation of shaping and manipulating the liquid glass into the required forms.

The general process in bottle making is as follows: The glass is gathered from the furnace on an iron tube, which is 4 to 5 ft. long, the amount of glass gathered depending on the required weight of the article to be blown. It is then rolled on a stone slab or an iron plate, the workman giving the pipe a rotary motion with his hands. This rolling is accompanied by occasional blowing on the part of the workman, these operations regulating the distribution of the glass in the article about to be blown, and also fashions it into a shape resembling the bottle to be blown. It is then transferred to a mould, and the workman blows through the pipe, until the glass is forced against the sides of the mould. By this time the temperature of the glass has reached a point which enables it to retain its shape if handled with care. The bottle is now ready for the final operation, that of finishing the mouth. This may be performed in two ways. While the bottle is still in the mould, the workman continues to blow after the bottle has been fully shaped, the result being the formation of a glass globe between the mould and the end of the blow pipe which finally breaks, thus detaching the pipe from the bottle. The bottle is then taken from the mould and placed in a punty, a sheet iron form, attached to which is a handle, which leaves exposed only the shoulder and neck of the bottle. The neck is then reheated at a glowing furnace until it reaches a molten heat; it is then fashioned into shape by means of a pair of spring tools, which consist of an iron plug, which enters the mouth of the bottle, and is the exact size of the corkage required, and the jaws which press against the neck of the bottle force the molten glass against the plug inside. The punty is given a rotary motion by the workman, while the tools remain fixed. The result is the formation of any shaped ring or lip desired while the mouth will fit the size of cork intended.

Another method of accomplishing the same result is to remove the bottle from the mould still attached to the pipe, placing it in the punty, and then detaching the pipe from the bottle by breaking the glass near the end of the pipe. A small amount of molten glass from the furnace is then added to the extremity of the neck of the bottle, and this is then worked into shape with the same kind of tools before described.

The bottle is now ready to be annealed and should be immediately transferred to the oven or leer.

After the annealing is accomplished, the ware is put into trays, each kind or different mark by itself, and is taken to the packing department, where the perfect ware is sorted from that which is unsaleable and is then packed in boxes, branded, and is then ready for the market.

The manufacturing of the different varieties of glass in the United States is carried on very extensively, and the demands of our home market continue to increase year by year. This may largely be accounted for by the comparatively low cost at which it can be produced.

The industry is divided into various branches, which are quite separate and distinct from each other. They are the manufacturing of window glass, bottles and hollow ware. The window glass industry may be subdivided into the manufacture of polished plate glass; our product of this variety now comparing very favorably with the foreign makes; rough plate or ribbed glass, which is largely used for roofing and flooring purposes; and common window glass, the quality of which is too often sacrificed by the use of cheap materials.

Bottle manufacturing may be subdivided into three classes. Flint or white glass bottles for cutting and engraving; flint bottles for prescription use, and ordinary green glass bottles, used for a multitude of purposes.

In the manufacture of hollow ware, such as lamp chimneys, goblets and general table ware, we are said to excel our foreign competitors.

While we enjoy great natural advantages, such as cheap fuel in the form of coal, natural gas and crude oil, we are much behind our foreign competitors in the matter of furnace construction. In Europe, tank furnaces have almost entirely replaced the old style pot furnaces, the result being greater economy in the cost of manufacturing. It is largely due to the fact that our tariff policy has to a great extent prevented competition from outside, that we are not making the most of our opportunities to cheapen the cost of manufacturing.

It might be said here that the Siemens regenerative tank furnace in operation in our city, was the third of this style constructed in this country, and the first employed in the manufacture of bottle glass. At this time there are some six or seven in operation in various parts of this country and the manufacturers using pot furnaces are beginning to realize the necessity of replacing them with tanks, if they would continue in successful operation.

To give a faint idea of the quantity of glass bottles used in this country, a certain Boston house, manufacturers of inks and mucilage, use in their business annually from 75,000 to 80,000 gross of bottles (11,520,000), while a certain snuff manufacturer uses for packing snuffs some 30,000 gross per year (4,320,000). There are produced annually in the United States some 300,000 gross (43,200,000) of fruit jars, used to preserve fruit; if these jars were placed side by side in a straight line they would reach nearly half way around the earth at the equator.

The paper was discussed by Mr. Robert Good and Prof. C. B. Warring, the former of whom gave interesting reminiscences of many years devoted to manufacturing glass.

APRIL 25, 1893—SEVENTH REGULAR MEETING.

Thirty members and visitors present.

The annual reports were read by the Chairman, Curator and Librarian respectively.

The following paper was presented by Prof. James Winne:

MEMORY.

When the subject chosen for consideration this evening was given our Chairman, the speaker purposely left it general rather than limited, because he was uncertain what phase or subject would be presented.

The subject, however limited in specific title, is large, the facts many and complex; but most of the data, either vague or unreliable. The faculty discussed is fundamental, very generally misused and often abused, and the value of its service greatly over-estimated by most people, and the possibilities of its development, under wise treatment, not fully appreciated.

Many of the popular methods employed for strengthening the faculty are showy, but harmful rather than positively helpful.

While some definite conclusions have been reached in this study, and conclusions which are valuable to the speaker, the paper is read with considerable timidity. It is necessarily incomplete, and is presented as a memorandum of the study thus far pursued rather than as a discussion of the subject.

We barely note that memory is the chief source of joy or of sorrow in old age. It is not my purpose to give a history of wonderful memories. That can be found in almost every book which treats on memory.

However, I will cite two cases:

1. Sir William Hamilton tells of a Corsican who could repeat either forward or backward 36,000 names after hearing them once. The historian being of good repute, we accept the history as history of fact, but marvel at the wonderful memory of the Corsican.

2. A recent number of the Journal of Education is responsible for the following:

Rosseau had the greatest difficulty in composing his works because extremely defective in the gift of memory. Often, after having formulated sentences, he would forget them before he could write them.

I think a whole evening could be spent pleasantly, though I cannot say profitably, in narrating the history of wonderful memories, and sketching the characteristics of their possessors.

However fascinating would be the discussion of dreams, historic and non-historic, during wakefulness and during sleep, we cannot make them prominent in this paper.

An incident is related of the famous Agassiz that, suddenly awaking one night, he was in rapturous joy because he had seen in sleep the perfect skeleton of a fish, which he believed to be entombed in a stone which he possessed. But he waited till morning to sketch his vision, by which to work as he should try to reveal to sight his treasure. When the morning dawned, the vision of the night had escaped him. But a second night, a like vision appeared. On waking he produced a light and attempted to sketch, but the vision had gone! A third night the vision appeared. Taught by the experience of two former nights, he waited not to light his lamp, but sketched as best he could on the slate made ready at his bedside on the previous night. The result of his effort was wholly satisfactory, and by it he was guided in disentombing his treasure. His joy was unbounded when his sketch proved to be almost a perfect picture of the skeleton revealed.

Probably more than one of us, when in school, dreamed the correct solutions of problems which we could not solve in wakefulness, and remembered them on the following day to our great joy.

Did that lead us to believe in dreams?

It may be that, to some of us, the memory of dreams experienced during sleep would seem somewhat less mysterious if we believed in the physical basis of memory.

In presenting my memorandum, I think I cannot do better service to anyone present than urge him to read very carefully "Memory; what it is, and how to improve it," by David Kay.

The book is edited by Dr. Harris, U. S. Commissioner of Education. Mr. Kay most emphatically believes that not simply mind, nor simply brain, remembers ; but that every cell of the physical body either aids or retards memory of that sensation with which it was associated when the sensation was first perceived by the mind. And he quotes in his arguments the names of prominent writers.

On page 20 he quotes Prof. Bain as saying: "The organ of the mind is not the brain by itself ; it is the brain, nerves, muscles, organs of sense, viscera."

Mr. Kay recognizes the fact that "the general opinion of physiologists is that the movements on which our recalled sensations depend are confined to the brain, which are therefore regarded as the sole seat of the memory."

He believes "this is probably the case in many instances, as where the previous sensation is only imperfectly recalled ; but where it is brought back with any degree of vividness, as in the highest form of memory, we are of the opinion that the motion is not confined to the brain, but extends also to the connecting nerves and even to the special organ of sense, as in the original sensation, with this difference, that in sensation motion originates in external organ and travels inward to the center, whereas in recollection it originates in the center and passes outward to the outer organ. It is well known that if we gaze for a time on a particular bright color, the retina becomes exhausted for the reception of that color, and the object assumes the appearance of the complementary one. Now if, instead of gazing, we shut our eyes and vividly imagine the color, the same effect is produced—the retina becomes exhausted, and the complementary color takes the place of the original one, showing clearly that the retina is concerned in the latter case as in the former."

This may seem materialistic to some; but that is, I think, because my exceedingly brief statement of his theory, without any experiments or arguments to render it plausible, is inadequate to give you the correct view of his theory. In fact, Mr. Kay requires about three hundred and twenty-six pages to state his theory and explain it.

My personal observation and study lead me to believe there is much truth in Mr. Kay's position, and that farther study will reveal to us that mind—as known in man while inhabiting a physical body, is much more dependent on the physical than many of us to-night are willing to admit. As yet, mortals are unable to discover phenomena of mind, save as mind operates on and through matter. Of course, matter is subservient.

My belief that the nervous system is sympathetic with and delicately responsive to the rhythm of soul, was greatly strengthened by the following experience:

About five minutes past midnight I was awakened suddenly and very effectively by a noise in an adjoining room. The noise, though fresh in memory as if just heard, I dare not repeat to you, so hideous was it. It came from a young man who was suffering an epileptic fit. I omit farther detail.

As the fits were periodic, he asked me to awaken him on such occasions. I promised to grant his request, provided I was awake about the time when his fit would occur. However, I did not tell him that each night since I was so frightened from sleep I had awakened at exactly five minutes past twelve. With considerable curiosity I entered upon my new role.

When the periodic night for his fit came, I awakened him at exactly five minutes past twelve ; and the second night, and the third night. But on the third night, he very soon fell asleep and suffered the fit at eighteen minutes past twelve. Again I heard that hideous noise which he usually belched forth when the fit first attacked him. I no longer awakened at five minutes past twelve, but at eighteen minutes past twelve, and continued to awaken at exactly eighteen minutes past twelve, till an experience similar to the one just related changed the period of the fit to a later hour. As the year passed, the period of attack was made later and later (we played at "hide and go seek") till it became five o'clock a. m.

In the meantime, I had done much thinking, and announced my conclusion to the young man and to his physician. I was convinced that the period could be so disturbed by continued interruptions that the fit would seize him at irregular intervals ; and this irregularity would become dangerous because the young man was liable to an attack at a moment when to fall would mean to him immediate death.

The period was liable to become irregular because the activities of man are much more irregular in wakefulness than in sleep.

When I last knew of the case, the period continued to be at five a. m.

What is the character of that faculty which brings back to my view the events of former years with all the freshness and reality of present scenes? And how can we most effectively develop it?

Just at this point it may be helpful to discover the relation of this faculty to other faculties of mind.

I. Suppose you and I have been intimate friends for years ; moved to another state, I write to you. You read my letter, your mind is occupied, its activity awakened. The thoughts of the writer are communicated to your mind. You think. Here then is the exercise of one faculty—the faculty of thinking.

II. You continue the reading, and become conscious of something more than single thought. You become indignant at the wrong that has been done me. You feel that no punishment can be too severe for my persecutor. This action of mind is much more than thought. It is accompanied by another and quite distinct experience—feeling. Here then is the exercise of a second faculty—that of feeling.

III. Nor does the mental process cease here. Thought and feeling lead to action. You resolve what to do. You hasten to the relief of your friend. Thereby you have exercised the faculty of voluntary choice.

Thus we have three general divisions of mental action —thought, feeling, will. Somewhere within the department of thought will be found the faculty of memory.

I recently met, for the first time, a person whose presence impressed me. Had my optic nerve been paralyzed one moment before our meeting, my sense of sight would have been lacking, and to-day I could not say to you that I had seen that person. But the optic nerve does not see. It is only an organ whose function is to receive impressions, transmit them to the brain, and thus occasion sensations. Thus does mind, through the medium of some sense, take direct cognizance of external objects. That faculty whose function it is to present to the mind, through some of the senses, impressions of objects external and sensible, as now and here present, is called the presentative faculty.

But I am now conscious of having seen such a man. I have power to conceive of him in his absence, as though present, and thus I discover that mind has the power to represent, and this power we call the representative faculty.

A still further study would reveal a power of the mind both to generalize and to analyze. This power is known as the reflective faculty.

And, finally, we discover that the mind is capable of conceptions not furnished by sense. Such are the ideas of being, time, space, personal identity, number, cause, the right, the beautiful. These conceptions are ideas of reason rather than notions of the understanding. This faculty, whose function is original conception, has been styled intuitive faculty.

In passing, we desire to observe that years gone by have witnessed vast expenditure of energy by the teacher on the faculty of intellect alone, with very little or no effort to arouse the sensibility. Had a portion of the same energy been intelligently devoted to arousing the child's sensibilities, we are confident the teacher's failures and the child's sorrow in their combined experiences would have been vastly less, and their joys and their harvests vastly greater. The clergyman and the pedagogue alike seem to have assumed that intellect was the domain of the pedagogue, and one to be unmolested by the clergy; that sensibility was the realm of the clergy, and one to be undisturbed by the pedagogue.

Observation in later years reveals the fact that both the clergyman and the pedagogue are teachers and that both should seek the development of the whole man.

While it would thus seem that memory is regarded as one faculty and distinct from all other faculties, it is quite otherwise. Memory, instead of being one faculty and distinct from all others, is really the condition necessary for all mental activity, even to the general faculty of presentation. Were it not for memory, we could not even perceive, because we should be unable to compare the mind's present experience with any past experience.

Again there are two general phases of the memory, retention and reproduction. Doubtless memory, as generally used, signifies reproduction of some former state of mind.

Mr. Winship's experience, as related by him in his Journal of Education for Sept. 8, 1892, will illustrate the power of retention and of reproduction :

'I have had an experience this morning,—August 29, '92,—which may interest students in memory. F. W. S. was a soldier, enlisting for three years in Co. D., 7th Reg't, M. V. M. Last December his widow wrote the adjutant-general of the state for his army record. It was found incomplete, no record of his discharge appearing. She then wrote me that she had a memorandum in my hand-writing, "Discharged July 10, 1861," and wished to know where I obtained it. It was all a blank at first. I began by asking myself, at odd intervals, "Where could I have gotten that date?" "I must have gotten it from the State House." "Did I ever search through the war archives?" "Yes; I was there once for a long time, looking up material for a memorial address at W——." Then with a bound of delight—"The reason I went was because I saw what a reservoir it was when I was looking up the facts about F. W. S. about two years before."

I then knew that the address at W—— was thirteen years ago, and this must have been fifteen years ago. With my memory thus refreshed I went to the office of the adjutant-general and said confidently that I had found evidence in that office, fifteen years ago, that F. W. S. was discharged July 10, 1861. He smiled, as did his associates, and opened to me the records on the various books, which were kept in the most approved manner.

"Don't you see that you could not have found it here?" said he.

"Oh, but I did," said I, as he smiled. To satisfy me he went to the fire-proof vault and spent half an hour examining from "original sources" every document pertaining to the Seventh Regiment. Returning he reported that he had gone through all these, and that it was now impossible that I should have found it there.

"Ah, but I did," and he smiled again, saying that it was so easy for a man to be mistaken, and that a man sometimes forgot things that happened less than fifteen years ago. He was both amused and interested in my confidence, which was not in the least shaken.

"I found it in print," I said, the thought coming to me for the first time. "It was in the adjutant-general's report." He smiled again and went to another room and brought me the report of that official for that year, and I examined it carefully, and there was nothing there regarding F. W. S. He smiled again, and all of his associates smiled with him.

"What do you say now?" said he. "Give it up?"

"Not at all. I certainly found it here. There was another book,—large pages, like an atlas, with columns on it." At this he laughed outright, saying, "He means that old report," and one of the men searched for a dilapidated, coverless book, and as soon as it was opened, I said, "You will find it there. There it is, 'Discharged July 10, '61,'" and they all gathered around the book to read the entry.

Now I had not thought of that for fifteen years. It was wholly incidental. I have been moderately busy with other things. When my attention was called to the memorandum, I could recall nothing of it. There was nothing in the locality to help me, as the room has been wholly made over; but it came to me like the dawning of the morning, and I was as certain of my grounds from step to step as I am in crossing the room, and their assurances that the thing was impossible fell upon deaf ears.

It is a problem worth studying, this action of the mind after all these years.'

The following, "A Baby's Memory," is related by Jean Ingelow in Longman's: "A curious instance of dormant memory in infancy took place in our family. My mother went on a visit to my grandfather, who lived in London. She took with her a little brother of mine, who was eleven months old, and his nurse, who waited on her as her maid. One day this nurse brought the baby boy into my mother's room and put him on the floor, which was carpeted all over. There he crept about and amused himself according to his lights. When my mother was dressed a certain ring that she generally wore was not to be found. Great search was made, but it was not produced, and the visit over, they all went away, and it was almost forgotten.

Exactly a year after they again went to visit the grandfather. This baby was now a year and eleven months old. The same nurse took him into the same room, and my mother saw him, after looking about him, deliberately walk up to a certain corner, turn a bit of the carpet back, and produce the ring. He never gave any account of the matter, nor did he, so far as I know, remember it afterward.

It seems most likely that he found the ring on the floor and hid it, as in a safe place, under a corner of the Brussels carpet, where it was not nailed. He probably forgot all about it until he saw the place again, and he was far too infantile at the time it was missed to understand what the talk that went on was about, or to know what the search, which perhaps he did not notice, was for."

The following experience shows momentary torpidity of the power to reproduce:

On one occasion I stood talking with a friend, Mr. Smith. Near by stood two gentlemen conversing, one an acquaintance of Mr. Smith, and the other, Mr. Jewell, an acquaintance of mine. Mr. Smith asked the name of my friend, saying he would like an introduction. I assured him that it would afford me genuine pleasure to introduce to him Mr. Jewell, who was truly worthy his significant name.

Only a moment passed when Mr. Jewell was free, and I attempted to introduce to each other my two friends, saying: "Mr. ———," (to my profound amazement, and their amusement, both their names escaped me.) At this moment, Mr. Smith, anxious to relieve me from embarrassment, pointing to himself, said, "My name is Jewell." Then Mr. Jewell was amazed and I amused. "No!" interposed I, "this man's name is Jewell, and yours is——Smith!"

Mr. Smith, being something of a politician, appreciated the immense advantage that a person with a good memory for names, has over him who lacks the power. Hence he made it his business to fasten in memory the names of each person to whom he was introduced. This he did by intently associating the most striking characteristics of the individual, his name, the time and occasion of the introduction, and the friend who introduced. Thus, from the instant I uttered the name Jewell till the moment of the attempted introduction, Mr. Smith was intently associating the name Jewell with the neat personal appearance of Mr. Jewell, his quick, decisive, yet courteous bearing. Such was his admiration for the man, and so impressed on his mind was the name Jewell that, for the moment, Mr. Smith absolutely forgot his own name, and could recall no other name than Jewell.

In like manner my effort to introduce the two friends was interrupted not by a lack of ideas, but by a superabundance of ideas not desired at that instant.

First was the abundance of ideas pertaining to the two men as men and of my varied association with them. Then came the overwhelming confusion of ideas at my embarrassment when I did not readily recall the name of either friend.

The special feature of this experience is that, with both Mr. Smith and myself, the inability to recall the desired names was occasioned by an abundance of ideas and not by an absence of ideas.

The power to reproduce necessitates the power to exclude. The most valuable acquisition gained by education is the power to concentrate attention.

Listen to this experience of a friend, explaining one very general reason why we fail to reproduce. In the library I read the following sentence: "The secretary of war will suggest in his forthcoming report the abrogation of our treaty with Great Britain, which restricts our naval force on the Great Lakes to one vessel of an obsolete pattern."

The article was not a very long one but the above quotation, I remember, surprised me, and for some reason I said, "I'll mention this in the letter I'm about to send Mr. Winne." I finished the article with a feeling of pleasure that I had read it, put the paper on the rack, and started home. When I reached the door I halted. "Just exactly what is it that I'm to mention to Mr. Winne?" I asked myself. "What?" I tried to collect myself. All I had was the idea of war, and a picture of the Great Lakes. How these two ideas—war and the Great Lakes—were associated, I did not know. I was chagrined, for I suspected I had been doing just what I daily warn my classes against doing, viz: reading words without imaging. All effort to recall anything—save the name of the paper, place on the page, and like items—failed! Then I took myself to task. (I'll not give details.) I returned and re-read the article. As soon as the sheet was before me and I began to read, my whole action of mind redintegrated. I have given the quotation verbatim, having re-read it once rapidly, imaging. Think I shall never forget it.

As I re-read, I recalled that, at the expression "Great Lakes," I pictured them as known in the geography, and immediately compared that picture with my experience on the Great Lakes from Duluth to Buffalo. A whole week on that surface! that I could cover with my one little hand when I began to study geography. Then I enjoyed again the placid surface of Superior. I heard the captain say that in his experience of twenty-five years, he had never seen the Lakes so calm as on this last trip from Buffalo and this return. I saw the sun set in the blue water. Such a blue! It is said there is nothing like it save near the Bahama Islands. I took my glass and was enraptured with the "pictured rocks." A feeling of dread for Lake Huron crept over me, yet, when we reached Lake Huron, not a ripple could be seen. In brief, all the details of that happy week thronged upon me, and, in the sub-conscious, was a vast area of water on which I saw away in the distance a little speck that might be a vessel! Why I looked for a war vessel, I cannot tell.

Thus you have my experience, save an emphasis in details omitted. I stood amazed. Yes, reading without imaging was exactly what I was guilty of! And 'twas nothing new, I had done it previously and have done it since. But I'm enjoying the effort at maturing out such a destructive habit, and I believe I'll conquer!

Should the brief history of an accident be related to-night to ten people, we seriously doubt that two of the listeners would report the history accurately on the morrow.

Relying upon the fickleness of memory, lawyers strive to confuse the witness of his opponent, fully conscious that truth imperfectly remembered never makes so good a showing as falsehood well memorized.

I am told that those who are much in court remember that "Liars should have good memories," and govern themselves accordingly.

We are confident that much misrepresentation of facts, termed lying, is not intentional but results from poor memory and from a morbid imagination. A morbid imagination presents phantasy for facts.

Undoubtedly we retain in mind very much that we cannot recall at will.

Dr. Carpenter writes: "It is, I believe, the general creed of metaphysicians that no idea once fully comprehended by the mind ever permanently drops out of it; while physiologists are no less strong in the conviction that every act records itself in some change in the brain, which may lead to its reproduction before the consciousness at any distance of time."

And De Quincy adds: "I feel assured that there is no such thing as ultimate forgetting; traces once impressed upon the memory are indestructible; a thousand accidents may and will interpose a veil between our present consciousness and the secret inscriptions on the mind. Accidents of the same sort will also rend the veil. But alike, whether veiled or unveiled, the inscription remains forever."

But there exists a wide gulf between the belief thus expressed—that the mind never forgets anything—and what we all feel to be our actual experience, that we do forget very many things.

Mr. Kay attempts to explain what is the nature of that gulf, and suggests how it can be bridged in many places.

Those who regard memory a distinct faculty instead of a condition of activity of all the faculties, are liable to the serious error of concluding that exercise of memory in any direction whatever insures increased power in all directions. But this is not true. Dr. Harris well says: (Kay's "Memory," p. 5.)

"The cultivation of one species of memory may assist or it may hinder another kind of memory, according as the mental activity by which the attention is fixed on one subject aids or hinders the mental activity of the other kind of memory." And Mr. Kay writes: (p. 13.)

"We may cultivate the memory for persons without at all improving that for places, and a good memory for colors may afford little help toward the remembrance of forms." Dr. Harris adds: (Kay, p. 7.)

"On the other hand, the memory of names assists the memory of persons, and that of places assists that of forms."

We belive this erroneous view of memory, as a single faculty, has led to most of the systems of mnemonics.

Two girls stand talking with a friend, who sees in the sunset a wondrous beauty. As the friend tries to convey to them a notion of what she sees, they try to see, but fail to hear in her words more than sounds, and to see in the sunset other than the view common to thousands who never see the glory of a sunset and who never experience the inspiration of a sunrise.

But the girls cannot forget the beauty of that friend's face as she essayed to awaken their souls to the beauty of the heavens. And day after day they study the sunset, wondering at the beauty of the friend's face and questioning what she saw so beautiful in that sunset. After many, many days, their questioning is answered. They no longer wonder at the beauty of their friend's face, because they now know that it was only the reflection of the beauty in the sunset—rather it was the activity of her soul giving expression to her face. They have discovered the glory in the sunset.

Is it strange that in former days the two girls remembered no particular sunset, and that now the heavens are full of glory to them, and that no two sunsets are longer "all alike," and that now they describe, with details that would delight an artist, the sunset of a particular occasion, and that they remember many occasions.

When the soul has nothing to remember, it can remember——nothing!

What has this line of thought to do with memory?

Culture has much to do with memory. We fear that memory without a corresponding culture will prove an expensive possession.

Day dreaming on unrelated ideas, indulgence in degrading thoughts, and still more the realizing of degrading thoughts, all tend to weaken the faculty of memory. All activities of the opposite character, viz: the exercise of the imagination under the control of reason—the condition necessary for investigation—the indulgence of aspiration to a purer life and truer culture, impress the soul by experiences, which are worth remembering, and which will delight the soul to remember. Hence another maxim:

Memory cannot be really strengthened by clap-trap devices; but must be strengthened—if at all—by culture of all the faculties of the soul.

Do you tell me it is a truism—that one cannot remember when he has nothing to remember? Why then our disappointment that a small soul fails to remember great sights or great thoughts, when we know small souls are incompetent to see great sights and to think great thoughts?

The practice of the Druids was logical. They never allowed their records to be written, fearing that written records would be considered secure, and thus those who had the records in charge would cease to think of them, and their memory would become weak for lack of practice.

Confidence inspires confidence, and a desire not to betray the confidant. Memory is much more worthy of confidence than many realize or admit.

In one's effort to improve his memory, the first question to be answered is: What phase of my memory is weak—for the cases are rare in which a person has a weak memory in all directions; and secondly: Is an increased power of this phase of memory desirable?

Adults who desire the vivid memory of their childhood can possess that luxury—if they will pay the price, viz: "attention to the accidental features of an event, to the details of trivial gossip, and neglect the main issues and the casual processes." We offer this assurance: they will find themselves able to do a far greater amount of superficial observation and recollection than children can do.

Every observant person has discovered that the establishing of new habits in the place of the opposite old ones requires the displacement of the old habits before the new ones can be established. The physical habitation of the soul is so impressionable and so faithful a recorder of impressions that, doubtless, each one of us recognizes this moment one or more habits which mean to us bondage. A man upon the tempest-tossed sea in a boat which he cannot control is fully as much in bondage, I consider, as is the prisoner behind iron bars. Many a soul who suffers from a poor memory is in the bondage of bad habits—so far as are concerned those habits which tend to weaken the power of memory.

I am persuaded that the most serious cause of weak memory is the lack of intelligent and confiding exercise of the memory. This intelligent exercise requires the exclusion of all thought, save the thought concentrated on that which we desire to remember. The prayer of the little child: "Father, make me so full of goodness that there shall be no room for evil in me," is philosophical and illustrative of my argument. If memory is to be strengthened, there must be coincident with intent and concentrated attention at the time of learning, logical association of the ideas or thoughts to be remembered, with experience and truths already known.

But suppose the soul, who desires to remember a thought expressed or a fact observed, has not already an appropriate thought with which to associate that which he desires to remember. Under such conditions, we see no other plan possible than intent attention to the thought expressed or the fact observed, followed by careful investigation of what the observed fact teaches and what the expressed thought signifies. In this investigation, the mind will proceed from the known in experience or the accepted in axioms to the related unknown. In this investigation it is probable the investigator will find such a richness of truth that he will exclaim, "not even the half was told," "how very little I saw of what was to be seen."

It is not what the soul holds in memory, but the quality of activity exercised in investigating and memorizing that determines the soul's tone and power. Hence two of the most important maxims in education: "Never tell the child that which he can discover for himself," and "Proceed from the known to the related unknown." Personally I believe that no other two maxims are so frequently violated as is each of these, by both parent and teacher. But teaching is an art. Few practitioners profess to be artists.

I quote from Dr. Harris: (Page 5, Kay's "Memory.")

"It is a matter of every day comment that much memorizing deadens the power of thought. * * * * But it is equally true that memory may paralyze the powers of sense-perception, imagination, and will. With an over-active memory, we suppose ourselves to see in an object what we remember to have seen in it before, and any new features escape our superficial perception. * * * * Even the imagination may be dulled by a too active memory, and degenerate into a mirror of the past. The productive imagination should belong not only to poets and artists, but to all men, as a faculty of discovering ideals and emancipating us from the imperfect reality. It should give us a tendency to invention and to aspiration. But, under the weight of prescribed forms and the sway of memory, a civilization crushes out self-activity on the part of individuals and imposes the rôle of external authority upon all. Thus the will of the individual loses freedom, and settles down into passive obedience to custom and prescription. The important question to determine is the proper amount of memory cultivation."

* * * * * * *

"The antidote for this baneful effect of memory is to be sought in a method of training that associates effects with causes, and individuals with species; that associates one idea with another through its essential relations, and not by its accidental properties. One must put thought into the act of memory."

I would add that: In all systems of mnemonics, so far as I can learn of them, the common device is to associate the items of one province of memory with those of another province of memory. The great sin of these systems is the habit of consciously seeking accidental relations and, consequently, the subversion of the power of logical thought by neglecting essential relations for unessential.

The true method of cultivating and strengthening a defective memory is to exercise it persistently on the kinds of items that it forgets easily. Thus, and thus only, can we correct the weak faculty and not impose its work upon another faculty.

At the conclusion of the paper it was discussed by Members Burgess and Dwight.

The following were elected officers of the Section for the ensuing year: Chairman, Edward Burgess; Curator, Prof. W. B. Dwight; Librarian, C. N. Arnold; Secretary, F. S. Arnold.

TRANSACTIONS

OF

VASSAR BROTHERS INSTITUTE

AND ITS

SCIENTIFIC SECTION.

POUGHKEEPSIE, N. Y.

1894-1896.

VOL. 7.

TRANSACTIONS

OF

VASSAR BROTHERS INSTITUTE

AND ITS

SCIENTIFIC SECTION.

1894-1896.

VOL. VII.

PART I.—Transactions of the Institute.
PART II.—Transactions of the Scientific Section.

PUBLISHING COMMITTEE:

WM. BANCROFT HILL, EDWARD ELSWORTH,
HENRY V. PELTON.

POUGHKEEPSIE, N. Y.
PRESS OF A. V. HAIGHT,
12 LIBERTY ST.

CONTENTS OF VOLUME VII.

PART I.

PART II.

VOL. VII.

PART I.

TRUSTEES.

1893–1894.

1894–1895.

1895–1896.

OFFICERS OF THE INSTITUTE.

1893–1894.

Rev. Wm. Bancroft Hill, . . .	*President.*
Mr. James Winne, ...	*Vice-President.*
Mr. John A. Williams, . . .	*Secretary.*
Mr. Edward Elsworth, ...	*Treasurer.*

1894–1895.

Rev. Wm. Bancroft Hill, . . .	*President.*
Mr. James Winne, ...	*Vice-President.*
Mr. John A. Williams, . . .	*Secretary.*
Mr. Edward Elsworth, ...	*Treasurer.*

1895–1896.

Mr. Irving Elting, ...	*President.*
Mr. James Winne, ...	*Vice-President.*
Mr. Safford A. Crummey, . . .	*Secretary.*
Mr. Edward Elsworth, ...	*Treasurer.*

TRANSACTIONS

OF

VASSAR BROTHERS INSTITUTE,

1894–1896.

NOVEMBER 14, 1893.—SIXTY-THIRD REGULAR MEETING.

President Hill in the chair. The meeting was devoted to a discussion of the interests of the Literary Section of the Institute, and the formulation of plans for its work in the future.

MAY 1, 1894.—SIXTY-FOURTH REGULAR MEETING.

President Hill in the chair. The President reported that the work of the Institute had been confined to that done by its two sections. The Literary Section, under John C. Sickley, chairman, had arranged and carried out a series of meetings according to the following programme:

1893.
December 5. "The Hawaiian Question."..........Mr. Irving Elting
December 19. "The Jury System."............Mr. Edward Elsworth
1894.
January 16. "Review of Goldwin Smith's United States."
Mr. John C. Sickley.
February 6. Debate: "Is the Annexation of Canada to the United States Desirable?"
Mr. Safford A. Crummey. Affirmative: Mr. Edmund Platt. Negative.
February 20. "Browning not an Esoteric Poet."
Rev. George Clark Cox.
March 6. "The Single Tax."............Mr. William J. Bolton.
March 20. "The Swiss Referendum."..........Dr. J. W. Poucher
April 3. "The Taxation of Church Property."
Prof. T. H. Hiscrodt.
April 17. "The Higher Criticism."......Prof. Harlan P. Amen.

Chairman Burgess presented the report of the Scientific Section. The standing committee on Museum and Library presented a report. Chairman Cooley presented the report of the Board of Trustees, and Edward Elsworth, Treasurer, presented the following report:

Amount on hand May 2, 1893, in Repair Fund		$1,051 08
" " " " " " " Museum "		810 35
" " " " " " " General "		164 41
" " " " " " " Special "		787 63
Cash collected from all sources to date to the		
Credit of Repair Fund	$250 00	
" " Museum "	503 32	
" " General "	1,009 94	
" " Special "	750 00	
		2,513 26
		$5,326 73

DISBURSEMENTS.

Repair Fund	$189 29	
Museum "	735 15	
General "	827 99	
Special "	25 00	
		1,777 43
Balance		$3,549 30

Which is divided in the several funds as follows:

In the Repair Fund	$1,111 79
" " Museum "	578 52
" " General "	346 36
" " Special "	1,512 63
	$3,549 30

The following trustees were elected to serve for the ensuing year:

A. P. Van Gieson, E. Burgess,
E. Elsworth, H. V. Pelton,
C. B. Herrick, C. N. Arnold,
E. R. Williams, W. B. Dwight,
W. T. Reynolds, L. C. Cooley,
I. Elting, C. B. Warring.

The following officers were elected :

W. BANCROFT HILL, ... *President.*
JAMES WINNE, ... *Vice-President.*
JOHN A. WILLIAMS, ... *Secretary.*
EDWARD ELSWORTH, ... *Treasurer.*

NOVEMBER 13, 1894—SIXTY-FIFTH REGULAR MEETING.

President Hill presented the following paper :

THE GOTHENBURG OR NORWEGIAN SYSTEM OF LIQUOR TRAFFIC.

BY REV. WM. BANCROFT HILL.

The history of legislation in the United States upon the manufacture and sale of intoxicants is most varied and comprehensive. Each State has the right to legislate for itself concerning this matter, except so far as interstate commerce laws and excise laws are framed by the national government. We have, therefore, practically more than forty independent sovereignties, each trying to solve for itself the great difficulties of the liquor problem. And in no two States are the conditions exactly the same. Maine is largely isolated geographically from the other States, and can enforce its laws with little interference ; but Iowa has only artificial boundary lines, or the Mississippi and the Missouri Rivers, to separate it from its neighbors, and has to contend against influences from without as well as from within. New Hampshire is a State which has no city of any size to introduce special difficulties or to predominate in politics; New York is a State of large cities whose condition and influence are the chief topics to be considered in temperance legislation. Vermont is purely agricultural ; Rhode Island is as purely manufacturing. Massachusetts has a large and increasing foreign population, coming from Europe and the Canadas; South Carolina has almost entirely native whites and blacks. In Kansas women have the right to vote at all municipal elections; in Wyoming they are by the State constitution given equal suffrage with men.

Evidently the field for experiment is large; and a survey of it shows that experiments have by no means been lacking. Every State has legislated concerning the liquor traffic, and most States have changed and tinkered and reversed or transformed their legislation repeatedly. An English barrister at the request of a Member of Parliament made a tour through the United States and Canada, winter before last, to gain information concerning our liquor laws and their workings; and the result of his observations and enquiries, put in very compact form, fills an octavo of 400 pages. From it one would conclude that every variety of temperance legislation is somewhere in our country now on trial. They might all be grouped under three heads—free traffic, restriction, and prohibition. By free traffic I mean when any person of reputable character, with a liberal interpretation of the word reputable, who wishes to open a saloon, may, upon payment of a small license fee, do so. Restriction limits the number of saloons either by imposing a high license fee, or by declaring that only a certain number of licenses (usually proportioned to the population) shall be granted, or by transferring the sale of liquor from private individuals to agents appointed by the State. Prohibition may either be local, in accordance with the vote of a town or larger district, or it may embrace the whole State.

These all are more or less familiar to us; and I need not stop to describe them in detail. I think, too, that most of you will agree with me when I say that no one of them, thus far, has altogether proved a success. Prohibition has had a long trial in Maine, and seems to have succeeded well there, especially in the rural districts; but other States less favorably situated geographically, and with a different population or larger cities, have given it a trial and then abandoned it as a failure. Local option at one time was thought to be the solution of the liquor problem; but it is less in favor to-day. Where some neighboring town stands ready to supply liquor, the local prohibition accomplishes little; and the common cry that business is being diverted to other places often serves to restore the saloon. High license is to-day unquestionably the most popular form of restraint upon liquor selling, and many things may be said in its favor. But while it reduces the number of saloons, it increases the attractiveness, the activity, and the political power of those which remain, and it appeals to the sordid interests of the taxpayer against any real curtailment of the liquor traffic.

Without going into a discussion of these matters—so familiar to you all—I may sum up the obstacles in the way of any successful temperance reform as being threefold. First, there is the unwillingness of certain honest, earnest and tireless reformers to co-operate in any movement which does not immediately and absolutely abolish the sale of intoxicants. Their demand is "all or nothing;" and against any system of restriction which is less than prohibition, they set their faces like flint. "Free rum" seems to them less objectionable than fewer saloons, and they may be counted upon to work side by side with the whisky party against anything like high license, or numerical limitation. Second, there is the influence of politics. The saloon allies itself with different parties in different States. It is Democratic, Republican or Socialist as best suits its own interests. And in the great cities it stands ready to support any ring which will in turn support it. The number of votes it controls and the amount of money it can furnish make it a most formidable ally or antagonist. Recent movements towards female suffrage have been largely prompted by the hope that this would create a body of voters over whom the saloon could have little influence. On the other hand the temperance party, too, is usually a factor to be considered in any political situation. Prohibition was once adopted by one of the two great political parties in New Hampshire, with no special interest in it and no real intention of enforcing it, simply to secure the vote of prohibitionists for other party measures. And in numerous instances promising temperance measures have been rejected by persons really in favor of them, because they were mixed up with purely political matters to which these persons were opposed. The greatest obstacle by far is the greed of gain. The liquor traffic is enormously profitable both to the manufacturer and to the retailer. A vast amount of capital is invested in it. Any blow against it strikes the pocketbook, and the pocketbook is the most acutely sensitive organ in the human system. The manufacturer, his workmen, his agents and distributors, the property owner who doubles and quadruples his rents by leasing his premises for liquor selling, the proprietor of the saloon, his bartenders, waiters and hangers-on form an army of persons who make a living or a fortune from liquor, and they are alert and active to prevent any interference with their pecuniary interests. If there were no money in whiskey making and whiskey selling, undoubtedly every saloon would put up its shutters and almost every still put out its fires within a week. And if the profits were only on a par with those of more reputable occupations, the business would speedily dwindle to a quarter of its present proportions. Other things being equal most men would prefer keeping a corner grocery than a common grogshop, or making rye into flour rather than into whiskey, or renting their premises for butcher shops rather than for beer saloons. The liquor traffic is not attractive in itself; nothing but its dazzling promise of wealth makes it so. Destroy the profits, and you destroy the perils. The community, also, is often demoralized by the revenues it receives from taxing the traffic. License fees furnish an income certain and easily collected which goes far towards reducing the taxes upon more reputable business. Even in our own city the answer has often been made to an appeal to limit or abolish saloons, "We are poor; our taxes are high; this is the easiest way to raise money." The question whether the saloon does not impose upon the community a burden of taxation for police duties, for the relief of the poor, and for the custody of criminals which fully offsets its license fees, is too complex to have much influence upon City Fathers. The direct income is evident, and determines their action.

Evidently any scheme of temperance reform will meet with great opposition, and can succeed only after a mighty conflict. It will, however, from the outset have this great advantage—the temperance sentiment in the United States is stronger, bolder and more active than in almost any other country. Forty years ago—that is, in the period between 1850 and 1860—there seemed to be a brilliant prospect that total abstinence would become the law of the land. Prohibitory laws were enacted by every State in New England, by Ohio, Indiana, Illinois, Michigan, Iowa and Wisconsin, and even New York came near securing them. But the breaking out of the war turned men's thoughts in another direction, and the liquor interests speedily undid the work which had been done. Since the war a flood of immigration, indifferent or hostile to temperance movements, has poured in upon us, and has made the work difficult and discouraging. The same activity and effort which under other circumstances would have produced a decided advance can only hold the ground already secured. That they have held the ground is very creditable. The consumption of distilled spirits in the United States last year was almost exactly the same per capita as twenty years ago. The consumption of wine was no greater. The consumption of malt liquors has, as we all know, greatly increased—more than doubled in that same time. This was inevitable with the incoming of beerdrinking peoples. Upon them in the first generation temperance appeals can have little effect, and it is better that they should bring their lighter intoxicants with them, than adopt our national beverage. What can be done with the second generation is a question we are even now busy in trying to answer.

I say the fact that intemperance has not made greater advances is a proof of the interest and activity which we as a nation bestow upon temperance measures. But that we have not yet discovered the true way of solving the liquor problem seems evident from the lack of agreement among temperance workers, and from the constant changes in legislation going on in all our States. It is also evident from the increasing interest displayed in the so-called Gothenburg or Norwegian system of liquor traffic. Massachusetts in the past two years has made a strenuous effort to adopt that system, and though the combined opposition of the liquor party and the extreme wing of the temperance party has defeated the effort, yet its advocates stand ready to push it again at the earliest opportunity. South Carolina has partially adopted it, though with many changes which do not seem likely to increase its efficiency. The United States Government has made it the subject of special investigation, and published in March, 1893, an elaborate report upon it for general distribution. It is being discussed in leading periodicals both here and in Great Britain, and those friends of temperance who are not satisfied with the results of high license or local option, and who see little present possibility of prohibition are turning to it with increasing interest as possibly the most practicable remedy for existing evils. It has seemed to me, therefore, a very profitable subject to present to the members and friends of Vassar Institute on the present occasion, and I have given the few spare moments which a minister can take from other duties to the preparation of a simple statement of just what the system is, and a suggestion of its advantages or possible obstacles. In doing this I have made use of the Government Report just mentioned, and of an equally full report prepared for the Commonwealth of Massachusetts, as well as of several articles in the Forum and other magazines.

Sweden at the beginning of the present century was one of the most intemperate states in Europe. The national drink was a fiery liquor distilled from grain or potatoes, and containing about fifty per cent of alcohol. It is properly our whiskey, though the Swedish name bränvin is commonly translated brandy. Anyone who paid a trifling tax might manufacture it; a still was part of each farm's equipment, and brandy could be bought in almost every cottage. There was a still for each seventeen inhabitants; and though later on the number was diminished, yet their product was increased by improved methods, so that in 1850, according to the most moderate estimates, the consumption of native brandy was seven gallons for each man, woman and child in the land. (In the United States last year it was one gallon and a half.) The situation can easily be imagined. To quote from a native writer, "The very marrow of the nation was sapped. Moral and physical degradation, insanity, poverty and broken family ties, brutal habits, all those grim legions that ever range themselves under the banner of intemperance took possession of the land." Of course such a state of things must sooner or later bring a reaction or else end in irretrievable ruin. In 1830 a temperance society was organized in Stockholm; and we are interested to know that it borrowed its leading ideas from a total abstinence meeting held in Boston, Mass. Massachusetts in her present attempt to introduce the Gothenburg system is simply claiming with interest that which she loaned sixty odd years ago. Years of struggle followed; I need not repeat the story of it, for similar struggles in our own country have familiarized us with its details. In 1855 a liquor law was enacted which produced practical prohibition in all the country districts. But it only increased intemperance in the cities. In Gothenburg, for example, a seaport of about 35,000 inhabitants, at the beginning of 1860 there were 136 licenses for the sale of brandy and about 200 saloons. The liquor power there seemed to be unconquerable. When the dean of Gothenburg presented a petition, signed by 8,800 citizens, asking the magistrates to prohibit the sale of brandy on Sundays and holidays, or at least to limit it to two or three hours, and backed up the petition by all the arguments which rose from the heart of a man deeply interested in the miserable condition of the poor, he was curtly answered that the magistrates did not deem it incumbent upon them to take any steps in the matter. Such insolence was pride going before a fall. A year later political changes brought into office magistrates more favorable to temperance; and in 1865 a proposition coming from a committee appointed to enquire into the condition of pauperism in the city was accepted. The committee naturally found that brandy was the great cause of poverty and distress, especially among the lower classes; and their proposition was that advantage should be taken of an insignificant clause in the law of 1855, which provided that when a company was formed to carry on the liquor trade, the community might give it the monopoly, and so all licenses–which hitherto had been disposed of by auction–– should be handed over to a company organized for the purpose of diminishing the existing evils. This company was to provide light, clean and roomy premises for their traffic ; was to sell no liquor on credit or for pawn-tickets ; was to have eating houses with lighter drinks in connection with their saloons ; and (most important of all) was to hand over to the city or devote to the interests of the working classes all the profits of their business beyond the ordinary rate of interest upon capital actually invested. This, in brief, is the Gothenburg system ; I will describe it more minutely later on. The example of Gothenburg was followed by other towns. But five years later the distillers, who after a manner we are familiar with had practically owned the saloons but could get no control over these new companies, and now, were finding their sales rapidly diminishing, began a tremendous opposition to this new state of things, led by a certain Smith who was "the brandy king of Sweden." Every ill that slander could devise was charged against the companies, and every agency that money could set in motion was used to overthrow them. The fight lasted fifteen years ; and it ended in 1885 with the complete victory of the Gothenburg system. It is only since then, therefore, that the system in Sweeden has had a chance to show fully what it can do ; and the prolonged opposition has hindered it from reaching as yet its full measure of usefulness.

From Sweden in 1871 the Gothenburg system passed over into Norway. In that country it had less hostility to encounter, and could develop more fully. Moreover, from the outset Norway guarded against certain evils possible to the Swedish system. For example, it abolished all clan distinctions, and provided that the profits should go to objects of public utility in order that the taxpayer might be less tempted to encourage the business of the company and thereby lessen his burden of taxation. As matters stand to-day Norway is the better of the two countries to pattern after; and the Massachusetts advocates of this temperance reform call it, not the Gothenburg, but the Norwegian system. This may be in part because while Sweden is aristocratic in its institutions, Norway is intensely democratic.

Now let me try to state briefly, and without confusing details, just what that Norwegian system is.

1. The whole liquor traffic of a town both wholesale (by which I mean liquor sold in any packages, less than 66 gallons to be drunk off the premises, e. g. a grocer's trade) and retail is put in the hands of a company. In neither Norway nor Sweden as yet have malt liquors been included with distilled. For a time the consumption of beer was encouraged as an antidote to brandy-drinking; and partly through this and partly through the restrictions upon brandy, beer-drinking has greatly increased in Sweden, although not at all in Norway. But either country drinks only about 30 quarts per capita as against 60 in the United States, 126 in Great Britain and Ireland, and 239 in Bavaria. They certainly cannot be set down as heavy beer-drinking countries. And the prospect is that before long the sale of malt liquors will also be handed over entirely to the companies.

2. These companies must be composed of reputable men; their by-laws approved by proper authorities; their books and accounts kept open for public inspection; and their proceedings published annually. They are to receive only a stipulated sun, usually the current rate of interest, on capital actually invested; and the remainder of the profits is to be turned over to "objects of public utility" determined by a special committee. These objects include charities, parks and tree planting, industrial education, libraries, amusements, baths, gymnasiums, rescue homes, Young Men's Christian Associations,

chapels, and the like. The distribution of the profits has, on the whole, been creditably made. But we can see that it is a diffcult matter. At the outset it was supposed that the surplus would be small, for no one realized what a profitable business the liquor traffic is, even when kept under the strictest restraints. Now that it is found to produce a large revenue, the constant problem is what to do with this. In Sweden it is divided in fixed proportions between the municipal or the county and the crown treasuries and the local agricultural society. The company's charter is granted for only two or three years; and may be revoked or renewal refused on proof of abuse. If two or more companies make application for the traffic, the authorities must choose between them.

3. A company, when put in charge of the traffic, pays the same license fees that individuals would. It may use all, or only a part of the licenses handed over to it. As a matter of fact it seldom uses more than part; for we must remember that it has no temptation to do a large business. It may transfer some of the licenses to hotels or clubs or grocers; but such transfer must be approved, and the sub-licensee is simply its agent, who must comply with its regulations and turn over to it all profits. The company has a general manager who is its executive officer. He must be a competent man whose appointment is sanctioned by the authorities. Men most interested in temperance reforms make, of course, the best managers; and it has been found that they are willing to accept the position, even when (as sometimes happens) they have conscientious scruples against owning any stock in the company. The noted leader of the temperance party in Sweden was for several years the manager for the Gothenburg Company.

4. The whole management of each separate saloon is regulated with regard, not to profits but to the economic and social welfare of the community. The person in

charge of it,—call him bartender, if you please,—receives a fixed salary. If he wishes to retain his position, he must strive to keep his place orderly, must keep out minors, intoxicated persons, and immoral influences. The less liquor he sells, the better satisfaction he will give. This last is such a paradoxical position for a bartender to stand in, that bartenders trained under the old regime could not conform to it. In Gothenburg at the outset they retained the old bartenders; but it was found impossible to break them of their former habit of urging people to drink; so new ones had to be substituted. While care is taken that the liquors furnished should be pure, there is no attempt to make them also cheap. On the contrary the price has been constantly raised, and the percentage of alcohol at the same time diminished. Everything is done to prevent drunkenness. Only a certain amount of liquor can be sold to one person; and if he is guilty of a misdemeanor in any barroom, he may be refused admission to all bars for a certain period. The saloons are closed on Sunday and holidays, and at a specially early hour on the days preceding; in Gothenburg the common bars are always closed at six in winter and at seven in summer. Minors are not allowed in saloons, neither are habitual drunkards nor persons dependent upon the public for support; and lingering in a saloon after a drink has been obtained is forbidden. But these are matters of detail which vary in different places. They are simply regulations which the local company thinks will tend to discourage drinking. In Sweden restaurants are connected with the saloons; and the profits rising from the sale of food and temperance drinks go to the proprietor. But in Norway this is forbidden; there is no inducement to enter the saloon except the desire to get a drink; the place is not a comfortable or commodious one, smoking is forbidden, and the customer sees before him a placard inviting him to depart as soon as he has taken his dram. The company seeks to avoid even the appearance of encouraging people to drink. For example, in Bergen once a lot of imported whiskey was received, each bottle of which had a flaming label bearing a portrait of the poet Burns with this quotation

> "Freedom and whiskey gang the gither
> Take off your dram."

The company declined to subscribe to this sentiment, and took off, not the dram but the label.

I trust I have described the system sufficiently to make it intelligible to you all. Of course its methods are not precisely the same in any two communities, as no two communities have precisely the same conditions to deal with. And if it were to be adopted anywhere in the United States some alterations would probably be made. But the system is not dependent upon minor details.

What are its advantages?

1. It educates the community in total abstinence. It is not offered as a substitute for prohibition; but as a stepping-stone towards it. In the country parts of both Norway and Sweden prohibition is in force, and the men who are laboring most zealously in support of this Gothenburg system look forward to the day when it will make prohibition possible in the cities. We must all admit that no prohibitory laws, however stringent, can be enforced in a city unless the great majority of the citizens are strongly in favor of their enforcement, and are willing to give time and thought to it. The saloon as now conducted, whether with high or low license, constantly generates a mass of moderate drinkers and frequenters who will be opposed to prohibition. But a saloon managed under the Gothenburg system makes drinking disreputable, removes the attractions of the place, abolishes treating, and largely stops the creation of new drunkards. As the generation trained under the old system passes away, the next generation should be

ready to dispense with saloons altogether. All temperance men, therefore, ought to be willing to work together in support of the system. Though I confess that the extreme prohibitionists in Massachusetts have thus far refused to imitate their brethren in Norway.

2. It divorces liquor selling from politics. The company is composed of men who are interested in the welfare of their community, regardless of party lines. They have no political favors to ask and none to grant. The saloon keeper with his regiment of heelers becomes a figure of the past. There is no longer the question of high license or low license or of manipulation of the police through alliance with some political party. Each saloon keeper is responsible simply to the company, and will gain no advantage by political deals.

3. This seems almost incredible; but it is secured by the complete separation of individual profits from the traffic. This is its third and chief advantage. So long as the liquor seller puts into his own pocket a large fraction of the price of each drink he sells, so long he will use all his influence to encourage drinking, and will be ready to evade any laws which limit his sales. And so long as modifications of the liquor laws materially increase or diminish his gains, so long will he combine with his fellows to manipulate elections and bribe legislatures and secure the privileges he wants. The saloon, as I have already said, is not Democratic or Republican or partisan at all; it is a party in itself interested in only its own welfare. It joins with any party whose success will for the time being benefit itself, no matter if that is even the Prohibition party. And if all parties should agree to cut off its profits, then the saloon would retire from politics. The Gothenburg system makes liquor selling unprofitable. It allows the company a small percent on the little capital required to run the business, for there is no reason why money thus employed should

be altogether unremunerative; but the returns are not great enough to make it a favorite investment. Persons interested in the manufacture of liquor are forbidden holding stock in the company; and no single individual is allowed to own more than a fixed small number of shares. Thus it cuts the taproot of the liquor evil, the love of money. Politics can enter only at two points: first, when the question of adopting the system is before the public. Then undoubtedly the saloon will exert itself in combination with some party to prevent the measure. But a community, not strong enough to carry local option, may be able to carry this less advanced measure. The temperance sentiment of most towns is stronger than any party combination, provided it is called upon to support a measure which really seems practicable and efficient. Politics again may enter into the question of the distribution of the profits. But if the law distinctly specifies in advance the method of their distribution, and if the accounts of the company are always open to public inspection, this danger may be avoided.

It is easy to raise objections to any measure, for no measure can escape all difficulties or be carried out without watchfulness and effort. Certain persons will say that this legalizes and makes respectable a nefarious business. They might as well say that nailing up a notice from the board of health on the door of a typhus stricken house and prescribing who shall enter it, makes fever legal. Law does not create the right to sell liquor, for without a law every man has that right; the purpose of law is to restrict it as far as possible. There is, moreover, this vital difference between a license under the old system and under the Norwegian: the old system said, "You may sell all the liquor you can"; the Norwegian system says, "You must sell as little as possible." One is a license for revenue; the other a license for reform. There is no danger of the business becoming respectable so long as the men who have it in charge are temperance men who have no wish that it should be thought respectable.

Will not saloons be run without licenses, and illegal selling go on after the formation of the company? Undoubtedly if the temperance sentiment of the community is not alert to prevent it. Yet the fact that there is an organized company to contend with this evil, and the fact, also, that public institutions or interests suffer a loss of profits by all illegal sales must do much towards suppressing it.

The saloon is confessedly the workingman's club-house; will he not for this reason object to its suppression? The cheerless Norwegian drinkingplace in which he is not allowed to linger, and finds nothing to make him wish to do so, cannot delight him or give him a cosy spot in which to meet his friends. This should be recognized and a substitute provided. It is only necessary to devote part of the company's profits to public reading rooms, or club-houses where amusements, light refreshments, billiard tables and the like can be enjoyed by the poor at a nominal expense and without the evil influences and temptations to drink which our present saloons offer. We all see the need of such places, but at present the expense of maintaining them is largely prohibitory: the Norwegian system removes that obstacle.

Leaving the discussion of these and similar points to yourselves, let me briefly state in closing just what the Norwegian system has actually accomplished in the countries which have given it a trial. The two largest cities of Norway (Christiana and Bergen) have a population of about 150,000 and 50,000 respectively. There are three other cities of above 20,000 each. The population of the whole country is over 2,000,000. Sweden has a population of 5,000,000. Its chief city, Stockholm, has nearly 250,000 inhabitants; and five other cities range from 20,000 to 100,000 each. I give these figures that we may not confuse either country with such a State as Maine, which has a population of less than 700,000, and whose two largest cities, Portland and Bangor, have but 37,000 and 20,000 respectively. The larger the State and the cities in it, the more difficult the problem of reducing intemperance. The large cities of Norway and Sweden, moreover, are seaports; and the presence of seamen, especially the crews of coal and grain steamers (notoriously the most drunken of their kind), adds peculiar obstacles. Summer tourists, too, are said to be a difficult class to bring under temperance restraints.

The first evident result of the new system is a marked reduction of places where liquor is sold. In Norway in the country districts only 25 licensed places remain, and half of these are in the northern fishery districts; in the towns the number has been reduced from one for every 591 inhabitants to one for every 1,413,—a reduction of more than one-half,—almost of two-thirds. In the city of Bergen the reduction is from one for every 1,498 to one for every 5,137. In Sweden where (as I said) the system has not had so free a chance to work, the reduction is less, but still is decidedly large. As for Gothenburg itself it has only one place where liquor is sold by the glass for each 2,658 inhabitants; part of these places are restaurants, hotels and clubs; of saloons proper, Gothenburg has only one for every 11,000 inhabitants.

2. In all saloons, as we have noticed, early closing throughout the week and absolute closing on Sundays and holidays are enforced; the sale of liquor to minors and other incompetent persons is forbidden; the price of a dram has been raised (for example, in Gothenburg from 1½ to 2¼ cents); and the amount of alcohol in the beverage has been somewhat reduced. Drinking in public places,—especially in Norway,—has become dis-

reputable. The investigator sent over by the Massachusetts commission asked the public inspector why it was that certain persons seemed embarrassed at being discovered in a bar-room. "Oh," was the answer, "they simply hate to be seen here; it isn't thought respectable."

3. Elaborate statistics concerning the number of arrests for drunkenness, the cases of delirium tremens, the deaths from chronic alcoholism, the number of paupers, and the amounts deposited in savings banks during the past twenty years, are to be found in the United States report. But local conditions—for example, the alacrity of the police in arresting drunken persons, or the financial prosperity of the country as influencing poverty and savings—so largely affect these statistics, that it is not safe to draw conclusions from them without careful discriminations. A much simpler question is, How far has the consumption of liquor been diminished? Sweden in eighteen years has brought it down from over 14 quarts per inhabitant to less than 6 quarts. During this time, however, the consumption of malt liquors nearly doubled. But in Norway, without at all increasing the amount of malt liquors, the consumption of distilled liquors has been reduced from 6.8 quarts to 3.3 quarts per inhabitant. This should be contrasted with the consumption in the neighboring kingdom of Denmark, where it is over 17 quarts per inhabitant. Norway to-day is one of the most sober countries in Christendom.

4. The verdict of public opinion is generally pretty true in a matter of this sort. And public opinion in the Scandinavian peninsula, though at the outset decidedly doubtful or opposed, now with remarkable unanimity endorses the Gothenburg system. Not a single community that once has tried the system has been willing to abandon it. The police say that it makes their duties much lighter; the prohibitionists believe that it is ad-

advancing their cause; and the people in general rejoice over the improved condition of affairs.

Of course it would be untrue to ascribe all of Norway's advance in temperance simply to her system of liquor traffic. There has been steady and earnest work for temperance all the time that the system has been in operation; temperance societies and temperance agitators have done their utmost to spread the principles of total abstinence. It is owing to them that the system was first adopted, and has been successfully carried on since. No legislation, however severe, and no system of liquor traffic, however excellent, can turn a drunken community into a temperate one unless there be constant and faithful labor by men and women whose hearts are given to the temperance cause. The redemption of the world from any sin is secured only by the self-sacrifice of those who are not guilty of the sin. The Gothenburg system or any other system cannot be a substitute for personal devotion and personal influence. All that can be claimed for it is that it furnishes an instrument by which temperance workers can control what they cannot yet exterminate, and can force the saloon itself to work for the cause of temperance.

The Gothenburg system is not to be confounded with the so-called "church saloon," of which we have heard sometimes. That, as I understand it, is an attempt to make the saloon respectable; but the Gothenburg system emphasizes its disreputability. The church saloon system says, "Since men must drink, let us furnish them a pleasant place, more attractive than other saloons, and free from vicious surroundings, in which to do their drinking"; but the Gothenburg system says, "Since all men cannot at once be stopped from drinking, let us make the drinking places as unattractive as possible, let us reduce their number, and limit their sales, that in this way if we cannot cure drunkards already made, we may prevent the making of others."

Neither must the Gothenburg system be confounded with the recent experiment in South Carolina, though they have some features in common. That in the first place was a political measure; instead of a company the State took control of the liquor traffic, its agents were political appointees, only a very few persons in any community were directly interested in and responsible for the manner in which sales were conducted, and the scheme was perhaps too close to practical prohibition to meet the situation in any but a most advanced temperance community. The Gothenburg system divorces liquor from politics, makes the immediate community the interested and responsible parties for its enforcement, and advances towards absolute prohibition as fast as public opinion is ready for such advance. The value of placing the initiative with the community, rather than with the State, and of fixing the responsibility upon the community cannot be overestimated. Then, in the second place, the South Carolina experiment was, in reality (so it is said) a measure for revenue. Governor Tillman had promised reduced taxation; this was the way in which to bring it about. But a liquor traffic conducted for State profits is only one degree less harmful than a liquor traffic conducted for individual profits. It perpetuates the evil, tends to increase it, and makes it respectable. The Gothenburg system takes away the idea of profits altogether. The less money made, the better satisfied are those who conduct it; and the distribution of unavoidable gains is sought to be made in such a way as to demoralize neither State nor community.

One word more. Massachusett's failure last winter in securing the Norwegian system as an alternative with local option, so that each town would have the right to decide (1) Shall any licenses at all be granted? and (2) if granted, shall it be under the Gothenburg system or under the old system ? is somewhat discouraging ; although the friends of temperance in that State are ready to take up the matter with new zeal this winter and hope to carry fully what they barely missed carrying before. It shows us that the saloon is not going to pass out of its present hands without a bitter struggle. I do not wonder at that. If I were a saloon keeper I would fight the Gothenburg system much more strenuously than any prohibition measure ; for I believe that as things are to-day it more seriously endangers the liquor traffic. But I am decidedly of the opinion (and Massachusetts has shown it to be a fact), that temperance men of all parties and degrees can be more fully united upon this Gothenburg measure than upon any other. And whenever all men who recognize and deplore the evil of the saloon unite in opposition to it, then unquestionably the days of the saloon are numbered and the downfall of the liquor power is at hand.

APRIL 2, 1895.—SIXTY-SIXTH REGULAR MEETING.

President Hill in the chair. The meeting was occupied with the proposal and discussion of various amendments to the constitution and by-laws.

MAY 2, 1895.—SIXTY-SEVENTH REGULAR MEETING.

Vice-President Winne in the chair. Chairman Sickley presented the report of the Literary Section, which had held meetings during the past year according to the following programme :

1894.

November 20. Symposium : "What can be done to decrease Pauperism in Poughkeepsie ?"
Superintendent Hitchock, Rev. James Nilan, Rev. Fields Hermance, Mayor Ketcham, Mayor-Elect Arnold, Prof. Herbert E. Mills, Rev. William Bancroft Hill and others.

December 4. "State Interference: with special reference to Trusts." Prof. Herbert E. Mills.
December 18. "Emerson: his Writings and Philosophy." Dr. Selwyn A. Russell.

1895.

January 8. "The Exaltation of Trade."........Alfred H. Peters.
January 22. Debate: "The theory of Protection the only proper basis upon which a Government should raise its revenue."
Hon. John I. Platt, Affirmative; Hon. Edward Elsworth, Negative.
February 5. "The Independent in Politics." Martin Hermance, Esq.
February 19. "The Waiting Laurel."..Prof. David Taggart Clarke.
March 5. "Church and State: the American Principle." President James M. Taylor.
March 19. "What have Foreign Missions Accomplished?" Rev. William Bancroft Hill.
April 2. "The Perpetuity of the United States as a Nation." President C. C. Gaines.
April 16. "The War Between China and Japan." Irving Elting.
April 30. "Art and Morals."........Robert F. Wilkinson, Esq.

Chairman Burgess presented the report of the Scientific Section. Charles N. Arnold presented the report of the committees upon the library and museum. Chairman Cooley presented the report of the Board of Trustees. The treasurer, Edward Elsworth, presented the following report:

CREDIT.

By amount in Repair Fund, May 2, 1894		$1,111 79
" " " Museum " " " "		578 52
" " " General " " " "		346 36
" " " Special " " " "		1,512 63
		$3,549 30
By interest received on Repair Fund	$250 00	
" " " " Museum "	500 00	
" " " " General "	875 00	
" " " " Special "	750 00	
" cash from dues	94 00	
" " " Rubinstein Club	30 00	
		2,499 00
		$6,048 30

DEBIT.

Repair Fund	$ 53 90	
Museum "	404 92	
General "	565 19	
		$1,024 01
Balance of cash in hand		$5,024 29

Which is divided in the various funds as follows:

Repair Fund balance	$1,307 89	
Museum " "	673 60	
General " "	780 17	
Special " "	2,262 63	
		$5,024 29

Numerous amendments to the Constitution and By-Laws, presented at the previous meeting, were discussed and adopted.

The following trustees were elected:

CHARLES N. ARNOLD,
EDWARD BURGESS,
LEROY C. COOLEY,
WILLIAM B. DWIGHT,
IRVING ELTING,
EDWARD ELSWORTH,
WILLIAM T. REYNOLDS,
CHARLES B. HERRICK,
A. P. VAN GIESON,
EVAN R. WILLIAMS,
HENRY V. PELTON,
WM. BANCROFT HILL.

The following officers were elected:

President, ... IRVING ELTING.
Vice-President, . . . JAMES WINNE.
Secretary, ... SAFFORD A. CRUMMEY.
Treasurer, ... EDWARD ELSWORTH.

MAY 5, 1896—SIXTY-EIGHTH REGULAR MEETING.

Vice-President Winne in the Chair. The President presented his annual report as follows:

In accordance with the requirement of the Constitution, which calls for a report from the President of the Institute upon the progress and work of the Institute, the following is presented for the year 1895:

The membership of the Institute at the beginning of the year was ninety-six (96) and during the year, of the number elected to membership, fifteen (15) have qualified by paying their initiation fees to the Treasurer, this making the total membership at the close of the year one hundred and eleven (111).

In addition to the regular work of the sections, which is confined to the members of the Institute and is reported by the Chairman in each section, the Institute gave during the year in its auditorium five public lectures. Four of these, given by Miss Elisa A. Sargent, of New York, were upon the history of Art and illustrated with stereopticon views. The first lecture was on March 3, 1896, and was introductory in character; the second, March 18, was on Ancient Art, including specially Egyptian and Greek Art; the third, March 25, took up Mediæval Art, and the fourth, April 8, treated of Modern Art, including the Renaissance and later art progress.

These lectures were well attended, and it is hoped that they proved profitable, at least to the younger portion of the audience, which was made up in great part of pupils in our schools.

The other lecture given by the Institute was April 1, by Mr. H. E. Krehbiel, the musical critic of the *New York Tribune*, and was illustrated by Miss Mills upon the piano.

As Seidl was to give a concert at the Opera House ten days later, it was thought that additional interest and educational value would be added to the lecture if Mr. Krehbiel would take up for illustration the programme of the concert, which included Liszt's Mazeppa, Beethoven's 7th Symphony, and the following Wagner selections: Bird Music from Siegfried; Funeral March from Götterdamerung; Good Friday Spell from Parsifal, and the Prelude and Finale from Tristan and Isolde.

This Mr. Krehbiel consented to do, and the interesting and masterly way in which he treated the history and development of these musical compositions enabled those who heard him to derive a much greater enjoyment from the Seidl concert than would otherwise have been possible. Although the evening of the lecture offered several counter attractions, the Institute auditorium was entirely filled and some of those who came left for lack of seats.

The decoration and alteration of the auditorium and the accessions to the museum property of the Institute have been reported by the chairman of the Board of Trustees.

Respectfully submitted.

IRVING ELTING,
President of the Institute.

Chairman Sickley reported that the Literary Section had held meetings according to the following programme:

1895.

December 3. Symposium: "Desirable legislation for city government—especially for the City of Poughkeepsie."
Robert F. Wilkinson, Edward Elsworth, John I. Platt, John Corcoran, Charles N. Arnold, Charles B. Herrick.

December 14. "Constitutional systems compared."
Henry V. Pelton.

1896.

January 14. "Three recent books."
Safford A. Crummey, Gifford Wilkinson, Edmund Platt.

January 28. "How far is scientific knowledge a guide to religious truth?"
Rev. George Clarke Cox.

February 4. "The foreign policy of the United States."
John I. Platt.

February 18. "The Niagara Power Co."
Rev. A. P. Van Gieson.

March 10. "The care of the insane."
Dr. Chas. W. Pilgrim.

March 24. "An Elizabethan theater party."
Prof. Wentworth.

Chairman Burgess presented the report of the Scientific Section, and Chairman Cooley that of the Board of Trustees, incorporating the following report of the Committee on Library and Museum :

Number of Books received during the past year..........	31
Society proceedings bound into volumes........................	63
Total number of books in the library.........	1,362
Total number of atlases and maps..............................	66
Number of miscellaneous pamphlets.............................	386

To the exchange list has been added the following :

Brooklyn Institute of Arts and Sciences.
Chicago Academy of Sciences.
Colorado College Scientific Society.
Field Columbia Museum (Chicago).
Natural Science Association of Staten Island.
Memoirs of the New York Academy of Sciences.

A new section has been added to the library cases, and 75 or 80 volumes of Proceedings are in the binder's hands.

To the Museum there have been added by purchase during the year, twenty-five specimes of minerals ; a large collection of corals, shells, sea-urchins, star-fish, etc., comprising more than one hundred specimens ; two mounted groups of animals and birds in glass cases ; one bald eagle (Haliaetus Leucocephalus) ; one American herring gull (Larus argentatus) ; one pair of buff-breasted sheldrake (Mergus merganser). An aerolite found in Stanford, Dutchess County, has been presented by Martha Bockeé Flint.

Edward Elsworth, treasurer, presented the following report for the year ending May 5, 1896 :

CREDIT.

By amount in Repair Fund, May 7th, 1895..................	$1,307 89
" " " Museum " " "	673 60
" " " General " " "	780 17
" " " Special " " "	2,262 63
" cash received from Members..........................	56 00
" " " " Rubinstein Club..................	10 00
" " interest on Repair Fund..........................	250 00
" " " " Museum "	500 00
" " " " General "	625 00
" " " " Special "	750 00
	$7,215 29

DEBIT.

Repair Fund.			
To cash paid E. Lundell, decoration......	$206 04		
" " " Shurter & Briggs, furn., etc.	212 90		
" " " W. H. Rust & Son, repairs,	153 40		
" " " Schrader & Son, curtains..	8 50		
" " " Po'keepsie E.L.& Power Co.	148 75		
" " " Cannon & Lloyd, plans.....	20 00		
		$749 59	
Museum Fund.			
To cash paid J. H. Wiggers, mounting specimens, etc...........	$33 50		
" " " Books and publications....	26 10		
" " " Specimens.................	170 65		
" " " Salary of Librarian.......	100 00		
" " " Sundries, postage, etc.....	15 40		
		345 65	
Special Fund.			
To cash paid Cash on remittance from New York................	$ 0 35		
" " " Mrs. Sargent..............	50 00		
" " " H. Krehbeil......	65 80		
" " " F. B. Leuyster, lantern....	8 00		
		124 15	
General Fund.			
To cash paid Coal........................	$93 29		
" " " Janitor....................	247 00		
" " " Lighting..................	38 68		
" " " Water......................	3 08		
" " " Printing and advertising..	187 49		
" " " Botanical prizes...........	25 00		
" " " Stationery.................	1 58		
" " " Hardware, furniture, supplies..	64 68		
		$660 80	$1,880 19
			$5,335 10

Balance in Repair Fund.........................	$808 30	
" " Museum "	827 95	
" " General "	810 37	
" " Special "	2,888 48	
		$5,335 10

The following Trustees, whose terms of office had expired, were re-elected for four years: Charles B. Herrick, Edward Elsworth and Henry V. Pelton.

Officers were elected as follows:

IRVING ELTING, ...	*President.*
JAMES WINNIE, ...	*Vice-President.*
SAFFORD A. CRUMMEY.	*Secretary.*
EDWARD ELSWORTH, ...	*Treasurer.*

THE CARE AND TREATMENT OF THE INSANE.*

BY CHAS. W. PILGRIM, M.D.

Insanity is undoubtedly one of the saddest afflictions that can befall mankind. There is no other disease which is so far reaching in its effects and which creates so much and such varied distress. In the language of Conolly, "It extinguishes knowledge, lays waste all accomplishments, renders beauty itself painful or fearful to behold; whilst it breaks up domestic happiness and perverts or annihilates all the habits and affections which impart comfort and joy to human existence." When we consider the serious effects that this "complicated misery" has, not only upon the individual sufferer, but upon his family and friends, as well as upon the community at large, it is obvious that the question of the care and treatment of the insane is one worthy of the most careful consideration.

Insanity has been recognized from the very earliest times, and classical writers who lived many years before Christ frequently allude to it. In the Old Testament it is recorded how Saul, a thousand years before Christ, "was possessed of an evil spirit and was made well again by the music of David's harp." David, himself, feigned madness and in the first book of Samuel, Chapter

*The following paper, which was read before the Literary Section of Vassar Brothers Institute, March 10, 1896, by Chas. W. Pilgrim, M. D., Superintendent of the Hudson River State Hospital, is thought by the Committee on Publication to deserve a place among the scientific papers of the Institute, and accordingly is printed here.

XXI, we read that "he scrabbled upon the doors of the gate, and let his spittle fall down upon his beard."

Of Nebuchadnezzar, the King of Babylon, it is written that "he was driven from men and did eat grass as oxen and his body was wet with the dew of heaven, till his hairs were grown like eagles' feathers and his nails like birds' claws" (Daniel IV, 33), and at the end of seven years he recovered (569–563 B. C.), and was re-established upon his throne.

Up to the time of Hippocrates, who was born 460 B. C., insanity was generally looked upon as being due to "diabolical possession." Probably the most important work of the Hippocratic school was the apparent recognition by the "Father of Medicine" of the physical basis of insanity. Hippocrates taught, in a misty way to be sure, that the brain was the organ of the mind, and he regarded it as the site and starting point of most forms of insanity, although their causes were sought in irritation supposed to be due to morbid changes in the principal secretions, such as bile, mucus and water. With the recognition, even in this imperfect way, of the great truth of the physical basis of mental disorders, the first attempt was made to withdraw from the hands of the priesthood the treatment of the insane. Instead of conjurations and magic remedies, we find the gradual substitution of rational and sedative measures, such as warm and cold douches, rest, diet and exercise. It is true that the treatment was quite uniform, for the distinctions between the different kinds of insanity were not recognized, and mania and melancholia were classed as one.

The followers of Hippocrates were so generally his imitators that but little was done to add to the knowledge of insanity during the next three centuries. What is generally known as the Alexandrian period is without special interest and is merely the connecting link between

Hippocrates and the Greco-Roman period represented by the names of Asclepiades, Celsus, Aretaeus, Soranus and Galen. Their writings, although fragmentary and incomplete in many respects, show that they possessed an accurate knowledge of some forms of insanity and that their treatment of lunatics was marked by an amount of wisdom and kindness which would be no discredit to physicians of to-day.

Unfortunately, however, the bright prospects for medical advancement which existed with the dawn of Christianity were destined to soon fade away. With the fall of the Roman Empire, the decay of medicine began and the achievements of antiquity sank into oblivion. The knowledge possessed by the ancients disappeared more and more and soon the fact of the physical basis of insanity was entirely forgotten and the old doctrines of demoniacal possession returned with increased force. The devil was suspected everywhere and superstition and religious bigotry struggled for the upper hand in the treatment of the insane. In quiet cases the symptoms of the disease were regarded as sins and were treated by confessions, fastings and self-castigations and prayer. But when prayers and exorcism were of no avail the most cruel tortures that could be invented by human ingenuity were tried. The whipping post, the torture chamber, and the funeral pyre were resorted to with such frequency that historians tell us that during a period of two hundred years no fewer than fifty thousand persons in Europe were put to death for witch-craft. It was not until 1736 that the laws against witch-craft were finally repealed in England by George the II. During the two preceding centuries the belief in demoniacal possession had such a firm hold throughout Europe that even such distinguished physicians as Paracelsus and Ambrose Paré were inclined to believe that in rare cases Satan played the pranks attributed to him by the ignorant and superstitious. Luther's firm belief in the doctrine of possession did much to prevent a true appreciation of the nature of insanity, especially in the north of Europe.

As we look back upon the darkness of the middle ages, we can scarcely bring ourselves to believe that such things were possible, for now it is no longer a matter of doubt that the majority of those who suffered agony and death on account of their supposed relations with the evil one were victims of disease and should have received medical treatment instead of the tortures of the whip and flames. The wretched condition of the insane at this time who were allowed to live, almost beggars description. They were treated worse than animals. Many were confined for years in cells destitute of windows or doors, with only an opening in the ceiling through which limited supplies of food and drink were lowered to them.

During the seventeenth and eighteenth centuries a certain degree of improvement took place. The insane were admitted to houses of correction and the prisoners were compelled to wash, dress and feed them. But even then they were as a general thing neglected and abused or gibed and mocked by their keepers. The belief in mechanical restraint was universal. Physicians vied with each other in devising means of restraint and the result was the ball and chain, the rotary chair, in which the patient was revolved a hundred times a minute, until emesis occurred, the gloves fastened to the hands and attached to iron rings in the wall, the muff, the camisole, the restraint chair, the closed sack, the bath of surprise and other ingenious methods of torture. Is it a wonder that under such treatment the unhappy victims of insanity made their loathsome cells resound in their impotent rage with howlings and cursings, and became in the presence of their brutal keepers almost as savage as the beasts of the forests?

Such was the condition of the insane throughout the civilized world until near the close of the last century. In 1792 the asylums of Paris were in a shocking condition, the insane, the vicious and the criminal being huddled together and treated alike. But in that year, Pinel, whose name has become immortal, was appointed physician to the Bicêtre, one of the largest public hospitals in France. When this large hearted philanthropist entered upon his duties, with him entered, says his affectionate eulogist, "Pity, goodness and justice." Slowly and cautiously he began to investigate the subject of the humane treatment of the insane, but those with whom he talked recoiled with horror from his proposal to remove all manacles and chains. At last, however, he could bear the sufferings of the poor insane no longer and one morning, unaided and alone, he removed with his own hands the chains which had bound an English captain for forty years. In a paroxysm of furor this man had killed one of his keepers with a blow from his manacles. He was more closely watched than any of the others and was considered the most dangerous man in the asylum. When Pinel entered his cell and offered to release him from his chains if he would promise to behave well, the poor man said, "Yes, I promise you, but you are laughing at me, you are all too much afraid of me." But the chains were removed and his door was left open. He raised himself slowly from the floor, but fell back again, as his long confinement had produced temporary loss of power in the legs. After a while he succeeded in maintaining his balance and with tottering steps went to the outer door, looked at the sky and exclaimed "How beautiful." In the evening he returned to his cell of his own accord, where a better bed had been provided, and slept tranquilly.

During the two succeeding years which he spent in the asylum he had no return of his paroxysm and became a helpful patient. In a few days after the above experiment Pinel released fifty-three maniacs from their chains. In his writings he states that the result was beyond his hopes and that "tranquillity and harmony succeeded tumult and disorder."

But despite his best efforts he could not accomplish all that he desired, and in 1818 Esquirol reported to the Ministry that in France many of the unfortunate insane were treated worse than convicts, and their condition was worse than that of beasts. In Germany, in 1817, their treatment was equally bad, and Hayner described in pathetic language the abuses then existing.

In England their condition was still worse. In 1770 they were exhibited to the public for money, the price of admission being at first two pence and afterwards a penny. In 1814 the Royal Hospital of Bethlem, in London, was in a deplorable condition. The report of the "Committee appointed to consider the better regulation of Mad Houses in England," published in 1815, says that chains were almost universally used and preferred to waistcoats because they were less expensive. There was no medical treatment, and "the rude attendants," the report says, "employed seclusion and baths of surprise and flogging at will." One notable example of the treatment of the times is described in Esquirol's works and illustrated in the celebrated engraving known as "Norris in chains." The patient was a large, powerful man, and on one occasion had resented what he considered improper treatment by striking his attendant. For this offense he was fastened by a long chain which was passed through a hole in the wall to the next room, where his vicious keeper could drag him close to the wall whenever the fancy seized him. Poor Norris managed to mitigate his sufferings by wrapping straw around the chain, but soon even that small comfort was denied him, for a new means of torture was invented. A stout ring of iron was riveted around his neck, from which a short chain passed to a ring made to slide upwards and downwards on a massive upright bar, more than six feet high, inserted into the wall. Round this body a strong iron bar about two inches wide was riveted; on each side of this bar was a circular projection which being fastened to and enclosing each of his arms, pinioned them close to his sides." The effect of this cruel invention was that he could raise himself up against the wall but could not move one foot from it. Neither could he lie down except upon his back. In this thraldom he lived for twelve years, and although it is said that he was rational in his conversation much of the time, he was never allowed even a single chance to breathe the air outside or to look upon the country which God had made or to see the beautiful blue of the heavens. Each unhappy day was like the one that had preceded it, and each miserable night was like the one that was to follow. At last relief came and the doors were opened, but the broken constitution refused to rally and poor Norris lived but a few months in freedom. Pinel and Esquirol, however, were not alone in their undertakings, for in other parts of the world similar efforts were being made. The brutalities of the York asylum and the good work done by the Tukes in founding the York Retreat, and by Conolly in the Hanwell asylum, need only be mentioned. They are now matters of history, and my tale of horrors will become too long if I attempt to cover the subject fully.

We must now turn from the question of the care of the insane in Europe and look at the subject from a closer view and see what was being done, or rather what had not been done for them in our young Republic. In the picturesque language of Dr. Godding "the early part of the century found the lunatic in America but little changed from his Judean prototype of the first Christian era. His environment was the cage and the alms-house, he was shunned of men, hooted at; 'crying and cutting himself with stones,' happy only—like him in Judea—when he found refuge in a tomb." In practice, the common law which permitted the confinement of a lunatic anywhere, as a person dangerous to be at large was followed, and the insane were therefore immured in jails, poor-houses, out houses or in any place where cupidity or convenience suggested.

The first public attempt to provide care and treatment for the insane in this country was made by Dr. Thomas Bond of Philadelphia. With the encouragement and assistance of Benjamin Franklin he succeeded in 1751 in having a bill passed by the legislature appropriating two thousand pounds "for the purpose of encouraging the establishment of a hospital for the relief of the sick poor and for the reception and care of lunatics." A private house was rented, and on the 11th day of February, 1752, the first patients ever placed in such an institution in the United States were admitted. This was the foundation of what is now known as the Pennsylvania Hospital for the insane, which was opened for the reception of patients on the 23d of May, 1755. The first *State* institution in this country, however, was established at Williamsburgh, Va., in 1773. In 1791 a few cases of insanity were cared for in the New York Hospital, and in 1807 a law was passed by which the overseers of the poor were empowered to contract with the governors of the New York Hospital for the care and maintenance of pauper lunatics in that branch of the hospital which has since been known as the Bloomingdale Asylum. It will be noticed, however, that the admission of pauper lunatics was optional with the governors of the hospital and many who needed treatment most were unable to obtain it. As a result, the jails and alms-houses in all the

States continued to be filled and the condition of the insane poor became lamentable in the extreme.

In the alms-houses in the immediate vicinity of cultured Boston, Dr. Butler, the first superintendent of the Boston Lunatic Hospital, tells us many pitiable cases were found. Even as late as 1839 he states that it was the custom of the alms-houses of Massachusetts to keep the violent cases in wooden cages and that as a specially humane feature the cages were put on wheels so that the patients could be drawn out in the air in pleasant weather.

A great step in advance in this State was made by the passage of Chapter 294 of the Laws of 1827, which says that "no lunatic shall be confined in any prison, jail or house of correction, or confined in the same room with any person charged with or convicted of any offense." This was the beginning of a movement for the betterment of the condition of the insane which resulted, after several failures and disappointments, in the establishment of the State Lunatic Asylum at Utica. Governor Throop, in 1830, '31 and '32, called the attention of the legislature to the uncared for condition of the insane poor, and Governor Marcy, in 1834, followed his example. As a result a special committee was appointed in 1835, and in 1836 Chapter 82 authorized the establishment of the State Lunatic Asylum at Utica. It was not opened, however, for the admission of patients until the 16th of January, 1843, seven years after the passage of the bill authorizing its erection.

In the meantime the needs of the insane had increased so much that in the very first report the managers made an earnest plea for the rapid enlargement of the institution. As it had been founded solely with the intention of caring for the acute insane, it can be readily understood that the condition of the chronic insane was in no wise bettered, but had on the other hand gone from bad to worse. The report of Miss Dix, that noble woman whose work counted so much in the amelioration of the condition of the insane poor in nearly every State in the Union, is filled with graphic descriptions of the horrors of county care. She visited many county houses and nearly every jail in the State, and found that in almost every one the pauper insane were herded like animals, their malady being utterly ignored. When too feeble to take their chances with the other paupers or to be able to attend to their own wants, "they became objects of disgust and were thrust, like anything else offensive, into dark and out of the way places." In nearly every county house Miss Dix found the insane neglected, uncared for and abused. Some were confined naked, in dark, foul-smelling cellars; others were in chains; and frequently helpless women were exposed to nameless vice. In fact her whole report is one long tale of misery and suffering with only a bright spot here and there in the cheerless desert of neglect.

I am sure it will be gratifying to my audience to know that one of those bright spots was found in Poughkeepsie. When I read the report, for the purpose of verifying my statements, the monotony of the description of the unsatisfactory condition of almost every almshouse saddened and wearied me, but to my relief, under the heading of "Dutchess County House," I read the following: "The Dutchess County House at Poughkeepsie is a model of neatness, order and good discipline. The household arrangements are excellent; the kitchens and cellars complete in every part. I have seen nothing in the State so good as these. Every apartment in the almshouse was exceptionally clean, well furnished and neatly arranged. Such of the insane as were highly excited were in clean, decent rooms. Great credit is due to those who have the immediate charge of this house for so thorough supervision and energetic administration of its affairs."

While this report, published in 1844, aroused sympathy to a considerable extent, it failed for the time to secure tangible results. In 1854 the condition of the insane in the poor houses had become so bad that the superintendents of the poor addressed a communication to the Legislature asking for relief. Again public sentiment was stimulated for the time but again the results were barren. Things went from bad to worse until 1865, when the report upon the condition of the insane in the poor houses of the State, made by Sylvester D. Willard, undertaken by legislative authority, granted a year before at the suggestion of the State Medical Society, whose Secretary Dr. Willard was, resulted in the passage of what was known as the Willard Asylum Act. This act was designated Chapter 342 of the Laws of 1865, and was entitled "An act to authorize the establishment of a State Asylum for the chronic insane, and for the better care of the insane poor, to be known as the Willard Asylum for the Insane." The fact that the State owned about 300 acres of fertile land on the beautiful shores of Seneca Lake, which had been originally obtained for the purpose of establishing an agricultural college which was broken up by the Rebellion, resulted in the location of the asylum in that part of the State. This was the first decisive step on the part of the State to assume the care of all its dependent insane. The asylum, however, grew slowly and was not opened for patients until October 13, 1869. In the meantime the needs of the insane had become so urgent that other institutions were projected at Poughkeepsie and Middletown, and later at Buffalo and Binghamton. But despite all efforts the accommodations were never adequate to the demands, and in 1871 a great step backwards was taken when Chapter 713 was passed giving counties the right to resume the care of their insane upon satisfying the State Board of Charities of their ability to properly maintain them. The county authorities, however, were not long satisfied with this exemption and several counties shortly afterwards obtained, directly from the Legislature, permission to care not only for their own chronic insane but to take those from other counties. Thus the important step in advance taken by the State in 1865 was completely nullified, and in less than a decade no fewer than one-third of all the counties in the State were caring for their chronic insane, and in some instances for the acute insane as well, and boasting that they were doing it for less than one dollar a week per capita. In the meantime, however, there was a quiet but powerful sentiment at work which was ultimately to bring about an entire change in the policy of the State in regard to its insane. Much of this good work emanated from the State Charities Aid Association, a voluntary organization founded in 1872. In 1886 this association attempted to secure the passage of a bill providing for the removal of all the insane from the poor houses of the State, but the effort met with defeat on account of the determined opposition incited by local and selfish interests. In 1889 a State Commission in Lunacy, consisting of three members, was created and many of the powers heretofore vested in the State Board of Charities were transferred to them. They immediately took up the question of State Care and refused to grant any further exemptions to the Willard Act. Their first annual report glows with indignation at the sufferings of the insane in the poor houses of the State, and their influence in helping to secure the passage of the State Care Act, which had again been brought forward by the State Charities Aid Association under the able leadership of Miss Louisa Lee Schuyler, cannot be over-estimated. This Act, in brief, provided for dividing the State into hospital districts so that each hospital would receive all of the insane of its own district, thus doing away with the unscientific and inhumane *legal* distinction between acute and chronic insanity. It also provided for building a sufficient number of small detached buildings, in connection with existing institutions, to accommodate all of the insane then in the poor houses of the State. The cost of these buildings was limited to $550 per capita, including furniture. Strange as it may seem, these features of the bill were the ones which received the most criticism and arguments were advanced on every side to show the supposed injurious effect of "herding," as it was called, the acute and chronic insane in the same institutions. These arguments appealed to many, for it is a common belief that association with the insane acts unfavorably upon recent cases and especially upon those who are just on the border line. This supposition, however, is entirely unwarranted, for experience teaches that the contrary is true and that the judicious mingling of the curable and incurable may even be beneficial if we have facilities for proper classification and are able to separate the excited and untidy from those who are quiet and neat in their habits. New patients frequently become interested in the delusions of their fellow patients and in that way take the first step towards forgetting their own. The chronic patients are helpful in assisting the newly admitted ones in becoming acquainted with their new surroundings, and teaching them by the force of example that they must be guided by "the strict, though sympathetic spirit of order" which pervades all well-managed institutions, rather than by the dictates of their own morbid wills. The chronic cases are also benefited in turn by the presence of the newly admitted ones fresh from the bustle of the outside world, and the frequent discharge of those who have been cured keeps hope alive in the breasts of those who remain. Until advanced dementia supervenes nearly every patient believes that his chances for recovery are good, and he never grows weary of asking when he will be well enough to go away. If his question is answered by his transfer to an asylum whose very name suggests the unhappy words "all hope abandon, ye who enter here," the effect can be readily imagined. We are all aware of the powerful influence of hope in the cure of disease and in no class of maladies is it more potent than in mental disorders. Even when the disease is apparently chronic, efforts toward cure should not be abandoned, for recovery after insanity has existed for several years is by no means uncommon. This fact has done much to make alienists of to-day firm in the belief that advancement lies not in the establishment of separate plants for the supposedly curable and incurable, but in having mixed institutions so planned and equipped as to give to each patient every possible chance for recovery. Small, well-arranged hospitals, reception wards in the administration building, and other wards or buildings near by adapted to the care of the untidy, the excited, the demented and the epileptic, to which and from which transfers can be made according to the exigencies of each particular case, is the arrangement which a modern hospital for the insane should present.

Statistics show that the majority of those who become insane belong to the ranks of the hard working, industrious and self-supporting classes who until the visitation of insanity contributed their share towards the prosperity of the State. While about eighty per cent of all the patients in the various State hospitals are supported wholly at public expense, not more than five per cent of the whole number belong properly to the pauper class, with its accompanying improvidence, vagrancy and vice. It must be admitted that quite a number owe their insanity to intemperance in drink and other excesses, but even they, as a general thing, have been able to maintain themselves without public aid and cannot therefore be properly classed as paupers. While we may criticise and blame them for their sins and excesses, who will say that when bereft of reason they should be deprived of the benefits of proper treatment? It seems incredible that so much opposition could have been aroused and so many exciting controversies could have been incited over the passage of the bill which marked the most signal triumph ever attained for humanity in this great State.

This act, however, while it aimed ultimately to entirely abolish county care, exempted three counties for the time, giving them the privilege of coming in under State Care whenever they desired to do so. Those counties were Monroe, Kings and New York. Monroe came in immediately, Kings gave up its old system last year and within the past few weeks a bill has been passed bringing New York, the only remaining one, under the State Care system. New York, therefore, enjoys, after sixty years of effort, the proud distinction of being the only State in the Union which has all its insane poor absolutely under State care and supervision.

Now let us examine into the workings of our State hospitals as they exist to-day. They are all thoroughly equipped from an architectural and sanitary standpoint and differ but little in their main features. I will, therefore, confine myself to a description of the Hudson River State Hospital, as it is the one in which we are all the most interested. The very title of this institution has been productive of a great amount of good and has played no small part in shaping the policy of similar institutions. To my predecessor, Dr. Cleaveland, belongs the credit of having been among the first to drop the unpleasant words "lunatic" and "asylum" from the nomenclature of institutions for the care and treatment of the insane. His commendable example has been followed in many states, and six years ago the names of all such institutions in this State were changed by legislative enactment from asylums to hospitals. That is only one evidence, however, that what were formerly asylums or places of safety and detention have become, by gradual evolution, hospitals, in fact as well as in name, where skilled physicians and trained nurses put forth their best efforts to "minister to the mind diseased."

Probably nothing has done more to improve the service in hospitals for the insane than the training of attendants. About fifteen years ago this question began to be agitated, but it is only within the last eight or ten years that training schools in connection with hospitals for the insane have obtained a solid foothold. To-day there is scarcely an institution in any part of the United States where efforts are not made to train the attendants. In this State every hospital is obliged to have its training school, and graduates, who pass their final examinations before a board of examiners composed of three superintendents, are entitled to an increase in wages and are always selected for promotion in preference to non-graduates.

This policy, together with a strict compliance with the principles of Civil Service Reform, is beginning to tell. We are now getting more intelligent employés and more faithful service than it was possible to obtain a few years ago. There are of course occasional exceptions, but in the vast majority of instances attendants are kind and conscientious and perform faithfully their arduous duties under most trying and discouraging conditions.

Since the practical abandonment of mechanical restraint the attendant has occupied a most important place in hospital management. Even locks and window guards are not always necessary, and in some wards of nearly all institutions the doors are left open through the day, so that patients may come and go at will. There is of course in every hospital a considerable number of patients with destructive and suicidal tendencies, but even with them the eyes and ears of the attendants are made to take the place of the camisole and muff of earlier days. Neither are large doses of stupifying drugs given for the mere purpose of quieting a noisy and troublesome patient. We have found a much better and more satisfactory method in exercise and employment. If a patient is physically strong but too destructive to engage in any kind of occupation, he is taken for long walks and kept in the open air in suitable weather until nature calls for rest through sleep. If, however, he can be induced to work, as nearly all can if the effort is persevered in, some suitable and congenial occupation is provided in which a couple of hours are spent each morning and afternoon. I have seen patients in the last stages of dementia spending their time in picking their clothing and bedding into shreds, who upon being taken to the upholstery shop would quietly pick the curled hair used in mattress making for hours at a time, thus satisfying themselves while performing some useful work. The amount of useful work performed, however, is never the object sought. I have had women sew for hours upon work which would have to be done over again, and have had men wheel dirt and stones from one spot to another simply for the sake of the exercise and occupation thus obtained.

There must be some outlet for the pent up nervous energy, and if it does not find vent in occupation and recreation, unprovoked attacks upon attendants and fellow patients and destruction of clothing and furniture will follow. The recognition, and practical application, of this fact accounts almost wholly for the difference in the amount of violent excitement found in the asylums of ten years ago and those of to-day.

In the Hudson River State Hospital during the past year sixty-five per cent. of the patients were engaged in useful employment of some kind. This means that occupation was found for 964 persons each day, either in ward work, farm and garden work or mechanical pursuits. When it is stated that besides cultivating a farm of more than a thousand acres and keeping the grounds and several miles of road in good condition, there is a large tailor shop and sewing-room where all the clothing worn by patients is made; a shoe-shop where all the boots and shoes are manufactured; a brush and broom shop where we make not only all the brushes and brooms we use ourselves, but supply other institutions; an upholstering shop where furniture is repaired, chairs caned, mats and mattresses made; and a laundry where forty thousand pieces are washed each week, it will not seem surprising that so many hands can be kept busy. For those who are not strong enough to do such work there is a school, in charge of an experienced teacher, where the morning hours pass pleasantly. Physical training is not forgotten even there, for a part of the instruction includes calisthenic exercises.

It is to be regretted that so little is known by the general public in regard to actual asylum life. The majority of persons, even the most intelligent and well-informed, upon their first visit to an asylum expect to find many of the patients in cells and padded rooms, and it is difficult to convince them that such things are relics of the past. In my experience of sixteen years I have only seen one padded room and that was in an asylum in Europe. Frequently after visitors have been shown through every ward they will ask to be permitted to see the "bad patients," and when assured that they have already seen them, although they may not say so, they go away firmly convinced that a great deal has been withheld and that they have only seen the quiet wards. It is difficult for those who are not familiar with the facts to understand that it is possible for life in a hospital for the insane to move with quietness and regularity and to present many pleasant features.

The majority of the wards have pianos or other musical instruments, and games, such as cards, dominoes, checkers, shuffle-board and billiards are freely provided. The rooms and wards are attractively furnished, many being supplied with carpets and rugs; the windows are draped; easy chairs and settees abound, and the walls of even the most disturbed wards are well supplied with pictures, which are seldom broken or destroyed. Entertainments and dances are provided two or three times a week and an excellent orchestra furnishes suitable music whenever desired. In summer ball-games, field sports, croquet, open air concerts, boat sails on the river and picnics take the place of the indoor entertainments of the winter. In fact it is the constant effort of all alienists to find occupation and diversion for their patients, for they all agree in thinking that under proper supervision it is one of the most important measures in the treatment of the insane.

I would not, however, be understood as advocating employment, or even recreation, in all cases. In the acute stages of mania and melancholia the power of attention and concentration of thought may be so weakened that the slightest effort results in extreme fatigue. That is why travel and change of scene, with the necessary bodily and mental restlessness, so rarely accomplish any good in the acute stages of mental disease. Such cases need rest and quiet and all our efforts should at first be spent in improving their general condition and restoring their exhausted forces. When improvement begins, or if the result be less fortunate and symptoms of chronicity supervene, efforts should be made to turn their thoughts into regular and healthy channels by the use of manual and mental occupation.

It may not be inappropriate here to say a few words in regard to the "home treatment" of insanity. A noted neurologist a short time ago in an address on the subject of hospitals for the insane said that it was his belief that they should "never be used save as a last resource." Such advice is too frequently followed, and we who spend our lives surrounded by the saddening influences of "minds o'er thrown" know full well that in the majority of cases when that "last resource" is reached, all hope of cure has passed. I am quite willing to admit that in the homes of the wealthy where expense need not be considered, where a sufficient number of nurses can be obtained, and where hospital conditions can be closely approached, in fact where the home can be, for the time, transformed into a hospital, that it may be desirable and even advisable to undertake the home care of certain forms of acute insanity. But the cases where all such conditions can be provided are comparatively few, and the fact still stands that the vast majority must sooner or later find their way to the hospital. The sooner they are sent the better it will certainly be for all concerned. In a paper which I wrote a couple of years ago on "Communicated Insanity," I cited several cases where home care resulted in the mental break down of other members of the family and also showed that an analysis of the cases with which I had had to do for the previous ten years proved conclusively that from six to eight persons recovered when placed under hospital treatment during the first three months of the attack, where only one recovered where hospital treatment was delayed a year.

I realize that even in this day and generation there is a certain amount of stigma attached to insanity, but much has been done during late years to remove this unjust discrimination against sufferers from brain disease. I fear, however, that it will never be quite done away with until the admission into hospitals for the insane is made easier and freer from legal restrictions. Our pressing need, in my opinion, is for a law, such as they already have in some states, permitting voluntary commitment on the part of those who realize their need of hospital treatment. There should then be established in connection with each large state plant a small detached hospital and a convalescent cottage for each sex. The former need not be large but should contain everything possible in the way of structural arrangement and equipment to insure the highest degree of care and treatment for acute and hopeful cases. An important step looking towards this result has been taken in this State by the appointment by the Commission in Lunacy of a State pathologist, and the equipment at the different institutions of laboratories for the accurate and scientific study of insanity in all its aspects.

The convalescent homes it would be well to have some distance from the parent insitution and far enough away to insure a complete change of scene and mode of living. My experience leads me to believe that it is exceedingly difficult to tell just when a patient should be discharged and returned to his old life, and I believe the difficulty would be overcome if we had cottages for convalescents where doubtful cases, especially the friendless ones, could be sent for a time to be prepared for renewing the struggles of outside life. It is true that we have a partial solution to this difficulty in the system of parole by which we are enabled to permit patients to go home on a trial visit of thirty days before final discharge. This practice, however, cannot be put in force where the patient is without home and friends, and it is such cases that occasion us the most anxiety. In England and France they recognize the fact that

> " 'Tis not enough to help the feeble up,
> But to support him after,"

and in the former country they have what is known as an "After-Care Association" and in the latter "Convalescent Homes," where suitable cases are provided for for a period of from four to six weeks. Friendless ones are helped to obtain employment and assistance is rendered in many ways.

Another accusation made by the same neurologist is that hospital physicians foster the belief that there is a sort of "mysterious therapeutical influence" behind asylum doors unknown to those outside. We, of course, make no claim to having "ways of curing" unknown to other members of the profession but we do claim, in the language of Sir Clifford Allbutt, that there is more in the medical care of the insane than mere "bottle medicine," and that "the established regimen and discipline of a hospital are felt for good by the patient as soon as he comes under their influence. They tend to establish habit and automatism and the annihilation of self. He sees everything about him moving with system and regularity, obedient to one will, subservient to established rules. He finds it more comfortable to fall into line and follow, rather than move in the erratic tracks which fancy dictates, and gradually his delusions and impulses lose control and sane ideas gain the ascendency." The same views are expressed by Clouston, Bucknill and Tuke, Spitzka and other eminent authorities.

In addition to the regular methods the dietary holds an important place in hospital management and is receiving each year more and more attention. In this State the experience of the various superintendents and stewards has been combined with the theories of one of the most eminent physiologists of the times, and a dietary table has been prepared which fulfills all physiological requirements while it gives sufficient variety to satisfy the most capricious appetite.

From what I have said it might be imagined that medicine plays but a small part in the treatment of insanity. In chronic cases it is true that medicines have but little direct effect and, like other chronic diseases, we must devote our energies to treatment on general instead of on special lines. There is no danger, however, that the asylum physician will fall into routine methods unless he desires to do so, for the ordinary ailments which so frequently occur in the insane give ample opportunity for general practice and keep him in touch with all branches of medicine. In acute cases of insanity, medicines and nursing play a most important part, and the treatment and attention given to such cases often decide whether the result is to be speedy recovery or death, or what is still worse, hopeless dementia.

My paper has already assumed unexpected proportions but I have not touched upon the most important thing of all, that is the result of treatment in modern hospitals for the insane. In the Hudson River State Hospital there have been admitted since its opening in 1871, 7,003 insane persons. Of that number 5,496 have been discharged from our records while 1,507 still remain in the institution. Of the 5,496 discharged, 1,474 were entirely recovered, 804 improved enough to live at home, 1,906 did not improve under treatment, and 1,316 died. If we therefore take the record of this State Hospital for the quarter century of its existence, we find that about twenty-one per cent. of all those admitted recovered; eleven and one-half per cent. improved sufficiently to live at home; nineteen per cent. died; twenty-seven per cent. did not improve, and twenty-one and one-half per cent. still remain under treatment. In other words, and with sufficient accuracy for practical purposes, of every six patients sent to hospitals for the insane, three will not recover and will have to remain in the hospital for the rest of their lives, with possibly brief intervals of home care during periods of remission; two will either entirely recover or get well enough to live without hospital care, and one will die during the attack. While this may not at first sight appear to be a satisfactory showing, we must remember that we have a grave disorder to deal with and that we do not generally receive our patients until home treatment, water cures and sanitariums have failed. In addition, the foundations upon which we have to work are often very defective. When we take into consideration the influence of heredity and imperfect development in the causation of insanity and then add the large number of cases of general paresis, idiocy, imbecility and epilepsy, I think the results realized from treatment in hospitals for the insane will compare favorably with those obtained in other hospitals where diseases of a serious nature are treated.

When the heart, lungs or kidneys become gradually and seriously affected, complete recovery is generally out of the question, and the physician who manages such cases so that his patients are able to pass the balance of their days in comparative comfort has done all that can be expected and no one thinks of complaining of the futility of medical treatment. Why, then, should it be different with diseases of the brain? Surely when that delicate organ becomes affected, if we succeed in restoring nearly 33⅓ per cent. to home and friends and in making the existence of fifty per cent. more useful, and in many cases happy, even when they have outlived their friends or been forgotten by them, has not something been accomplished, and is not the State justified in assuming entire care of him who is often in a position to exclaim in the touching language of Job, "My brethren are far from me, and mine acquaintance are verily estranged; my kinsfolk have failed and my familiar friends have forgotten me; Have pity upon me—have pity upon me, for the hand of God hath touched me."

SCIENTIFIC PAPERS

OF

VASSAR BROTHERS INSTITUTE,

AND

TRANSACTIONS

OF ITS

SCIENTIFIC SECTION.

1893–1896.

VOL. VII. PART II.

TRANSACTIONS

OF THE

SCIENTIFIC SECTION.

1893–1896.

DECEMBER 12, 1893.—FIRST REGULAR MEETING.

Chairman Burgess presided, and about forty members and guests were present.

Mr. John Sutcliffe read a paper on "Silver," describing, largely from personal experience, silver mines and the methods of working them.

JANUARY 9, 1894.—SECOND REGULAR MEETING.

Chairman Burgess presided, and sixty members and guests were present.

Mr. Edward Elsworth read a paper entitled, "Some Notes on Hypnotism."

JANUARY 23, 1894.—THIRD REGULAR MEETING.

Chairman Burgess presiding, and sixty members or visitors present.

Mr. William C. Albro presented a paper on "The Basis of Currency."

FEBRUARY 13, 1894.—FOURTH REGULAR MEETING.

Chairman Burgess presided, and fifty members and visitors were present.

A paper was presented by D. B. Ward, M. D., upon "Diatoms." Photographs, the microscope, and black-board drawings were used to illustrate it. It was as follows:

DIATOMS.

BY D. B. WARD, M.D.

About the end of the last century naturalists discovered by the help of the microscope certain animalcules, as they supposed, swimming about in the water and they named them the bacillaria, by which name they are still called by some German and French writers, but are more frequently known as the diatoms. They differ in several respects from all other animalcules. Most of these little organisms, at least the free-swimming ones, have one grand aim and object in life, namely, to get something to eat. They are exceedingly active and exceedingly voracious. While these bacillaria were never seen to eat anything, they swam about apparently on important business which they did not visibly transact, but did not eat.

Then although in some species their motion is quite rapid they have no perceptible organs of locomotion. They have none of those little hair-like processes which are called *cilia* or *flagella* with which so many of the animalcules thrash their way through the water with such marvellous speed that it is necessary to benumb them with drugs or to thicken the water with syrup in order to examine them at all. Nor have they any syphons or collapsible organs to propel them forward by ejecting a jet of water. I shall have more to say presently concerning their motion. Another peculiarity is this: if you dry the drop of water in which they are swimming instead of drying up to utter nothingness, as is the case with infusoria, rotifers, etc., they retain their shape and are found to have hard shells of silex, which resist the action of intense heat so that they may be heated to a white heat without destruction or boiled in strong mineral acids—nitric, sulphuric and hydrochloric without injury—indeed we constantly employ both these methods for the purpose of cleaning the shells for examination.

Other forms were soon found unmistakably of the same character but which were not free-swimming and were exceedingly plant-like in appearance. Some grow on the ends of minute stalks, the other ends being attached to submerged twigs, or stones or water plants; others grow embedded in long gelatinous tubes which are attached at one end. Others, again, being rectangular and flat, arranged side by side like boards upon a fence, form ribbons of considerable length, while others attached by one corner only form ziz-zag chains. Some are cylindrical and form tubes resembling many of the fresh water algæ except in color. Others generally oval or round are purely parasitic and are attached to water plants by their flat surfaces. Again others destitute of motion are loose in the water and lie on the mud or are tangled in weeds. Then, as sometimes happens even in scientific matters, a controversy arose as to the nature of these organisms. Were they animal or vegetable? And as also sometimes happens when a good deal may be said on both sides, this controversy got a trifle peppery at times. They had been classed among the infusoria and were so classified, even as late as 1861, when the last edition of Pritchard's Infusoria was published. The question was finally settled by Mr. Mathieu Williams, an English chemist. He collected the little bubbles of gas which arose from a mass of living diatoms and found it to be oxygen. Now no animals exhale oxygen but plants do, and the fact that some bacillaria or diatoms move is not at all a strange thing, for many of the lower and even of the higer plants move very freely.

Last fall Mr. Van Brunt, who formerly resided here, while in my office related an experience of his in photographing plants last summer. In order to preserve the true color values of leaves and flowers he used the orthochromatic plates with a yellow screen, consequently employing a very long exposure in order to get sufficient detail into his negatives, when he ran against a most unexpected obstacle. He couldn't get his plants to keep still long enough to have their pictures taken. The leaves and stems of flowers writhed and twisted to such an extent that he considered himself fortunate if he obtained one good negative for three or four plates. Each diatom consists of a single cell which forms—no matter what its shape may be—a little box. If we take a pill box for an illustration the top and bottom of the box represent the two valves of the diatom and the sides of the box and of the cover the two connecting bands or zones which slide over each other. The valves and often the zones are covered with ornamental markings often of the most elaborate character, and these markings add greatly to the beauty of the specimens.

Inside this small box we find at the centre a little mass of protoplasm which is called the nucleus and in this nucleus is a minute dot called the nucleolus. Arranged in various patterns according to the genus of the plant are masses of yellowish material called the *endochrome.* This is the same substance substantially as the chlorophyll or green coloring matter of the higher plants, and performs the same function, *i. e.* of splitting up the carbonic acid in the water into carbon and oxygen and setting the latter free. In a single specimen the color is a tawny yellow, but when seen in large masses it is a peculiar shade of brown.

By setting free the oxygen this substance purifies the water for animal life. Sandwiched in with the endochrome is a mass of protoplasm somewhat less dense than the nucleus, and interspersed throughout the cell are minute globules of oil. What function the oil performs is not known. The outer surface of the diatom moreover is covered with an exceedingly transparent delicate membrane of protoplasm.

Now with regard to the valve itself. The two valves are usually symmetrical and exactly alike, but in some species they are always different, for example, some being flat and the opposite valve very convex. They are of every conceivable shape—round, square, triangular, polygonal, boat shaped, star shaped, and in fact you can scarcely imagine any symmetrical form which is not represented by some of the species. The markings occur on the surfaces of these valves. One of the most frequent methods of ornamentation is by fine parallel lines or striae. The striae are found when seen under a high power to be formed of little dots arranged in rows so as to look under lower powers like continuous lines. The explanation of this was very simple and satisfactory until quite recently, viz.: that the dots were minute elevations or thickenings of the silex for the purpose of increasing the strength of the valve at the least possible expense of material. It was assumed that they were elevations, but within the last three years it has been demonstrated that they are depressions and the striae accordingly instead of adding to the strength of the valve really weaken it. This discovery was made by Mr. Gill, in England. He precipitated various chemical substances on the surfaces of the valves and then washed them thoroughly. Prussian blue, metallic silver and sulphide of mercury were used for this purpose. That deposited on the surface of the valve was easily washed off, while the little cup-shaped cavities retained the substances and proved that they were depressions, as they would be the first to wash clean if they were elevations. There is much yet to learn about the structure of the diatom valve, and many disputes have arisen regarding it. It is certain that it is composed of more than one layer, and in some species of at least three layers, differing from each other in thickness and in marking. The subject is a little too complicated to deal with in this paper, and as no one knows absolutely much about it, it would be unprofitable to give the views of eminent microscopists who fail to agree among themselves. Diatoms are all small—the smallest about the size of the human blood corpuscle, which measures $\frac{1}{3200}$ inch in diameter.

The largest I have ever read of, larger than any I have ever seen, measures $\frac{1}{32}$ of an inch in diameter or 100 times the diameter and 10,000 times the area of the smallest. (The head of a pin measures about $\frac{1}{16}$ of an inch.)

They are as widely distributed as water itself and *may* be found wherever it is a little wet. I don't mean that you will always find them wherever it is wet; but if you have a combination of sunlight and water, it is possible for them to grow. They love the sun, these little plants, and it is hardly worth while to look for them in dense shade. They grow in clear water and in stagnant; in salt water and in fresh water; in cold water and in hot.

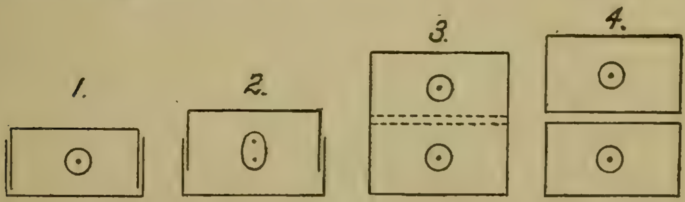
They have been found in thermal springs so hot that no other living thing could exist there, and they swarm in the waters of the polar seas, so that, washed up by the waves, they frequently discolor the ice pack for miles.

They have been found on a brick wall which was kept constantly damp by the exhaust pipe of an engine and in the moist climate of England have been found growing on the trunks of trees. A definition of a diatom then would be something like this: A minute water plant consisting of a single cell with a coating of silex more or less elaborately sculptured. They belong to the sub-class algæ which includes the sea weeds and the plants forming the green scums which mantle the surfaces of our fresh water ponds and ditches, and which we know as frog spawns. They are very humble plants, well down toward the lowliest of organisms. I have already alluded to the motion of the free-swimming kinds. By free swimming I do not mean that they are simply unattached and drifting about at the mercy of small currents of water, but they actually progress in the direction always of their long axis and with considerable speed in some cases. I have seen specimens of pleurosigma, for example, moving about as fast as the Mary Powell does in proportion to their size, *i. e.* the pleurosigma would move through its own length in about the same time that the steamer would require to traverse her own length. So you see the motion is rapid in some cases. Now what is the cause of this motion? I don't know, and the worst of the matter is no one else does. There has been no end of theories about it but none which explains all the facts. There is something weird and ghost-like about it, as they leave no commotion in the water behind them, nor any disturbance of minute particles in their vicinity. I have seen a navicula run into a little mass of decayed vegetable matter and back out, then change the direction of its axis somewhat and proceed again, clearing the obstacle. I remember a good while ago seeing a little crab in an aquarium butting against the glass time after time in an effort to go in that particular direction. He kept at it until I was tired of watching him, and when I saw this diatom I thought that to all appearance the diatom was more intelligent than the obstinate little crab, although the latter was a highly organized animal and the former one of the lowliest of plants. I have no doubt that the change in direction of the axis just mentioned was accidental in this case but the backing away from the vegetable debris was *not* accidental, but was similar to the action of the sensitive plant in avoiding contact with foreign substances. When we have the two phenomena of motion and sensitiveness combined in any organism, we obtain results closely allied to the manifestations of intelligence. The vital processes of these organisms are exceedingly active. Professor Bischoff has estimated that in order to form their valves they must take into their interior the same quantity of water in proportion to their mass as would be swallowed by a man drinking a cubic foot of water per second. (A cubic foot of water I believe contains about seven gallons). You are doubtless aware that most waters, fresh and salt, contain only a trace of silica and yet from this minute trace the shells must be built. So rapidly do they grow that you may frequently find myriads of them where not one could be found the day before, and it is never safe to leave a lot of them expecting to collect them the next day. You may find no trace of them when you visit the spot then.

They propagate in two ways, both very simple, by fission or splitting apart and by conjugation and formation of spores.

When we get down toward the beginnings of life we find all the functions reduced to their simplest forms. For example, the simplest known animal is the amœba. This little creature is a minute mass of jelly or protoplasm and nothing else. It moves without any organs of locomotion, eats without a mouth and digests without a stomach. Whenever the amœba runs across a suitable article of food—let us suppose a diatom—it proceeds to wrap itself around it, shutting off its supply of water, and the diatom soon dies and falls apart. The amœba absorbs the contents of the shells and having no further use for the bands and valves it unwraps itself and looks for another meal.

When the creature after a succession of such repasts has grown large and unwieldy it simply splits in two and becomes two amœbas. Thus there is a sort of immortality about it, for each amœba must contain some portion of all its ancestors back to the original amœba. There is a familiar unicellular plant called the protococcus viridis which grows in the late fall and winter on the north side of the trunks of trees, coating them with a brilliant green whenever the weather is wet. This little plant has about the size of the human blood cell on the average. Each cell splits in two, then four, and so on, thus accounting for the extremely rapid growth which covers the bark in a few hours with a thick and brilliant coating of green. Now the diatom multiplies in the same way by fission or splitting; but as it is obvious that if it split in two in its ordinary state it would then be in the condition of an oyster on the half shell, a modification of the process is necessary. This modification is shown in figures 1, 2, 3, 4.

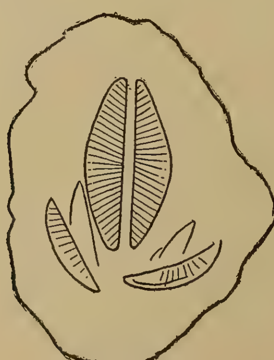


The hoops slide over each other and the diatom becomes thicker, the nucleus becoming elongated and the nucleolus split in two. Then the nucleus itself splits and a new valve is formed from each hoop, as shown by the dotted lines. In Fig. 4 the process is complete and the two diatoms have separated, each one having a new and an old valve. After a certain number of repetitions of this process the vitality of the plants seems to become impaired. They have as it were "run out" and become small and feeble, when a new process restores the race to its full size and activity. This is the process of conjugation with formation of spores. Two diatoms coming in contact throw out about them a cloud of gelatinous material which keeps them together and excludes foreign matter. The valves then separate and the semi-fluid contents, protoplasm, endochrome and oil globules mingle and form a spore, in some species more than one. From this spore is formed one or more new diatoms much larger and more robust than the parent forms.

5.

6.

7.



8.

It seems to be the universal law of all lowly organisms that the spores are much more resistant than the complete forms to adverse influences—heat, cold, dryness, &c.

The spores of bacteria are much harder to kill than the bacteria themselves, while the diatom spores retain their vitality when dry, a condition which would be fatal to the perfect plant. Pools of water, ditches, etc., dry up and the diatoms are killed, but the spores remain and some of them are blown about by the wind and find some wet place to develop, and when it rains those remaining in the pool spring into life and repopulate the water. This accounts for the wide diffusion of species.

As the valves of the diatoms are practically indestructible, when the plants die the empty shells settle to the bed of the ocean or lake where they grew, and thus in the course of time they have in various parts of the world formed vast deposits in which the shells remain as perfect as when they were living. Many of these fossil species have long since become extinct. The city of Richmond, Virginia, is built over such a deposit, which was laid down during the tertiary period, and this deposit is in places forty feet thick. Some specimens of this earth consist of diatoms and nothing else, others have a good deal of fine sand mixed with them, but in all the diatoms are very abundant.

Three or four years ago Mr. Lewis Woolman, a geologist of Philadelphia, in examining the material brought up by the drill of an artesian well at Atlantic City, N. J., found a large number of diatoms at a depth of 406 feet from the surface. These are in a brown miocene clay, and at 550 feet another rich diatomaceous clay was reached and still another at 625. The intervening strata contained diatoms in smaller quantities at all depths. Subsequently other wells pierced these strata at different depths in other places. At Weymouth the upper stratum is only forty feet below ground, and at Shiloh there is an outcrop. It would seem therefore that a large portion of the State of New Jersey has an enormous bed of diatoms beneath it some 300 feet thick. In this miocene clay have been found many new species and other forms in comparative abundance which are very rare elsewhere.

Back of Sing Sing some three miles, on the site of an old pond long since dried up, is a fresh water deposit of pure diatoms unmixed with any foreign matter worth mentioning. From similar fresh water deposits the polishing powder known as electro-silicon and the Star Polishing Powder are made and the Sozodont tooth powder (not the liquid Sozodont, which is a soapy fluid) is made, from a deposit at or near Troy, New Hampshire. This latter is mixed with arrow-root, starch and various flavoring substances.

That exceedingly energetic explosive, dynamite, is made by mixing nitro-glycerine with a diatomaceous earth from Germany.

Other sources from which we obtain a supply of diatoms are somewhat curious. Some of the most beautiful of known species are found in the guano from Peru and Southern California. They get there in a roundabout way.

The diatoms are eaten by minute sea-animals, crustaceans, etc. These in their turn are eaten by fishes, and the latter fall a prey to the sea-gulls. As the shells of the diatoms are utterly indigestible, even the rugged gizzard of a sea-gull can do nothing with them and they are deposited intact on the rocks. The stomachs of fishes, oysters, sea-slugs and other marine creatures sometimes furnish many rare and curious species. Soundings from the deep sea have brought up many kinds hitherto unknown, and washings from the anchor chains of ships have yielded their quota of diatoms.

The number of species and varieties is enormous. A catalogue was written in 1885 by a man named Habirshaw. This gave the names of all the species then known and references to all the information regarding them which had been published. This catalogue was never printed, but about fifty copies were made by an electric pen and are in the hands of those interested in the subject. The catalogue contains references to 8,000 species or more. Since then several thousand additions have been made and I would not be surprised if a complete list would contain 14,000 or 15,000 names.

The nomenclature is in a wildly chaotic state, one single form frequently having been named by from two to a dozen different botanists and sometimes, as in the case of Ehrenberg, the same man has named his own species over again, having forgotten that he had seen the form before. Slight, very slight, variations in shape and markings have been erected into separate species, the German observers being particular sinners in that respect. The whole thing makes the study of the diatomaceae a very puzzling and difficult one. If you send a slide to three different experts for identification the chances are that you will get three different names and all of them correct.

Eliminating all the synonyms and reducing the mere varieties to their proper species would do much toward simplifying this very tangled skein of names, in many instances of bad Latin and worse Greek.

But with all this done there would still remain an enormous number of species; more than any one man would be likely to retain in his memory. The literature of the subject is scattered through periodicals, pamphlets, and monographs and illustrations of special deposits, so that a complete library on this subject is very expensive and the work of a lifetime to collect. As in all forms of life, animal or vegetable, monstrosities sometimes occur—abnormal forms of all kind.

Double forms, like Siamese twins, distorted shapes and variations in the markings are found. Thus far, however, as in the study of monstrosities generally, little light has been thrown on the causes of their formation nor has much knowledge been added as to the physiology of the normal forms.

A few words here may be of interest concerning our local flora. The Hudson River at Poughkeepsie is a very good place for collections and no better place can be found for this purpose than the filter-beds at the pumping works. They furnish an ideal habitat. They are cleaned at frequent intervals; the water in them is free from currents and is exposed constantly to the rays of the sun, so that the diatoms collect in vast numbers and as the water is lowered they sink gently to the bottom and are deposited on the surface of the mud which is held back by the layer of filtering sand. When the water is all drawn off, by gently scraping the surface of this mud myriads of diatoms can be obtained. A singular fact is to be noticed. During the summer months, in July especially, the most frequent, or at least most conspicuous species, is a marine one. It occurs in the river at this point and is much more frequent here than it is further down the river. I failed to find it at all at Sing Sing, although most of the forms there are marine. It is called coscinodiscus subtilis and is a beautiful little disc with fine radial markings arranged in groups or bundles. In July, 1888, I got from the filter bed a gathering almost pure of this beautiful little species. It seems to have colonized here in the filter bed, and finding suitable conditions for its growth has made a permanent home. It grows the year round and I have collected it every month in the year, but it is most abundant in hot weather. The photograph of it is taken from a very large specimen. In Florida this diatom grows to perhaps twice the diameter of the largest here, and I have specimens from the Richmond earth four times as large, but these are exactly the same in markings and are identical with our form. Other marine forms are found here also in considerable variety, but no great number of individuals. The marine forms are here evidently as the result of back-water from storms at sea or prolonged drought, making the water brackish and bringing these marine species up from the ocean. Such as are capable of living in fresh water have remained and propagated their kind; those incapable have died and sunk into the ooze on the bottom of the river. The marine species differ from those of fresh water.

Each flora is distinct. Most of the very large and showy forms are marine, although there are some exceptions. Some genera are exclusively marine, some exclusively fresh-water, while others have representatives in both salt and fresh water. It would be quite impossible, even after years of observation, I think, to catalogue all the diatoms found here so as to make the list complete, on account of the occasional presence of stray forms. Indeed I would not be surprised to find here any of the species found on the Atlantic coast, and we would naturally expect in so large a body of water fed by so many streams from the east, west and north, a great number of fresh-water species, and such is the fact, and even with these there is the same difficulty of stray visitors as with the marine forms. For example, from a collection made at Mine Point I found a minute diatom which was a stranger to me, and for which I could not for a long time find any name, and in the mean time I lost the diatom although I had a good photograph of it. I searched through the same material, looking over hundreds of thousands of diatoms, and failed to find a single valve like the one I lost. Some time after I chanced to run across hundreds of them in a fossil deposit from Canada. The gentleman who sent me this material was familiar with the form and I have found that it is quite common in some places. I can testify that it is not common here. It is called achnanthidium flexellum. It is only about $\frac{1}{600}$ of an inch long, and it seemed a waste of time to take so much pains with so insignificant a specimen, but I have found it will not do to despise a diatom because it is little, for many of the most interesting species are very minute and the most useful of all—amphipleura pellucida—owes its value to the extreme delicacy of its markings, while the entire value is very small. A favorite collecting place of mine is at the upper or northern end of Morgan Lake.

When the wind is from the south a scum is blown ashore there which is full of diatoms, but unfortunately the number of species is not great although we may sometimes gather them by the ounce. The principal forms are stauroneis phœnicenteron and navicula cuspidata, both of which are found also in the river. Indeed I can recall at this time only two species found in the ponds and streams near here which I have failed to find in the river.

The best time to collect diatoms is in the spring and fall, especially in the spring.

The outfit is simple and inexpensive and consists of a tin pail, a number of wide-mouthed bottles, a magnifying glass and a long-handled spoon. If we visit a pond we first look out for dirty brown scums on the surface of the water. These are often blown by the wind so that they are massed on the surface within easy reach of the shore. They are skimmed off by the spoon and put into a bottle, if found to contain diatoms by examination with the hand-glass. These scums, nasty and unpromising as they look, are often masses of pure diatoms, and by a very little cleaning make excellent slides. Then we fish out some of the water weeds and squeeze them out into the pail. The common myriophyllum, which grows abundantly in almost every pond, is usually a perfect museum of plant and animal life. Its peculiar foliage affords protection and support to innumerable small creatures, including desmids and diatoms. We then let the water squeezed from the weeds settle for a half hour, and pouring off all but about an inch put the remaining portion in a bottle, then the pail is washed out. Or if the weeds are particularly rich in diatoms some of them may be put in the bottom of the pail and carried home. Wherever there is tide-water, as in the river here, collections should be made at low water ; scrapings from the dock timbers and stones which are covered at high water often yield immense numbers of fine specimens. The mud in the coves along the river too often has an abundance of living and dead diatoms. This latter (the mud) is hard to clean or rather the process is a very tedious one and is conducted as follows : A portion of the mud—say about an ounce—is put into a wash basin, which is then filled with water and allowed to stand for about a half hour, when the water is carefully decanted close to the surface of the mud, the basin refilled with water and the process repeated until the water will settle clear in one-half hour. Now this will take from two days to a week. Then the remaining mud being transferred to a glass beaker after the water has been poured off close, sulphuric acid in equal or greater bulk is added, after which bichromate of potash is added until all action ceases. As this action is very energetic if much organic matter be present, the bichromate is added a little at a time. The beaker is allowed to stand an hour or two, when the washing is resumed and continued until the acid is all washed out. There should be, if the process has been thoroughly done, only diatoms and sand left—too often a few diatoms and a great deal of sand. The diatoms are separated by putting a small quantity with water in a two-ounce beaker or a thin liquor glass and allowing it to settle. When the water is perfectly clear a very slight rotary motion is given to the beaker and the diatoms come up in a little cloud and the sand remains on the bottom. They are then removed with a large pipette, more water is added and the process repeated until nothing but sand is left in the beaker. This looks easy but it is not, and requires a good deal of judgment, as the heavy forms require a greater depth of water and more energetic rotation while the lightest require the least possible rotation and very little water.

Fossil earths, like this Richmond specimen, are treated more energetically. The specimen is first boiled in weak caustic soda or potash. This disintegrates it and it falls to pieces in the form of a thick mud. This mud is washed in clean water as in the other case, until it settles clear. Then the sediment is boiled in sulphuric acid for ten or fifteen minutes. The organic matter, of which it contains a considerable quantity, is blackened and the mass gets very dark. Then a little chlorate of potash is added very cautiously and the diatoms are bleached. The color changes to light green, when the whole is washed as before, until all trace of acid is gone. Then it is put in an evaporating dish and boiled with carbonate of potash until it begins to spatter, when the whole is turned into a large beaker, in the bottom of which is a layer of sulphuric acid. It is washed again and then sanded, when it is ready to use. The diatoms are kept in vials in equal parts of alcohol and distilled water. If we run across a mass of free-swimming forms, nitzschias or naviculas for example, they should be carefully scraped up, taking as little mud or sand as possible, and put in a bottle. This should not be more than half filled, otherwise the plants will die. When they are brought home they are poured out into a saucer and allowed to settle; when the superfluous water is carefully poured off, a piece of wet cheese-cloth is then put over them smoothly and the saucer set near a window. In a day or two the diatoms will come up through the meshes of the cheese-cloth and can then be removed with a camel's-hair pencil. In this way I have obtained perfectly clean specimens with little trouble. Of course only the free-swimming species only will answer for this method. When we wish to mount them for microscopic use we draw off the alcohol and water from the vial in which they are kept and substitute an equal quantity of distilled water. A few drops of the mixture are then placed on a thin cover-glass and evaporated with very gentle heat. Then the cover is mounted on a glass slip (3 x 1 inches) in Canada balsam, or liquid amber, or styrax, and we have a permanent spread slide which can be examined at any time. Of course in a preparation like this the diatoms are all mixed up, many are broken, and any particular specimen difficult to find, and some years ago microscopists undertook to pick out and mount different species separately. If you put a fine hair in the end of a stick for a handle, and then try to pick up under the microscope a minute object, the chances are a thousand to one that you won't succeed for a long time, but if by constant practice you do succeed in picking up a diatom for instance, you will require a longer training still to make it let go of the hair when you want to put it down anywhere. It will illustrate better than anything I know the utter and total depravity of inanimate things. A little instrument was devised by Mr. Zentmeyer, of Philadelphia—a famous maker of microscopes in his day—which simplifies things somewhat. It is called a "mechanical finger," and is fastened to the nose-piece of the microscope. The hair fastened into the end of the iron rod is raised or lowered by means of a screw and the motion in the horizontal plane is attained by shoving the slide carrier about. This obviates to a great extent the effects of tremor in the hands which exists in all persons to a greater or less degree, yet even with its help a good deal of practice is required before good results can be obtained ; and as the instrument must be vertical and as the operator must adapt his own position to that of the microscope, he needs above all things, except perhaps unlimited patience, a good strong back, as the attitude necessarily assumed is a very trying one.

Mr. J. D. Möller, of Wedel, in Holstein, Germany, at the suggestion of a friend made the first so-called type-plate of diatoms. On this slide the forms are arranged in rows and can be catalogued, and any particular form readily found even under a high power. This first slide was made in 1867, and hundreds of them have been made and sold by this preparer since. It was a long time before any one else attempted to duplicate this difficult work, but now several men make and sell them, but none of them have ever equalled the beauty of Möller's best work. It is simply perfect. This gentleman, after five years' patient work, got together the materials for the greatest diatom slide on record. It took him forty days to place the forms in position, but he finally succeeded in getting the mount completed. The diatom group is $6^{mm.}$ by 6.7 in size and is divided into 9 squares, with 133 rows, containing 4,026 different species and varieties. He hopes to sell it to some rich man or museum and wants about $10,000 for it, I believe. The type-plate I show here to-night is *not* one of Möller's and contains only 100 species. They are selected mainly for their beauty and are generally large forms.

Of what use are diatoms? As I have already stated, they purify the water for animal life. They also furnish food for myriads of small creatures which are in their turn devoured by a higher class of organisms.

In the fossil state they have various uses in the arts—dynamite, packing for boilers, steam pipes, etc., to prevent radiation of heat. But the diatom under the microscope has led to the most important and brilliant results. On account of the fineness of the striation of various species they are used as test objects to determine the defining or resolving power of any objective. For a long time no human eye had seen the lines on amphipleura pellucida, but by analogy the lines must be there, unless it should prove a remarkable exception to all its race, and so the diatomists or, as some call them, the diatomaniacs, called on the optician for better glasses, and men of science and brains worked on new mathematical formulae and chemists tried experiments to obtain glass of higher refractive power, and the water immersion lens was invented and the lines were faintly seen.

After that the oil immersion or homogeneous immersion objective, where the ray of light goes through a homogeneous medium from the bottom of the condenser to the front of the objective, and then followed later the splendid apochromatics of Zeiss, the nearest approach to theoretical perfection at present obtainable. The existence of these magnificent instruments has made possible the newest of the sciences—bacteriology—and has been the means of adding the wonderful discoveries of Pasteur, Koch and Lister to the sum of human knowledge. What these mean is not perhaps fully appreciated outside the medical profession. Twelve years ago Koch discovered the bacillus tuberculosis, but consumption is still incurable (practically). Ten years ago he discovered the comma spirillum of cholera, and cholera still destroys half its victims, but we battle now with a known enemy and no longer fight in the dark. I have no doubt that the close of the next century will see the last of the bacillus tuberculosis and its victims, who now number one-seventh of the human race, and this will be accomplished by sanitary means alone and not by the discovery of any specific cure for the disease.

But in surgery—thanks to Lister—the gain is immediate and immense. Operations are done now without a thought of evil results which would have been regarded as assault with intent to kill when I was a medical student eighteen years ago.

Now for all this, and this new science is only in its infancy, the humble diatom is largely responsible, and this is perhaps its chief claim to the respect of humanity.

FEBRUARY 27, 1894.—FIFTH REGULAR MEETING.

Chairman Burgess presided, and one hundred members and guests were present.

The following paper was read by Mr. Frederick S. Arnold on

GYPSIES.

BY FREDERICK S. ARNOLD.

One warm July evening last summer while the writer of this paper, like a good proportion of the rest of the American people, was spending his vacation at the Chicago World's Fair, he dropped into the Vienna Bakery restaurant in the Midway, weary of sight-seeing and hungry for dinner. The big, brightly lighted room was full of men and women whom the fair had drawn from all the ends of America and Europe. Pretty daughters were grouped at one table round a dignified papa, lunching before going home for the evening. Gay young men at another table were dining before spending the evening at the Syrian dancers and in the Turkish cafês of the Plaisance. Old farmers off the prairies contrasted with tired-out youths from London or Paris and amongst them all, under the electric lights, the German waiters hurried around from table to table. I ate my dinner and thought about the things I had seen all day and where I should go that evening till it was time to go home, when all of a sudden there burst on my ear a wild, outlandish strain which I knew—violins and *zymbals* playing Hungarian *czardas*. Outside the restaurant, a few little bushes in flower pots and an arbor with electric lights amongst the vines made a "garden" where tables and chairs were placed and those who liked to eat outdoors, European fashion, might do so. It was thence the music came and I paid my scot and went out to it. A Hungarian band sat in the out-of-door cafê, a *zymbal* in the middle, the violins grouped around. There were about a dozen men short, dark, black-haired, snaky eyed, wearing blue, gold-trimmed uniforms. I knew what they were at once, but having the key to the situation was in no hurry but sat down close to them and listened to their playing, which was good for those who like that kind of music—and I happen to be one of those who do. When they stopped, I fixed the *Kapellmeister* (the leader) with my eye, and cried; "*Lăcho hi, pral, boro lăcho!*" (Very good, brother, very good!) They all looked up and a faint surprise showed in the face of the *Kapellmeister* which broke into astonished delight and spread round the circle when I said: "*Miri Roma chalior, sarishan! Me shom Roma rai adre acova tem.*" (My Romany lads, how are you! I am a Gypsy gentleman in this country.) We were on good terms and talking together at once.

For these were Hungarian Gypsies, brought for their music all the way from Vienna, perhaps from Buda Pesth, to Chicago, and delighted and wonder-struck they were—as the Hungarian Gypsies I have seen always are—to find a stranger, thousands of miles off in the West, who spoke the language which not nine people in ten, besides themselves, understood in their own Hungary. "Why," as the bar-tender of the Cafè Liberty on Houston Street once said to me, "you might go a hundred thousand miles around the earth, sir, and not find one man who could speak that language!"

And there we sat and talked, helping out the Gypsy language when I wanted for words, and that was unfortunately pretty often, with German (which was one of the three languages they spoke, the other beside Gypsy being Hungarian) and they asked me numberless questions about how I learned the language, and were there Gypsies in America, and did they wear big blue coats with antique coins for buttons as they do in Hungary and Siebenbürgen, and were Gypsies ever fair, blue-grey-eyed like me. And a very stylish party of young ladies and gentlemen at a neighboring table leveled their glasses and lorgnettes at me and wondered what the long, lanky, fair faced northerner could have in common with the short, dark-haired, almost black Hungarians.

But the Gypsy band were business men and their business was to play and the management could not allow them to spend the night talking to a newly found Yankee brother, so they had to strike up, and I departed and in the confused, hurried sight-seeing of my week at the fair, I saw them no more. And now I know you are asking where and how I learned the language the Hungarian Gypsies spoke. You knew there were Gypsies in Hungary, you knew they were musicians, perhaps you have some of you heard them yourselves in Vienna or Paris, or even in New York where for several years there has been a band at the Eden Museè and where another band, with which I was acquainted, played all the summer of 1892 in the Park Avenue Hotel. But who, you would like to know, taught me their language? Of course I learned it from some rare volume on East European dialects, or something of that sort. No, you are wrong. My instructors in the language which Gypsies talk to-day on the banks of the Danube were the Gypsies you have all seen who pass through Poughkeepsie and tent in Dutchess County every summer, who themselves or their ancestors came to this country from England, and whose people have lived in English speaking lands for four hundred years since their progenitors entered England from France and the Low countries.

Yet still to this day the Gypsies right here in Dutchess County speak the same language (of course with important dialectic variation) which Gypsies speak in Spain, Hungary or Turkey, and still they show the same or similar physical characteristics, traditions and customs. And more than that, language and race have left traces till to-day in India, Persia, Syria and Egypt, and the mysterious language I talked in the midway can be traced all the way back to that idol of the philologist the Sanskrit, while the races from which the Gypsies sprang are to be found amongst the semi-wandering tribes of Northern India.

The first appearance of the Gypsies in Europe is generally placed at about 1417. They came in with the renaissance and the Hussite war and the end of the great Schism, but there is no reason to believe that they bothered themselves much about these great questions which were troubling all western Christendom. They entered Europe probably through Transylvania and Hungary, whither they had come up the Danube from Greece and Turkey. Their first known settlement was in Moldavia near Szuesava, where about three thousand of them appeared in 1417 and got permission to remain from Alexander, Vojvode of the district. Other bands made their way into Hungary and in 1423 got writs or privileges from the Emperor Sigismund, permitting them to settle near the free cities and on the crown estates. (Borrow, "Zincali," Introduction, p. 10.)

They soon passed into Bohemia and Germany and because their descent on the west of Europe was largely from Bohemia, they were known to the French and in literature as Bohemians. They spread in a short time over all the continent. "In 1418 they were found in "Switzerland; in 1422, in Italy; in 1427, they are men-"tioned as being in the neighborhood of Paris; and "about the same time in Spain." (Simpson, "History of the Gypsies," Chap. I, p. 69.)

From the very first they seem to have been the same wild, uncanny, nomadic race, but their leaders, at the time of their arrival, must have been men of more than the average ability, for, by a diplomatic fiction carefully concocted to chime in with the prejudices of the times, they contrived to hoodwink all Europe, get free passage for themselves through the various countries, and secure the privilege of living in their peculiar way without molestation until at last they were found out through their roguish and criminal goings-on, after which strenuous laws were almost every where passed against them.

They pretended to be pilgrims travelling as they did under a vow. Sometimes the story ran that they were Christian inhabitants of lower Egypt driven out by the Saracens. The Pope or their bishops had laid this penance on them for some sacrilege or other and they showed letters from the then pontiff and passes from the Emperor Sigismund all over Europe. These passes and letters were probably forged.

They travelled in bands or hordes, which on their first arrival were quite large. Accompanied by their women and children in carts and their droves of horses, even as now, they would camp down outside such towns as Paris or Bologna (in both which places there are records of their first coming), telling the burgesses their story about the penance and soforth—which the burgesses would immediately proceed, Middleage-fashion, to swallow whole—and then plying their customary trades of iron and glass and basket making, horse trading—and horse stealing—and, above all, fortune telling, until their petty roguery and general impudence made the nuisance unbearable, when they would be made to move on to the next town or even out of the country. (See Borrow, "Zincali," Chapter I, p. 15, and Encycl. Brit., Art. "Gipsies.") The leaders of these bands assumed various high sounding titles; in the Sclavic lands Vojvode, in Spain, Count, while in Scotland we have "John Faw, Lord and Earl of Little Egypt," a character of such importance that King James V actually made a treaty with him. (Simpson, "Hist. of Gipsies," p. 101.)

They may have assumed these names to give themselves weight in dealing with other people, or like the name Gypsy itself, these titles may have been given them by the populace.

The name Egyptian, Gypsey, Gipsy, was certainly given them by the people about them, and there is no reason to believe that they ever had any connection with Egypt, except that some of their tribes have found their way there (where they are called Rhagarin), as they have gone nearly everywhere else. The name was given them because they came from the east, just as our Thanksgiving bird is called Turkey and our native tribes Indians.

But when the name was once given and the legends built upon the name the Gypsies had good reason enough to retain and adopt both, for, as Egyptian penitents, they passed for a while, unmolested, everywhere. (Borrow, "Zincali," Chap. X, p. 43.)

The arrival of the Gypsies in France was about 1427. That part of their history has been immortalized by Walter Scott in Hayraddin Maugrabin just as he has immortalized Scotch Gypsydom in Meg Merrilies. France has never been a congenial home for the Gypsies. It is the land of the proprieties. The Gypsies were early expelled (1504, A.D.) from the country, and to this day I am assured by a Frenchman, a friend of mine, are excluded. Still there are some Gypsies in France, especially in the Pyrenees on the Spanish frontier.

The Gypsies came into Italy about 1422 and were soon very numerous, thriving best in the States of the Church, which were the worst policed and where was the most superstition which they turned to their own account. A curious law was enacted against them to the effect that no Gypsy should spend two nights in the same place. Not a very severe statute, one would think, for such nomads.

When peasant uprisings and penal statutes drove the Gypsies out of France, they fled into Spain, where a number had penetrated before. From then till this day Gypsies have always been found in the peninsula, where, owing to the backward civilization and brigandage, &c., they have generally flourished. Laws were passed against them in 1491, when King Ferdinand wished to expel them. Philip III also wanted to drive them out. But the force which had expelled the Jews and the Moriscoes and stamped out Protestantism was not able to combat the will-o'-the-wisp, every-where-at-once tactics of the wanderers, and they remained. They even settled in some towns which had their Gitanerias, or Gypsy quarters. Borrow believes that in certain thieving, fortune telling tribes of the Barbary coast, called the *Dar-Bushi-Fal*, he has found a race of probable Gypsy origin, and this is quite likely. The Spaniards frequently seized Gypsies and exiled them to Morocco, besides which they might easily have found their way across the straits. By the end of the fifteenth century the Gypsies had probably penetrated into nearly every quarter of Europe.

There is reason to believe that there were Gypsies in Scotland as early as 1460. They probably came from Spain *via* Ireland, driven out by King Ferdinand's edicts. By 1506 they were in full force in the northern kingdom, for King James IV wrote a letter to the king of Denmark recommending to him, "Anthonius Gawino, 'Earl of Little Egypt,' * * * and the other afflicted and lamentable tribe of his retinue" who, he said were travelling by command of the Pope and had sojourned in Scotland "for several months, in a peaceable and catholic manner." From this letter of James IV it is evident that the gentle Romanies had "come it over" that religious and melancholy monarch pretty thoroughly. They had stuffed their penance legend down his throat and gotten him to recognize the noble pretensions of their leader ; but, to offset the case, it may be added that this letter acted as a passport to get them out of Scotland into Denmark, and perhaps King James thought he could do no harm by giving them that sort of recognition. Even so in olden time, Shankal, Maharajah of Hindoostan, sent Behram Gour, the wild-ass king of Persia, all the low caste musicians and strolling singers he could rake out of his dominions as a present to that monarch, who wanted to hear some Gypsy music.

The true practices of the race, however, soon came to light. James V enacted that whenever three Gypsies were found together one of the three was instantly to be seized and hanged or shot by any loyal citizen who chose to take the law into his hands. But such laws were unable to expel them and, in the years after James's death, Simson, himself a Scotchman, has admitted that things were so upset in Scotland and there was so much robbery and brigandage on a large scale that the petty roguery of the Romany Chals was not noticed in the general confusion. Scotch Gypsies have prospered in days since, though James VI and James VII enforced laws against them, and very lately Kirk Yetholm in the Cheviot Hills was almost entirely a Gypsy town. The Scotch Gypsies do not speak the language with any purity, half of the words given by Simson being not Gypsy at all but thieves' cant or slang of the roads (but then it has to be admitted Simson was a very injudicious collector).

I never, myself, had the pleasure of studying any Scotch Gypsies, though there are some in the United States. A gang of them, named Williamson, once camped near Poughkeepsie. I met one of their men in town at the time. He was dressed in ragged clothes, didn't look like a Gypsy very much, and had only one touch of the roads, that was a bright red handkerchief about his neck. I accosted him in Romany but he didn't understand it, called it cant, and said *he* talked another kind of cant. I imagine his was a Gypsy dialect very much corrupted by slang of the roads.

"Your're talken' cant," he said to me, "you can talk it good. I don't know your kind. I'm Scotch. "Name's Williamson; ain't *Romanes*. Do I know "Wells? (a Gypsy friend of mine). Yes; he's out near "Bull's Head. We was with him but we left him. "Couldn't stand him. He can talk that what you talk "in this country. I talk *cant*. The words are *cadji*, "like that. Will I be here several days? Yes, I'm out "by the Asylum. So long!" And he trudged away, up the hill, basket on arm, never looking back. I meant to go out and see this gang but they got away before I could do it. I have since heard one of their girls married an American gypsy, a friend of mine. This shows that whatever their differences they accept each other as kindred—"all rogues, and from Egypt." The one word he gave me, *cadji*, which probably was slang for one of his own gang, is Scotch slang and means a wanderer or beggar. The "Slang Dictionary" gives *cadge*, "to beg in an artful, wheedling manner," and says it means in Scotland also, to wander, to go astray. It may be derived from Gaelic *cad*, a friend, or from Welsh *côd*, a bag or pouch (which would be carried by a beggar).

According to Hoyland (a Quaker who married a Gypsy girl and wrote a book about them from the Gypsy-Quaker combination standpoint), the ancestors of our American Gypsies arrived in England in 1512. Leland (Johnson's Encycl., Art. "Gypsies") gives 1506. They had a leader of the name of Giles Hathor, who was termed their king, with a woman named Calot called their queen. These two rode through the country on horseback in strange attire, followed by their ragamuffin pack. Although I have seen no record of it, they no doubt tried to impose on our ancestors as penancers and lords of little Egypt, just as elsewhere, but the trick didn't work very well with bluff King Hal, and in the 10th chapter, 22 Henry VIII (1530 A. D.), they are legislated against as "an outlandish people, calling themselves Egyptians" (Blackstone's Comm., IV, 165), and in 1549 "there "was privy search made through all Sussex for all vaga-"bonds, Gypsies, conspirators, prophesiers, players, "and such like." (Simson, "Hist. of Gypsies," Chap. II, p. 91.) The government of England was at that time very strenuous against the Romany. 5 Eliz., c. 20, enacted that if any Gypsy remained in the realm a month, or if any person over fourteen years of age associated himself with the Gypsies, it was felony without benefit of clergy, and Gypsies were to be deprived of a jury *per medietatem linguae;* and although the last recorded execution under this act is the execution of thirteen Gypsies at one Suffolk assizes just before the restoration, described by Sir Matthew Hale, the rigorous statute was not repealed until the 23 Geo., III, c. 51, since when Gypsies have been punishable in England under the vagrant act (Blackstone Comm., IV, 166, Christian's Note 6). The various laws against vagrants have also always been applicable to them in the United States, probably. It is interesting in the old statute to note the depriving them of a jury *per medietatem linguae.* The existence of their secret language was early known and is somewhere called "The right Egyptian language" (Hoyland).

Literary men took considerable notice of the Gypsies from the first. Beaumont and Fletcher's very interesting comedy of the "Beggars' Bush," while it does not mention them, teems with their spirit, and several real Gypsy words are found in the slang vocabulary there introduced. Ben Jonson has written a masque called "The Metamorphosed Gypsies," the plot of which is laid in Wales. He introduces a lot of cant and slang words, but I only noticed one or two real Romany ones and those were such as had become slang and were therefore known to others than Romanys. Shakspeare, perhaps, mentions Romany in one place. When in Henry IV, Act II, Scene IV, he makes Prince Henry say: "I am so "good a proficient in one quarter of an hour that I can "drink with any tinker in his own language during my "life," he may refer to Romany. Leland, however, thinks he means *Shelta*. I doubt if he knew of their separate existence. The Gypsies were tinkers and smiths by trade and are called "tinklers" in Scotland.

That none of these writers, however, knew any Romany is evident from the vocabularies, which are all thieves' cant and low slang, unless a few words originally Gypsy which had been incorporated with slang.

Despite all laws, the Gypsies persisted, just as they did in Spain and the empire and modern civilization, the parish schools, but particularly the enclosure of the commons, their camping grounds, have done more to break down Gypsydom than all the sanguinary legislation of the Middle Ages.

As to the United States, we have had Gypsies here from very early times. According to 13 and 14 Charles II, c. 12, the justices in sessions might transport such rogues, vagabonds, and sturdy beggars, as were duly convicted and judged incorrigible to America. Many were so transported and others enlisted and were sent here as soldiers in the Revolution. Such generally deserted and took to their wandering life. Since that time, hundreds have come over in the emigrant ships, and I know many an old Gypsy who was born in England, while most American Gypsies speak with a British accent and some even drop their h's and have other Cockney, lower class English habits.

Our historical survey so far has followed the Romany since his entry into Europe in 1417, and though Miklosich thinks he has identified them in the Ἀθίγγανοι, snake charmers and sorcerers, who figure in Byzantine history in the ninth century under Nicephorus I (802–11) and his immediate successors, and though friar Simeon Simeonis describes some nomadic rogues who wandered about, living in black tents, in Crete in the fourteenth century, still their recorded history can not be said to antedate 1417.

As to their origin and their path before entering Europe, however, we are now pretty certain and the mystery which enveloped the subject has been largely cleared up.

The great means toward learning about their past is their language. This is a pure Sanskritic tongue, the grammar, as it is spoken in Turkey to-day, being Aryan and the vocabulary, even that which is used here on the Hudson River, being directly related to the Sanskrit, indeed not further removed from that sacred language than are the modern Hindustani, Bengali, and Guzerati, with which Romany would have to be classed. The language is of course the great proof for the Gypsies' Indian origin, but when once we are on the scent their physical traits, customs, traditions, superstitions form a great additional mass of evidence.

There have always been in Northern India a number of tribes, perhaps only semi-Aryan, of distinctly Gypsy-like characteristics. One of these tribes is the Jats, formerly a race of warlike horsemen, of the northwest; another the Nauts of the interior, who are wandering Gypsy-like tribes. There are the Dom, Gypsies *par excelence*, and the Persian Luri, from whom is named Luristan and who are the descendants of the strolling musicians whom tradition states Shankal sent Vahrahran V or Behram Gour, whose land was without music or song. This connection of the Luri with Vahrahran V is, however, disputed by Rawlinson, who does not think any of the supposed relations with India of this prince historical (7th Mon., Chap. XIV, p. 402).

The Jats were a warlike race until their power was completely and forever broken by the Mohammedan conquerors of India. To this day they inhabit the north-west and form two-fifths the population of the Punjab, and half that of the Rajput states, while they are scattered in Baluchistan and Sind. They are a peaceful, agricultural, cattle raising people, but the wandering instinct sometimes seizes them and they leave their homes and travel off in the guise of itinerant pedlars into central Asia. These migratory habits are ancient. They wandered in the ninth century as far west as Syria, where there was a Jat quarter in Antioch, while for twenty-four years a colony maintained themselves in the Chaldaean marshes, though in 834 the Caliph's troops vanquished them and they were transferred to the Cilician frontier.

But of all the Indian races Charles G. Leland has shown (Gypsies, p. 331), there is a race preëminently Gypsy, called the Dom. These tribes live in Central India. They are wanderers like the Gypsies, their language is closely similar, they have no religion to speak of, they make baskets and handle corpses, their women tell fortunes, and they have many other Gypsy characteristics.

When in the tenth century and from that time on wave after wave of Mohammedan and Mongol conquest broke over India, there is reason to believe that many of the dregs of the population, some of whom were outcasts already, who had nothing to lose if nothing to gain, left the country. They probably left gradually, some of them may have wandered away before the conquest began—there were Jat colonies on the Persian gulf before the ninth century and we have seen them at that period in Syria and Cilicia—while some may not have left until the last Mongol conquests in the sixteenth. The *hanptstamm* of these nomads was probably the Jats who are a race of notorious thieves, without religion, and devoted to raising and riding horses and who, we have said, were very early and are still a half migratory race. The Nauts and Persian Luri, all tinkers, thieves, musicians like the Gypsies, probably swelled the throng, while Mr. Leland's *Dom* tribes permeated and gave character to the whole.

If this be so the Gypsies are descendants of various Hindu tribes who wandered out of India under the pressure of Mohammedan conquest and their language may be said to prove this.

An itinerary of their travels can be made up from the non-Hindu words they preserve. From the very large number of Persian words it is evident they spent some time in Persia and probably were joined by some of the inhabitants. Their road must have lain through Turkey into Asia Minor and Greece and they still preserve a number of Greek stems. Thence they entered the Danube and South Sclavonian lands, where they are most numerous and where their language and their Gypsydom is purest to this day. They remained there a long while and there are numerous Sclavic words in their language. Leaving the South Sclavic lands they enter western Europe and history together.

English Gypsy, to fill out the itinerary, has some Teutonic and Italian elements but very little French.

Our historical sketch has now prepared us to consider the present condition of the race, especially here in the United States, to which we shall limit ourselves as far as possible.

Scattered through every country of Europe and America (there are even Gypsies in Brazil) this cosmopolite race bears a different name almost in each. The name by which the majority of Gypsies are still known is, in the German, *Zigeuner*, in the East, *Zingarri*, in Russia, *Zigani*, in Hungary, *Chingany*, in Italy, *Zingari*, in Portugal, *Sigano*, in French, *Tsigane*, in Persia, *Zingan*, in the Punjab, *Tchangar*, and is used under these different forms by the people of most except the English-speaking countries. The derivation of this word is not agreed upon. An article in *Blackwood's Magazine* (No. 99, p. 565) derives *Zigeuner* from old German *ziehegan*, that is wanderer, and the great Romany Rai, Charles G. Leland has derived it from the Gypsy words *chen* (*chon*), moon, and *gan* or *kan* (*kam*), the sun, and he gives a Turkish Gypsy myth to explain it, about the sun and moon being a brother and sister with a criminal passion for each other, who were once, on earth, chiefs of the Gypsies' tribe. But in the face of a better derivation *ziehegan* and *chen-kan* will have to go, and it seems probable that *Zingarri* means simply the people of Zind, or Scinde, that is, from the Indus river, the ancient Zindhu. This very probable derivation makes Zingarri a doublet of Hindu and Indian and is another proof of the Indian origin of the race. In Spain the Gypsies call themselves *Zincali*, which means "the black men of Sinde," *kâlo* being black both in Gypsy and Hindustani, and their language in some parts of Germany is called *Sinte*.

In Scandinavia they are called Tartars, being identified with the Mongol hordes which overran eastern Europe, and in Holland, *heydens*, heathen. The French use the words *Bohémiens*, *Mattois*, *Gueux* (or Beggars) and *Cagoux* and call their language *Blesquin* (Art. "Gypsies," Amer. Encycl.). In England they were known as *Egyptians*, of which *Gypsie*, *Gipsie*, is in English lands a corruption as *Gitano* is in Spain.

The theory that they came from Egypt also lead to the Greek *Γύφτος*; Magyar *Pharao népek* (Pharaoh's people), and Turkish *Färäwni*, by which names they are called in those countries. In Scotland *tinkler* and *Gypsy* both appear and they call themselves *Nawken* (the derivation of which I do not know), while we have the *Darbushi-fal* in Morocco, the *Rhagarin* in Egypt, the *Trablus* (i. e. Syrians), *Nats*, and *Dom* in India.

The last word *Dom* has been shown by Leland to be the same as *Rom* ("Gypsies," p. 334), and this brings us to the *hanptname*, the great name by which Gypsies call themselves all the world over—the Romany.

The word is slightly modified in different lands, besides which I believe the very much corrupted and only half Gypsy *Rhagarin* of Egypt do not know it and possibly some other outlying waifs of Gypsydom are without it. Still it is practically universal.

Its form in the East is *Roma. Roma chal* (a Gypsy), *Roma rai* (a Gypsy king, Gypsy gentleman) were given me by the Hungarian Gypsies who, when I pronounced *Ramani* as in English, thought I referred to Roumanian. George Borrow delights to write the word *Roman*, with how much authority I know not. The word without doubt means simply "man." In modern Gypsy *ram* or *ramnus* means man, or husband, *ramni* abbreviated to *ram*, means wife. The Sanskrit *domba*, connected with Rom through Hindu *Dom*, means "'a man of low caste, who gains his livelihood by singing and dancing.'" (Skeat, under *rum* 2.)

As the Gypsies everywhere call themselves *Ramani* (Romany), so everywhere, almost, those not Gypsies are called *Gorjios*, which may be translated "gentile" if we forget that word's etymology. In Russia and the East this becomes *gajo. Gajo*, the Hungarian Gypsies I talked with, translated by the German *Bauer*. In Spain Borrow says, however, the *Zincali* call gentiles *Busné*, perhaps from Sanskrit *purusha*, a man.

The American Gypsies all call themselves Romany and all speak more or less of the Romany language, but there exists an important division between the *puro Ramanis*, or *kâlo Ramanis* (deep, or black Gypsies) and the *Didikai* or half-breeds. These latter are not purely, often not chiefly, of Gypsy blood but are the results of crosses between pure Gypsies and the lower class English or Irish people. They exist in all grades from those whose mixture of gentile blood was a long way back and who are altogether Gypsylike in character through quadroons and octaroons to men who have much more gentile than Gypsy in them and who are lacking in many essential Romany traits. We have even heard of crosses between these half-bloods, while they were South for the winter, and negroes. The *Didikai* never know as much of the language as the *kâlo Ramanis* do but they are frequently more communicative, and it was a family of them, the Wells family, who were my first Romany acquaintances and amongst whom I laid the foundations of my knowledge of their language.

"Go down and talk to that man," said Lottie Wells once to me, "he's a black Gypsy. He knows an awful "lot of deep *Ramanes*." We were standing amongst the tents and vans of her father's and uncles' camp near Po'keepsie and the man alluded to was a *bude-mush*, or hired man, who stood at some little distance, brushing and curry-combing the horses. He was of average (American) height, not stout but muscularly built, of a complexion at least as dark as an Italian's, with jet black, unkempt hair and black, bright, roving eyes. Not a bad specimen of the *kâlo Ramani* or black Gypsy, though not all the pure blood Gypsies have quite such dark complexions as this one.

All of them are dark, however, while some of the *Didikai*, on the other hand, are nearly as light as the average American. Still I never remember seeing even one of the *Didikai* whose hair was not black or who would not have been emphatically styled brunette, and the fact that the Romany is necessarily sun-burned makes him look even darker than he really is.

When I went up and spoke to the black Gypsy in question he sort of chuckled but refused to answer my Romany in anything but English. "Yes, everyone's "gettin' to know the old language now. It used to be a "secret and some good, but now there's lots can speak "it." His behavior was characteristic of the *kâlo Ramani*, and while all that morning I collected Romany words from the *Didikai* families of Henry and Leonard Wells, I didn't get one word from their black-Gypsy servant, and he bewailed the decadence of the ancient Egyptian mystery and secret. I have since, however, found my way to the hearts of *kâlo Ramanis* and where they are willing they always have more to teach than the Didikai.

In describing Leonard Wells's *bude-mush* I have already described the dark, almost black complexion of the *kâlo Ramanis.* As to the purity of their blood, Borrow and Leland would lead us to believe that they are very particular about preserving it and never marry out of their race. Borrow describes, in the "Romany Rye," a Gypsy Adonis beloved of a countess who nevertheless preferred to marry a hag of his own tribe, and we have reason to believe that both writers state the truth about their caste feeling on this question. Yet the very existence of the *Didikai* proves that the *kâlo Ramanis* have sometimes mixed with the *Gorjio*, and I think it probable that in four hundred years in Englishry even the black Gypsies must have some gentile blood in their veins, however little.

The *Didikai* with their mixed blood are generally lighter in complexion and I think they are generally larger, taller, and stronger, though the wiry, lithe, black Romany is very muscular. Another name for these half-breed Gypsies is *pâsh an' pâsh* (half and half) and they are also called *churedi*, which word, I think, Borrow found in Spanish Gypsy *chororo*, meaning poor, and compared with Sanskrit *kshudra* and Hindu *shor* ("*Zincali*" *vocab.*). Although the *Didikai* are fraternized with and even, though not too commonly, inter-married among, they are rather despised by the *kâlo Ramanis*, who pride themselves on the purity of their blood and their "deep" knowledge of the language and look down on the less thoroughly gypsified *pâsh an' pâsh*.

Besides the two divisions of English Romany—*kâlo Ramanis* and *Didikai*—and the Scotch Gypsies already referred to, the immigrant steamers have recently brought some Hungarian and Turkish Gypsies to America. Most of these are in the West; our own Gypsies associate with them very little and say they cannot understand them when speaking their language, and I myself have never seen any of them. The Gypsy bands from Vienna, and the Gypsies who have left the roads and now live in houses, keep stores and saloons, or travel with shows and circuses like other people, make up the other real Gypsy elements of our population.

All civilization probably passed through a nomadic stage, and this earlier period of culture the Gypsy still perpetuates amongst us and shows an interesting case of survival of older, lower amongst higher forms.

Staying for only a few days in one *tän*, or camp, always moving from place to place, their wagons are their homes, and the big Gypsy van is their most important as it is their most valuable possession.

The van, or *wardo* is the big, covered, Gypsy wagon. It is twelve feet or more long and four or five wide. Its box is quite deep and it is completely covered with a good canvas cover. The wagon is generally gaily painted, with the owner's name often lettered on the side or on the tail-board. It is quite expensive, the last *wardo* which Henry Wells bought having cost over three hundred dollars, and it was not one of the highest priced. The inside of the *wardo* is arranged both for carrying things and as a living room. A bunk, perhaps three feet wide and two feet above the floor of the wagon, is placed at the back and a bed with sheets, pillows, coverlid, and all is neatly and cleanly made upon it. Two little doors under this bunk shut in a kind of closet where clothes and bedding may be kept. A narrow seat runs around the other three sides of the *wardo* under which things can be stuffed and on which women and children may sit when travelling in bad weather makes it necessary to keep in the van. Two small windows are let into each side of the wagon and one at the back. The baggage rack behind, where trunks or boxes may be carried, completes the description of the *wardo*, to whose long pole two horses must necessarily be hitched to pull the heavy load ; but the Romany can well afford to drive two horses, for horses are his wealth. Gypsies attach great value to their *wardos* and are very proud of them, and a Romany *chal* will show you his *boro wardo* with all the pride of possession a man might take in showing you his new house.

Besides the van, a Romany in good circumstances will have a buggy or two to help carry his large family, and also to hitch up and drive in town with. The *boro wardo* will not be hitched up until they mean to break camp and *lel their cuvers* and *jál avri* (take their things and go away).

After the van, or *wardo*, the *tän* or tent is the most important possession of the Romany. The word *tän* means both tent and camping ground. It is an interesting word. It appears in *stan* in such words as Hindustan, which might be rendered, Gypsie fashion, the *tän* of the Hindus, and comes from an Aryan root *tan*, to stretch, seen in our word tent. Perhaps it is related to *town*, Ger.' *Zaun.*

The wealth of a Gypsy may be noticed in his tents almost as well as in his horses. Your poor Romany is content with one dirty, ragged, black covering hardly big enough for six grown people crowding around the stove, always so full of smoke that the tears come to your eyes, and letting in wind and rain. This tent is pitched on the sod without a floor, and cluttered up with baskets, clothes and the boxes and cases of provisions.

Here the wife of the poorer Gypsy spends the day with her children, dogs, and chickens rolling round her in the dirt. In this tent or in the *wardo*, the *chal*, his wife and *chăbos* (children) sleep when they do not rest under the open sky. But where your Gypsy is prosperous he will have a fine, handsome, white tent.

My first visit to a large tribe of Gypsies was in the early summer of 1890. The Wells family of half-breed Gypsies, or *Didikai*, were camped in what is called "Gypsy Hollow," on Dorsey's Lane, near the North Road, above Poughkeepsie. I knew some of the tribe already and went out to see them with a friend of mine.

The spot is picturesque and in fact you can generally trust the Romany to choose a sightly place to *hăch* his *tăn* in (pitch his tent). Some vacant, unenclosed lots, lying to common, slope down from the road to a wooded dell through which a stream runs. The stream comes from the bush across the road and is dammed into a large pond, below in the lots, where the *chăbos* (Gypsy lads) go swimming. On the broken, uneven ground rising above the stream to the road, there stood this morning several Gypsy vans, some buggies, and two or three tents, showing that several families of the Romany were camping there at once. A number of horses were tied about and some men were currycombing them, but probably most of the *grais* (horses) were *hoiing chor* (pasturing) along the road. The men lay around on the grass, gossiping and loafing, while the women were busied cleaning up, washing, and cooking in and about the tents, and the bushes were covered with linen which they had hung out to air. A confused medley of *chābos* (children) and dogs, of both of which articles there is always a surplus in the Romany *tän*, and a few chickens make up the picture of a Gypsy camp on *Krokers* or Sunday morning.

As we approached, coming cross-lots from the woods, the children spied us, and with shouts of "*Ramani Rai! Ramani Rai!*" hurried to us, tumbling and falling over each other in their haste to beg for pennies. Amidst barking dogs and with their little chorus of "*Del mändi pänjors, del men yek ora!*" (give me five cents, give me a penny!) shouting around us, we entered the camp, shook hands with some of the men, and made up toward the principal tent to pay our respects to the *bori dai* or grandmother of the tribe.

Perhaps it will not do to call *Ramnipen*, or Gypsydom *matriarchal*, but certain it is that the old women are very important personages amongst the Romanys, and I think even the younger women have more to say in the *tän* than their husbands do. This may be partly due to the fact that they make so much of the tribe's money by their *dukerin* or fortune-telling. Almost every gang of Gypsies has some old ancestress called their *bori dai* (grandmother) whose opinion is greatly regarded, and who is much reverenced by the whole company. She is generally quite rich with a *kushto wardo te tän* (nice van and tent) and a number of *grais* (horses). While she is of course old, you will find her intelligent and well preserved, and however old she is her hair is nearly black, for with Gypsies, as with some tribes of Hindus, notably the Dom, the hair seldom turns gray, or does so very slightly and late in life. The good will of these old ladies is very important, and once secured will carry you far into the graces of the whole family, and help you to rare old words and customs of which the old women are repositories.

Amelia Wells, the *bori dai* of the Wells family, sat on a box, with a blanket thrown over it, at the door of her tent. She was a very Gypsy-looking woman, large framed, very dark, with strong, impressive features (she must have been a handsome girl) and black hair. She was smoking a clay pipe and her bright, black eyes twinkled greeting, as she took it out of her mouth, and answered my *sarishan* (how are you). I sat down beside her and the whole family gathered around, curious to see the Romany *rai.*

The tent before which we were sitting was quite large, and may have been ten by twelve feet or bigger. Its floor of boards was overspread by a carpet and the boxes, baskets, and piles of bedding and clothing were neatly arranged around the sides. The stove stood in the front beside the tent pole, and we were grouped around it. I remarked that I had never seen the traditional Gypsy kettle in use. "It's all made up, a "*hukaben* (lie). *Ramanis* never used them at all. "Most *Ramanis*, now-a-days, has stoves, but them as " don't has *kavi-sasters.*"

The *kavi-saster*, or kettle iron, is an iron rod, perhaps three or four feet long, one extremity of which curves over and is then hooked at the end. The straight end is driven into the ground obliquely, and the hook thus hangs over the fire, made of sticks, on the ground, and a kettle may be hung from it. The *kekaveskro sasters* (kettle irons) are still used, but where, as in most cases, she can afford it, the *Ramani dai* (Gypsy woman) has a small cook stove.

We spent a pleasant morning in the camp, and I went away with an addition to my Romany vocabulary and with the remembrance of a quaint scene of Gypsy life in America.

In describing Amelia Wells' tent I have described the handsome, white tent of the well-to-do Romany. But some go even further. Richard Stanley was a *kâto Ramani* (black Gypsy), who camped in the city of Brooklyn, in a vacant lot, on the Eastern Park way. Stanley was a stout, handsome, jolly Romany of the pure blood, very dark, very black haired. He could read and write, and was one of the finest and deepest Gypsies I ever met. A friend of mine, also a *Ramani rai*, took me out to see him.

Stanley had three large, handsome tents. One, the parlor tent, if we may so express ourselves, was peculiarly handsome and clean, carpet on floor, two couches with bedding neatly put away on them, several *skamins* (chairs), and some chromos and photographs of friends hung to the canvas. It was characteristically Gypsyish that, while Mrs. Stanley took us into this tent and placed chairs for us, she herself squatted, oriental fashion, on the floor. Stanley owned a house and lot in Albany, which he rented. Owned a house and lived in tents! Had chairs, and sat on the floor! Dark, strange and inscrutable are thy ways, oh, roving Romany!

The second tent was the one they sat around in and used most. It was a fair size and had boards on the floor and a carpet thrown over them, and was divided unequally in two by a curtain. The part curtained off would, perhaps, have been a sleeping room for any one who had been up all night and wanted a snooze in the day time. The third tent was the kitchen. It had no floor, was the largest of all three, and the stove and boxes and cases of food stood in it. There I sat down to a good lunch and one of the best beefsteaks I ever tasted. The Gypsy always asks you to eat with him, even if you will only drink a little *mutamengri* or tea.

After the *wardo* and the *tän*, the only property of the Gypsies of importance is their horses. The American

Gypsy word for horse is *grai*, the Hungarian Gypsies gave me *grast*. Borrow compares the word with Hindu *ghora*. We would like to suggest the Persian *gur* or *gour*, the wild ass.

From the very first the Gypsies have been horse dealers. The Jats were horse breeders and horsemen, and, to this day, breed horses and camels, and if the Romany is in part descended from the Jat, he shows it in his love for the horse. Approach a Gypsy camp when you will, before you sight the black tents and the fires, you will meet a drove of horses nibbling the grass along the road, and you will know by that token the camp is near.

His horse dealing is the chief source of wealth to the Gypsy, the only honest source, so far as I know, to the male Gypsy. The women, however, make nearly as much by *dukerin*, or telling fortunes, as the men do by horse dealing. I have sat by the hour beside a dark son of Egypt while he bargained with a *Gorjio* for the sale of some horse he very much wanted to sell, and looked all the time the most unconcerned and independent of mortals.

"It's as gentle as a kitten, sir; *lesti's a duller*" (she's a kicker), this last intended for me. "That there horse "is just the animal you want, sir;" and then to me, "*kuova si o bul grai!*" (that's a broken-winded horse!) How he would crack up the animal, put him through his paces, and even jump on him and ride him, without a saddle, up and down the road, for Gypsies are all horsemen. I can see Henry Wells now, his powerful form, in big, great coat and heavy boots, seated blanket-back on a big horse and trotting toward us down a wild country lane—us being the prospective purchaser, myself and a crowd of youngsters come out from town to see the Gypsies.

After an hour or so at talking the horse over and showing his paces, they go to the nearest *kichamen* (tavern or saloon), where perhaps the bargain is consummated over a *pi* of *tädipani* (drink of whiskey), or perhaps the buyer goes off, returns, and clinches the bargain in the evening. I once saw such a sale in progress; the horse in question was a worthless one, and the day after I found the Gypsies had left. "Where are "they gone?" I asked one of the neighbors. "I don't "know," the man replied; "but your friend sold that "horse last night and made a cool fifty dollars on it, and "I guess he thought he'd better leave town before he "heard any complaints of the bargain!"

That Gypsies are shrewd horse dealers is true, though I believe there are Yankees who are shrewder, but that they are horse thieves, as has been sometimes charged, I do not believe, if for no other reason, because it would be nearly impossible for them to escape detection.

The remaining property of the Gypsy consists in those little necessities of life, clothing, linen, and so forth, which he can carry about with him. Dogs are numerous and of all kinds from a thorough-bred, once in a great while, down to the lowest kind of cur, and almost every Gypsy carries some chickens round with him. Bantams and *kuren känis* (fighting cocks) he prefers. Many a Gypsy tent, too, has a big, gilt cage with a *cheriko* (bird) or parrot in it, the green parrot being very much admired and liked by the Gypsies, and often carried round by them.

Gypsies do some little odd jobbing work, by which they eke out their gains from horse dealing and fortune telling. Basket making and selling is one, though now they often buy the baskets they sell instead of making them. In England they make a lot of little knickknacks, and an Englishman presented me with a clothespin made out of a cleft hazel twig, kept from splitting too far by a band of zinc. These, he told me, they made, stuck on a stick and went round selling, in the old country. In former days Gypsies were smiths and tinkers, and the name Smith or *Petulengro* is common among them, but I never knew any Gypsy smiths or tinkers in America.

From our description thus far of the Gypsy and his belongings, we have gotten enough to form a good idea of the Gypsies' life. Gypsies generally move in gangs, several households, or rather tent-holds, travelling in company. Society, I suppose, is the main object in this, and perhaps also mutual coöperation makes the daily occupations of pasturing and tending the horses, cutting fire wood and tent stakes, *häching* the *tän* (pitching the tent), &c., &c., easier. As, however, one Gypsy is competitor to another in the *grai puriven* (horse swapping) and *dukerin* (fortune telling) business, and as, also, the pasture by the roadside for the horses has its limit, it is inconvenient for too many to travel together, and like all nomads their ways must often part. Thus, once on a time, the *bori dai* Amelia Wells separated at Poughkeepsie from her sons Henry and Leonard, and went down into Connecticut for the summer while they went on to Albany and beyond; "For there wasn't *chor* enough for "so many *grais*" (not grass enough for so many horses). Even so separated Abram and Lot, long ago. Strange, isn't it, how the patriarchal ways of past millenniums are reproduced to-day among the waifs and outcasts of our roadsides?

These Gypsy gangs can not properly be called tribes, since there is neither government nor common interest save that of temporary companionship. Both, however, are incipient, especially where the gang, as among the Wells, so often mentioned, is composed of several closely related families. Here the blood relationship combines the different tents into an incipient phratry and some sort of patriarchal, or more often matriarchal authority is wielded by the oldest members of the gang. I have already alluded to this authority and influence in describing the *bori dai* Amelia Wells. Plato Buckland and his wife—his wife to a much greater extent than he—stood in like relation to a band of *kâlo Ramanis*, or pure blood Gypsies, whom I saw several times in the last two years.

But the Romany gang does not always hold together and there is nothing at any time to prevent any family from separating and going off on its own account. So often you will see one lonely black tent pitched near its single *wardo* in some wild glen, or in some common field by a little frequented lane, and the smoke of a single unsocial fire straggling from the other side of a copse, in a spot where you expected to find only insects and birds. My observation has led me to believe that these less social wanderers are less prosperous than those who travel in gangs, and I believe one reason why they travel alone is because intemperate or dirty and shiftless habits make them unpleasant wayfellows.

If you want to see a Gypsy camp at its best go out to it Sunday morning. On weekdays you will hardly find a woman in the camp. Baskets on arm, the dark, black-eyed *dais* (women) set out for town early every morning, dressed in their gaudy, outlandish gowns and big bonnets and wearing their big gold ear rings. Or, if the camp is some distance from the town, the buggies are hitched up and the men drive them in and come after them in the afternoon.

All day they go from house to house, selling baskets, trading them for old clothes, begging clothes, food, and money, but above all telling fortunes—for the Gypsy witch is the priestess of a vast amount of popular superstition which gets into print in the shape of ten-cent dream-books, "Napoleon's oraculum, or book of fate," &c., and which supports not only the *Ramani chovihanis*

(Gypsy witches) but voodoo women, astrologers, clairvoyants, and many more popular mystics.

For every fortune the Gypsy wife tells she expects a *lil* (*i. e.*, a dollar), and for "setting the cards" she demands five dollars or a *bar*. But she is an oriental and you can higgle with her, and I have known her shade the price from a dollar down to a pair of old shoes. Still the gains of their fortune telling (and of other lower class seers too) are much larger than one would think possible in the face of our common schools, public libraries, and churches.

While the women are in town, the men loaf round the camp, tend the horses, look after the babies, who tumble about on the grass all day, clean up the pots and dishes, cut wood, and wait for horse customers. When any one who wants a real good horse turns up, of course they are ready for him. How they love to hail a green countryman, but how they hate a shrewd, horsey Yankee or a Jew, whom they call a "Christ-killer," for Gypsies have Christian prejudices whether they have the virtues or not. Some woman generally stays with the men in the camp to get dinner, though the *Ram* can cook for himself on a pinch.

But if you will go to the *tän* on *Krokers*, or Sunday, a word derived from the Greek *κυριακή*, they are all at home and all idle and glad to see you. The Gypsies keep the Sabbath pretty well, but if a customer comes for a horse, they can't help letting him look it over, and if he buys then and there why, isn't it his fault more than theirs? They didn't ask him to come Sunday.

The women sit around and talk, the mothers get dinner, and sometimes a little washing or mending goes on. After the fire wood is cut and the *grais* curried, the men lie round and loaf, as in fact I think they do twenty hours of the twenty-four any way. Even cutting wood and cleaning horses is often left to the hired man.

It may not be known to every one, but most Gypsies keep a *bude-mush* or servant to do all their drudgery. The servant gets his keep and some small wage. He is sometimes Romany himself, as in the case of the black Gypsy mentioned above, who worked for the Wells. But he is more often of lower class, American, "poor-white" extraction. I even once knew a member of a good, lower-middle-class Dutchess County family who worked for the Gypsies for years and had learned a good deal of their language. And old Mr. Smith, when I visited his camp on top of the Palisades near Guttenberg, complained that it was through the *Gorjio bude-mushes* (gentile servants) that the knowledge of the dark language got out in the world and the old secret leaked away. Still the *Ramani* are so careful to keep their language to themselves, and some of the *Gorjio* servants are so stupid withal, that in years of service some never learn a word.

"You couldn't larn him a word o' that language," said Plato Buckland, "in a thousand years. He ain't got the head." That Gypsy-lore has passed from these *bude-mushes*, and in other ways into the lower ranks of society is, however, true. Gypsy words creep into slang, Gypsy ways are adopted by tramps, peddlers, and so forth, not of the blood, and Gypsy superstition spreads and keeps alive the old witchcraft and shamanism which now survives only in the dregs of society, though all our ancestors confessed it once.

Talking about their life, the subject of their morality suggests itself. In this respect I believe the Romany will compare very well with the lower classes of society. Intemperance has always been his besetting sin, as of the Dom in India, but his life in the open air enables him to endure hard drinking. The American *Ramani* whom I have personally observed are, I believe, much more temperate, honester and better every way than those I have read of in England. Leland says Gypsies are building up the old race and reviving the old language in America. The sexual morality of their women is, I believe, better than that of our lower classes. At any rate it is with the pure blood Gypsies. The *Didikai* are inferior in this respect, as, I think, in most other ways.

Cheating, petty roguery, and stealing wood, chickens, &c., are no doubt Gypsy traits. But even these charges are often exaggerated and, while fortune telling is wrong from our point of view, it is with them the ancient custom of their race and they have brought it with their language and cultus from India. I have already spoken of their observance of Sunday. The Bucklands told me that in England they went to church regularly and I believe that if approached properly and not too stiffly the Gypsies would be open to the truths of the gospel, though their wandering life will probably prevent their ever going to church very often.

Before turning to the language of the Romany, the last point to be discussed, it will be worth while to name the principal gangs of Gypsies who frequent this county and of whom this paper is a description.

My first acquaintances, the Wells tribe, are a large family of *Didikai*, some of whose members are rather dissipated and not very prosperous. They often travel by single wagons, but every now and then their *wardos* come together and the family reunites for a time. They are tall, large bodied, and rather fair. The Coopers and some of the Stanleys are related to them. The Coopers are short, dark, pure blood Romanys. I have only seen a few of them here and those few travelled with the Wells. There also travelled once with the Wells a family named Quigley. These were not Gypsies by blood at all and they knew it, but, though they were fair and blue eyed, they spoke the dark language, and their fathers and grandfathers had lived on the roads.

Plato Buckland and Harry Small are two pure blood Romany patriarchs whose caravans pass through Poughkeepsie now and then. Buckland is the father of half a dozen really beautiful daughters, and his sons-in-law, the Pinfolds and Comeagains, as well as his sons, travel with him. In 1892 he and Harry Small were together, but in 1893 the Smalls had *jâll'd o wäver drom* (gone another way) and he was with the Smiths—very deep black Gypsies.

Then besides these there are Stanleys, who come here very seldom, Williamses from Connecticut, the Scotch Williamsons mentioned above, and so on.

New Jersey is a land very rich in Gypsies. Its winters are not so cold as New York's, its people are horsey, and it contains the races. There I know deep black Romanys, Evans, Lovels and others, but I have not met these in the Hudson River country.

Our Hudson River Gypsies light their winter fires in West Virginia and Maryland, or rarely Southern New Jersey. They move north with the spring through New Jersey and Pennsylvania. By June they are camped in the vacant lots under the old trees on top of the Palisades. Sometimes they cross over into the city and a friend of mine visited a Gypsy camp on Manhattan Island near Kingsbridge. Two weeks after their stop on the Palisades I have seen them in Newburgh on Snake Hill and in Wiesner's Lane and the next day they will be in Poughkeepsie. If they get here in July they will wander back and forth between Newburgh and Albany all summer, getting down into Delaware County when the peaches are ripe, not to the special benefit of the orchards. Or perhaps on leaving Poughkeepsie they will go down into Connecticut. There they may be found near Ridgefield, Danbury, or Bridgeport all summer. As the swallows fly home they are moving towards New Jersey and Pennsylvania again and they light their winter fires on the banks of the Potomac and Kanawha.

All Gypsies, however, do not go south in the winter. I have known some who hired lodgings and went into winter quarters in towns, in Bridgeport, Albany or Newburgh. This is called *kering* from *ker*, a house. That there are people of Gypsy blood who have left the roads and live permanently in houses, is also true. I heard of a Williams, a Gypsy, who kept a saloon in Bridgeport, and I knew a pure blooded Stanley who was looking for a place on the trolley cars in Brooklyn. Think of the "deadly trolley" with a wild, roving Romany for conductor.

The brief description of the history and present condition of the Gypsies is not complete without some account of the Romany language. It is from the comparison of Romany with Sanskrit and modern Hindu dialects that the Indian origin of the Gypsies has been proved, and it is by his knowledge of it that the scholar to-day wins their hearts and becomes able to study their character and folk lore.

When the Gypsy arrived in Europe he spoke a tongue entirely distinct from the people about him. It had a Hindu-Persian vocabulary and the elaborate Aryan grammar. Grammar and vocabulary are preserved in considerable purity in Turkey and Eastern Europe to this day, as I found out to my sorrow in talking with the Hungarian Gypsies, who were continually using words and forms which American Romanies, and, therefore I, know nothing about. Four hundred years in Englishry have very much corrupted the *kâlo jib* (black language) but Leland avers that Romany inflexions were still used in England early in the century. In Wales, too, the language is purer and deeper than in England and America.

The Romany language in its East European purity has two genders and eight cases to the noun; adjectives declined to agree with their substantives, a verb with a middle voice and a complication of tenses including a second aorist, and its own syntax. But the American Gypsies I have described preserve scarcely any of the original grammar and even their vocabulary is very scanty, and, in talking of any but the commonest occurrences of daily life, has to be eked out with English words. Of course the *kâlo Ramanis* (black Romanies) know much more of it than the Didikai (half breeds) and they pride themselves on their "deep" knowledge of the language. They retain some inflexions and a much larger vocabulary, including many "deep" (*i. e.*, nearly forgotten) synonyms for the words in common use.

The Romany noun has two genders, masculine and feminine, and the adjective ought to agree with it. I say "ought to" advisedly, for many Romanies have now practically forgotten even this and unite, for instance, a masculine adjective with a feminine noun. Still I think the *kâlo Ramanis* generally make the distinction properly. *O* is the adjective masculine ending and *i* the feminine. Thus: *kushto mush*, a good man, but *kushti juvel*, a good woman. The plural of nouns is formed by adding *or* or *ior* to the singular. Thus: *grai*, horse; *graior*, horses. This inflexion too is fast vanishing and the English termination *s* is taking its place. You hear *grais* used more often than *graior*. Beyond this I am not aware that the American Romany noun and adjective can be declined. The old Romany genitive ended in *eskoro*. Thus: *raklo*, a boy; gen., *rakleskoro*. But Borrow says the genitive is entirely wanting in English Romany. The American Gypsies form a possessive after the English model with *s: e. g.*, *o mush's dume*, the man's back; a *rai's chai*, a gentleman's daughter.

More declension is naturally preserved to the pronouns, but here too, of course, the datives and duals of the *puro Roma jib* (old Gypsy language) are forgotten.

I think the remnant of inflexion used in America is about as follows.

FIRST PERSON.

	Singular.	Plural.
Nom.	*Mändi*	*men, mendui*
Gen.	*miro, miri, mi, m'ro*	*mendui's*
Acc.	*män, mändi*	

SECOND PERSON—SINGULAR.

Nom.	tu, tuti
Gen.	tiro tuti's
Acc.	tut tuti

Plural like Nominative.

THIRD PERSON—SINGULAR.

	Masculine.	Feminine.
Nom.	*yuv*	*lâti* (properly acc.)
Gen.	*lesti's*	*lâtis*
Acc.	*lesti*	*lâti.*

COMMON PLURAL.

Nom. *lis.* An oblique case used, however, as nominative by our Gypsies.

Gen. *lendi's.*

Acc. *len lendi.*

Smart and Crofton give an elaborate series of forms for the pronoun, perhaps adapted from Paspati's Turkish Gypsy. I doubt if all their forms have been heard in England for many a day.

The verb has lost most. Gypsies add English terminations to the Romany stems and, I believe, all the old Romany endings among our American Romanies have practically been lost. The verb to be, however, retains inflexions ; its singular,

mändi shom, I am,
tute shan, thou art,
yuv si, he is,
lâti si, she is,

being still used by the Gypsies.

But for the rest they say : *mandi kams tute*, for, I love you, instead of *me kâmava tut ;* they say, *mandi dik'd*, I saw, instead of *dikdom ;* they say, to *pi*, to drink, instead of *pialini*, and they use such anglicized forms as *hoien' hâben*, eating food ; *lel'd apre*, taken up (slang for arrested), etc., etc.

But if we find little in the grammar of use to us the vocabulary they retain is still very large. "Not more "than fourteen hundred words, the greater part of which "seem to be of Indian origin," says George Borrow (Lavo Lil, p. 6). Leland, in the "Gypsies," thinks it quite possible very many more words might be found than Borrow knew of. I have taken down three hundred, fifty words from the Gypsies I have known on the Hudson river and I have worked at it only very occasionally and only during three years altogether.

The Indian origin of the Romany language has already been established by Pott, Miklosich, Borrow, Paspati, Leland, Simson, &c. In illustration of it, it may be well to introduce the following list of Romany words with the cognate Sanskrit ones, which has been kindly sent me by my friend Mr. George N. Olcott. The Romany words given are common ones, such as may be heard in every Gypsy's tent in New York state.

aläj, ashamed. *A* is added to assimilate it with English *a* shamed. In old Romany we have the form *laj*. Hindustani *laj* : Skts. lajja.

wangar, coal (also money). Old form angar. Hindi *angara :* Skt. *angara*, coal.

koko, uncle. Hindustani *kaka*, uncle.

kâlo, black. Hindustani *kala*, black ; whence *Calcutta.*

kam, to love. Hind. *kam.* Skt. *Kama*, love, the Hindu god of love.

kän, ear. Hind. *kan.* Skt. *karna*, ear.

kasht, stick. Skt. *kashtha*, stick.

ker, to make, do. Skt. √ *kr*, to make, do.
jib, tongue. Skt. *jihva*, tongue.
chiv, to put, throw. Skt. √ *kship*, to hurl.
chor, to steal. Skt. *chora*, a thief.
chumi, to kiss. Skt. √ *chumb*, to kiss.
churi, knife. Bengali, *churi*. Skt. *churika*.
jin, to know. Skt. √ *jña*, to know.
jukel, dog. Persian, *shagál*, jackal, (whence our Eng. jackal.)
divas, day. Skt. *divasa*, day.
duvel, god. Skt. *deva*, Hind. *dev*.
pani, water. Hindu, *pani*, water. Skt. *pana*, drink.
puv, ground. Hind. *bhu*. Skt. *bhumi*.
bak, luck. Skt. *bhaga*, luck.
mush, man. Old form *manush*. Skt. *manushya*, cf. Avestan, *mashya*.
matto, drunk. Skt. *matta*.
wast, hand. Skt. *hasta*.
sap, shake. Hind. *sarp*. Skt. *sarpa*.
yak, eye. Skt. *akshan*.
yag, fire. Hind. *ag*. Skt. *agni*. (Latin *ignis*).
rai, gentleman. Skt. *rajan*, king.
rati, night. Prakrit *ratti*. Skt. *ratri*.

The numerals also illustrate the same fact. Those known to our American Gypsies, with the Sanskrit, are as follows:

	Romany.	Hindu.	Skt.
1	*yek*	*ek*	*eka*
2	*dui*	*du*	*dva*
3	*trin*	*tri*	*tri*
4	*shtor*		*chatur*
5	*panj*	*panch*	*pancha*
10	*desh*		*dasan*
20	*hukter*		Greek ὀκτὼ

It will be curiously noted that the word our Gypsies use for a *score* (it has a rather indefinite meaning) is evidently derived from Greek οκτώ. Among the words the Romanies borrowed in Greece were the numerals *hefta*, seven; *okto*, eight, and *enea*, nine, still used in Turkey and Hungary. These are all, except *okto*, forgotten here, and *okto* only lives as *hükter*. The authorities give *bish* as Gypsy for twenty. Our Romanies have forgotten this and have blindly taken their old word for eight and used it to express first an indefinite large number, then a score, then twenty.

The fact that the numerals given above are the only ones the Gypsies retain is quite curious. These numerals have evidently been kept to count money with. They need to beg for *yek*, *dui*, *trin*, *shtar oras*, or pennies, and to trade with as many *lils* or dollars. As we have a five cent piece and a five dollar bill they can say *pänjors* (five cents) and *panj lil* (five dollars), or a *bar* (a pound). *Desh* is used in *deshors* (a ten cent piece), *desh lil* (ten dollars) and so forth, and *hukter* conveniently expresses a large number, being translatable by score rather than by twenty. *Hukter bar* (literally, twenty pounds) means a hundred dollars, a sum of money so frequently referred to, it is convenient to have a Romany word for it. In England there is a sixpence and English Romanies know that *shov* means six, but as our American currency does not make the word necessary, it has been forgotten.

It will be interesting to note here how words for English coins have been applied to American money. In England *ora* means a penny, *tringushi*, a shilling, and *bar* a pound. Here these words are retained, *or* for a cent, *tringushi* for twenty-five cents, and *bar* for five dollars. They call a dollar a *lil*, which meant book, a reference to our printed paper money.

Of other than Sanskrit elements in Romany a few examples must suffice. The Gypsies entered Europe through Asia Minor and Greece and staying a good while in those countries, Greek made some impression on their language. I have already cited *krokers* from Greek *κυριακὴ* and *hukter* from *ὀκτὼ*. *Drom* is their common word for a road and it comes directly from Gk. *δρόμος*. *Palal* is Romany for behind. It is the Greek *πάλιν*. The Romany articles *o* and *e* are borrowed from Greek *ὁ* and *ἡ*.

Of Slavic elements there are some. The Romany *kralis* (king) is Polish *król*.

In talking with the Hungarian Gypsies I mentioned the American Romany *mächka* for cat. "No," they said, "*mächka* means cat but it is a Hungarian word, "not *Roma*. The *Roma lav* (Gypsy word) for cat is *dandolo*." If this be true it is a case of a true Magyar word preserved in American Gypsy. The word *dandolo* for cat, I never heard before.

Besides the English inflexional endings and the good English words with which most American Gypsies eke out their Romany, they sometimes add the Gypsy ending *us* to English nouns ; thus they say *weekus* for week. Many things for which the Romanies had no names have been given figurative names made up of real Romany words. Thus a turkey is *kâli râni* (literally, black lady), a church *miduvels ker* (the Lord's house), a lawyer, *jinemester-mush* (knowing man), a plow, *puvse vardo* (field wagon). A *kori* means a match. Potatoes are called *puvengri* and turnips (also radishes) *puvakro*, both words meaning literally "field things." *Kuver* means thing, and is often added to form a noun. Thus, *täven-kuver* (smoking thing), a segar.

Of course this language, corrupted as it now is, always the secret dialect of ignorant bands of outcastes, is practically without literature. A few orally transmitted legends, spells, and folk rhymes are all that can be collected. Of magic spells and rhymes the east European Gypsies have a great number. The following, which I quote from Leland, will have to suffice as a sample. It is a spell to cure a fever and the sufferer, going to running water, casts pieces of wood backward nine times and says:

"'Shilályi prejiá,
"Páñori me tut 'dáv!
"Náñi me tut kámáv;
"Andakode prejiá,
"Odoy tut cuciden,
"Odoy tut ferinen,
"Odoy tut may kámen!
"Mashurdalo sástyár!'

"'Fever go away from me,
"I give it water unto thee!
"Unto me thou art not dear,
"Therefore go away from here
"To where they nursed thee,
"Where they sheltered thee,
"Where they love thee,
"*Mashurdalo*—help!'"
("Gypsy Sorcery," p. 16.)

Mashurdalo is a forest-ogre-spirit who eats human flesh, but may be incanted. Every writer on Romany gives some stories or *gudli* in the English Gypsy dialect. There are beside some rhymes and jingles current among them.

I have myself sought for such verses but have scarcely found anything. I got the two following insignificant jingles from the Wells family and have often heard them sing them.

Didikai, Didikai, what shall mändi ker?
Prasdid adrom with a wäver mush's ram!
(Half-breed, half-breed, what shall I do?
Run away with another man's wife!)

'Tis I Double-y-dawli,
We got to muler a bâlo,
John rig a de mailer
To fetch the mulo bâlo.
(Tis I Double-y-dawli,
We got to kill a pig,
John go for the donkey
To fetch the dead pig.)

On the title page of Borrow's Lavo Lil occurs the following:

"Can you rokra Romany?
"Can you play the bosh?
"Can you jal adre the staripen?
"Can you chin the cost?"
"Can you speak the Roman tongue?
"Can you play the fiddle?
"Can you eat the prison loaf?
"Can you cut and whittle?"

I would like to mention that I once heard one of the Bucklands humming over to himself the words,

"Can you raker Ramani?
"Can you play the bash?"

And this would seem to show that these lines are a folk-rhyme and were not composed by Borrow.

The superstitions and folk-lore of the Gypsies are a widely interesting subject I am at present studying up, but I have not thus far collected much of value.

In east Europe the Gypsies possess an elaborate mythology. They believe in the *mashurdalo*, the great, clumsy, stupid, man-eating giant of the forests, who, like norse trolls and German Rubezahl, will assist people who do him favors with his enormous strength and great wealth.

Malignant spirits named and unnamed cause their diseases and are exorcised by their spells. The Pçuvushi or Pçuvus-wife, "a female spirit of the earth," is one of these, and there are also the *Nivashi* or water sprites. The *urmen* correspond to our fairies and the *weshni-dye*, or wood mother, is a beneficent spirit of the forests.

Our own Gypsies, while they have no such mythology, preserve a good deal of small superstition from the belief in *mullos* or ghosts, down to the notion that if any one presents them with a knife they must immediately give him something, if only a chip of wood, or it will cut their friendship in two. They believe in fairies, and said they had often seen their tracks, like chickens' feet, in the soft mud round rivers in England, but some of them thought there were no fairies in this country. They also believe in *chovihanis*, witches, and think people with catalepsy or convulsions are bewitched.

The great palladium of *Ramnipen, dukerin*, or fortune-telling, they both believe and disbelieve. "It's *sar hukaben*" (all lies) many a Gypsy witch-wife will tell you, and it generally is so manifestly; but they show a disposition to believe that there are fortune tellers whose soothsaying may not be all lies, and Leland has given some remarkable examples of cases where they evidently believed in their own predictions.

Prof. H. E. Mills, Mr. A. E. Moseley, Mr. Edmund Platt and Mr. Frederick P. Robertson were nominated for membership.

MARCH 13, 1894.—SIXTH REGULAR MEETING.

President Burgess presided, and about fifty members and guests were present. Dr. Warring presented the following paper:

THE INSUFFICIENCY OF PHYSICAL LAW.

BY CHARLES B. WARRING, PH.D.

We often use the word law in the abstract as a generic term, including all laws which pertain to the subject under consideration, as the Law of the Land, Commercial Law, Maritime Law, Civil Law, Military Law. In the same way Physical Law refers to and includes all the laws of physics, hence I shall say Physical Law when speaking of the whole as if one, and physical laws when I desire to refer to these laws individually.

What is Law?

Moral and Civil law imply two parties, one of whom has authority to command and power to punish, and the other is under obligation to obey. This definition cannot apply to physical law, for that acts on matter, and matter cannot be punished, nor is it conscious of obligation to obey. Consequently Law in this connection has come to mean an order of action, or perhaps more accurately, a statement of an invariable order of sequence in or between physical phenomena. We note what comes first, and what invariably follows, taking care, of course, to eliminate all errors of observation, and we formulate the operation in words, and we have a law. For example, I toss a stone upwards. In a few moments it comes to the ground. I remove a support from beneath a body. At once it goes to the earth. I try various substances with the same result, and conclude that all unsupported bodies fall to the earth.

My faith may be shaken by seeing smoke ascend, and birds fly, but greater knowledge, and the use of my reasoning faculties, enable me to see that these are after all only other cases of the same law. As I discover the shape of the earth, I generalize my statement a little more, and say that all unsupported bodies fall towards the centre of the earth. Finally I rise still higher in my generalization, and say that all bodies on the earth, or at a distance from it however great, if free to move, do actually approach each other. Further observation establishes the fact that such bodies, *i. e.*, unsupported and free to move, approach each other with varying speed. If one is 100 times more massive than the other, the smaller will travel 100 feet to the larger's one. If we vary the distance between them, we find that at three times the distance apart the speed of each is but one-ninth as great as it would have been had their distance been unchanged. And from this we get the grand generalization that the velocity due to gravitation varies directly as the masses, and inversely as the square of the distance.

In ways more or less similar, we deduce other physical laws, *i. e.*, statements of the order of sequence of physical phenomena. But the mind refuses to rest satisfied with knowing in what order phenomena succeed each other. To say that a certain thing took place, because some other thing preceded it, gives little satisfaction to our desire for information. We persist in believing that there is some invisible efficient some thing connecting antecedent and consequent. In this way it has come about that Law is spoken of as if it were itself an entity, a force capable of bringing about results, from which there has sprung much confusion and false reasoning, that in the poverty of language is perhaps unavoidable. I shall be compelled in the paper I am about to read to conform to this usage, but I hope in needful cases to make clear the proper distinction.

Of Physical Laws, in the complex sense of underlying forces, and orders of sequence, the first, perhaps, in importance, certainly the first in the wideness of its influence, is gravitation, acting at all distances, leaping across the interstellar spaces with a speed more than 50,000,000 times greater than that of light. It passes through bodies, however great, and affects those beyond as if nothing intervened. Unlike all other forces, it is incapable of saturation. A magnet quickly gets its load, beyond which it can carry no more. If it spends energy on one object, it has that much less for any other. But the earth acts on an apple, on a planet, on the sun, and on each star in space, and affects each one as if it alone was the object of its attraction. Neither the presence, the absence, nor the intervention of one body, or of any number of bodies, has any effect on its influence on another.

The attraction of cohesion acts only at insensible distances, has no relation whatever to mass, and varies in intensity in some inverse power of the distance of a higher order than the square.

Then there are the Laws of Chemistry. Running through them all, and giving them use and vitality, is the law of chemical affinity. Unlike the law of gravitation, and like the law of cohesion, it acts only at insensible distances. Its most striking peculiarity is that there always results from its action a change of properties, the old disappearing and new ones taking their place. Unlike the organic world, the child is always unlike its parents. The only properties never affected by chemical action are mass and weight.

In electricity as in chemistry the number of observed "invariable orders of sequence" is very great. It attracts and repels not merely at insensible distances, but at distances whose limits are yet unknown. It travels from place to place, through solid wires, and refuses to go through a vacuum, while it all the time sends off waves of energy that most easily go through that which is impassable to the electricity itself. It pulls apart chemical compounds, and causes others to form. Nor can I detect any one principle that runs through and connects all its phenomena, unless it be the law of polarity, that apparently impossible, but yet actual condition by which two parts of the same molecule have opposite powers of attraction and repulsion.

Heat gives another example of physical law. It expands by its presence and contracts by its absence. By its incessant flow it tends to bring all things to one temperature. By changing the condition as to fixity of molecules, it accelerates in some cases chemical action, and in others, retards it. Within a certain range it is necessary to animal and plant life, beyond that range it destroys life.

Last of all there is light. Its laws of refraction, reflection, and polarization are of no account to the inorganic world. The rocks and mountains, seas and plains, although owing so much to heat, owe nothing to the laws of light. But to the vegetable and animal world these are of great importance; more than that, to them vegetables and animals owe the possibility of existence.

Thus much for the peculiarities of the various physical laws—points in which they differ. Look now at their common characteristics. First of all is there absolute inviolability. Though not omnipotent they cannot be broken. A moral law we may break. I am commanded to love my neighbor as myself, but I need not do it. Thou shalt not kill, thou shalt not steal, thou shalt not bear false witness, are not merely avoided, or in some way held in abeyance, they are flatly disobeyed every day. But if I walk off a precipice, I do not violate the law of gravitation. I obey it to my sorrow. My broken limbs are painful evidence that the destruction due to the kinetic energy put into them by the fall is exactly proportioned to the distance fallen, and the negative energy developed by the sudden stoppage is inversely as the square of the time that painful process occupies. Nor can I stay the action of this law. If I pile stones upon a table, the table will stand until, at last, the load becomes too great, and then the table is crushed to the floor. But gravitation was acting all the time. It is always thus: the falling body and the body lying on the ground each obeys the law equally well.

If I pull a bar of steel with force enough to draw it apart I do not violate the law of cohesion. I remove the parts beyond its influence, and it is a part of the law that in such a case the cohesion becomes infinitely small.

Nor can I in any way do violence to any law of chemistry. Bodies will unite in certain definite proportions, or multiples thereof, and I may do what I will, and waste as much material as I please, the result is unchangeable; if the bodies unite at all, it will be in exact accordance with their own laws. And what is true of these is true of all physical laws. To break any one of them is impossible.

Another characteristic of physical laws is that each law moves on in a straight line to its goal. It turns neither to the right nor to the left. The law of gravitation has but one mission, to bring every particle of matter as near as possible to the centre of the earth, and every particle in the solar system to the sun, and finally every atom everywhere as near as possible to the centre of the universe. The law of chemical action has but one final goal towards which it is pushing, the destruction of unstable compounds and forming, in their place, others of greater stability. The laws of cohesion make no betterments but tend to hold all things as they are. Electricity, the child of motion, itself would cease when matter came to rest. Heat and light are ever striving to pass off into that infinite space that surrounds all things.

Under the unrestrained influence of these forces, our earth would become as the moon is now. In it is neither atmosphere nor water. Life there is impossible. Silence forever reigns. Intense cold alternates with great heat. Its axial rotation has become so slow that it takes a month for a revolution. It is in the last stage of its separate existence. Physical Laws have done their work, and this is all they have, or can have, to show for it.

What better object lesson can there be to show their utter inefficiency to produce a world like this, a world clothed in vegetation, inhabited by living beings, and adorned with the work of men's hands!

Some other force must have been at work. What is it that has remedied the inefficiency of physical laws? Some have sought an answer in the power some bodies have of producing from an amorphous solution, or from a melted mass, forms of symmetry and beauty. The power of making crystals is indeed wonderful, but one can scarce be serious in regarding crystalization as analogous to the making of a tree or an animal. Heaping lumber in solid cubes, and bricks in parallelopipodons, or iron in pyramids, however skillfully and beautifully done, would do nothing towards building a house, and yet this is all that crystalization can do. It piles up in solid masses of regular geometrical shape, but does not advance one step towards an organism. It leaves untouched the question which our surroundings force upon us. What is the power which has supplemented physical laws? In our search for an answer we turn first to that with which we are most familiar, the works of man, and then will carry our reasoning to the deeper problem of organic being.

Taking for illustration this building in which we have met, all will agree that the unaided action of gravity could not cause it to arise. Clay might have hardened by the action of heat, but heat could not cause it to assume the proper form and size, and so become bricks. And if in some mysterious crystalization, and with proper amount of heat, the clay became bricks, yet heat, crystalization and gravity alone or together could not have got them into the walls. The lime and sand by some fortunate chain of accidents might have become mortar, but that would not bed the bricks in it. Had in some way the timber been cut, and had the metals needed for the nails, the pipes and the roof, been extracted from their ores, and then gathered by the winds and laid down in separate piles ready for use, all physical laws combined would be helpless to put them in their places. Gravitation could do no more than hold the various materials on the ground. Cohesion could merely keep them from falling to pieces. Chemical affinity has done its formative work, and now strives to the best of its ability to form new combinations useless, or worse, for this use. Electricity may scatter and destroy, but cannot raise a stick, or lay a brick, and light and heat have no part to play in reference to our building except to aid chemical affinity in its leveling work. Yet the edifice exists, and so do houses and streets, railroads and canals and innumerable other things for which physical law and natural forces fail to account. However far we extend our examination we find the same result, buildings, railroads, canals, machinery, statuary, paintings and innumerable other things, to which physical law is necessary indeed, but which it is utterly insufficient unaided to produce. All our investigation brings us back to the truth already stated. There is another force outside of, and in rank superior to, the laws of nature. We know of but one such force, and we call it the will power—a power which reaches its highest efficiency when guided by intellect. It is found in all living creatures, but most of all in man. But how can this will power connect itself with the outer world?

Given man endowed with all his faculties of mind and body, how does he make nature's powers work for him? First, by learning their laws, and strictly obeying them, he makes them his servants. By obedience he commands, by submission he conquers. This is that knowledge of which it is truly said, knowledge is power.

Secondly, man has the most wonderful instrument conceivable in his pair of hands. Having hands and will, how does the will set the hands in motion? Will is an attribute of mind, and between mind and matter there seems to be a great gulf, over which no bridge extends. We can conceive of no connection. And yet a connection does exist, as we have abundant proof every time we take pleasure through our senses, or move a muscle. We must then accept it as a fact that mind and matter act on each other, at least in our own internal mechanism. Nor, on reflection, shall we find any greater difficulty in this, than in the fact that matter acts on matter. How is it that the moon raises the tides? How is it that something, we call it gravitation, reaches across innumerable billions of miles and starts every mass of matter in the universe towards the tiny stone I pick up from the brook? How is it that my hand can push a body before it, and never under any circumstances come in actual contact with it? What is it that is so strongly repellent that no finite power can press through it to the substance within? We accept these things although inconceivable because we cannot do otherwise in face of the evidence, and for equally good reasons we must believe that mind has some connection with matter; that somewhere and somehow, there is a bridge across the separating gulf.

I open and close my hand; what has occurred? The anatomist tells me that in my forearm are certain muscles terminating in cords which are attached to my fingers. The muscles contract, and so pull the cords and the fingers move. This contraction is dependent on certain fine filaments or nerves running from the muscle to the brain. If the connection is interrupted at any point between the two, the muscle no longer contracts, and the fingers do not move. It is like machinery driven by electricity. It may be turned off or on by making or breaking connection, and this means moving something; or the cell arrangement may be like a plunge battery, and this, too, means an actual movement of matter. If the electricity is generated not by chemical action, but by contact of dissimilar substances, this also means movement of matter; or if the electricity be thermal, this also means movement of matter. Something has moved the molecules in the cell at the tip of the nerve, that sets what is probably some form of electricity in movement and my hand opens or closes. What is that first something? Evidently it is the act of that within which we call Soul, acting through that faculty which we call Will. This in some way causes those molecular changes, which produce force; whether large or small, is not the question, but force the will certainly causes to exist. What is force; who can answer me? Mind, force and matter are three distinct entities separated in our mental conceptions by an impassable gulf, but in reality intimately connected. True *we* cannot conceive of force independent of or separate from matter, but just as we are logically compelled to predicate a Cause antecedent to, and independent of, the material world, so we are logically compelled to recognize in that Cause the fountain of all power. Hence the highest logic makes us reach beyond our personal experience and accept as a fact that force primarily existed without and before matter, and that in the largest degree it now exists without connection with matter. May it not be, after all, that the part which matter plays is to make force evident to our senses? May it not be that the soul retains so much of its divine original that it can act directly on the nervous fluid and bid it go and come from the minute cell in the brain, as I, in a grosser and cruder way, let on or off the electricity of a battery? One may wander here in the field of imagination, but in it all there is one hard fact. In some way that within man which wills calls his muscles into action, and gifts him with power under the guidance of intellect to compel the blind, but stalwart forces of nature to work for him.

But for gravitation he would be helpless ; he could not walk, he could scarcely stand. The slightest push would send him off into space. Thanks to that force, he has a firm footing, and becomes a person of importance. He causes huge buildings to rise by dividing the weight to be lifted, and carries it up a little at a time. Or, if the load be too massive, he applies the lever, or the pulley, or the inclined plane, and by a small force long applied, always in the last analysis getting back to gravitation, he makes gravitation itself lift for him. If he employs water or wind, it is to gravitation that he owes his success. And if he uses steam or electricity, they could do him no service, did not gravitation hold the engine and the dynamo firmly to their bases. In short, gravitation is not only itself made to work for man but is his most valuable assistant in harnessing to his use all other forces.

Would he avail himself of the laws of chemistry, he brings the substances he would affect into close proximity, either in mass or dissolved in some liquid, or made fluid by heat. To do this changes must be made in the position of the substances to be operated on, of the fluid in which to dissolve them, of the apparatus, of the fuel, and so on through the list, and what changes could he make unless aided by that beneficent, omnipresent force, gravitation?

It is thus that all the works of man have been produced. Intellect utilizes and controls physical forces. Left to themselves they work with tremendous energy, but it is only to pull down ; they raise the mountains only to pull them down lower than before, actually casting them into the sea. The end to which they all tend is exhaustion, silence, cold, and death. It is mind that erects houses, builds railroads, cuts canals, paints pictures, carves statues. Physical law, compelled by man, its master to produce them, waits till his hand is removed, and then destroys them.

Long before man appeared on our planet, it was clothed in vegetation and "peopled" with animals. For these, also, physical law needed to be supplemented by some power outside of itself; a will and an intelligence that can make the forces of nature work under their direction. If physical laws cannot compel the elements that form a house, to take their places in the brick walls, and timber floors, and in the lath and plaster of its ceilings, or in the slate and tin of its roof, the glass of its windows, and the metal of its pipes, still less are they able to make the carbon, the hydrogen, the oxygen, the potassium and other elements that compose a tree, adjust themselves in bark, and wood, leaves and fruit, in sap and the tubes that carry it, the open mouthed rootlets that let it in, and the myriad outlets through which the surplus water and the rejected oxygen flow out into the atmosphere. Physical laws are powerless to do this, and yet all this is done, and a thousand fold more. Hence, if a controlling will and intelligence are needed in order that a house should be possible, *a fortiori*, they are required that a tree should be possible, and so through the whole vast range of organic forms.

To this it may be answered that my list of physical laws is too limited; that there are many other laws, as for example the law of youth, maturity, and old age; the law that like produces like, wheat produces wheat and not barley; the oak does not produce an apple tree; the young of every species is like its parents. And then there is the law of assimilation, that food becomes part of the plant or animal that consumes it. The grass or grain that enters a swine, becomes pork; that which enters the ox, becomes beef. The flesh of the timid sheep consumed by a lion takes on the strength, agility and ferocity of the beast that ate it.

To which I reply, these do not possess the characteristics of physical laws, they do not affect all matter, are not certain in their operation, and have no place save in a world already possessed of plants and animals. The passage from youth to old age, the process of assimilation, the production of like from like, are the results of the organism itself. They were provided for in its make up, and are necessary to its continuation. They, therefore, as much as the organism, need for their explanation a force outside of, and supplementary to, physical law. This force I have ascribed to the Will of an intelligent Being, but others think they find it in a fortuitous concourse of atoms. These descendants of Democritus profess to believe that the little particles which make up the universe, having tumbled together an infinite number of times, at last happened to come into the form of a cell. These cells, when enough had been formed, tumbled around into all sorts of positions, and at last happened to fall into the right shape and arrangement for the germ of a plant, and then of animals, and thus after sufficient time, all things were set in operation. If such a theory be insufficient for the making of a jack-knife, will it suffice for things infinitely more difficult? Others unable to accept this think they find escape from difficulty by referring all things to the working of an "unconscious intelligence." As if the most exquisite adjustments, the most delicate arrangement and co-operation of parts were the work of one who did not know what he was doing! Our minds revolt at this more, if possible, than at the doctrine of chance.

The result, then, of our inquiry is that those energies which we call physical, or taken collectively, physical law, and which immeasurably preceded organic law, are blind forces, each working irresistibly for its own individual end. Left to themselves, they would extinguish all light, and stop all motion, save the rotation on its axis of the one dead globe into which all present worlds would be collected.

But directed by the will and intellect of man, they are tireless workers in his behalf. He has planned, but they have done the labor. They have dug the canals, laid the railroads, erected the buildings, made all that we call the works of man. From wood and metals, they make, under his bidding, machines that cut and carve and sew, that count, multiply and divide, and write down the results in convenient tables, and do thousands of other things that save his muscles and relieve his brain. These, however, he must oil, and repair, and after a time replace with new ones at much expense of time, labor and money.

These same blind forces, directed by a higher will and greater intellect, gives correspondingly higher results. They have changed the surface of the earth from naked, barren rock to soil full of potentialities. Thus controlled and guided, they have made machines, but such as are infinitely superior to those made by man, for these obtain the power which drives them from materials which they gather themselves, and consume in a laboratory hidden within their frame. They extract and apply the oil which lubricates their bearings; they make their own repairs; and before they are worn out replace themselves with new and similar machines ready to go through the same round again. That we call such machines plants and animals, does not change their character, for each is a collection of parts adapted each to each for a common purpose, and working towards a common end.

In physical law, therefore, controlled by a will and guided by an intelligence higher than human, we find a rational solution of the living world about us. Without them all is in darkness. Physical law, unaided, might perhaps account for the production from nebulous matter, of a world, cold and dead, like the moon. For all else it is insufficient.

MARCH 27, 1894.—SEVENTH REGULAR MEETING.

Chairman Burgess presiding, and about fifty members and guests present.

Professor LeRoy C. Cooley gave a talk upon "The Mechanical Principles Involved in Hearing," illustrating it with the lantern and experiments. Professor H. E. Mills, Mr. A. E. Moseley, Mr. Edmund Platt and Mr. F. P. Robertson were elected members.

APRIL 10, 1894.—EIGHTH REGULAR MEETING.

Chairman Burgess presiding, and about forty members and guests present.

Rev. James Nilan read a paper on "Monism," tracing the theory through ancient and modern philosophy, and reviewing the arguments for and against it.

APRIL 24, 1894.—NINTH REGULAR MEETING.

Chairman Burgess presiding, and over one hundred members and guests present.

Professor Theodor Neumann, Ph.D., read the following paper on

ARTISTS AND ARTISANS IN THE FEATHERED WORLD.

BY DR. THEODOR NEUMANN.

Allow me to correct at once a possible misunderstanding which may arise [among some of you] very naturally when I speak of "Artists in the Feathered World." There will be not a few here who may expect something entirely different from what I am going to say; they will, as a matter of course, think of the bird's song first of all, which in so many cases has really been developed to a high degree of art, and which gives pleasure and delight to every human ear that is fortunate enough to listen to it. I shall, however, not speak about this art of song, although it is the most conspicuous and ranks highest in the appreciation of all. I would select quite a different subject to-night, one which may not stand prominent in your esteem, since you may scarcely believe that anything remarkable can be said about it; I would ask you to let me talk to you about the art and skill which birds show when building homes for rearing of their young and for shelter and protection against weather and climate.

"But how can you speak of art and artistic skill concerning such things as birds' nests?" you will object, "which are nothing but an aggregate of small twigs and stalks of grass, lined with feathers and other soft materials." Indeed, for many people birds' nests are nothing more than that; they have never taken the trouble of looking carefully, of comparing one nest with another; to them all nests look and are alike, and they wonder how I venture to talk a whole evening on such plain everyday things, and place at the head of my lecture such a presumptuous title. Well, I hope to succeed in proving to you that some interesting things can be said even about birds' nests, and that it is not wrong to speak of art, when we consider the fact that *even the most artless nest is constructed by a creature which had no instruments at all, no needle, no thread, no scissors, no hammer, no nails, only a bill and its two feet, a creature without any real instruction and guidance*, which nevertheless produced a piece of work such as we could never have done as well. A popular German author, Hebel, asked this question: "If you look at a finch's nest, do you dare to knit one yourself with mouth and feet only? Hardly. A skillful artist may with twenty delicate and elaborate instruments after many failures produce something which looks like a finch's nest, and which nobody who sees it can distinguish from a real nest built by a bird. Then the artist gets conceited and thinks now he is also a finch. Dear friend, you are far from the mark. For if a real finch should come and examine your work, just as the master does the piece of his apprentice, he would turn his head a little aside, wink at you with one eye, and if he could speak like a human being, would say: Dear sir, that is no finch's nest! I may look at it in whatever way I will, it is no bird's nest at all! No bird builds so stupidly and awkwardly. I'm sure, you bungler, you did it yourself."

Indeed, it will not be saying too much if we use the term artists, or at least artisans, in speaking of the wonderful skill with which birds make their homes; nay, according to the various forms of this skill, scientists have divided birds into different groups, and speak of *cave-dwellers*, *platform builders*, *carpenters*, *miners or tunnel diggers*, *masons*, *cement manufacturers*, *basket plaiters*, *weavers*, *felt makers*, *dome builders*, *tailors*, etc. And I should like to take you through the workshops of some of these wonderful little workmen and workwomen, so that you may have an opportunity to ascertain if we say too much in calling them artists, and to admire their marvellous skill unsurpassed by any other workers in nature.

Before we start, let us cast a look at the general features of this faculty of nest-making, and get a general idea for what purposes, where and how these domiciles are constructed.

There are other members of the animal kingdom who build nests, *e. g.*, mammals, fishes and insects; but with birds this ability has reached its highest development, and whenever we speak of nest-builders we at once think of birds' nests. A nest, above all other things, must protect the builders and their young from the influences of weather. It is not only the residence, but the cradle and the kindergarden, and only in rare cases, of which I shall speak later, do birds build certain structures for pleasure and recreation. Nesting is, therefore, a business; it means "work," which is, indeed, scrimped if not shirked by some. Consequently we find all degrees of diligence bestowed upon them, and they show all kinds of artistic development, while their size and shape vary in every possible way, so that we may find nests which we could hide in our closed hand, in opposition to structures nearly as high as a grown man; nests which resist the blow of a hammer, and others which cannot even be touched without crumbling or falling to pieces. Also the forms of the nest are greatly varied; we have open and cup-shaped, conical, dome-covered and suspended nests, all of which will receive due consideration in the course of this lecture.

One remarkable circumstance is that sometimes the nearest relatives build very different kinds of nests, or in very different places, while in other cases birds that have nothing in common, construct residences of very similar design. As a strange example of the former may be mentioned the Pyranus, of which one kind, Empidonax Traillii, builds its nest in a very substantial solid way in the vertical fork of some tree, while his near relative, E. acadicus, always chooses a horizontal fork as the best place for his residence, which is so fragile, without any base or support, that one is able to see through it.

The *localities* in which nests are placed are extremely variable, the birds seeming sometimes very careless, and again wonderfully capricious in their choice of a proper spot whereon to fit their residences. There is scarcely a place on the surface of the earth that does not find favor with some bird intent on building a home for himself and family. On rugged, precipitous cliffs, inaccessible by any other way than by winged flight, near or even on the water, in forest, field and meadow, on trees and within the underwood, in the reeds of the swamp and in caves hollowed by the forces of nature after many thousand years of work, everywhere nests may be found and nest-builders observed, busy at work to complete their task.

From the numberless examples of strange localities observed since men began to study bird-life, only a few can be selected, rather at random. The Kensington Museum in London contains a stuffed owl on the back of which a swallow had built its nest; and a statement is added that when the owl, which was found in the garret of some old house, was removed and taken to the museum, the man who brought it was asked to put an old lady's bonnet in the place of the owl. The following year the swallow built its nest in that, and the latter is likewise found in the museum.

A robin (Enythacus rubecula) has been known to make its nest in a workman's tool-basket hanging against the wall, in a fold of the window-curtain, upon a shelf in a green-house, in the side of a saw-pit, in a knot-hole of timber used in a ship which was being built. At Fort William the room above the pantry was occupied as a bird stuffing apartment; a redbreast visited it daily and was often expelled. The owner, finding expulsion of no avail, for it continued to return, had recourse to a novel and rather comical expedient. He selected the most fierce-looking animals and placed them at the open window, which they nearly filled up; the redbreast, however, was not so frightened "from its propriety," but made its "entrée" as usual and finally chose as nesting place the head of a stuffed shark which hung on the wall.

In the month of June, a mower hung up his coat, under a shed, near a barn ; two or three days elapsed before he had occasion to put it on again ; thrusting his arm up the sleeve, he found it completely filled with some rubbish, as he expressed it, and on extracting the whole mass, found it to be the nest of a wren (Sylvia domestica) completely finished, and lined with a large quantity of feathers. In his retreat he was followed by the little forlorn proprietors, who scolded him with great vehemence for thus ruining the whole economy of their household affairs.

Mr. Wood once found a missel thrush (Turdus viscivorus) nest in the crown of an old hat that had evidently been flung into the tree by some traveller. The hinge of a door has on more than one occasion been selected for the purpose, and in one instance the nest retained its position although the door was repeatedly opened and closed.

A railway carriage had been left for some weeks out of use in the station at Giessen, Hesse Darmstadt, in the month of May, 1852, and when the superintendent came to examine the carriage he found that a black redstart (Phoenicurus tithys) had built her nest on the collision spring ; he very humanely retained the carriage until its use was imperatively demanded, and at last attached it to the train which ran to Frankfort-on-the-Main, a distance of nearly forty miles. It remained there for thirty-six hours, and was then brought back to Giessen, and, after one or two short journeys, came back to rest at Giessen, after a period of four days. The young birds were by this time partly fledged, and finding that the parent birds had not deserted their offspring, the superintendent carefully removed the nest to a place of safety whither the parents soon followed. It is evident at least one of the parent birds must have accompanied the nest in all its journeys, for the nestlings would have perished from hunger during the stay away from Giessen, as they need food at least every two hours.

There are several examples of birds' nests being placed on different parts of a ship's rigging, for instance in the "bunts" of the main and mizzen topsails, *i. e.*, the place where the sail is gathered up into a bundle near the mast. A pair of sparrows built their nest under the slings of the foreyard of the ship "*Ann of Shields*," just before leaving port, and when the vessel reached the Tyne, the birds went ashore and brought back materials wherewith to complete their home.

According to the reports of many observers the nest of the titmouse (Parus major) may be found in the most extraordinary localities, such as hollow trees, holes in old walls, the interior of disused spouts, sides of gravel-pits, the hat of a scare-crow, the inside of a porcelain jar, or the cylinder of a pump. One bird had actually chosen a bee-hive as its residence, and had succeeded in building its nest and rearing its young while surrounded by the bees going to and returning from their work. Another titmouse continued to get into a weather cock on the summit of a spire, and there made its nest in security.

Many country housekeepers have learned to their sorrow how fond the sparrow is of building in water-spouts, thereby choking up the passage and causing the house to be overflowed.

The nest of the coot (Fulica atra) is a huge edifice of reeds and rank water herbage, sometimes placed at the edge of the water, and sometimes on little islands at some distance from shore. If the water should suddenly rise and set the nest floating, the coot is very little troubled at the change, but sits quietly on her eggs, waiting for the nest to be stranded.

The nest of the mallard duck (Anas boschas) is sometimes built in a tree at some elevation from the ground, so that when the young are hatched the mother is driven to exert all ingenuity in conveying them safely from their loftly cradle to the ground or to the water.

Other birds are rather particular in selecting sites for their nests and show admirable skill in hiding them so ingeniously that, even when they are watched to their homes, the discovery of the nest is a matter of great difficulty, and should it be discovered, the work of getting near it or obtaining it is very severe. The wheatear's (Saxicola œnanthe) nest is so deeply buried in the rocky crevices of the cliff-bound sea-coast that the only mode of obtaining the eggs is to hook out the nest by means of a bent wire at the end of a long stick.

No wonder that we find statements, of course originating in superstition, that the nests of some birds are actually invisible. There is no trouble in being convinced of such a belief, as even experienced hunters oftentimes find themselves at a loss to locate the abode of a bird, for instance that of the green-finch (Ligurinus chloris), even after they have watched its flight to the same spot for some time and are sure that its nest must be in the immediate neighborhood.

Next, I should like to say a few words about the material for such building purposes. Here, too, many rather interesting and curious things can be recorded. Each bird uses, as a rule, always the same things for his nest; many, however, accustom themselves easily to altered circumstances and are sometimes capricious without reason. Mud and dirt picked up from the streets and high roads is employed by swallows; lichens, moss, dry grass, straw, twigs, branches, sticks, etc., all are welcome for this one purpose, to construct a shelter for the family and the young. Not seldom do birds adapt themselves to modern views and use material which their forefathers could not possibly have known, for instance products of human industries.

A writer in *Ram's Horn* tells of a clockmaker who one day noticed in a tree in his yard a bird's nest of peculiar appearance. Examining it, he found that a pair of wagtails had built a nest almost entirely of clock springs. It was more than four inches across, and perfectly comfortable for the birds. After the feathered architects had reared their brood, the nest was taken to the museum, where it is preserved as a striking illustration of the skill of birds in turning their surroundings to advantage in building their nests.

Ross Mässler, in his popular magazine, "Aus der Heimath," tells a story of a magpie (Pica caudata) that had been annoyed several times by hunters shooting at its nest, which was on the highest top of a rather high tree. Later on several shots even with bullets had no effect at all on the bird or its nest, and closer examination revealed that the shrewd bird had covered the entire floor of its residence with old iron, which it had got for this purpose from a distant foundry.

Other birds which seem to care more for a warm bed, to which they may retire after the toils of the day, and which are anxious to provide the necessary protection for their offspring at all risks, are not particular in taking what they can get around human dwellings, so that investigations reveal rather ridiculous facts. An instance is known where a thrush carried off a lace-cap that was hanging on a clothes-line, and worked it into the sides of its nest; and wigs of venerable judges or professors have sometimes been stolen from the very heads of their dignified wearers by eager birds, and after long search found again as the nesting-place of some songster or the cradle of its young.

The next important questions are: How do our little artists go to work? What do we see and learn when we observe them at work? Which one of the two sexes is the designer, which the builder, which the furnisher of the new household? How long does it take to finish the task? Many of these must, of course, be answered individually, yet a few general remarks may not be out of place.

As a usual thing, the female is the builder; the male looks for the material and brings it. This is the rule, but it has many exceptions, as with the weaver-birds, where the male alone does the building, while the female condescends at the most to look after the furnishing of the interior. Still others take part equally in the construction, as is the case with the swallows. But even when the female alone is busy with this work, the male tries to make himself useful or to furnish pleasure in different ways, by singing or talking to the diligent wife, or by entertaining her by his skill in flying in long, elegant curves and performing all kinds of tricks. On the other hand it may happen that the husband will resort to force, to cries of indignation and anger and to blows with his bill in order to bring back the faithless or lazy wife to duty and diligence.

There is no doubt that the construction of the nest requires a very large amount of diligence, devotion and self-sacrifice. It is in most cases pushed with the utmost speed and carried through in a very short time. Often the work is abandoned and begun over again, as the birds may have discovered a more favorable site for the nest or a better way of building it.

The material is brought in their bills and claws, often even on their back; cut, twisted, made pliable, plucked to pieces; pressed, wound around the twigs of the plant where the nest is going to be. Careless birds simply throw the materials down on the place where they want to build the nest, others, more careful, carry them with their beaks and put them where they will do most good. Then they grasp these with their feet, divide and spread them skillfully and press them on. The lower part of the nest is shaped by the breast of the bird; he turns round and round, while holding his tail up nearly perpendicularly and pressing the materials. The upper part of the nest-wall receives its shape through the alternate work of the breast, the shoulders and the neck; the rim of the nest is shaped with the lower part of the beak or the chin, especially through wagging movements of the tail; it is finally smoothed by a stroking movement of the beak. Long stalks, which are to be wrapped around twigs, are always first broken or bent and made pliable; lumps of clay, used by some birds, are kneaded for some time before use. Any bird that builds with care takes away all stalks which protrude outside or inside, and if he finds that the nest itself is insufficient, does not hesitate to enlarge it or heighten its rim, often even after eggs are lying in it.

Some birds build common nests, and the different mothers lay their eggs together and may even sit on them in turns; others erect a main building, a tenement house, and divide that into different compartments, each of which serves as a domicile for one family; still others try to find a residence in the nests of other birds, especially in the substructure, and hatch their young together with their hosts.

In striking contrast to some of these birds, which produce really wonderful works of art, stand others which practically do not build any nest at all, and with these our review should be begun, although naturally not much can be said about them. Such birds as make no nests whatever, but deposit their eggs on the bare ground, or in some sheltered hollow, are the condor (Sarcorhamphus gryphus), some parrots, and a few others. Some scrape at least the earth away until a small hole is made which, however, does not yet show the slightest lining, either with grass, leaves or feathers. To these belong the ostrich (Struthio camelus), the bustard (Otis tarda), the peewit (Xema ridibundus).

The female penguins hatch their eggs by keeping them close between their thighs, and if approached during the time of incubation, move away, carrying their eggs with them. Some kinds make some attempt at nest-building by lining a hole in the ground with grass. As they are rather gregarious birds, this work does not proceed without much fighting. Every opportunity is embraced by the birds to steal grass or hay from their neighbors' nests when they do not look, and to drag it into their own; on discovery, the wronged bird is at once ready to retaliate, and thrusts with their long bills or blows of the wings must decide who will be the owner of the stolen goods.

Proceeding in our observations, we come to birds which also do not yet build a nest, but seek holes in trees or old walls, caves in rocks, etc., for their eggs. They may put some soft materials into these, but we cannot yet speak of real nests. Birds of this kind are especially apt to make use of holes prepared by other more diligent workmen (woodpeckers or squirrels), and not unfrequently a fight ensues between the righteous owner and the intruder. Such cave-dwellers among the birds are the creepers (Certhia familiaris), whose bills are really not able to do any such excavating as their relatives, the woodpeckers, also most owls, the wryneck (Yunx torquilla), the starling, and nearly all parrots, which, however, sometimes dig holes in trees or in the ground and may be reckoned as miners, of which I shall speak later. Special mention should be made of the New Holland goat-sucker (Caprimulgus australis), which resides in the hollow branches of the eucalyptus, technically called "spout" by the colonists. When the sportsman wishes to know whether a "spout" is occupied by one of these birds he has nothing more to do than to give a sharp tap to the branch with a stick or an axe. Should the bird be at home, it runs quickly to the entrance, pops out its head and, after surveying the intruder for a moment, retires into the seclusion of its domicile. It will repeat this process several times, but at last loses patience at the frequent interruptions of its quiet, and takes to flight.

One step farther will bring us to those birds which make a real attempt at nest-building, with results, however, which do not deserve that name at all, as they are merely heaps of leaves and grasses collected together on the ground, or in a small hollow in the ground, and with a very slight depression, caused apparently quite as much by the weight of the eggs as by the art of the bird. Such artless nests are built by the nightingale (Luscinia lusciola), the lark (Alauda campestnis), the snipe (Scolopax gallinago), the sparrow (Passer domesticus), the swan (Cygnus olor), etc.

Others, especially Australian birds, for instance the mound-bird or jungle-fowl (Megapodius tumulus), deposit their eggs in a heap of sand, or an accumulation of dead leaves, and trust to the heat of the sun, assisted in the latter case by the warmth produced by the decay of the vegetable matter, to maintain the temperature necessary for the evolution of the young. The brush turkey (Tallegalla Lathami) for instance collects an immense heap of decaying vegetable matter as a bed for the eggs, and the parents work on this structure not only for days, but weeks and months, nay, they add to it year after year, so that travellers have found cones of fifteen feet height and sixty feet in circumference. Of course this can not be the work of one single pair, but is the result of the united efforts of many. The way of carrying the materials is also rather peculiar, as the birds do not use their bills, but grasp a quantity of leaves, or whatever they want to use, with their powerful feet and throw it backward toward one point, so that the ground around is cleared for considerable distances, and no grass or leaf remains. The eggs are deposited in the mass, the holes excavated for that purpose being filled up, so that the natives can detect the existence of a newly laid one by observing the marks of the bird's feet upon the top of the mound. The old birds are said to keep in the vicinity of the nest at the time when the young might be expected to appear, to uncover the eggs frequently and cover them up again, even to regulate the heat of the mound by either adding more cover or removing some of it—a proceeding which truly ought not to be called instinct only, but classed among the proofs that these animals show an intelligence and a reasoning power little short of the human mind.

Nothing remarkable is found either among the nests of the *platform builders*, of the eagles, vultures, hawks, storks, pigeons, etc., whose nests are just what the name "platform" indicates. Nearly all birds of prey love to build upon elevated spots, and generally place their nests on the summit of some lofty cliff. These nests are very crude affairs, being chiefly composed of sticks laid inartistically together, and serving merely as a platform on which the eggs and the young may be kept from actual contact with the bare rock. To obtain such sticks the eagle drops with great vehemence from a great height on branches of trees which seem to serve his purpose; when they break, he catches them skillfully with his beak and carries them to the place where the nest is to be built. Similar constructions are those of the pigeons, whose work in nest-building is described in the old nursery rhyme:

" A few sticks across,
Without a bit of moss,
Laid in the fork of an old oak tree,
Coo—goo—roo—o—o,
She says it will do,
And there she's as happy as a bird can be."

—*The Ringdove.*

Nothing more need be said about it; it gives the complete idea of the work and the result. Other platform builders will attract our attention and interest just as little, so that we could go on to the following class of our feathered artisans, unless a few instances are worth mentioning, which show us that even apparently uninteresting things may be attractive from another point of view. Allow me to speak of the two following facts: The rook (Corvus frugilegus) is a very gregarious bird, building in numbers on the boughs of contiguous trees, and having a kind of social compact that often rises to the dignity of a law. For example, the elder rooks will not permit the younger members of the community to build their nests upon an isolated tree at a distance from the general assemblage, and if they attempt to infringe this regulation, always attack the offending nest in a body and tear it to pieces.

A singular attachment frequently takes place between the fish-hawk (Pandion haliætus) and the crow black bird (Quiscalus versicolor). The nest of the former is of very large dimensions, often from three to four feet in breadth and from four to five feet high, composed externally of large sticks, among the interstices of which sometimes three or four pairs of crow black birds will construct their nests while the hawk is sitting or hatching above.

Now, let us pay a visit in the deep, silent forest to the guild of the *carpenters*, which are represented by a most peculiar and charming class of birds, the woodpeckers (Picidæ). The sagacity of these birds in discovering, under a sound bark, the decaying limb or the hollow trunk of a tree, and their perseverance in perforating it for the purpose of incubation, are truly surprising. The male and the female alternately relieve and encourage each other by mutual caresses, renewing their labors for several days till the object is attained. On this work they are so extremely intent that they may be heard till a very late hour in the evening. So rapidly do the blows follow each other that the head of the bird seems to be vibrating on a spring, and the sound can only be described by comparison to a watchman's rattle. Chips and bark fly in every direction, and should the tree be an old one, whole heaps of bark will be discovered at its foot. Before commencing the operation for the special purpose of nest-making, the woodpeckers always find out whether the tree is sound or rotten, and they can ascertain the latter fact, even through several layers of sound wood. When they have fixed upon a site for their domicile, they go discriminately to work and speedily cut out a circular tunnel just large enough to admit their bodies. Sometimes this tunnel is tolerably straight; ordinarily it turns off in another direction. At the bottom of the hole the female bird collects the little chips of decayed wood that have been cut off during the boring process and deposits her eggs upon them without any further preparations. This process does not always go on without hindrance, for many little birds which like to build their nests in hollows, but do not care to work themselves if they can have it done by others, or which are not strong enough to scoop habitations for themselves, will often allow the woodpeckers to make a deep hole just fit for them, and then drive them off through some ruse or even mere impudence—for the woodpecker is particular and prefers to begin work over again somewhere else if at all disturbed—and take possession of the deserted residence. Another grief may visit the woodpecker, against which neither the height of the tree nor the depth of the cavity is the least security. This is the black snake (Coluber constrictor), which frequently glides up the trunk of the tree and, like a skulking savage, enters the woodpecker's peaceful apartment and devours the eggs or helpless young, and, if the place be large enough, coils himself up in the spot and remains there for several days. The eager school-boy, after hazarding his neck to reach the woodpecker's hole, at the triumphant moment when he thinks the nestlings his own, and, stripping his arm, plunges it down into the cavity and grasps what he thinks to be the callow young, starts with horror at the sight of a hideous snake, and almost drops from his giddy pinnacle, retreating down the tree with terror and precipitation.

Other carpenters are not equal to the woodpeckers, either in skill or in strength; they are, at the most, only able to widen and extend holes which are already at hand, or to work in decaying wood only. The black-capped titmouse (Parus major) digs out a shallow hole in the decayed side of an old stump in early May. Not rarely, after working for a day or more, the pair encounter a layer of hard wood in the old weather worn stump, and have to cease their efforts and seek a more suitable spot, for the conical beak has not sufficient strength to penetrate hard substances. The excavation is usually about six inches deep and widened out to accommodate the prospective family. Nearly one-half of the space is then filled with the fluffy material of the nest.

Close to the carpenters we must put the *miners* or *tunnel-builders*, because they also make holes, though not in wood, but in the ground, usually in the banks of rivers, even in hard, rock-like material. Prominent among them is the bank swallow or sand martin (Clivicola riparia). Although its little beak and slender claws would seem at first sight to be utterly inadequate for the performance of miner's work, the sand martin is as good a tunnel-driver as the mole or the rat, and can manage to dig a burrow of considerable depth in soil that would severely try the more powerful limbs of the quadruped excavators. The soil which it loves most is light sandstone, because the labor which is expended in the tunnelling is very little more than that which would be required for softer soils, and the sides of its burrow are sufficiently firm to escape the likelihood of breaking down. The depth of the tunnel is extremely variable, some tunnels being only eighteen inches or two feet deep while others run to a length of nearly five feet. In excavating its domicile the sand martin displays wonderful activity and ingenuity, and abandons itself to its work with a thorough recklessness of enjoyment. Clinging to the face of the rock, it delivers thereon a firm sharp blow with its closed beak, as if to test the quality of the material, and then nimbly runs or flutters to another spot where it repeats the same process, until it has fixed upon some suitable locality. It then fairly sets to work, and by dint of repeated blows in the same spot loosens a considerable piece of soil, which comes tumbling to the ground. The bird then cuts a circular, funnel-shaped depression by running around the circumference, and working from the centre outwards, and in wonderfully short time succeeds in forming a well-defined circular hole. Having made so much progress, it rests for a short time and then redoubles its ardor, chipping away the stone or sand with repeated blows of its bill, and cleaning the fallen material with its claws. This seems the most fatiguing part of the work, as the earth must, as soon as the tunnel gets longer, be pushed or carried a considerable distance from inside before it can be dumped over the edge. Both mates help each other in the most charming way. As a strange fact it must be mentioned that these birds are not readily satisfied with one locality, and being in no wise sparing with their labor, will often dig three or four holes before they will make a final settlement. The burrows are generally straight unless turned out of their course by some impediment, but in all cases they are slightly globular at the extremity where the nest is deposited and slope gently upwards, so that the eggs and young cannot be inundated by rain. The sand martin is very gregarious in its habits and crowds its burrows closely together, so that a cliff is often absolutely honey-combed by these persevering little diggers. It is a most bewitching sight to see them all at work together, to observe their eagerness and activity, and to watch the progress of the labor. Soon they all seem to have disappeared entirely; the knowing one only is aware that they are in their holes digging. If one should stamp upon the ground above them, they all rush forth from the tunnels, and the air seems alive with them; soon, however, they return to their work and proceed more rapidly than ever.

An interesting tunnel-builder is the burrowing owl (Strix cunicularia), which dwells, at least during the breeding season, in burrows formed in the earth either by its own labor or by that of some digging animal. In the western prairies of the United States the burrowing owl is a constant inhabitant of the villages of the marmot or prairie dog, as it is called, living on pretty good terms with the true owners. In fact, the manner in which the marmots sport about near the entrances of the burrows, while the owls move briskly among them, furnishes a most delightful and amusing spectacle.

Among this trade must be reckoned further the stormy petrel (Procellaria pelagica). It breeds among the stones and debris of rocks on our coasts, burrowing the necessary cavity for its nest in the crumbling stone and deepening it sometimes to considerable extent. The female sits so closely upon the eggs that she may be readily taken by hand; when thus treated, she vomits a quantity of oil, which is collected in many places by persons going from nest to nest teasing the bird and making her eject the oil into a pail brought for that purpose.

No less remarkable as a burrowing bird is the king fisher (Alcedo ispida), which also digs holes of three or four feet depth in the perpendicular banks of rivers. The fabulous stories related by the ancients concerning its nests are too trifling to be repeated here. Its nest is neither constructed of glue nor magic roots; it is not thrown on the surface of the water to float about, with its proprietor, at random, but snugly secured from the winds and the weather in the recesses of the earth. If we follow the entrance we notice that the cavity rises towards the rear and has a little gutter on each side in order to let the water flow black which may have adhered to the feathers of the bird. At the end of the burrow we find a spacious, oven-shaped enlargement to accommodate the nest, which is built from most remarkable material, fish bones. Here does not the question present itself to your minds—which is more admirable, the strength, perseverance and skill of these birds in burrowing during two or three weeks so far into the interior of the ground, or the precaution to arrange these gutters in order to give the incoming water an outlet?

Other continents have likewise very noteworthy specimens of tunnel-building birds. In Australia lives the diamond bird (Pardulotus punctatus), which makes a deep burrow in the face of some bank, usually on the margin of a stream, and builds its nest at the extremity of the hole. Contrary to the usual custom of burrowing birds, this one builds a most neat and elaborately constructed nest in its burrow, the marvel being increased by the evident difficulty of working in the dark.

In the next division we find skillful artists of an entirely different nature—birds which build a real nest, not by weaving or plaiting it, as a good many do, but by doing regular masonry. Let us take a look at some of our *bird-masons.* There are few persons in this country unacquainted with the barn swallow (Hirundo hordeorum). Indeed, the whole tribe is so distinguished from the rest of small birds by its sweeping rapidity of flight that the light of heaven itself, the sky, the trees, or any other common objects of nature are not better known than the swallows. We welcome their first appearance with delight as the faithful harbingers and companions of flowery spring and ruddy summer ; even the solitary Indian seems to have a particular respect for this bird and takes care to prepare a convenient nesting place for it by hanging on a neighboring tree an empty gourd in which a hole has been roughly cut. The more civilized inhabitants of farms provide for its roosting by fastening nesting boxes against the wall, and some persons even build regular cotes, of which the sociable birds soon take possession.

The nests of the different species are very variable in shape and size, some of them cup-shaped, others semiglobular, others closely resembling a common oil-flask or having the form of an inverted cone with a perpendicular section cut off on that side by which it adheres to the wall.

In every case, however, the nest is built of mud or clay, which the birds bring along in small lumps in their beaks, sometimes after having kneaded it thoroughly, and then stick in irregular rows so as to build up the sides of the little edifice. Here and there the dainty architects mix the walls with fine hairs or long thin pieces of hay, as plasterers do their mortar, to make it adhere better and to add strength to the building. There may be an attempt at smoothing the surface of the nest, but each lump is easily distinguishable upon the spot where it has been stuck. Except upon wet days, the birds work in the evening and morning only, as the heat of mid-day seems to dry the mud so rapidly that it cannot be rightly kneaded together; moreover, they must wait until the part done acquires the requisite firmness to hold the following layer. Consequently these nests obtain such a rigidity and strength that they may be used ten years and more, each year needing only to be repaired, cleaned and lined anew with feathers and other soft materials to be ready for use again. Several times it has been reported by trustworthy observers that swallows, finding their nest occupied by insolent sparrows which could not be forced to leave the territory on which they trespassed, summoned a number of companions which helped the rightful owners speedily to wall up the entrance of the nest so that the intruder was summarily and most effectively punished for his offense.

The marsh wren (Certhia palustris) is another mason, is perhaps deficient in singing, yet excells in the art of design. It constructs a nest which, in durability, warmth and convenience is scarcely inferior to any, and far superior to those of its more musical brethren. This is formed outwardly of wet rushes mixed with mud, well intertwisted, and fashioned into the form of a cocoa-nut. A small hole is left two-thirds up for entrance, the upper ledge of which projects like a pent house over the lower, to prevent the admission of rain. This nest, when hardened by the sun, resists every kind of weather, and being tied so fast in every part to the surrounding reeds, it bids defiance to the winds and the waves.

Besides these, we have some other birds doing masonry, less known perhaps, but just as skillful as those mentioned. The nest of the song thrush (Turdus musicus) is hemispherical, composed of clay and cowdung, covered externally with moss, internally plastered with rotten wood of old trees which the bird has chewed, ground to powder, mixed with his own saliva and kneaded through, then covered the nest with it and smoothed it over. This is indeed a fine work of art, but it contains another wonder, for when the walls of this nest have become humid with rain or dew, then the rotten wood begins to get phosphorescent, and thus produces all kinds of superstitious tales.

A very skillful and cunning mason is the nuthatch (Sitta europaea), which likes to nestle in holes of trees, but takes the precaution to close a portion of the external aperture of its abode with clay so as to leave only a sufficient space for its own passage. The object of this proceeding is evidently to prevent woodpeckers and other enemies from getting in, destroying the nest and taking possession of the hole. When observing this bird at its work, one cannot help thinking of it as of a little mason that, in order to close a hole in a wall, puts in one stone after another and fastens them with mortar. In the heat of summer this wall dries and gets so firm that one cannot break it with his finger, but must use a chisel. Another very curious mason bird is the variety of hornbill known as Tockus melanoleucus, Licht. The nesting habits of this hornbill are so extraordinary that they have been repeatedly referred to by various writers, but owing to the difficulty of finding the nests of the birds, many details of the earlier accounts are not quite correct, while others are not touched upon at all. Dr. Schonland, of Cape Town, has examined several nests with the birds belonging to most of them. The birds are often seen in winter in large numbers in the gardens at Graham's Town, but in the summer they are only to be met with in proximity to closely wooded kloofs, and this is due to the fact that they nest in places where hollow trees are to be found. All observers agree that during incubation the female is a prisoner in a kind of cage, the entrance to which is closed to such an extent that it has to be broken before the female can leave the nest. In all the cases he had seen the nests were built in hollow trees, sometimes between the crowded stems of the tall euphorbia. The birds have apparently no preference for any particular tree so long it suits their purpose. The essential point for them is that the hollow stem shall be sufficiently large for the female to move about in the nest, and whether there is one or more entrances, all must be of such a nature that they can be partly or wholly closed up. The female once inside, is fed by the male through the narrow slit left in the material with which the entrance is closed, or through a natural cleft in the wood. In the latter case the main entrance is closed up completely. This may be a precautionary measure to protect the female during the season of incubation. It is doubtful whether the male builds or the female; probably the female takes an essential part in the plastering up of the entrance.

The female, after going into the nest, usually begins to molt, and is found sometimes almost naked. She is usually very fat while in her prison, as the male bird brings her food every few minutes. As soon as danger approaches the female bird climbs up the nest as far as possible away from the entrance and keeps perfectly quiet until the danger has passed. The young behave in the same manner, the birds relying for protection on the fact that the nest is not easily recognized as such. No doubt, if attacked, the hornbill could give a good account of itself. The female is imprisoned for seven or eight weeks, certainly for not less than six weeks. The eggs are laid about the end of December or beginning in January, and are usually three or four in number and vary in size.

Among foreign masons, the most remarkable is the oven bird (Furnarius fuliginisus) of South America. It builds its nest always in an exposed situation, such as a naked branch, the palisades of a garden, or the windows of a house, so that a quantity of them will form landmarks of surprising character. The birds seem indeed to be convinced of the perfect safety of their nests and never take the trouble of hiding them, so that they are nearly always found in the most conspicuous places. The nest is built of earth, always in the shape of a small oven; it is hemispherical in form, six or seven inches in diameter and five or six inches high; its walls have a thickness of one or two inches. Inside we have a dividing wall, separating the interior into two partitions, in the inner of which the eggs are deposited, while in the outer the male keeps watch and defends the entrance against any intruder. Both sexes engage in its construction by bringing small pellets of clay, and working them into the edifice, and they carry on their operations so energetically that, under favorable circumstances, when the mud which they use is moist, not dried up by the heat, they complete the nest in two days. This very fact is the cause that the Brazilians consider the oven bird as sacred, because, as they maintain, it never works on a Sunday. This is very likely the case, for if he has not begun just on a Sunday, he has surely finished his work before the next one comes around.

Rather ridiculous seem the stories told about the nest-building of the flamingo, who is said to erect a conical hill of mud, to hollow out its upper part for the reception of the eggs, and then to stand erect or sit on it astride, with his feet dangling down, like a long-legged man sitting on a mile-stone. The truth is that the nest is a heap of earth and other material, not high enough to permit those long feet to dangle; the incubating bird doubles her legs under her in the usual way, so that she can sit upon the eggs conveniently, which are kept dry, out of reach of the tides.

Continuing our way through the different workshops of our winged friends, let us make another stop to observe a division which, for a long time, has furnished material for the most incredible stories about birds and their life. We refer to the guild of the *cement-manufacturers*, which comprises foreign birds only, and particularly the esculent swallow (Collocallia esculente). Their nests, which are built in fissures and caverns of rock, are the celebrated edible birds' nests, so highly prized by the Chinese for the preparation of soups and sauces, and also introduced into this country to be used as extraordinary delicacies. They are composed almost entirely of saliva, which in many other cases assists materially in binding together the materials of which nests are composed. In the genus collocallia the salivary glands reach an enormous development, and swell even more at the time of nidification. They secrete a thick, glutinous matter, like mucilage, which can be drawn out in threads, and which hardens to a transparent, whitish mass in the open air. If the birds want to begin their nests, they fly repeatedly against the chosen spot on a perpendicular rock, and press the saliva against the stone with the tip of their tongues. This they do perhaps twenty or thirty times in rapid succession, whithout going far away, which proves that they do not bring any material from outside, but have it in abundance with them. Thus they build first a semi-circular or horse-shoe shaped structure, the real foundation for the whole nest, which one species, collocallia nidifica, builds of its saliva only, while another one, collocallia fuciphaga, makes use of sea-weeds cast upon the shore by the waves, also glued together by their saliva. The nest of the former consists of a dry, whitish, transparent substance, which is distinctly cross-striped. These stripes run in wave-lines, more or less parallel to each other, and indicate the layers which were put on one at a time. The specimens under the microscope give no evidence of any distinct vegetable structure, nor of any distinctly vegetable product as cellulose. All the relations go to prove that the great mass of the substance was mucine, and such microscopic features as are apparent confirm the view that the nest is formed of strings of mucus plastered together. The mucus, when separated, gives some reactions, different, to a certain extent, from those which are given by ordinary mucine; but these differences are not great enough to weaken the conclusion that the nests are really composed of mucus secreted by the peculiar glands of the bird. In most cases they can scarcely be recognized as nests, since they look more like corals or sponges, and are, in the opinion of many, not appetizing. The island of Java seems to be peculiarly adapted for the dwelling-place of these birds, which congregate in large flocks in caverns and fissures of the rocks, and build their nests upon the walls of these. The collection of the nests is managed by the government, which has laid down special regulations for this singular harvest. It takes place at three periods in the year, the principal one being gathered in the month of October, after the birds have been left undisturbed for about six months; the other two gatherings are in December and March, which furnish nests of superior quality, clean and white, and free from any extraneous matter, while during the longer interval of six months the quantity of nests becomes much larger, but the quality is not so good, as the nests are older. The number of nests collected in Java is very great, and the total value of the nests imported into China is said to be $1,500,000. This value increases, moreover, to a very considerable extent as the delicacies are conveyed away from the port of entry and from the coast, so that one pound may bring about $50 in any inland town of China.

Another most remarkable cement manufacturer is the klecho (Dendrochelidon longiplunis), which builds its nest always alongside of a horizontal branch which, at the same time, forms the hind wall of it. It is a rather shallow, very small cup, just big enough to receive the one egg of the bird. The walls of the nest are extremely thin, scarcely thicker than paper, and consist of feathers, lichens and small pieces of bark glued together, as in the case of the salangans, with the saliva of the bird. The smallness and frailty of the nest does not permit the rather large and heavy bird to sit on it, she must, consequently, take her seat on the branch and cover the egg with her breast only. As soon as the young is hatched, it grows so rapidly that it fills the available space completely and soon finds no more room in these narrow quarters; it therefore leaves the nest and occupies the same position as the mother before, *i. e.*, on the branch, resting with its breast only on the nest.

Still another swallow, the dwarf swallow of India (Micropus parvus), glues its nest, made of cotton fibres, to the leaves of certain palm trees; but as the swinging motion of the leaf during any storm would cause the eggs or the young to be thrown out, it very wisely glues the eggs, as well as the young, to the nest with its saliva, and thus prevents completely the accident which otherwise might happen whenever the breezes shake the branches.

As the last of this tribe I would mention the true swift (Pauyptila Sancti-Hieronynis) in Guatemala, whose nest is composed entirely of the seeds of a plant, secured together and hung from the under surface of an over-hanging rock, by the saliva of the bird. The whole forms a tube two feet long by six inches in diameter. The entrance is through the lower end of the tube, and the eggs are placed on a kind of a shelf at the top. About the middle of the tube, on the external side, is a protruding eave, as if over an entrance, but there is no hole, and it has the appearance as if it was placed there in order to deceive some enemy, such as a snake or a lizard, to the attacks of which the parent bird or its nest would, during the time of incubation, be more exposed.

In the guild of the *basket-plaiters* we find not only, as in the previous divisions, untiring and, in proportion to their little strength and their imperfect tools, admirable workmen, but excellent artists. In the melodious world of our singing birds we meet the best and most numerous representatives of the basket-plaiters, weavers and felt-makers, and they must really be reckoned among the most distinguished artists. It ought to be said right here that it is often rather hard to place a bird in the proper department, as in more than one case the little artist combines in his edifice the work of two or more trades, but usually one feature is eminent and decisive.

Let us begin with a look at the simplest baskets, made by the crows, ravens, magpies, and others. They are twisted of dry twigs and stalks, and have in the centre a nice bunch of hair, wool, feathers and other soft material. They do not show any special skill, but are twisted firmly and durably, and fill their purpose to a nicety. On a higher level are the basket-shaped nests of the different finches, which are carefully built in the forks of some bushes or trees, and must be considered as very neat and even elegant structures, composed of moss, grass, fine roots and twigs, often intermixed with other suitable materials, adorned externally with fragments of lichens, and lined with wool, hair and feathers. The twigs with which the outward parts of the nests are constructed are short and crooked, so that they may the better hook in with one another, and the hole or entance is so contracted to prevent the intrusion of enemies that it appears almost impossible for the bird itself to enter.

High above these basket-plaiters rank some foreign birds, above all, the weaver birds. They do not belong to the weavers, however, as their name might indicate, but to this group, for their nests show all the peculiarities of the other basket-plaiters. Their work is truly wonderful, surpassing all the other curious examples of bird architecture. Although we find in them a great variety in shape, form and material, there is yet a nameless something in the construction of these edifices which at once points them out as the workmanship of the weaver birds. Some of them are huge and massive, clustered together in vast multitudes, like regular tenement houses, and bearing down the branches with their weight. Others are light, delicate and airy, so thin that the breezes may pass through their net-like walls, the whole hanging daintily from the extremity of some slender twig. Others, again, are so firmly built of flattened reeds and grass-blades that they can be detached from their branches and subjected to very rough handling without losing their shape, while others are so curiously formed of stiff grass-stalks that their exterior bristles with sharp points, like the body of a hedge-hog.

Let us inspect some of these more closely. There is, first, the sociable weaver bird, or republican grosbeak (Ploceus socius). He will not use the same nest in the following season, but builds a new house, which he fastens to the under side of his previous residence. As, moreover, the number of the nests is increased year by year, the weaver birds are forced to enlarge their thatched coverings to a proportionate extent, and in course of years they heap so enormous a quantity of grass upon the branches that it fairly gives way with the weight, and they are forced to build another habitation. The object of this remarkable sociable quality in the bird is somewhat obscure. As in many instances the nests of the weaver birds are evidently constructed for the purpose of guarding them from the attacks of snakes and monkeys, it is not improbable that the sociable weaver birds may find in mutual association a safegard against their adversaries, who do not care to face the united attacks of so many bold, though diminutive antagonists. Monkeys sometimes form chains down from overhanging branches, to get at the nests and their toothsome living contents. It is reported that in one such case the bird flew to the first monkey, who held all the others, pinched him at the tail, so that he let go, and all the monkeys dropped into the water flowing underneath.

More artistic still is the nest of the Philippine weaver bird (Ploceus philippium), which suspends its domicile by a cord of considerable length from the branch of a tree, so as to be inaccessible to snakes and monkeys. The nest is said to contain a chamber for the male and another for the female, the former being situated close to the opening at the bottom of the nest, through which the birds obtain admission to their snug apartments; here the male stations himself to watch over the safety of his family, and the natives believe that he attaches to the wall of his chamber a patch of soft clay, to which he fastens a fire-fly to serve as a night-light.

The baya of India (Ploceus Baya) which is very nearly allied to the Philippine species, twists thorns with their points directed to the outside in the walls of its nest, so that no enemy, not even a snake, can come near it, and the old as well as the young are perfectly safe in this elegant home. It consists only of a single chamber, the opening of which is at one side, access to it being obtained by means of a cylindrical passage hanging down from the bottom of the nest. The whole structure is so durable and firm that the natives believe whoever can take such a nest apart without breaking one of the composing twigs will find a golden ball in the interior.

Among the group of basket-plaiters must be counted another family of birds whose wonderful structures have aroused astonishment not only among travellers in foreign lands, who saw these laborers at work and inspected their marvelous buildings, but also among such as heard their reports and saw the nests of those birds on exhibition in museums. This is the group of the bower-birds (Ptilonorhynchus holosericeus), which have received their name from the peculiar structures which they build apparently for the purpose of pleasure as sporting places, where the males meet to pay their court to the females, and which are constructed with such wonderful skill and taste that we are forced to recognize the intellect manifested by them as inferior to that of man only in degree and not in kind. These bowers are usually placed under the shelter of the branches of some tree in the most retired part of the forest; they differ considerably in size, some being larger, others much smaller. The base consists of an exterior and rather convex platform of sticks, firmly interwined, on the centre of which the bower itself is built. This is also formed of sticks and twigs, but of a more slender and flexible description, the tips of the twigs being so arranged as to curve inwards and nearly meet at the top, thus forming an arbor-like gallery of uncertain length in which the birds amuse themselves. They pursue each other through it; they strike attitudes to each other, the males setting their feathers in the most grotesque manner, and making as many bows as a cavalier in a minuet. The architecture of the bower is exceedingly tasteful, and the interest in it must decidedly be enhanced by the fact that it is artistically decorated at and near the entrance with the most gaily colored articles that can be collected, such as bright bird-feathers, shining stones, shells, bones, flowers which the birds bring from long distances in the bush for this purpose, and which they even arrange anew from day to day, sticking them in among the twigs or strewing them around before the bower. Indeed, the æsthetic tastes of our "gardener-birds" are not restricted to the construction of a bower. Their fondness for flowers and for gardens is still more remarkable. Directly in front of the entrance to their bower is a level place, a real miniature meadow of soft moss, transported thither, kept smooth and clean, and free from grass, weeds, stones, and other objects not in harmony with its design. Upon this graceful green carpet are scattered flowers and fruit of different colors, in such a manner that they really present the appearance of an elegant little garden, so that this group of birds may be taken as the representatives of a particular trade, that of *land-*

scape-gardeners, an entirely proper addition to the list of trades or guilds mentioned in the beginning of this lecture. The variety of the objects thus collected is very great, and they are always of brilliant colors; and these ornaments are selected not only from among flowers and fruit, but showy fungi and elegantly-colored insects are also distributed about the garden and within the galleries of the bower. When these objects have been exposed so long as to lose their freshness, they are taken from the premises, thrown away, and replaced by others. So persevering are these birds in carrying off anything that may strike their fancy that they have been known to steal a stone tomahawk, pieces of cloth, a tobacco-pipe, silver money pieces, etc.; and the natives are so well aware of their habit of taking anything that they can fly away with, that on missing any small article they seek it at the nearest bower, usually with success.

Among the *weavers* we find not only the most artistic nest-builders of the feathered world but also the most eminent artists of the entire animal kingdom. Scientists of all nations and lovers of nature generally speak with enthusiasm of the work of these wonderful little builders, and often do not find words of praise sufficient to express their admiration and astonishment. The nest of the penduline titmouse (Parus pendulinus) is surely the most wonderful example of bird architecture we know of. No other structure surpasses it in beauty of design, in elegance of construction, in comfort of arrangement, in safety of situation. It is woven, twisted and felted in a really inexplicable way, so that nobody is able to say where one part of the work ceases and the other begins or how this little artist has ever managed to produce such a remarkable result. It is always hung up on the extreme end of a thin, slender twig which reaches out over the surface of some lake or pond, so that "when the wind blows the cradle rocks."

The bird begins its work by winding some wool or hemp several times around the twig and then tying to that a few pieces of long stalks which, hanging down, serve as a frame-work for the whole building, for between them particles of moss, flakes of wool from the reeds, willows, poplars and thistles, and a good many other things hard to recognize and still harder to describe, are woven in and connected with each other, until the nest assumes the shape of a bag, a long knitted purse or a hanging stocking, with a little tube sideways, as the entrance, near the top. Sometimes the nest contains two openings, and people say that one of them is used to accommodate the rather long tail of the little bird. It is very easy to see that this marvelous structure has attracted the attention of men in a marked degree, and we ought not to wonder that all kind of superstitious beliefs go with it. In Italy these nests are considered absolutely sure protection against lightning and hail, when hung over the house door ; in Russia and Poland people boil them in water, and consider this soup a splendid remedy for intermittent fever and rheumatism ; in other countries people are more practical ; they use these nests as stockings and praise their fine qualities, their softness, flexibility and warmth.

Another no less magnificent nest is built by the long-tailed titmouse (Parus caudatus), which differs, however, from that of the former by the circumstance that it is never hung up freely, but always supported in the fork of some branch, or in the twigs of a thick bush. It is also a very neat and comfortable structure, composed of moss and wool, grass, spider-webs and soft bark, thickly lined with soft feathers, and adorned externally with fragments of white lichens.

It has an oval form, snugly domed over at the top, and a single opening rather high up on one side. Under all circumstances the building birds choose, as an external cover, moss and lichens of the same tree on which the nest is built, and arrange them in exactly the same manner as they are on the bark of the tree. Consequently, it looks so exactly like its surroundings that it is hard to find ; but if one has found it, he cannot but admire the elegant appearance of this residence, and we need not wonder that it has inspired even poets to sing its praise. In a little nursery-rhyme book I found the following lines which I beg to read to you, trusting that you will find them just as charming as some of my friends to whom I showed them :

NEST OF THE LONG-TAILED TITMOUSE.

There, where those boughs of blackthorn cross,
Behold that oval ball of moss ;
Observe it near, all knit together,
Moss, willow-down, and many a feather,
And filled within, as you may see,
As full of feathers as can be ;
Whence it is called by country folk
A fitting name, the feather-poke ;
But learned people, I have heard,
Parus caudatus call the bird.
Yes, here's a nest ! a nest indeed,
That doth all other nests exceed,
Propped with the blackthorn twigs beneath,
And festooned with a woodbine wreath !
Look at it close, all knit together,
Moss, willow-down, and many a feather ;
So soft, so light, so wrought with grace,
So suited to this green-wood place,
And spangled o'er, as with intent,
Of giving fitting ornament,
With silvery flakes of lichen bright,
That shine like opals, dazzling white.
Think only of the creature small,
That wrought this soft and silvery ball,

Without a tool to aid her skill,
Naught but her little feet and bill—
Without a pattern whence to trace
This little roofed-in dwelling place—
And does not in your bosom spring
Love for this skillful little thing?
See, there's a window in the wall;
Peep in, the house is not so small,
But snug and cosy you shall see
A very numerous family!
Now count them: one, two, three, four, five—
Nay, sixteen merry things alive—
Sixteen young, chirping things all sit,
Where you, your wee hand could not get!
I'm glad you've seen it, for you never
Saw aught before so soft and clever.

Some of these weavers have been observed when actually at work, and the information gained in this way is doubtless very interesting and valuable. Thus a noted scientist describes the work of the spotted fly-catcher (Muscicapa maculata) when building her nest, in these words: "First she arranged a rather large bundle of fine dry grass in the thick fork of some branches, and having pecked it about for some little time, as if to shake it up regularly, she sat in the middle of it, and by a rapid movement of her wings spun round and round like a top, so as to produce a shallow, cup-like hollow. She then fetched some more grasses, and after arranging them partly around the edge and partly on the bottom, repeated the spinning process. A few hairs and some moss were then stuck about the nest and woven in very neatly, the hairs and some slender vegetable fibres being the threads, so to speak, with which the moss was fastened to the nest. In working out the long hairs and grasses she generally moved backwards, laying them with her bill, and continually walking round the nest. In one instance the bird began at seven o'clock on a Tuesday morning and the nest was finished in good time on Friday afternoon."

The nest of the Baltimore oriole (Icterus galbula) is also a very elegant structure, generally of a thicker and tougher substance, and more ingeniously woven. It has the form of a cylinder, six to eight inches in length, rounded at the bottom. The materials are flax, hemp, tow, hair and wool, woven into a complete cloth, the whole tightly sewed through and through with long horse-hairs, several of which measured two feet in length. The female bird seems to be the chief architect, receiving a constant supply of materials from her mate, and occasionally rejecting the fibres or hairs which he may bring, and sending him off for another load better to her taste. So solicitous is the Baltimore oriole to procure proper materials for his nest that, in the season of building, the people in the country are under the necessity of carefully watching their threads that may be out bleaching or lying around, knowing that the oriole is ever ready to pounce upon such valuable material, and straightway to weave it into his nest. Pieces of loose string, skeins of silk, or even the bands with which young grafts are tied, are equally sought by this ingenious bird, and often purloined, to the discomfiture of the needle-woman or the gardener.

Somewhat differently from their name-sake do the orchard orioles (Icterus spurius) build their sumptuous residences.

They usually suspend their nest from the twigs of the apple tree; often from the extremities of the outward branches. It is a really magnificent structure, woven into a hammock or bag-like shape from long grasses and so firmly constructed that it will stand no small amount of rough treatment before its texture gives way. It is formed exteriorly of a particular species of long, tough and flexible grass, knit or woven in a thousand directions, partly passing over the branch to which the nest is hung, then carried down to the very bottom of the bag, so as to support the structure in the firmest possible manner. Nilson once detached one of those fibres and found it thirteen inches long, and in that distance thirty-four times hooked through and returned, winding round and round the nest. No wonder that a lady to whom he exhibited this edifice remarked that the orchard orioles might learn to darn stockings. The size and form of the nest may vary greatly, according to the climate in which the bird lives, and the kind of tree on which its home is placed. Should the nest be suspended to the firm, stiff boughs of any strong-branched tree, it is comparatively shallow; but if it is hung to the long and slender twigs of the weeping willow, the nest is made much deeper and of slighter texture. These long pendent branches have a large sweep in the wind and make this variation necessary, in order to prevent the eggs or young from being thrown out of their home by the swaying of the boughs in the wind. Male and female build the nest together. One comes flying with a long thread or stalk in its bill and holds firmly on the branch, perhaps gluing it on by means of some saliva, while the other grasps the hanging end of the thread and flies around both parts of the fork with it several times, thus making a foundation, a kind of a hammock, deeper or more shallow, between the two prongs of the fork and then weaves in more material, stalks, feathers, wool and so on, which the female arranges in very skillful manner, so as to give the whole structure depth, roundness and finish.

Allow me to point out to you only one or two more examples of woven nests which necessarily attract the interest of any attentive observer on account of their strange shape. One of them is the nest of the blue gnit-gnit (Caereba cyanea).

It is of the pendent order, being neatly woven upon the extremity of some slender twig which sways to and fro even with the trifling weight of the mother and her tiny brood, and will in no wise bear the heavy bodies of the various snakes and lizards that abound among the branches of the tree, and keep up a relentless persecution of young nestlings and eggs. The shape of the nest is not unlike that of a large chemist's retort, the lower extremity being produced into a large tube with the mouth below, and the eggs placed in a large rounded portion of the nest. No predaceous reptile could venture into so formidable a stronghold, and any noxious insect that might make its way through the tunnel would soon be snapped up by the watchful parent.

Very peculiar also is the nest of the white-shafted fly-catcher (Rhipidura albiscapa), notable for a long and apparently useless tail that hangs far below the branch to which it is attached, and which, owing to its narrow dimensions and slight weight, can be of no service in preserving the balance of the structure. It has been offered as a suggestion that this singular form may have reference to the electrical conditions of the atmosphere, and serve as a conductor, whereby the superabundant electricity is carried off, and conveyed harmlessly to the ground.

Let us again wander into an orchard or a little grove to look at one of the most common and yet most admirable works of art in nature. We are already close by it, and yet our inexperienced eyes do not perceive it, the nest of the chaffinch (Fringilla coelebs), one of the nicest and neatest of all the nests of our singing birds, the first one which represents the guild of the *felt manufacturers.* It is always located in the fork of some bush or tree, deep cup-shaped, composed of moss, hair, wool and lichens, the latter, however, spread abundantly over the outer surface, so that it is rather difficult to recognize it, as those lichens, taken from the same tree, make the whole look exactly like some bough. They are, moreover, connected with the other component parts through spider-webs, caterpillar silk, etc., and the whole worked up to a very dense and uniform felt-like mass, which fulfills its purpose, sheltering the eggs and protecting the young splendidly.

A similar, not much less elegant, structure is the nest of the goldfinch (Carduelis elegans); but as the real and genuine felt manufacturers we must consider the humming bird (Trochilidae), which, masterpieces themselves of nature, as to beauty and magnificence of color, build also works of art which claim the highest admiration of every observer. Their tiny nests are generally fixed on the upper side of a horizontal branch, not among the twigs, but on the body of the branch itself. They are composed, in most cases, externally of fragments of bluish, gray and green lichens, glued on with a sort of saliva and tied with fine fibres, tender roots or cobwebs; inside of these layers, which protect this building against any atmospheric humidity, we find thick layers of the wings of certain seeds; the whole is lined with the fine down of the mullein and of the stalks of ferns. The base of the nest is continued around the branch, so that when viewed from below it appears to be a mere mossy knob or protuberance. In some cases the rim is slightly bent inward in order to prevent the eggs or the young from being hurled out from the "procreant cradle" by tempestuous winds. The most remarkable nests, in this regard, is surely that of the sun humming bird (Phaëtornis eurynome), which uses a certain lichen only. The latter adds a very fine look to the nest, but when the breeding goes on the lichen develops a special coloring substance and covers the nest as well as the eggs with a magnificent red. Another peculiarity is worthy of a passing notice. Mr. R. Hill, who had paid close attention to the nests of humming birds, has ingeniously hit upon a connection between their structure and the electrical condition of the atmosphere. The injurious effect of a sudden increase of electricity is very strongly marked upon the young of all animals, the hurtful influence being in proportion to the growth of the victim. Eggs are peculiarly susceptible to the influence of electricity, and are, even when the embryo is partially matured, often killed by a passing thunderstorm. In climates where thunderstorms are frequent and violent, it is needful that the eggs should be protected from the deadly influence, and we accordingly find that the nests are oval or rounded in shape, and made of substances which are bad conductors to electricity.

Of other birds whose structures must be classed among those of this group let me name the pinc-pinc, the copocier, and the schapu. The nest of the pinc-pinc (Drymoica textrix) is of considerable dimensions, being often more than a foot in circumference, and of a most singular shape and structure. The materials of which it is composed are vegetable fibres, beaten, twisted and woven into a fine felt-like substance, and strongly fastened to the branches among which it is situated. It is of a rough, gourd-like shape, and always entered by means of a neck or spout, so that the bird is able, from the interior, to present its sharply pointed bill to any assailant, and to prevent its entrance. Near the mouth of the nest there are generally one or two projections, which serve as perches for the bird to rest upon before it enters the nest, and may probably be used by the male as a seat whereon to recline while his mate is sitting upon the eggs within. The color of the nest varies according to the substance of which it is composed, sometimes being of a snowy whiteness, and at other times of a dingy brown.

Another species of the same genus, the copocier, builds a nest which, although of coarser texture, is quite as beautiful, a very large edifice in proportion to the dimensions of the architect. Cottony down, flaxen fibres and fine moss are felted together in so skillful a way as to excite our sincere delight. A pair of copociers, being watched during their hard work, were occupied for a whole week in their task. One of these nests will sometimes reach nine inches in height.

The schapu, crested oriole (Cassicus cristatus), in South America, fixes its wonderful nest on very high trees. It has the form of a very long, slender bag, round at the bottom, often four or five feet long, hung on a thin twig, where there is also the entrance. The shape and the flexible material of the nest leave it entirely to the mercy of the wind, swaying it if even the softest zephyr blows. The bird weaves and felts this nest of tillandsia threads and other similar material so artistically and firmly that one can hardly tear it. Often two nests, with one common entrance, are built side by side; the annex then serves as a dormitory for the male.

From the felt manufacturers we come to the *dome-builders*, called so on account of the peculiar shape of their nests, which are always covered from above by means of a cupola-shaped dome. Examples are the nest of the common wren (Troglodytes vulgaris), the gold crest (Regelus cristatus), etc. The nest of the former is rather large in comparison with the size of the architect; it is usually oval in its form, with a dome-like roof, and with a small entrance either at the end or at the side. It nearly always contains green moss, besides many different kinds of material, wood, grass, leaves, little soft twigs, so that these birds might just as well be counted among the weavers or felt-makers, unless we place them in a special group on account of the peculiar shape of their buildings. Usually the outer wall consists of dry leaves, plant stalks, and tender twigs, then follows a very closely and firmly woven layer of moss and, as the innermost lining, a mat of all kinds of feathers, which lies smoothly and gives the whole inner chamber a very elegant appearance. Especially, if the nest does not stand in a hole, it is entirely built of green moss so densely felted together that it looks as if glued and perfectly smooth. The form of such a nest comes very near a perfect sphere. The roof over the entrance is constructed with particular care, very neat looking and almost waterproof, so that the whole nest appears exactly like a country mansion with a side entrance. It is a singular fact that the bird will often build several nests in one season—not that it needs so many separate dwellings, or that it finishes them when built, but it builds as if for the very pleasure of the work, or for the sake of possessing more than one house—a feathered real estate owner.

Among the dome-builders we must also count the magpie (Pica caudata), although its nest does not offer any peculiarities or any great skill. It is composed of thorny sticks, strongly interlaced, plastered with mud on the inside, and lined with grass and root fibres. The whole structure is then provided with a big hood of thorns and dry twigs, perhaps not so solid that one could not see through, but protecting the bird completely from attacks by birds of prey.

A nest not unlike that of the magpie, built by another foreign bird, the pomatorhynchus, would not deserve our special notice were it not for a rather peculiar circumstance connected with it which adds another proof to the well established fact that "just the unexpected often happens."

The blue-faced honey-eater (Meliphaga cyanops) is in the habit of taking possession of the deserted nests of the pomatorhynchus, and of saving itself the trouble of building, by making a small depression in the domed roof of the deserted domicile and therein laying its eggs. It might be expected that the bird would prefer to avail itself of the protection offered by the peculiar form of the usurped nest and take possession of its interior. Such, however, is not the case; the eggs of the intruder are always placed on the roof.

Only one more kind of birds which belong here may be presented to complete the description of the work of our dome-builders. This is the shadow bird (Scopus umbretta), a relative of the storks. Its nest is of enormous dimensions, most artistically composed of clay and small twigs. The structure reaches sometimes the dimensions of six feet in diameter, has a cupola, and is found usually in the lower forks of mimosa trees. The interior contains three completely separated rooms: an ante-chamber, a parlor, and behind these the sleeping room, a little higher than the others, so that no water can reach it. All the rooms are just as nicely finished as the exterior, and their entrances just big enough to allow the bird to crawl through. The bed or sleeping room is the most spacious; in it both mates sit on the eggs alternately; the parlor serves also as a pantry and store-room. In the ante-chamber the guard takes his post, always on the lookout for danger, and ready to eject any one intruding into the sacred inner chambers of their home.

Of the *tailors*, the last group of bird-workers which I present to you to-night, scarcely one is of any special importance to us, as they nearly all live in foreign countries; yet their way of nidification is considered by many as the most surprising sample of bird architecture. The master of them all is the tailor-bird of Hindostan (Orthotomus longicauda). This little animal, which does not even reach the size of a common wren, is a most skillful artist. Selecting a suitable green leaf, the ingenious little architect proceeds to draw the edges together by means of its bill and feet, then piercing holes through the edges brought near each other, it secures them in their place by means of threads of cotton, at the ends of which it even leaves small bunches or knots to prevent their drawing through. Sometimes the bird picks up a fallen leaf and, applying it to one still growing on the tree, sews the edges together in the same way, and thus prepares a hanging cradle for its nest. The cavity is filled up with a mass of cotton, flax and other vegetable fibres, mixed with a little hair, and in this comfortable pouch the eggs are deposited.

Equally admirable appears the performance of the fantail warbler (Salicaria cisticola), whose cradle in which it rears its young is most ingeniously constructed from the living reeds among which the bird loves to make its residence. Being so minute a creature, it cannot make use of the thick and sturdy stems, but employs the flat leaf-blades and the smaller grasses in its architectural designs. Each leaf is pierced by the bill, drawn closely to another blade, and secured to it by means of a cottony thread, which is passed through the perforation and secured at each stitch by a knot so elaborately tied that "it appears the work of reason." Thus the leaves surrounding the nest are sewn together and the walls of its domicile strengthened and fastened so that it will resist the most violent storms which may shake the reeds round about. If even it should be damaged, the male is always ready to make repairs wherever it finds them necessary, so that, according to careful observers, some nests have grown three times as big during the hatching season as they were at the beginning of it.

With the remarks on this guild I have reached the end of my paper. I should be happy to feel that I have succeeded in showing to you that it is really worth while to look for a moment at the wonderful structures which have passed before your eyes, that it pays to study this side of bird life a little more closely, and to find out all the charming features connected with it. Indeed, can there be anything more delightful in life than to go out, especially at this season of the year, when the snow begins to melt away, when mother earth awakens to new life, when all the buds and flowers begin to sprout and to deck themselves with rich variegated colors, to go out then into garden and field, into forest and meadow, to watch the birds and their beautiful mode of life, to listen to their songs, to see how they enjoy their existence and (that which brings them nearest to us human beings) how they make homes of their own?

Officers were elected for the ensuing year as follows: Chairman, Edward Burgess; Secretary, Frederick S. Arnold; Curator, Charles N. Arnold; Librarian, Charles N. Arnold.

NOVEMBER 27, 1894—FIRST REGULAR MEETING.

Chairman Burgess presided, and about one hundred and twenty members and guests were present. Dr. Charles B. Warring gave an address upon "The Tides and their Reflex Action on the Moon's Position," illustrating it with crayon drawings.

DECEMBER 11, 1894—SECOND REGULAR MEETING.

Chairman Burgess presided, and eighty members and guests were present. Prof. W. B. Dwight gave an interesting talk on "How a Great Dictionary is Made," describing specially the making of the Standard Dictionary, of whose staff he was a member.

The resignation of Mr. F. S. Arnold as Secretary was presented and accepted, and Prof. F. M. Barber was elected to that office.

JANUARY 15, 1895—THIRD REGULAR MEETING.

Chairman Burgess presided, and seventy members and guests were present. Mr. Edward Elsworth presented a paper on "The Compromises of the Constitution."

JANUARY 29, 1895—FOURTH REGULAR MEETING.

Prof. Barber presiding, and seventy members and guests present. Prof. Edward Burgess read a paper entitled "Some Thoughts on Economic Subjects."

FEBRUARY 12, 1895—FIFTH REGULAR MEETING.

Chairman Burgess presided, and about fifty members and guests were present. Mr. Edmund Platt read a paper on "Canals."

FEBRUARY 26, 1895—SIXTH REGULAR MEETING.

Chairman Burgess presided, and twenty-five members and guests were present. Prof. Barber read a paper on "The Past and Present of Photography."

Dr. Selwyn A. Russell and Dr. George T. Howland were elected members.

MARCH 12, 1895—SEVENTH REGULAR MEETING.

Chairman Burgess presided, and eighty members and guests were present. Dr. D. B. Ward presented a paper on "Bacteria," illustrating it with microscopic slides. The paper was as follows:

BACTERIA.

BY D. B. WARD, M.D.

Although bacteriology, as a science, is only twenty years old or less, the bacteria have been known to scientific men for more than 200 years.

Van Leenwenhoeck, "the father of microscopy," during the 17th century made a great number of powerful little lenses, and with these simple microscopes he made many interesting discoveries.

He saw, in 1685, a number of very small rod-like bodies swimming about in stagnant water, and afterwards found that similar bodies existed in tartar from the teeth and in the dejections of diarrhœa. They moved, hence, according to the logic of that time, they must be animals, for the motion of plants, so frequently observed since, was then unknown. In 1838 Ehrenberg, the great naturalist and microscopist, who, perhaps of all men before or since, possessed the greatest mania for scientific arrangement and classification, could not let these bodies, small though they are, escape him. He had a fashion of putting on good old Greek and Latin names to everything he could find, and he was not always careful to ascertain whether any one else had named the object before. Indeed he sometimes renamed minute objects, having forgotten that he himself originally described them. These minute organisms are so small that they tax the powers of the best microscopes and the best eyes of to-day, and they must have looked very small and very faint under the instruments of that time.

Nevertheless Ehrenberg made a classification of four genera, which he called bacterium, vibrio, spirillum and spirochaete respectively, according to the shape of the rods, whether flexible or inflexible, curved or straight. The name bacterium, or its plural, bacteria, is now applied to the whole class. They are undoubtedly plants, and are closely allied to the fungi and algæ.

I think, in view of their prodigious importance in the economy of nature, that they should be put into a separate class by themselves and not incorporated with any other. It may be said of all of them that their mission is destruction. They are the active cause of all decomposition of dead animal and vegetable tissues. They attack these substances and resolve them into their simpler elements, or rather proximate principles, so that these principles are free to enter into new combinations. You see, then, that what at first might appear to be a mischievous and malevolent action is really absolutely necessary to the maintainance of life upon this earth. Let us suppose that every plant and every animal remained unconsumed when dead. It would not be very long before all the available material of which plants and animals are made would be used up entirely and then all life would cease. I think we are too apt to overlook this beneficent function of the bacteria and to magnify the mischief done by a few disreputable microbes which have departed from their original functions and now prey upon our unhappy race. Then there is a group of bacteria which is quietly at work in the soil. They are called the *nitrifying* bacteria because, as a result of their work, the nitrogen is presented to the roots of plants in a form which they can assimilate. Without them no plant life, hence *no* life. So you see we owe our very existence to this humble class of almost invisible plants.

We can divide all the bacteria into two great groups: First, those which live on dead matter only, and which we call saprophytes, and, second, those which attack living organisms and which are called parasites. These latter are the cause of disease.

If we take a little of any infusion of animal or vegetable substances—beef tea, for instance—and expose this clear liquid to the air, we find in a day or two that it has become cloudy and will begin to give out a disagreeable odor. Now, if we look at the liquid under a high power microscope we will find it swarming with very minute organisms—some round, like dots or periods in a book, others are rods of varying length and thickness, which are straight, and still others are curved, some kinds forming spirals. Many of them are quiet and others are in rapid motion. These are the bacteria, and we call the dot-like form a micrococcus, the straight rod a bacillus and the curved rod a spirillum. This classification is not a scientific one, but is the most convenient for our purpose. The micrococci are further divided into several groups: when in pairs we call them diplococci; when in rows, like beads on a string, streptococci; and when in little clusters, like bunches of grapes, staphylococci. Then there is the tetracoccus in groups of four, and the sarcina in cubical bundles of multiples of four. The organism which causes pneumonia is a diplococcus and it can always be found in the sputum of patients suffering from that disease. This diplococcus is found almost constantly in the saliva of healthy persons, so that it may be said that we carry about with us in our mouths the elements of our own destruction. It is only, however, when the system becomes depressed from some cause that the micro-organism starts its growth, and the disease develops. The sarcinæ are found sometimes in large numbers in the fermenting contents of the stomach in cases of chronic dyspepsia and in cancer of the stomach. The bacilli, as I mentioned, are straight rods of varying length and thickness, some so short that they are apt to be confounded with the previous group. The majority of the spirilla are simply curved rods, which sometimes are joined end to end, forming undulatory lines. In some instances they are arranged like a corkscrew and form spirals. A very large one of this sort is found frequently in sewers and ditches. The bacteria are propagated in two ways: first, by fission, or simply spliting apart; hence they are known sometimes as the fission fungi. When a bacillus, for example, attains the maximum length of the species to which it belongs, it breaks in two in the middle and becomes two bacilli. Some species have a tendency to grow very long before the separation occurs, when it breaks up into many individual bacilli. One species growing in that way—the bacillus subtilis—is very common in the city water at present. This reproduction by fission is exceedingly rapid and we can readily see how, under favorable circumstances, an enormous number of organisms may be developed. Prudden says that an eminent biologist has calculated that if the proper conditions could be maintained the progeny of a single organism 1.1000 of an inch in length would in five days fill all the oceans of the earth to the depth of one mile.

The other mode of reproduction is by the formation of spores. The spores appear in some part of the organism, sometimes in the middle, sometimes at the ends. The organism which causes that horrible disease tetanus, or lockjaw, has a spore at one end so that the bacillus looks like a nail or pin with round head. As in all the lowly organisms which produce spores—the fungi, algæ, etc. —these spores are much more resistant to unfavorable conditions than are the mature plants. They will stand a higher temperature and will not die if dried, but remain ready to spring into life and activity under more favorable conditions of temperature and moisture. As these organisms are omnipresent—in the air, in the water —everywhere, and as some of them are the particular enemies of our race, a great deal of serious and intelligent thought has been given of late to the subjects of fumigation and disinfection. This is too large a subject to deal with in this paper and I shall therefore omit it.

Sprinkling a little camphor or chloride of lime about the corners of a sick room may have a good moral effect on patient and attendants, but would only make an intelligent microbe with a sense of humor smile derisively. In order to study these organisms and find out the manner of their growth, their various properties, whether pathogenic or not, and to determine their species, it is necessary to cultivate them in some medium in which they will grow rapidly, and then we must be able to separate one species from another, so as to obtain them in "pure cultures." We can, if we choose, use simply beef broth for this purpose. The bouillon is put into tubes which are then plugged with cotton. Now, although the air can pass freely through the cotton, and the beef tea can slowly evaporate through it, no bacteria can get through. The cotton acts as a very efficient filter, so that when once the liquid is sterilized no putrefaction can occur in it, no matter how long it may be kept, provided that the cotton plug remains undisturbed. Then the tubes are sterilized with streaming steam on three successive days for ten to fifteen minutes each day. The principle is this: although the first steaming will kill all the bacteria in the tubes it will not kill the spores. At the end of twenty-four hours most of the spores will have developed into mature bacteria, which are killed by the second steaming. The few remaining spores in turn develop and are destroyed on the third day. The fluid is then perfectly sterile and ready for the growth of the plants. A needle which has been sterilized by passing through a flame is dipped into material containing bacteria and then, after rapidly removing the cotton plug from the tube, the needle is plunged into the tube and the plug replaced as soon as the needle is withdrawn. In a day or two the bouillon is crowded with organisms developed from those carried in on the needle and a portion of it can be dropped on a cover glass, dried, stained and examined under the microscope. In general, however, the bouillon is very inconvenient, as it gives no clue to the manner of growth of the organisms, so we mix with it ten per cent. of gelatine and make a jelly which is solid at ordinary room temperatures. This is employed in the same way after careful sterilization. Now we note some peculiarities which the beef broth could not show. Some species grow in little colonies so minute that we need a magnifying glass to see them, and these colonies extend all along the track of the needle. Others liquefy the gelatine, so that in forty-eight hours the whole mass becomes liquid. Some grow most rapidly at the top of the puncture in the jelly and some at the bottom furthest away from the air. Indeed, a considerable number will not grow in the presence of air at all. These latter are called anaërobic. Thus we can make another division of the bacteria into aërobic and anaërobic. A few will grow either with or without air, and we call them facultative anaërobics. The tetanus bacillus I have mentioned is a strict anaërobic, and this accounts for the fact that lockjaw follows usually a punctured wound and not a cut. The puncture closes up and the bacilli which have been carried in, no longer being exposed to the air, grow and produce the disease. It will be found that some species produce colors of various kinds when growing on gelatine or on potatoes; these species are called chromogenic. One of the most curious of these is a short bacillus —almost a micrococcus—which is called the bacillus prodigiosus. When grown on moist bread or potato it forms red spots or stains which look as if they might be of blood, and this phenomenon has excited great consternation in the days of old. I quote from Prudden's "Story of the Bacteria": "The miracle of the bleeding Host has appeared again and again in the hands of the priestly defenders of the faith as a most potent evidence of divine intervention with the affairs of men. The consecrated wafer placed over night in the moist and bacteria-laden air of the church edifice would in the morning be found to be besprinkled with bright red drops. What could it be but blood? No human hand could have come near the place, and so what else could be believed but that it was the hand of God? It was one of those early miracles in which both priest and layman could share alike in believing with perfect honesty. The divine finger pointed, but to what?—it was the office of the priest to say.

How many lives were sacrificed and homes destroyed through that most honest of ecclesiastical delusions, the miracle of the bleeding Host, it were useless now even to conjecture."

Some bacteria cause the phosphorescence seen in decaying fish, and tubes of these have been photographed by their own light.

I have no time to mention here some of even the more important peculiarities of very many interesting species among the saprophytes, as I wish to speak later on of some of the microbes which cause disease. We owe to Koch, the great German bacteriologist, the easy and efficient method of separating species, known as the plate method. If I have a mixed culture in a tube, and wish to separate the species, I melt the gelatine in three tubes by putting them in warm water, then with a needle I put a little—very little—of the mixed culture in the first tube and stir with the needle to mix them thoroughly through the gelatine, then transfer a little of this first dilution to tube number two and mix as before. The probabilities are that tube number two will still contain a great many more bacteria than I want, so I repeat the process and inoculate tube number three from number two. When the contents of tube number three are poured out on a sterilized glass plate they will contain few microbes, and these will be widely separated the one from the other. The gelatine immediately solidifies and the plate is covered up and kept at the ordinary room temperature. In a few days little dots or colonies will appear all over the plate, and these are the progeny each one of a single germ. From the different colonies gelatine tubes are inoculated, and then we have in these tubes pure cultures of the different species contained in the original mixed culture. This process requires great care and scrupulous cleanliness, and everything must be carefully sterilized to ensure success. Some bacteria will grow only at the temperature of the human body, and of course gelatine will not answer for cultures of them, as it melts at the body temperature. So we can use a jelly made of agar, a Japanese seaweed, which melts at a much higher temperature. For most of the parasitic forms the agar medium is necessary, and the cultures are kept in a brood oven which is constantly—night and day—heated to 98° or 100° Fahrenheit. In this way only can the bacteria of tuberculosis, diphtheria, pneumonia and many others be grown outside the body. The spirillum of Asiatic cholera, however, and the bacillus of typhoid fever will grow readily at the room temperature. A large number of bacteria—mostly saprophytes—will not grow at a temperature so high as 100°. There has been in this city during the last two or three years a good deal of discussion with regard to our city water. It may be safely asserted that all drinking water contains bacteria. Now the danger of drinking any particular sample of water does not depend upon the *number* of bacteria which it may hold but on the *kind*. Two hundred organisms to the cubic centimetre may be perfectly harmless if they are simply saprophytes, while one-tenth of that number may be very dangerous if they chance to be the bacilli of typhoid fever, or the spirillum of Asiatic cholera. The problem for us to solve, then, is to find not the number but the kind. Our river is unquestionably the dumping ground for the sewage and refuse of the city, and the tides sweep this refuse up as well as down the river, and some of it gets into the filter beds. Would you prefer to drink an infinitesimal quantity of sewage with the whole of the noble Hudson as a diluent, or to drink cistern water collected from roofs and containing a large proportion of the excreta of birds, and all the unutterable abominations of street dust, tubercle and typhoid bacilli perhaps included, with the bodies of insects and slugs for variety—the whole mixture standing stagnant in the dark for weeks before it is used? You have your choice.

A chemical examination does not help us in this matter, but there is one way to determine whether water is fit to drink or not, and this is the way to do it: A number of tubes of bouillon are carefully sterilized and to each one is added a cubic centimetre or thereabouts of the water to be examined. The tubes are then put in the brood oven and kept at 100° for twenty-four hours. They are then found to be turbid from the growth of bacteria. The cultures are mixed together in a sterilized bottle and some of the mixture is injected under the skin of a rabbit. If no harm comes to the rabbit the water is pronounced fit to drink. It is axiomatic that microbes which will not grow at the body temperature can do no possible harm if introduced into the system. With the assistance and careful and able co-operation of Dr. John Faust, the veterinary surgeon, I made injections of such cultures into three healthy rabbits on the tenth of January last. Dr. Faust kept a record of the temperature of the animals and watched carefully for symptoms of local or general disease. With the exception of a very slight rise of temperature immediately following the injections, and probably due to the foreign matter so suddenly introduced into their systems, no harm whatever resulted to the animals; the same experiment was repeated on March ninth on two other rabbits with the same result;

the animals remain perfectly well. Our water supply has been accused of being the cause of the winter cholera which has been prevalent here for some years past. Now, any theory to be tenable must explain *all* the facts, and this water theory does not. It does not account for the existence of the disease throughout the county or on the other side of the river where the water is not used, and it certainly fails to account for the numerous cases where it has occurred in this city among people who do not use the river water at all. There has been an epidemic in Millbrook where the water supply is mainly from springs, and I have reports of cases from other places in the vicinity. In fact, if you will take the trouble to inquire, you will find that this malady has existed for a number of years past all over the country. As about nine-tenths, probably, of our population drink the river water, it is natural to suppose that nine-tenths of the cases would occur among these people, supposing that some other cause were at work. That cases do occur among the other tenth is an undoubted fact to which nearly every physician in town can testify.

I do not claim that my two experiments made upon rabbits settles the matter, for a good many experiments of this kind should be made to enable one to state positively that the water is at all times absolutely harmless, but I can say certainly that the particular samples of water used in these two experiments were free from pathogenic germs and were fit to drink. We have a disease which commenced some years ago, which occurs in the winter only, attended by fever, great muscular and nervous prostration, and slow recovery, and we call that disease the "grippe." If we add a diarrhœa to these symptoms we have a typical case of winter cholera. And I believe the latter to be but one of the numerous forms of that protean malady—the grippe. Whenever the one has been frequent so has the other. Last winter, for example, we have had many cases of both; the winter previous ('93–'94) few of either. This grippe theory of mine I have not been able to demonstrate under the microscope, but simply as a theory it at least has the advantage over the water theory in explaining the wide distribution of the diarrhœal complaint, which the water theory does not.

I presume you have all noticed that in the fall, especially during November, there is a decidedly yellow tinge in the city water, and this is accompanied by a somewhat peculiar and fishy odor. This is due to the growth of a very beautiful and graceful diatom called *asterionella formosa* in the reservoir (not in the river). This would probably grow there whatever the source of the water. Like other plants it has its season of perfect development, and that occurs in November in this climate. It is perfectly harmless and I know of no way by which we may get rid of it.

In Sternberg's Bacteriology, the best work on the subject in the English language, which was published in 1893 by the present Surgeon General of the U. S. Army, there are described 489 species of bacteria, and of these 158 are pathogenic, *i.e.*, they cause disease either in human beings or in the lower animals. These pathogenic species were undoubtedly ages ago saprophytes but have become parasitic and remain so, and some of them are among the most fearful scourges of our race. One of them alone, the bacillus tuberculosis, destroys one-seventh of the whole human race. It is only recently that the fact was recognized that consumption is an infectious disease, and that it is to a great extent preventable. We are so accustomed to the presence of this terrible scourge among us that we have become indifferent to its presence. Consumptives walk about our streets expectorating millions of these bacteria on the sidewalks, in street cars and in public places generally. The sputum dries up, and the wind blows the bacilli about, and we get them in our lungs. If we are susceptible to the disease either by inheritance or by some particular depression of vitality we too take it and then we too go about, unconsciously, perhaps, doing our best to spread it. Suppose some other disease were to spring up among us which would claim not one victim in seven but one in one hundred. What an uproar and excitement there would be! Then would the average citizen as usual write articles denouncing the board of health and demanding the immediate and complete isolation of all the unfortunate victims of the new disorder. Don't you think that would be the case? Isn't it so whenever the cholera lands here; and did the worst epidemic of cholera ever known anywhere kill as many as die of this other equally infectious disease? A good deal is being done already by the destruction of tuberculous cattle to decrease the spread of tuberculosis in the human race, and I am strongly inclined to believe that the diffusion among the people of the knowledge that the disease is infectious will do much more, and that in one or two generations this terrible blight will be controlled by sanitary measures, even if we find no way to cure it. I am hardly sanguine enough to believe that it will be ever entirely stamped out. Before Jenner's time every third face in Europe was pitted with small-pox scars and one in ten of the population died of small-pox. We can hardly realize that now, when the loathsome plague is so scarce as to be hardly dreaded at all. Yet in spite of vaccination the disease still exists and where it attacks the unprotected it is as virulent as ever. If we can do as well with consumption, I think we should be satisfied. The bacillus of tuberculosis is a rather slender rod which looks as if it were made up of a number of short segments joined together. It has one peculiarity which is shared by no other except the bacillus of leprosy, and that is, that if it is stained with one of the basic aniline dyes, it retains the color so tenaciously that it can be washed with twenty-five per cent. of nitric acid without parting with its color. In the sputum of a consumptive there are usually other kinds of bacteria besides the bacillus tuberculosis, but these lose their color in the nitric acid. We generally use a red solution for staining the bacillus and then a blue aniline for a contrast stain. The bacilli then appear red on a blue ground.

To determine whether or no a particular organism is the cause of a given disease, three things are necessary: First, the organism must be found in all cases suffering from that disease. Second, it must be capable of being isolated and cultivated in a pure state outside the body. Third, such cultures, when inoculated into healthy, susceptible animals, must give rise to the same disease in them. For some time it was impossible to grow this bacillus outside of the body and many physicians believed it to be the result rather than the cause of consumption. Old opinions die hard, and in spite of the innumerable medical fads and fashions, the medical profession as a whole is very conservative. But it was found that by adding glycerine to agar or to beef broth as a medium the bacillus would grow readily enough. By injecting such cultures into guinea pigs or rabbits the animals invariably became tuberculous and died, so that the chain of proof is complete and no one whose opinion is of any value whatever now doubts the causative influence of the organism. This, like other pathogenic species, kills, not by direct destruction of lung tissue but by the generation of a poison which acts upon the system. I think that almost all who have for the first time attended an autopsy of one dead from consumption have been struck with the small amount of actual loss of lung tissue. The doctor who gravely informs the anxious friends of a patient that "one lung is all gone and the other nearly so" is certainly not telling the exact truth. We know many cases of undoubted phthisis where the general health is for a long time unimpaired. Then there comes a little fever, a little flush of the face, a trifling falling off of strength and weight. What has happened? The bacilli have been all along manufacturing this poison—a ptomaine or a toxin, but not in so large a quantity but the system could eliminate it. But the time has arrived when the quantity of the toxin is too great for the system to get rid of and the symptoms appear. Then the poison having the upper hand it is only a question of time before the microscopic demon claims its own. The ptomaines of tubercle act as a slow poison but some of the others are exceedingly virulent and powerful, indeed as powerful for evil as any poisons known.

Roux and Yersin have found that one-fifth of a milligramme of the ptomaine of diphtheria obtained from pure cultures of the bacillus discovered by Klebs and Löffler is capable of killing eight guinea pigs or two rabbits. This quantity is only $\frac{1}{320}$ of a grain. While Bryer and Cohn killed a mouse with $\frac{1}{10000}$ of a milligramme ($\frac{1}{65000}$ of a grain) of the ptomaine of tetanus. No snake venom will compare with this. I remember hearing the elder Austin Flint, in a clinic in Bellevue Hospital in 1875, announce his belief that pneumonia is an infectious disease, to be classed among the fevers and not among the inflammations. Of course in those days nothing was known of the bacterial origin of *any* disease, and the professor based his opinion on chemical grounds alone. In the next edition of his book on the Practice of Medicine, I believe, he called the disease pneumonic fever and placed it with the infectious diseases. I suppose the most of the profession at that time thought that the learned professor had a tile loose or was in his dotage, but time has demonstrated that he was right (and he generally was right, by the way), and we can inject cultures of the diplococcus of pneumonia into that favorite martyr of science, the guinea pig, and cause the disease. Just at present the newspapers and medical journals have a great deal to say about diphtheria and its treatment by the antitoxin.

This disease which is so destructive, especially to children, is due to a bacillus which resembles very much the bacillus tuberculosis, though it is usually smaller. Being deposited in the throat it multiplies with marvellous rapidity and forms a ptomaine which, being absorbed by the system, leads too often to fatal results. I have told you how poisonous this ptomaine is. It acts as a profound depressant of the heart and nervous system and kills usually by paralysis. I have had a patient die two weeks after all symptoms of the disease had vanished. I had ceased my visits and the child was playing about the house when she fell over dead. If a small swab of cotton is passed over the membrane in the throat and then rubbed over the surface of some coagulated blood-serum in a tube, colonies of the bacillus will be found on the serum if the tubes are put in the brood oven at from 95° to 98° for about 18 hours. These colonies consist of myriads of the bacilli and they may be transferred to cover glasses, stained and examined. I will tell you of the antitoxin in a few minutes. The problems presented to the bacteriologist are many and puzzling, but perhaps none is more puzzling than the subject of immunity and susceptibility. Why is it that a culture of anthrax will kill a common rat but have no effect upon a white rat? Why is it that Mr. A's family of rugged and healthy looking children all die of consumption while Mr. B's sickly brood die mostly of old age; and why do cats have consumption and dogs do not? Finally, why is it that we don't all die whenever an epidemic comes around? It is to the solution of such problems as these that the best medical thought of the day is directed, and little by little clues are obtained which some day will, I doubt not, lead to answers to these questions. Of course the main problem is how to get rid of these diseases; how to stamp them out from the community and how to treat them in the individual case. We cannot give powerful germicides to our patients to kill the microbes without killing our patients at the same time, for these simple organisms are much more tenacious of life than the exceedingly complex structure we call a man. Only the quacks have caught at that idea and advertise microbicides and microbe killers in the public prints. In the first place, can the system be put into such a condition that the bacteria will not grow in it? Some doctor a year or so ago in a medical journal proposed to cure consumption by introducing rheumatism into the system. He says that the gouty and rheumatic are never consumptive, owing to the excessive acidity of their blood, the bacillus tuberculosis growing only in an alkaline medium. I know from sad personal experience that a rheumatic can get, both mentally and physically, as sour as a pickle factory, and since I read the article I have been looking for a rheumatic consumptive but haven't found one yet. How, in the absence of the bacteria of rheumatism, which have not yet been discovered (although I thoroughly believe the disease is bacterial), we are going to confer upon the consumptive the boon of rheumatism I do not know and the doctor doesn't say. The idea, however, may be worth thorough investigation. In the second place, can we introduce other and antagonistic germs into the system? Quite recently efforts have been made to cure cancer and sarcoma by injections of the streptococcus of erysipelas. This of course sets up at once an active attack of erysipelatous inflammation in the part and after this subsides the cancer in some instances is found to be cured. However, I believe that thus far this treatment has been found disappointing and it is certainly extremely dangerous to life. Only the terrible nature of the original disease warrants so perilous an experiment. The bacillus prodigiosus has also been used in anthrax with success.

Third, an attenuated or modified virus might be used to check the growth of organisms as vaccine does small pox. This of course is of more value as preventive than as cure. Pasteur succeeded in so modifying the virus of anthrax that while the animals, mostly sheep, which were inoculated failed to have the disease itself they were afterward found immune, even if inoculated with the most virulent cultures. It has been estimated that the work of Pasteur in France in stamping out anthrax and the silkworm disease has been of sufficient value to that country to make good in twenty years the enormous amount lost by the payment of the war indemnity to Germany.

Fourth, the injection of the blood serum of an immunized animal. This is the principle of the antitoxin. I use the word immunized instead of immune, since the serum of naturally immune animals seems to produce no effect so far as it has been tried. The theory is that in the course of a disease in the human being or a susceptible animal there is gradually formed in the blood a substance which has not yet been isolated which we may call an antitoxin, and this substance counteracts the effect of the toxin or ptomaine in the system and recovery takes place. There is none of this substance in the blood of naturally immune animals, else we could cure consumption, for example, by injecting the serum from such animals, dogs, donkies, &c., into our consumptive patients. The diphtheria antitoxin is produced in horses, which animals are susceptible to the disease. A very virulent culture is filtered so that the bacteria are all out of it and only the toxin remains. A small quantity is injected into the horse, which immediately becomes feverish and shows signs of the disease. After all reaction has disappeared some more toxin is introduced in double the quantity and again the horse reacts in the same way. This is repeated again and again with constantly increasing amounts of the toxin until the horse ceases to react, even when a half pint of the virulent culture is injected under his skin. The animal is bled and the serum thus obtained is the antitoxin which is creating such a stir in the medical world to-day. Experiments with guinea pigs and rabbits show that with them it is efficacious and statistics of its use in the human subject seem to be favorable. We must wait, however, until the smoke clears away a little before it is proper to pronounce definitely upon its true value. A similar antitoxin to tetanus has been prepared and successfully used in Italy in several cases of lockjaw in the human subject. Now the question arises—is there a similar antitoxin formed in cases of consumption? A good many very brilliant men are at work on this problem.

There is the first great difficulty to overcome, that susceptible animals have not yet been immunized and no way has yet been found to do it. You observe that we may give diphtheria to a horse and he gets well, but if we inoculate a susceptible animal with tuberculosis it dies, and if we employ a naturally immune animal we get no effect whatever. It is to be hoped that this difficulty may be overcome and then we will be able to tell whether blood serum from such animals will contain an antitoxin or not. A way may be found to so modify the virus of tuberculosis that the animal may recover, and after repeating the process be found to be immune to virulent cultures. If this can be done we will probably be able to cure consumption or at least to protect those who are especially susceptible to it so that they will not take it.

MARCH 26, 1895—EIGHTH REGULAR MEETING.

Chairman Burgess presiding, and about thirty-five members and guests present. Mr. W. C. Albro presented a paper on the question "Can Currency be made Elastic?"

APRIL 9, 1895—NINTH REGULAR MEETING.

Chairman Burgess presided; about fifty members and guests present. Dr. Theodor Neumann gave an address, illustrated with drawing and microscopic slides, upon:

ENTO-PARASITES AND HYGIENE.

BY DR. THEODOR NEUMANN.

In public as well as in private life, many persons not anxious to work honestly and hard try to get food and shelter wherever they are able to find those necessities of life, or where they meet good-hearted people willing to furnish them with accommodations. In the same way we find in the animal kingdom many forms of life which do not earn their living by honest work, but live on the property and the income of others. Both kinds, which present in their whole way of doing and living many points of analogy, are called parasites, and have been known since times immemorial more for their disagreeable than their pleasant qualities. This is easily explained, since their behavior is little esteemed, and they stand morally as well as physically on a very low level. In the comedies of the old Greeks and Romans the *παράσιτος* plays a rather woeful part, being the type of eternal hunger, of greediness and of low character; he is the target for the mockery and the jokes of all decent people. And what do we see when we look upon the parasites of the animal kingdom? Are they not also beings which, to obtain an easy existence, cling to others, adapt themselves to all the qualities and even whims of their hosts, and have the latter provide entirely for their food and lodging? To-day when the life of these parasites lies before us clear and distinct, we know that they indeed arrange their own existence according to such motives; and just as their morals (if there be any!) are none too praiseworthy, their physical development is also very much neglected.

It is a well known fact that all organisms, as to their form and development, are dependent on exterior conditions of existence, to which they must adapt themselves. The forms of the animal body, its inner and outer construction, have been developed in the course of time through such adaptation; and they change even now with changing environment. But the kind of development which parasites were and are still undergoing is entirely different from that of other organisms. The latter showed a progressive character; they became more complicated in the course of time, in proportion as their surroundings lost their former simple character; the parasites, on the contrary, show us how certain conditions, which make life especially easy, by providing the necessities of existence without hard labor, may cause degeneration in an organism which was at first highly developed and of complicated structure. All parasites show such degenerating effects of their mode of living; some more, others less, according to the round which they have reached on the ladder of parasitism. Before considering the circumstances, it will be necessary to inquire what forms and beings must be included in the name "parasites."

We shall soon see that a strict definition of the word and the idea "parasite" is difficult, if not impossible; for parasitic life is developed by degrees from ordinary life, and a definite boundary line between parasites and non-parasites cannot be drawn. In general, it is safe to say that parasites are such organisms as do not earn their necessities of life, but live as guests with, on, or in other living organisms and satisfy their wants from the property of the latter. They proceed in such a way as not to eat them up entirely, or even partially, but to draw food from the vital fluids which fill the bodies of their hosts, without killing them. The important point about a parasite, therefore, is its kind of food and the way and manner in which it is taken in.

Organisms which live on the vital liquids of other living organisms are found not only in the animal kingdom, but also among plants, the former being called zooparasites, the latter phytoparasites. Among both classes we meet those which live in or on plants and others which lives in or on animals, so that we actually have four classes:

A. *Zooparasites.*

1. In or on animals (leech, tape-worm).
2. In or on plants (phylloxera, anguillula tritici).

B. *Phytoparasites.*

1. In or on animals (bacilli, bacteria).
2. In or on plants (fungi, etc).

The following remarks will be restricted to "A. 1, Zooparasites; living in or on animals," for they show the effects of parasitic life in the most evident manner, in their development as well as in their bodily construction.

Only a few decades ago there prevailed the most extravagant and nonsensical ideas about the origin and the development of parasites. There was scarcely any question concerning temporary parasites, such as fleas and leeches, because their development was well known to scientists and even to many other enthusiastic lovers of nature; complete darkness, however, surrounded the existence of those forms which, with their slender, by no means complicated body, and their simple construction, penetrate deeply into the living body of their host, and often leave no track at all on the road by which they come. Indeed, we find parasites not only in the organs of the body which are open to the outside, such as intestines, lungs, etc., but also in the eyes, in the heart, the brains, and other parts of the body which have no connection at all with the outer world. Thus the study of parasites, the discovery of their mysterious methods of development, the explanation of their remarkable ways and means of living and of creating new generations is to-day one of the most interesting and brilliant chapters of biology, allowing us, as scarcely any other does, to look into the innermost connections of the different shapes and phases of animal life.

When we consider the circumstance that an animal which draws its food from another one does not kill the latter entirely, but only taps it, we have at once the explanation of the fact that parasites are always small and weak, the host big and strong, superior in force; for if it were otherwise, the parasite would not be satisfied with a mere extraction of vital juice, but would eat up its host. There is no more question that the parasites are throughout small, and belong to the lower classes of the animal kingdom, while their hosts are large and more highly developed.

Since from the very nature of getting food from some other animal a parasite is always obliged to go to its host, it is a very natural consequence that a large number of parasites simplify this by taking permanent quarters on or in the host: in other words, the latter provides not only food for its guest but also shelter. On the other hand we must not draw the conclusion that an animal which is found on or in another one is at once characterized as a parasite; it is necessary to prove also that the food is drawn from the animal inhabited.

If this cannot be proved without doubt, we have before us a so-called pseudo-parasitism, cases of which are by no means rare, often puzzling and taxing the skill of the scientist as to their true nature, because they may gradually pass into true parasitism.

We may observe, for instance, that one animal is found usually and regularly in the interior of another, thus arousing the suspicion of being a true parasite. On closer examination, however, we find that such supposed parasites do not get their food from the animal they inhabit; they only take part of the meals of the host by grasping what they can of the food of the latter and claiming it for themselves. Such animals are called, in opposition to the true parasite, table companions or "*commensals*."

A very nice case of such commensalism is that of certain mollusks (Cyprina islandica and Arga arenaria). They house in their mantle cavity a worm (Malacobdella), which might easily be taken for a real parasite, if close observation, especially the examination of the contents of its intestines, did not prove the contrary. Never are blood or tissues of the mollusc itself found in the worm, but mostly little animals and plants that float in the water, such as algæ, diatomeæ, little crabs, etc. The reason for this strange behavior is obvious. The "table companion" or host is seated where especially favorable circumstances make it easy for him to get food; the worm mentioned has its abode just where a constant stream of water produced by the gills of the mollusc, laden with many small particles of food-material, passes by, so that it need only help itself to what is floating by in order to be provided with its few necessities of life.

Beside these commensals or pseudo-parasites we have in the true parasites creatures which concerning their food are utterly dependent upon another animal. They are not able to live on any thing but the liquid contents of the animal body. It would be a rather hazardous undertaking to give the approximate number of all known species of parasites; doubtless it is several thousands, and every day new forms are discovered, studied and added to the list. Nearly all types of the animal kingdom furnish representatives of parasites, yet the participation is rather unequal. Vertebrates and molluscs have only very few forms; more are found among the protozoa; a much greater number among the arthropods and the hydrobiotic crustacea; while the type of vermes is very largely composed of parasitic forms. Parasitic worms are those which live eminently inside the human body, and it was they which were first called *παράσιτοι*, and still nowadays we meet the name entozoa (inside animals), indicating all those animals which live in the interior of another.

In the same way that most types of the animal kingdom contain parasitic forms, we may safely maintain that there is probably no animal which might not be the host of some parasite. Neither size nor manner of life nor peculiarities of the individual are sufficient protection: and it might make us smile to think of the established truth that there are parasites in parasites. Another rather peculiar circumstance is the experience that certain animals are visited with preference by only one or a few kinds of parasites: on the other hand, the opposite case is more frequent that one animal, especially a vertebrate, houses and feeds a good many different parasites at the same time. Man stands at the top of this scale, since we know that he is the host of about eight kinds of protozoa, fifty-one worms and twenty arthropods—and these are probably not all.

A great difference exists among parasites concerning the part of the body in which they settle. Some do not seem to be very particular, as they are found in nearly every organ, while others confine themselves strictly to only one part of the body—the brain, the eye, the stomach, etc., so that on examination of the interior of an animal rather queer collections may sometimes be made. Leuckart, in Leipzig, relates a case where a black swan was dissected and the following specimens found therein: 24 filaria in the lungs, 60 syngamus in the trachea, more than 100 spiroptera in the stomach, many hundred holostomum in the small intestine, about one hundred distomum in the large intestine, 22 other distomum in the œsophagus, and several more in small numbers, eight different kinds at the same time—and the bird, when alive, is said to have given no sign of uneasiness.

There are different degrees of parasitism, beginning on one side with such individuals as visit their hosts only when they are driven by the want of food, leaving again when they are satisfied and, not returning until they feel hunger again; on the other side with such as are permanently fixed on or in their host, the latter furnishing not only food, but also shelter. The former class may be called temporary parasites. Among them are those insects which cling and suck the blood of man, certain flies, the leech, etc.; the others are the stationary or permanent parasites, which are characterized by the fact that they live always on or oftener in their hosts, even in organs which seem to be completely closed up, so that one often does not suspect the presence of any parasite inside. Another marked difference between the two classes is the fact that while the former have mostly a well developed locomotive apparatus and highly perfected organs of sense, which indeed they need in order to move around, and to find a victim for their craving for food, the ento-parasites, those which live in the interior of other animals, have more or less lost the segmentation of their bodies, and with it the power of locomotion as well as the ability to receive through their senses impressions from without. They have become so helpless that they are no longer able to lead such a free life as the others before mentioned, and they would surely perish if they should become separated from their abode.

We must not think, however, that these two classes are really the only ones to be found, nor that they are distinctly separate. There are many connecting links between both; in other words, there is no sharp dividing line between them, but many intermediate forms may be reckoned with one class just as well as with the other. Even more remarkable is the fact that a large part of such parasites as seem most settled in their habits change them during certain periods of their lives to such an extent that they begin a free life again. For some of them this change is really necessary, and occurs regularly from generation to generation. We shall look into these peculiarities more closely later on, after we have answered one more question, namely, how was parasitism developed from the ordinary forms of animal life? Investigation reveals to us the fact that it is really nothing specific, but only a certain modification of general animal life, connecting with it in different ways and at different points. Some animals are at first living free, then as parasites, while others show us through their relatives a more or less uninterrupted transition to parasitic life; in short, we see that this is not a life of a peculiar character, but only a special feature which was gradually formed from free life by adaptation to peculiar conditions of existence. It is an axiom now-a-days in the scientific world that parasitism, never sharply distinguished from free life, can also never have been a peculiar division of it, but must have developed from it gradually. The way in which this transformation took place lies rather plainly before us. We may assume the following: Some small animal of low organization feeds on other little animals which it catches, overpowers and devours just as happens now-a-days.

Let the possibility arise that those little animals become rare for some reason, or that other circumstances make it hard or actually impossible for the organism spoken of to go on finding its food in the way followed hitherto. It need not die out at once in consequence; being a lively individual, it will easily surmount such difficulties and try to make good the deficiency in some other manner. It may go to other, perhaps bigger animals, trying to take from them whatever it can get, in order to supply its need of food. Of course it cannot kill these bigger, stronger creatures, nor eat them up entirely like its former prey; it must be contented to tear away from them single parts of their bodies—*it has become an occasional, a temporary parasite.* This new mode of getting food may be found even more advantageous than the old one; the little creature has "tasted blood" and goes about in the same way whenever there is another opportunity, without, however, carrying through this mode of living consistently. They will in the majority of cases fall back on their old way. After many generations it may result that the parasitic way of getting food is practised oftener and more constantly; while it was the exception formerly, it becomes the rule now; the going back to the original mode will be the exception. A very good example of this state of things is the leech, which formerly fed on shells and snails, but has in the course of time become a regular parasite, living on the blood of frogs and fishes. Should it happen that the latter are missing, it returns to its former habit of devouring the above evertebrates.

This gradual adaptation to parasitism will bring about also a definite relation to the new host. In the beginning the latter will not have been chosen deliberately, but taken just as change brought it along. By and by a certain selection will take place; one animal is liked especially by our candidate for parasitism, or circumstances, local conditions, etc., make one species as hosts more or less necessary; thus it will happen that certain animals become the principal hosts of others, the latter being their regular parasites, though this still may not yet be permanent, but only temporary, the one host being visited merely from time to time for the purpose of getting food. Nevertheless, here we have the beginning of a purely parasitic manner of life; the continuation is not hard and follows soon. It cannot be denied that subsistence by means of nourishment which is prepared by other animals, ready for use, offers many advantages over that which is secured by the process of catching prey and preparing it for digestion and assimilation. If, therefore, an animal finds a possibility of continuing such a cheap way of providing food, it will readily adopt it, although the adoption must be paid for often very dearly in other ways.

Hand in hand with this goes, of course, an adaptation of the organs which serve the purpose of drawing food from another animal. We shall discover a completion and perfection of sucking organs, of clinging apparatus, or, if there were none before, a new formation of such. Then it may happen that the parasite loses completely the ability to obtain food in the ordinary way and can satisfy its needs only in parasitic fashion. It becomes entirely dependent upon a host, often upon a specific host, and is therefore forced to stay near it at all times. When located on it, it will not like to leave it, at least except for special, urgent reasons; later not at all, the parasite thus becoming stationary, permanent.

Still it may have its seat only on the outside of the host, but from there to the interior is only a short way. The parasite will soon look for more protected parts of the body in order to be less molested by outside influences, and the mouth or the gill-openings, the outer ear of animals, will be welcome hiding places. From there the parasite can easily continue its migrations and get into the interior of the body—the ento-parasite is created.

To repeat, for all such changes great length of time is required ; the transformation from the free-living animal to an ento-parasite is long and slow, and cannot be traversed within a few generations. It has not been watched by any human eye, and anybody has the right to ask why the origin of parasites is explained in such a way. Well, though we have not seen the whole process of development, we may observe still now a days certain phases, we might call them halting places, on that long road, which, properly put together, enable us to reconstruct the whole road from the starting point to the end. No great difficulty arises when we try to find out the connection between temporary parasites and their free-living relatives, *i. e.*, those forms from which they developed in the course of time. Not so easy is the task with the stationary and especially the ento-parasites.

There are, indeed, some which have free-living relatives of rather similar form and shape; others no longer show any relation to forms from which they may have taken their origin. In such a case nothing is to be expected from the comparison of those creatures with other animals, and we should know little in this direction if we had not an excellent assistant in embryology, whose doctrines are a most valuable key for the unveiling of hitherto unknown facts. It furnishes in many cases hints concerning relations which could not be discovered by any means in the fully developed animals.

This importance of embryology for the investigation of the origin of our parasites should be stated most emphatically; besides, a few words must be said in general on the importance of embryological facts. We know today after careful observation that the development of any animal from the egg on to the moment when it reproduces its species has nothing arbitrary or accidental, but is influenced in a very regular fixed way by the development which its ancestors had to undergo. All those changes which occurred in the course of former generations, the result of which is shown in the organism in its shape to-day, are repeated in the development of the individual. The oldest and simplest forms of life which we know are organisms consisting of one cell only; all the animals now living, however large and complicated in their structure, originate from an egg, one single cell. The oldest vertebrates were water-animals breathing through gills; in the earliest stages of development of any vertebrate there is a stage where indeed not the gills themselves, but parts of the skeleton bearing them, are apparent. Mammals and birds have developed from reptile-like ancestors; and thus their embryonal development contains even now phases which can not be distinguished from each other. All these are features which disclose to us a common origin. In one word, in its development each individual reproduces, as it were in outline, the different stages in the gradual metamorphosis of the animal during the series of generations of its ancestors. If we, therefore, know the history of the development of one animal, the stages through which it passes during its creation, or its ontogeny, we possess, consequently, nearly always data for the determination of its ancestors and its relatives; we obtain light on the various changes which the ancestors of the animal had to go through until they arrived on the present standpoint: in other words, we can trace its phylogeny.

Such changes are usually of a twofold character—either degenerative, regressive, or progressive; that means, the parasites lose certain characteristics of their structure and obtain others instead. We have stated that temporary parasites are in form and shape essentially equal to the free-living animals. They must have, like the latter, effective organs of locomotion in order to be able to get at their host; they need fully developed apparatus of sense, which leads to the hunting up and finding out of the right animal to provide the food. The only thing which may in some way be characteristic of such animals is the formation of the parts of the mouth which are especially adapted for the reception of liquid materials—for sucking. Since, however, these liquids never lie open, but must be taken from another living organism, we find beside such sucking apparatus also mechanical appliances to wound the host, to sting, to cut, to saw, to scrape.

Comparing the permanent parasites with these, we shall observe several important changes. Above all other things, it is no longer necessary for them to leave their host and to come back to it again in case of need; they can dispense with the possession of apparatus for locomotion and subtile organs of sense; the latter have become superfluous, at least at the moment when the parasite has reached its permanent residence. Very naturally such organs, if still there, will soon sink down from their level of perfection; they begin to degenerate, and this so much the more, the more settled the parasite is on its bearer. We know several parasites which are indeed permanent, which do not leave their host any more, but still move around on the surface or in the interior of the same. They still have organs of locomotion, and may possess also organs of sense for the perception of outside impressions. These are, however, rather reduced and simple in comparison to those of the free-living animals.

Such reduction may go on and affect the nervous system. First the organs of sense disappear, and later it will be most difficult to discover any traces of nerves. At the same time the segmentation of the body becomes indistinct, its shape more simple and clumsy, and the muscles dwindle in corresponding manner. The end is that all organs of locomotion, all the organs of sense, are gone; the body is reduced to utmost implicity: we have before us nothing but a bag, somewhat irregular in shape, because of a few appendages and unevennesses. Coincident with this disappearance of movability is the complete reduction of all muscles of locomotion; in short, only a very small and simple remnant of the original animal is left, and that has often lost all resemblance to a living creature.

These degenerative changes which occur in consequence of parasitism have been described here as a single continuous process. They can not, of course, be observed in nature, for within the short space of a human life they are by no means visible; the form of the animal remains constant. But if we keep in mind that of one group of parasites not all began parasitic life at the same time, but one earlier, another later; that perhaps one species resisted those degenerative influences more than others; then we are allowed to suppose that among creatures now living one kind may be more changed and degenerated than another. We are consequently able to observe side by side different phases which really follow one another, and from them we may, under favorable circumstances, put together a series which gives a very distinct picture of the gradual development into a parasite.

Thus the order of the Nematods possess still considerable mobility of their bodies and make extensive migrations. Especially is the thread-worm (Oxyuris vermicularis) famous on account of its nightly wanderings, which it undertakes out of the intestinal canal of its bearer into the surrounding exterior regions of the body—wanderings which are by no means pleasant to the host, since they cause a very disagreeable itching and tickling.

In other Nematods this development of the muscular system is not of so high a character, but is reduced in the same measure as they lead a more stationary life (Filaria, Gordius, Mermis, etc.). Still more rudimentary are the muscles in the Trematods and Cestods, which in many cases can execute only very slow contractions of the body. However, even here many differences occur, according to circumstances.

This degeneration of the locomotive and sensitive apparatus does not remain without influence upon the nervous system. In many cases we can observe how the reduction of one system is strictly parallel to that of the other. Only a short time ago a nervous apparatus seemed to be missing in many worms; now we know that it must be present, though its actual existence has not yet been proved.

Those parasites living in the interior of their hosts get ahead of their exterior colleagues on account of their floating in a nutritious liquid, so that they need not have any special organs for taking up food and digesting it, as the ecto-parasites must have. The latter must necessarily be provided with borers, stings, saws and other instruments to tap the host in order to get near its blood or lymph. The ento-parasites live in a place where they always have their food ready for use without any special endeavor on their part. And yet there are a few of them which possess some armament around their mouths, especially when they do not live chiefly on the liquids in which they float, but on blood, which they must cause to flow. There is especially one family of Nematods, the Strongylids, which live in that way; they possess an extremely firm, horny mouth, on the rim of which may be seen a number of chitin hooks, that are thrust into the mucous membrane of the alimentary canal. Through powerful sucking these parasites are able to cause a good deal of blood to flow, and examination reveals the fact that their intestines are always tightly filled with blood. If such parasites exist in great numbers in one host, it is easily to be understood that the latter will suffer severe damage; less perhaps through the loss of blood than through the constant irritation and inflammation of the mucous membrane. These Strongylids are the more interesting since one of their representatives belongs to the most dangerous parasites of man, and has done much harm through its presence. This worm has the name Ankylostoma duodenale or Dochmius duodenalis. It lives, and mostly in large numbers, in the upper part of the small intestine, the duodenum, from which it has its name, and it produces through its parasitism the symptoms of a highly dangerous anæmia which was a long time known under the name of Egyptian chlorosis. Later a similar disease was discovered among country people of Sicily who came from swampy territories, and in the northern parts of Italy, especially among people who work in rice-fields and in brick-factories. During the construction of the St. Gothard tunnel the very same suffering spread rapidly among the laborers employed in this work; it was called "tunnel disease," "mine anæmia," "mountain cachexy," etc. There, for the first time, the worm was discovered as the cause of the disease; it was found in all the patients, and later more searching investigation proved the fact that it caused the same disease among the coal miners of Belgium and on the Rhine. This ankylostomiasis (or dochmiosis) is a rather dangerous disease which may extend through many years and finally lead to death. The parasite itself is indeed not very large (8 to 11^{mm}), but through the constant irritation which it exerts by means of its horny armament around the mouth, and through the loss of blood which it causes, it takes few individuals to produce the most serious results. How much worse must the effects be if hundreds, nay, thousands of individuals inhabit the alimentary canal of one individual! Moreover, it is very hard to drive these parasites off; even after continued treatment some may remain in the intestines and produce a repetition of the former symptoms.

Apart from this and similar cases, however, the ento-parasites possess no apparatus which may be used to wound and injure the inner organs of the host, although quite a number of the former do not live on the lymphatic liquids of their bearer, but on their blood as such. Then the upper part of the alimentary canal is transformed into a sucking apparatus, which produces a so-called diapedesis, or an emigration of the corpuscles of the blood through the walls of the capillaries. Mostly trematods do this, whose very name comes from this action of sucking (τρῆμα, a pore or a sucker). We shall have occasion to speak about them and their dangerous influence later.

Not only the presence but also the condition of the food in which these animals live, and their surroundings, exercise a certain influence upon their organization. When we think that all the food which is being taken up has already been prepared by the host, transformed into liquid state, and represents then material which may be absorbed without delay; that in consequence of this, a great part of sometimes rather tedious and hard work is spared the intestines of the worm; then we shall scarcely be surprised to find that this intestinal apparatus has been simplified to a very great extent. Never does its length surpass that of the body; never is its inner surface enlarged through folds or bags; in many cases it lacks entirely those glands which are such important additions in the alimentary apparatus of non-parasitic animals—in short, the canal is built in the simplest way possible. But this degeneration does not stop even here; it may go on so that the rear end, ordinarily used for the throwing off of unused material, disappears, the alimentary canal is a blind alley, and everything which cannot be absorbed must be ejected through the mouth (distomum). However unheard-of such an arrangement may be for all more highly developed animals, it is quite a suitable thing where the quantity of stuff to be rejected is extremely small.

This alimentary canal may get shorter and shorter, so that in some cases it consists only of two bulbs hanging near the œsophagus (distomum heteroporum). This arrangement is possible because the parasite does not by any means depend on things which come to it through the mouth only. Hand in hand with this reduction of the alimentary canal goes a change in the animal's outer cover which begins to take part in the process of feeding the body. Far more than our own skin, which is permeable to a great extent, the cover of the parasite allows the liquids in the intestines of the host to permeate through and be absorbed inside. Of course it must not be thick and horny, as in animals which live in the open air, but it must possess the faculty of passing liquid and gaseous matters and enabling the parasite to combine nourishment and breathing in one process.

Such a way of providing food has certain effects on the body of the parasite. The material which passes through the skin reaches at first those parts of the body closely behind it: only after they are fully provided for, can the others, which lie still deeper, receive their share. In consequence of this arrangement, and in order to secure an equal and abundant nutrition of the body, it is desirable to bring all its parts as near the surface as possible, or, what is the same thing, to make the latter as large as possible. Consequently these animals have a characteristically flat, leaf-like shape, for only thus is it possible to have the whole surface of the body take part in the general nutrition of the individual.

Thus, when the whole surface takes part in the absorption of food, it is easy to believe that in a great many parasites the alimentary canal may be dispensed with entirely, and that all its functions are assumed by the outer skin. The great number of cestods do not possess the slightest trace of it, their outer surface being stomach and intestine at the same time, a condition readily conceivable when we keep in view that they live in a place filled with nutritious material that can be absorbed at once without the least amount of energy on the part of the parasites.

So we discover in all these animals a gradual simplification of their outer and inner bodily structure, which must be regarded as a direct and immediate consequence of their mode of living. This explains fully why all parasites, whatever their original shape and form may have been, possess such a simple and similar appearance.

We must, however, not lose sight of the fact that there are also influences of a progressive nature, and it will be necessary to examine them and their relations to the life of the individual also. They are prominently connected with the preservation of the animals, and consist mainly of appliances for getting a firm hold, for clinging to the place where they have become sessile. Temporary parasites did not need them, for they were provided with organs of sense and of locomotion, so that in case they were removed from their host it was a simple thing for them to get back. Yet even among these we may find a remarkable development of hooks and clamps, because the individual wants to guard itself against an unnecessary removal from the seat of life (*e. g.*, leech, etc.) Such an occurrence would, of course, be a very serious mishap to the more sessile parasites which have no organs of locomotion; consequently, in exact proportion to the reduction of their locomotory apparatus, their organs of clinging are developed to a much greater state of efficiency. In the beginning, those organs already on hand are only strengthened; hooks which at first serve as legs are changed to organs of fastening; in other parasites strong, muscular sucking-cups perform that service. Our leeches, which are temporary parasites, show us their development in a very significant way. Such sucking cup's may be strengthened by hooks or frames of chitin, and their size is sometimes so enormous that the parasites cannot be removed by a mere pull, but are torn if the attempt is made. Parasites in the inner parts of the body do not need such highly developed clinging apparatus, and if they have it, we usually find as the reason that they have located in exposed and dangerous places, for instance near the rear end of the alimentary canal. They would be hopelessly lost if they were swept away, and as that danger is rather imminent if they are not firmly fixed, the worms must look out for a secure and entirely safe settlement. In all inner organs, on the other hand, which are entirely away from the outside world, the danger of being disconnected is small for any parasite. Thus we see that their organs of fixation are essentially smaller and lighter. Trematods living in the interior of bodies have only one or two sucking cups; nematods have none at all; cestods, however, show a larger development of the same. They have largely two (bothriocephalus) or four (taenia) cups, consisting of hemispherical, hollow muscles; in some cases the later may be transformed into large, separate appliances which contain chitin frames for support. Sometimes these cups bear in addition a regular crown of hooks placed on a special elevation of the head. These hooks point backward; thrust into the mucous membrane of the intestine, they effect a firm hold of the worm.

These influences of parasitism, degenerative as well as progressive, on the condition of life of the individual, are however not the only ones of which we have knowledge. They all had a bearing on the organization of these animals. Let us direct our attention once to the embryology of these creatures; we shall find a number of most remarkable facts which owe their appearance largely to parasitic life or to certain features thereof.

The sexual relations of parasites are peculiar indeed. It may be stated at first that all parasites have a distinct sexual character and reproduce their species through eggs. The latter are either deposited outside or developed inside of the mother animal, so that we call such forms viviparous, the young being fully alive when they begin their existence away from the mother. As to the separation of the sexes, we find upon investigation among the parasites, especially among the more sessile ones, very few with separated sexes, but in most cases hermaphroditic forms, *i. e.*, such as produce in their bodies at the same time male and female materials of reproduction and are therefore able alone to bring forth a new generation. Thus among the worms the most degenerated tape-worms, nearly all trematods or flukes, and a great number of round-worms are such hermaphroditic individuals.

According to all modern scientific views this latter form is the original one; it is more advantageous, especially for the sessile parasites, because only then will they have a chance to get their eggs fructified; in the other case, when the sexes are separate, the fulfillment of this condition is often left to chance.

At all events we can distinguish four different ways of reaching the aforesaid end, the fructification of the eggs:

1. The sexes are separate, both sessile, the products, however, more or less movable ; large quantities of the latter are deposited in the surrounding mediums and the meeting of egg and sperma is left to chance. In spite of this the probability is no small one here, since the number and movability of the germs is rather great. Such a case is possible in water only.

2. The sexes are separate, only one of them sessile.

The male individuals keep up their movability and use it to find and fructify the females.

3. The sexes are united in the same individual and make a fructification of the eggs possible through the same animal's sperma.

4. This case is limited to parasites only : from the eggs of sessile animals with separated sexuality larvae are developed which live free for some time, copulate in the free-living state, and then become sessile again. In this case the grown forms are females only, which bring the eggs to maturity; for since the males have filled their purpose of life by delivering their sperma to the females, they perish soon after and do not enter the state of parasitism.

Within these limits many peculiarities of individual species are of course encountered. Bilharzia haematobia (Distomum haematobium) is a very dangerous parasite of man, especially in Egypt and in Abyssinia. It lives in the veins, especially in the portal vein, but descends to the vessels of the abdomen for the purpose of depositing its eggs, which sometimes block the circulation, through their enormous number. True, they cannot get out from here at once, as the blood system is closed all round ; through the irritation, however, which they exert on the walls of the blood vessels, sores spring up which break through into the urethra and the rectum and thus allow the eggs to escape. The blood also flows into these canals, and we have before us a case of that dangerous disease called haematuria, when blood instead of urine is discharged. Bilharzia has separate sexes. We understand that the constant presence of two animals made hermaphroditis unnecessary. With this differentiation into sexes we find also a change in the form of the body: the male becomes rather broad, flat, and forms a canal by bending over the rims of its body so that the slender, round female may be received into it and carried around for life.

This advantage of having the eggs of an individual fructified by the sperma of another is impossible in worms which are thoroughly sessile ; because they cannot move, they are only able to fructify their own eggs. Yet that was not sufficient for a length of time; they needed "fresh blood," a "renewal of blood," and soon special arrangements were made for the copulation with other individuals. This is done by free-living larvæ. Such are always to be found when the sessile animals developed from the former, and they are essentially necessary, because only in this way an extension of the species may be possible. All sessile parasites have a free-living early stage, which settles in a proper place after some time, and then reaches its full development and sexual maturity. Part of these free-living early stages, however, obtained such sexual maturity even earlier still, during their free life, and they were now able to transfer their germinal matter upon a sessile companion. If we ask which of the two sexes was prominently suited for such a part, we shall learn that the male animal had to take that task upon itself, since among nearly all lower forms of animal life the females, as bearers of many and heavy eggs, possess a much more awkward and clumsy shape and less movability. Moreover, the maturing of the sperma takes place always somewhat earlier than that of the eggs. Even in immature hermaphroditic forms the important question must have been how to deposit the male sexual products of the free-living individuals on the female organs of the sessile animals.

In developing this state of things further, the female element could be suppressed completely, and there remained at last only freely moving male individuals which served as sperma-depositors upon the females and then had fulfilled all that was required of them. Here we have within the same species two entirely different forms which come from equal larvæ : the principal form hermaphroditic, which is produced after the settling down of the larva, and males which remain more or less in the larva state and do not become sessile. Both kinds are, of course, very differently formed; the species is, to use the scientific term, dimorphous, because besides the real animals which have sex we have very small complementary or dwarfish males.

There is no more doubt now that all parasites are differentiated concerning their sex at some time of their life, and produce fructified eggs from which a new generation is developed. This sounds very simple now, but it required a long time, and enormous difficulties had to be overcome before this fact was recognized and fully established.

Those eggs seem indeed to be treated rather carelessly, when we compare their way of being brought forth with that of free-living animals. Most of the latter take at least some care of their brood; they deposit them at some place where they are protected from outside dangers, and where the embryos coming out of the eggs find at once suitable food and shelter. What a difference from the parasites! They can scarcely ever look out for the welfare of their offspring. They are forced to lay their eggs just there where they are without being able to do the least for their good; they must leave all the following stages of development to chance. One might think that the continued existence of the young larvae is by no means doubtful, as they are born in a place where the parents have all the conditions of life fulfilled to the best advantage, so that nothing would be left for the young but to grow up beside their parents. This is, however, an impossibility, for the accumulation of parasites in the same host in such a way would lead within a short time to destruction of health and life of the host and would, in consequence, also endanger the existence of the parasites themselves. Bearing in mind this fact, we are ready to understand the law that the young never grow up beside their parents, at least never attain their full development, but must always leave their abode and seek a new host before they can reproduce their species. This seems to be rather beneficial to the host, but it is a somewhat precarious state for the parasites whose existence is now to a large extent left to chance, because, as said before, the parents cannot provide a way for their young to get along in the world, but must deposit them at random. This danger is met on the side of the parasites by the production of an enormous number of germs, so that in every place and at all times the opportunity is given to infect a suitable animal happening to be near by. All parasites have an enormous fertility, a fertility which leaves anything else in this line far behind. Many such parasites are, strictly speaking, nothing but living ovaria, whose other organs have more or less completely disappeared in favor of the egg-producing organs. Taenia solium, for instance, produces 42 million eggs yearly; ascaris lumbricoides, 64 million eggs, which would be the same thing as if the human female gave birth to seventy children every day throughout the year.

This immense fertility is easily conceivable when we imagine that no other animals find all the conditions for it so favorable. They need not spend any time nor bodily effort on locomotion nor the supplying and digestion of food; they can easily turn all their energies upon reproducing their species. Thus we see that these two circumstances, which are important for the existence and preservation of the animals, are also in close connection with each other. Great fertility enables the parasites to risk a rather uncertain way of reproduction, *i. e.*, of preservation of species, and their mode of living warrants on the other side an extreme fertility, an enormous number of progeny. There is never a lack of probability that one or the other of those millions of eggs which are strewn out every year will reach a suitable place where it finds all the conditions of development, and if only one single one of many millions should succeed in finding such favorable conditions, the preservation of the species is secured; the remaining millions may perish!

Nevertheless, the number of eggs produced and laid is always in a certain and well settled proportion to the probability of whether the embryos will get along easily and develop properly. For we must remember that the development of the brood is not so simple as often imagined by non-specialists. Many people think that the egg must simply get into another host in one way or other in order to grow up there; this is very rarely the case. On the contrary, the wanderings and travels of some of these creatures are sometimes truly marvelous, and the investigation of the same have taxed the ingenuity and sagacity of the shrewdest and most experienced observers. One example may suffice as an illustration: Trichina spiralis—that famous round-worm which has brought death upon hundreds of people. Discovered by Hilton in London in 1832 in a human corpse, recognized as a worm by Owen in 1835, it was for a long time a puzzle for scientists as well as medical men, until Leuckart, in Leipzig, succeeded in 1860 in clearing up the darkness concerning this worm, and in proving that this little animal, far from being a harmless guest of man, as people had believed until that time, belongs to his most terrible foes. How true this statement is has been woefully and disastrously experienced many times in nearly every country of the globe since high percentages of people died from infecting themselves with trichinas. This disease is known under the name of trichinosis, which sometimes appears in really epidemic form.

The principal carrier of this worm from which men get it in most cases is the pig; it lives also in rats, dogs, cats, foxes, etc. Ordinarily it is found in encysted stage in the muscles of different animals. In these muscles, and in these only, the observer notices numerous small white knots, capsules, in which the worm is seen rolled up in the form of a spiral. In this form and shape the trichina is able to wait a long time, sometimes ten or twenty years, even more, and this form is also nearly always the one being observed. Yet this does not represent its definite state, only one of immaturity. As soon as such meat studded with encysted trichines is eaten (even if it should be slightly boiled, the worms will remain alive in their capsules), they leave their cysts in the stomach, grow to maturity within a few days, and produce a progeny numbering many thousands for each single female. These young parasites make haste to leave the alimentary canal in enormous quantities, bore through its walls,and arrive finally in the voluntary muscles, where they come to rest. They live on the substance of the same and cause them to decay and perish. During their growth they roll up in a spiral, surround themselves with a capsule of a lime-like nature, and become again encysted trichinas. The other forms which became mature in the intestines have correspondingly the name intestinal trichinas; they soon perish after having produced their eggs, at all events they play a much less important rôle concerning their mode of life than their early immature forms. Since we know this development of the trichina, we are able to put a stop to its introduction into the human body—in other words, to prevent trichinosis. This is one of the first and most important practical results which these researches in parasitism have produced,for which we all must be eminently thankful to such investigators as Leuckart (the "inventor" of trichinas), Virchow, Zenker and others. But only in our day have we succeeded in banishing this gruesome foe from our doors and from our bodies through a strict, general and systematic examination of every piece of pork which is to be eaten.

In the life history of trichina we have the simplest possible way before us in which the development of a parasite may proceed. The young forms are introduced into a host, mature there and produce progeny which grow up in the same spot and then wait for another transfer. The whole development happens inside of the host. In most other parasites, however, the eggs get outside and are scattered around, where they often encounter different fates before finding such conditions as enable them to finish their development. The embyro may leave the egg already in the interior of the old host and thus go outside as larvæ. In other cases the embryo does not leave the egg before the latter has reached the outside world, and then it may be able to do so spontaneously, leaving the egg of its own free will and moving around independently, or it may be obliged to wait for delivery inside the egg for weeks, months, or years, this delivery occurring only after the egg has been swallowed by a certain new host whose alimentary canal grants conditions which are necessary for development of the embryo. Both kinds of embryos are built accordingly, the former having organs of locomotion, either muscles (young nematods), or cilia (Bothriocephalus, trematods), in some cases even eyes, while the latter, who need not perform any extensive migrations, have scarcely any such organs or decidedly none. In both instances, however, the eggs must succeed in reaching a locality where they can remain alive for a long time, *i. e.*, water or moist places, for it would be a rare case if a new host were at once on hand to take up the germs. Consequently, probably all parasites possess in this state of development the ability to wait a very long while, not only months, but even years; nay, some of them seem actually to need such a long torpor in order to proceed later in their regular development.

Others have the remarkable faculty of drying up completely without losing their power of recovering and continuing their existence (Ascaris). They can also live in surroundings which would doubtless destroy any other organism, putrescent, decaying material, in corrosive liquids, in alcohol, oil of turpentine, etc. If these species had not such remarkable power of resistance they would have perished long ago on account of their manner of life.

However different the fates of the various kinds of parasites may be, they all have one thing in common: they must resume parasitism sooner or later, in order to reach their full development. This return may be effected in more than one way, either by active immigration, the young animals entering their new host spontaneously—the rarer case—or by passive transportation back into the definite host, the young parasite being taken up by chance in the food or the drink of the future host. The eggs or the larvae dried up cling to leaves or little animals, and the possibility of an importation is at once on hand. This explains why children are so frequently infected by round-worms (Ascaris, Oxyuris)—they are not so strict concerning cleanliness as it would be desirable, and the eggs of those parasites, sticking to fruits, leaves, etc., which are handled by children, gain easy access to their hands and mouths.

The drinking water furnishes another opportunity for carrying the germs of parasites into suitable hosts. This way is used by Ankylostoma duodenale, the worm mentioned before. It is found among people of the lower classes, in Italy for instance, who are not distinguished by an abundance of delicacy concerning the use of water-closets. These people often prefer to get rid of their fæces in the immediate neighborhood of their working places; here those excrements come into contact with the ground-water or are scattered by the rain, and the larvæ contained in it, which need moisture, find thus the best opportunities for growth; very easily they have a chance to be introduced into human beings again, for bricklayers, farmers, gardeners, and all such as come in contact with earth and water cannot help getting dirt on their fingers, and as they are when eating not often so scrupulously cleanly as is necessary to prevent the worms from gaining admission into the alimentary canal, as they drink the water without caring what is in it, they introduce incessantly young worms into their intestines. No wonder that under such circumstances an enormous quantity of parasites may be accumulated, and that the danger for all fellow-workmen is great.

The return of the young parasites into their host is possible only if there are close relations between the latter and the temporary place of sojourn of the former; in other words, the host must at least once in a while come in direct contact with the water or the earth where the embryo is waiting for a transfer. Such conditions are, of course, not always fulfilled, and the prospects for the transportation to a suitable place would be very small for these parasites if nature had not introduced another simple expedient to ward off the dangers possibly resulting from such conditions.

The young parasites are not at once transferred to their final host, but are satisfied with a temporary stay in any animal that just happens to be at hand; they enter into this by active migration or passive transportation, and wait here quietly until they can exchange this temporary place of shelter for their permanent residence. This new host is called the intermediate host, in which the young germs may stay any length of time without, however, obtaining sexual maturity. The latter is possible only in their final host; they must, therefore, be transferred again, which is usually done by the final host devouring the intermediate. The parasites which have remained usually in the muscles of the latter, enclosed in a cyst or capsule, are freed by the digestive liquids of the stomach and begin at once their migration to their final place of abode, where they then grow up to their full size. Thus the life of these animals consists of two phases, represented by two different animals, one serving as habitation for the immature form, the other for the adult individual; and it will not surprise us to find that the intermediate host nearly always belongs to those animals which serve as food for the final host. Thus the larva of echinorhynchus lives in the wornil, which is the favorite food of the pig. Indeed, some parasites can find favorable conditions for further development in certain animals only: they would perish if they happened to get somewhere else—for instance, taenia saginata, the human tape-worm, living in cattle, the tape-worm of the cat, in the mouse, etc. At all events we see that these facts are explained by the necessity of procuring or rather warranting for the parasitic germs as much as possible the ability of being transported into their final host in time and successfully.

But this is not all yet. In many cases this development does not remain so simple; it is complicated by a very strange phenomenon which again increases the immense number of the germs and thus prevents anew a possible extinction of the species. This is the "alternation of generations," which means that all those animals which are subject to it appear in alternating and more or less different forms; the children do not resemble the parents, but the offspring of these children resemble again their grandparents. Only one of the two forms is differentiated sexually, being either separated into male and female individuals or hermaphroditic; the second form does not possess any developed organs of sexuality and produces its progeny always without sexual intercourse. Several kinds of this way of reproduction are possible. It may happen through division, the whole body falling into two or more parts, which then form separate organisms, or by budding, when the individual pushes out small protüberances, "buds," which later drop off and form animals themselves.

A third kind of reproduction is possible and especially found in some of our most interesting and also most dangerous parasites, that of sporocysts,—internal budding. These forms are produced inside the body of the individual parasite; they are egg-like cells, separated from the inner walls of the body, falling into its cavity and then growing up. Before they get outside they must break through the walls of their birth-place, either by means of a previous hole or by tearing the enclosure. This kind of development mainly happens among the trematods or flukes. The simplest imaginable case would be when the progeny produced by the sexual animals in sexual way, after passing through a stage of free life, get into an intermediate host, but do not encyst here nor wait for a re-transportation into the final host, but develop into creatures different from the parents, which creatures produce now in a sexual way a new generation. The latter take early the shape and form of their grandparents and are, after having finished their development, transported passively into their original host, where they become sexual individuals. In opposition to the latter the other, a sexual generation, has been called "nurse."

Some species of Distomum present a still more complicated form of development: the embryos develop into a "sporocyst" or a "redia," both of which may by means of internal budding produce a generation of so-called "cercaria," which become free, then encyst in the body of a second intermediate host after losing the sting near the mouth and tail, and being finally transported into the organism of the definite host, grow up to be sexual animals. This fact is especially interesting since it shows that the young parasites must acquire for the period of their free life a sum of contrivances which they actually need for it, especially organs of locomotion and of sense. Other larvæ, waiting quietly in the interior of their host, do not need such arrangements, and they develop directly into the final form, while the larvæ with a period of free life provide themselves with organs which they later throw off or lose again. Thus these young trematods possess a very movable tail, which helps in the locomotion. They have eyes, etc., all organs which later on disappear again. These forms were at first called "cercaria," because scientists considered them as independent species; later it was discovered that they were only undeveloped forms of other well-known trematods, but they kept this name. These cercariæ have a very limited active life, and in order to prolong it, and the possibility of reaching a host, they encyst, *i. e.*, they form a little capsule around themselves and wait until they are introduced passively into a new host, usually by means of its food.

Thus the cercaria of Distomum hepaticum, the fluke of the Ruminantia, encyst on plants, grass and leaves, with which they are eaten by the beasts. Others select animals, penetrate into their bodies and become thus parasites again before having even reached their final host.

This second intermediate state is always temporary. The parasites do here not reach any higher state of development, they must wait until their host is devoured by another animal. In such a case it may happen that they receive companions in the course of time.

Of two cercariæ of the same sporocyst which went out and found their intermediate host, one succeeded perhaps soon in reaching the final host and producing again progeny ; its grandchildren or great-grandchildren meet perhaps the other one which had been waiting patiently until it might find favorable conditions. The younger one lives besides the old one ; they equal each other perfectly ; and yet one belongs to a time long past, which flowed by without leaving any traces, the other one belongs to the offspring of another that fell to pieces long ago.

In numerous cases there may be a third intermediate host for a third entirely different generation, which also produces germs.

In other instances the sporocysts remain small and baglike, the number of the germs within is only small, and no cercariæ originate from them. Instead of these with their flat bodies, forked alimentary canal and movable paddle-tail, we see forms of cylindric shape, more or less elongated, hose-like, with simple tubular intestines. Their movements are mostly creeping, slow and sluggish; they do not leave the snail-liver, but grow up in it. This form has been called "redia" in honor of the Italian scientist Redi. So we have here three generations: the sexual animal, the sporocyst and the redia. The latter two are the nurse generations, the redia the proper nurse, the sporocyst the grand-nurse.

The germs formed in the redia nearly all develop into cercariæ, some however into so-called daughter-rediæ, which remain at home while the cercariæ emigrate. The daughter-rediæ again give birth to cercariæ and rediæ, and thus we may find a whole series of generations, forms which look alike, but which are by no means so closely and plainly related to each other, but present greater complications than can be stated in a few words. How seasons affect this production of rediæ and cercariæ may be studied in the distomum hepaticum, the liver-fluke, which produces a very dangerous, usually fatal, disease of the sheep. It has also been observed in man, but is not so dangerous here. The liver-fluke has its seat in the liver, the gall-bladder and the gall-ducts, in which it produces many disastrous changes; the functions of the liver being thus impeded, the animal becomes weak, and when the liver is completely destroyed death comes as the inevitable result. There is no remedy for this disease, for if the worms are once in the body the fatal end cannot be averted, because we possess no way to reach them, neither by means of medicines nor with the surgeon's knife. It is therefore necessary to guard against the introduction of the germs, but the life-history of the early stages of the liver-fluke being entirely unknown, nobody could say what was to be done. As soon as untiring researches stated the different crooked ways of development, the farmer and ranchman could protect his sheep and thus himself against damage.

This first necessity was therefore to find the intermediate host which housed the first stage of embryonal development. After many fruitless experiments and investigations a little snail, limnæa minuta, was found to be the first intermediate host. It has a very wide extension, living especially in shallow ditches and ponds and is scattered in spring when rain and the melting of snow swell the waters far over the adjoining meadows. In May, when these localities are not yet dry, the cercariæ emigrate and encyst on plants of all kinds. Here they wait as long as their surroundings remain moist, and are finally swallowed again by the sheep into whose liver they wander. Thus we know how sheep may be infected, and it is not hard to guard ourselves against possible harm: keep the sheep from wet places, use the grass dry only, since cercariæ cannot live for any length of time when dried up.

In similar way, somewhat simplified, the development of the cestods take place. The grown tape-worm has a rather sharply defined head with four sucking-cups and possesses a long tape-like body composed of single joints and destitute of a special alimentary canal; each joint, however, possesses an entirely independent sexual apparatus with special orifices, while the other organs stretch through the whole length of the body. This chain of joints must be considered not as a single animal, but as a colony of individuals, the joints, which are always in internal connection. These individuals, the proglottids, may loosen themselves from the colony and live an independent life for some time. The organization of these animals is very simple, but sufficient for their needs, consisting only of muscles and genital organs. After their separation from the chain these proglottids stay in the alimentary canal of their host for some time, move around and may even be able to leave the latter spontaneously (taenia saginata), while others are ejected with the fæces and thus scattered around on fields, etc. Such proglottids originate from the head or scolex of the worm which sticks to the wall of the intestines, and represents thus the organ of fixation for the whole chain, the joints being saved the trouble of producing their own. After the formation of one joint, another one is produced between the first and the head; all others originate in the same way, so that the first and oldest joints are to be found at the remotest end away from the head. They increase in size and thickness toward the end and develop more and more their inner organs, the sexual organs; a fructification takes place, and the eggs inside wait until the joint leaves the host. The number of such joints may vary greatly, likewise their form and size. Several tape-worms never have more than four joints (taenia echinococcus); others possess many hundreds. Man has the largest tape-worms (taenia solium, the hook-bearing, and taenia saginata, hookless); other large specimens are taenia coenurus of the dog and bothriocephalus, whose number of joints often reaches seven or eight hundred and even goes beyond one thousand, the whole chain having a length of ten yards and more. The head or scolex is then the same as the nurse which produces sexual individuals in a sexual way; it corresponds to the redia, with the difference that the latter produces its progeny inside, not outside, as the scolex of the tape-worm.

Bothriocephalus, "having suckers in its head," is in shape like a cucumber seed and instead of sucking cups has only two shallow furrows lying on the edge of the head, also no hooks at all. A representative of this species, Bothriocephalus latus, the broad tape-worm, is found in man in places where fish are eaten raw. Its joints are much longer than wide, and the worm itself reaches a length of nine or ten yards, while the number of its joints, which are distinguished by the rosette-shaped ovarium, may run up to several thousands. Their eggs are deposited in water; the young embryos break through by opening a little cover provided for that purpose, and wander into an intermediate host, usually some fish, where they lose such organs as they had developed for this short period of their free life,—organs of locomotion, etc.

Eggs of other cestods are not deposited, but must wait until they get out of the host passively. The proglottids reach the outside; they may creep around, are brought on the fields with the manure, and even if they should dry up and die, the eggs which they contain are protected from the inclemencies of the season, from cold and bad weather, by three or four layers of tissue, one of them of especially great thickness. The form of the embryos coming out of those eggs is very characteristic, so that they may always be defined. They are small, globe-like bodies, whose chief distinguishing features are six sharp hooks with bent tops. These hooks are movable by means of muscles and may be turned backward and forward.

The eggs with the embryos therein are transported into the stomach of some intermediate host, usually some herbivorous or omnivorous animal; there the young worms leave the eggs and begin at once to work a path through the walls of the intestine, especially by means of the hooks mentioned. Sooner or later they reach a blood-vessel, and may thus be carried to the remotest parts of the body until they finally settle in some definite organ. Here they lose their embryonal hooks, which may often be found in the surrounding tissues a long time after, and change into thin or thick-skinned bladders filled with water, which do not betray their animal nature in any way, save by some slow, wave-like contractions. These bladders grow, however, and become at last a rather considerable object, around which the tissues of the host have secreted a cover of connective tissue—a cyst. At the same time we notice on closer inspection that the wall of the bladder begins to thicken in one place; this thickening increases and protrudes into the interior as a hollow projection, which grows in length and finally, as it does not find sufficient room inside, folds itself into many wrinkles and curves. The walls become also thicker and exhibit soon at the bottom of the depression some growths which prove to be four sucking cups inverted, and sometime a rostellum with a circle of hooks. All this lies yet in the interior of the bladder like the finger of a glove turned inside out; soon, however, this formation does turn out, so that the inner wall of the growth becomes the outer, whereupon the whole represents a well developed scolex of the tapeworm with sucking cups and hooks.

The bladder is called cysticercus. For a long time it was considered an independent animal; only recently its relations to the grown-up form of the tape-worm have been established. Formerly they were considered as water-bags, degenerated parts of the animal body, and no one had any idea of their being real worms. Küchenmeister succeeded in proving that when brought into the alimentary canal of another animal they lose the bladder and grow up to be tape-worms. These are a necessary stage in the development of the tape-worms, so that the latter may be said to have a regular metamorphosis. Quite frequently there is not one head being developed in the bladder of the cysticercus but several, even a great number, so that we are justified in calling this form the nurse or grand-nurse, producing a new generation by means of budding. This new progeny does not leave its place of birth but remains in contact with the nurse exactly as the redia did, until the nurse gets into the body of the final host and produces there in a sexual manner the generation of sexual individuals, the tape-worm chain.

Still more interesting and more noteworthy, because sometimes infecting human beings, is another tape-worm, taenia echinococcus, whose cysticercus produces a much greater number of growths developing into a scolex. Its embryonal state is known as echinococcus or "sheath-worm." It is a very small tape-worm whose chain is composed of not more than four or five joints. The last one only is mature, but as soon as it is thrown off the following one ripens. The worm lives in the intestines of the dog, the cysticercus is developed in cattle and often also in man, where it many times is the cause of death. The structure of this cysticercus is rather remarkable: the skin hard and firm, while the young tape-worm heads do not grow directly on the inner side of the wall of the bladder, but on the outside of little bladders which have grown from the walls of the primary bladder. Later they are turned inside out as described before, and closely packed in the interior of the cysticercus, waiting for a chance to be transported into a final host.

The size of this parasite varies; ordinarily it is about that of a hazelnut or walnut. Cases are known, however, when echinococci of the size of a child's or even of a man's head were found that weighed ten or fifteen kilogrammes. It cannot be astonishing that such a parasite causes serious troubles through its bulk and the dislocation of surrounding organs. Lungs and liver are its favorite abode, yet it has been found in nearly all other organs, even in bones, which it softens and sometimes destroys completely. It is also found in the brain, and in the eye; in short, there is no part of the body which may not harbor an echinococcus at times. Its real hosts are pigs, cattle, and sheep, which have many opportunities to be infected with it. It finds, however, all the conditions for full development in man also, and then it becomes a very dangerous guest. It appears all over the earth, especially in some countries, *i. e.*, in Egypt, in Australia, prominently in Iceland, which has a sad reputation for its "liver disease": among 25 people there is surely one suffering from it. This disease has several very different symptoms, depending upon the seat of the worm. In many cases no disturbances arise, and a post-mortem examination only reveals the presence of the parasite. The number and size of the individuals will, of course, also influence the degree of the ailment. A cure is rarely possible, and treatment is not often accompanied by real and lasting relief. Under such circumstances the only reliable remedy is guarding against infection. We know that the dog is the real host of this tape-worm, and the only animal that furnishes its eggs; therefore *beware of coming in close contact with dogs.* The observation that Icelanders are visited by this ugly disease is corroborated by the circumstance that they have such intimate intercourse with their dogs, sharing not only food but even lodging with them, so that a non-infection is really the exception. Also in other countries intimacy with dogs is a wide-spread bad habit. Kissing dogs or being licked by them is indulged in as a special treat by many people of the fair as well as the stern sex, and the consequences are only natural. How may we find the desirable protection? As a rule worms found during the slaughtering of cattle should be carefully destroyed, not simply thrown away where they will find new opportunities of infecting other individuals, but burned.

The cysticercus of taenia solium, called cysticercus cellulosæ, has at first its seat in the muscles and other organs (tongue, brains, heart, diaphragm) of pigs. It makes its appearance there often in great numbers, because those animals frequently devour whole tape-worm joints together with the eggs therein. The muscles then look as if studded with pearls, and it is astonishing how the animal can live with such an infection. This cysticercus meets favorable conditions for development not only in the pig but also in man, and has in this case the dangerous inclination to locate in the eye or in the brain, thus, of course, destroying the power of vision in the first case, and causing epilepsy, convulsions, lameness, etc., in the latter, in short, it often causes severe and dangerous suffering. These cysticerci are taken up in the usual way by infecting one's self with the eggs of taenia which may stick to the hands of a friend or fly around with the dust. Such a friend harboring a taenia solium should be declared a "nuisance" and made harmless.

Other tape-worms possess only one or a few intermediate hosts, and these are represented by animals which form the chief food of the final host, for the young parasites have a better opportunity to enter the system of a carnivorous animal and develop there when their intermediate host is devoured by the other. On the other hand the germs which the final host strews out everywhere and at all times are especially deposited where they find ways and means of being taken up by another intermediate host, *i.e.*, where the latter lives and gathers its food. There they hang on leaves, on grass, lie on the ground, stick then to the skin and feet of the animal and find thus ample opportunity of being transported into the mouth and from there into the alimentary canal.

These discoveries have all been made within a comparatively recent period, and would not have occurred to any one in former years; still a good deal of investigation remains to be done. What we know now about parasites is only the frame-work of the whole structure of knowlege. We lack yet very many of the details. It will be necessary indeed to continue untiring observations and researches, to add stone after stone to the glorious building of truth which is being erected by hundreds of faithful workers. Then only can we think of solving the many other questions of our "helminthology," of studying not only the anatomy and embryology of the parasites, but also the whole sum of conditions which exist between their different representatives, between them and other animals, between them and their hosts, between them and their way of living—truly a large and extensive territory! However, the beginning is made, and we have a right to hope that it will have a successful continuation. And just this recognition of what is still to be done may teach us how hasty and wrong the conclusion is that we have accomplished everything we wanted to know and to do. No doubt we have a right to say, when we look upon that has been accomplished: "Well done, good and faithful servants!" Nevertheless, let us look ahead and keep in mind that we have only stepped over the threshold of the temple of science, that we have not yet advanced into the Holy Place, and that the curtain which hides the most precious facts of truth has not yet been withdrawn. In 1780 a well known scientist called that century the century of natural history, because such giant steps had been taken in it . . . . what do we think today of those giant steps? And who can tell us what the people of the coming century will say concerning our present knowledge?

APRIL 23, 1895—TENTH REGULAR MEETING.

Chairman Burgess presiding, and forty members and guests present. Dr. J. W. Poucher presented the following paper on

TUBERCULOSIS.

It almost seems as if I ought to offer an apology for coming before this learned institute to-night with so old and worn a subject as consumption, a subject with which you are all well acquainted and still a subject of which we are all still far too ignorant. All other contagious diseases are kept at arms' length. Small pox, diphtheria, scarlet fever and even cases of measles are rigidly kept under quarantine and carefully avoided by all; but this arch enemy of the human race, which lurks everywhere around us, is scarcely dreaded at all, and by the vast majority not even known as a contagious disease, to be feared and shunned as more fearful and deadly than all others put together. Tubercle in its various forms at the present day carries off annually about 110,000 persons in the United States alone, about one-seventh of all who die. At the ages between 15 and 45, the most useful stages of human existence, it kills more than one-third of the people who die, and between the ages of 15 and 35 nearly one-half. Moreover, its prolonged and painful course prevents its victims from earning a livelihood. Its habit of seizing upon the flower of the population; its slow, but in the majority of cases almost certain progress toward death; the very distressing weakness and suffering of the last few weeks or months of the fell disorder, render its study all important, not only to medical men but also to all who are concerned in the welfare of the nation. Up to quite a recent date, not only was consumption supposed to be incurable, but it was also regarded as almost inevitable. Families in which there existed a taint of the disease were supposed to be doomed to lose some of their members from this cause.

A great change has, however, been wrought of late years in medical opinion upon this subject, and tuberculosis has come to be looked upon as both a curable and preventable disease. With regard to its preventability there is not the shadow of a doubt. In England the report of the register general is positive proof that the influence of modern sanitary measures, such as good drainage, good ventilation and improved hygiene, has reduced the mortality from this disease during the past thirty years more than one-third. In the year 1858, out of every million persons 2,560 died from phthisis or consumption, but in 1888, thirty years later, it was only 1,541 per million, a diminution of over 1,000. This in a population of over 29,000,000 was the rescue of about 30,000 lives every year from this cause alone. In Massachusetts, which has at present probably by far the best hygienic management of any state in the Union, the number of deaths from consumption in 1857 was 39.50 to every 10,000 of population. In 1883, under improved hygiene, this was reduced to 29.90 to 10,000 people. In 1858 a commission was appointed to inquire into the sanitary state of the British army. The result was the publication of a very interesting table showing that the mortality among soldiers crowded into unsanitary, illy ventilated barracks, many of them in foreign and unhealthful climates, from consumption alone was something frightful, ranging from 15 to as high as 91 to 1,000, almost one to every ten men, and these had been selected, healthy men. In 1874 this high death rate from consumption had been reduced in the army to less than 10 to 1,000, and in 1883 it was 6 to 1,000. At the present time it is still further reduced. Up to 1882, when Koch's great discovery and positive demonstration of the bacillus tuberculosis as the "causa vera" of consumption, there had been no end of learned and elaborate theories as to the origin and nature of tubercle.

All these surmises are now of interest mainly as matters of history. Scrofula and phthisis have also been shown to be due to one and the same cause, and lupus is recognized as a tubercular disease of the skin. Besides Koch there were many observers on the lookout for specific organisms, especially Chauvau, Baumgarten and Zeigler. I have said that lupus and scrofula are believed to be identical with tuberculosis, and there is another important disease which very closely resembles it, and that is leprosy. In their pathology, in their course and distribution, and in many other features these diseases show the closest relationship. A micro-organism is closely associated with each disease, and the bacillus of leprosy is so similar in appearance and in its reception of staining fluids that the most accomplished bacteriologists can find little or no difference in appearance between it and the bacillus of tubercle. Differences in action, however, exist, for the bacilli of lepra exist in much larger proportion than those of tubercle in diseased tissues. Leprosy has never been produced by inoculation and pure cultivations of lepra bacillus cannot be obtained. It is probable that leprosy was even more prevalent during the middle ages than phthisis is even now. During the reign of Louis VIII it is known that in France alone there were no less than 2,000 leper hospitals endowed by his will, and that throughout France, England, Germany and Italy there was no less than 19,000 of these asylums.

There has never been any doubt as to the contagiousness of leprosy, for in all countries from the earliest time the leper was "unclean," and his clothing and dwelling were equally regarded as contaminated, and all kinds of devices were adopted to avoid contagion. He wore a distinguishing costume and carried a bell or clapper with which to warn those he met. He had a separate "borde," or hut, or slept under a hedge. He might not even look into any well or fountain, or drink from any stream but his own. He must keep to leeward of any one whom he might meet or speak to. He had to wear gloves when he passed over a bridge, and could go nowhere without a special license. In the 14th century they were supposed to be associated with the Jews in a horrible plot to poison all the springs, wells and rivers with their blood, and in 1321 a fearful massacre of them took place in France. At Chinon 160 were burnt in one day, and at Perigord and Languedoc in a plague panic, fires were lighted everywhere and lepers and Jews heaped thereon. One thing is certain, the fears of the people and the means they adopted had the effect of banishing the dread disease from most of the civilized world. Should not we with our fuller knowledge be able to banish a disease so similar?

HISTORY.

Tuberculosis has been known to exist and has been the dread of the human race since the time of Hippocrates, but it has remained for the men of our day to get acquainted with it Virchow first accurately described the miliary tubercle about 1860. In 1866 Klenke, in Germany, first suggested, and Villemin, in Paris first proved its contagiousness by inoculation, but it remained for Robert Koch, nearly twenty years afterwards, to make the final advance by his brilliant discovery of the producer of tuberculosis. What had been so long sought in vain,the virus which produces tuberculosis, was found in the tubercle bacillus. Koch proved incontrovertibly in 1882 that it alone can produce tuberculosis. Koch also showed that the bacillus may be cultivated outside of the human body in an artificial nutriment (best in blood serum, coagulated by heat or nutrient agar, to which five per cent glycerine has been added), and finally that in suitable climates tuberculosis may be produced by inoculation with pure cultures. He found the bacillus constantly present in thirty-three cases of tuberculosis in men, and in thirty-four cases in animals, and in three cases of scrofula in men. He had by its means produced experimental tuberculosis in 174 guinea pigs, thirty-two rabbits and five cats. He had subjected his discovery to every crucial test. From this time on the bacillus tuberculosis has been the subject of earnest work of all students of general bacteriology and experimental medicine. It is a minute, rod-shaped vegetable organism, varying from 1.5^{mm} to 3.5^{mm} in length, and 0.2^{mm} in breadth. It is easily recognized by its staining peculiarities, differing from all other bacteria except that of leprosy.

Except in proper cultures in favorable temperatures, it does not multiply outside infected persons or animals, although it has been proven that it will retain vitality and virulence for months, and even years in dark rooms that have been occupied by tuberculous patients. The bacillus or little rod is so minute that it is practically impossible to see it unless it is brought into contrast with its surroundings by staining it and leaving the back ground unstained or *vice versa.* One method is to color the whole mass with a saturated alcoholic solution of fuchsin and then by immersion in dilute nitric acid the color is abstracted from the surrounding substances, leaving the tubercle bacilli standing out as little rods on a colorless ground. When the world accepted Koch's theory of the bacillary origin of consumption, most of the previously existing theories and axioms concerning it had to be given up, and none of these were clung to with as much tenacity as that of hereditary. There is perhaps no fact of experience which was regarded so strongly as the heredity of tuberculosis. Every day we see tuberculosis reap its harvest among the progeny of a tuberculous father or a phthisical mother. We see the children of such parents grow up scrofulous in childhood and perish tuberculous in youth, yet late and elaborate investigation has not found one single proof that a child or animal was ever born tuberculous. On the other hand, there are very many evident methods for the infection of young children. The intimate contact of the nursling with a sick mother or nurse, the kisses of a tuberculous father, the infection of the child's food with tubercle bacilli, the bacillary infection of wounds.

All these are means of infection against which the helpless infant is so much less resistant the weaker its organism. Infection of milk containing germs is probably the most direct method next to direct infection by diseased relatives, on account of the frequency of tuberculosis or "pearl disease" among cattle. It is possible that the fear of bacilli in milk is very much exaggerated, but the frequency of tuberculosis of the mesenteric or abdominal glands in children always points toward infection by food; and since the infectiousness of milk of cows suffering from the pearl sickness has been proven, we can look upon it only as a great danger. If so large a proportion of our milk is tuberculous, you may ask why does it not infect everybody, for everybody must at some time introduce these germs into their systems. All are not at all times susceptible; there is an unknown pathological something which we call predisposition, when certain conditions are present which favor certain developments, and it is in regard to this predisposition that heredity plays an important role. Heredity has its influence in the transmission of lowered vitality. If there is hereditary predisposition to consumption, marked by the slim body, flat chest, thin limbs, delicate complexion, weak voice, etc., there is also an acquired predisposition to it produced by modes of life, insufficient and improper food, unhealthy habitation and want of fresh air, worry, over-exertion, both bodily and mentally, as well as disease. Of all these factors perhaps none exerts as great an influence as want of out-door exercise and fresh air.

Consumption is a house air disease. Animals which perish in captivity nearly always die of consumption as the result of bad air and little exercise. The general mortality from phthisis is about 15 per cent. whereas from the accurate tables prepared by Dr. Baer the mortality in prisons is from 40 to 60 per cent, the highest in the prisons of Austria, where it was 61 per cent, and the lowest in Bavaria, 38.2 per cent, and the average amounts to the fact that about one-half the inmates of penal institutions die of phthisis. In these instances there are two powerful factors to consider, close confinement and a cell that has in all probability been infected with tubercle bacilli by a former occupant. Prof. Von Ziemssen says that over 50 per cent of the Sisters of Charity in the Munich hospitals die from tuberculosis. These are generally chosen from among robust, red-cheeked country girls, but their arduous and sedentary duties undoubtedly predispose them, and almost constant contact with tuberculous patients does the rest. One of the difficulties in the way of tracing the disease to any particular source of infection is the fact that after gaining access into the system it may remain latent for a long time—even years, before springing into activity. I once treated a young girl for incipient pulmonary tuberculosis who improved so much that I thought she was cured, but an attack of measles three years later so aggravated it that she died of acute tuberculosis in a few days.

The two most common avenues for the introduction of tubercle bacilli into the human system are by inhalation into the air passages, and by its introduction into the stomach with articles of food and drink, but there are many authentic cases where it has been accidentally inoculated into the skin and caused tuberculosis. A veterinary surgeon named Moses, while doing a post-mortem upon a tuberculous cow, accidently cut his hand. He first suffered from local tuberculous abscesses, and afterward developed general tuberculosis, which proved fatal. Only a few months ago Prof. Gutzman, of Berlin, while holding an autopsy on a patient who had died from acute tuberculosis, slightly injured one of his fingers under the nail. He felt a slight pricking sensation at the time at the tip of his finger, but could see no wound. He washed the finger carefully in corrosive sublimate and alcohol and forgot all about it. A month later it became painful and a small abscess was found under the nail. This was opened and the pus examined and found to contain tubercle bacilli. This cavity was, of course, carefully cleaned and every precaution possible taken against general infection, but the professor is awaiting results, as may be imagined, with no little anxiety. However, by far the most common mode of infection is by inhalation into the air passages, and since the lungs are by far the most exposed of all the organs, pulmonary consumption is the most common form of the disease.

Just what conditions are necessary in the bronchial or alveolar mucus membrane for the favorable reception of the bacilli is not exactly known, but it is pretty well agreed that there must be either a predisposition or a deteriorated condition of the air passages which favor the lodgment of the bacilli, which are inhaled in the form of dust in the air. In all probability every person living has breathed into his lungs very many of these deadly little germs, but in perfect health they have done no harm. The healthy mucus membranes of the air passage are covered with little arms or cilia, which are in constant motion, and doubtless serve more than anything else to prevent the lodgment of dust and bacilli there; but any little patch of congested membrane or any spot that has become denuded of its cilia by a cold or cough, or other cause, may be pounced upon, and when once the living bacillus has found a place to lodge, it immediately multiplies and becomes a focus around which myriads of baccilli form. These in time prey upon the immediately surrounding tissues. As soon as they have exhausted the material in the center of this area, the bacilli dies and a cheesy degeneration takes place, and we have a mass of small grayish miliary tubercles (so called from their resemblance to the millet seed), with a belt of living bacilli working their way into the surrounding healthy tissues. These in time die, for the life of the bacillus is very limited, but under conditions favorable to them the supply is always replenished. Then a few bacilli are taken up by the circulation and carried to another part of the organ, and another focus is established. At length a number of these foci coalesce, and the degenerated tuberculous mass suppurates and becomes broken down, and the result is a lung cavity or abscess.

Sometimes this process takes place very rapidly, and a fatal termination is reached in a few weeks or months, and then again it may continue on for years. There are well authenticated cases where the process has to all appearances been entirely arrested, but where the germs have laid latent in the system for many years and suddenly broken out in its most virulent form. The material coughed up by persons suffering from consumption contains these germs often in enormous numbers.

This material, when expectorated, frequently lodges in places where it dries, as on the street, floors, carpets, handkerchiefs, bedding, etc. After drying in one way or another it is very apt to become pulverized and float in the air as dust. The bacilli have been found in almost all kinds of public conveyances, and in all conceivable places. The bacteriologist of the Brooklyn Board of Health has recently made cultures of dust from dried sputum found in the street cars in that city, and has found bacilli which produced fatal tuberculosis in guinea pigs inoculated with it, and the health commissioners have ordered that all stations and cars in Brooklyn be thoroughly cleaned every three days with a solution of corrosive sublimate. Dr. Cornet has made some very interesting observations. Of 112 samples of dust collected from the walls of hospital wards and bedsteads and rooms of phthisical patients, forty were found to be infective and produced tuberculosis on being inoculated into susceptible animals. Among other novel sources of infection are bedbugs. Two young men having died from general tuberculosis in a room that had been especially disinfected, examination showed the bedstead to be filled with these parasites. Thirty of the bugs were gathered and inoculated into three guinea pigs, which soon died of tuberculosis. Sixty per cent of the bugs were found to be tuberculous. In another set of experiments the bugs were placed in contact with sputum, and some weeks afterward virulent cultures were obtained from them.

RULES FOR AVOIDING CONSUMPTION.

In 1889 the New York Board of Health formulated these rules, by which it hoped to lessen in a measure the spread of the infection:

(1) Do not permit persons suspected to have consumption to spit on the floor or on cloths, unless the latter be

immediately burned. The spittle of persons suspected to have consumption should be caught in earthen or glass dishes containing the following solution: Corrosive sublimate, 1 part; water, 1000 parts.

(2) Do not sleep in a room occupied by a person suspected of having consumption. The living rooms of a consumptive patient should have as little furniture as possible. Hangings should be especially avoided. The use of carpets, rugs, etc., should always be avoided.

(3) Do not fail to wash thoroughly the eating utensils of a person suspected of having consumption as soon after eating as possible, using boiling water for the purpose.

(4) Do not mingle the unwashed clothing of consumptive patients with similar clothing of other persons.

(5) Do not fail to catch the bowel discharges of consumptive patients with diarrhœa in a vessel containing corrosive sublimate, 1 part; water, 1000 parts.

(6) Do not fail to consult the family physician regarding the social relations of persons suffering from suspected consumption.

(7) Do not permit mothers suspected of consumption to nurse their offspring.

(8) Household pets (animals or birds) are quite susceptible to tuberculosis, therefore do not expose them to persons afflicted with consumption ; also do not keep, but destroy at once, all household pets suspected of having consumption, otherwise they may give it to human beings.

(9) Do not fail to cleanse thoroughly the floors, walls and ceilings of the living and sleeping rooms of persons suffering from consumption at least once a week.

A CASE OF CONTAGION.

A few years ago I had among my patients in this city a woman afflicted with chronic phthisis, and as these cases frequently do in patients over fifty years old, it ran a slow, tedious course during the greater part of three years, and during all this time, in spite of all I could say or do to prevent it, she went about coughing and expectorating everywhere, at first in ordinary cuspidors, or in any convenient place, and after she had grown too weak to get around, began to use cloths, although I tried and did finally discourage their use ; but during all this time I never succeeded in arousing in any of the family any realization of the danger they were in. This woman was the mother of seven children, the youngest a girl sixteen years old. Five of these were at home and two were away during this time. This patient died about five years ago, and since that time every one of the five who remained at home during the illness of their mother have died from consumption, though up to that time they had all been healthy. The two who remained away are still in first class health. There is no evidence that tubercle bacilli are ever exhaled by the breath, but Koch, Villemin and Thaon have all proven that the disease can be produced in animals by their inhaling tuberculous liquids in the form of spray, and in one of these experiments Prof. Thaon himself contracted phthisis, from which he died.

Next to inhalation by the lungs, the most common source of infection is as I have said, through the food and drink, raw or partially cooked meat, or drinking water that has been exposed to the dust of drying sputum. I myself have seen pails of drinking water stand in dusty factories and workshops, where scores of persons all quench their thirst with one common cup. But when we consider the alarming prevalence of tuberculosis in cows, and how much of the milk we drink is infected, we must consider this a very common source of the disease, especially the infant abdominal tuberculosis, or "tabes mesenterica," as it is called by the Germans. The reason why children are more often infected is perhaps two-fold. They are usually fed almost exclusively upon milk, and the very young of all species are most susceptible to the disease. This question of tuberculosis of cattle is one of the most important matters with which our country now has to deal, for it certainly exists to a most alarming extent, and not in our own country alone, but all over the world. To New York State belongs the credit of passing the first law which gave authority to deal with the examination of cattle to determine the existence of tuberculosis, beginning in 1893 in a small way the examination of cattle. It was found that Koch's lymph or tuberculin (which is a culture fluid in which tubercle bacilli have been grown) is so accurate as a means of diagnosis that any competent veterinarian can point out a diseased animal with absolute certainty. The action of tuberculin is explained by the fact that the animal system has a certain amount of toleration for all kinds of poisons. The most powerful poison may be given to man or animal in small doses without toxic effect. Most of you are acquainted with the characteristic fever and chill in advanced cases of consumption, which is caused by the absorption of ptomaines and other poisonous substances from the degeneration of dead tuberculous matter in the system. In other words, where the disease is already present, enough tuberculin is manufactured in the system to overcome the toleration for it, and when a fresh supply is injected there is a very decided toxic effect produced. This effect is, of course, greater or less in proportion to the extent of the disease. If it is injected into a healthy animal or person in ordinary quantity it is tolerated and gives no reaction.

EXAMINATION of CATTLE.

During the year 1894 the New York State Board of Health examined 22,000 cattle, and of this number caused to be slaughtered about 800, and so important was this work thought to be that in May, 1894, a commission on tuberculosis in cattle was appointed. This commission has shown that nearly 7 per cent of all the cattle in the state are tuberculous, and I believe there is a bill now before our Legislature asking for an appropriation large enough to enable this commission to examine every head of cattle in the state. Massachusetts already has such a law, and only the other day the governor of New Hampshire vetoed the bill giving $100,000 for this purpose in that state. Pennsylvania and other states are now preparing for the work. The department of agriculture at Washington is doing everything to encourage the work, and is engaged in the manufacture of tuberculin. Outside our own country, Denmark, Germany, Switzerland, France, Belgium and Great Britain are engaged in the work of eradication of tuberculosis. Even Australia is making investigation. The relation of the milk supply to infant mortality has been insisted upon by every health officer who has made it the subject of systematic investigation. It has been proven again and again that infected milk and its products will produce tuberculosis. On an average 10 per cent of the world's milk supply is tuberculous. Prof. Roth, of Zurich, went into the markets of Switzerland and purchased butter from twenty different sources representing different cantons of Switzerland. He then inoculated guinea pigs with the butter, and two out of the twenty produced tuberculosis, and the same experiment was tried in Turin, Italy, with exactly the same result. Perhaps the first and most important step is the destruction or proper disposal of all tuberculous animals, and as cattle are the most susceptible, and most other animals derive their infection from this source, the careful examination and destruction of every diseased bovine should be insisted upon. I say that cows are the most susceptible to tubercular infection, and this is doubtless true, but this does not mean that other animals escape it. Horses and dogs are less susceptible probably from their outdoor life, large vital organs and abundant circulation, but they are not immune, for as to immunity from tuberculosis, we are not sure that such a thing exists.

We know that in other infectious diseases there are some, such as erysipelas, diphtheria and pneumonia, where no immunity is produced by an attack, however severe, while in others, as variola, scarlatina, measles and whooping cough, one attack affords perfect immunity for a life time. It was the great hope of Prof. Koch and his followers that tuberculin would furnish the much desired immunity, but it failed in this, though it found such a broad field of usefulness as a means of diagnosis of consumption in cattle.

CONSUMPTIVE PEOPLE.

Although we can destroy diseased cattle, what shall we do with the great number of humans who are already infected and infecting others? I am not going to advise their destruction, but merely to point out what I think the best means to prevent their destroying others. Next to the disposal of tuberculous cattle, if not first in importance, comes disinfection of the sputa. Every particle of sputa that is raised or coughed up by patients suspected of having tuberculosis should be directly ejected into some strong antiseptic solution, such as corrosive sublimate, 1-1,000; carbolic acid, 1-30, or a strong solution of chloride of lime, or formalin; and the utmost care should be used to educate the patient and those around him to the danger to which he subjects those living with him, if any of the spittle is allowed to dry upon the floors or handkerchiefs, or even the public streets.

Persons suspected of having consumption should not be allowed to marry, for should a consumptive and a healthy person marry the latter is sure to become infected sooner or later, and the children born of consumptives are always naturally predisposed to tuberculosis. Thus the centers of infection are increased and the danger to society becomes much greater. No consumptives should marry; and it is perfectly proper for science to interfere and use all its influence to prevent such marriages. Simple advice in such a manner does little good, as we all know. I once had quite an expensive experience of this kind. It happened several years ago while I was practicing in a country town. A young man, a patient of mine, came to me one day telling me that he was engaged to mary a certain young lady, also a patient of mine, and as he had some little suspicion that she was not very healthy asked my opinion in the matter. I thought it my duty to let him know just how matters stood, so I informed him that I considered his fiancee in the first stage of consumption and advised him to temporize for at least a year. Instead of taking my advice he confided it to his sweetheart, who resented what she considered "none of my business," and the result was that my advice hastened instead of delaying the wedding, and I lost two good families. In about a year the young wife died of tuberculosis, leaving as a legacy to her husband the same disease, from which he has since died. Now what can be done for those already infected and suffering from tuberculosis? First, the disease must be recognized by an early examination of sputum. The earlier the disease is discovered the more chance for improvement, or cure. The patient must early give up any confining in-door occupation and seek outside employment, and if possible change of climate. There are many localities much more favorable than others, and above all things it is necessary to leave the city with its vitiated atmosphere far behind. It seems to me almost the duty of the state to build sanitaria in different parts of the country, where the poor can be taken for treatment under compulsion, if necessary. There are at present many mountain resorts for the well-to-do. Mountain air is preferable, and that in a tolerably cold climate. Probably the best planned and most beneficial institution for the treatment of tuberculosis in existence to-day is the Adirondack Cottage Sanitarium at Saranac Lake. It has at its head Dr. E. L. Trudeau, a celebrated student and bacteriologist. It began in 1885 with two small buildings to accommodate six patients, while now it has 22 buildings and accommodates 82 patients. Here the system of out-of-door treatment is carried out as fully as possible. Few medicines are used, and these only to meet various symptoms. About 25 per cent of the cases are reported cured, and many more go out with the disease arrested.

In our county Gen. J. Watts De Peyster has given $30,000 towards building a hospital at Verbank for the care of victims of tuberculosis, and within the past month Mr. J. Pierpont Morgan has contributed $20,000 for building a stone sanitarium at Liberty, Sullivan County, for the treatment of consumptives. These will undoubtedly be conducted on the Adirondack plan.

At Asheville, North Carolina, Dr. Karl Von Ruch has a sanitarium for the exclusive cure of lung diseases, where he combines the hygienic or fresh air treatment with the etiological or the treatment by animal serums or toxins. In favorable cases he uses tuberculin, but in most cases uses anti-phthisin, a modification of tuberculin, made by Prof. Klebs, in which the germ products and toxins are removed. It is claimed for it that it can be used in doses 1,000 times larger than tuberculin without any toxic effects. Dr. Von Ruch claims for tuberculin and anti-phthisin that they will cure cases of phthisis where there is not too much degenerated tissue.

Where large masses of degenerated caseous tubercular tissues are found the action of tuberculin causes it to rapidly break down, and thereby hastening the process and endangering the patient's life. If, however, tuberculin never cures a case of consumption the world owes to Robert Koch more than to any other living man, for first in 1882 he showed us the nature of the disease by his demonstration of the bacillus tuberculosis, and again in 1891 he gave us a positive means of finding out disease wherever it may lurk; for if tuberculin has not proved a specific for the cure of all cases of consumption it was a discovery that is likely to lead to greater results than any discovery of the century.

With the light that is dawning brighter and clearer every day there can be no doubt that we shall soon be able to place consumption with small-pox and leprosy upon the retired list.

The annual report of the Curator and Librarian was received and placed on file. Officers were elected for the ensuing year as follows: Chairman, D. B. Ward; Secretary, F. M. Barber; Curator, C. N. Arnold; Librarian, C. N. Arnold.

DECEMBER 10, 1895—FIRST REGULAR MEETING.

Chairman Ward presiding, with about sixty members and guests present. Mr. Edward Elsworth read a paper on

THE SANITARY DISPOSAL OF SEWAGE.

Mr. Elsworth spoke of the importance of the subject in connection with the conservation of public health and gave an historical description of many ancient sewers built for the disposal of public waste.

The contaminating devices of later times, such as cesspools and vaults, which still are used in many crowded communities, and quite generally by the scattered rural population, were condemned as being unsanitary in principle and the fruitful sources of the contamination of domestic water supply.

With the growth of large cities in Europe and America came the problems of sewage disposal and the necessity for avoiding the pollution of rivers and streams. Much time was devoted to a description of modern methods, consisting principally of disinfection, chemical precipitation, underground disposal with incidental æration, and filtration through broad areas. The latter is approved as the system offering the best results at the least expense, wherever local conditions are favorable thereto. As illustrations, the systems in successful operation in Berlin, Paris and other European cities, and in this country at South Framingham, Lawrence, Brockton, Marlboro, Gardner and Amherst, Mass., were cited. This system consists in collecting, through ordinary sewers, all town sewage at a given point, and pumping it thence (or allowing it to flow by gravity), to fields of gravelly or sandy soil, where it is allowed to flow over the surface and filter gradually through the soil. By having several fields the operation can be made intermittent, and a comparatively small area suffice for the reception and disposal of a large amount of sewage for an almost indefinite period.

A history of the treatment of sewage at Vassar College was given, to which was added a description of the methods at present employed. Heretofore the sewage was filtered imperfectly through tanks of muck and gravel, and the final effluent discharged into a small stream flowing through the college grounds; thence into the Hudson River at a point some six miles distant. During the summer of 1895 a farm of two hundred acres adjoining the college property was purchased, and a system of intermittent filtration installed. All sewage from the college buildings, including storm water, is led through the main sewer into a receiving tank, whence it is pumped onto filter beds, prepared on the purchased farm. Conduits have also been laid so that the sewage can be applied directly to growing crops. This system was adopted by the college authorities after a most exhaustive examination of all known modern methods of sewage disposal, and the results attained justify the choice. It is the most satisfactory solution of the question from both a scientific and sanitary standpoint.

Mr. John I. Platt was proposed for membership.

JANUARY 21, 1896—SECOND REGULAR MEETING.

Chairman Ward presiding, with about one hundred members and guests present. Dr. Selwyn A. Russell read a paper on "The Miracles of Lourdes." Mr. John I. Platt was elected a member of the Section and Dr. E. M. Burns was proposed for membership.

FEBRUARY 11, 1896—THIRD REGULAR MEETING.

Chairman Ward presiding, with about fifty members and guests present. A paper was read by Rev. James Nilan on "The Philosophy of Revelation." Mr. E. M. Burns was elected a member of the Section.

FEBRUARY 25, 1896—FOURTH REGULAR MEETING.

In the absence of Chairman Ward, Mr. John C. Sickley presided. A paper was read by Mr. W. C. Albro on "Excessive Taxation."

MARCH 17, 1896—FIFTH REGULAR MEETING.

Chairman Ward presided, with about fifty members and guests present. Mr. Charles E. Fowler, Superintendent of the Poughkeepsie City Water Works, read the following paper on the

PURIFICATION OF PUBLIC WATER SUPPLIES.

BY CHAS. E. FOWLER.

When we speak of the purification of public water supplies clarification is to be understood, as a matter of course, but it is intended to go much farther and remove those substances that are prejudicial to the practical operations of domestic and manufacturing interests and to the health of the community, the latter taking precedence.

The opinion of scientists as to the constituents which render water injurious to health, as well as their methods of detection, have obeyed the common law and experienced change with the march of years.

It is not many years since it was the prevailing opinion that the specific substances contained in water and revealed by chemical analysis rendered it injurious, regardless of their source, or the circumstances of their formation; hence the careful determination of mineral constituents.

At the present time the effort of the sanitary water analyst, ordinarily, is to determine the origin and condition of the organic matter, and judge therefrom as to the probable presence of those germs of disease which may accompany organic matter, but which cannot be detected by chemical examination, and which constitutes the chief source of danger in ordinary surface waters, such as comprise the much larger portion of the water supplies of this country.

It is interesting to compare two chemical analyses of the water of the Hudson river. The first, made by Prof. Farrar, of Vassar College, in 1869, and the other by Prof. Drown, of Mass. Inst. of Technology, in 1893. Both analyses have the same purpose, to wit: to determine the suitableness of the water for domestic use.

Prof. Farrar's analysis is as follows:

	Grains in Imperial Gallon.
Silica,	2.64000
Sesquioxide of Iron,	4.37606
Carbonate of Lime,	1.27297
Sulphate of Soda,	3.33753
Chloride of Sodium,	0.13079
Carbonate of Soda,	2.54746
	14.30481
Organic matter,	0.92864
Total,	15.23345

He adds, "whether the organic matter is of animal or vegetable origin I am unable to say. * * The organic matter of less than a grain in weight might do infinitely more mischief than the 14 grains of mineral matter."

Prof. Drown's analysis is as follows:

Turbidity,		slight, clayey.
Sediment,		considerable, earthy.
Color,		0.38.
Odor, cold,		very faintly vegetable.
" hot,		very faint or none.
Residue on evaporation	Total,	6.05 parts in 100,000
	Loss on ignition,	1.40 " " "
	Fixed,	4.65 " " "
Nitrogen	Albuminoid Ammonia,	0.0156 " " "
	Free "	.0054 " " "
	Nitrites,	.0002 " " "
	Nitrates,	.0130 " " "
Oxygen consumed,		.5925 " " "
Oxygen consumed in solution,		.5250 " " "
Chlorine,		.100 " " "
Hardness,		3.3

It will be observed that in the former analysis there are seven determinations, of which six are of mineral constituents, while the organic matter is simply noted in quantity with no effort to determine its origin or character.

In the latter there are sixteen determinations, three of which relate to mineral substances and the remaining thirteen to ascertaining the character of the organic matters.

The nitrogen compounds are especially interesting because of the change which takes place in the process of purification, called nitrification, wherein the ammonias and the nitrites diminish and the *nitrates* increase.

When the former analysis was made bacteriology, as an aid to chemical analysis, as now practiced, was unknown. The belief that all forms of disease *transmitted* by water have their origin in those minute objects termed bacteria, and the knowledge that the actual number, and in some cases the precise kind, of bacteria contained in a given water may be determined, has brought this method of water examination into great prominence. Of course it does not do away with the necessity for chemical analysis, for water may contain mineral constituents very objectionable and which can only be determined by chemical examination. Moreover, the differentiation of specific bacteria is a tedious and costly operation, and therefore when the number of bacteria in a water is determined the probable presence of pathogenic germs is usually inferred from the chemical analysis and the surrounding conditions.

When, however, the normal chemical constitution and surrounding conditions of a water have been determined, the efficiency of any process of purification can be reliably observed by a comparison of the number of bacteria present in the applied and effluent waters of the system in use.

Until within a very few years, in this country the principal object aimed at in securing public water supplies has been never-failing abundance. We desire plenty. Having been endowed as a nation with plenty of land we desire an abundance of water also. Consequently, while European cities are content and cleanly with twenty-five or thirty gallons of water per inhabitant per day, American cities require from three to five times that quantity. To meet this extravagant demand has, therefore, occupied the attention of projectors and authorities largely to the exclusion of the more important considerations of quality.

The more general distribution of sanitary knowledge has directed public attention to the fact that the quality of water supplied to a community has even more direct relation to its health and prosperity than the quantity and investigation and efforts are being put forth accordingly.

The recent growth of municipal water supplies in this country has been something remarkable, as regards numbers. The Manual of American Water Works, issued in 1890, stated that—

In 1800	there	were	5	public	water	supplies	in	the	U. S.
In 1810	"	"	14	"	"	"	"	"	"
In 1820	"	"	18	"	"	"	"	"	"
In 1830	"	"	31	"	"	"	"	"	"
In 1840	"	"	50	"	"	"	"	"	"
In 1850	"	"	69	"	"	"	"	"	"
In 1860	"	"	133	"	"	"	"	"	"
In 1870	"	"	245	"	"	"	"	"	"
In 1880	"	"	636	"	"	"	"	"	"
In 1889	"	"	1960	"	"	"	"	"	"

Showing that from 1881 to 1889 more than twice as many public water suppplies were constructed as existed prior to 1881. Of course the enormous later development consists of the smaller cities and villages that seem to have realized at once the greater convenience as well as healthfulness due to public water supplies in general.

Of the 1,960 municipal water supplies existing in the United States in 1890 it may be said that 192 had at that date attempted by some means to artificially improve the quality of the water. Of these 94 were but crude attempts to remove the coarser particles in suspension by means of boxes or cribs placed at the intake and filled with stones and gravel, sometimes adding charcoal, and sometimes sponge, or even screens of cloth; beds or banks of sand are used in some cases, but with no provision for cleaning, regulation or intelligent control. Thirty-four use a slow, natural filtration by means of wells and infiltration galleries excavated in a porous stratum near a river bank.

There remained, therefore, in 1890 but sixty-four municipal supplies of which it could be said, strictly speaking, that intelligent efforts were made for the artificial purification of the water.

That water may be strongly offensive to the senses and produce no ill effects upon health finds a marked illustration in an investigation conducted by Prof. A. R. Leeds, in relation to the water supplied to the city of Philadelphia, in January, 1883, from the Schuylkill River, which at that time was covered with ice and extremely offensive to smell and taste, the odor being in some instances communicated to the food cooked therein, and gases were evolved sufficient to be ignited. After discussing the causes, etc., Prof. Leeds says: "Letters addressed to eminent physicians in Philadelphia elicited the uniform response that no connection could be established between the character of Schuylkill water supply in the month of January and any case of disease within their practice." Many forms of algæ growths, under certain conditions, impart a very disagreeable odor and taste to water, yet they are usually regarded as having no tendency to produce disease. On the other hand a clear mountain stream has been known to scatter the seeds of suffering and death through an entire community.

On the principle that "an ounce of prevention is worth a pound of cure" the negative method of purification, by prevention of pollution, adopted by the city of New York, should take a high rank in methods of water improvement. The supply of New York is drawn mainly from the water shed of the Croton River. This water shed comprises within its limits a number of villages and a few manufactories. The entire area is under surveillance, and under a special enactment of the State Legislature, every objectionable feature, artificial or natural, has been or is being removed from within a distance of 250 feet from every stream, pond, or reservoir therein. The village of Carmel consisted of a principal street running north and south near the easterly shore of Lake Glenida, within the Croton water shed, its outlet forming a tributary to the middle branch of Croton River. Houses were located on both sides of this street, those on the westerly side being within the prescribed distance. They were consequently ordered removed, and now a beautiful lawn has taken their place. Throughout the entire Croton basin above Croton dam this process of removal has taken place in greater or less degree until the waters are as free from contamination by refuse from human habitations or industries as they well can be. Watch is also maintained to prevent any encroachment upon this prescribed limit.

The simplest method of direct purification is by sedimentation, by the use of settling basins or their equivalent. The efficiency depends upon the character of the substances in suspension, little or no effect being had upon matters in solution, and the length of time available for deposition. It has been stated that even bacteria are subject to the laws of subsidence, and gradually pass to the bottom, so that, with sufficient time, varying from a few days to many months, almost any water may be rendered safe for use by simply standing quiet in a basin or reservoir, unless its character is such as to develop algæ growths. Except where the impurities are such as to subside rapidly, as the sand of some western rivers, the size of reservoirs required renders the method impracticable. It is used to some extent in the west. In 1889 a series of experiments were conducted at St. Louis, Mo., to determine the most favorable conditions, from which the conclusion was drawn that filling one basin at a time and allowing it to stand until needed is preferable, from an economic point of view, over continuous flow through a larger basin.

In 1889 thirteen western towns were using settling basins.

Precipitation or sedimentation may be greatly facilitated by the use of some coagulating substance that will group together the finer particles, having nearly the same specific gravity as water, and carry them down. A small quantity of alum, sulphate of alumina, placed in a bottle of water turbid with clay will produce a precipitation in a few hours that without this aid requires many days. It is said to have been in use for centuries in India and China to purify water from suspended matters. Its efficiency is said to be somewhat dependent upon the presence of calcium carbonate in the water. By the decomposition of the alum calcium sulphate is formed and a gelatinous aluminum hydrate which, together, surround the particles of foreign matter, including bacteria, and carry them down.

A similar effect may be produced by metallic iron in solution. If in a bottle partly filled with turbid water a quantity of iron borings be placed and the bottle be corked and shaken vigorously for a few minutes and then uncorked and set aside, sedimentation will soon begin and in a comparatively short space of time the water will be clarified.

The chemical action, it is said by Dr. Leffman, of Philadelphia, "consists in great part in the conversion of the iron into ferrous carbonate (proto carbonate of iron) through the agency of the carbonic acid, which partly dissolves in the water and partly remains suspended in the form of dark green turbidity. On exposure to the air the iron is converted into ferric hydroxide (hydrated sesqui-oxide of iron) which, settling rapidly, carries down with it and oxidizes the organic matter. * * * * * In addition to the above chemical effect it is probable that in some waters, *e. g.*, those containing much dissolved organic matter, a direct oxidation of this occurs at the same time that the iron is acted upon, with the result that the iron salts of organic acids are developed and these are subsequently thoroughly oxidized when exposed to the air." Efforts have been made to put this aid to sedimentation in use in one or two places in this country.

One method of operation is to cause the water to be treated to pass longitudinally through one or more iron cylinders which revolve slowly.

Attached to the inner periphery of these cylinders are shelves. A quantity of cast iron borings or wrought iron plate punchings are placed in the cylinders. As these revolve the shelves take up the fragments of iron and shower them down through the water in its passage through the cylinders.

The diameter and length of the cylinders are so proportioned as to give the necessary length of contact between the water and the iron. The constant attrition of the fragments of iron keep their surfaces bright, and thus in the best condition for being dissolved by the water. Some method of æration is used in connection with this process to hasten the oxidation of the dissolved iron. After passing through the cylinders and the ærating device, the water is delivered to the settling basins where it is allowed to stand until clarified. This method was said to have been tried at St. Louis, Mo., and to give excellent results.

Beside being used as above stated, simple æration is sometimes used as a method of purification in connection with sedimentation, and sometimes in ordinary distributing reservoirs.

Its peculiar function is to drive out the gases arising from the excessive development of certain forms of low plant life, which impart an unpleasant odor or taste to the water, and also to prevent such excessive development. It is usually accomplished by forcing atmospheric air, under pressure, through small openings in pipes laid around, into, or through the reservoir or basin; and sometimes by means of cascades or other methods of exposure in open air. It has been commonly supposed that the forcible introduction of air into water, or the agitation of water in contact with air, would hasten the oxidation of organic matter contained therein by a process analogous to combustion.

Elaborate experiments by both A. R. Leeds and T. M. Drown show conclusively that such is not the case. Dr. Drown sums up the results of a long series of investigations in connection with the Massachusetts State Board of Health as follows: (1) "The oxidation of organic matter in water is not hastened by vigorous agitation with air or air under pressure. (2) The æration of water may serve a useful purpose by preventing stagnation, by preventing the excessive growth of algæ, by removing from water disagreeable gases, and by the oxidation of iron in solution."

The sewerage of the village of Brewster, N. Y., within the Croton water shed, discharged into the east branch of the Croton River. There was no land available suitable for the disposal of this sewage, so a method of electrical treatment, before its discharge into the river, was adopted. This method is known as the "Woolf" system. In this instance "salt is added to water at the rate of 16 pounds per 100 gallons. The brine thus formed is electrolized and the decomposed product is discharged directly into the sewer.

The operation is performed in a wooden tank inside a small building. The current from a small dynamo passes through a positive electrode of copper, plated with platinum, and a negative electrode of carbon, both immersed in a tank." The outlet sewer discharges into trenches excavated in a meadow near the river. The object of this process was to *disinfect* the sewage, and it is said that both chemical and biological examinations indicated most satisfactory results. This process was subsequently, in 1893, applied to the water of the Croton itself at this point, by increasing the capacity of the previous plant, and using a 3% solution of salt and water for the purpose, the electrolized solution being discharged into the stream through a perforated pipe extending across the river.

I have seen no statement of the efficiency of this latter application of this process. Dr. T. M. Drown, in a paper read before the N. Y. Water Works Association in 1894, says of it. "The so-called electricial purification of water by treating it with an electrolized solution of salt is simply a process of disinfection by sodium hypochlorite; electricity, as such, has nothing to do with it. There is nothing peculiar in the sodium hypochlorite produced by electrolysis; it has no different properties from that made by the ordinary process of passing chlorine into a solution of caustic soda." Dr. Drown further says: "In cases where a water supply is in such a hoplessly bad condition that nothing will render it safe but disinfection by chloride of soda or chloride of lime, it is high time, I think, to abandon the supply."

Several other attempts have been made to apply electricity to the purification of water, both in England

and in this country. One, in this country, attempted to charge the water with oxide of iron by the electrolysis of that metal. None of these, however, have as yet advanced beyond the experimental stage.

One effort recently made, however, is so unique as to justify a brief description. The principle of action is the destruction of the bacteria and their subsequent precipitation. The water is made to pass transversely through a small, short cylinder, in the axis of which are two electrodes approaching nearly. A current of high voltage is passed through the electrodes and the water is so directed as to pass between them. The shock is supposed to destroy every atom of bacterial life. After leaving this cylinder the water is passed through three chambers, in each of which are a number of carbon plates connected with a powerful battery located on its top, the carbon plates being placed vertically near the top of the chambers. Electric terminals are connected to each side of each chamber below its center. A powerful current is passed through the battery and at the same time through the sides of the chambers. A magnetic field is thus induced in which the vibratory impulses are at right angles to each other and the molecules of water in passing through this field are *dissociated* and freed from all extraneous matter, which is thrown down, the effluent water being purified. I visited this experimental plant in Brooklyn, last summer, at the urgent request of the inventor and saw it in operation; but there were no appliances at hand for even the simplest comparison between the applied and effluent water. The appearance of the former was good enough, and that of the latter was certainly none the worse. The only chemical analysis shown me indicated a slight increase of "organic and volatile matter" by the treatment; the figures in parts per 100,000 being before treatment 3.8, after treatment 4.0; mineral matter, non-volatile was reduced, being before treatment 4.3, after, average of two, 1.5. I was urged to enquire of Dr. Cyrus Edson, late of the Board of Health of New York City, as to its efficiency and did so. He replied saying that he had caused many analyses, chemical and bilogical, to be made of water treated by this process, and although he had not preserved them he could assure me the results were most satisfactory, particularly from a bacterialogical standpoint, the water so treated being rendered absolutely sterile.

At the present time there seems to be but one practically efficient means of purifying water on the large scale, as practiced in this country and Europe, namely, filtration through sand.

Two methods of sand filtration are in use, to wit: rapid, commonly known as mechanical, filtration, and slow or natural filtration.

The first or rapid method is largely in use in this country but, as yet, seems to have found little favor abroad. In this method the sand is placed in tanks of iron or wood to a depth of from four to six feet. Perforated pipes, or other appliances, are arranged on the bottom of the tank so as to retain the sand and yet permit a free exit of the filtered water. They are usually operated under a greater or less pressure or head of water, the top of the tanks being closed. The water is forced through the sand at a rapid rate, usually about seventeen feet, vertically, per hour and filtering about 3,000 gallons per square foot in twenty-four hours, depending of course upon the condition of the applied water.

With this high rate the accumulation of silt and other impurities is very rapid and the sand soon (in twenty to thirty hours) becomes so clogged that the required quantity of water will not pass through. It is necessary, therefore, that some means be provided by which the sand can be quickly and thoroughly cleaned. This is sometimes accomplished by means of reversed currents of filtered water forced upward through the bed of sand and run to waste until it runs clear. Mechanical devices are sometimes added for the purpose of agitating the sand while the reverse current is passing. In others the entire body of sand is forced upward with the washing current into a chamber and then allowed to flow back into its proper position. This process of cleaning the sand is one of the essential features of so-called mechanical filtration. It is usually done once in twenty-four hours and is ordinarily accomplished in about half an hour.

The various mechanical devices adopted for this purpose, as well as the appliances before mentioned for retaining the sand while permitting the water to pass, are the subjects of many patents held by different inventors and covering, apparently, every possible variation of arrangement. This method of filtration is, therefore, at the present, entirely controlled by patents.

With the rapid rate of passage of the water through the sand, this substance alone is able to accomplish very little in the way of purification, only the very coarsest matters in suspension being retained by the sand, the effluent otherwise differing in no degree from the applied water. The use of coagulants is, therefore, a necessary feature in this method of filtration. Any substance that will group together the minute particles of clay or other impurities will serve the purpose.

Sulphate of alumnia has, however, been found to be not only cheaper but equally efficient and the most easily applied of such substances. It is, therefore, generally adopted for this purpose. A solution of lump alum is prepared of known strength and this solution is applied to the water entering the filter in the precise proportion requisite to accomplish the necessary coagulation. This is a very difficult as well as a very essential part of the operation and many mechanical devices are in use to perform this duty. The principle of applying a substance to water for the purpose of coagulating its impurities is not patentable for it has been in use, as before stated, for centuries. But the various devices for regulating the strength of the solution and of proportioning the supply to the volume of influent water are the subjects of many patents.

In 1890 forty-three public water supplies were said to be using this method of filtration. I have received statements from officials where it was in use expressing great satisfaction with the results obtained. Eminent authorities express their approval of the process.

In 1887 the city of Newburgh was considering the matter of improving its water supply and the manufacturers of a mechanical filter plant proposed a method of purification involving the use of their filter with subsequent æration. The proposition was regarded favorably by the water board, who employed Prof. C. F. Chandler to investigate and report upon its adaptability to their case. His report stated that experiments made with the water supplied to Newburgh showed that the plan proposed was "simple, efficient and economical, and that no objections whatever can be found to it on sanitary grounds." The plan was not, however, adopted. Prof. A. R. Leeds is an ardent advocate of this method of purification, although it should be stated in this connection that he is also a director in one of the companies manufacturing filters of this class. Nevertheless I believe that his analyses of water and opinion based thereon can be relied upon.

In regard to a sample of water from Cincinnati, Ohio, before and after treatment with this process, he says: "The change from a dirty, opaque, turbid water—with strong taste and smell—to a colorless, palatable water, the removal of all suspended matter and the great difference in the results of analysis after filtration, compared with those of the water before filtration (the analysis of the filtered water showing a high degree of purity), are most emphatic proofs of the benefits conferred by this process. It seems to be admitted by the ablest opponents of this method of filtration that coloring matter can be removed from water more readily by this process than by any other.

The quantity of alum used is generally stated at about one-half grain per gallon of water filtered and to vary from 3-10 to 7-10 grains, according to the condition of the water treated. There are waters, however, which require very much more.

The water of the Hudson is of that class. In the spring of 1886 the water of the river was very turbid with clay and our filter beds were unable to clarify it. One of the mechanical filter companies sent a small filter here and erected it at our pumping station and operated it for a month or more. Its mechanical operation was apparently satisfactory and it was possible to render the water as clear and bright as the purest spring water. When I enquired as to the quantity of alum used, the attendant stated that he did not know and had no means of determining it. From experiments made by myself, with barium chloride and hydrochloric acid, I found it necessary to add at the rate of about five grains of alum per gallon to the water of the river to produce the same reaction that was obtained with the water as it came from the small filter. I concluded, therefore, that more than five grains of alum per gallon were required to produce the results obtained. In other conditions of the river less alum would, of course, be necessary.

With a very small filter and slower rate of filtration and less clay in the applied river water, I have found four grains of alum to produce excellent results.

Slow or so-called natural filtration through sand has been practiced in Europe for half a century. About thirty years ago the city of St. Louis was considering the question of purifying its water supply and employed the late James P. Kirkwood, civil engineer, to investigate the filtration systems of Europe with a view to their application to the needs of that city. As the result of his investigation he submitted a report that has become standard authority for the condition of filtration at that date. St. Louis did not adopt that method of purification.

A few years later, however, the water supply of the city of Poughkeepsie was projected and Mr. Kirkwood employed as consulting engineer. According to his plans, and under his supervision, the filtration system of this city was constructed upon the general principles and arrangement of the slow sand-filtration systems of Europe.

Our city thus became the first in this country to adopt a systematic purification of its water supply by sand filtration, the mechanical methods having been invented several years later.

In this method of filtration the standard rate at the present time is about three inches vertical per hour—less than one-sixtieth part of the rate adopted in the mechanical filters.

Consequently the area of sand surface to filter a given quantity per day must be proportionally greater. Therefore basins of masonary or of earth embankments are constructed to contain the filtering materials. Sand is the filtering medium, and as in the mechanical filters, means must be provided to retain the sand while the filtered water passes freely out. This is sometimes accomplished by placing upon the bottom of the basin a layer of coarse, broken stones, then a layer of smaller stones, then successive layers of coarse and fine gravel until the upper layer of gravel is fine enough to support the sand. Sometimes instead of broken stone, bricks laid dry, with open joints, are used, and sometimes drain pipes of virtrified clay, laid also with open joints, are used. The purpose of the stones, bricks or drain pipes is to conduct the filtered water to the main drain usually running lengthwise of the basin through its center. The thickness of sand employed varies from two feet to four feet. The area of filtering surface should be about one acre for every 2,000,000 gallons filtered in 24 hours. The filters recently built at Hamburg, Germany, were designed for one acre for each 1,600,000 gallons in 24 hours. Other German filters have one acre for each 2,500,000 gallons in 24 hours, and a few have a much higher rate. The London filters, and that recently built at Lawrence, Mass., have an area of one acre for each 2,000,000 gallons in 24 hours. The impurities removed from the water are collected on the surface of the sand, and when this has accumulated to such an extent as to prevent the passage of the desired quantity of water, the water, which is usually four or five feet in depth over the sand, must be drawn off and a thin layer of the sand, about one-half inch, together with the accumulated silt, removed by means of laborers with shovels, after which filtration proceeds as before. The period of time elapsing between these cleanings varies ordinarily with the condition of the water, from two weeks to two months. An essential requirement of this method of filtration is an ample area always in good order.

At the present time the efficiency of this method of filtration is judged, principally, from the results of bacteriological examinations of the water before and after passing the filters. In European filtration systems from 98 per cent. to 99¾ per cent. of the bacteria in the applied water are removed by filtration. The new filter bed at Lawrence, Mass., is said to remove something over

98 per cent. In the matter of water purification by this method of filtration Germany is in advance of all other countries. In 1894 the German government adopted a set of rules regulating the filtration of surface waters used for public water supplies. Among other requirements is that of daily bacteriological examinations of the filtrate from each single filter; and every city in the empire is requested to make a quarterly report of their working results (bacteriologically) to the Imperial Board of Health.

A sand filter bed is a very efficient but highly sensitive appliance. When in good order and properly operated the results obtained are most satisfactory. When the conditions are changed the efficiency rapidly deteriorates. My observation of the working of our own filter beds has been that, while unfavorable conditions greatly reduce the efficiency no condition has ever existed by which the effluent water was rendered *worse* than the applied river water but always better. The appearance of the water always indicates this and all the chemical and biological examinations made, without an exception, show this to be the case.

Our beds were designed to filter at a much more rapid rate than the established rate before stated. The total area of filtering surface is 29,300 square feet, or about two-thirds of an acre. The quantity filtered was intended to be 3,000,000 gallons in 24 hours, giving an area of one acre to 4,500,000 gallons in 24 hours, or less than half that above mentioned. The quantity filtered frequently considerably exceeds 3,000,000 gallons in 24 hours, in fact, adding the leakage, the quantity passing through the sand is nearly 4,000,000 gallons in 24 hours.

In the practical management of filter beds many difficulties, not apparent to the casual observer, are encountered. In most cases they are open to the weather, their great area rendering any method of covering a matter of large cost. Some of the European beds are covered. So far as known, the few built in this country are open, except one or two of very small area.

The difficulties mentioned arise from three principal causes, namely, algæ growths on the sand, conditions of weather preventing cleaning, and changes in the character of the water supplied to the filter.

The conditions vary in different localities. Their effect is more marked in our own case for the reason that when our beds are in their best possible order they are too small in area for the work required of them, as shown by the foregoing comparisons.

With us, in warm weather, commencing sometimes with the latter part of May, the development of green algæ begins in small patches on the surface of the sand. Under favorable conditions it spreads rapidly and soon covers the entire area and stops filtration as effectually as a rubber blanket. It cannot be removed so long as any water remains above it. Although forming an impervious covering when undisturbed, so soon as it is touched with a shovel or other implement for its removal, if the water is still over it, it flies in all directions in minute pieces, only to settle in a short time and commence growth as vigorously as ever.

Therefore the water must be entirely drained from the surface of the sand before its removal can be effected.

In our case, as is usual, there is no provision for complete draining except down through the sand. Whenever, therefore, the development has gone so far as to entirely, or nearly so, stop the passage of water, a long time will be required to drain the sand sufficiently to permit it to be properly cleaned. If at such times the water in the reservoir should be low there is great danger that the supply of filtered water shall be exhausted before the beds can be put in operation. Of course it is the constant effort to maintain a sufficient quantity of water in the reservoir to meet such contingencies, but this difficulty always appears at one of the seasons when the daily consumption of water is the greatest and nearest to the maxium capacity of the filters, so that from ten to fifteen days, at the best, are required to fill the reservoir, which would be exhausted in much less than half the time when pumping is discontinued. It sometimes happens that the algæ begins to decrease the delivery from the beds in 48 hours after removal and entirely stops it in seven days, and before we have been able to fill the reservoir to the point where the first development began, so that if a succession of these occurrences should happen the supply would be exhausted from this cause alone; but fortunately these extreme instances do not frequently occur in succession.

The second of the difficulties mentioned, the conditions of the weather, sometimes combines with the former to make matters worse. One of the peculiarities of this method of filtration is that the surface of the sand cannot be cleaned during a storm of any kind. Even if the men could be induced to work it would be of no avail during an ordinary rain storm as the silt and algæ, under the action of the rain slip from the wet shovels only to form a more impervious coat on the cleaned sand. The attempt has been repeatedly made only to find that the work had to be done over again after the rain ceased. It will be understood therefore that if when, by reason of algæ growth, we have been compelled to stop filtering, empty and drain the beds for cleaning, thereby reducing the filtered water supply to just enough to last during the operation of cleaning, and a rain storm sets in delaying the work, the result must be to entirely exhaust the supply and compel us to pump unfiltered water. Ordinarily, when the cold is severe and continuous, the water in the river is comparatively clear, in fact at its best, and the beds would run for several weeks without cleaning. The past winter the cold, though severe, has not been continuous and, from some cause, the river was in in an unusually muddy condition. Much of the time it was impossible to filter the maximum rate while the consumption was much greater than usual, in some days equaling that pumped. In such cases it is impossible to store water in the reservoir. On January 2d an effort was made to clean the beds, but before they could be drained ice formed and the sand froze so that although a large force of men was employed the entire surface could not be properly cleaned and we were compelled to start pumping with but about three-fourths of the area in order. A similar condition occurred on January 13th.

The effect of a change of character in the water of the river is sometimes to very unexpectedly stop filtration, as was the case in the early part of this month. Pumping was stopped on Saturday night with the bed working well and the reservoir full. A heavy rain-storm occurred on Saturday and Sunday. On Monday it was necessary to make some repairs to the pumping engine. When pumping was resumed on Tuesday the water was so heavily charged with mud that we were compelled to stop on Thursday morning, and then to such an extent were the beds clogged that the water did not drain off sufficiently to permit an attempt at cleaning until Sunday morning, and even then not completely. As there was not sufficient water in the reservoir to last over Monday a large force of men was employed on Sunday and were just able to finish the work so that pumping could begin on Sunday night. The difficulties arising from algæ growths and conditions of weather could be entirely obviated by covering the beds; as algæ will not grow except in the sunlight and, with proper covering, the sand would not freeze in the coldest weather and but little if any ice would form on the surface of the water.

We have had many narrow escapes during the past few years but nevertheless have escaped; and during the past fifteen years no water has been pumped to the city that has not passed through the filter-beds.

The efficiency of these beds, when in good order, is shown chemically in the following analyses made by Professor Drown, in June, 1893. These results being the averages of nine analyses of river water at the intake and of six analyses of the water taken at the same date from the clear water basin of the filter-beds:

	Parts in 100,000. Intake.	Clear Water Basin.
Albuminoid Ammonia,	0.144	0.0089
Free "	0.0031	0.0001
Nitrogen as Nitrites,	0.0007	0.00003
" " Nitrates,	0.0108	0.0151
Oxygen consumed,	0.5197	0.3677
Chlorine,	0.1100	0.1110

We observe that *nitrification* or the reduction of ammonias and nitrites accompanied by an increase of nitrates has taken place to a very material extent, indicating that a large portion of the organic matter present has passed into a mineral condition. What has caused the change I do not know. From another analysis we find the following:

	Inlet Basin.	Clear Water Basin.
Albuminoid Ammonia,	.0158	.0096
Free "	.0000	.0000
Nitrites,	.0001	.0000
Nitrates,	.0100	.0150
Bacteria per cubic centimeter,	1576	34

In this we note the same reduction of ammonia and nitrites and a greater increase of nitrates. We note also a reduction of 97.7 per cent. of bacteria.

Whether nitrification has caused the destruction of the bacteria or the destruction of the bacteria has produced the increase of nitrates or if they are independent of each other I do not know.

We have not as yet adopted the practice of having bacteriological examinations made daily, as have the Germans. The first reliable examinations of this kind were made by Prof. Drown, of Boston, in November, 1891. The samples were collected by myself in sterilized bottles, which were placed, each, in an air-tight metallic case, and these in a tin pail with sufficient ice to keep cool without freezing. In freezing weather no ice was used. They were, except the first, collected in the afternoon and forwarded by express, so that they were received by Prof. Drown early the next morning.

The results were as follows:

1891.	Bacteria per Cubic Centimeter. Inlet Basin.	Clear Basin.	Per Cent. Removed.
November 19, high water,	1160	62	94.4
" " low "	1576	34	97.9
December 17, . . .	741	56	92.4
1892.			
January 27, . . .	1020	182	82.1
December 1, . . .	527	43	91.8

The past year we have made a decided advance, and since April 17th ten examinations were made. These were made by D. B. Ward, M. D., the President of this section. The samples were collected in sterilized bottles, and taken to Dr. Ward generally within an hour of collection.

The dates and results are as follows:

Date. 1895.	Bacteria per Cubic Centimeter. Inlet Basin.	Clear Basin.	Per Cent. Removed.
April 17, ...	1215	150	90.1
May 10, ...	1370	75	94.6
June 6, ...	735	11	98.6
July 24, ...	2310	194	91.6
October 4, . . .	440 uncertain	62	85.9
" 16, ...	1005	16	98.4
November 13, . . .	1620	56	96.5
December 5, . . .	1820	76	95.
1896.			
February 14, . . .	1064	736	31.
" 24, ...	80 liquefying	50 liquefying	37.

A marked variation is observed in the number of bacteria in the river water, doubtless owing, in part, to different stages of the tide. The bacteria of the last samples are noted as "liquefying," so that they probably do not represent the full numbers present.

When the beds are in good order the efficiency is very good, considering the rate of filtration. The difficulty, under present conditions, is to keep them in good order and obtain a sufficient supply of water.

This has been impossible during this winter, or, in fact, in any winter, though in some a much nearer approach can be made than in others.

The longer the beds can run without cleaning or undue pressure, the more efficient they are. Results immediately after cleaning are not as good as a week later.

Coagulants can, of course, be used with this system of filtration; but alum has never been used because of the belief that, in the quantity required by the water of the Hudson, its use would be more prejudicial to health than the turbidity. An attempt was made by a private company, about three years since, to introduce oxide of iron by the method before described, but thus far it has failed, by reason of mechanical difficulties.

It is said to have been very successful in connection with some of the European filter plants. Here, however, the experiments made indicate that long contact with the iron is required, with large sedimentation capacity before passing to the beds, and filtration at a very slow rate, to effect satisfactory results. In fact, all experience thus far points to the conclusion that the Hudson River water is not adapted to the use of coagulants.

I am convinced that the best method of purifying the waters of the Hudson at Poughkeepsie is that of slow sand filtration, as now in use. One essential, however, is plenty of filtering area, so that a sufficient surface may always be in perfect order and not overtaxed. The additional bed, for which plans and specifications have been prepared, which is to be built as soon as possible, will double the present area, giving us a total of one and one-third acres, and afford great relief; but, to render them complete, both the old and the new should be covered. Algæ can grow just as rapidly on two beds as on one, and storm and frost can act on both at the same time.

The ablest authorities agree that, in this climate, to obtain best results at all seasons, filter beds should be covered and our experience unmistakably leads to the same conclusion.

MARCH 31, 1896—SIXTH REGULAR MEETING.

Chairman Ward presiding, and about fifty members and guests present. Dr. J. W. Poucher presented the following paper on:

CREMATION AS A SANITARY MEASURE.

Time and experience test the works of man and the highway of progress is strewn with the wreckage of countless inventions, and upon the wrecks of the knowledges of thousands of years the search light of chemistry and microscopy has builded up the new science of Biology that has taught us to look far down into the very proximate principles of our organism for the underlying causes of disease.

I said upon the wreck of the knowledges of thousands of years but I meant upon the wreck of customs, prejudices, dogmas and superstitions. These have one by one given way before the truths of science. But there is one custom still remaining with us, that of earth burial, which, before the Christian era, had become obsolete but was revived through the superstitious belief of the early

Christians regarding the resurrection. At the commencement of the Christian era cremation was the prevailing custom of the civilized world, with the exception of Egypt, where bodies were embalmed ; Judea, where they were buried in sepulchres, and China, where they were buried in the earth. The Greeks, fifteen centuries before Christ, invariably buried their dead ; but in time they learned the advantages of cremation, which became universal. Suicides, unteethed children and persons struck by lighting were, however, denied the right of being cremated. The Romans, who had originally buried their dead, borrowed in time the sanitary practice from the Greeks, and from the close of the Republic to the end of the fourth century of our era burning on the funeral pyre was the usage regarded as most honorable and appropriate. But no sooner had the Christian religion gained ascendancy in the state than its followers abolished this practice, which they looked upon as a pagan custom.

Another reason, as I have said before, contributing to the restoration of earth burial, was the belief in the body's resurrection. That the trumpet would sound and the dead come forth, was a doctrine literally accepted in a physical as well as in a spiritual sense. The superstitious reverence in which the tombs of saints and their mortal remains were beld, enhanced, likewise, the predilection of the Christians for inhumaticn. Gibbon says : "that in the age which followed the conversion of the Emperor Constantine the emperors, the consuls and the generals of the armies devoutly visited the sepulchres of a tentmaker and a fisherman.

The bodies of St. Andrew, St. Timothy, and St. Luke, after reposing for three centuries in obscure graves, were transported in solemn pomp to the Church of the Apostles, which Constantine had founded on the banks of the Bosphorus. When the relics of the prophet Samuel were carried to Constantinople, an uninterrupted procession of devotees filled the highways from Palestine to the gates of the city. By a heavenly vision the resting place of the Martyr Stephen was revealed to Lucien and the remains were taken up and removed to a church built in their honor on Mount Sion, where the learned St. Augustine makes special mention of over seventy miracles performed by the relics of St. Stephen, of which three were resurrections from the dead. These things are mentioned merely to show what state of mind controlled the members of the early Christian church and to show how firmly earth burial became founded upon prejudice and religious superstitions. It is a sanitary question and not a religious one. Our sanitary welfare and our natural affections are alone involved in the final disposition of the dead, and the method that is most conducive to public health and the requirements of human love is assuredly the best. In some instances there is much sentiment involved regarding the perpetuation of the graves of loved ones, but cannot the same care be bestowed upon the resting place of the pure ashes left after cremation as upon the putrefying body, for from the very moment the vital spark abandons the living body putrefaction begins its slow and loathsome process; it gradually passes through the different phases of putrid decomposition too horrible to behold or even describe, until all the constituting elements of the decomposing body are finally set free by a slow and dangerous process of combustion. This process has been known to last, according to circumstances, especially according to the nature of the soil in which it takes place, ten, twenty, fifty and even hundreds of years. While this slow and horrible process is going on, every particle of matter around it is being saturated and infected with these germs of disease and death. This pollution of earth, air and water takes place more readily in certain soils than in others. For instance, in Louisiana, where the atmosphere and soil are saturated with dampness, the land is such that it readily absorbs and retains all sorts of poisonous and offensive matter. On this account the city of New Orleans has adopted a method of disposing of the dead quite peculiar to that locality. Instead of being buried in the ground they are placed in tombs or ovens above ground. These cemeteries are mostly in an overcrowded state and situated in the heart of the city and no care is taken to disinfect them.

There is no place in the world, or especially in our country, where cremation is so sadly needed as in New Orleans. We all know something of the fate of graveyards. Take our own fair city for example. Many of you here know much more than I what has become of the graves where our ancestors rest. Prior to the establishment of Greenwood and other suburban cemeteries, hundreds of thousands were buried on Manhattan Island, where the most populous portions of New York City now stand, and their remains, as well as the tombstones on which their quaint epitaphs were written, have been scattered in every direction.

Dr. Holmes, in speaking of one of Boston's graveyards, says, "The stones have been shuffled about like chessmen, and nothing short of the Day of Judgment will tell whose dust lies beneath. Epitaphs," he adds, "were never famous for truth, but the old reproach of 'Here lies' never had such a wholesome illustration as in these outraged burial-places, where the stone does lie above and the bones do not lie beneath." Prof. Tyndall and others have proven that some disease germs are very tenacious of life, and will survive and propagate after being boiled for hours. Grain entombed with Egyptian mummies for 4,000 years has been planted and sprouted into life. We scrupulously disinfect and quarantine the houses of the plague-stricken, while their bodies we place in the ground, to contaminate the earth, the air, and the life-giving springs. We even dare to preserve in the earth vast storehouses of yellow fever fomites, coffers of Asiatic cholera, and every year accumulate and treasure up small-pox, scarlet fever, whooping cough, diphtheria and measles. The sanitary records of every nation give point and force to this question, and illustrate this danger. Dr. J. Lewis Smith, of New York, mentions the case of a grave-digger who contracted and died from diphtheria, from having disinterred the remains of a person who had died from this disease twenty-three years before. In 1828 Prof. Bianchi, of Italy, demonstrated how the fearful reappearance of the Plague at Modena was caused by excavations in the ground where, three hundred years before, the victims of the pestilence had been buried. It has been fully demonstrated that the opening of a plague burial-ground in Derbyshire, England, occasioned an immediate outbreak of the disease. The same writer proved that the cholera epidemic which scourged London in 1854 could be traced to the excavations made for sewers in the soil where the bodies of those dying from plague were buried in 1665, two hundred years before.

As eminent an authority as Sir Lyon Playfair regards Roman fever as resulting from the exhalations of soil saturated with organic remains. In 1843, while rebuilding an old parish church at Minchinhampton, England, the superfluous soil of the burial ground was distributed as a fertilizer in many of the neighboring gardens. As a result the town was nearly decimated. In 1823, when the plague broke out in Egypt and over 2,000 died in Kelioub and even more in Cairo, the French government instituted a special investigation and traced the evil to the digging up of a disused burial-ground. We seldom take any very great pains to discover the origin of local diseases unless they assume a malignant or epidemic type, and it is quite safe to assume that many thousands of deaths are caused by the disinterment of human remains. We all know that every few years a dreadful epidemic of cholera or yellow fever or small pox breaks out in an unaccountable way and thousands die and are buried by the panic-stricken survivors, and necessarily in an imperfect manner, and is it not safe to aver that in after years, when these localities have been forgotten or the dread has passed, that a new epidemic has been started by digging up this poisoned soil or by an attempt to move some of these remains; for who is there who knows whether this person died from small-pox or that one from yellow fever? It is a matter of history that in 1785 the neighborhood of the Cemetery of the Innocents, in Paris, became so offensive and unhealthy that it was decided to remove all the remains outside the city. But so poisonous were the gases generated by the decomposing bodies that grave digger after grave-digger was stricken with death on the spot, until no one could be found willing to risk his life in the work.

In 1744 three grave-diggers met death and two others narrowly escaped, from entering a newly dug grave, and in 1841 two grave-diggers perished in the same way at Aldgate, England. Dr. Reed, of Manchester, after investigating this case says, "The carbonic acid gas simply flowed into these deeply dug graves from the porous surrounding soil like so much water," and, he continues, "these gases will rise to the surface through 8 or 10 feet of gravel, just as coal gas will do, and there is practically no limit to their power of escape." Dr. F. D. Allen, in his official report of the yellow fever epidemic in New York, in 1822, said that the unsanitary condition of Trinity church-yard aggravated the malignity of the epidemic in its vicinity. This church was built in 1698, and the ground had been receiving the dead for 124 years, and some of the bodies were not more than 18 inches beneath the surface, and it was impossible to dig anywhere without disturbing some of the remains. During the Revolution this burial ground became so offensive that the Hessian soldiers covered the ground with a layer of earth 2 or 3 feet deep. During the epidemic, so offensive was this church-yard, and so virulent was the disease in its vicinity, that active measures were called for, and Dr. Roosa covered the ground with 52 casks of quick lime during the night of September 22d, and a few days later it was found necessary to treat St. Paul's church-yard and the vaults of the North Dutch church in the same way. The same writer gives us a report of a battalion of militia stationed next to the Potter's Field, which was attacked with dysentery and fever, and although several died before their camp was changed, all survivors rapidly recovered as soon as more healthy quarters were found. This Potter's Field was soon after closed and is the present Washington Square. Can any one estimate how many men, women and children have since fallen its victims? Cemeteries do not always need to be disturbed to be dangerous, for besides the epidemics they have been known to cause, how many cases of low fevers, ulcerated sore throats, dysentery, etc., occur among the dwellers in their vicinity?

The air becomes vitiated and the springs and wells contaminated. Have any of you read a description of Haworth Parsonage, the home of Charlotte Brontë and her gifted sisters? It stood surrounded on three sides by the parish church-yard and Gaskell, in his life of Charlotte Brontë, says: "The great old church-yard lies above all the houses and it is terrible to think how the very water springs of the pumps must be poisoned." Charlotte tells in her letters that so often was she affected with fevers, sore throat, sick headaches, nausea and depressed spirits, that she, time and time again, left home on account of illness and returned with improved health only to have her old troubles reappear. In 1852 her own words were, "Slow fever was my continual companion.' Her sisters, Emily and Anne, died in 1848 and 1849 aged 29 and 27, and she followed in 1855, all victims of Haworth church-yard without a doubt.

This contamination of wells, fountains and running water, in and around cemeteries, is well known and may extend to quite a distance and become a great source of danger. This water is clear and sparkling, owing to the large proportion of nitrates and nitrites which are the products of animal decomposition and are the surest carriers of deadly zymotic contagion. There are many examples of transmission of such diseases as typhoid fever and dysentery by water apparently pure and attractive, running in or near burial grounds or places where the excreta from those diseases had been thrown. In the strata of air lying above a cemetery Prof. Selmi, of Bologna, discovered an organic corpuscle (Septo-pneuma), which poisons the atmosphere to the detriment of the living economy. This substance he says is easy to collect, and if placed in a solution of glucose produces the phenomena of putrid fermentation, a process similar to butyric fermentation; but if a few drops of this solution is injected under the skin of an animal, symptoms of typhic infection occur, and death supervenes on the third day. Infiltrated into air or water it is easy to see how dangerous is this substance to human life. It was this same Prof. Selmi who discovered those deadly organic poisons which he called ptomaines. He proved that the common constituents of the body, such as brain, blood, fibrin, &c., perfectly innocuous in health, may become rapidly converted by decomposition into new alkaloids or ptomaines exactly analogous to those of plants and equally virulent. He also showed that this sometimes even takes place before death, especially in diseases that induce internal decomposition. Dr. Freier, of Rio Janeiro, a few years ago while investigating the causes of an epidemic of yellow fever came upon the dreadful fact that the soil of the cemeteries was alive with micro-organisms exactly identical with those found in the vomitings and blood of yellow fever patients.

In France some years ago spleenic fever or charbon nearly destroyed all the sheep in the country. In order to blot out the disease in one locality the sheep that died were buried at a depth of twenty feet and the pasture was not used for twelve years, when some healthy sheep were pastured there and were at once attacked by the deadly disease. Dr. Pasteur found that the sheep that had been buried twelve years before at a depth of twenty feet were the cause, the germs of the disease having been brought to the surface by earth worms, since the germs were found in great numbers in the intestinal canals of these worms.

Burying in the earth then presents the evil not only of contaminating the earth, but of producing special contagious and infectious diseases from germs which are buried with the human body but not destroyed. Now to destroy every vestige of danger, there seems to be but one remedy, that of cremation. It applies not only to the dead human body, but to animals, garbage and everything which is offensive or dangerous to health. Cremation is the only thing that can completely annihilate the living germs of contagious and infectious diseases, and render the remains of patients who die from plague, small-pox, yellow fever or cholera as innocent as the ashes of the purest wood. Outside of the question of cremating the bodies of the dead the garbage and refuse of cities should be by all means cremated. It is by far the cheapest and safest manner of disposing of it.

In most large cities it has become compulsory to establish cemeteries at certain distances from the city limits; but this only slightly lessens the danger, for it must always be a fact to consider that every large city has in its immediate vicinity a number of decomposing, putrefying corpses, about equal to the living population. I have briefly mentioned the religious prejudices against cremation; but I believe they are fast disappearing, for the strong opposition at first offered by the Catholic clergy of Italy has, I believe, entirely ceased. I might speak strongly in favor of cremation from an economic point of view, when we consider the modern tendency to expensive funerals, and the utilizing of thousands of acres of valuable land in the immediate vicinity of large centres. Statistics show that the sums expended in the United States, as funeral expenses, exceed the annual produce of all our gold and silver mines, and equal the amount of all the failures of our business houses.

An ordinary, decent burial costs about $100 in this country, exclusive of the cost of tomb or vault; and oftentimes we see luxurious burials given to people who have lacked all their lifetime all the ordinary necessities of life.

Cremation, as practiced in Milan, Italy, where it has perhaps reached the highest point of perfection, costs eight francs—a little over one dollar and a half. This is saying nothing of the enormous tracts of valuable land now used as graveyards, and lost to the general uses of agriculture and industry. In the city of London, at a death rate of 21 to 1,000, the annual number of deaths is about 81,000. Just calculate how much space is required for the burial of 81,000 persons. Allowing only the small space of two feet by six for each person—the bare size of the grave—you can bury 3,630 bodies in an acre. At this rate London requires twenty-two and one-third acres every year to bury its dead.

On the other hand, should cremation be practiced, any small plot of ground could accommodate an edifice, divided into compartments, that would serve for the reception of the incinerated remains for ages. It has been calculated that six millions of urns, each containing the remains of one person, would not, if placed in separate compartments, require twenty acres of land, including flower-beds, walks, etc. Greenwood Cemetery, at this rate, would receive no less than twenty millions of urns. Every church might have an apartment set aside for the reception of four or five thousand urns, from which no inconsiderable income might be derived.

Cremation would do entirely away with the ghoulish occupation of the body snatcher, and there would be no danger of the graves of celebrated personages being desecrated, as in the cases of A. T. Stewart, and the attempted desecration of Lincoln's and Garfield's graves. How often, too, do we find it difficult—even dangerous and expensive—to transport the remains of a friend or relative from one distant place to another. How simple this could be made with only the pure ashes left after incineration.

If burials were always conducted properly and cemetery associations always used sanitary methods, earth burial might lose a large proportion of its danger, but this is not often the case. A committee appointed by the Newtown, L. I., Board of Health, when they visited the poor section of Calvary Cemetery found a trench fifteen feet deep in which bodies were deposited, one above the other, until near the surface of the ground, when a little earth was thrown over it. As soon as one trench was filled another was started alongside; thus one side was always open. As nearly as the committee could estimate, 1,500 bodies were deposited in a space 10x200 feet. This is one of the large cemeteries in the close vicinity to New York and Brooklyn. This committee found also that at Calvary Cemetery the authorities make it a practice to disinter the bodies of children whenever the body of an adult is to be buried in the same grave, and considering how many children die from diphtheria, scarlet fever, small-pox and other contagious and infectious diseases, they respectfully ask the Board of Health to suppress such practices. 35,000 people from New York and Brooklyn are annually interred in Newtown. The population of the town is about 17,000.

Many cemeteries are located upon the beautiful banks of our rivers, and within them thousands of putrefying dead. It is well known that 85 per cent. of the human body is water. These little drops of water which drift into the rivers from the dead are loaded with sure death to the living who drink it. A professional wag of Philadelphia once told a patient that when he drank Schuylkill water he was sampling his grandfather. Typhoid fever is never communicated by the atmosphere nor from one patient to another but in almost every instance epidemics of typhoid have been traced to polluted water.

The question of how to dispose of the dead with the least danger to the living has at all times absorbed the attention of sanitarians and occupied the public mind. Sound papers condemning burial in churches and cities were published as early as 1539, and since then the subject has been almost constantly agitated and discussed all over the world in medical and scientific publications; but although the custom of earth burial was condemned by the most enlightened men of all countries during over three hundred years, and although hundreds of striking examples of the dangers of infection from burying in the earth have been shown, it was not until 1874 that the first crematory for the systematic incineration of the bodies of the dead was built at Milan, Italy. In 1869 Professors Caletti & Casliglioni, "in the name of public health and civilization," introduced in the International Medical Congress at Florence the question of cremation. A resolution was passed at this congress urging that every possible means be employed to promote the substitution of incineration for burial, and in 1872, three years later, the Royal Institute of Science and Letters of Lombardy offered a prize for the best practical method. From this time on interest in the movement steadily increased and cremation found champions among the most learned professors and physicians of Italy. In England it was strongly urged by such men as Sir Henry Thompson, Sir Spencer Wells and Wm. Eassie, and in America by Dr. Samuel D. Gross and Dr. Julius LeMoyne. As a result cremation societies were started all over Europe and America. In 1876 a second crematory was built at Lodi, Italy, and a third at Washington, Pa., by Dr. LeMoyne. The fourth crematory was built by the municipal council of the city of Gotha, Germany, and opened to the public in 1878, the fifth was at Woking, England, in 1879, but it took six years before they could discover that there was no law in England, ancient or modern, forbidding the practice of cremation. Consequently no incineration took place in England till 1885. Cremationists were greatly encouraged at this time to find among their number such men as Bishop Monrad, prime-minister of Denmark, Lord Beaconsfield, Gambetta, General Garabaldi and even Pince Bismarck. During the first ten years of cremation in Italy 787 incinerations took place in that country alone, and during the first eight years the crematory at Gotha incinerated over 500 bodies. During the year 1885 the friends of cremation laid before the German Reichstag a petition signed by 23,365 names, earnestly requesting that the practice of incineration be allowed in all the cities of Germany.

In France the first crematory was built in Paris for the cremation of the remains of the 4,000 persons annually dissected in the hospitals. It is frequently the case that an enterprise will succeed in proportion to the amount of opposition it meets, and it was so with cremation in Portugal, where organized and violent opposition was shown on the part of the clergy. But, as usual, the teachings of science prevailed. To-day the use of cremation is not only optional throughout the kingdom, but the authorities at Lisbon have decreed that it should be compulsory in times of epidemics. Cremation societies are now numerous in Switzerland, Holland, Denmark, but has made greater progress in Japan, where more than half the dead are now cremated.

In the United States the first cremation took place in 1876, the body being that of the Baron de Palm in the private crematorium of Dr. LeMoyne. The second crematory was built at Lancaster, Pa., in 1884, the furnaces being designed by Dr. M. L. Davis. During the next year, 1885, the crematories at Buffalo and Fresh Pond, Long Island, were built, and during the next six years seventeen crematories were built throughout this country. In September, 1883, the grand jury of New Orleans recommended on sanitary grounds that a crematory should be established in that city for the burning of bodies who die of contagious diseases. The Legislature of Massachusetts, in 1885, passed an act authorizing the formation of corporations for the purpose of cremating the bodies of the dead. New York was, however, the first state to authorize the erection of a crematory. In 1888 the Legislature appropriated $20,000 for the building and equipping of a crematory on Swinburne Island, for the use of the commissioners of quarantine, and the cremation of 300 bodies already buried at Seguin's Point. The crematory in Oakwood Cemetery, Troy, was built in 1889 and is one of the finest buildings of its kind in the world. It is an imposing and costly structure, built of Westerly granite in Romanesque style, and was erected by Mr. and Mrs. Wm. S. Earl as a memorial to their son, the late Gardiner Earl. The building is 136 feet long, 70 feet wide and has a tower 90 feet in height. On the whole it is a model structure.

A few years ago a pamphlet was published, giving the opinions of a great many prominent people upon the subject of cremation.

Bishop Philips Brooks said: "I believe there are no true objections to the practice of cremation and a good many excellent reasons why it should become common."

Chas. A. Dana, *N. Y. Sun*: "It is my judgment that cremation is the most rational and appropriate manner of disposing of the dead."

Dr. Wm. A. Hammond says: "I have for many years been heartily in favor of cremation of the dead. So far as I can influence the matter I shall be cremated myself at the proper time."

Prof. Chas. Eliot Norton, Harvard University: "The arguments in support of cremation are so strong, and those against our present fashion of burial so conclusive, that I have little question that when they are fairly presented to intelligent men, the development of sentiment favorable to cremation will be rapid and the adoption of the practice speedy."

Hon. Abram S. Hewitt, Mayor of New York: "Eliminating the question of sentiment, which depends largely upon custom, it seems to me that cremation is the only sensible way of disposing of the dead. I can imagine no argument against it, while all the considerations of public health are in its favor."

Rev. Dr. R. Heber Newton, N. Y.: "For many years I have thoroughly believed in cremation on a variety of grounds. Having tried to live a life of usefulness to my fellows, I object to the possibility of injuring any one after I am dead. The thought that what I cannot take away with me to a higher form of life is to be left as a means of poisoning life is abhorent to me. I prefer that my body shall be so disposed of as to put this out of the question. The religious objection has always been nonsensical to my mind. On every hand cremation has commended itself to my judgment, and I am sure that it is destined to prevail in the future. I expect to be disposed of thus myself and do not know of any expression of opinion which I could offer that would have more weight than this."

Andrew Carnegie says: "Cremation must be ranked as one of the greatest hygienic improvements of a progressive age. Its universal adoption is most desirable and it is to be hoped that the people of this country, always heretofore quick to be educated in matters of reform, will soon recognize that cremation is something with which religious prejudice or false sentiment should not be allowed to interfere any more than with the other sanitary expedients of modern life. I am convinced that the adoption of cremation in place of burial in this and other enlightened countries is only a matter of time. Personally I am heartily in favor of it."

Mrs. Cooly (Jennie June): "I consider such disposition of human remains as the wisest, cleanest, most healthful and economical method of disposing of what is no longer of any use and must in time become a positive source of injury."

Dr. Clement Cleveland, N. Y.: "The sanitary consideration is the one that chiefly influences me, and to my mind is of such vital importance that it outweighs all conceivable objections."

Charles Francis Adams, Boston: "The sanitary argument is, of course, all in favor of cremation. By burying the bodies of the dead in the ground we preserve, in so far as we can, and spread germs of disease."

Rev. John L. Scudder: "I believe in cremation with all my heart, and consider it the only proper method of disposing of the dead. I prophesy that inside of twenty-five years cremation will become well-nigh universal in this country. My sister was cremated at Fresh Pond, and my father, Rev. Henry M. Scudder, D. D., has left orders that upon his decease his body be cremated and brought home from Japan to the State of New York. It is my desire and command that when I die my body shall be cremated. I prefer a 'fiery chariot' to being eaten by worms."

Mrs. Lippincott (Grace Greenwood): "Surely it is the simplest, the surest, purest manner of rendering 'ashes to ashes,' of giving back our mortal part to the immortal elements."

Kate Field: "Cremation is not only the healthiest and cleanest, but the most poetical way of disposing of the dead. Whoever prefers loathsome worms to ashes possesses a strange imagination."

Mme. Alice D. Le Plongeon, Brooklyn: "I am most decidedly in favor of burning the dead, and can not comprehend why so many object to it. The terrible diseases that from time to time cast communities of human beings into an abyss of grief would lose their hold in a short time if the victims were promptly consigned to the purifying action of the flames. What possible good can there be in burning clothes and furniture if the infected flesh be allowed to remain in existence? In 1868 there was a dreadful epidemic of yellow fever in Lima, Peru, as many as three hundred patients dying each day. From the beginning Dr. Le Plongeon, then practicing in that city, urged the cremation of the dead. It was impossible to bring the public mind to contemplate such a course. Finally an arrangement was made to keep large fires on the trenches filled with corpses, public attention not being drawn to the fact. At once the plague abated, and soon died out.

"Do mourners ever reflect what a disgusting sight would meet their gaze if the flower-laden sod was lifted from the remains of their beloved ones? The thought is terrible! To my mind, rapid incineration rids death of half its horror. The sacred frame that has been so long inhabited by the dear friend is wafted to the pure element, instead of being trod beneath the feet of coming generations. Often and often have we seen in ancient deserted cities skulls kicked about like balls (by unthinking fools, to whom nothing is sacred), and the sight has aroused a thousand thoughts. Unless the ocean waves engulf me, I trust that some friend will kindly see my remains confided to the fiery furnace."

Owing to the lack of a quorum the annual election of officers had to be postponed.

APRIL 14, 1896—SPECIAL BUSINESS MEETING.

Chairman Ward presiding. Members Arnold, Van Gieson, Heermance, Burgess, Poucher, Burns, Robinson and Barber were present. The report of the Librarian and Curator was presented.

The following officers were elected for the ensuing year: Chairman, Edward Burgess; Secretary, Edmund Platt; Curator, Chas. N. Arnold; Librarian, Chas. N. Arnold.