BROCHURE 2.

PAGES 101–216, WITH
VOLUME INDEX AND CONTENTS.

PROCEEDINGS

OF THE

ROCHESTER ACADEMY OF SCIENCE

VOLUME 1.

PUBLICATION COMMITTEE:

H. L. FAIRCHILD, F. C. BAKER,
GEO. W. RAFTER, M. L. MALLORY.

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CONTENTS OF BROCHURE 2.

SCIENTIFIC PROCEEDINGS.

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OCTOBER 13, 1890.

STATED MEETING.

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

Fifteen persons present.

The Council report recommended the payment of certain bills, which were voted.

REV. JOHN WALTON presented the following

NOTE ON THE OCCURRENCE OF MESODON SAYII:

In July of 1890, at the Natural Science Camp on Canandaigua Lake, while conducting a class of young men in their search for Helices, I found two specimens of a very rare shell, namely *Mesodon Sayii*, Binn. I had not met with this species before, and in corresponding with my conchological friends in this locality in regard to it I learned they had never found it, nor had any of them a specimen of it in their cabinets.

This Helix was named *diodonta* by Mr. Say in 1824, and in 1840 this specific name was changed to that of *Sayii* by Mr. Binney, who describes it —

"Shell umbilicated, orbicularly depressed, thin, epidermis light "russet, shining; whorls between five and six, with numerous fine "oblique striæ; suture impressed, aperture lunately subcircular, not

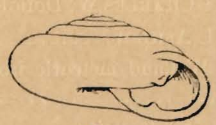


Fig. 1.

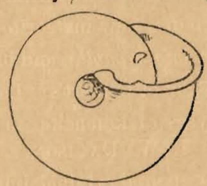


Fig. 2.

MESODON SAYII.

"dilated, peristome white, narrow, thickened, reflected, with a slightly "projecting tooth on the inner edge of the basal portion near the um-"bilicus; parietal wall with a sub-prominant, white tooth, umbilicus "open, deep, not wide, exhibiting all the volutions, slightly contracted "by the reflected peristome; base rounded, with striae distinct, con-"verging into the umbilicus. Shell about one inch wide."

"Animal light reddish brown, eye peduncles and tentacles smoky, "eyes black, head and neck cylindrical, foot narrow, terminating in an "acute point; length about twice the diameter of the shell."

The name *Sayii* has been very generally adopted by recent writers on the mollusca, in honor of the well known naturalist Thomas Say, a leading American conchologist of the last generation.

The allied species are *M. profunda*, *thyroides* and *albolabris*.

Why this Helix should be so scarce may perhaps be explained by the following incident :

"On the 3d day of July, 1836, Dr. Binney discovered an individ-
"ual of this species in the act of laying its eggs in a damp place under
"a log ; he transferred them, with the animal, to a tin box filled with
"wet moss. * * * They were white, adhering together very
"slightly, flaccid, and apparently not entirely filled with fluid. During
"the succeeding night the number had increased to about fifty, and in
"a few hours they became full and distended. As the *snail now began*
"*to devour the eggs*, he was obliged to remove it. On the 29th of July
"all the eggs were hatched."

We hope during the present camping season to test the embryocidal propensities of *Mesodon Sayii*, and if able to do so, will report accordingly.

In March last while Mr. S. G. Crump and myself were shell hunting in a piece of woods at Pittsford, N. Y. he had the good fortune to find one specimen of this Helix alive, under a log. It was a great stimulus to us, and we searched diligently for hours, in the hope of finding more specimens, but in vain; although we gathered scores of the other allied species.

Since that time we have made several trips together to this and other localities, but have not yet succeeded in finding a second *Sayii*, although we have added to our collections several forms that we had not found previously in this neighborhood.

REV. C. B. GARDNER and the PRESIDENT described a day's excursion through the gas territory of Indiana, in August last, with the American Association for the Advancement of Science.

The PRESIDENT gave an account of the gas well in Stony-Brook-Glen, Steuben County.

PROF. A. L. AREY reported finding selenite at Jefferson Avenue Quarry ; *Phacops trisulcatus* at Lower Falls ; *Lichas Boltoni* at the Lower Falls, three feet below the graptolite layer ; and at Lime Rock a *Dalmanites aspectans*, which measured 5⅛ x 3½ inches, an entire specimen of which had never before been found.

PROF. HENRY A. WARD mentioned a peculiar phenomenon observed by him at the Grotto del Cane, near Naples, Italy, in which the carbon di-oxide gas appeared, as one approached it from the path, like the surface of a mirror, or like a thin sheet of ice, the surface of the gas being on a level with the sill of the door.

The Secretary, PROF. AREY, suggested that this was a case of total refraction.

Mr. J. M. DAVISON exhibited a photograph of the coast at Kennebunk Beach, Me., showing stumps of large trees said to be the remains of a submerged forest. These stumps have every appearance of being in their original position. They are at the water edge at low tide, and buried to the depth of 5 or 6 feet at high tide.

He also exhibited a specimen of basalt from the same locality showing quartz pebbles included in the mass.

MR. E. E. HOWELL suggested in explanation that this rock was from an "intrusion," the conglomerate being carried up with the eruptive mass.

PRESIDENT FAIRCHILD called attention to a letter by Dr. M. A. Veeder, published in the New York Herald, in which he shows that a series of auroras may be traced backward through several years, recurring at intervals of twenty-seven days.

OCTOBER 27, 1890.

STATED MEETING.

Vice-President A. S. MANN, in the chair.

Forty-seven persons present.

The paper for the evening was read by MR. F. W. WARNER, on

PERU: ITS PEOPLE, PRODUCTIONS AND PHYSICAL CHARACTERISTICS.

The paper was illustrated by numerous photographs and specimens of pottery.

A vote of thanks was, on motion of Mr. Davison, extended to Mr. Warner by the Academy.

November 10, 1890.

STATED MEETING.

The President, Prof. H. L. Fairchild, in the chair.

Fifty-four persons present.

The Council recommended :

(1.) The election as active members of :

Prof. Chas. W. Dodge,
Mr. Frank C. Baker.

(2.) The election of Mr. Robert Bunker to life membership, in consideration of his gift to the Academy of his collection of insects.

(3.) The payment of certain bills.

The items of the report were separately adopted, the bills ordered paid, and the candidates elected by formal ballot.

The following candidates for fellowship, nominated May 12th, were elected Fellows by formal ballot :

Mr. J. M. Davison,
Mr. E. E. Howell,
Mr. Emil Kuichling,
Dr. Franz Muecke.
Mr. H. L. Preston,
Mr. Frank A. Ward,

A lecture was given by Prof. Henry A. Ward, on

THE SPERM WHALE, AND OTHER CETACEANS.

Illustrated by charts and osteological material.

November 24, 1890.

STATED MEETING.

The President, Prof. H. L. Fairchild, in the chair.

Fifty-seven persons present.

MR. J. E. PUTNAM reported observing a peculiar form assumed by dust deposited on electric wires. The dust seemed to be attracted to the wires by the current of electricity. Wires with high tension currents become black much sooner than those with low tension. The deposits of dust were confined to the positive and negative wires. The soot had formed in one particular spot a little bunch of filagree work. Mr. Putnam also mentioned that the spiders did not build webs near the wires in the Edison Station. He thought that their absence was due to the singing noise produced by the brushes.

The President, PROF. H. L. FAIRCHILD, gave an illustrated lecture on

COAL ; ITS ORIGIN, COMPOSITION AND STRATIGRAPHY.

Illustrated with specimens, diagrams and drawings of Carboniferous plants, and with lantern views of Pennsylvania coal-mining.

DECEMBER 8, 1890.

STATED MEETING.

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

Twenty-two persons present.

The Council report recommended :

(1.) The election as active members of :

MISS ELIZABETH BOWLES,
MR. W. H. CALDWELL,
MR. BENJAMIN W. DODGE,
DR. CHARLES FORBES.
DR. GEORGE A. GOLER,
MR. ALVAH D. PRATT,
MR. WARD V. RANGER,
MR. E. H. SCRANTON,
MR. F. W. WARNER,

(2.) The payment of certain bills.

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

The following paper was read :

ROOT FOODS OF THE SENECA INDIANS.

By Geo. H. Harris.

A complete history of the foods of the aborigines of North America would fill volumes. The list comprises nearly all indigenous vegetation including grass, seeds, leaves, barks and roots ; all game animals, and many not usually eaten, as reptiles, insects and mollusks. We take into special consideration the root foods of the Seneca Indians who, but a century ago, possessed the magnificent domain their pale-faced successors denominate Western New York.

The Seneca was one of five separate nations that, about the middle of the fifteenth century, united in a confederacy termed by later white men the League of the Iroquois ; the territory of the confederated nations covering the present State of New York from the Hudson River to the Genesee, and by later conquest extending west and south of Lake Erie.

The mythology of the Iroquois assigns their creation to Hä-wen-né-yu, a Good Spirit who, with his brother Ha-ne-go-até-geh, an Evil minded spirit, once ruled the world. The Good Spirit created all useful animals and products of the earth ; while the Evil Spirit created all monsters, poisonous reptiles, and noxious plants. To assist them in their labors Hä-wen-né-yu and Ha-ne-go-até-geh created classes of subordinate spirits and committed to each the care of some particular thing. Every object in nature had its protecting spirit. Those spirits created by Ha-wen-né-yu were termed Ho-no-che-nó-keh, or the Invisible Aids. They were the guardians of fire, water, medicine, and all species of trees, shrubs, and plants, that bore good fruit or were beneficial to man. The spirits subordinate to Ha-ne-go-até-geh were, like their creator, antagonistic to all good things. They were the spirits of all plants and roots of a poisonous nature, the progenitors of witches and enchanters, and destroyed men with disease and pestilence.

Possessing a perfect knowledge of the topography of their vast territory, the Iroquois selected for their summer homes the open glades of the forest or the alluvial bottoms of the numerous valleys, where their crude efforts in cultivating the rich soils were repaid by abundant crops. When, in 1687 De Nonville, the French governor of Canada, came to Irondequoit bay and destroyed the Seneca towns, he was astounded at the immense supplies of food the Indians possessed. In his official account of the expedition De Nonville stated that the

French officers had the curiosity to estimate the whole quantity of ripe and green corn they had destroyed in the Seneca villages and fields, and they found the total amount 400,000 minots or 1,200,000 bushels. This was undoubtedly an exaggerated statement, yet it illustrated the fruitful returns of native industry, and the prosperous condition of those Indians who depended upon agriculture for their main support.

Ninety-two years later, during the revolutionary war, General Sullivan led an army of 4000 men to the Genesee river to chastise the Senecas for their destructive raids upon the border settlements of New York and Pennsylvania. The principal town of the western Senecas, then known as the "Genesee castle," was located upon the present site of Cuylerville, and consisted of 128 houses. On the rich soil of the valley near at hand the Senecas had 200 acres of grain, large crops of beans, potatoes and other vegetables, and several orchards, one of which contained 1,500 trees. The great Genesee valley was an ideal Indian paradise where all their simple wants were fully supplied ; but Sullivan's soldiers destroyed everything of a nutritive nature, and at their departure did not leave in the locality food sufficient to save a child from starvation.

The deplorable circumstances of the Senecas, subsequent to these destructive invasions of the whites were fair examples of a condition to which these warlike people were constantly subject from enraged enemies. From riches and abundance they were liable at any moment to be reduced to poverty and starvation. In such emergencies their first recourse for food was wild game ; and during the season of scarcity their rude implements of husbandry were often employed to delve in uncultivated plains and unfrequented nooks of the forest, for esculent roots upon which they subsisted for long periods.

We learn something of the domestic habits of the Iroquois from the narration of Luke Swetland, who was a prisoner among the Senecas at Kendaia, near Seneca Lake, from August 1778, to September 1779, and who, after his release, published an account of his adventures. Regarding their means of subsistence Mr. Swetland says : "The Indians live in some respects as one family, on corn, beans, squashes and potatoes while those last, some meat, sugar, milk and butter ; but in the summer chiefly on ground nuts and other weeds and roots. Their country contains many lakes affording plenty of fish, salt springs where I made salt, a sort of root with which they make bread, they call it ook-te-haw, a great plenty of wild mandrakes, etc." [1]

1 Narrative of the captivity of Luke Swetland, among the Seneca Indians. 18.

Mr. Swetland gave little attention to the logical construction of sentences, and his statement "a sort of root from which they made bread, they call it ook-te-haw," leaves the reader—unversed in the Indian language—in doubt whether the term ook-te-haw applies to root or bread. In the Seneca dialect root is pronounced oke-tah′-a. Beets, carrots, parsnips, and turnips are all called roots and distinguished by their color, as oke-tah-a, root ; oke-tah-dane-yo, roots ; quin-tah-a, red ; jit-quâ-a, yellow ; no-wunt-dâ-a, white. In some cases the name of a root is circumstantial, and either describes the particular root or explains its quality and use. The Seneca word for bread is o-ak′-qua. It would thus appear that the term ook-te-haw, if the orthography is correct, did not apply to either word, root or bread, in its specific sense. According to the Seneca principle[2] of uniting nouns and adjectives to form new words, the compound term for bread-root would be oke-tah-ak′-qua ; and it is clear that ook-te-haw was the proper name of a particular root then in such common use that a special description was deemed unnecessary ; our inquiry therefore, properly includes the identity of this root.

In writing of the root ook-te-haw Mr. Swetland evidently had no reference to either the potato (*Solanum tuberosum*) or the ground nut (*Apios tuberosa*) as he in several instances distinctly mentions those articles of food by their common names ; yet a partial history of these native plants is essential in our line of evidence.

Seneca tradition asserts that the Iroquois originally consisted of two tribes named after the bear and deer, each tribe using a picture or crude drawing of its appellative animal as a totem or clan mark. These tribes or clans increased in number and in the distribution of sachemships at the institution of the League, about the middle of the 15th century, eight distinct clans were recognized. The Paris Documents of 1666 contain an extended account of the Iroquois cantons at that date, and name nine tribes giving the title of the sixth as Sconescheoronon or Potato people; the clan totem consisting of a string of potatoes. It is probable that this tribe was originally composed of captives whose special food consisted of potatoes, or whose particular business was the cultivation of that class of roots. Later designators of tribal names omit that of the Potato people, who had either received a new clan title, or been absorbed by other tribes.

An early historical mention of the potato is found in the journal of Thomas Herriot, who came to America in 1584 in the expedition of Sir Walter Raleigh. "Openawk," says Herriot, "are a kind of roots of round form, some of the bigness of walnuts, some far greater, which

2 Drop all letters following the inital consonant of the last syllable of the noun, and all letters following the first consonant of the adjective, then suffix the latter to the former.

are found in moist and marsh grounds, growing many together one by another in ropes, as though they were fastened with a string. Being boiled or sodden they are very good meat." The openawk was carried to England on the return voyage in 1586, and in 1597 Gerard figured the tuber in his Herbal under the name Potato of Virginia. From the date of their first settlement in America the colonists propagated the potato as a staple food, and at the middle of the 18th century it was considered a product of agriculture by the whites, who regarded the ground nut as a native or wild root. Contemporary tribes of red men also recognized the distinction between the potato and ground nut and gave a specific title to each plant. At the period of the revolutionary war the potato was cultivated by the Senecas who termed the tuber o-nun-un-da and planted it with their corn, beans and squashes. The modern Seneca term is o-no-nok′-dah ; and many of the present generation of Indians regard the potato and ground nut as one species and apply the same name to both.

In his Travels in North America, in 1749, Professor Kalm writes : "at the first arrival of the Swedes in this country, and long after, it was filled with Indians. * * The food of these Indians was very different from that of the inhabitants of other parts of the world. Wheat, rye, barley, oats, and rice groats, were quite unknown in America. * * The maize, some kinds of beans and melons, made almost the whole of the Indian agriculture. * * Hop-nis was the Indian name of a wild plant which they ate at that time. The Swedes now call it by that name and it still grows in the meadows. The roots resemble potatoes. They were boiled by the Indians, who ate them instead of bread. Some of the Swedes likewise ate them for want of bread. Some of the English still eat them instead of potatoes. * * Dr. Linneas calls the plant *Glycine apious.*"

The narrative of the Gilbert Family captured in Pennsylvania and brought through the Genesee region in 1780, describes the arrival of the party in the vicinity of Canandaigua where "necessity induced two of the Indians to set off on horseback, into the Seneca country, in search of provisions. The prisoners, in the meantime, were ordered to dig up a root, something resembling potatoes, which the Indians called whop-pan-ies. They tarried at this place until towards evening of the succeeding day and made a soup of wild onions and turnip tops ; this they eat without bread or salt. * * They left this place and crossed the Genesee river * * They fixed their station near the Genesee banks and procured more of the wild potato roots before mentioned for their supper."

The name hop-nis, as rendered by Professor Kalm who obtained it from Indians on the Susquehanna river, and the term whop-pan-ies as used in the Gilbert narrative, differ in orthography, but the pronunciation of the two words is so nearly alike there can be no reasonable doubt of their identity. The modern Seneca for ground nut is yo-a-jah-go-o, which is interpreted, "being always in the ground."

An extended study of the subject impresses the writer with a belief that the bread root mentioned by Luke Swetland, can be identified as *Arum*[1] *triphyllum* of the botanist, commonly known as Indian

FLOWER AND FRUIT OF ARUM TRIPHYLLUM, AND O-A-O-SAH OR BABY-BOARD.

turnip, and variously termed three-leaved arum, wake robin, dragon root, pepper turnip, swamp turnip, starchworth, bog onion, priest's pintle, lord and ladies, jack in the pulpit, etc. This plant possesses every essential of nativity and quality requisite for a bread root, such as may have been used by the Indians during Swetland's enforced residence among them. It grows in damp woods, in swamps, in low

1. The name Arisæma is said to be a play upon the older name Arum. Torrey's Flora.

meadows, along ditches and in moist, shady places. It is well known to all lovers of wild plants as a floral curio, both on account of its peculiar flower and acrimonious nature. The root is roundish, flattened, an inch or two in diameter, covered with a brown, loose, wrinkled epidermis, and internally white, fleshy and solid. In its fresh state it is violently acrid, producing, when chewed, an insupportable burning and biting sensation in the mouth and throat, which continues for a long time, leaving an unpleasant soreness. It is used when fresh, and may be preserved a year by packing in damp sand. When dried and pulverized it produces a beautiful snow white powder, that when properly prepared, may be employed as a substitute for flour in making bread.

For many years the Senecas have called this plant "baby board," from its resemblance in form to the board used by Indian mothers as a convenience in the transportation of infants. The frame of a baby board is about two feet long, fourteen to sixteen inches wide, has a narrow shelf or foot-rest at the lower end and a hoop arched at right angles over the head. The infant is wrapped in a blanket and lashed to the board with broad belts. A small cloth is then drawn over the upper end and hoop, forming a hood that leaves the face of the child exposed yet secure from the weather. This board is termed o-a-o-sah. The peculiar shape of Arum triphyllum always attracts the attention of Indians who hold up their hands and say : "Just like baby board, that flower!" [1] hence they apply the name o-a-o-sah to the visible portion of the plant, but the part below the surface of the ground is known simply as oke-tah'-a, a root. It is probable that Swetland mis-pronounced the smooth flowing Seneca word o-a-o-sah, rendering it, in crude Yankee vernacular, ook-te-haw.

At the period of which Mr. Swetland wrote, the Senecas were associated with the British, in their efforts to subdue the American colonists, and received some aid from their English allies ; but as a people they were mainly uncultivated nomads of the forest, characterized by the same habits and customs their ancestors had possessed for unknown centuries, dependent upon their skill as hunters and, to some extent, upon the natural productions of the soil. Our inquiry regarding the identity of ook-te-haw may, therefore, extend to the customs and diet of their forefathers as recorded in early chronicles.

In Thomas Herriot's account of Virginia in 1585, that writer informs us that "Cos-cus-haw * * groweth in very muddy pools and moist grounds. * * The juice is poison, and therefore heed must be taken before anything be made therewithal ; either the roots must be first sliced

1 The writer gratefully acknowledges his obligations to J. H. Van Valkenburg, Superintendent of the Thomas Asylum at Cattaraugus, to Solomon O'Bail, A. Sim Logan and William P. Buck for interpretations of various Seneca terms.

and dried, and then being pounded into flour, will make good bread ; or else while they are green they are to be pared, cut in pieces and stamped ; loaves of the same to be laid near or over the fire until sour, and then being well pounded again, bread or spoon-meat, very good in taste and very wholesome, may be made thereof."

Captain John Smith's Virginia, 1606, says :—"The chief root they (the Indians) have for food is called loc-ka-whough. It grows in the marshes * * and is much of the greatness and taste of potatoes. * * Raw, it is no better than poison, and being roasted, except it be tender and the heat abated, mixed with sorrel or meal, it will prick and torment the throat extremely ; yet in summer they use this ordinarily for bread." Carver's Travels in North America, 1766, says : "Wake Robin is an herb that grows in swampy lands, its root resembles a small turnip and, if tasted, will greatly inflame the tongue, and immediately convert it from its natural shape into a round hard substance ; but when dried it looses its astringent quality and becomes beneficial to mankind."

"Taw-ho and taw-him," wrote Kalm, "is the Indian name of a plant the root of which they eat. * * Some call it tuc-kah. The roots are reckoned poison in a fresh state, * * but when prepared (by roasting) taste like potatoes. * * This taw-ho is the *Arum Virginicum*, or Virginian wake-robin, and seems to be the same plant the Indians in Carolina call tuc-ka-hoo. * * A stranger from Carolina gave Mr. John Bartram the following description of tuc-ka-hoo :—'It grows in swamps, marshes and woods, and the Indians in Carolina, in their rambles, gather the roots, dry them in the sunshine, grind and bake bread of them. While the root is fresh it is harsh and acrid, but being dried it loses its acrimony.' To judge by these qualities the tuc-ka-hoo may very likely be the *Arum Virginicum*. * * The Indians are very fond of turnips and call them sometimes hop-nis, sometimes kat-nis. * * Throughout the summer before the Swedes came, their hopnis or the roots of *Glycine apious*, their katnis or roots of *Sagittaria sagittifolia*, their tawho or roots of *Arum Virginicum*, their tawkee or *Orontium aquaticum*, and whortleberries, were their chief food."

The above accounts of the old writers are conclusive, that the aboriginal inhabitants of Virginia and Pennsylvania used *Arum Virginicum* as a material for bread. The variation of *A. Virginicum* and *A. triphyllum*, is so trifling that some authorities class them as one. The great aboriginal water communication between Lake Ontario and the Atlantic was through the Seneca country to the Susquehanna river ;

thence, via Chesapeake bay to the Ocean, and it is well understood that the Indians of New York, Pennsylvania and Virginia were in constant intercourse (in fact the Iroquois claimed the country from Lake Ontario south to the Tennessee river), and that the customs and foods of the natives of those sections were in many respects the same. Swetland, unfortunately, gives no description of the root he calls ook-te-haw; but evidence in the hands of the writer shows that the pioneers of the Genesee Valley and County of Ontario, used the Indian turnip *Arum triphyllum* as a substitute for flour, and that they obtained their knowledge of the manner of preparing this root from Seneca Indians. It would seem that the cos-cus-haw of Herriot, the loc-ka-whough of Smith, the wake-robin of Carver, the tuc-ka-hoo of the South, the taw-ho of Kalm, the o-a-o-sah of the Senecas and the ook-te-haw of Swetland, were identical and that the bread root mentioned by Luke Swetland was *Arum triphyllum.*

Was it not a pressing necessity, that first induced aboriginal man to test the nutritious qualities of the most nauseous of all wild plants *Symplocarpus fœtidus*, commonly known as pole-cat root or skunk cabbage? The early Swedish settlers on the Susquehanna river called this plant, byron blad, or bear's leaf, and some termed it byron retter, or bear's root, from the fact that bears on leaving their winter habitations in the spring were excessively fond of it. The early Senecas called the plant o-sha-ta. They used the root for all purposes of food and medicine where arum could be employed. As a bread root it was roasted or baked to extract the juice, in much the same manner as arum. When the Seneca towns were destroyed by General Sullivan in 1779, the Indians found themselves utterly destitute and many moved to Fort Niagara where the British fed them, mainly on salt meats, during the following winter. As a result hundreds died of scurvy; but those who used the root of skunk cabbage as an anti-scorbutic, recovered their health.

That beautiful and curious plant, Solomon's seal, was also a welcome addition to the aboriginal larder in times of necessity. Many years ago a Seneca who was roving over the ground now named Highland Park, in this city, called the attention of his boy companion, the late John Nutt, to Solomon's seal as a plant once highly prized by Indians. He said it was formerly much used by the Senecas as a medicine, and that they also boiled the young shoots in the spring and ate them. The mature roots were gathered in the fall, dried, ground or pounded, and made into bread.

The method of manufacturing bread from roots was very simple. After the roots had been thoroughly dried and pulverized the flour was seasoned, mixed with a little animal or fish fat, moistened, worked into a pastry dough and patted into the form of a cake or loaf, which was placed on a piece of bark or flat stone turned up on its side close to the fire. Occasionally the stone was heated and the cake was thus at once baked on both sides. Sometimes the loaf was baked in a kettle or placed in the ashes under a cover of hot coals ; and the individual who objected to eating the mass as it came from the fire with its covering of gritty ashes, was considered a person of poor taste and quite ill bred.

There is a question regarding the identification of an Indian bread root that is worthy the attention of the botanical section of this Academy. In narrating the privations suffered by the whites who settled on the Chenango river in 1788, Wilkinson's Annals of Binghampton says, that when their crops of corn failed and festive bruin had devastated their pig styes, the starving settlers went to an island in the river, and dug quantities of a tall weed termed Anicum, the roots of which they dried and ground or pounded into a coarse flour for bread-stuff.

It is possible that this so-called anicum was a species of the genus *Panicum* or panic grass, the seeds of which the wild Indians of the West still use for bread in the same manner white people use wheat ; but the writer cannot learn that the seeds of anacum were utilized for food. Inquiries resulted in the description of a plant in many respects resembling *Psoralea esculenta*, commonly known in the western States as Indian bread root, prairie turnip, etc. Botanical authorities usually report *Psoralea esculenta* a native of the West and South ; but a Seneca friend who had visited the Sioux Indians and was familiar with their bread root tip-si-u-nah, which plant possesses none of the poisonous qualities of arum, positively assured the writer that such a plant once grew in New York. A public agitation of the bread root topic last summer, was productive of the following letter from General J. S. Clark, the distinguished Indianologist and botanist, to Hon. George S. Conover of Geneva :

AUBURN, N. Y., July 11, 1890.

Dear Sir :—You are at liberty to state that *Psoralea esculenta* has been found in New York, in Washington county, many years ago by Mr. Frank R. Rathbun, of this city, and fully identified as the genuine plant growing in its wild state. A little more inquiry will probably establish the fact, that it has been discovered in other localities and may now be found in Central New York. I fully believe, however, that Luke Swetland's ook-te-haw is the well-known Indian turnip.

Very respectfully, JOHN S. CLARK.

In response to a request for particulars General Clark forwarded a letter from Mr. Rathbun from which we extract the following :— "The plant in question was found by myself, in the early summer of 1856 or 1857, at Fort Edward, Washington Co., N. Y., west of the Collegiate Institute, in a moist situation near the location, of the Jane McRea spring. As something unique, I carried the bulb, flower or seed vessel and leaves, to the Professor of Natural History at the Institute for analysis, before the class in botany. Pronounced by him a rare find, something new. I recollect he seemed surprised ; also recollect the specific term *esculenta* or Indian bread root applied to the specimen. His name was Solomon Sias. By the last Naturalists' Directory I find his address to be Schoharie, N. Y., (Solomon Sias, A. M., M. D.)"

It is well known that the flora of New York, has changed greatly during the past hundred years, and it may be an interesting question for our botanical section to decide, whether *Psoralea esculenta* can be added to the list of extinct plants.

The yellow pond lily, now so greatly admired as an aquatic flower, is a native of marshes, and the Senecas who frequented Irondequoit bay often procured the roots from the marsh-beds that surrounded that beautiful and historic sheet of water. The roots are large, sweet, and glutinous and not an unpleasant food when boiled or roasted and eaten with wild fowl or meat ; or if well seasoned with salt. The lily was known to the early Senecas as o-was-oos-hah, a word almost identical in sound with the native name (o-a-o-sah) of arum or baby board ; but the writer has been unable to learn the meaning of the term as applied to this particular flower.

Musk rats, which once abounded in all the shallow waters of the Genesee country, stored quantities of the lily roots in their rude houses for winter support ; and it was the usual custom of the Indians when hunting the little water animals, to search their houses for the roots. It is a fact, well attested by men who have been familiarly associated with Indians and accustomed to their food, that when properly dressed to remove the rank odor, the flesh of the musk rat is excellent meat ; and the Senecas doubtless had good reasons for heartily enjoying their winter dishes of ju-no-dâ-gâ, or musk rat flesh, and o-was-oos-hah, or pond lily root.

A more extended list of root foods might be presented, but a sufficient number has already been described. The hungry aborigines satisfied the cravings of appetite with all manner of vegetation not absolutely poisonous, and rendered edible many plants and roots of a known poisonous nature, by maceration in cold and hot water, and by baking and frying ; thus evaporating the deadly juices and nullifying the unpalatable characteristics. Vegetable matter reduced by such means is usually insipid, and the Indians often resorted to various expedients for seasoning. Salt was the principal and natural recourse. There were sev-several saline springs in the territory of the Sencas besides those east of Seneca lake mentioned by Luke Swetland. The Indians of the Genesee Valley often came to Irondequoit bay to make salt. There was a salt spring at the head of the bay on the west side, one in Dunbar hollow, and others east of the bay. The last one used by the Senecas was located in Webster, south of Forest Lawn. When the Senecas retired to reservations about 1796, an old chief from Moscow, in company with Jacob Walker the tory first-resident of Irondequoit, covered the Webster spring with stone, so effectually concealing it that it remains undiscovered to this day.

As substitutes for salt the Indians used the white portion of hard wood ashes, the ashes of corn cobs and certain leaves, and occasionally the lye of wood ashes. Fish, animal fat, and oils produced from nuts were also employed to modify the unpleasant qualities of root foods. The meats of nuts were often mashed into a sort of butter-grease for seasoning. Butternuts especially were reduced to a thin milk that was considered nourishing for infants and children. Other vegetable matter, such as acorns and dandelion roots, was roasted, pounded and sprinkled over the cooked roots. Squash rinds, corn meal and maple sugar were dainties. Horse-radish was boiled with meats as well as roots, and mints and cress proved acceptable relishes.

Acids were supplied by wild fruits and berries when those could be obtained. A loaf of root bread well sprinkled with berries was not to be sneezed at. The sumach also provided an agreeable wholesome acid. It was called ote-kó-dâ, by the Senecas who were careful to select the red-berried sumach, as the white-berried species is poisonous It was a happy day when the hungry root-eater discovered a nest of black ants. The insects were called je-hus-to-qua. The Indians laid upon the nests pieces of freshly peeled bark upon which the ants gathered in large numbers and were at once secured. The sharp vinegar-like taste of the insects was a great incentive to appetite.

The kâ-no was, or cow-slip, the o-nah-sâ, or mushroon, the o-nus-tâ-sah, or sassafras, the green shoots of o-nó-to-wâ-nes, or the burdock, the ya-ho, or mandrake, the jes-tâ-ga-â-go-wâ, or wintergreen, the leaves of the birch, beech, willow, basswood and gooseberry, the ground seeds of â-wâs-â-sâ, or the sunflower, were all utilized as relishes, and in extreme cases as substitutes for solid foods.

Among the various nations of Indians that now roam the plains and forests of the West, with the unrestrained freedom of ancient nomadic life, the old time habits and customs still prevail, and whole tribes eke out a precarious existence upon vegetable diets consisting mainly of esculent roots; but the reservation Indians of the State of New York have long been dependent for subsistence upon the products of intelligent agriculture, and even the legendary knowledge of ancestral foods has in many instances utterly faded from remembrance. Occasionally an educated Indian will cast a gleam of light upon the dark kitchen mysteries of his progenitors, and now and then the student of aboriginal history discovers a diamond of knowledge in the crooning of some aged Seneca who cherishes a memory of the strange habits and stranger tastes of his wild-wood forefathers.

DECEMBER 22, 1890.

STATED MEETING.

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

Twenty persons present.

The accessions to the Library were noted.

The paper for the evening was read by MR. H. L. PRESTON, on

QUARTZ; THE PROTEAN MINERAL.

Illustrated by a large collection of various forms of the mineral.

JANUARY 12, 1891.

TWELFTH ANNUAL MEETING.

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

Seventeen persons present.

The Annual Reports of the officers and sections were presented.

SECRETARY'S REPORT.

The report of the Secretary, PROF. A. L. AREY, is summarized as follows :

Eighteen meetings were held during the year, the average attendance being fifty persons. All the meetings have been held in the University of Rochester. The suspension during the winter of street cars was the cause of the small attendance at several meetings.

Twenty-three active members have been elected, and six members have been made fellows.

During the year eighteen papers have been read, divided among the following subjects: Archaeology, Astronomy, Physics, Engineering, Geography, Mineralogy, Physiology, one each; Biology, Botany, Geology, Zoology, two each; Meteorology, three.

The Council has held its regular meetings.

CORRESPONDING SECRETARY'S REPORT.

MR. GEORGE W. RAFTER, the Corresponding Secretary, transmitted a report, in abstract, as follows :

A number of Honorary and Corresponding Members were elected at the meeting of May 12, 1890, and each person so elected notified by formal letter. With one exception all have signified acceptance, and generally in terms exceedingly complimentary to the Academy.

Correspondence has also been held with some of the Honorary and Corresponding Members in reference to the presentation of papers during the year 1891, and it is expected that such will soon be received.

The initial publication of the society has been sent to all Honorary and Corresponding Members and to one hundred and thirty societies, journals, institutions and government bureaus in the United States and the Dominion of Canada.

Two hundred and ninety-three copies of the publication have also been forwarded to the Bureau of International Exchanges of the Smithsonian Institution for distribution in foreign countries. Each copy, both to home societies and to foreign, is accompanied by a circular letter asking that the receipient of the same exchange publications with the Academy.

Acknowledgements of receipt have been received from nearly one hundred of the addresses in the United States and Canada ; and exchange publications have also come to hand from a considerable number. Others to whom the Academy publication was forwarded have promised exchanges at an early date, and we may confidently expect a considerable addition to the library from this source.

Relative to the foreign exchanges it may be stated that it is too early to receive returns from them.

All exchanges received to date have been acknowledged, and deposited at the Library, at the disposal of the Librarian.

LIBRARIAN'S REPORT.

The Librarian, MISS MARY E. MACAULEY, transmitted a report on the condition of the library, from which the following is extracted: "The small size of the library is due * * to the fact that until the last year the Academy published none of its proceedings for exchange, the few papers printed being mainly for local distribution. During the past few months the accessions have become sufficiently numerous to warrant the belief that the Academy will soon possess a creditable and valuable library."

TREASURER'S REPORT.

The Treasurer, Mr. E. E. HOWELL, made a report of the year's finances of which the following is a summary:

Receipts.

From former Treasurer	$ 96.36	
From initation fees and annual dues	438.00	
From interest	5.76	
Total		$540.12

Expenditures.

Notice of meetings, stationary, postage, janitor, etc.,	$122.97	
Printing Proceedings (Brouchre I)	233.30	
Illustrating " " "	110.00	
Total		$466.29
Balance in treasury		$73.85

REPORT OF THE SECTION OF BOTANY.

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

The officers of the Botanical section are: Miss M. E. Macauley, Chairman; Miss Florence Beckwith, Vice-Chairman; Mrs. J. H. McGuire, Recorder.

The Section has met regularly each alternate Friday evening, and has held 25 meetings during the year.

The practical studies from Bessey's Botany with the microscope, have been conducted as far as possible in accordance with the author's plan, and have been eminently successful.

In the studies of plant tissue, when growing specimens could not be obtained, prepared slides from Mr. Streeter's extensive collection have been used.

Plants indigenous to this vicinity have been examined in their season, and their habits and variations noted.

Extracts from the Minutes of the Section.

January 24, 1890. Microscopical studies. Parenchyma tissue of Castor-oil Bean. Bast tissue of *Abutilon.* Rind of Orange showing oil vessels. Bark of Cinnamon. Spore fruit of *Chara fragilis. Protococcus.*

February 21, 1890. Microscopical studies.

Mr. Walker showed pollen grains of *Symplocarpus fœtidus.*

Mr. Dumond showed a specimen of *Vaucheria sessilis*, with zoospores in process of formation.

Mr. Dumond exhibited specimens of the Scotch Heather and Holly; also Lichens and Mosses which he brought from Scotland.

April 18, 1890. Miss Macauley exhibited a *Sanguinaria Canadensis* having pink blossoms, found at Fairport; also *Dicentra Canadensis* and *D. cucullaria* which were found growing together in great abundance.

Miss Beckwith showed *Pellæa atropurpurea* from Wisconsin.

The microscopical studies were spore-sacs of *Peziza coccinea* in various stages of development, also a number of Desmids.

May 16, 1890. The plants examined were *Smilacina stellata, Pedicularis Canadensis, Geranium maculatum, Ranunculus repens, Viola cucullata, Anemonella thalictroides, Saxifraga Virginiensis, Sambucus pubens. Caltha palustris, Ribes floridum* and *Mitella diphylla.*

Mr. Dumond exhibited the spores of *Equisetum arvense*, showing the movements of the elators.

May 30, 1890. The evening was chiefly devoted to an examination of the phanerogams.

The microscopical studies were, *Protococcus* shown in the motile stage, and the red form in the resting stage.

June 13, 1890. *Lithospermum hirtum* was shown by Miss Macauley. The habitat of this plant, as given by botanists, is decidedly west and south of this locality. It is possible this specimen may have been an escape, as it was found near the roadside. Miss Macauley also showed the *Veronica Buxbaumii*, which is rare.

July 4, 1890. The Section made an excursion to Bergen swamp. The following account is quoted from Miss Macauley's report:

"The *Mitchella repens* covered the ground, in many places forming a dense carpet. Both the long and short styled flowers were found. The *Linnæa borealis* was nearly out of bloom. Although many blossoms were seen they dropped as soon as picked. The *Cornus Canadensis*, too, was just about gone, only a few blossoms being gathered. The ferns were many and beautiful, *Cystopteris bulbifera* growing in some places in graceful luxuriance. The *Aspidiums* were not in fruit. *Osmunda cinnamomea* was very abundant. *Botrychium Virginicum* was found with unripe spores. *Lilium superbum* was also found. Among orchids were found the *Calapogon pulchellum*, *Habenaria viridis*, *Habenaria dilatata*, *Cypripedium spectabile*, *Pogonia ophioglossoides*. The *Sarracenia purpurea* was found, but the petals had fallen. The *Drosera rotundifolia* was found in blossom, also the *Monotropa uniflora*. Growing along with *Mitella diphylla* was found the *Mitella nuda*, which is very scarce. In some places the *Coptis trifolia*, or Gold-thread was seen in abundance. The *Taxus Canadensis* was found in fruit."

Although too late in the season for many of the plants common to Bergen, to be in flower, Miss Macauley's list shows the rich flora of that favored locality.

August 1, 1890. Among the many plants examined were *Asclepias tuberosa*, *Cornus stolonifera*, *Lysimachia ciliata*, *L. quadrifolia*, *Galium triflorum*, *Desmodium acuminatum*, *D. nudiflorum*, *Lobelia inflata*, *Stachys palustris*, *Solidago arguta*, *Scutellaria galericulata*, *Epilobium angustifolium*, *Verbena hastata*, *V. urticifolia*, *Adiantum pedatum*, *Apocynum androsaemifolium*, *Pontederia cordata*, *Helianthus divaricatus*, *Utricularia vulgaris*.

The pollen of *Ceratophyllum demersum*, rarely found in fruit, was examined with the microscope.

August 15, 1890. *Sagittaria variabilis* var. *obtusa*, *and S. variabilis* var. *hastata* were shown and the staminate and pistillate flowers noted.

August 29, 1890. Miss Beckwith called the attention of the Section to a curious differentiation in the size and division of the leaves of *Taraxacum officinale*. In four different plants which she exhibited, each had leaves peculiar to itself. These variations are not mentioned in either Gray's or Wood's Botanies.

In microscopical studies the sieve tissue of the stem of the Pumpkin vine was shown. Also the fruit of *Adiantum pedatum.*

Mr. Dumond exhibited the *Pandorina morum* with escaping cells and resting spores.

August 29, 1890. The microscopical studies were the terminal bud of Ash, the laticiferous tissue of Salsify, sections of Corn-stalk, and *Gymnogramme triangularis* and fruit.

Mrs. Streeter read an article on the Movements of Diatoms.

Mr. Bacon read an account of artificial germination of milk-weed pollen. Two pressed specimens of *Goodyera pubescens* were shown; also *Blitum capitatum.*

September 26, 1890. The seeds of *Pentherum sedoides* were examined and found to be beautifully marked; the attaching stalks were a bright scarlet.

Three varieties of Aster were shown, *A. Novæ-Angliæ*, *A. miser*, *A. puniceus. Gentiana Andrewsii* and a fine specimen of *Marchantia polymorpha*, showing gemmæ cups were also exhibited.

October 24, 1890. Miss Beckwith showed two beautiful Southern plants, *Cosmos bipinnatus* and *Euphorbia heterophylla.* The former had rose-colored rays and finely divided leaves; the latter had a strip of scarlet in the upper bracts. A section of the stem showed the latex vessels.

A number of species of Fungi were examined. Among them were several specimens of *Polypori*, one *Ciavaria*, *Agaricum velutipes, A. laccatus; Marasmius rotula*, and a Peziza of a pale gray color.

The *Azolla Caroliniana* was shown and the formation of the spores explained.

November 7, 1890. Mr. Streeter showed the abscissa cells in the petiole of the leaf of Horse-chestnut, also the seeds of Beech-drops.

Agaricus fabaceus and *A. illicitus* were shown. An article on Cacti was read.

One of the most interesting objects, and one never before seen in the section, was the *Lunularia vulgaris*, one of the Hepaticæ, shown by Miss Beckwith. The gemmæ were well defined.

November 21, 1890. Miss Macauley showed a number of Fungi and Lichens.

A section of gill, showing the spore-bearing cells, was examined with the microscope.

The Chairman showed the following plants in blossom: Goldenrod, Mallow, Sonchus, Capsella, Clover, Carrot, Buttercup, Dandelion and Hedge Mustard.

December 19, 1890. Mr. Streeter showed the sieve tissue of *Cucurbita pepo* and also of Bryony ; prepared slides of annular, spiral, and reticulated vessels ; Glœocapsa, showing cell division ; Spirogyra in conjugation ; Starch grains ; Crystals from Onion ; Aleurone from *Ricinus communis* and raphides.

The circulation of protoplasm in *Vallisneria spiralis* was shown by Mr. Dumond.

January 2, 1891. Mr. Streeter exhibited a number of pressed flowers from Alaska. Among them were species of Anemone, Strawberry, Clematis, Geum and Larkspur. There was also a plant similar to our Dwarf Cornus.

Miss Beckwith showed a *Shepherdia argentea* from Big Horn City, Wyoming. She also reported finding in blossom at this date Dandelion, *Capsella*, Chickweed, and *Senecio vulgaris.*

The microscopical studies were leaf of *Narcissus*, scale and bud of *Shepherdia*, growing point of Indian Corn and a section of squash showing spiral and ringed vessels.

REPORT OF THE SECTION OF GEOLOGY.

(*In abstract.*)

Read by H. L. Preston, Recorder of the Section.

During the past year the Geological Section has held sixteen meetings, with an average attendance of ten persons, the smallest number present at any meeting being seven, the largest seventeen.

The plan of work and the character of the meetings have been the same as last year. The meetings were held on Tuesday evenings, twice a month, in the Section Room of the Academy, on the second floor of Anderson Hall, University of Rochester.

The Section has received during the year eleven new members, making a total of twenty seven names now on the roll.

Extracts from the Minutes of the Section.

Jan. 20, 1890. Mr. Walker presented to the Section a fine specimen of Labradorite taken from a large boulder near No. 19 School building. Mr. H. L. Preston read a paper upon agates and waterstones from Uruguay.

The topic of the evening was, The Chemical Agencies of Water. Mr. E. E. Howell spoke of the necessity of keeping the native iron from Greenland exposed to the open air, in order to keep it from disintegrating, and cited other illustrations of this unusual fact. The topic was further discussed by various members of the Section.

Feb. 3, 1890. Various specimens were exhibited by the members. The topic, Internal Heat of the Earth, and Earthquakes, was discussed by the Section.

Prof. H. L. Fairchild exhibited, in illustration of this topic, large volcanic bombs from Auvergne, France, and various forms of lava from other localities, especially from the Sandwich Islands. Also a series of lantern slides illustrating volcanic phenomena.

Feb. 17, 1890. Mr. E. E. Howell exhibited a portion of a new iron meteorite, recently added to the Ward and Howell collection, from Welland, Can., which was found April 30, 1888. Mr. Walker presented a glaciated rock, obtained on a new street in the western part of the city. Mr. J. M. Davison described glacial markings at Saratoga, also others found beneath the Detroit river, Mich.

Mr. Howell described glacial furrows two feet wide and one foot in depth near Dunville, on the north shore of Lake Ontario; also furrows of a size sufficient to receive a cane, which made a complete turn in direction, a phenomenon he had noticed only at one other locality, St. Catharines, Canada.

The topic for the evening, Geysers, was illustrated by specimens from the Yellowstone Park, and from Iceland.

Various specimens were presented for identification.

March 3, 1890. The topic for the evening being Earthquakes, Mr. Howell, the Chairman, exhibited a model and diagram of the earthquake at Tokio, Japan. Jan. 15, 1887.

Professor Fairchild exhibited U. S. weather maps, and described the system of publishing weather observations.

March 17, 1890. The by-laws were changed, making the meetings occur on Tuesday evenings following the first and third Mondays in each month.

The topic for the evening was Organic Agencies, and the formation of Coal. Professor Fairchild exhibited a quantity of material illustrating the subject, and described a peculiar deposit of peat, found in the city of Scranton, which showed the formation from peat, of the coal-like mineral known as dopplerite. Mr. Crump presented for identification a coal fossil, probably a cast of the pith of some coal plant. Other material was presented for identification by different members of the Section

April 1, 1890. The topic for the evening was Petroleum, Coal, Graphite, Etc. Various specimens were brought in for identification.

April 22, 1890. Mr. Preston exhibited the largest gold nugget ever found in South Africa.

The topic was, The Formation of Coral Reefs. Mr. S. G. Crump discussed the topic, and gave several theories of the formation of coral reefs. Professor Fairchild illustrated the subject with lantern views. Various minerals were presented by Mr. Walker and Miss Beckwith for identification.

May 6, 1890. Various fossils from the phosphate bed of Charleston were exhibited.

The Chairman of the Section, Mr. Howell, described an interesting example of jointing in gneiss on the Potomac River, which in form resembled the basaltic columns in the Rhine Valley.

The topic of the evening was Geographic Distribution of Animals. Miss A. M. King and Mr. Walker presented various minerals for identification.

May 20, 1890. Professor A. L. Arey exhibited a specimen of micaceous hematite, also Mexican onyx.

Mr. Howell, the Chairman, exhibited several aerolites that fell May 2, 1890, near Forest City, Iowa. He also spoke of the recent discovery of some twenty pieces of meteorites in Kiowa County, Kansas. He also exhibited a polished and etched slice of the Puquios, Chili, meteorite, which showed a definite fault-plane running through its mass; this being the first fault recorded as occuring in iron meteorites.

The difficulty of working and cutting meteoric iron was commented on by the Chairman.

The topic of the meeting was, The General Formation and Structure of the Earth.

June 3, 1890. Mr. Walker presented to the Section a nearly complete specimen of the *Halysites catenulates*, which he obtained at a limestone quarry on Brown Ave.

Specimens of rock were exhibited by Mr. Howell and Professor Fairchild, which had been obtained at Stony-brook Glen, Steuben Co., on the occasion of the geological excursion of the Academy, May 30th. These rocks were calcerous and contained large rounded masses that were either boulders or concretions.

Mr. Howell also described a fault which he had observed in Stony-brook Glen, in which the overhanging wall had risen, an illustration of the abnormal form.

Mr. J. M. Davison described a phenomenon at Saratoga, where the Trenton limestone was so mixed with fragments of the underlying calciferous sandrock as to give it the appearance of a breccia.

Oct. 21, 1890. The evening was mostly spent in discussion as to whether the specimens of rock from Stony-brook Glen, exhibited at the Section, June 3d, were boulders or concretions, but without arriving at definite conclusions.

Professor Fairchild exhibited two forms of clinomoter, and explained their use.

Mr. Preston exhibited a specimen of *Dalmanites aspectens*, the property of Professor Arey, found at LeRoy, N. Y., which was the only complete specimen of this trilobite known, although heads and tails of this species have been found separately in abundance.

Various specimens were presented for identification.

Nov. 4, 1890. The topic for the evening was Cleavage. Professor Fairchild exhibited several specimens, illustrating different kinds of cleavage.

Nov. 18, 1890. The officers of the Section for the ensuing year were elected as follows: Chairman, Mr. E. E. Howell; Vice-Chairman, Mr. S. G. Crump; Secretary, Mr. H. L. Preston; Sectional Committee, Mr. J. M. Davison and Rev. John Walton.

Dr. Franz Muecke exhibited a specimen of bog iron ore and manganese from Brighton, near Rochester. Also an incrustation of leaves and twigs from the travertine bed, of Mumford, N. Y. Mr. W. W. Gilbert exhibited a specimen of silicified wood from the drift in the Genesee Ravine; also zelenite from Frost Avenue.

Professor Fairchild described the mineralogical character of the Niagara limestone in Pike's quarry on Frost Avenue.

Mr. Worthington exhibited fossil coral from England.

The topic for the evening, Concretionary Structure, was discussed by various members, and Professor Fairchild exhibited numerous specimens illustrating various forms of concretionary structure.

Mr. Walton exhibited a fine concretion, showing a fossil as a nucleus.

Mr. Davison showed a thin section of silicified oolite, from Center county, Pa.

A committee, consisting of Professor Fairchild and Mr. Howell, to whom was referred the Stony-brook Glen specimens, reported their inability to arrive at a unanimous conclusion.

Dec. 2, 1890. Mr. Davison exhibited a specimen of silicified shell, from near the lower falls of the Genesee.

Mr. A. S. Mann exhibited alumn from Greigsville, N. Y.

Professor Fairchild and Mr. Howell were appointed a special committee to obtain samples representing the strata penetrated in drilling for natural gas on the premises of Otis and Gorsline on Oak street.

The topic for the evening was Fossilization.

Dec. 16, 1890. Professor Fairchild reported that arrangements had been made to secure borings from the gas well of Otis & Gorsline.

Mr. Preston, the Recorder, was instructed to secure a case in which to deposit the collection of local fossils presented to the Academy by Prof. A. L. Arey.

The topic for the evening was Sedimentary Rocks.

Jan. 6, 1891. Mr. Muecke exhibited a specimen, thought by him to be the fossil of some gasterpod shell, and which he obtained in a quarry on Goodman street. Silicified shells were exhibited by Miss King.

The topic for the evening was Igneous Rocks. Mr. J. M. Davison exhibited and described several microscopic sections of igneous rocks, which showed the crystaline structure of such rocks, and the development of crystalline forms in rock masses.

REPORT OF THE SECTION OF ZOOLOGY.

The preliminary steps for the organization of this Section were taken after the regular meeting of the Academy of March 10, 1890, at which time a meeting for temporary organizations was held, and a committee consisting of Prof. H. L. Fairchild, Dr. J. Edw. Line, and Dr. J. L. Roseboom appointed to draft rules, and suggest an organization. This committee reported to the Section, April 14, 1890, the organization suggested by them being adopted, namely, for Chairman, Frank A. Ward, for Recorder, Geo. W. Rafter. The rules adopted were similar to those of the Geological Section.

The first regular meeting for the discussion of scientific subjects was held April 30, 1890, at which time Prof. H. L. Fairchild presented to the Section a letter from Mr. G. W. Hill, of Fisher's Station, in reference to a number of weasels attacking a man. According to Mr.

Hill's account, John Briggen, a tenant of his, while waiting for his horse to drink at a small stream, saw on the opposite side about twenty-five to thirty little red animals of different sizes. This army of weasels as it turned out to be, advanced across the stream and climbed up the legs of both man and horse. They were only driven off by considerable effort on the part of the man and by the assistance of his dog coming to the rescue. Mr. Hill concludes that these weasels were probably traveling, and states that he on a previous occasion saw as many as fifteen together, and last summer he also killed a large one that had chased and frightened a little boy. Mr. Geo. H Harris is also cited as having been once attacked by a weasel.

In discussion of Mr. Hill's letter Prof. Henry A. Ward related a number of cases of other animals, which occasionally travel in large numbers and which are at such times very aggressive.

At the meeting of May 14, 1890, the scientific topic of the evening was on *Chlamyphorus* by Mr. Chas. H. Ward, who gave an account of the classification and place of the Chlamyphori, and explained in detail the structure of these animals. Mr. Ward exhibited several mounted specimens of the Armadillos. Among them a fine specimen of the Peba, the only Armadillo found in the United States.

Mounted specimens of Sloths were also exhibited, as for instance the *Chevelepus Hoffmani*, distinguished by wearing a covering of green Algæ when found. It was stated by Prof Henry A. Ward that nearly all the Sloths carried similar parasitic growths of Algæ.

Pulmonary Gastropods were the subject for discussion at the meeting of May 28, 1890, presented by Mr. S. G. Crump, who discussed the subject with reference to a collection from the Philippine Islands. Prof. Henry A. Ward also exhibited and described a collection of snails from Lake Tanganyika.

At the meeting of June 11, 1890, Prof. Henry A. Ward took as a topic the sperm whale, and discussed it in all its phases, with a large amount of illustrative material.

No further meetings were held until Oct. 13, 1890, at which time Mr. Geo. W. Rafter, discussed the Entomostraca of the vicinity of Rochester, exhibiting a number of photomicrographs of the same, and mounted objects under the microscope.

At the meeting of Dec. 10, 1890, Mr. Frank C. Baker discussed the Digestive System of the Mollusca, illustrating the topic by charts, microscopic mounts and a collection of shells.

The foregoing comprises the more important work of the Section during the year. Although a numbei of other topics have at different times been up for discussion. An exceeding pleasant feature of these meetings has been the presence of Prof. Henry A. Ward, and the interest in the work of the Section has been largely due to his extensive fund of information on all the subjects discussed.

ELECTION OF OFFICERS.

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

President, H. L. FAIRCHILD.
First Vice-President, A. L. AREY.
Second Vice-President, J. EUGENE WHITNEY.
Secretary, FRANK C. BAKER.
Corresponding Secretary, GEO. W. RAFTER,
Treasurer, EDWIN E. HOWELL.
Librarian, MARY E. MACAULEY.
Councillors,
For three years, { FLORENCE BECKWITH. J. L. ROSEBOOM.
To fill vacancy,—H. L. PRESTON.

The following paper was read :

DESCRIPTIONS OF NEW SPECIES OF MURICIDÆ, WITH REMARKS ON THE APICES OF CERTAIN FORMS.

BY FRANK C. BAKER.

Several months ago I gave the results of my investigation upon the apex in the typical or *Tribulus* group of Murices.* In that paper I described the apex of thirteen species. In the present communication I shall add five species to that number.

The embryonic apex of the typical group appears to be divisible into two principal groups or divisions ; first, those with smooth, rounded whorls, and second, those with carinated whorls.

The smooth rounded whorls appear to be but little diversified, whilst those of the carinated group are subject to no little variation. The carina, for example, may end either in the suture below, or be merged with the lowest of the four spiral liræ of the succeeding whorls. The embryonic varix is not always present, and the carina, not infrequently, ends abruptly in the center of the last embryonic whorl. The number of whorls seems to be quite constant, two, to two and a half

* (Proc. Acad. Nat. Sci. Phil., 1890, p. 66.)

being the usual number. In not a few cases the apices of (apparently) totally different species have been found upon examination to be identical in every way; thus, *Murex Tryoni*, Hidalgo, *M. Cailleti*, Petit, and *M. Similis*, Sowb., have the same form of apex which does not vary in the minutest degree. Due allowance must be made, of course, for the wear to which the shell is subjected, as in many cases the carina might be totally obliterated by wear, and thus give the entire apex a different appearance.

The present condition of the synonomy of this group, is a continual and perplexing bar to the solution of the problem of specific identity, and will remain so until large quantities of specimens have been gathered from well authenticated localities, and when more is known concerning the soft parts.

Genus MUREX, Linn.

Subgenus *Murex* (Sensu Stricto).

MUREX TRIBULUS, Linn.

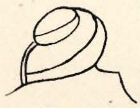


FIG 5.

The nucleus consists of one and a half brownish glossy whorls; a carina begins at the apex, encircles the embryonic whorls and finally runs into the lowest spiral liræ of the succeeding whorl; this carina is very faint and only to be seen by the aid of a powerful lens; the extreme point is bent down to one side and the tip is immersed in the body of the second whorl; the first half of the apex, looking at the lateral outline, is about two-thirds the size of the second half; the whole whorl is decidedly knob shaped and rapidly increases in size from the apex to its juncture with the matured portion of the shell; there is a slight varix at the ending of the embryonic whorls; the succeeding whorls are crossed by four spiral liræ; the spines begin upon the fourth whorl.

This species was first described in my former paper (p. 68), but after its publication I found that what had been identified as *tribulus*, was really *Martinianus*, Reeve. This species has been placed by some authorities as a synonym of *tribulus*, but the two species seem to be quite distinct. I have examined upwards of twenty specimens of each species, and there is no intermingling of characters.

The general character of the present apex is quite different from any hitherto described.

Subgenus *Rhinocantha* A. Ad.

MUREX BRANDARIS, Linn.

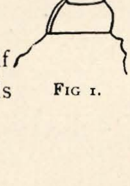


FIG 1.

The embryonic nucleus consists of one and a half rounded glossy, smooth whorls, of which the second half is but little larger than the first ; the tip of the apex is bent down to one side and concealed in the succeeding portion of the whorl ; there is no carina and the whorls are smooth and glossy in texture, and of a light horn color ; a view of the lateral outline shows a well rounded profile with rather a strong varix at the left side ; after passing this varix, the whorls are crossed by four spiral liræ, which are made nodulus by the crowded condition of the varices ; the suture of the embryonic whorl is well developed and a trifle impressed. This apex resembles that of *Murex brevispina*, *M. nigrospinosus* and *M. recurvirostris*, but is at once distinguished by the absence of a carina near the base of the last whorl. It more nearly resembles that of *Murex similis*, except that the whorls are more rounded than those of *brandaris*.

This is the only species of the *Rhinocantha* group (there are but two, the other being *cornutus*, *L.*) that I have been able to study. I have before me eight specimens of this species all in perfect condition, and the apex shows no variation.

Subgenus *Chicoreus* Montf.

MUREX RUFUS, Lam.

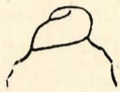


FIG. 2.

The embryonic apex of this species consists of one broad, flat whorl, which is of a reddish or rosy tinge ; the tip is immersed in the body of the spire, and is considerably bent down to one side ; there is no carina and the whorl is rough and coarse in texture, nearly approaching to granulose ; there is no varix at the ending of the embryonic whorl, but the four spiral liræ, and the longitudinal costæ gradually appear and grow stronger as the shell increases in size ; the whole apex of the shell for three whorls from the top is of a deep rose color.

Of this species I have seen three examples in perfect condition and the characters expressed in the above diagnosis show little or no variation.

Murex Salleanus, A. Ad, may be included here as a synonym. I have examined many hundred of this species from Florida, Yucatan, and the West India Islands, and do not for a moment hesitate in referring this species to *rufus*.

MUREX PLICIFERUS, Sowerby.

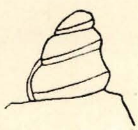


Fig. 4.

The apex of this species consists of two and a half rounded, waxy whorls of gradual increase ; the first, or tip, is a little oval knob, which is not bent down or immersed as in most of the species examined ; a carina begins at the very apex, encircles the shell just above the suture below, and finally enters the suture below the third whorl; there is a varix of considerable size at the ending of the embryonic whorl, which is rounded and transparent; after passing this varix the whorls are longitudinally costate, there being nine costæ to each whorl; these are crossed by four narrow, thread-like spiral lines; the spinose varices appear upon the fifth whorl.

I have before me four specimens of this species in perfect condition, and have seen nearly a dozen more in good condition, and the characters of the apex appear constant. The number of embryonic whorls is a condition not possessed by any member of the *chicoreus* group which I have examined. The spiral carnia encircling all the whorls is also a prominent character.

Pliciferus was considered by Mr. Tryon* a synonym of *calcar*, Kiener. I have examined specimens of both forms and do not hesitate to separate them as good and distinct species. *M. pliciferus* was first described by the elder G. B. Sowerby in Zool. Proc. 1840, p. 138, and first figured in Conch. Ill., Murex, f. 101, from a single specimen in the Cumingian collection. Since that time numerous specimens have been collected from the China coast and I have had the pleasure of examining quite recently a fresh lot of nearly a hundred specimens. It is a beautiful species of yellowish color and when full grown measures four inches in length.

MUREX BREVIFRONS, Lam.

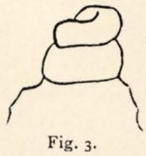


Fig. 3.

The embryonic apex of this species consists of about two rounded, rather smooth whorls; the tip of the apex is bent down to one side, and immersed in the coil of the succeeding whorl; the second whorl is but little larger than the first, after the latter leaves the extreme point; there is no indication of a carina; the whorls succeeding the two embryonic, are longitudinally ribbed until about the fourth is reached when the first varices appear; they do not become spinose until about the fifth; there are four spiral lines crossing the whorls, after passing the embryonic; the texture of the apex is more or less hyaline and rather shining.

I have examined eleven specimens of this species and the characters expressed above show no variation.

The synonomy of this species appears to be rather mixed and for the purpose of bringing it together I give below a table containing all the known synonyms.

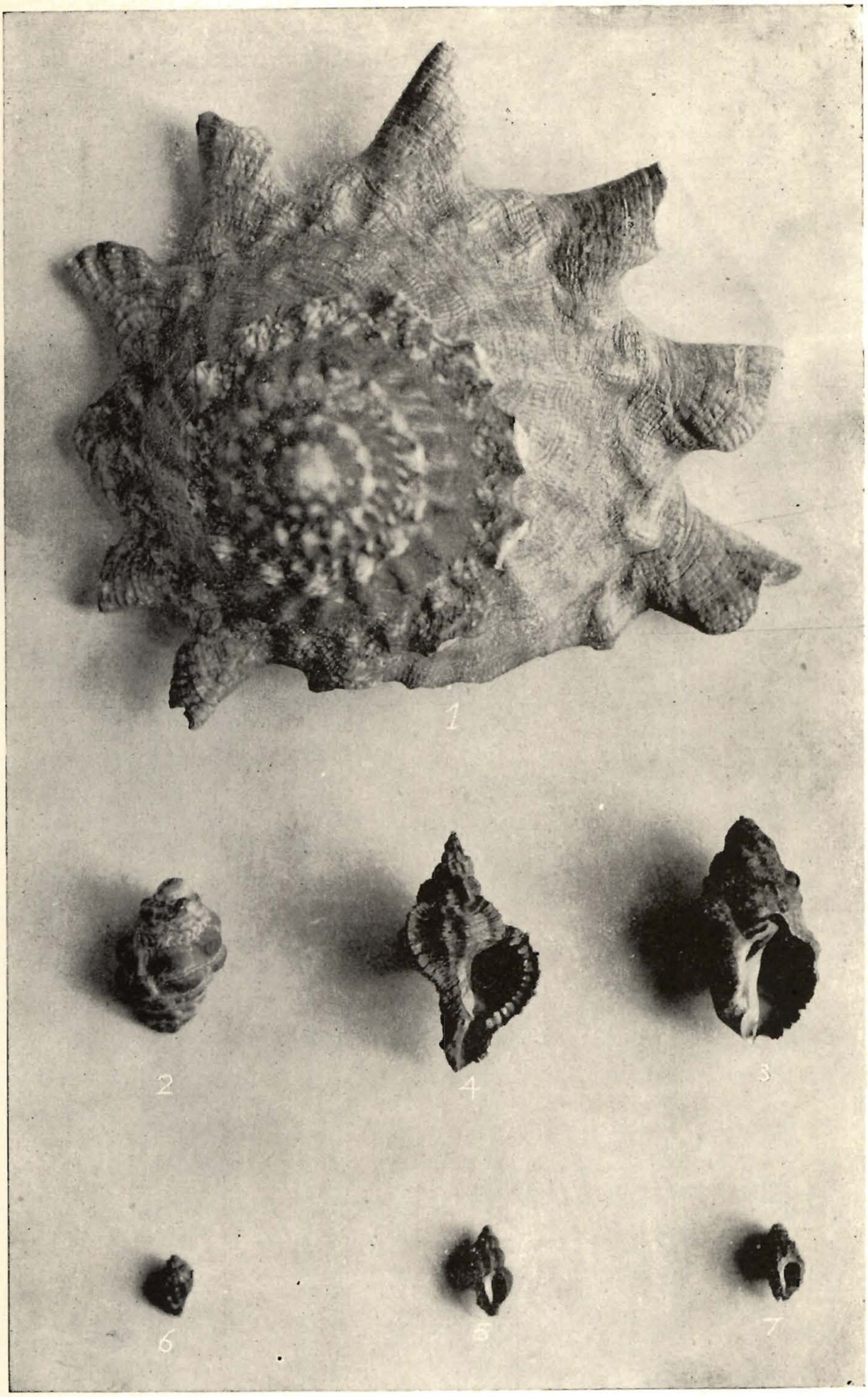
* Manual of Conchology, vol. 2, p. 94.

PLATE 11.

NEW SPECIES OF MURICIDÆ, &C.

1. *Astralium Wardii.*
2–3. *Purpura problematica.*
4. *Murex bituberculatus.*
5. *Ocinebra Wardiana.*
6–7. *Ocinebra rubra.*

ALL THE FIGURES ARE NATURAL SIZE.



BAKER—NEW SPECIES OF MURICIDÆ.

MUREX BREVFIRONS, Lam. Anim. Sans. Vert., IX, p. 573, Synonyms :

Calcitrapa, Lam. Anim. Sans Vert., IX, p. 573.
Crassivaricosus, Reeve. Zool. Proc., 1845, p. 86.
Elongatus, Reeve. (non Lam.) Conch. Icon.
Purpuratus, Reeve. Conch. Icon., sp. 183.
Approximatus, Sowb. Thes. Conch., 13 f. 62, 1879.

Description of New Species.

During the past six months I have had occasion to examine and study a large number of species and specimens of the *Muricidæ*, and among them I found four which appeared new to science. Of these, two may eventually prove merely varieties of nearly allied forms, but at present the paucity of material fully warrants their description as novelties. The types are in my private collection of *Muricidæ*.

MUREX (CHICOREUS) BITUBERCULATUS, sp. nov. Pl. 11, Fig. 4.

Shell oblong, ovate, rather thin, chocolate colored ; whorls eight, crossed by three longitudinal varices on each whorl with two intervarical nodes between each varix ; spire acute, pyramidal, about half the length of the entire shell ; sutures distinct, slightly impressed ; the body whorl is crossed by nine coarse spiral lines with a finer line between ; on the canal these lines are all of the same size ; the whorls are gracefully rounded and stand out upon the surface of the shell in great prominence ; the surface is further ornamented by extremely fine longitudinal lines, which intersects the spiral lines giving rise to small nodules at their intersection ; on the varices the spiral lines are raised into heavy, erect lines, giving the varix a crenulated aspect ; aperture a long oval ending below in a wide canal ; collumella arcuate, smooth and partly covered by a thin callous ; outer lip thickened by the varix, crenulate upon its edge ; canal moderate, wide, open nearly straight ; umbilicus closed ; color light chocolate, the nodes darker and the liræ lighter than the body of the shell ; apical whorls two in number, smooth and hyaline.

Alt. 34, diam. 18 mill. Aperture (excluding canal) alt. 12, diam. 8 mill. Habitat : *Australia.*

This species has long been a puzzle to me and it remained in my collection unnamed for a long time. I finally had an opportunity of comparing it with a large collection, and with all the published descriptions of the members of the *Chicoreus* group, and was convinced, after a careful study, that it was an undescribed species.

It can only be compared with *Murex Thomasi* Crosse, its nearest ally, from which it is separated by the two intervarical tubercles, there being but one in *Thomasi*. The spiral liræ are coarser and fewer in number in *Thomasi* than in the new species. The spire of *bituberculatus* is higher and the general aspect of the two shells is quite different.

OCINEBRA WARDIANA, sp. nov. Pl. 11, Fig. 5.

Shell fusiform, thick, rather solid of a cinereous color ; whorls five, rounded, crossed by numerous rounded, elevated, longitudinal ribs which are encircled by thread-like spiral liræ ; spire rather acute, outline of whorls rounded ; sutures impressed ; there are nine longitudinal ribs on the last whorl which are elevated and rounded ; these are crossed by about eighteen large, somewhat scabrous lines, with occasionally a finer line between ; aperture ovate ; outer lip rounded and thickened by the last longitudinal varix ; inner margin of outer lip provided with seven well developed denticles ; collumella area covered by an extending callous, smooth ; interior of aperture light-rosy ; canal short, wide, closed, a little recurved ; umbilicus closed, surrounded by a strong fasciole ; color yellowish overlaid by a blackish epidermis.

Alt. 14, diam. 7 mill. Aperture (excluding canal) alt. 5, diam. 3 mill. Habitat : *Australia.*

This is a pretty little shell having a superficial resemblance to *Ocinebra aciculata* Lam., but separated from that species by the more developed umbilical region, greater development of the tubercles within the outer lip and in the less accuminate spire. The color of the two shells is quite different, that of *aciculata* being light rosy, while *Wardiana* is yellowish or cinereous. *Wardiana* is also a more robust species than *aciculatas*, and the general shape of the two species is quite different. Unfortunately the apex is broken so that I am unable to describe that interesting and valuable portion of the shell.

The habitat of *Wardiana* will at once separate the two species, *aciculata* being from the Mediterranean Sea and Atlantic coasts of Europe and the British Channel. The new species is from Australia.

I take great pleasure in dedicating this interesting little species to Prof. Henry A. Ward, of Rochester, New York, who has for many years been a student of conchology and who has collected in many portions of the world.

OCINEBRA RUBRA, sp. nov. Pl. 11, Figs. 6, 7.

Shell fusiform, solid, reddish to chestnut in color ; whorls four (the apex is broken off on all the specimens so that but four whorls can be counted), stongly shouldered and crossed by strong, raised longitudinal ribs and spiral lines ; spire rather short and occupying about half the length of the entire shell ; there are on each whorl eight or nine strong raised, longitudinal costæ, which are crossed by six strongish, raised spiral lines arranged in pairs, two being at the shoulder, two at the periphery, and two at the base of the whorl ; the intersection of these longitudinal and spiral lines cause the shell to be cancellated or pitted, the pits being squarish or quadrate ; between each pair of spiral lines is a finer spiral line of a thread-like character ; spire rather stumpy ; sutures well defined ; whorls above the shoulder, between the shoulder and the suture, deeply excavated by the crossing of the longitudinal and spiral lines ; aperture ovate, white within ; canal short, moderately wide and closed ; columella smooth, white ; outer lip strongly arcuate and five-toothed within, the denticles forming nearly raised tubercles ; umbilicus defined but closed ; color red or chestnut overlaid by a lighter epidermis ; aperture white within.

Alt. 12, diam. 7 mill. Aperture (excluding canal) alt. 4, diam. 2, mill. Habitat unknown.

This species belongs to the *alveata* and *Peasei* group of Murices, but from the material at hand appears to be distinct from any thing hitherto published. The shell is shorter in the spire than *alveata* Kiener, and the aperture is much larger in proportion than *Peasei* Tryon (*foveolata* Pease), It has some resemblance to the figures of *Ocinebra interfossa* Cpr., but does not at all correspond with specimens of that species. I think there is very little danger of its being confounded with any other shell.

The species of Ocinebriæ are very numerous, and the material ordinarily at the disposition of the student very small, so that no satisfactory catalogue of the group has as yet been published ; and the species described in this paper as new, may eventually prove to be of the many unfigured species, which have been described with brief Latin diagnoses and have not been identified by subsequent authors. Many of these descriptions have been very brief, of scarcely three lines, and furthermore without dimensions of any kind. Such careless work does not deserve recognition, and the species so described should be consigned to oblivion. The task of the monographer has not been an easy one on this account. A perusal of Sowerby, Reeve and Tryon will convince the student of the truth of my statements.

PURPURA (THALESSA) PROBLEMATICA, sp. nov. Pl. 11, Figs. 2, 3.

Shell strong, solid, chocolate colored under a cinereous epidermis ; spire conical, occupying about half the length of the entire shell ; whorls about five in number, crossed by four spiral riblets on the body whorl which are cut into nodules giving the shell the appearance of a mulberry ; the body whorl is encircled by ten spiral lines, two between each of the series of nodules ; the nodules are further crossed by numerous microscopical lines which are only to be seen with the aid of a glass ; the lateral outline of the whole shell is more or less fusiform ; the upper row of nodules gives the shell a shouldered appearance and the character is continued to the apex ; aperture ovate—oblong ; columella smooth but twisted at its base ; outer lip crenulated externally, and three toothed or denticled within, the denticles prolonged in long processes which are continued to the apex ; anterior canal a mere notch ; posterior canal slightly developed ; umbilical region covered by the columella callous which is provided near the center with a narrow thread-like fold ; columella muscle scar placed near the posterior canal, square and chestnut colored ; aperture light-yellowish within, the inner edge of the outer lip stained with black.

Alt. 30, diam. 18 mill. Aperture alt. 17 diam. 8 mill. Habitat : *Japan.*

This species is closely related to both *Purpura hippocastaneum*, Lam., and *P. tumulosa* Reeve. From *hippocastaneum* it is separated by the tubercles being nearly obsolete and not spinose ; the whole shell smaller, more fusiform and of a more compact form. The spire is more conical and the whorls flatter than in the latter species.

From *tumulosa* it is separated by its smaller size, its greater length as compared with its width, and by the presence of *teeth within the outer lip*, a character *not* possessed by *tumulosa.*

The species was first diagnosed from three specimens without locality, obtained from the Wagner Free Institute of Science of Philadelphia, Penn. Sometime afterwards nine additional specimens were received from Japan, thus confirming the validity of the species and giving, fortunately, an authentic locality. I have twelve specimens of these species now before me and there is no variation from the above diagnosis.

This species is well figured on pl. 46, f. 48 of the second volume of Tryon's Manual and is in that work considered to be a variety of *tumulosus*, but from a comparison of abundant material, seems to be distinct.

Description of a new species of Astralium.

ASTRALIUM (POMAULAX) WARDII, sp. nov. Pl. 11, Fig. 1.

Shell large, depressed conic, imperforate ; rufescent with a tinge of green ; whorls six, sloping, conical, obsoletely longitudinally wrinkled below the sutures ; periphery expanded, carinated, armed with ten wide spines, the spines being cut into narrow cinguli by the lines of growth ; there is a row of nodules running spirally around the shell just above the peripheral spines which upon the last and penultimate whorls are greenish in color, but which become white upon the upper whorls ; there are about twenty-two of these nodules to each whorl ; base planulate with about thirteen concentric tuberculate spiral lines encircling it ; umbilical region white, with two strongish ribs, one at the end of the callous and the other forming part of the columella ; texture of surface, both above and below the periphery, granulose ; aperture transversely dilated, angulate ; interior of aperture pearly ; columella callous depressed.

Alt. 42, diam. 108 mill. Aperture alt. 20, diam. 40 mill. Habitat: *Australia.*

This large and beautiful shell is closely related to *Astralium japonicum*, Dunker,* and may prove but a variety of that species. *Wardii* is a much wider and a more depressed shell than *japonicum*, and the peripheral spines are more developed. The dimensions of the two species are very different and I give them both below to show their relative proportions.

Japonicum. Alt. 65, diam. 95 mill.

Wardii. Alt. 42, diam. 108 mill.

This shell was collected by Prof. Henry A. Ward, to whom the species is dedicated, in Australia some years ago and now forms part of his large and fine collection of shells.

The operculum is unfortunately unknown.

JANUARY 26, 1891.

STATED MEETING.

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

Twenty-two persons present.

The following paper was read :

THE ZODIACAL LIGHT.

By M. A. VEEDER.

There is in or near the plane of the ecliptic, at a distance from the sun greater than that to which the glow of twilight or dawn extends, a faintly luminous cone or band known as the zodiacal light. Under

*Described in Phillippi Abbild., Vol. 1, Pl. 5, Fig. 1, 1845.

exceptionally favorable circumstances this band has been traced completely across the sky. In that portion of it which is most remote from the sun there has been found a spot brighter than the rest, which has been called the gegenschein. The zodiacal light is brightest in the tropics, and in that location has been thought by some to exhibit pulsations. Its spectrum however is usually continuous, indicating that it shines by reflected sunlight. Auroral or other lines have been detected in its spectrum only exceptionally and under such circumstances that they may perhaps have been due to intermixture of light from other sources.

In the middle latitudes the zodiacal light is brightest in March and October, in the former case after sunset, and in the latter before sunrise. At these times one margin of the band is better defined than the other, and more exactly included within the plane of the ecliptic. At other seasons there is decreasing brightness, and both edges become ill defined. It does not seem possible to explain these differences fully by referring them to variations in the angle made with the horizon, or to the interference of twilight. The peculiarities mentioned, and others yet to be described, are consistent with the idea that the zodiacal light is a visible extension of the solar corona.

This extension of the corona is probably double, corresponding to the bifurcation seen during eclipses, each section overlying a sunspot belt. It consists doubtless of meteoric particles of the usual ferruginous character, moving in definite orbits, and shining by reflected light. It is a solar appendage, but not a part of the sun's atmosphere. Like the rings of Saturn, it does not conform to the plane of the earth's orbit but to that of the equator of the body which it surrounds, which in this case is the sun itself. As viewed from the earth these coronal extensions are at times foreshortened, and at times opened out, so as to become more plainly visible. In the spring months the south pole of the sun is inclined toward the earth, so that the latter is almost exactly in the heliocentric zenith of the southern sunspot belt and coronal extension. Consequently the particles composing this extension are in a direct line between sun and earth, and shining as they do by reflected light, like the new moon, they become almost invisible. Coincidently the coronal extension overlying the northern sunspot belt is opened out to its widest extent, and reflects more light earthward than at any other time. Hence if these extensions become visible as the zodiacal light, the southern edge at this season should be the more sharply defined, and more exactly include within the plane of the ecliptic, because of the lack of illumination described, and the northern edge on the other hand, should shade off very gradually departing more widely from the plane of the ecliptic, and this is precisely what has been found to be the case. At this time of year also the northern coronal extension, thus opened out to its greatest extent, is in full view on the sunset side of the plane of the earth's orbit. In Autumn, on the other hand, the north pole of the sun is directed earthward, and the northern coronal extension fails of illumination, and the southern coronal extension is opened out and most completely illuminated, and is in full view on the sunrise side of the plane of the earth's orbit. Thus the zodiacal light is brightest in Spring and Fall, but in the evening in the one case and in morning in the other. In Summer and Winter, on the other hand, the earth occupies a position intermediate between these disc-like coronal extensions. Coincidently the zodiacal column becomes less clearly defined on both edges and diminishes greatly in brightness, less light being reflected earthward, and it is seen equally well, though faintly, both in the morning and in the evening.

It is in their relation to magnetic phenomena, however, that the peculiarities of the zodiacal light acquire their greatest interest. Indeed the present research probably would not have been undertaken had it not grown out of the investigation in regard to the aurora and its associated phenomena, some of the results of which were presented before the Academy and printed in the Proceedings of Nov. 11, 1889. (See page 18.) At that time evidence of a periodicity of auroras at intervals of about twenty-seven days had been secured. Subsequently, with more complete information and longer lists, this period was amended by successive approximations until it became twenty-seven days, six hours, and thirty-six minutes. It was then for the first discovered that this result, which had been obtained independently from magnetic phenomena alone, differed only four minutes from the most generally accepted value for a synodic revolution of the sun, as determined from the average rate of movement of sun spots. For the sake of uniformity this four minutes was added, and tables were constructed, (see plate,) showing the numbers of stations reporting auroras each day in all accessible lists for nearly two hundred years, arranged in periods of twenty-seven days, six hours, and forty minutes each. Portions of these tables comprising forty-six years were compared with the coincident records of magnetic perturbations at Greenwich, and for three years with records from the Naval Observatory, Washington, and likewise with the results obtained at Point Barrow, in connection with the International Polar Expedition in 1882 and 1883. The consensus of all this very voluminous testimony is to the effect, that there is an unmistakable periodicity at an interval which does not differ very much, if at all, from that finally adopted as above stated. This periodicity is, however, subject to modifications which require further investigation. The chief of these are certain annual interruptions which are plainly apparent in the accompanying plate. At first it was supposed that these were due to the interference of moonlight, or summer twilight, as the case might be, preventing auroras from being seen. But the records of magnetic perturbation which are not affected by moonlight show the same thing, so that further explanation is required.

By the identification of the disturbed portions of the sun, concerned in the production of particular series of outbreaks of magnetic phenomena, we may learn whether cessation of solar activity attends the annual interruption in the recurrence of auroras to which reference has been made. For the purpose of such identification the surface of the sun was considered to have been divided meridionally into as many sections as there are days, and fractions of a day, required for the completion of a single synodic revolution. Lists were then made of all sunspots observed on each section, together with their sizes, as determined by the measurements made at Greenwich Observatory upon the photographs, taken under the auspices of the Solar Physics Committee of the Royal Society. The sums of the numbers, indicating the sizes in each of these lists for the entire period selected, show the corresponding amount of sunspot formation on each section. The numbers of stations reporting auroras each day during the period selected, were also arranged in accordance with the time of a synodic revolution, and the sums for corresponding days of all these synodic periods were obtained. By this means the portion of the sun associated with a given series of outbreaks of magnetic phenomena at once becomes apparent. Thus it appears that the areas most frequented by sunspots are most actively concerned in the production of auroras, having this power occasionally, even when spots are temporarily absent, and in any case manifesting it chiefly, if not exclusively, when at the eastern limb, appearing by rotation. As regards explanation of the interruptions at regular intervals of series of recurrences of auroras, it appears from the tabulation here described that they cannot be accounted for by cessation of solar activity.

This tabulation, by increasing our knowledge of the nature and consequence of solar activities, may contribute positively to the explanation of the interruptions of series of auroras in question.

The association of phenomena indicated and their periodicity, afford positive proof that the body of the sun is a coherent mass prob-

PLATE 12.

TABLE SHOWING PERIODICITY IN OCCURRENCE OF AURORAS.

The accompanying table has been constructed by counting the stations, reporting auroras each day in the Monthly Weather Review of the United States Signal Service, and arranging the numbers thus obtained in periods of twenty-seven days six hours and forty minutes. The six hours, or one-quarter day, is provided for by adding a day to each fourth period, and the forty minutes, or one-thirty-sixth, day by adding a day to each thirty-sixth period. The grouping together of larger numbers indicates increased prevalence of the aurora at this interval, which corresponds to the time of a synodic revolution of the sun. Annual interruptions of such series of recurrences are also apparent. (See columns 4 to 10 and 18 to 24).

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	1/4	1/16
1885	Feb.16 to Mar.15	3	3				2	1	1			1							2	7	2						2	9	72	·
	Mar.16 to Apr.11	7	2	2	1	14	4					1					1			1			1	15	2	1	1			
	Apr.12 to May 8	2	3	4	1					1	1	1					3							1		2	1	2		
	May.9 to Jun.4	5		19	1	21			1		1							2	2	7				1	4	1	3	2		
	Jun.5 to July 2	1		1	4			1		2		1	1		1	1			2	2	14	5	1				1		1	
	July 3 to July 29			2							2	1		1	1	1	1			1	1		1			1				
	July 30 to Aug.25	1	1	6	4		1		9	5	2	1		2	1	1	1	1	1		1									
	Aug.26 to Sep.21	1	1	1	3		1	1	2	9	15	2									10	46	1	3	2					
	Sep.22 to Oct.20					1	2		1							1		16	2		13	2	2	4	8	4	1	1	*	*
	Oct.21 to Nov.16								1	3	1	5	5						1	11		19	5	5	3		1			
	Nov.17 to Dec.13	1														14	2		1	1	28	15	7	1						
	Dec.14 to Jan.9				1									1			1	1		5	2	1	1			2	5	8		
1886	Jan.10 to Feb.6	4	3	1		3						1		1	1			1		6	8	2			2	5		1	6	
	Feb.7 to Mar.5	7	7	1	8	1	1	1			1	1					6		2				1			1	1	1		
	Mar.6 to Apr.1	3	1		1	2	1	3			1	1	1	1	1		2	3		1		18	5	15	1	13	6	11		
	Apr.2 to Apr.28	2	1	3		1		1			3	3		13					2	16				3	3					
	Apr.29 to May 26	2	8	4	1	1		1		1	37	18	1	1	1	3	1			4			4	3	1	1	1	1	1	
	May 27 to Jun.22		2	2	2		2	1	2	23	19	1			1		1								1	3				
	Jun.23 to July 19	1	3	1	2	2	1	47	21	1	8	2	1	1		1	1				2				1			1		
	Jul.20 to Aug.15	1		9	1		2	3	96	9					1		2	1		2				3	2	3	2			
	Aug.16 to Sep.12	1	3			3	1	1	64	3	1	3	1												1	2	6	1	*	
	Sep.13 to Oct.9	1	1	1		2		1	12	2	1	1				1		6	11	8	2		2	4	6	11	12	2		
	Oct.10 to Nov.5	1		2				1	1	7			3	2		1	1	4	10	24	4	3	1		12	8	7	2		
	Nov.6 to Dec.2	2	1							1	1			1		3	1	2	7	1	2		1		4	4	3	2		
	Dec.3 to Dec.30		1			1					1			1		2			1		4	1		3	2		4	3	*	
1887	Dec.31 to Jan.26	1							1							2		3	1	3		1		5	1	2	2	1		
	Jan.27 to Feb.22			1				1		1						1	7	33	23	9	2	5	1	1	42	6	4	1		
	Feb.23 to Mar.21	3	1	4	1		1	1							2					2		3				5	5	2		
	Mar.22 to Apr.18		5	4								2									1	a			a	a			a	
	Apr.19 to May 15	4				5		1			2				4	2	1							1	6	1	1			
	May 16 to Jun.11		3	7	2	1	1	2	19	16	5	1					1	1		2		2				3	3	1		
	Jun.12 to July 8			1	1	1	1	2	1	2	1	1				3	1	1							1	5	1			
	July 9 to Aug.5				1		1	3		2	13	15	4												1				*	
	Aug.6 to Sep.1				1		1		5	12	4	2				1			2					4	3		2	1		
	Sep.2 to Sep.28					3					1	1	1	2	11	5	3	1			5	3	2	3	40	2	13	1		
	Sep.29 to Oct.25				1			1			2		3		3	6				1			1	2	7		1			
	Oct.26 to Nov.22														9	4			1	1	1	2		2	1	5	2	2	1	
	Nov.23 to Dec.19														4	1	1				8	7	2	1	8	5	1			
	Dec.20 to Jan.15	1	12	1							1								1	9	10	1	2		3	9	4	2		
1888	Jan.16 to Feb.11	4	3						1	2	1		1	1				1		4	5	2			40	1	2	1		
	Feb.12 to Mar.10			1	1			5	4	2				2							1					12	2	1	1	
	Mar.11 to Apr.6		1			18	4	6	4			2		1	1						5		2	76	17	5	8	1		
	Apr.7 to May 3	1			5	57	8	11	3	5															2	4	5	1		
	May 4 to May 30	1	1	6	28	6	6	1		1			1			2		55	6	2					1	2	3	1		
	May 31 to Jun.28	1	2	4	20	2	2					1	2		1	2													*	*
	Jun.29 to July 25		5	3						1									1	1					1					
	July 26 to Aug.21			3	2				3	15		1						5	1	1	1	1	4	3	1					
	Aug.22 to Sep.17					1				1	2	2	1					1	1	2		2	3	3	4	1		1		
	Sep.17 to Oct.15							1		2		2	1			2		2						5	10				1	
	Oct.16 to Nov.11	1			2		2				1	1			1	40	7	1			1	4	3	1			1			
	Nov.12 to Dec.8	1	1			1	1								3	2	1			2	1		2	2	2		1	2		

ably containing a solid nucleus, and that it is not entirely liquid or gaseous as some have supposed. At certain points in this mass, there is something akin to volcanic action in progress. On the earth such action is attended by electrical phenomena, and this is probably the case upon a much grander scale on the sun. Indeed, the evidence is conclusive that these solar eruptive forces are concerned in the production of disturbances of terrestrial magnetism, at intervals of about twenty-seven days, as well as in eleven year cycles, and at more or less irregular intervals. The next step is to inquire how these solar electric impulses are conveyed from sun to earth.

It is a well known principle, that when bodies in a condition of electrical strain with reference to each other are put in motion they become the seat of currents of electricity. Thus, in the telephone, a thin plate of metal is adjusted in proximity to a magnet so as to be held in a condition of strain. When put in motion by the sound of the voice, this plate vibrates to and fro, varying its distance from the controlling magnet, and as the result electrical currents are generated. By means of a wire these currents are conducted to a second instrument in which they modify the attractive force of another magnet in such manner, that it causes vibrations in a plate under its control, entirely similar to those imparted at the outset by the sound of the voice. It is motion, therefore, which under proper conditions generates electrical currents. Thus the motion of the sun on its axis, carrying forward at an enormous velocity the electrically excited portions of its surface, generates currents which tend to propagate themselves, as is the rule, along certain lines of force. It is for reasons connected with these peculiarities of magnetic induction that disturbances at the eastern limb alone are capable of conveying the strongest electrical impulses earthward. In the conduction of such impulses there is not an actual conveyance of material substance from one point to another, but each particle intervening, that is capable of serving as a conductor, tends to become a magnet and arrange itself with reference to every other particle in its vicinity, in accordance with the principle of polarity, as is seen when iron filings attach themselves to a magnet. In the case of the telephone the varying stress or strain is conveyed by means of the conducting wire, the particles composing which are magnetized, or in other words, tend to become magnets. Without such conducting medium there can be no conveyance of currents, even for comparatively short distances, to say nothing of ninety-five millions of miles.

Now we have in the disc-like extensions of the solar corona, which become visible as the zodiacal light, such a distribution of ferruginous meteoric particles, as would serve as a conducting medium, not only from sun to earth, but much farther, as appears from the presence of the zodiacal band and gegenschein, shining faintly though it be, in the part of the heavens most remote from the sun. The probability that these coronal extensions serve as conductors of electrical impulses originating in the sun will be strengthened in proportion as it is found that the diurnal, annual and other variations of terrestrial magnetism are directly related to the varying location of the earth, and of the disturbed parts of the sun in reference to these discs.

In Spring and Fall the earth, as we have seen, is traversing one or the other of these coronal extensions, and it is at these seasons as a rule that auroras are most brilliant and numerous, the earth then being in the very midst of the conducting magnetic material. Thus certain interruptions in the recurrences of similar magnetic conditions, to which reference has been made, may at length be explained. They are due simply to the varying position of the earth itself in respect to the conducting medium.

There is evidence, also, that it makes a difference as to which hemisphere a solar disturbance is located upon. In 1888, and for several years preceding, there were series of bright auroras at the interval from each other of a synodic revolution of the sun, which were confined almost entirely to the Spring and early Summer months of each year; these series being interrupted almost completely at other seasons. (See columns 4 to 10 of plate.) It is likely in this case that the originating solar disturbance was confined to one hemisphere of the sun, and in proper relation to one coronal extension only, so that its full effect was experienced by the earth for a limited period recurring annually. In another case, likewise extending over several years, the originating solar disturbance seems to have been of such extent as to involve both coronal discs, the result being greater persistence of magnetic phenomena throughout the entire year, but with the customary pronounced maxima due to the position of the earth in Spring and Fall. (See columns 18 to 24 plate.) Thus another series of the interruptions and modifications of periodicity to which reference has been made, may be accounted for by differences in the position of solar disturbances, with respect to the coronal discs, which serve as the conducting medium for the conveyance of the impulses which they originate.

Other effects of the varying position of the earth in reference to these coronal extensions and other effects of their varying inductive power, remain to be described. Thus the permanent magnetic poles of the earth are displaced from the poles of its axis of rotation a distance almost exactly equal to the inclination of the latter to the plane of these extensions of the corona. Induction at this angle, continued through long series of years, seems to have established the latitude of the magnetic poles, their location in longitude being determined, perhaps, by the magnetic properties of the materials of which the earth itself is composed.

Changes in the sub-permanent magnetism of the coronal extensions, resulting from the variability manifest in the sun, necessarily cause slow variations in the strength and location of the permanent magnetic poles. Thus the well known secular variations of declination and magnetic dip become explicable. Changes in the temporary magnetism of these same coronal conducting discs, such as must exist during magnetic storms, will on the other hand, occasion the induction of temporary magnetic poles in the same latitude as the permanent poles, but undergoing a diurnal change of longitude. The inductive effect is exercised at a fixed point as regards the coronal extensions, but different parts of the earth come under its influence in succession, because of the diurnal motion of rotation. Near the track which this temporary pole traverses, during magnetic storms, the needle is much more disturbed, and auroras are brighter than elsewhere. Thus, also, these phenomena are at their height at the hours of local time, when this temporary pole is brought nearest to the point of observation by the revolution of the earth on its axis. Once in twenty-four hours this temporary pole coincides with the permanent pole, re-enforcing the effect of both, and occasioning the absolute maximum of auroras for that day. Thus an aurora has been observed to attain its greatest brightness at about ten o'clock P. M., local time, in many different localities from Russia westward to Alaska, its greatest absolute brightness however being at the time of its closest approach to the permanent magnetic pole near Hudson's Bay. During magnetic storms there is at midnight a reversal in the direction of the characteristic deflections of the needle, evidently due to the changing location of this temporary magnetic pole. When magnetic storms persist for several days the curves recorded by the declination magnetograph, not infrequently are almost precisely similar both as respects direction and extent, at corresponding hours each day. So, too, in the case of very severe magnetic storms the needles have been observed to have been thrown into a state of agitation at practically the same instant throughout the earth, but the direction and extent of the movements in different localities are not the same, being dependent upon proximity to the temporary pole, in the manner above indicated.

Still another form of induction from these coronal discs is due to the orbital motion of the earth in reference to them. In this case also a wandering pole is developed, but unlike that just described it undergoes very large changes of latitude as well as longitude. Its effect is apparent in smooth and sweeping deviations of the needle, which recur daily and are entirely different from the fitful and irregular movements characteristic of magnetic storms. These deviations depend for the most part upon the persistence of the permanent and sub-permanent magnetism of the coronal matter, rather than upon sudden variations in the extent of its magnetization. They consist of a large deflection eastward during the morning hours and a corresponding westward deflection about noon, and similar movements eastward and westward but upon a very much smaller scale during the night. In Winter this diurnal variation is very much less than in Summer, and the time of its occurrence is slightly modified. This appears to depend upon a transference of the wandering pole, which has been developed, from the Winter to the Summer hemisphere of the earth because of some relation which this latter hemisphere sustains to the direction of the orbital motion. In other words, the earth's axis remaining parallel to itself, and at a certain angle with the plane of its orbit, induction due to orbital motion will have its chief effect first in one hemisphere, and then in the other, according to the situation of the earth in its annual course about the sun. The revolution of the earth on its axis brings all points on its surface more or less directly under the influence of this pole, at certain hours of local time, the proximity and consequent effect being greater in Summer than in Winter. There is, therefore, in this case, a compounding of diurnal and annual periodicity. Also in years when sunspots and auroras are numerous the range of this regular diurnal movement increases, probably because of the increase of the sub-permanent magnetism of the coronal particles.

There is evidence also that other members of the solar system beside the earth are affected by magnetic induction of solar origin. There are regular variations of the needle which depend upon the position of the moon. The tables of auroras show likewise that magnetic phenomena acquire greater intensity when the moon is in certain parts of its orbit. This was noticed moreover by Sir John Franklin, in the case of auroras in the Arctic regions. There is evidence too that the planets Jupiter and Saturn, in certain parts of their orbits, react upon each other and upon the earth by magnetic induction. These are phases of the subject, however, which have not been studied as yet, except in an incidental way.

It will be observed that no account has been made of any presumed variability of solar heat. The forces concerned in the various forms of periodicity described, whatever else they may be, do not appear to be thermo-electric. It is inconceivable that puffs of heat should be conveyed from disturbances at the eastern limb, or any other point on the sun exclusively, so as to originate a periodicity, such as that manifest in the case of auroras. The electrical impulses are conveyed, not as heat radiations, but in accordance with ordinary principles of magnetic induction, bearing no other than merely incidental relations to heating effects. Nor is there any conclusive evidence that these impulses are conveyed as light radiations. Indeed, some of the chief effects which they produce are confined to the darkened side of the earth. In short the preponderance of evidence is to the effect that they constitute a special form of solar activity, having well defined peculiarities and standing apart from the rest.

It will be observed also that no reference has been made thus far to the idea that tidal strain due to planetary positions may originate the conditions in the sun upon which magnetic phenomena depend. The writer has been unable to reconcile the eleven year period and other peculiarities with any schedule of planetary positions thus far devised. On the other hand the somewhat irregular character of the periodicity, and the ways in which it tends to manifest itself all indicate that the originating forces in the sun are chiefly, if not entirely, volcanic. At times of apparent solar quiet, there is an accumulation of energy which bursts forth when a certain limit has been reached, causing the characteristic rapid increase of sunspots, auroras and magnetic storms at the beginning of each fresh cycle of solar activity, which in turn is followed by the usual comparatively slow decline. In a viscous mass, such as that of which the sun probably very largely consists, eruptions will be most likely to recur with considerable regularity, as they do in the case of the terrestrial volcano Kilauea, whose lavas are characterized by unusual viscidity. Thus the eleven year period may be simply of solar volcanic origin.

As bearing upon the manner in which the explosive forces manifest at certain points on the sun, originate and propagate electrical impulses, the various facts in regard to the zodiacal light acquire very special interest. The purpose of the present discussion has not been so much to elaborate a working hypothesis, although perhaps this is really involved, as to present a compendious account of phenomena actually observed in their natural relation to each other. It is a continuation of the research some of the results of which were presented before the Academy and printed in the Proceedings last year under the headings "The Aurora" and "The Forces Concerned in the Development of Storms."* The conclusions set forth in those papers are in conformity with what has been stated in the present discussion. The most practical result thus far attained is perhaps the securing of evidence that the belt-like distribution of atmospheric pressure about the magnetic poles as a center, which varies in different years and in different parts of the same year, producing different types of weather, is very largely dependent upon magnetic induction of solar volcanic origin conveyed from sun to earth through the medium of the coronal extensions which become visible as the zodiacal light.

February 9, 1891.

STATED MEETING.

The President, Prof. H. L. Fairchild, in the chair.

Twenty-four persons present.

The Council report recommended,

(1) The payment of certain bills.

(2) That the Academy appropriate $6.50 for the construction of a case to hold a collection of fossils, presented to the Academy by Prof. A. L. Arey.

The items of the report were separately adopted, the bills ordered paid, and the appropriation made.

The candidates for Fellowship, nominated at the previous business meeting, were elected by formal ballot.

The following paper was read:

NOTES ON MEXICAN ARCHÆOLOGY.

By F. W. Warner.

The numerous temples and other archæological remains found in Mexico, are mostly of Toltec origin. The temples were used by the Aztecs in the exercise of their superstitious rites and it is quite probable that their religious ceremonies were especially adapted to the buildings which they found when they came into the country. Some of the temples, and among them the great pyramid of Cholula, were in exist-

* See Proceedings of November 11, 1890, pp. 18 and 57 of this volume.

ence when the Toltecs first made their appearance in Mexico, about the year 680.

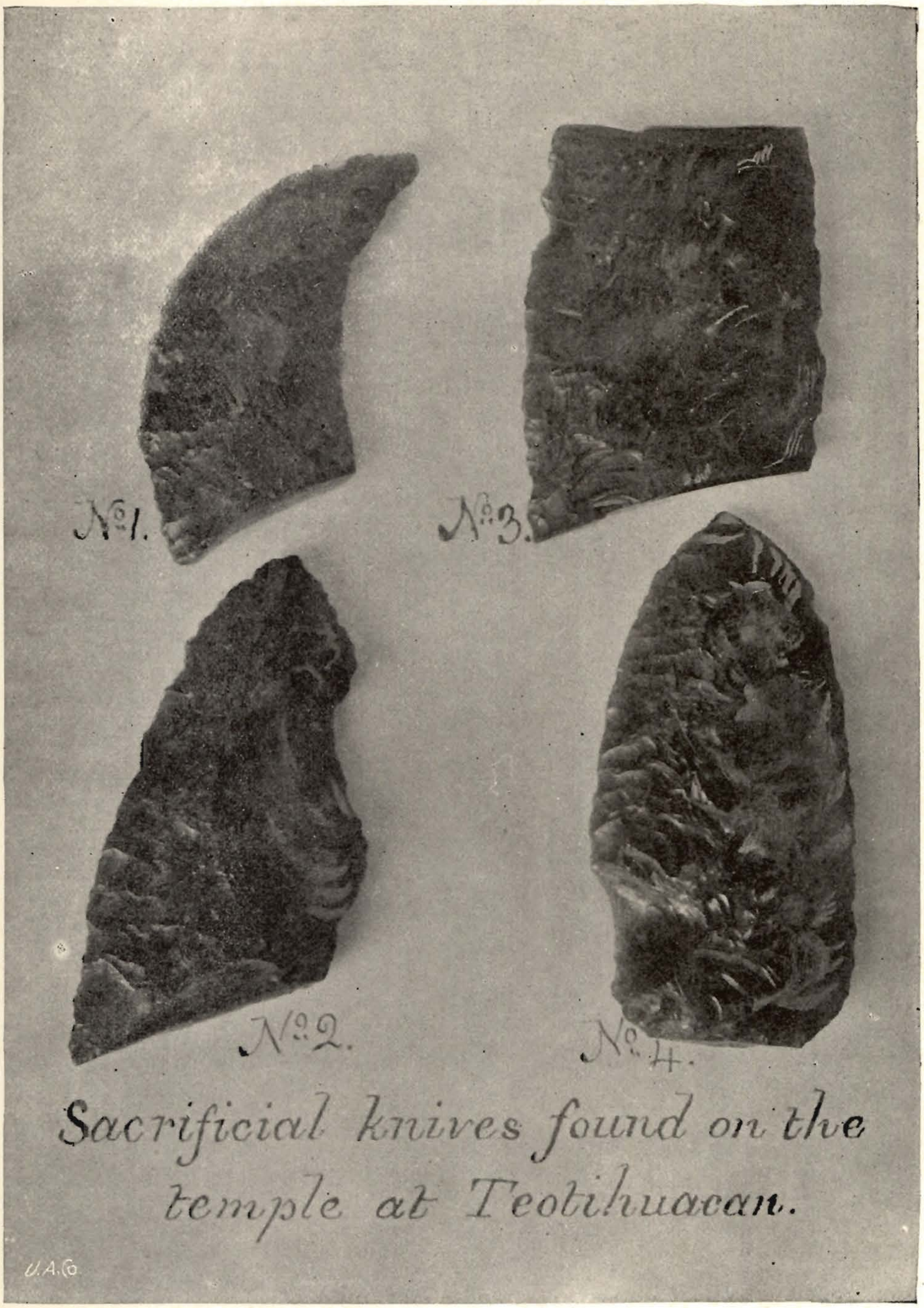
Forty miles east of the city of Mexico there is found a very remarkable group of temples at a place called San Juan Teotihuacan. From the size and extent of the pyramids and the other ruins, as well as from the great number of pieces of pottery and broken implements scattered over miles of territory, it is evident that this was once a large city and a center of worship: an Aztec Jerusalem or Mecca. The principal pyramid of Teotihuacan is mentioned in the old records as the To-na-ti-uh, Itz-a-cu-atl, or the Temple of the Sun.

This structure is made in the form of a truncated pyramid, and though the sharp angles have been somewhat rounded by time, the pyramidal form is retained. The temple is overgrown with weeds and cactus, but the stairway and the terraces are clearly cut, though somewhat obscured by the verdure.

The pyramid stands upon a raised platform or foundation which may or may not be included in the measurement. The building covers an area of 12 acres and rises to a height of 202 feet above the elevated area about it, and 216 feet above the level of the plains. The measurements are usually given, without including the raised platform, as 700 feet on each side of the base; my own measurement made it fall short a few feet of that figure. A Mexican writer, Señor Cubas, includes the base and makes it 768 feet on the sides running north and south, and 720 feet on the sides running east and west. The flat space at the top covers about half an acre and upon it there is a large altar of mason work still standing. The approach to the summit is by a zigzag stair case, and there are two narrow terraces passing completely around the pyramid, each measuring a third of the distance from the base. The building is made of small stones and broken rock firmly cemented together with lime. On one side a deep cut has been made, showing the solid and uniform nature of the work.

From the summit of this pyramid we may survey the entire field and get a good idea of the size and position of the lesser pyramids. To the north, and slightly to the west, is the pyramid known as the Temple of the Moon, while to the south and east are twelve smaller pyramids called the *Temples of the Stars.* These are arranged so as to enclose a court or hollow square. Each side has four pyramids and is about a mile in length, thus enclosing a square mile. The smaller pyramids are each about one hundred feet square at the base and forty-two feet in height. The temple of the moon is well worth a careful study. It is distant 2,700 from the temple of the sun, and, as I have indicated, a little to the west of north. The pyramid is 137 feet in height and 511 feet on a line of the base on the north and south sides, and 426 on the east and west base lines, covering exactly five acres. On the west face of the pyramid is a large opening disclosing a horizontal passage. This leads in for a distance of about forty feet, where it terminates in a well about fifteen feet in depth. The object of this chamber is left to conjecture. Lying about two hundred feet from the west side is a sculptured rock of porphyry, which once served as the sacrificial stone, while near the north side lies a sculptured image also of porphyry which once stood upon the summit of the temple. These valuable relics of the Toltecs were rolled from their position and mutilated by order of Bishop Zumar-ra-ga, who made such havoc of the Aztec and Toltec records, and spent his energies in trying to destroy every trace of the heathen races, believing that the natives would the more readily embrace the christian faith. Coming down the stairway on the southern face of the pyramid, you come into the the Camina de la Muerta, or way of death, which terminates on this face. This way is laid in cement and is as smooth and clean as a floor. It is about a hundred feet in width and between three and four thousand feet in length. The paved way is laid in levels and any change of level is marked by a descent of steps which are of the full width of the road. As one can imagine, a stairway a hundred feet in width is a striking architectural feature. On either side of this pavement are imposing structures from twenty to sixty feet in height, some in pyramidal form and some are built square with cornices. The pavement for its entire length is lined on both sides with these buildings which were used as tombs. The southern end of the pavement terminates in a large square structure of solid masonry, which has a heavy cornice. Looking from this point the architectural effect is imposing in the extreme. The broad pavement with the stairway of full width is sunken deep between the rows of tombs and terminates far away in the stairway of the pyramid. This wonderful pavement, with the tombs and terminal temples, is one of the grandest archæological studies on the continent.

Some two miles away from these remains we came upon several large buildings. One of them was 60 feet in length by 28 in width. The walls were standing about four feet high, with a doorway in the face only. Two rows of columns were left standing about the same height as the outer walls. I visited this place first in 1874 and again in 1875. I made a third visit to the place ten years later. During my first visit I was astonished at the number of "finds." In a search of an


No. 1.
No. 3.
No. 2.
No. 4.
Sacrificial knives found on the temple at Teotihuacan.
U.A.Co

hour, on and about the pyramids, I picked up nearly a peck of curious objects which consisted mostly of implements of obsidian knives, spear points and arrow tips. But the most common of the objects were the images and little heads (cabacitas) of terra cotta, which were found lying around everywhere. Some of these were quite grotesque. The accompanying cuts are taken from the figures picked up near the temple of the sun, but are considerably reduced in size.

FIG. 1.

FIG. 2.

FIG. 3.

"CABACITAS,"—OR LITTLE HEADS FOUND NEAR THE TEMPLE OF THE SUN.

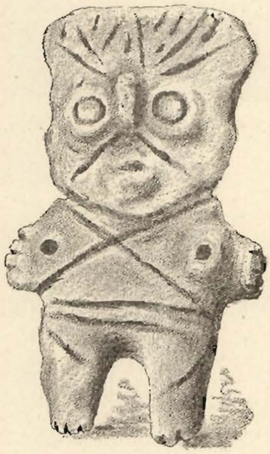


FIG. 4.—TERRA COTTA IMAGE FOUND AT SAN JUAN TEOTIHUACAN.

The early Aztec writers quoted by Prescott, Lord Kingsborough and others, give accounts of the use made of these temples in the offering of human sacrifices. In the year 1486, at the dedication of a temple to their god, Huit-zil-o-poch-tli, it was recorded that seventy thousand human beings were sacrificed upon a single altar. In making the sacrifice a peculiar form of knife is described as being used by the priests in opening the breast before removing the heart. The knife is made of obsidian and is formed like a pruning knife with a curved point and with two cutting edges.

In talking with Mexican archæologists while in the city of Mexico, my attention was called to the fact that, although the peculiar curved form of the sacrificial knives is carefully described in connection with the accounts of the human sacrifices, no such knife had ever been found or ever existed in any collection. Considerable doubt has been expressed as to the truth of the Aztec accounts of these human sacrifices, on account of the lack of the corroborative evidence of the sacrificial knife. I examined carefully the public and private collection in Mexico and could find nothing different from the straight two-edged knife. I naturally reasoned that if these knives ever existed otherwise than in the imagination of the early chroniclers, they would be found about the altar on the summit of the Temple of the Sun at

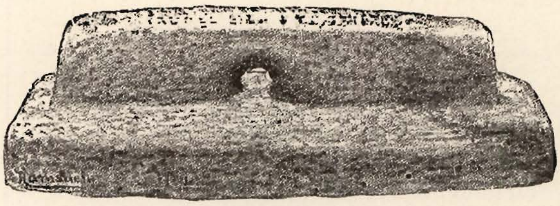


FIG. 5. STONE TROWEL, SIZE 6 x 2½ INCHES.

Teotihuacan, where so many bloody scenes of human sacrifice were said to have taken place.

I made an expedition to this place in 1875, and by a few moments digging about the altar on the summit, I was rewarded by finding four fragments of knives. All of them were nearer than six inches to the surface.

Judging from the place where I found these relics, I think that all of them are fragments of sacrificial knives, although they do not all show the convex and concave cutting edges.

Number one in the accompanying cut is unmistakably the point of a sacrificial knife. The concave edge is so decided as to leave no doubt as to its design.

Number two, though not having the concave cutting edge, is different in form from the ordinary obsidian knife, and has no doubt been used in the human sacrifice. The fracture from the shorter cutting edge may have been caused by prying against a human rib in opening the breast to reach the heart, as was required by the Aztec priest.

Number three is a fragment of a well formed knife, while number four is the ordinary form of the Aztec knife made from the itztli. From the fact that it was found at the base of the altar, we may infer that it played some part in the human sacrifices.

These fragments are all made from obsidian, and the cut represents them in their exact size.

Number one has attracted considerable attention among Mexican archæologists, and is important as corroborating the account of the human sacrifices. In digging at the base of the temple, I found a trowel shaped stone, (Fig. 5,) which might have been used in the mason work of either building or in repairing the temple. A piece which is almost the exact counterpart of this stone is in a large private collection in Mexico, and, before my finding this, was thought to be a unique example of an Aztec mason's trowel.

FEBRUARY 23, 1891.

STATED MEETING.

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

Thirty-five persons present.

The additions to the library were announced.

MR. J. E. PUTNAM spoke of the peculiar sensation produced by electricity. He had recently received a severe shock, which had rendered him quite unconscious for a few seconds. The current was received through a hand and bare arm, the strength of the current being about two hundred and forty volts. The sensation experienced was like a flash of lightning passing before the eyes. The effect was over in the fraction of a minute.

The Secretary, Mr. Frank C. BAKER, gave an illustrated lecture on

EXPLORATIONS IN YUCATAN AND SOUTHERN MEXICO.

(*Abstract.*)

The lecturer briefly outlined the course of the scientific expedition sent out by the Academy of Natural Sciences of Philadelphia, under the charge of Prof. Angelo Heilprin. The expedition left New York City Feb. 15, 1890, and returned June 10, 1890, having traversed the northern part of Yucatan and Southern Mexico, from Vera Cruz to Jorullo. Two of the party, Prof. Heilprin and the speaker, ascended and took barometric measurements of Orizaba, Popocatepetl, Ixtaccihuatl, Nevada de Toluca and Jorullo. The heights of the first four mountains as finally determined, are as follows :

Orizaba	18205 ft. alt.
Popocatepetl,	17523 "
Ixtaccihuatl	16960 "
Nevada de Toluca,	14954 "

Large collections in Zoology, Botany, Geology and Mineralogy were made.

The lecture was illustrated by blackboard diagrams, photographs and numerous specimens.

March 9, 1891.

STATED MEETING.

The President, Prof. H. L. Fairchild, in the chair.

Sixty persons present.

The Council report recommended :

(1.) The payment of certain bills.

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

Mr. Geo. H. Ashley,
Mr. Edmond N. Guer'et.

(3.) That the Academy extend an invitation to the American Association for the Advancement of Science to hold its Annual Meeting of 1892 in the City of Rochester, and that the other institutions of city, and the city government, be asked to join in the invitation.

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

It was moved and voted that the Council be empowered to carry the resolution of invitation into effect, in the name of the Society.

Under deferred business the following change in the By-Laws, proposed Nov. 10th, 1890, was considered and adopted unanimously.

Resolved, that Section 5, Chapter XIII, of the By-Laws be changed to read as follows:

The Council shall have power to remit the fees or dues of individual members or fellows, provided that such remission shall not be anticipatory in its effect.

A lecture on

A VISIT TO THE GRAND CAÑON OF THE COLORADO, ARIZONA,

was given by MR. CHAS. D. WALCOTT, Chief Palæontologist, United States Geological Survey.

Illustrated by charts, models and lantern slides.

A vote of thanks was given the lecturer.

MARCH 23, 1891.

STATED MEETING.

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

A very full attendance.

The collection of local fossils recently presented to the Academy by Prof. A. L. Arey, was exhibited, and a vote of thanks extended to him by the Academy.

The following paper was read by title :

CATALOGUE AND SYNONOMY OF THE RECENT SPECIES OF THE FAMILY MURICIDAE.

First Paper.

BY FRANK C. BAKER.

The following Catalogue is based upon a five years' study of the family ; a majority of the species have been examined, and all the literature upon the subject to the present date carefully compiled. In many cases the material at my command has been ample for the satisfactory adjustment of the synonomy ; in other cases, where the type specimens were only known, or where there was a paucity of material for examination, I have followed the best authorities, not, however, without a careful study of the original figures and descriptions. There are several species in this catalogue which will, in all probability, become synonyms when an abundance of material is obtained for their study, but at present I have thought it best to admit them as valid species until more is definitely known concerning them. It will be noticed that several references have been omitted after some of the specific names; these were not found in any work accessable to me, and I have only given such information as I could find.

In no group of mollusks is the specific distinction more difficult of determination than in the Muricidae ; shells inhabiting a sandy or muddy, sheltered locality, will be thin and elegantly frilled, while the same species from a rocky, exposed locality will be thick and almost smooth. The degree of spinose development is no criterion, inasmuch as a series of specimens from a single locality will show every degree of development, from simply nodulous to the most pronounced condition of spinosity. The soft parts in many species are nearly identical, but the opercula show some very good characters.

The larval shell, or nucleus, appears to afford good specific characters, and I have availed myself of this feature in many cases. Unfortunately the specimens are usually received by the student in an imperfect condition, and almost invariably with the apex either broken off or eroded. In a lot of 250 *Murex brandaris* recently examined by myself there were but ten specimens with a perfect apex, and in a lot of 200 *Murex adustus*, not a single specimen was perfect. These specimens were received direct from the original collectors and had not been tampered with by middlemen. This illustration shows the difficulty under which the student works while studying this interesting branch of Malacology.

There are doubtless many who will disagree with me regarding some of the species admitted in this catalogue as valid, which have been by Tryon and others included in the synonomy, or as varieties of other allied species. In the present catalogue I have admitted as valid any species which can be distinguished from another by good characters, and which is not seen, in an abundance of material, to intergrade into other forms.

During the past ten years several European conchologists have separated certain species of the family into sections, but they are not stable, and the characters used merge into each other so that it is impossible to determine just where certain of the species belong in these sections. As an example of this splitting up I cite the gerus *Typhis*, which is divided by Jousseaume into twelve sections; there are but fifteen species in the genus. Such work seems to me hardly worthy the consideration of the true conchologist. Our science is now overburdened with generic, sub-generic and sectional names, and it is simply absurd to give a group name to every two or three species which happen to differ in a slight degree from their congeners.

I trust this catalogue will be found useful to conchologists in arranging their collections, and while by no means perfect, yet I feel confident that it is a step in advance of its predecessors.

Family MURICIDÆ, Fleming, 1828.

Sub-family MURICINÆ, H. AND A. Adams, 1853.

Genus MUREX, Linn.

Syst. Nat., X, ed., 746, 1758.
Purpura, Humphrey, Mus. Callon.
Aranea, Perry, Conch., t. 45, 46, 1811.

Sub-genus MUREX, Linn. (Sensu stricto.)

Haustellum, Klein., Ostracol, 63, 1753.
Brontes, Montf., Conch. Syst., ii, 622, 1810.
Haustellaria, Swains., Malacol., 296, 1840.
Acupurpura, Bayle, 1880, Fischer, Man. Conch., p. 641.
Tubicauda, Jouss, 1880, Fischer, Man. Conch., p. 641.

1. **Murex scolopax,** Dillw. Cat., II, 681.
Tribulus-maximus, Chemn., conch. cab., t. 189, f. 1819, 1820.
crassispina, Kiener, t. 4, f. 5.
Forskali, Bolten, Mörch.
hystrix, Martini Conch. cab. III, 363, t. 113, f. 1052.
hystrix, Martini, Mörch, Yoldi Cat., 98.
Red Sea; Indian Ocean; China.

2. **Murex occa,** Sowb., Zool. Proc., 137, 1840. Conch. Ill., f. 45.
China.

3. **Murex Macgillivrayi,** Dohrn, Zool. Proc., 203, 1862.
Lizard Isles, Australia.

4. **Murex tribulus,** Linn., Syst. Nat., edit. XII, p. 1214.
unidentatus, Sowb., Conch. Ill., f. 52 (Orig. list).
rarispina, Sowb., (non Lam.) Conch. Ill., f. 52.
crassispina, Lam., Anim. Sans Vert., IX, 564.
Red Sea; China; Japan.

a. var. *nigrospinosus*, Reeve, Zool. Proc., 88, 1845. Conch. Icon., sp. 79.
Indian Ocean.

b. var. *aduncospinosus*, Beck, Reeve, Conch. Icon., f. 93
ternispina, Sowb., (var.) conch. Ill., f. 68.
Red Sea.

c. var. *Carbonnieri*, Jouss., Le Naturaliste, No. 44, p. 349; Nouvelles Archives du Museum, p. 31, t. 4, f. 1a, 1b, 1882.
China.

5. **Murex acanthodes** Watson, Journ. Linn. Soc. London 1883, p. 599; challenger Gastropoda, p. 151, t. 10, f. 1.
Australia, 3–12 *fms.*

6. **Murex Coppingeri**, E. A. Smith, Zool. Voyg. H. M. S Alert, p. 42, t. 5, f. a.
Arafura Sea, Dundas Strts, 17 *fms.*

7. **Murex serratospinosus**, Dunker, Mal. Blatt., 1883, p. 35. t. 1, f. 45.
Island of Flores.

8. **Murex acanthostrephes**, Watson, Journ., Linn. Soc. London, 1883, p. 596; Challenger Gastropoda, p. 149, t. 10, f. 2.
West of Cape York, 28 *fms.*

9. **Murex ternispina**, Lam, Anim. San Vert., IX, p. 566.
tenuispina, Quoy (not Lam.), Voy. Astrolabe, II, 528, t. 36. f. 3, 4.
I. O.; Japan; China; Phil.

10. **Murex tenuispina**, Lam., Anim. San. Vert., IX, p 566.
tenuirostrum, Lam, Anim. San. Vert., IX, p. 569.
tribulus-duplicatus, chemn., conch. cab., t. 189, f. 1821; t. 190, f. 1822.
duplicatus, Mörch., Yoldi Cat., p. 98.
I. O.; Japan; Australia.

11. **Murex Martinianus**, Reeve, Zool. Proc., 188, 1845; conch. Icon., sp. 72.
trapa, Bolten, Mörch, Yoldi cat., 98.
China; Japan.

12. **Murex Troscheli**, Lischke, Jap. Moll.
Japan.

13. **Murex sobrinus**, A. Ad., P. Z. S., 267, 1851.
Japan, 29 to 55 *fms.*

14. **Murex Cabritii**, Bernardi, Journ. Conch., VII, 301, t. 10, f. 3, 1858.
West Indies, 50–164 fms.

15. **Murex concinnus**, Reeve, Conch. Icon., sp. 104.

Locality unknown.

16. **Murex plicatus**, Sowb., Conch. Ill., f. 6.
unidentatus, Menke, Zeitsch., 1850.

W. C. Cent. Am. to Gulf of Cal.

17. **Murex recurvirostris**, Brod , P. Z. S., 174, 1832.
messorius, Menke, Zeistch, 1850.

Panama.

18. **Murex messorius**, Sowb., Conch. Ill., f. 93.
funiculatus, Reeve, Zool. Proc., 88, 1845.
lividus, Cpr., Mazat. cat. 519, 1856.
Gundlachi, Dunker, (described where ?)

Cedar Keys to Aspinwall.

a. var. *rubidum*, Dall, Blake Gastropoda, 1889.

Cedar Keys.

b. var. *nigrescens*, Sowb., Conch. Ill., f. 113.

Panama.

19. **Murex eximius**, Brazier, Proc. Linn. Soc. N. S. Wales, 170, 1877.

N. Australia, 30 *fms.*

20. **Murex Tryoni**, Hidalgo, Manual of Conch., Tryon, p. 134, t. 70, f. 427, 1880.
(= *M. Cabrittii*, Bern. Young ?)

Lesser Antilles.

21. **Murex rectirostris**, Sowb., Conch. Ill., f. 111.

China ; W Columbia.

22. **Murex Mindanensis**, Sowb., Conch. Ill., f. 92.

Mindanao, Philippines.

23. **Murex Beaui**, Petit, Jour. de Conch.. v, 295, t. 8, f. 1, 1856.

West Indies.

24. **Murex pliciferus**, Sowb., Zool. Proc., 138, 1840; Conch. Ill., f. 101.

Japan.

25. **Murex superbus**, Sowb., P. Z. S., 1888, p. 565, t. 28, f. 10, 11.

Japan.

26. **Murex calcar,** Kiener, Coq. Viv., t. 36, f. 2.
Senegambia.

27. **Murex Antillarum,** Hinds, Zool. Proc., 126, 1843.
nodatus, Reeve, Conch. Icon., sp. 107.
West Indies.

28. **Murex rarispina,** Lam. An. San. Vert., ix, 567.
unidentatus, Sowb., Conch. Ill., f. 32. (Provisional list.)
formosus, Sowb., Conch., Ill., f. 112.
coronatus, Sowb.. Thes. Conch., f. 199. (Not Adams.)
Indian Ocean.

29. **Murex similis,** Sowb., Conch., Ill., f. 70.
West Indies.

30. **Murex motacilla,** Chemn., Conch. Cab., ix, t. 163, f. 1563.
West Indies.

a. var. *Caileti*, Petit, Journ. de Conch., v, 87, t. 2, f. 1, 2, 1856.
West Indies.

b. var. *elegans*, Beck, Sowb., Conch. Ill., f. 84.
trilineatus, Reeve, Conch. Icon., sp. 103.
West Indies.

31. **Murex chrysostoma,** Gray, Sowb., Conch. Ill., f. 1.
bella, Reeve, Zool. Proc., 88, 1845; Conch. Icon., sp. 84.
variegatus, Mart., A. Ad., Gen. I, 98.
West Indies.

32. **Murex brevispina,** Lam., An. San. Vert., ix. 567.
Red Sea; *I. O.; S. Africa.*

a. var. *senilis*, Jouss., Rev. et Mag. de Zool., t. 1, f. 5, 6, 1874.
Philippines.

33. **Murex haustellum,** Linn., Syst. Nat., Ed. xii, p. 1214.
Red Sea; I. O.; China; Mauritius; Philippines.

a. var. *longicaudum*, Baker, Proc. Acad. Nat. Sci. Phila., 1891, p. 56.

Subgenus BOLINUS Pusch. 1837.

Fischer, Man. de Conch., p. 641.

Rhinocantha, H. and A. Adams, Genera, 1853.

34. **Murex brandaris,** Linn., Syst. Nat., Ed. XII, p. 1214.
brandariformis, Locard, Ann. Soc. Agric. Lyons, vol. 8, p. 164; Ann. Soc. Linn. Lyons, 1885, p. 219.

coronatus, Risso, Eur. Merid., IV, 190, f. 78.
rudis, Michelotti, Monog., p. 14.
subbrandaris, d'Orb., Prodr. Pal. 72.
trunculoides, Pusch, Polens, Palaeont, 136, t. 11, f. 23.

a. var. *trifariospinosus* Chemn., Frauenfeld, Vehr. Zool. Bot. Gessell., 889, 1869.
trispinosus, Locard, Ann. Soc. Linn. Lyons, 1885, p. 219.
Mediterranean.

35. **Murex cornutus,** Linn., Syst. Nat., Ed. XII, p. 1214.
tumulosus, Sowb., Zool. Proc., 1840; Conch. Ill., f. 71. (Young.)
Mediterranean.

Subgenus PTERONOTUS, Swainson.

Malacol, 296, 1840.
Pterynotus, Swains., Elem., 19, 1835.
Naquetia, Jouss., 1880, Fischer, Man. Conch. p. 641.
Morchia, Jouss., 1880, Fischer, Man. Conch. p. 641.
Triremis, Bayle, 1880, Fischer, Man. Conch. p. 641.
Poropteron, Jouss, 1880, Fischer, Man. Conch. p. 641.
Pteropurpura, Jouss., 1880, Fischer, Man. Conch, p. 641.
Alipurpura, Bayle, 1884, Fischer, Man. Conch. p. 641.

36. **Murex trigonulus,** Lam. Anim. San. Vert., IX, 581.
triqueter, Kiener, Coq. Viv.. t 40, f. 3.
pulcher, A. Ad. of Sowb., Thes. Conch., f. 119, 1879.
Gambia, Africa.

37. **Murex triqueter,** Born. Mus. Cæs., t. 11, f. 1, 2.
trigonulus, Kiener, Coq. Viv. t. 25, f. 2.
Cumingii, A. Ads., Zool. Proc. 270, 1851.
Cumingii, Sowb., Thes. Conch., f. 115, 1879.
roseotinctus, Sowb., Zool Proc., 429, t. 32, f. 6, 1859.
Red Sea; I. O.; Phil.; Paumotus; Mauritius.

38. **Murex rubridentatus,** Reeve, Zool. Proc., 1846.
Habitat unknown.

39. **Murex Barclayi,** Reeve, Zool. Proc., 209, t. 38, f. 2, 1857.
Mauritius.

40. **Murex triformis,** Reeve, Zool. Proc., 87, 1845, Conch. Icon., sp. 53.
acanthopterus, Sowb., var., Conch. Ill., f. 51.
Port Jackson, Australia.

41. **Murex bipunctatus**, Sowb. Thes. Conch., p. 22, f. 188, 1879.

Australia.

42. **Murex acanthropterus**, Lam. Anim. San Vert., IX, 577.

Watson's Bay, N. S. Wales.

43. **Murex alabaster**, Reeve, Zool. Proc., 86, 1845.

Philippines.

44. **Murex canaliferus**, Sowb., Zool Proc 142, 1840, Conch. Ill., f. 74.

cancellatus, Sowb., Zool. Proc., 143, 1840.

Habitat unknown.

45. **Murex lingua**, Dillw., Desc. Cat., II, 688.

gibbosus, Lam., Anim. Sans Vert., IX, 580.

jatonus, Brug., Encyc. Meth., t. 418, f. 1.

lingua vervecina, Chemn., Conch. Cat., X, t. 161, f. 1540.

W C. Africa.

a. var. *flavidus*, Jouss., Rev. et Mag. de Zool., 8, t. 1, f. 7.

rusticus, Jouss., Rev. et Mag. de Zool., 8, t. 1, f. 7, 1874.

W. C. Africa.

46. **Murex hemitripterus**, Lam., An. San. Vert., IX, 579.

gibbosus. Kiener, (juvenile) Coq. Viv., t. 7, f. 4

jatonus, Sowb., Conch. Ill., f. 60

Senegambia.

47. **Murex abyssicola**, Crosse, Jour. Conch., XIII, 30, t. 1, f. 4, 5, 1865.

Guadeloupe, W. I

48. **Murex Adamsi**, Kobelt, Jahr. Mal. Gesell., IV, 154, 1877.

alabaster, A. Ad., Zool. Proc., 508, 1863.

West Indies.

49. **Murex macropterus**, Desh., Mag. Zool., t. 38, 1841.

Off Cape Hatteras, 63 fms.

50. **Murex tripterus**, Born, Mus. Cæs., t. 10, f. 18, 19.

trialatus, Kiener, Coq. Viv., t. 31, f. 2.

Red Sea; I. O.; Philippines.

51. **Murex pinnatus**, Wood. Ind. Test. Suppl., t. 5, f. 20.

pellucidus, Reeve, Zool. Proc., 86, 1845; Conch. Icon., sp. 54.

alatus, Bolten, Mörch. (described where ?)

Martinianus, Pfr, Krit. Reg., 8.

China.

52 **Murex clavus,** Kiener, Coq. Viv., t. 37, f. 2.
bipinnatus, Reeve, Zool. Proc., 85, 1845.
uncinarius, Sowb., Conch. Ill., f. 106.
Philippines.

53. **Murex osseus,** Reeve, Zool. Proc., 87, 1845.
Gambiensis, Reeve, Zool. Proc., 88, 1845.
Gambia River, W. C. Africa.

54. **Murex speciosus,** A. Adams, Zool. Proc. 121, 1855.
Japan.

55. **Murex Lobbeckei,** Kobelt., Jahrb. Deutsch, Malak. Gesell., vol. 6 p. 78; vol. 7, p. 80, t. 3, f. 2.
Indian Ocean?

56. **Murex Bednalli,** Angas, Proc. Zool. Soc., 1880, p. 418, t. 40, f. 2.
Port Darwin, Australia.

57. **Murex percoides,** Löbbecke, Jahrb. Deutsch. Malak. Gesell., vol. 6, p 78; vol. 7, p. 80, t. 3, f. 1.
China?

58. **Murex uncinarius,** Lam. Anim. San. Vert., IX, 379.
mitriformis, Sowb., Conch. Ill., f. 75.
Cape of Good Hope.

59. **Murex phaneus,** Dall, Bull. Mus. Comp. Zool., Harvard College, vol. 18, pt. 2, p. 201; Proc. U. S. Nat. Mus., vol. XII, 1889, p. 330, t, 11, f. 1.
Off St. Augustine, Florida, 434 fms.

60. **Murex tristichus,** Dall, Bull. Mus. Comp. Zool., Harvard College, vol. 18, pt. 2, p. 202, t. 15, f. 3.
Off Cuba, 152-450 fms.

61. **Murex cordismei,** Watson, Journ. Linn. Soc. London, vol. 16, p. 601; Challenger Gastropoda, p. 156, t. 10, f. 5.
Bass Strait, 38 fms.

62. **Murex Angasi,** Crosse; Journ. Conch., XI, p. 86, t. 1, f. 2, 1863.
eos, Hutton, Journ. de Conch., 3 ser., XVIII, 12, 1878.
zonatus, Woods, Proc. Roy. Soc. Tasmania, 132, 1876.
Australia; New Zealand.

63. **Murex quinquelobatus,** Sowb., Thes. Conch., p. 22, f. 218, 1879.
Habitat unknown.

Subgenus CHICOREUS, Mont.

Conch. Syst., II, 610, 1810
Siratus, Jouss., 1880, Fischer, Man. Conch., p. 641.
Euphyllon, Jouss., 1880, Fischer, Man. Conch., p. 641.
Inermicosta, Jouss., 1880, Fischer, Man. Conch , p. 641.

64. **Murex palma-rosæ**, Lam. Anim. San. Vert., IX, p. 572.
arginna, Meuschen, Mörch, Yoldi Cat.. 97.
Indian Ocean.

65. **Murex Maurus**, Brod., Zool. Proc., 174, 1832.
Sauliæ, Sowb., Zool. Proc., 141, 1840; Conch. Ill., f. 77.
affinis, Reeve, Conch. Icon., sp. 182.
Moluccas; Philippines; E. Indies.

66. **Murex microphyllus**, Lam., An. San. Vert., IX, 576.
Poirieri, Jouss., Nouv. Arch. du Mus., 1882, 58, t. 4, f. 2, a. b.
Jousseaumi, Poirier, Nouv. Arch. du Mus., 1882, 58, t. 1, f. 1, a. b.
Indian Ocean.

67. **Murex Banksii**, Sowb., Conch. Ill., f. 82.
Bourguignati, Poirier, Nouv. Arch. du Mus., 1882, 57, t. 5, f. 2, a. b.
Moluccas.

68. **Murex torrefactus**, Sowb., Zool. Proc., 141, 1840; Conch. Ill., f. 120.
Steeriæ, Reeve, Zool. Proc., 85, 145; Conch. Icon., sp. 28.
microphyllus, Kiener, Coq. Viv., t. 23, f. 1.
Rochebruni, Poirier, Nouv. Arch du Mus., 1882, 57, t. 5, f. 1, a. b.
rubiginosus, Reeve, Zool. Proc. 86; 1845; Conch. Icon., sp. 32.
China.

69. **Murex adustus**, Lam. An. San. Vert., IX, 373.
trivialis, A. Ad., Zool. Proc., 71, 1853.
despectus, A. Ad., Zool. Proc., 72, 1853.
fuscus, Dunker, Jap. Moll.
versicolor, Gesell., Mörch.
I. O.; Philippines; Japan.

a. var. *Huttonæ*, Wright, Sowb., Thes. Conch., f. 57, 1879.
New Caledonia.

b. var. *Australiensis*, Angas, Zool. Proc., 72, 1853.
Australia.

70. **Murex rufus,** Lam., An. San. Vert., IX, 574.
Salleanus, A. Ad., Zool. Proc., 70, 1853.
pudoricolor, Reeve, Zool. Proc., 108, 1845; Conch. Icon., sp. 168.
Florida; Yucatan; West Indies; *Indian Ocean.*

a. var. *florifer*, Reeve, Conch. Icon., sp. 188.
Honduras.

71. **Murex multifrondosus,** Sowb., Thes. Conch., p. 16, f. 192, 1879.
Australia; I. Ocean.

72. **Murex palmiferus,** Sowb., Conch. Ill., f. 104.
N. Australia.

a. var. *dilectus*, A. Ad., Zool. Proc., 120, 1855.
Habitat unknown.

b. var. *corrugatus*, Sowb., Conch. Ill., f. 72.
Australia; I. O.

73. **Murex Hidalgoi,** Crosse, Journ. de Conch., XVII, 408, 1869; 3 ser., XI, 68, 1871.
West Indies.

74. **Murex territus,** Reeve, Zool. Proc., 108, 1845; Conch. Icon., sp. 167.
Sydney, Australia.

75. **Murex Penchinati,** Crosse, Jour. de Conch, IX, 351, t. 16, f. 6, 1861,
Liu-Tschiu Islands.

76. **Murex nubilus,** Sowb., Zool. Proc. 428, t. 49, f. 4, 1859.
Habitat unknown.

77. **Murex Rossiteri,** Crosse, Jour. de Conch., XX, 74, 228, t. 13, f. 2, 1872.
Lifou Isl.; Loyalty Group; N. Calédonia.

78. **Murex Thomasi,** Crosse, Journ. de Conch, XX, 212, XXI, t. 11, f. 4, 1872-3
Marquesas Archipelago.

79. **Murex bituberculatus,** Baker, Proc. Roch. Acad. Science, vol. 1, p. 113, t. 11, f. 4.
Australia.

80. **Murex cervicornis,** Lam., Anim. San. Vert., IX, 575.
I. O.; Torres Sts., Austr., 20-30 *fms.*

81. **Murex longicornis,** Dunker, Novit. Conch., 64, t. 22, f. 5, 6, 1864.

Amboina.

82. **Murex recticornis,** Martens, Jahrb Deutsch. Malak. Gesell, vol. 7, 81, t. 4, f. 3.

East Australia, 76 *fms.*

83. **Murex monodon,** Sowb., Tankerv. Cat. App., 19, 1825.
aranea, Blainv., Kiener, t. 36, f. 1.

Japan; Torres Strs., Austr.

84. **Murex axicornis,** Lam., Anim. Sans. Vert., IX, 574.

Indian Archipelago.

a. var. *spectrum*, Reeve, Conch. Icon., sp. 187.

imbricatus, Higgins & Marrat, Proc. Litt. & Phil. Soc. Liverpool, XXXI, 413, t. 1, f. 2, 1876-7.

Grenada.

b. var. *aculeatus*, Lam. Anim. San. Vert., IX, 575; Sowb. Conch. Ill., f. 63.

Moluccas.

85. **Murex rubescens,** Brod., Zool. Proc., 174, 1832.

Taheiti.

86. **Murex anguliferus,** Lam., Anim. San. Vert., IX, 588.
Erythræus, Fischer, Journ. Conch., XVIII, 177, 1870.
cyacantha, Sowb., Thes. Conch., f. 160, 1879.
anguliferus, Vaillant, Jour. Conch., XIII, 105, 1865.
rudis, Link, Mörch, Yoldi Cat., 97.
virgineus, Bolten, Tapp. Mur. Mar. Rosso., 14.

Red Sea; I. O.; Seycheles; I. Bourbon.

a. var. *ferrugo*, Wood, Ind. Suppl., t. 5, f. 16.

Red Sea.

b. var. *ponderosus*, Chemn., Conch. Cab.

Ceylon.

87. **Murex clausii,** Dunker, Jour. de Conch., 213, t. 8, f. 6, 1879.

Gulf of Guinea, W. Africa.

88. **Murex Senegalensis,** Gmel., Syst. Nature, 3537.
Brasiliensis, Sowb. Conch. Ill. f. 55.
costatus, Gmel., Syst. Nat. 3549.
sirat, Adams, Seneg., 125, t. 8, f. 19.

Senegal.

89. **Murex Gubbi,** Reeve, Conch. Icon., sp. 193, 1849.
W. C. Africa.

90. **Murex Leanus,** Dall, Proc. Nat. Mus., vol. XII, 1889, 329, t. 7, f. 1.
Cerros Isl.; L. Cal., 44 *fms.*

91. **Murex capucinus,** Lam., Anim. San. Vert., IX, 576.
monachus-capucinus, Chemn., Conch. Cab., XI, t. 192, f. 1849, 1850.
Philippines; Valparaiso; Porto Rico.

92. **Murex fasciatus,** Sowb., Zool. Proc., 144, 1840.

93. **Murex ramosus,** Linn., Syst. Nat., Ed. XII, 1215, partim.
frondosus, Mörch., Yoldi Cat., 97.
inflatus, Lam., Anim. Sans. Vert., IX, 570.
incarnatus, Bolten, Mörch, Yoldi Cat., 67.
Red Sea; I. O.; China; Isle. Bourbon; N. Zealand; Austr.; Pacific Ocean.

94. **Murex elongatus,** Lam. Anim. S. Vert., IX, 571.
Sinensis, Reeve, Zool. Proc., 85, 1845; Conch. Icon. sp 25.
Ind. Ocean; China.

95. **Murex brevifrons,** Lam., Anim. San. Vert., IX, 573.
purpuratus, Reeve, Conch. Icon., sp. 183.
crassivaricosus, Reeve, Zool. Proc., 86, 1845; Conch. Icon., sp. 33.
approximatus, Sowb., Thes. Conch., 13, f. 62, 1879.
elongatus, Reeve, Conch. Icon.
Brazil; W. Indies.

a. var. *Calcitrapa*, Lam., An. San. Vert., IX, 573.
Red Sea; I. O.; China.

96. **Murex Toupiollei,** Bernardi, Journ. de Conch., VIII, 211, t. 4, f. 5, 1860.
Habitat unknown.

97. **Murex crocatus,** Reeve, Zool. Proc., 108, 1845; Conch. Icon. sp. 168.
West Indies.

98. **Murex Jickelii,** Tapparone, Mur. Mar. Risso., 18, t. 15, f. 6, 1875.

99. **Murex laciniatus,** Sowb., Conch. Ill., f. 39.
scabrosus, Sowb., Zool. Proc., 1840; Conch. Ill., f. 73.
Philippines.

100. **Murex laqueatus,** Sowb., Zool. Proc., 142: 1840; Conch. Ill., f. 78.

Habitat unknown.

101. **Murex angistoma,** Küster, Conch. Cab., II, 88, t. 31, f. 7.

Habitat unknown.

102. **Murex Benedictinus,** Löbbecke, Jahrb. Deutsch. Malak. Gesell., vol. 6, p. 79.

Indian Ocean.

103. **Murex pomum,** Gmelin, Syst. Nat., 3527.
pomiformis, Martini, Mörch, Yoldi Cat., 96.
oculatus, Reeve, Zool. Proc., 86, 1845; Conch. Icon., sp. 36.
Mexicanus, Petit, (young) Journ. Conch., III, 51, t. 2, f. 9, 1852.
asperrimus, Lam., Anim. Sans Vert., IX, 576.

Subgenus PHYLLONOTUS, Swainson.

Malacol. 296, 1840.
Muricanthus, Swain., Malacol. 296, 1840.
Hexaplax, Perry, Conchology, 1811.
centronotus, Swains., Elem. Conch., 1835.
Bassia, Bayle, 1880, Fischer, Man. Conch. p. 641.
Poirrieria, Jouss., 1880, Fischer, Man. Conch. p. 641.
Paziella, Jouss., 1880, Fischer, Man. Conch. p. 641.

104. **Murex rosarium,** Chemn., Conch. Cab., X, t. 161, f. 1528, 1529.
ananas, Hinds, Zool. Proc., 127, 1843.
bifasciatus, Sowb., Thes. Conch., 155, 1879.

W. C. of Africa.

105. **Murex brassica,** Lam., Anim. San. Vert., IX, 581.
rhodocheilus, King, Zool. Jour., V, 347, 1831.
ducalis, Brod. et Sowb., Zool. Journ. V, 377.

Mazatlan; Gulf of California.

106. **Murex regius,** Wood, Index. Test. Suppl., t. 5, f. 13.
taeniatus, Sowb., (young) Zool. Proc., 428, t. 49, f. 3, 1859.
tricolor, Val., Voy. Humb., II, 300.

Panama to Mazatlan.

107. **Murex bicolor,** Val., Zool. Humb., II.
regius, Schub. et Wagn., t. 230, f. 4066, 4067.
hippocastaneum, Phil., Abbild., I, t. 1, f. 2, 1845.
erythrostomus, Swains., Zool. Ill., II, 73.

Panama to Guaymas.

108. **Murex imperialis,** Swains., Zool. Ill., 2 ser., II, 67.
West Indies.

109. **Murex saxatilis,** Lam., An. San. Vert., IX, 583.
hoplites, Fischer, Jour. Conch., 236, t. 8, f. 3, 1876.
Eurystomus, Swains., Zool. Ill,, III, 101.
Ind. O.; W. C. Africa.

110. **Murex endivia,** Lam., An. San. Vert., IX, 583.
saxatilis, Linn., pars. Mörch, Yoldi Cat., p. 95.
cichoreum, Gmel., Syst. Nat., 3530.
lactuca, Bolten, Mörch, Yoldi Cat.

a. var. *saxicola*, Brod., Zool. Jour., II, 201, t. 11, f. 3
depressospinosus, Dunker, Novit. Conch., 126, t. 42, f. 3, 4.

b. var. *albicans*, Tryon, Man. Conch., II, 102.
Morrisii, Reeve, Conch. Icon., sp. 129.
Philippines.

111. **Murex coronatus,** A. Ad., Zool. Proc., 372, 1862.
Tsusaki, Japan, 35 *fms.*

112. **Murex humilis,** Brod., Zool. Proc., 176, 1832.
Sowerbyi, Kobelt, Jahrb. Mal. Gesell., 1877, IV, 248.
octogonus, Sowb., Zool. Proc., 428, t. 49. f. 7, 1859.
St. Elena, W. C. Cent. America.

113. **Murex multicrispatus,** Dunker, Novit, Conch., 125, t. 42, f. 1, 2.
crispus, Brod.. (preoccupied) Zool. Proc., 176, 1832.
tortuosus, Brod., Sowb., Conch. Ill., f. 8.
Pacasmayo, Peru.

114. **Murex melanomathos,** Gmel., Syst. Nat., 3527.
oxyacantha, Brod., Proc. Zool. Soc., 176. 1832.
Real Llejos W. C. Cent. Amer.

115. **Murex fimbriatus,** A. Ad., Zool. Proc., 71, 1853.
Gulf of California.

116. **Murex Stainforthi,** Reeve, Zool. Proc , 104, 1842; Conch. Icon., sp. 68.
hirsutus, Poirier, Novelles, Archiv du. Museum, 1882, p. 83, t. 6, f. 2a, 2b.
W. Australia.

117. **Murex angularis,** Lam., Anim. San. Vert., IX, 593.
sexcostatus, Brug., Encyc. Meth., t. 441, f. 3.
octonus, Sowb., Conch. Ill,, f. 32.

Senegal.

118. **Murex tenuis,** Sowb., Thes. Conch,, f. 174, 1879 (possibly young of *augularis*, Lam.)

Senegal.

119. **Murex lyratus,** A. Ad., Zool Proc., 269, 1851.

Cape Verde Islands.

120. **Murex fimbriatulus,** A. Ad., Zool. Proc., 375, 1862.

Japan.

121. **Murex nitidus,** Brod., Zool. Proc., 179, 1832.
melanoleuca, Mörch, Yoldi cat., 96.
nigritis, Phil., Abbild. I, t. 1. f. 1, 1845.
ambiguus, Reeve, Zool. Proc., 86, 1845.

Mazatlan.

122. **Murex radix,** Gmelin, Syst. Nat., 3527.
nigritus, Meusch., Mörch, Yoldi Cat, 96.

Panama.

123. **Murex princeps,** Brod., Zool. Proc,, 175, 1832.

W. C. of Cent. Amer.

124. **Murex turbinatus,** Lam., Anim. San. Vert., IX, 586.
Formosus, Sowb., Zool. Proc., 1840; Conch. Ill., f. 91.

Senegambia.

a. var. *spinosus*, A. Ad., Zool. Proc., 268, 1851.
turbinatus, Küster, Murex, 59, t. 23, f. 1, 2.
Küsterianus, Tapp-Can., (subfossil) Mur. Mar. Rosso., 71, t. 19, f. 1, 2, 1875.

Senegambia.

125. **Murex Beckii,** Phil., Abbild., III, t. 2, f. 1.

Habitat unknown.

126. **Murex spinicostata,** Val., Kiener, Coq. Viv., t. 41, f. 1.
fulvescens, Sowb., Conch. Ill., f. 30.
turbinatus, Sowb., Conch. Ill., f. 30.

West Indies.

127. **Murex quadrifrons,** Lam., Anim. San. Vert., IX. 586.
Bourgeoisii, Tournouer. Jour. de Conch., XXIII, p. 156, t. 5, f. 5, 1875.

West Africa.

128. **Murex Megacerus,** Sowb., Zool. Proc., 1840; Conch. Ill, f. 18.

Moquinianus, Duval., Journ. de Conch., IV, t. 5, f. 4, 1853.
castaneus, Sowb., Zool. Proc., 1840; Conch. Ill., f. 44.

West Africa.

129. **Murex varius,** Sowb. Conch. Ill., f. 57, 108.

West Africa.

130. **Murex trunculus,** Linn., Syst. Nat., edit, XII, 1215.
asperrimus, Grateloup, Atlas, t. 30, 31.
falcatus, Sandri, Elengo, II, 48.
polygonulus, Lam., Anim., Sans. Vert., VII, 173.
subasperrimus, d'. Orb., Prodr. Pal., 175.
subtrunculus, d'. Orb., Prodr. Pal., 74.
Turonensis, Dujardin, Mem. Geol., II, 295.
Yoldi, Mörch, Sowb., Thes. Conch., f. 210, 1879

Mediterranean; Atlantic Coast of Senegal; Canary Islands

131. **Murex Zelandicus,** Quoy et Gaim., Astrol., t. 36, f. 5-7.

New Zealand.

132. **Murex Pazi,** Crosse. Journ de Conch., XVII, 183, 1869; XVIII, t. 1, f. 4, 1870.

West Indies.

133. **Murex carduus,** Brod., Zool. Proc., 175, 1832.

Paycosmayo, Peru.

134. **Murex luculentus,** Reeve, Conch. Icon., sp. 127.
fimbriatus, Hinds, Voy. Sulph., t. 1. f. 18, 19.
lamelliferus, Dunker, Mal. Blatt., XVIII, 158, 1871.

Formosa; Straits of Macassa.

135. **Murex hystricinus,** Dall, Bull. Mus. Comp. Zool., Harvard College, vol. 18, pt. 2, p. 200, t. 16, f. 4.

West Indies.

136. **Murex squameus,** Dunker, Zeit. Mal., 50, 1852.

Manilla.

Subgenus HOMALOCANTHA, Mörch.

Yoldi Cat., 95, 1852.

137. **Murex scorpio,** Linn., Syst. Nat., edit. XII, 1215.
Lamberti, Poirier, Novelles Archiv. du Museum, 1882, 86, t. 6, f. 3a, 3b.

Moluccas; Phillippines.

138. **Murex rota,** Sowb, Conch. Ill., f. 119.
Philippines; Moluccas; Red Sea.

139. **Murex secundus,** Lam., Anim. Sans Vert., IX, 568.
Philippines.

140. **Murex varicosus.** Sowb., Conch. Ill., f. 49.
digitatus, Sowb., Conch. Ill., f. 114.
Red Sea.

141. **Murex fenestratus,** Chemn., Conch. Cab., X, t. 161, f. 1536, 1537.
Phillippines; Red Sea.

Genus MURICIDEA (Swain) Mörch.

Malacol., 296, 1840.
Muricopsis, Buc. et Dautz., 1882.

1. **Muricidea cristatus,** Brocchi, Conch. foss. sub-app. 394, t. 7, f. 15,
subspinosus. A. Ad., Zool. Proc., 72, 1853.
rugulosus Costa, (juv.) Microdor, Med., 57, t. 9, f. 4, a, b, 1861.
fortis, Risso, Eur. Merid., IV, 195.
pliciferus, Bivona.
catafractus, Sowb., Conch. Ill., f. 40.
Blainvillei, Blainv., Faune franc., 139, t. 5, f. 4.
Blainvillei, Maravigua, (described?)
Brocchii, Cantraine, (described ?)
Mediterranean; Madeira.

a. var. *Blainvillei,* Payr., Moll, Corse, 149, t. 7, f. 17, 18.
serotinus, A. Ad., Proc. Zool. Soc., 268, 1851.
porrectus, Locard, Am. Soc. Linn. Lyon, 1885, vol. 32, p. 221.
inermis, Montr., Ann. Soc. Linn. Lyon, 1885, vol. 32, p. 221.
Mediterranean.

b. var. *atterrima,* Dautzenberg, Memoirs Soc. Zool. France, Tome III, p. 166, 1890.
Dakar, Senegal.

2. **Muricidea diadema,** Aradas et Benoit, Conch. Sicil, 271, t. 5, f. 8, 1870.
Palermo, Mediterranean.

3. **Muricidea hexagonus,** Lam., Anim. Sans. Vert., IX, 585.
West Indies.

4. **Muricidea dubius,** Sowb., Conch. Ill., f. 23.
aculeatus, Wood, Ind. Test. Suppl., t. 5, f. 19.

Panama.

a. var. squamulata, Carp., Zool. Proc., 281, 1865.

Cape St. Lucas.

5. **Muricidea pauxillus,** A. Ad., Zool. Proc., 171, 1853.

Mazatlan.

6. **Muricidea Angasi,** Tryon, Manual of Conch., II, p. 109.
scalaris, A. Ad., (preoccupied) Zool Proc., 71, 1853.

So. Australia.

7. **Muricidea octogonus,** Quoy et Gaim., Astrol., 531, t. 36, f. 8, 9.

New Zealand.

8. **Muricidea cuspidatus,** Sowb., Thes. Conch., p. 36, f. 203, 1879.

Japan.

9. **Muricidea dipsacus,** Brod., Zool. Proc., 194, 1832.
octogonus, Reeve, Conch. Icon., f. 134.
Peruvianus, Sowb., Zool. Proc., 1840 ; Conch. Ill., f. 103.

St. Elena, W. Columbia.

10. **Muricidea vittatus,** Brod., Zool. Proc., 176, 1832.
vitellus, Brod., Sowb., Thes Conch., f. 249, 1879.

Bay of Guayaquil.

11. **Muricidea lepidus,** Reeve, Conch. Icon., sp. 113.

Habitat unknown.

12. **Muricidea Caledonicus,** Jouss., Le Naturaliste, No. 44, p. 349 ; Nouvelles, Archiv. du Museum, 1882, p. 110, t. 5, f. 3a, 3b.

New Caledonia.

13. **Muricidea balteatus,** Beck, Zool. Proc., 146, 1840.

Philippines.

14. **Muricidea noduliferus,** Sowb., Zool. Proc., 147, 1840.
fruticosus, (Trophon) Gould, Bost. Proc., III, 125, 1845 ; Moll, Wilkes Exped., 236, f. 287.

Philippines; Upola.

15. **Muricidea euracanthus,** A. Ad., Zool. Proc., 268, 1851.
noduliferus, Reeve, Conch. Icon., sp. 150.

Habitat unknown.

16. **Muricidea rusticus,** Reeve, Zool. Proc., 108, 1845.

Habitat unknown.

17. **Muricidea interserratus,** Sowb., Thes Conch., 39, t. 31, f. 204, 1879.

Habitat unknown.

18. **Muricidea incisa,** Brod., Zool. Proc., 176, 1832.
a. var. *gemma*, Sowb., Thes., Conch., p. 32, f. 214, 1879.

W. Columbia ; California.

19. **Muricidea Floridana,** Conrad., Am. Journ. Conch., V. 106, t. 12, f. 4, 1869.

Florida.

20. **Muricidea multangula,** Philippi, (Fusus) Zeit. Mal., 25, 1848

21. **Muricidea Philippiana,** Dall, Bull. Mus. Comp. Zool. Harvard College, vol. 18, pt. 2, p. 213.

Spurious and undetermined species.

Australis, Quoy et Gaim., II, 536.
lignarius, A. Ad., Zool. Proc., 268, 1851.
pulcher, A. Ad., Zool. Proc., 270, 1851.

PROF. H. L. FAIRCHILD gave a lecture on

METHODS OF ANIMAL LOCOMOTION,

illustrated by charts and lantern views.

APRIL 13, 1890.

STATED MEETING.

Vice-President JAMES E. WHITNEY in the chair.

Thirty persons present.

The Council report recommended,
(1.) The payment of certain bills.

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

HON. THEODORE BACON,
MR. FREDERICK CROFOOT,
MR. HENRY C. DENSLOW,
REV. W. C. GANNETT,
DR. SUMNER HAYWARD,
MR. HENRY H. LAUDADALE,
MR. J. MOREAU SMITH,
MRS. C. H. WARD.

(3.) The election of PROF. S. A. LATTIMORE as honorary member.

(4.) The election of the following persons as curators:

MISS FLORENCE BECKWITH, in Botany.
REV. JOHN WALTON, in Conchology.
MR. GEORGE H ASHLEY, in Geology.
PROF. CHARLES W. DODGE, in Biology.

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

The following amendment to the By-Laws, proposed March 9, 189 , was adopted:

Resolved, That Section 1, of Chapter XIII, of the By-Laws, be stricken out; and that in Section 1, Chapter 1, of the By-Laws the words "initiation fee" be stricken out, and the words "first annual dues" inserted instead.

DR. CHARLES FORBES read a paper on

PROPERTIES OF LIGHT IN THEIR RELATION TO ORTHO-CHROMATIC PHOTOGRAPHY.

Illustrated by photographs and diagrams.

The following paper was read:

NOTICE OF A NEW METEORITE FROM LOUISA CO., VA.

BY EDWIN E. HOWELL.

If the subject of the present sketch is a distinct "fall," it makes the eighth reported from the State of Virginia.

The first fell in Chesterfield County, June 4, 1828, and is the only one of the eight seen to fall. Both the Grayson County and the Roanoke County were found in 1842 and the Botetourt County in 1850.

Of the Augusta County meteorite five distinct pieces have been found, the largest weighing 152 pounds, being found in 1858 or 1859.

This came into possession of Ward & Howell in 1876, and was cut into sections and distributed to the various collections of meteorites throughout the world. The other pieces weighed as follows: 56 pounds, 36 pounds, 3.5 pounds, 2.2 pounds. This last and smallest piece was found in 1887. Since the finding of the Louisa County meteorite two other meteorites have been reported, one from Henry County, the other from Pulaski County.

The Louisa County meteorite was found on or about March 3rd, 1886, by Mr. Fred. H. Crofoot, while prospecting for gold in the bed of a small stream in the vicinity of the Old Louisa Gold mine, about three miles south-east of Tolersville, Louisa County, Virginia. The total find consists of only a small fragment, less than ¼ oz. in weight. It is an octahedral iron, so much decomposed that the tænite, kamacite, and plessite are easily seperable. What there is of it so clearly resembles the Augusta County meteorite in structure that one is forced to suspect that it may be identical; the only argument against it being the distance—50 to 75 miles—from where the other Augusta County fragments have been found. This is not an insuperable objection, but as all the largest pieces have been found within a radius of a few miles it seems preferable to consider this a distinct fall, to be known as the Louisa County Meteorite.

Mr. Howell exhibited several sections of other meteorites.

APRIL 27, 1891.

STATED MEETING.

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

A large audience present.

The second lecture of the Popular Lecture Course was given by Mr. E. E. HOWELL, on

GEOLOGICAL EXPLORATIONS OF OUR WESTERN COUNTRY.

Illustrated by relief maps, charts and lantern views.

MAY 11, 1891.

STATED MEETING.

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

Thirty persons present.

The Council report recommended the payment of certain bills, which were voted.

The third paper on the printed programme was given precedence, and was read by MR. CHARLES W. DODGE, entitled :

ON JEFFERSONIA DIPHYLLA, AND ITS OCCURRENCE NEAR ROCHESTER.

(*Abstract.*)

This plant is usually regarded as one of rather local habits and botanists regard it as quite a "find" when they discover one. So far as I am able to learn it is quite rare in the immediate vicinity of Rochester, hence, the discovery of a small colony of plants in a patch of woods near Pittsford by Shelly G. Crump, Esq., is of considerable interest. The colony originally consisted of about fifty plants, all growing within a radius of about one hundred feet, a fact which would point to their all being descendants of a single plant. Mr. Crump is thoroughly familiar with all of the woods around Pittsford, but has never found *Jeffersonia* until this spring, although the particular piece of woods in which it was found has been his favorite collecting ground for several years.

Aside from its rarity *Jeffersonia* is interesting for several features; its sepals fall off as the petals expand, a rather uncommon occurrence among flowers ; its anthers open by valves, which open upwards like trap-doors, swinging out sidewise from the top of the anther ; the seed-pod is a pyxis, the top being hinged to the bottom and opening upward, the hinge extending about one-fourth of the way around the pod ; the leaf is parted into two leaflets, which fact has given the plant the common name of Twin-leaf, and likewise its specific name, *diphylla*; further, the name, *Jeffersonia*, which was given it in honor of Thomas Jefferson, whose scientific achievements are almost entirely unknown to the present generation, furnishes the almost solitary instance in which any of our statesmen have been commemorated by having their name given to a newly discovered plant or animal.

Mr. Dodge exhibited a growing specimen and also herbarium specimens.

MR. GEORGE H. ASHLEY gave

A REVIEW OF GILBERT'S "LAKE BONNEVILLE"

The speaker opened by calling attention to the fascination which attaches to the development of such a story as that of Lake Bonneville.

Following the definition and brief description of inland basins, and of our Great Basin, was given an outline history of the discovery, exploration and development of this region by Capt. Bonneville and Fremont on the Great Basin, and on Lake Bonneville, from Standsbury, who first noticed the shore lines, to Howell and Gilbert, the latter of whom named as well as described the lake. Lake Bonneville was a great inland sea, deeper, though smaller, than Lake Superior, and occupying a large part of western Utah. Existing in post-Pliocene times it has left to-day striking shore lines, great deltas, benches, etc. The story of the lake, as developed by Mr. Gilbert, is briefly as follows:

The region was long a dry one. A change in atmospheric conditions, the causes for which were discussed, resulted in a slow and unsteady but gradual rise of accumulating water until it was 1,000 feet deep, and covered an area of 40,000 square miles. A long period of rest followed, when the previous conditions returned and the waters subsided.

After a long period under the arid conditions the disturbing causes reappeared, and again the lake rose, with frequent pauses, which produced numerous shore lines. Rising 70 feet above the first high water mark it overflowed a great alluvial deposit in a pass to the north. It rapidly cut its way 475 feet through the deposit to rock bottom, forming a mighty river to the Columbia, and lowering the lake the same distance. A long stand at this point resulted in what Mr. Howell called the Provo shore-line, characterized by its great deltas and beaches.

After standing a time, estimated at five times the wait at the Bonneville shore line, a return of pre-existing conditions caused the waters to subside, with a number of stops, the principal one being the Standsbury, half-way down to the present level of Great Salt Lake.

Faulting, glacial and volcanic action, were discussed in their relation to the history of Lake Bonneville, and the speaker ended with a history of some interesting changes that have taken place in that region in the last quarter century.

The paper was illustrated by a map.

Mr. H. L. Preston read a paper on

ECONOMIC MINERALS OF THE ANCIENTS.

June 1, 1891.

STATED MEETING.

The President, Prof. H. L. Fairchild, in the chair.

A large audience present.

Mr. Adelbert Cronise gave the third lecture of the Popular Lecture Course, on

RUSSIA: FINLAND, ST. PETERSBURG, MOSCOW, EASTERN RUSSIA AND THE CRIMEA.

Illustrated by maps and lantern views.

June 8, 1891.

STATED MEETING.

The President, Prof. H. L. Fairchild, in the chair.

Forty-four persons present.

The Council report recommended:

(1.) The appropriation of certain sums of money towards payment of printing the Proceedings, etc.

(2.) The election of the following candidates:

Miss Gertrude C. Blackall,
Dr. S. H. Lynn,
Mr. George Moss.

The appropriations were voted, and the candidates elected by formal ballot.

The following paper was read :

ANALYSES OF KAMACITE, TÆNITE AND PLESSITE FROM THE WELLAND METEORIC IRON.

By John M. Davison.

The siderolite which is the subject of this paper is described by Edwin E. Howell on pages 86–87 of the proceedings of this Society for 1890. Its analysis gave Fe. 91.17 and Ni. 8.54 It is singularly free from troilite and schreibersite, and thus offered an unusually good opportunity for the analysis of its separated nickel-iron alloys.

On sawing the meteorite the outside was found much decomposed; but between this and the compact center was a zone in which the oxidation was superficial, and confined, for the most part, to planes of contact of the different nickel-iron alloys that form the Widmanstätten figures. It thus became possible to separate the kamacite and tænite in quantities sufficient for analysis.

The quantity of kamacite used for analysis was gm. 0.934 ; of tænite gm. 0.4522.

The physical character of these alloys differ widely. The kamacite is brittle, breaking with a subconchoidal fracture, and is of the color of cast iron. It was coated with a thin film of black oxide, which had often a resinous luster as if covered with lacquer, particularly where the tænite had been freshly stripped off. This oxide was attracted by the magnet and is probably the magnetic oxide $Fe_3 O_4$ Some pieces of kamacite of a millimeter or two in thickness were entirely altered to this oxide. The kamacite shows, in places, a corrugated surface in some specimens resembling bundles of rods, like the columnar structure of hematite. Figures 1 and 2, Plate 14, show this columnar structure. In the latter the tænite which closely followed the form of the kamacite, is laid back but not detached.

The tænite has a silvery luster, with, when slightly oxidized, a tinge of bronze. It is flexible and elastic, and fuses on the edges in the oxidizing flame of the blowpipe, turning dark. Its fusibility seems to be about 5. It resists oxidation better than the kamacite, the contrast between its comparatively fresh appearance and the dark film covering the other was marked, and facilitated their separation.

Both kamacite and tænite were magnetic, and exhibited a weak polarity, which was more marked in the latter. Pieces of tænite floated directly on water, and pieces of kamacite, buoyed on a cork, arranged themselves in the magnetic meridian : the tænite promptly, the kamacite after being left for some time protected from air currents under a bell glass. The meteorite as a mass also showed polarity. The tænite is found separating the plates of kamacite, and enveloping the crystals of plessite. Figures 3 and 4 show plates of kamacite which were in close contact, and when separated were found to have been joined by a little triangular prism of the same substance. It is attached to 4, and has penetrated 3 to the depth of 1.5 m.m The socket in 3 was lined with tænite. It was at first intended to analyze the plessite as a whole; but on examination, its fine layers were so suggestive of alternate lamellæ of kamacite and tænite that the attempt was made to separate them, and to analyze each separately.

It was found that one was brittle, the other flexible and elastic; one dark with superficial oxidation, the other showing the tænite luster. Physically their correspondence, the one with kamacite, the other with tænite, was exact, and in the kamacite-like part the columnar structure was shown on a diminutive scale, the diameter of the rods being from $\frac{1}{6}$–$\frac{1}{3}$ m. m.

Their separation then became simply a matter of patience, and with the aid of a watchmaker's glass and a magnetized needle, to pick up the grains and flakes, most of which were too small for even delicate forceps to handle, there was obtained for analysis, of the part resembling kamacite, gm. 0.5261, of that resembling tænite, gm. 0.1314.

The thickness of the kamacite was from 1–2 m.m., that of the tænite from $\frac{1}{15}$ to $\frac{1}{30}$ m.m.

In the plessite the kamacite-like bands were from $\frac{17}{30}$ to $\frac{1}{30}$ m.m thick; the tænite-like bands, as nearly as could be measured, from $\frac{1}{130}$ to $\frac{1}{220}$ m.m.

The method of analysis was the same in each case. The material was gone over repeatedly, piece by piece, with a watchmaker's glass, and very carefully assorted and cleansed, the pieces of kamacite being scraped bright. It was not possible to do this to any extent with the kamacite-like part of plessite. It was dissolved in dilute hydrochloric acid by the aid of a weak galvanic current at the positive pole of the battery.

The carbon thus separated was collected on a Gooch filter and burned. The nickel and cobalt were separated from the iron by digestion in ammonium hydrate, the process being repeated four times. The iron was weighed, and the nickel and cobalt first determined together by electrolysis, then separated by potassium nitrite and each determined separately in the same manner.

For comparison the analyses of kamacite and tænite are given, each next to its corresponding part of the plessite.

	Kamacite.	Plessite.		Tænite.
		Kamacite-like part.	Tænite-like part.	
Fe	93.09	92.81	72.98	74.78
Ni	6.69	6.97	25.87	24.32
Co	.25	.19	.83	.33
C	.02	.19	.91	.50
	100.05	100 16	100.59	99.93

These physical and chemical correspondences justify, I think, the conclusion that in the Welland siderolite there are but two distinct nickel-iron alloys, viz.: kamacite and tænite, and that the so-called plessite is merely thin alternating lamellæ of kamacite and tænite.

It is unsafe to generalize on a single analysis; but an examination of the markings of other meteoric irons suggests the thought that in them also there may be but two distinct alloys. Such are the Descubridora, the Glorietta Mt. and notably the Kiowa County, and the Augusta County, Va. meteorites. In sections of the last two irons in Ward & Howell's collection every piece of so-called plessite in the Augusta County iron shows its thin lamellæ, and in the Kiowa County pallasite the gradations of the markings are such that in parts of the iron it would be difficult to say which should be called kamacite and which plessite.

In etching meteoric iron the kamacite is attached by acid more readily than the tænite, richer in nickel. The tænite and plessite stand in relief. Where lamellæ do not show in plessite it may be that closely crowded tænite bands have protected neighboring kamacite layers from acid action, and more careful or prolonged etching might perhaps develop lines in plessite that now appears homogeneous.

Remarks upon the paper were made by Mr. E. E. Howell and the President.

In the absence of the author, Mr. J. G. D'Olier read the following paper.

PLATE 14.

Figs. 1 and 2. Kamacite, showing columnar structure. 2 also shows the tænite, which had followed the corrugations, laid back, but not detached.

Figs. 3 and 4. Kamacite with triangular prism of same on 4, penetrating 3 to depth of 1½ m. m.

Fig. 5. Tænite enclosing decomposed kamacite; half of upper plate of tænite (toward smaller end) removed.

The other figures are plessite crystals.

The figures are all magnified two diameters.

× 2 diam.

DAVISON—WELLAND METEORITE.

NOTE UPON ABORIGINAL IMPLEMENTS RECENTLY FOUND IN IRONDEQUOIT.

BY GEORGE H. HARRIS.

(*Abstract.*)

This paper described a recent discovery in Irondequoit, of aboriginal relics consisting of war club heads, lead bullet, brass finger ring, 150 knife blades of flint, stone arrow finisher, and a quantity of war paint. The lead and rings are memorials of the early use of fire arms by the Indians, and of the christian labors of the Jesuit fathers in the ancient Seneca territory. The flint blades and paint were found in *cache*, and doubtless constituted the stock in trade of some stone worker of the first half of the 17th century. The find was exhibited, and the method of mounting stone implements illustrated by several articles shown. In this connection the speaker mentioned the marked distinction existing in certain forms of stone relics, assigning each to a special class.

The following paper was presented :

GEOLOGICAL DATA OF THE OTIS AND GORSLINE WELL.

BY H. L. FAIRCHILD AND E. E. HOWELL.

The samples of rock-borings from the well were exhibited and discussed. The results are embodied in a paper to be found on a subsequent page.

JUNE 22, 1891.

STATED MEETING.

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

A large audience present.

MR. G. K. GILBERT gave the fourth lecture of the Popular Lecture Course, entitled :

THE GREAT BASIN.

The lecture was illustrated by charts.

The following paper was read by title :

A SECTION OF THE STRATA AT ROCHESTER, N. Y., AS SHOWN BY A DEEP BORING.

BY HERMAN LEROY FAIRCHILD.

By means of the drill an examination has lately been made of the rocks beneath the city of Rochester, with results of some geologic interest. In the faint hope of obtaining gas from the Trenton limestone, or other horizon, the firm of Otis and Gorsline have bored to a depth of over three thousand feet. These gentlemen were impelled to this test, partly by the objections made to the smoke from the large quantity of soft coal required in the burning of their sewer pipe, and partly from a commendable spirit of enterprise and investigation. Their hope was based upon the gas-yielding character of the Trenton limestone of other, though distant, localities, and the fact that only seventy miles away, at Buffalo, the firm's establishment was supplied with natural gas from Canada. Although the search was declared quite hopeless, no one could say it was impossible that gas should be found at some horizon, perhaps under new and unexpected conditions.*

Despite probable failure, and the large outlay of money required, Messrs. Otis & Gorsline showed an admirable perseverance. The boring began Dec. 2, 1890, and stopped March 13, 1891. The drill was sent to a depth *in the rock* of 3,078 feet, where the exceeding hardness of the rock made further progress very difficult. Small but evanescent quantities of gas were found at various depths, the greatest at the depth of 378 feet. A little brine was encountered at a depth of 1330 feet. The only valuable result of the boring is the addition to geological science, in our knowledge of the buried rocks as detailed below. The desire to express appreciation of the enterprise and public spirit which gave us this knowledge is the writer's apology for this preface.

At the beginning of the work the Geological Section of the Rochester Academy of Science appointed a special committee upon the well, consisting of the chairman, Mr. E. E. Howell, and the writer. It was impossible for either member of the committee to personally watch the drill and collect samples. It was consequently left to the drillers, who are believed to have been trustworthy, and were certainly willing and accommodating. They were asked to save samples of the rock for every fifty feet, and as often as the rock perceptibly changed in character.

*In a lecture before the Rochester Chamber of Commerce, Dec. 19, 1890, the writer, by invitation, discussed the subject of rock gas and the conditions necessary for its accumulation.

These directions were followed, after the first samples, as carefully, it is believed, as could conveniently be done by the drillers. There is, of course, a range of error of a few feet. The record obtained is of special value because the section includes all the strata from the Niagara to the Calciferous or, possibly, to the Archæan ; because of the care with which it was made; and also because samples of the boring will be preserved in the Museum of the University of Rochester, and duplicates in the National Museum at Washington, and in the museum of Cornell University.

In the neighboring ravine of the Genesee, about one mile distant from the well, the strata of the Niagara Period are shown as far down as one hundred feet into the red Medina, which enables us to check off the first few measurements of the well record. The first sample was taken at the top of the rock-section, in the Niagara limestone, and covers 156 feet, the second sample being taken 156 feet lower and representing the upper Clinton shale.

The following table shows the correspondence between the exposed strata and the first part of the record.

Well Record.			Thickness shown in Genesee Ravine.
Sample.	Strata.	Thickness.	
	Drift.	22 feet.	
1	Niagara limestone.	156 feet.	60 feet+—
	Niagara shale.		80 "
	Clinton limestone.		18 "
2	Clinton upper green shale.	22 "	24 "
3	Clinton (Pentamerous) limestone.	15 "	14 "
4	Clinton lower green shale.	35 "	24 "
	Medina gray band.	(not noted)	5 "
5	Red Medina sandstone.	+	+

The discrepancy shown above in the measurement of the Lower Clinton shale may be due to counting in the top of the Medina, or, possibly to a thickening of the shale in the direction of the well. The whole table indicates more accurate observation and measurement than is usual in well records.

Following is the

CONDENSED SECTION OF THE ROCHESTER WELL.

Altitude, 484 feet above tide.

HORIZON.	THICKNESS.	KIND OF ROCK.	DEPTH.
Niagara,	156 ft.	Niagara limestone, Niagara shale, Clinton limestone, sample 1.	156 ft.
Clinton,	22 "	Clinton upper green shale, sample 2.	
	15 "	Clinton (Pentam.) limestone, sample 3.	
	35 "	Clinton lower green shale, sample 4.	228"
Red Medina,	1075 "	Red sandstones and shales, samples 5-21.	1303"
Oneida, (Oswego)	25 "	Blue shaly sandstone, sample 22.	
	45 "	Hard gray sandstone, sample 23.	
	13 "	Dark gray shaly sandstone, sample 24.	1386"
Hudson & Utica	598 "	Dark shales, samples 25–37.	1984"
Trenton,	954 "	Dark limestone, samples 38–57.	2938"
Calciferous?	10 "	Gray limestone, sample 58.	
	30 "	Drab limestone, sample 59.	
	50 "	Dark gray limestone, with shale, sample 60.	
	44 "	Black magnesian limestone, sample 61.	
	3 "	Dark calcareous shale, sample 62.	3075"
Algonkian? or Archæan?	2 "	White quartz sandstone, sample 63.	
	1 "	Powdered ferruginous quartz, sample 64.	3078"
	3078 "		

As three sets of the borings will be deposited in institutions, it is unnecessary to go into detailed description of all the rock samples.

Down to sample 57 there is no chance for any doubt. The limits of the Medina, Hudson and Trenton are very sharp.

The last samples of the Hudson–Utica are considerably darker than the earlier samples, but no separation can be made.

Samples 56 and 57, making 60 feet, are pure drab-colored limestone. Indeed, 160 feet of the bottom of the Trenton, samples 54–57, are drab-colored, with "birds-eye" structure, and are regarded by the writer as representing the Birdseye and Chazy limestones. Mr.

Howell, however, was inclined to regard these as proper Trenton, and considered that which I have marked Calciferous as partly Birdseye and Chazy.

The last two samples are the most doubtful. The drillers declare that they worked thirty-six hours to cut the short distance represented by the last sample, and that the resistance of the rock surpassed any previous experience. This sample is a very fine ferruginous quartz, mostly angular fragments, and represents either a crushed red sandrock, a siliceous conglomerate or a ferruginous quartzite. The small proportion of rounded grains might, perhaps, have been derived from the stratum above, sample 63. The fineness of the material would indicate that the rock was of extreme hardness, and that the drill expended its energy in pulverizing the material, like a pestle in a mortar, instead of penetrating the rock. It is doubtful if any rock except metamorphic would so resist the drill. No material except quartz has been observed after careful study. Other minerals might have been removed by the water. The iron color seems to be largely superficial.

The probability of this representing the Archæan or the Algonkian is reasonable, as at the nearest exposures the Calciferous lies directly upon crystalline rock.

By aid of published and manuscript records, chiefly of Mr. C. S. Prosser,[1] it is possible to make some interesting comparisons of the thickness of the rocks in this and near localities. Sections to the westward are available from St. Catharines, Canada, eighty-two miles from Rochester, and Gasport, N. Y., fifty miles from Rochester; to the eastward, from Clyde, forty-two miles from Rochester, and Wolcott, a few miles northeast of Clyde.

THICKNESS OF MEDINA.

Red Medina alone.

St. Catharines.[2]	Gasport.[3]	Rochester.	Wolcott.	Clyde.
850	———	1075	690	942

Medina, including the transition strata Oneida or Oswego.

St. Catharines.	Gasport.	Rochester.	Wolcott.	Clyde.
850	1056	1158	1070	1034

THICKNESS OF HUDSON AND UTICA.

St. Catharines.	Gasport.	Rochester.	Wolcott.
785	640	598	650

1. *The thickness of the Devonian and Silurian rocks of Western Central New York*, by Charles S. Prosser, in AMERICAN GEOLOGIST, Vol. 6, October, 1890.

2. Ashburner, in Trans. Am. Inst. of Min., Engrs., Vol. XVIII., 1890, p. 300.

3. For the record of the Gasport well the writer is indebted to Mr. Prosser, also to Mr. C. V. Messler of Gasport.

Thickness of Trenton.[4]

St. Catharines.	Rochester.	Wolcott.
677	954	750 + 850 (?)

Thickness from the top of the Medina to the top of the Trenton.

St. Catharines.	Gasport.	Rochester.	Wolcott.
1635	1696	1756	1720

Thickness from the top of the Medina to the bottom of the Trenton.

St. Catharines.	Rochester.
2312	2710

The following paper was read by title :

A LIST OF THE INDIGENOUS FERNS OF THE VICINITY OF ROCHESTER, WITH NOTES.

By C. W. Seelye.

Ferns are properly mentioned as shade-loving plants. But with some species, at least, it is evident that the conditions they seek and require are those which are attendant upon shady places rather than the shelter from the sun ; it is the moist atmosphere and the cool soil which are favorable to their existence, not merely the exclusion of more or less sunlight. The shaded sides of rocky banks, the banks of streams, bays and lakes, open or thin woods with undergrowth, the bases of railway embankments facing the north and north-east, rich and moist grounds which have been cleared from the forest and afterwards allowed to grow up to small trees, shrubs and underbrush, all these are favorable situations for the growth of ferns.

In many places some species of ferns will be found growing where they are quite exposed to the sun, but the conditions in such cases are always favorable to a more or less moist atmosphere and a comparatively cool soil. As an instance of this kind may be noticed a certain locality which was under the observation of the writer for several

4. The term "Trenton" is here intended to include all the strata from the Hudson-Utica to the Calciferous.

seasons. It was at the lake shore, near Charlotte, west of the river and where formerly a broad beach of fine sand extended back to a piece of low and swampy ground, where grew coarse grasses and other herbs and a few shrubs. Along the border of this ground, amid the grasses, grew *Onoclea sensibilis* in great abundance; but the ferns did not confine themselves to the shade supplied by the other plants ; they extended out into the sand twenty to thirty feet or more distant from any shade whatever, and apparently flourished as well. The cause of this was that the soakage from the swamp kept the sand under the surface constantly damp, thus providing the roots of the ferns with an unfailing supply of moisture.

Another example illustrating the point under consideration may be given. The Common Polypody, *Polypodium Vulgare*, L. is not common in this region. Wherever found here it is in close proximity to water and in shade. The plant seldom assumes ample proportions in this region. In striking contrast to it, as it appears here, is it found in the northern part of this State, and especially along the banks of the St. Lawrence. Among the Thousand Islands it may be seen springing from the crevices and pockets of bare rocks, fully exposed along the water's edge, disdaining all shelter from summer's sun and winter's winds and storms. And in that vicinity, on the main land, on the Canadian side, not only near the river but for miles back, the writer has seen it growing over rocks in solid masses, covering many square yards of surface, and without any shade unless it may have been that afforded by some distant tree-top which intercepted the slanting rays of the rising or the setting sun. In all the northern region of our neighboring dominion, with comparatively few days of hot sunshine, and an atmosphere that is profoundly modified by the currents of air moving down from the Arctic Ocean and passing over its chains of lakes and rivers, and over that great inland sea, Hudson's Bay, and over the great lakes, there is an atmospheric condition admirably adapted to the welfare of the plant mentioned, and it flourishes in great vigor all through that region. The botanical collector of our own neighborhood might wonder, as did the writer in his early study of the ferns, why a plant which is so seldom found here, as is *Polypodium vulgare*, should bear the specific name which it does. The author of this name, it may be noted, was Linnæus. Undoubtedly he may have received specimens of the plant from many sources and so recognized its wide range ; but the appropriateness of the name was apparent to him chiefly, it may be presumed, because in his native land the plant grows abundantly. The great peninsula comprising Norway and Sweden having its northern shores swept by the waves of the polar ocean, its western boundary by the Atlantic, its southern by the North and the Baltic seas, and its eastern by a great gulf, has an atmosphere and a general temperature well adapted to the wants of the plant, and it grows throughout that region, even extending within the arctic circle.

The condition of humidity is the one of prime importance to this species; it can maintain itself in a warm climate if shaded from a bright sun and near the water. So, in its southern localities it grows in hilly and mountainous regions traversed by streams and in other places where its necessary conditions are met. Hooker, in *"British Ferns," says it "is found in the cold and temperate regions of the globe; throughout Europe to its extreme south; North Africa, Madeira, the Canaries, and Azores. In Siberia we possess specimens from the Amur, from Manchouria, and from Japan, from Erzeroum; but in the more tropical parts of Asia it seems unknown, even in the great Himalayan range, which exhibits so many European forms. In North America, in the United States and Canada, and in the Hudson's Bay territories, it is frequent. East of the Rocky Mountains, and in California, whence I have seen it only from Benicia, (A. B. Eaton, U. S. Army), the fronds are larger, much acuminated, yet not universally so. South of California, on the great continent of America, I am not prepared to say it exists. Eaton, in †"Ferns of North America," says: "The North American range extends from the Atlantic to the Pacific, and from the Slave River and Winnipeg Valley to the mountains of Colorado, Arkansas and North Carolina, and probably to those of Alabama also. * * * Throughout Europe and Northern Asia to Kamtschatka and Japan; Azores, Madeira, Barbary States, and Cape Colony. Mexico and the Hawaiian Islands are also mentioned by some authors; but the evidence is not satisfactory." A climate like that of Great Britain, with its humid atmosphere, might be supposed, as it really is, well adapted to the wants of this plant. Hooker says of it: ‡"Common throughout England, Scotland and Ireland, on old banks, walls, rocks, mossy trunks of trees, etc." And George W. Johnson, another English author, says: §"This species is common throughout the British Islands on old walls, old roofs of cottages, shady banks, and trunks of old trees." It is not found in Florida. Chapman mentions, for the Southern States, ‖"Mossy rocks, etc., in shady woods, in the upper districts of Alabama, and northward." These references are sufficient in evidence that this plant disappears in the hot and arid regions and delights in coolness and humidity; and with

*Hooker, British Ferns, t. 2.

†Eaton, Ferns of North America, Vol. 1, p. 238.

‡Hooker, British Ferns, t. 2.

§Johnson, British Ferns, p. 228.

‖Chapman, Flora of the Southern United States, 2d Ed., p. 588.

these facts in mind we can satisfactorily account for the paucity of the plant in our own vicinity, which, though not lacking an atmosphere comparatively moist, yet has few localities well sheltered from the sun whose fervent summer rays are felt for a long term ; where favorable spots exist here, close to a body of water, the common Polypody is sometimes found.

Shirley Hibbard, an English horticulturist, remarks in relation to this plant : *"None of our native ferns endure drought so well as this." In view of what has been written above, this statement would seem at least doubtful to one not well acquainted with the habits of the plant. Yet it is true that when once established it will persist in localities which are apparently very unpropitious, such as on the brink of cliffs, nestled beneath the exposed root of some tree or shrub and where all about, outside of shade, the sun for half the day strikes with great power. In such places the fronds for many days in summer will partially roll up and wither and seem to be dying, but with the return of the cooler season and plentiful rains, will straighten out and resume a normal appearance. In these circumstances, however, the plants never exhibit exuberant growth. When the plant has become established in a spot where its existence is something of a struggle it is enabled to endure a long season of drought by means of the nutriment stored up in its somewhat fleshy rhizome. The mode of root growth of *Polypodium vulgare*, is the cause of its shrinking from the sun in unfavorable locations. It sends down no strong roots, but from the rhizome spread out laterally some rootlets, almost hair-like, into the light vegetable mould on the surface or in the crevices of rocks from which alone it gathers its nourishment. As has been noticed in the case of the *Onoclea*, which can stand a full exposure to the sun when its roots are constantly supplied with moisture, so this Polypody when surrounded by conditions which enable it easily to conserve its moisture can bear the full sunshine on the face of a rock. One other example in illustration of the same point may be given. *Aspidium marginale*, Swartz, in this region, grows only in the shade, but in the Canadian locality which has been mentioned, it grows freely in the open fields, and next to the common Polybody is the fern most frequently found in that region. Both Gray and Eaton give the habitat of this fern as "rocky hillsides in rich woods," and the definition is correct for most parts of the United States ; in the Dominion of Canada, however, it is different, and it was a pleasure to have my own observation on this point confirmed by Dr. Lawson, of Dalhousie University, when a copy of his †Fern Flora of Canada was received last year. In

* Shirley Hibbard, The Fern Garden, 4th Ed., p. 84.

† Lawson, Fern Flora of Canada, p. 242.

that manual the habitat of the Marginal Shield Fern is described as "Rocky banks in shady and exposed places, the large rhizome enabling this species to resist the heat and drought of summer." That description is correct for the most of Canada, while the descriptions of Gray and Eaton are proper for the most part of this country. In regard to these two ferns, and in relation to their power to bear sun exposure, the two localities mentioned are on the opposite sides of a dividing line, and their climatic conditions are nicely indicated by the behavior of these plants in each region.

The territory about Rochester, taking in Monroe and adjoining counties, presents a considerable variety of surface ; generally it is slightly rolling, but in a few places rises to a height of three hundred to five hundred feet. There are some swamps of considerable extent. The Genesee river and numerous creeks and small streams intersect the land, and from Lake Ontario a number of deep bays extend inward ; ponds and small lakes add to the diversity. Ravines and gullies traverse the hilly sides of the bays, lakes and water courses. The rougher and broken portions of the land are mostly covered with timber or a growth of shrubs and smaller plants in a state of nature. A region of this character possesses the requisite conditions for a suitable home for many species of ferns, and, as may be seen by the list herewith, the fern flora is well represented in the vicinity of Rochester.

The complete list of the Ferns of New York, as given in the Bulletin of the Torrey Botanical Club,* comprises fifty-three species and varieties ; forty-six in the order Filices or true ferns, and seven in Ophioglossaceæ. Of these there are found in this vicinity thirty-five species and varieties, and, also, two varieties of *Cystopteris* not contained in that list.

The species lacking in our flora, eighteen in number, and which are found in some other portions of the State, are the following :

Cheilanthes vestita, Swartz.
Pellæa gracilis, Hooker.
P. atropurpurea, Link.
Woodwardia angustifolia, Smith.
Asplenium montanum, Michaux.
A. Ruta-muraria, Linnæus.
Scolopendrium vulgare, Smith.
Phegopteris polypodioides, Fée.
Aspidium fragrans, Swartz.
A. Boottii, Tuckerman.

* Bulletin Torrey Botanical Club, vol. vi., p. 268.

A. aculeatum, var. Braunii, Koch.
Woodsia obtusa, Torrey.
W. Ilvensis, R. Brown.
W. hyperborea, R. Brown.
W. glabella, R. Brown.
Lygodium palmatum, Swartz.
Botrychium simplex, Hitchcock.
B. Lunaria, Swartz.

An examination in detail of the above list will show that some of the species are rare in the whole country, some rare in the State for the reason that their range is either farther south or west, or farther north. *Cheilanthes vestita*, Swartz, has only been found in this State in one spot, on Manhattan Island. Its range is farther south. *Pellæa gracilis*, Hook, and *P. atropurpurea*, Link, are rare both in the State and elsewhere in the country. *Woodwardia angustifolia*, Smith, is never found far from the Atlantic coast. *Asplenium montanum*, Mchx., has been found in this State only in Ulster County. *A. Ruta-muraria*, L., is a scarce species in the State. *Scolopendrium vulgare*, Smith, is known in this State only at a few stations in Onondaga and Madison Counties. *Phegopteris polypodioides*, Fée, is found only in the northern and mountainous parts of the State. *Aspidium fragrans*, Swartz, has been found in this State only at Lake Avalanche in the Adirondac mountains. *A. Boottii*, Tuck., occurs in the southern and central part of the State. *A. aculeatum*, var. *Braunii*, Koch, belongs to the north, as do also the *Woodsias*. *Lygodium palmatum*, Swartz, is a local species, being found in this State only in Greene County, and possibly one other station. *Botrychium simplex*, Hitch., and *B. Lunaria*, Swartz, are both rare in the State, only a few stations for them being known.

With the exception, therefore, of the very rare species and those with which our latitude is out of range, the locality of Rochester shows a complement of the species belonging to the State. A few of these species are rarely found here, even careful collectors not having met them ; and this inspires the hope that some species not yet known to the locality may yet be discovered by future explorers.

In addition, the writer has to say that the list has been formed by comparing and combining with his own the records of the following named persons, who have kindly supplied them for the purpose : Dr. Anna H. Searing, Mr. George T. Fish and Mr. Joseph B. Fuller, all of this city. Each of the records contains one or more species not in the others, and it is believed that the list as now offered is nearly or quite complete to this date. The species belonging to the State but which are absent in our flora are given in their respective places in the list in italics, thus showing at a glance a comparison of the species of the State and those of this vicinity. Gray's Manual of Botany, Sixth Edition, has been closely adhered to in the sequence of genera and species, the nomenclature, and the authorities.

ORDER, FILICES.

Polypodium, Linnæus. POLYPODY.

1. **P. vulgare,** Linnæus. This little evergreen fern is rare in this region, being found only near water and in the shade, on rocks, and roots of trees. The most favored locality in the near neighborhood of Rochester is the east side of Irondequoit Bay, near the sand bar, in the shade, close to the bank. George T. Fish reports it on the west bank of the Genesee river without being more explicit ; probably somewhere between the city and Charlotte. Professor Lennon, of Brockport, mentions finding it in a ravine at Holley, Orleans County, twenty miles west of the city. It is sparsely scattered along the cliffs, in the shade, on the eastern shore of Canandaigua Lake.

Adiantum, Linnæus. MAIDENHAIR.

2. **A. pedatum,** Linnæus. One of the most graceful of all the numerous species of the Maidenhair fern. Common in rich and moist shady woods and on shady banks. Very generally distributed throughout this region.

Pteris, Linnæus. BRAKE, OR BRACKEN.

3. **P. aquilina,** Linnæus. Very commonly distributed in partially shaded places and hillsides and old, cleared, but uncultivated grounds, and shaded roadsides.

Cheilanthes, Swartz. LIP FERN.

4. *C. vestita*, Swartz. Absent.

Pellæa, Link. CLIFF BRAKE.

5. *P. gracilis*, Hooker. Absent.
6. *P. atropurpurea*, Link. Absent.

Woodwardia, Smith. CHAIN FERN.

7. **W. Virginica,** Smith. A rare species in this region. The writer has never seen it growing here. Reported by George T. Fish and Joseph B. Fuller at the Mendon ponds.

8. *W. angustifolia*, Smith. Absent.

*The species, the names of which are printed in italics, are absent from this vicinity, but are found at some other points in the State of New York.

Asplenium, Linnæus. Spleenwort.

9. **A. Trichomanes**, Linnæus. Fish mentions as a station for this rare fern, "near Irondequoit Bay, east of the Float Bridge." Fuller says, "same ravine as *Camptosorus*." Prof. Lennon found it in the ravine at Holley. It grows somewhat freely on the rocky walls of Watkins' Glen.

10. **A. ebeneum**, Aiton. The writer discovered a single plant of this species in the summer of 1882, near the "Sea Breeze," on the grounds of the summer resort of F. S. Rew. A natural growth of trees remains on the place, and under one of the trees was growing this Black-stalked Spleenwort. As it was known to be rare here the spot was carefully noted, and the following year another visit was made to see it and it was found to be there as previously. The third summer the place was again visited, and, although the spot being well known was found, there was no trace of the cherished plant. It is believed that this is the only specimen of the species ever seen very close to Rochester, and the only other reported is in the ravine at Holley, collected by Professor Lennon.

11. *A. montanum*, Wildenow. Absent.

12. *A. Ruta-muraria*, Linnæus. Absent.

13. **A. angustifolium**, Michaux. This species is not found plentifully here. It formerly grew in a piece of rich woods east of the city. Fish mentions it as "not rare" west of the city, in the town of Gates. On low ground, not far from the entrance, in the "Glen," at Seneca Point, on Canandaigua Lake, it grows in some profusion. The writer has carefully looked over hundreds of plants there, as well as at the first station mentioned above and elsewhere, but has never had the good fortune to find a fertile frond of it.

14. **A. thelypteroides**, Michaux. The Silvery Spleenwort is common in rich woods and thickets.

15. **A. Filix-fœmina**, Bernhardi. A common species, and well distributed throughout our region in rich woods.

Scolopendrium, Smith. Harts Tongue.

16. *S. vulgare*, Smith. Absent.

Camptosorus, Link. Walking-Leaf.

17. **C. rhizophyllus**, Link. This interesting fern is rare. It grows east of the city, in the town of Brighton, in some rocky fields in which a few large trees are standing about. It is usually found in

the shade of rocks, sometimes in pockets on the rocks in which a little soil is lodged. Fuller mentions as a station "the east side of Irondequoit Bay, or rather on a small stream emptying into the bay, at the eastern end of the Float Bridge." Fish gives the same station, and also mentions the town of Gates and the "Glen" at Seneca Point, on Canandaigua Lake. At the latter place a few plants of it may be found.

Phegopteris, Fée. BEECH-FERN.

18. *A. polypodioides*, Fée. Absent.

19. **P. hexagonoptera,** Fée. A rather common fern in thin woods. Along the lake shore, from the river to the "Sea Breeze," it is found sufficiently plentiful.

20. **P. Dryopteris,** Fée. Fish makes this species as "not rare," but gives no stations for it. Professor Lennon found it in the ravine at Holley.

Aspidium, Swartz. SHIELD FERN, WOOD FERN

21. **A. Thelypteris,** Swartz. The Swamp Shield Fern is common in moist or marshy grounds. Very generally distributed.

22. **A. Noveboracense,** Swartz. The New York Shield Fern is common in moist woods and moist, shady places.

23. *A. fragrans*, Swartz. Absent.

24. **A. spinulosum,** Swartz. This graceful and variable evergreen species, the Prickly Shield Fern, in some of its forms is a common inhabitant of woods, thickets and other shady places throughout our regions. It is reported as found in this vicinity by J. B. Fuller, Geo. T. Fish and Dr. Searing. Mr. Fuller informs me that he has not attempted to determine the variety or varieties of his specimens ; as Mr. Fish was a co-collector with Mr. Fuller, it may fairly be presumed that his specimens are in a similar state. Dr. Searing, however, gives this the typical form, as well as the two following. In my own collection I have specimens which I believe may be referred to the two following varieties, but none of the typical species. W. H. Lennon reports *A. spinulosum* from Holley, without designating species.

25 **A spinulosum, var. intermedium,** D. C. Eaton. This is undoubtedly the most common form in this region of the Prickly Shield Fern, or Common Wood Fern.

26. **A. spinulosum, var. dilatatum,** Hooker. This variety, as well as the one above, is reported by Dr. Searing. It appears in my own collection and is marked as having been found at Charlotte.

27. *A. Boottii*, Tuckerman. Absent.

28. **A. cristatum,** Swartz. The Crested Wood Fern is not an uncommon inhabitant of moist and marshy woods and thickets, and even in marshy places in cleared grounds throughout our region. The sterile fronds are evergreen.

29. **A. cristatum, var. Clintonianum,** Eaton. Reported by Dr. Searing, also by W. H. Lennon, as found at Holley. It appears in my own collection of this region without exact locality being mentioned.

30. **A. Goldianum,** Hooker. Goldie's Wood Fern must be considered rare in this region. It is an inhabitant of rich and moist woods and shady places. It is reported by Fish and Fuller in the town of Gates, and by W. H. Lennon in the ravine at Holley.

31. **A. marginale,** Swartz. The Marginal Shield Fern is one of the most common species. Dry grounds more or less shaded and rocky hillsides.

32. **A. acrostichoides,** Swartz Commonly known as the Christmas Fern. Its fronds are evergreen and are collected for the winter decoration of rooms, for which it is prized. Common in rocky woods.

33. *A. aculeatum, var. Braunii*, Koch. Absent.

Cystopteris, Bernhardi. BLADDER FERN.

34. **C. bulbifera,** Bernhardi. This graceful fern is found in this region wherever the situation is favorable. It inhabits the moist, rocky walls of shaded ravines, depending from their surfaces. River banks north of the city, and Palmer's Glen, on the grounds of James Palmer of Brighton; reported by W. H. Lennon in the ravine at Holley; in the glen at Seneca Point, Canandaigua Lake; common at Watkin's Glen.

35. **C. fragilis,** Bernhardi. The Brittle Fern is very commonly distributed, being found on shaded cliffs, rocky banks, shaded or wooded hillsides and shaded banks of brooks or ditches. The fronds vary greatly, in different plants, in regard to the shape of the pinnules, some being merely toothed, others deeply incised. Besides the common form which all of our local collectors report, Dr. Searing reports var. *dentata*. Specimens in my possession, collected on the farm of the late George B. Benjamin, in the town of Ogden, on the line road between Gates and Ogden, and but a few rods north of the Buffalo Road, present a form the most delicate and graceful I have ever seen. It

appears to be the form described by Eaton, in the Ferns of North America, as var. *augustata.*

Onoclea, Linnæus.

36. **O. sensibilis,** Linnæus. This is the so-called Sensitive Fern, a name of no significance in its application. A common species in moist fields and thickets, widely distributed. This fern is peculiar and interesting as relates to both its sterile and its fertile fronds, which are so widely different.

37. **O. Struthiopteris,** Hoffman. The Ostrich Fern, though not so common as the preceding, is, yet, not rare. It is found in rich, moist soils, in shaded places. The plant presents a grand appearance with its tall fronds arrayed in vase-like form. The tallest specimens which I have seen have been about four feet. Both Gray and Eaton mention the plant as sometimes growing to a height of ten feet.

Woodsia, R. Brown.

38. *W. obtusa*, Torrey. Absent.

39. *W. Ilvensis*, R. Brown. Absent.

40. *W. hyperborea*, R. Brown. Absent.

41. *W. glabella*, R. Brown. Absent.

Dicksonia, L'Heritier.

42. **D. pilosiuscula,** Wildenow. The Hay-Scented Fern is not plentiful in the immediate vicinity of Rochester. The writer has never had the good fortune to find it. W. H. Lennon reports it from the ravine at Holley. Fuller, on the authority of Booth, reports it "Vicinity of Rochester." Fish mentions it from the town of Ontario, in Wayne County, and as he was a careful and industrious collector, the fact of absence of any mention of it close to the city or in Monroe County, with no mention of it by Fuller or Dr. Searing, leads to the conclusion that it is scarce, and perhaps absent from this county. I have seen specimens of it from Allegany County. It is a fern of rather delicate texture, finely cut and very beautiful. Eaton, in Ferns of North America, mentions its habitat as "moist woods, and often in low, grassy places." Gray says, "moist and shady places." Lawson, in the Fern Flora of Canada, says, "stony pastures and waysides" The same author mentions it as common in Nova Scotia, Quebec, and New Brunswick, but in Ontario, "not common, and

decreasing westward." Apparently it adapts itself to northern, and hilly and mountainous regions.

Lygodium, Swartz. Climbing Fern.

43. *L. palmatum*, Swartz. Absent.

Osmunda, Linnæus. Flowering Fern.

44. **O. regalis**, Linnæus. The Royal Flowering Fern is not uncommon in this region and may be found in moist, low-lying or swampy grounds, in the open, or in light shade. It has been collected west of Charlotte, at Allen's Creek, along the low ground about the head of Irondequoit Bay, and similar places.

45. **O. Claytoniana**, Linnæus. This is one of the most common species in low grounds, in the open or in shade.

46. **O. Cinnamomea**, Linnæus. The Cinnamon Fern is as common as the last mentioned, and is found associated with it, or alone, in similar places.

Order, OPHIOGLOSSACEÆ.

Botrychium, Swartz. Grape Fern,

47. *B. Lunaria*, Swartz. Absent.

48. *B. simplex*, Hitchcock. Absent.

49. **B. lanceolatum**, Angstroem. A specimen collected by Joseph B. Fuller is referred to this species. It is also reported by W. Lennon from the ravine at Holley.

50. **B. matricariæfolium**, Braun. Reported by W. H. Lennon from Holley.

51. **B. ternatum**, Swartz. This species is reported by W. H. Lennon as from the same locality as the last two ; and by Fish under the form, *lunarioides*, from the Bergen Swamp in Genesee County. Fuller also reports it under the same name from the same locality.

52. **B. Virginianum**, Swartz. This species is common in our territory in rich woods.

Ophioglossum, Linnæus. Adder Tongue.

53. **O. vulgatum**, Linnæus. Specimens of this rare species were collected at Buck Pond by Dr. Searing, in July, 1891. It was also reported several years since by John A. Paine, Jr., to have been found at Henrietta, Monroe County.

The following paper was accepted for publication by the Council:

ON THE SEPARATION AND STUDY OF THE HEAVY ACCESSORIES OF ROCKS.

By Orville A. Derby.

The importance of the study of the accessory elements in rocks is universally recognized by petrographers, and various ingenious and useful methods have been devised for their isolation from the more abundant essential elements in the midst of which they usually play the part of the traditional needle in the haystack. The methods of separation by treatment with acids, use of heavy liquids, and of the electromagnet are essentially laboratory processes, and become expensive and tedious when any considerable amount of material is to be treated. The use of these methods could be greatly extended if the greater part of the essential elements could be got rid of by some rapid and inexpensive process. The primitive panning process of the gold and diamond miner, which depends on the sorting power of water in motion in a suitably shaped vessel, is admirably adapted for this preliminary concentration.

Although the method of washing rock powder in water was employed with striking success by Cordier in the early part of this century, it seems to have been generally neglected until recently revived by Thurach in his admirable studies on zircon, etc. Without knowledge of the latter's methods and results, the writer and his assistants have, during the last few years, employed quite extensively a process suggested by an experienced miner, which differs from that of Cordier and Thurach in the use of the batêa or Brazilian miner's pan instead of the glass or porcelain dishes of the laboratory.

The batêa is a vessel of the shape of a conical kettle cover without the raised rim. The best material is copper, as wood is cumbersome and is liable to retain fine mineral grains in its fibers and thus carry them over from one wash to another, while zinc, tin and iron are more subject to oxidation than copper, and the two latter do not permit the use of the magnet when it is desirable to remove magnetite in the course of washing. Any tinsmith can make the instrument. Tolerably thick sheet copper strengthened with a heavy wire set in the rim should be used, and the joint should be carefully smoothed so as to make the inner surface as regular as possible. A diameter of 12 inches, with an angle of 120° at the apex, gives a convenient size and shape, as it is of sufficient size and capacity to afford as large a residue as will, in most cases, be required, and can readily be carried on excursions in a cloth sack slung from the shoulder. In such a batêa a quantity of crushed or decomposed rock, equal in amount to a large sized hand specimen, can be treated at a single operation, which should generally afford sufficient heavy residue for a considerable number of microscopic slides. If material is scarce, a much smaller volume will usually be found to give a satisfactory result unless the accessories are extremely rare, as fragments (which can be chipped from a museum specimen without injury) representing the bulk of a butternut will give enough for at least one slide.

The knack of washing is readily acquired, and with a little experience one soon learns to vary the process according to the character of the material. In washing a decomposed granite, for example, the first process is to thoroughly disintegrate the mass and to get rid of the clayey portion by kneading and stirring it under water with the hand, pouring off the suspended clay with frequent changes of water. When sufficiently free from clay to permit the granular portion to move freely in water, a vigorous shaking from side to side with a slight circular motion brings a layer of the coarser fragments of quartz and feldspar to the top and, after pouring off the water, this is scraped off with the hand. After repeating this process till the remaining sand is of comparatively uniform grain, a circular motion is given to the batêa which brings a considerable portion of sand into suspension in the water, and permits the heavier and finer grains to settle towards the centre, while the lighter and coarser ones tend towards the surface. By a dexterous jerk the water and moving sand is thrown to the side and, after pouring off the water, the outer portion of the trail of sand on the sloping side of the batêa if scraped off with the hand. After repeating this process until the volume of sand is reduced to about a teaspoonful, it will be noticed that the white color given by the predominance of quartz becomes tinged with black and red through the concentration of the iron minerals and garnet. When, at about this stage, the motion is sufficiently vigorous to set the whole mass swirling about the side of the batêa and is then gradually slowed down, the heavy concentrate may be seen to settle together in a very pretty manner, in a mass at the apex of the batêa, while the quartz swings about in the water on top, When a little farther reduced the behavior of the different minerals according to their specific gravity is most beautifully seen. On throwing the sand out into a trail, it will be found to be transversely streaked with different colors, according to the arrangement of the minerals. The outer part will be white with quartz, then comes a reddish band with garnet, then a black band with titaniferous iron and, finally, (if magnetite is not present, or if it has been removed with a magnet) a white band with zircon, or white and yellow if monazite is also present. This grouping, in which the range of specific gravity is from 2.5 to 5 only, well illustrates the delicacy of the process. Indeed, by skillful manipulation minerals differing so slightly in specific gravity as titaniferous iron and monazite (4.7 to 5) can be almost completety separated when the process is facilitated by a slight difference in the size of the grains. Usually, however, it will be found best to make the separation in the batêa at about sp. gr. 3, throwing away the greater part of the quartz and feldspar and retaining all the heavier elements for further sub-division with heavy liquids.

The whole operation, from the preliminary crushing to the mounting of a microscopic slide, can be performed in a few minutes, usually in less time than is required to prepare a rock section. Thus the least abundant accessories can be determined as quickly and readily as the essential elements, since they appear completely isolated in numerous specimens and with clearly defined crystalline outlines. Accessories so rare that only half a dozen grains or less occur in an ordinary hand specimen will often be found.

The application of the batêa in the laboratory in the preparation of material for microscopic study and for chemical analysis is too obvious to require farther mention. A somewhat extended series of observations indicate that it will prove even more valuable in work which is more strictly geological. This application depends on the two following conclusions, based on several hundred tests of Brazilian rocks, that will presumably be found to hold good for other parts of the world: 1st. Most of the prominent rock groups afford residues which are characteristic, either through the presence of accessories peculiar to each group, or by the relative abundance, or peculiarities of form and structure, of those that are common to several groups. 2nd. Many of the most common heavy accessories are practically indestructable and can therefore be recovered in recognizable form even when the rocks or their debris are so completely altered that their original type is not otherwise recognizable.

Possibly with more extended observations the first conclusion will not be found to be general. This, however, will scarcely detract from its value if the geologist finds that in his limited district he can identify the rock types by their residues, as he has in them a means of forming a definite opinion regarding many rock masses that otherwise would have to be left out of account, or be identified by a mere guess. Rocks too much decomposed for section making will not only give the accessories in a perfect state of preservation, but also some grains of the essential elements that have escaped decay. If sufficiently decomposed to be reduced to a pulp by the pressure of the hand under water, the washing may be done at the nearest stream or pool, and residues representing the really essential part of many pounds weight of rock can be carried home in the pocketbook. The batêa can be as readily carried on excursions as a hammer, and in regions of decomposed rocks will often prove quite as useful. For wrapping the residues, the little books of cut paper for cigarette smokers have been found very convenient. If the rock is still too hard for washing in the field, specimens that otherwise would not be worth carrying home will repay transportation for examination in the laboratory.

A process of what may be called reconstructive geology is thus rendered possible. Several applications of such a process have already been made with complete success, the clue afforded by the heavy residue of a rock completely reduced to clay having been followed through successive stages of decay to the sound rock. For purposes of identification only material decomposed *in situ* should be washed ; but if a quantity is desired, the accumulations of sand in rain-runs or stream beds may be washed with advantage, as they are natural concentrates of the heavy minerals with the quartz of the adjoining rocks.

The minerals most commonly met with in decomposed rocks and in these natural concentrates are the iron and titanium minerals : (magnetite, pyrite, ilmenite, rutile, anatase, sphene, perofskite,) zircon, monazite, xenotime, apatite, tourmaline, garnet, staurolite, epidote, orthite, corundum, spinel, cassiterite, etc. The general distribution of these minerals in sound rocks is pretty well known, though the batêa will often reveal their presence where they would otherwise be unsuspected. The following observations on their occurrence in the residues of decomposed rocks may be of service to those who may feel tempted to try this method of investigation. The greater part of the minerals of the above list appear unchanged even in the most completely decomposed material ; magnetite is occasionally altered to martite and limonite, pyrite to limonite, and ilmenite to an aggregate of microscopic needles of rutile ; rutile (sagenite) and anatase, not present in the sound rock, may appear in the decomposed form, being formed apparently at the expense of ilmenite ; epidote may appear in the partially decomposed rock, but be lacking in the sound and totally decomposed forms, while orthite, sphene and perofskite seem at times to disappear altogether, though the observations on this point are too scanty for a definite conclusion.

The successful application of this method of study of the heavy residues to rocks altered by decomposition, naturally suggests the hypothesis that it may also be of value in the investigation of those that have suffered alteration by metamorphism. Some of the crystalline schists are now generally admitted to be derived by dynamometamorphism from eruptives ; others are as generally conceded to be metamorphosed sedimentaries, while the genetic relations of the greater part are still in dispute. Those of the first group should afford residues containing the characteristic accessories of the original eruptive type, either unchanged or in a secondary form, with, perhaps, others that have been produced in the process of metamorphism. Those of the second group, on the contrary, should only afford such accessories as may have existed as transported fragments in the original sediments, or as are susceptible of being produced during the metamorphic process ; the former can generally be recognized by the evidence of wear that they present,* while the latter are well known through the studies on contact metamorphism.

The minerals developed in undoubted metamorphosed sedimentaries are the same that occur in the eruptives, and although the two groups present differences in the aspect, association and relative abundance in the constituents, no certain rule has yet been laid down by which they can be distinguished. Certain silicates, like staurolite, andalusite, etc., are generally regarded as more characteristic of metamorphosed sedimentaries than of eruptives, but as they have been occasionally reported from the latter, and as there is no apparent reason why they should not so occur they cannot be taken as guide minerals. If any such guide minerals are to be found, they must be looked for among those containing the rare chemical elements. The almost universal distribution in eruptives of zircon, with its frequent associates, monazite and xenotime, show that the rare elements zirconium and the various members of the cerium and yttrium groups occur, the first almost universally, the others frequently in eruptive magmas. The usual combination is that of the minerals above mentioned, which only exceptionally (so far as my experience goes only in the comparatively rare potash granites) suffer alteration in the decomposition of the parent rock. Owing to their generally minute size and high degree of hardness they also escape any considerable

*Generally, but not universally, since very hard minerals like zircon, are frequently found in sands and gravels with as sharp angles and brilliant lustre as in any eruptive rock. A rounding of the angles cannot always be taken as evidence of wear as some minerals, especially zircon and monazite, are often rounded in undoubted eruptives. A lacklustre aspect without evidence of alteration is the most certain sign of wear. The grains of the softer minerals in the residue can be appealed to in cases of doubt.

amount of wear in the formation of sedimentaries from eruptives, so that it may be said that, when occurring in the former, these elements are still in the original packages. Moreover, in virtue of their high specific gravity (near 5) they become concentrated in the coarser arenaceous deposits, being almost completely sifted out of the finer argillaceous ones, as can be verified by a comparative wash in any sand and mud bank. Unless, therefore, these rare chemical elements are introduced into the mass subject to metamorphism by the action of the so-called mineralizing agents, (as fluorine, boron and tin are supposed to be in the formation of tourmaline, topaz and cassiterite,) it is difficult to conceive how the minerals in question can appear as new formed elements in a metamorphosed sedimentary. Their early crystallization and uniform distribution in eruptives, as well as their absence from schists metamorphosed by contact (in the rare cases in which zircon has been noticed it may be presumed to have existed in the original sediment) exclude the hypothesis of such an introduction.

On the hypothesis of a sedimentary origin for the crystalline schists that so frequently contain zircon alone, or zircon and monazite, we should expect these minerals to show more or less distinct signs of wear and to characterize quartzose rather than feldspathic rocks. The observations thus far made that bear upon this point are as follows : schists free from quartz, such as amphibolites and amphibole schist, often show an abundance of perfectly, sharply defined and fresh looking zircons ; staurolite-bearing argillaceous and micaceous schists often fail to show zircon, or give only a few grains, usually with a worn appearance ; the Brazilian gneisses and feldspathic mica schists have never failed, so far as tested, to show zircon, more frequently than otherwise associated with monazite, in about the same abundance and with the same perfection of form and lustre as is found in the typical granites.*

The first of these observations is contrary to the antecedent probability above established, but in harmony with the studies of Lossen, Williams and others, as well as with the field observations in Brazil, tending to prove the derivation of many of the amphibole schists from eruptives. The second case, in which the schists are unquestionably of sedimentary origin, confirms the *a priori* reasoning regarding the probabilities of the appearance of minerals of the rare elements in metamorphosed sediments. The third observation is in accord with an opinion now held by a number of able geologists that many of the

*Chroustschoff's observation (Tschermak's Mittheilungen, VII, 1886) that granite is characterized by sharp angled and gneiss by rounded zircons, does not hold good when a larger series is examined. In both rocks perfectly sharp angled crystals are the exception rather than the rule, and apparently characterize the amphibolic rather than the micaceous types.

gneissic rocks are dynamo-metamorphosed phases of eruptives and affords an additional argument ln favor of this view.

There is thus a reasonable probability that zircon, and to a less degree monazite, may prove to be guide minerals by which eruptives and their derivatives can be certainly identified, no matter what degree of alteration they may have suffered. This probability gives an additional interest to the study of the heavy residues of rocks which, it is hoped, will lead geologists to thoroughly test this hypothesis in other parts of the world.

In conclusion, a word on the discrimination of monazite and xenotime may not be out of place, since the extremely minute grains in which they occur in the residues are often liable to be confounded with other minerals or with each other. Mr. Allen Dick, of London, has kindly examined some of my slides with the spectroscope and finds that the smallest grains can be readily distinguished by the absorption bands of didymium in monazite, and of erbium in xenotime. By bringing, by the use of condensers beneath the stage, the image of the sun, or of a small lamplight, *within* the grain and substituting an ordinary hand spectroscope for the eye-piece, the bands can be distinctly seen.

APPENDIX.

Since the above was written the receipt of a collection of American rocks from the National Museum of Washington has permitted a comparison of their heavy residues with those of the corresponding groups of Brazilian rocks. By chipping from the specimens, residues were obtained from 18 granites and 9 gneisses which, though too small for a complete study, were sufficient for a determination of the more abundant and characteristic accessories.

Zircon was found in all, the rounded and sharp cut forms being about equally distributed in the granites and gneisses and frequently occurring together in the same specimen. In the gneiss of Ayer, Mass., and White Mountain Notch, N. H., the crystals are small and rare and in this respect are similar to those from the mica schist at the top of Mt. Washington, N. H., where their character is such as might be expected in a metamorphosed argillaceous sediment. They are, however, equally rare and small in some of the granites, particularly in that of Fairfield, S. C., and Somerville, Me., in the latter of which geniculated twins occur. The crystals are especially abundant and handsome in the granite of Otter Creek, Mt. Desert, Me., Hurricane Ils., Me., Ilchester, Md., and the gneiss of Endfield, N. H. and

Pascoag, R. I. In the granite of Vulcan, Menominee Co., Mich., they are discolored as if by superficial alteration.

Monazite, giving the absorption band of didymium, occurs in the granite of Westerly, R. I., Narragansett Pier, R. I., and the gneiss of Wessford and Ayer, Mass., Randolph, and East Pond, Waxefield, N. H. In the gneiss of East Blue Hill, Me., are grains that might be referred, from a microscopic examination alone, to monazite, but that fail to give the spectroscopic test, possibly from a deficiency of didymium. It is particularly abundant and characteristic in the Westerly granite and Randolph gneiss. In the latter the aspect of the mineral is precisely that of the Brazilian localities, while in the former its color and appearance is quite different from any yet seen elsewhere. The strong absorption band, high specific gravity and phosphoric acid reaction serve to identify it as monazite.

Xenotime appears in minute octahedral crystals identical in aspect with those of the Brazilian rocks, in the gneiss of Wessford, Mass. The muscovite granite of Narragansett Pier and the pegmatite of Auburn, Me., which looked favorable for this mineral, failed to show it, possibly from insufficiency of material examined.

Orthite has already been reported by Messrs. Hobbs, Cross and Iddings from two of the rocks examined, viz., the granite of Ilchester, Md. and Vinal Haven, Me. Grains identical in appearance with these occur in the granite of Somesville and Hurricane Ils, Me., Batesburg, S. C., Burnett, Texas, and the gneiss of Pascoag, R. I. and Endfield, N. H. The granite of Ryegate, Vt. may also contain it though the grains look more like sphene, which mineral probably occurs also in some of the other rocks mentioned, although with the material at hand it cannot be positively distinguished. In the Brazilian rocks orthite has been found in the granite of Itaquy in Sao Paulo and the gneiss of Santos, Sao Paulo, and Areal, near Petropolis, Rio de Janeiro. In all of these localities the mineral disappears on the decomposition of the rock, which is probably the reason that it has not been more generally met with, since most of the washings have been made on decomposed material. All the Brazilian, and apparently the greater part if not all the American, rocks affording orthite carry hornblende which, in the case of Areal at least, has been in great part altered to biotite. There is thus apparently a relation between the presence of hornblende and the crystallization of the elements of the cerium group as a silicate instead of a phosphate as monazite, the usual form in the purely micaceous rocks. That this is not due to the absence of phosphoric acid is proved by the presence of apatite in all the rocks examined.

The widespread distribution of the elements of the cerium group in the form of the easily decomposed orthite may perhaps bear a relation to the phosphatic nodules, evidently of secondary origin, containing these elements in the diamond gravels of Brazil (Gorceix, Bul. Soc. Min. de France, Fol. VII, 1884, page 179) and which will probably be found elsewhere.

Rutile was noted in the granite of Ryegate, and Craftsbury (orbicular granite) Vt., and Silver Mt., Madison Co., Mo., and in the gneiss of Ayer, Mass., and East Pond, Waxefield, N. H. The very abundant mineral referred to rutile in the latter may prove to be cassiterite.

Apatite is about as universal as zircon in the rocks examined and is usually quite abundant.

In the course of the examination several indeterminable minerals were met with of which the most notable are yellow isotropic grains, in the granite of Somesville, brown isotropic ones in that of Winnsboro, S. C., and white ones with a bluish cast in that of Vinal Haven that may prove to be corundum.

The rocks examined but not specially mentioned in the foregoing are the granites of Milford, Mass., Dedham, Mass., Newberry, S. C. and Fairfield, S. C., and the oligoclase gneiss of Swanzey, N. H.

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