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PREPARED UNDER THE DIRECTION OF THE COUNCIL

BY WALTER B. BARROS, SECRETARY

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LETTER OF TRANSMITTAL

TO HONORABLE HAZEN S. PINGREE, *Governor of the State of Michigan:*

SIR—I have the honor to submit herewith the Second Annual Report of the Michigan Academy of Science, for publication in accordance with Section 14 of Act No. 44, of the Public Acts of the Legislature in 1899.

Respectfully,
WALTER B. BARROWS,
Secretary of the Michigan Academy of Science.

Agricultural College, Mich.,
November 30, 1900.

SCIENTIFIC USES FOR MICHIGAN FOLK-LORE.

BY HARLAN I. SMITH.

The Indian tribes of Michigan have a considerable literature, consisting of legends and myths which, since they had no written language, have been preserved by frequent repetition. As literature, these are not of the highest type, although probably better than is generally supposed. The scientific use of this material is not necessarily impaired by its lack of literary merit.

The following tale which is an example of this folk-lore was collected in October, 1894, at Peoriagowink, an Ojibwa Indian community, situated on the west side of the Flint river in Saginaw county, Michigan. It was told in broken English by an old Shaman, now an exhorter in the Indian Methodist church:

My ancestors told me that at one time eleven Ojibwas went on the warpath beyond the Rocky mountains. Their leader, when a young man, had been painted with black coal and, with other young men, had fasted from ten to twenty days, until they began to dream of what to do in life when they went to war. If a war party would be successful it should take the exact number of men indicated by the dream. This man had not been in the habit of dreaming. He led his party westward, fulfilling all the directions he had received in his dream until on a mountain they saw a nest surrounded by water, like an island. There they saw two birds as white as snow, which their leader told them not to harm. One of the party, lingering in the rear, foolishly attempted to shoot the birds with his bow and an arrow. Whenever he aimed at one of the birds it winked and the arrow was split by a slight stroke of lightning accompanied by a little thunder. The party went on. They saw black clouds gathering in the east and heard heavy thunder. The leader told his men to separate and stand under the large trees. The thunder approached rapidly and became terrific. The man who had attempted to shoot the birds was struck by lightning which left only his skin. The party was frightened and feared that they would be punished because that member of their party had done wrong in trying to kill the birds. The leader was successful in obtaining some scalps and returning home, at which time they had a dance.

This tale is a curious combination of mythological and legendary characters and also contains unmistakable references to puberty rites. The narrator, although an old man, could not explain the story, which like all folk-lore preserves ideas and traces of philosophy long forgotten by his people.

The references to the thunder bird, the painting of the face and fasting when young, show that the same influence was present with his people as with people even as far west as British Columbia. There is folk-lore evidence showing a continuous line of influence transferred from tribe to tribe from the mouth of the St.

Lawrence to the head waters of the Columbia. Michigan folk-lore is one of the links in this chain.

The puberty rites illustrate the fact that religion and philosophy may be reconstructed to a certain extent, from survivals in the tales told by people who have long since failed to understand their import.

To a certain extent the earlier ethnological customs are recorded in these homely tales. In this case we have a clue to the great distance war parties traveled, the method of painting and fasting, a knowledge that the bow and arrow were carried by war parties, the taking of scalps, the social organization under a leader, and the dance.

The narrator of this story did not believe it, although he did when young. His son does not know it, his grandchildren probably have never heard it. The two latter generations talk English, this is practically the case with all of the Indians of Michigan. When these old Indians die this mass of literature and its possibilities become extinct. Bibles and song books have been printed in which Indian words have been substituted for English, but we can hardly say that, of the literature of the several Indian languages of Michigan, any has been recorded in the State for future study.

The development of the State has been so rapid that these matters have been overlooked. There are yet a few old men living who can relate such material. A record of it by phonetic symbols retaining the original Indian is most desirable for the uses above suggested. The imminent danger of the entire loss of the material, however, pleads that it be recorded in any manner, however imperfect or fragmentary. The Indian who keenly feels that his race is doomed to extinction likes to leave such records behind him and may be easily persuaded in the matter.

THE PREHISTORIC ETHNOLOGY OF THE THOMPSON RIVER REGION.

BY HARLAN I. SMITH.

My archæological explorations, for the Jesup North Pacific Expedition in the Thompson River region, were carried on from Lytton at the junction of the Thompson with the Frazer River, to Kamloops at the union of the north and south branches of the Thompson as well as in the tributary Nicola Valley as far eastward as the head of Nicola Lake. The work was done in 1807 supplemented by visits in 1898-99.

The streams of this region have cut small mountains out of the rolling plateau which extends from the Coast Range to the western slope of the Rocky Mountains. The climate is dry and consequently vegetation is scanty except along the streams. Deer and elk in great numbers formerly grazed on the hills among the open timber. Salmon ascend the streams from the Pacific to spawn. There was however insufficient quantities of any few staple products to enable a people to live without resorting to the many resources of the country. In this respect the early people of this region were less fortunate than those of the coast who had such immense quantities of cedar, seals, salmon and shell-fish that they required little of other products.

The archæological literature of this region, until visited by this expedition, was largely confined to pages 10-12 of notes on the Shuswap people of British Columbia by Dr. George M. Dawson in the Transactions of the Royal Society of Canada, Sect. 2, 1891. There were a few specimens in the Provincial Museum at Victoria and the Geological Museum at Ottawa, practically all other data being unavailable because unpublished or in private cabinets.

The archæological specimens were found in ancient village sites but largely in graves, some of which were in the ground, others formed by causing talus material to slide down over the bodies placed on the ground at the foot of a bluff. The skeletons were usually found buried upon the side, and always flexed. They were sometimes covered with fragments of matting and fabric made of the sagebrush bark which had been preserved by the dryness of the climate.

The greatest antiquity which can be assigned to these remains is best judged by the fact that some of the graves were not known to exist by the natives and were not mentioned in their traditions. Objects obtained from the whites were not found in these graves.

Circular holes from ten to about thirty feet in diameter by two to five feet deep, surrounded by an embankment, indicate that the ancient winter houses were identical in type with the underground houses used by the natives of the region in historic times and of which two examples still exist, although fast going to ruin. Saucer shaped depressions indicate the sites of summer lodges, also similar to those of which one or two may still be seen in out of the way places. These are the typical conical tepes of the plains and ally the culture of this region with that further east.

The implements used in procuring food were chipped points of stone for arrows, spears, etc., points rubbed out of slate and bone, and antler implements for killing bear. Roots were dug as indicated by the crutch-like handles made of antler for digging sticks. Scrapers for securing the edible inner bark of various pine trees, and bone tubes like those used for drinking water by modern Indian maidens during puberty rites, were also found. For the preparation of food stone pestles, anvils, mortars, and fish knives made of slate like those still used on the coast were secured.

For building houses and carpenter work wedges made of elk antler, stone hammers, nephrite adzes or chisels which may also have been used for battle axes, whetstones, carving knives made of beaver teeth, and chipped stone scrapers and drills were found. Pairs of coarse sandstone semi-cylinders grooved in the middle

of the flat sides, similar to the modern arrow shaft smoother, bone awls, skin scrapers, and flat needles such as are now used for sewing cattail stalks into mats, with which to cover the houses, were frequently secured.

For war, besides the objects which were used for procuring game for food, there were found war clubs made from the ribs of whales. The handles were carved to represent human heads and the sculpture resembles that of the coast, from which the bone must have been imported. There were also bone daggers.

For dress, skins of deer and birds as well as fabrics woven of vegetable fibre were used, as is testified by fragments preserved by the dry climate. Red and yellow ochre and blue paint for decorating the body, head scratchers, hair ornaments, nose bars and ear pendants, were used for adornment, as well as copper, bone and shell beads and the perforated teeth and claws of animals. Irridescent abalone shells of the coast had been imported and made into ornaments.

For gambling dice similar to those still made of the beaver teeth, and tubes resembling the modern gambling implements of the region were found. Large pecten shells perforated like those used for rattles in the dances of the coast, had penetrated to this inland region. The pipes were made of steatite, of the shape of a wine glass, and were decorated by incised designs which the modern Indians interpret as representing guardian spirits. These tubular pipes and the stone mortars resemble those found to the southward as far as California.

The art of the people, although most characteristically shown by the engraved designs on the pipes and digging stick handles, reached its excellence in the sculptured war clubs, which most nearly resembles coast art.

The prehistoric culture of this region resembles that of the present natives, some of whom still use stone implements. The present pipe, however, is not tubular but crooked like the elbow of a stovepipe. The recent arrow point is smaller, and the modern Indian believes the large ones were made in a mythical period before the time of man. Although these changes have come, yet the Indians can still explain the old incised designs. There is found evidence of only one culture and type in this region.

The dependence on many resources instead of relying upon a few, the circular form of the lodge, the arrow shaft smoothers, incised designs, chipped points and practice of burying the dead in isolated graves or in small cemeteries show affiliations to the plains. The tubular pipe and stone mortar show contact with the culture of California and the interior of Oregon. These affiliations differentiate the culture from that of the coast, but the sea shells, bone of the whale, beaver teeth diet, rubbed slate points and fish knives, and the sculpture shows contact with the coast culture. The flexed position of the skeletons in the graves resembles the posture of those found in the graves of the Lillooet valley, the shell heaps of the Frazer delta, and the cairns of southeastern Vancouver island. As on the coast the potter's art was not practiced nor has a single specimen of it been found in the entire region. On the whole the culture must be classed with that of the plains rather than with that of the northwest coast.

A NEW METHOD FOR THE MECHANICAL ANALYSIS OF SOILS.

J. A. JEFFERY, AGRICULTURAL COLLEGE.

In studying many of the soil problems it is desirable to know the size of the soil grain. Upon the size of the grain depends the amount of moisture the soil will hold capillarity or otherwise, the amount of soluble salts, the rate of solubility of the soil itself, the rate at which the moisture content of the soil will disappear downward by percolation or upward by capillarity and evaporation. Indeed there are few agricultural functions of the soil which do not depend upon the size of the soil grain.

Here is a soil (a) so coarse that the openings between the grains are so large as to be perceptible to the naked eye. Here is one (b) which appears to be so closely arranged as to have no openings or pores, and yet this (a) has but 34 per cent of unoccupied space between its grains, and this (b) has 52 per cent of unoccupied space.

This (a) is a typical truck soil because it allows the passing downward rapidly of the excess of water which may enter it. This in turn allows the rapid warming of the soil, and the ready entry of air, all of which is desirable for the rapid growth and early maturity of vegetables. This soil (b) is a typical grass soil (1) because it does not allow the rapid passing downward of its moisture, and (2) because of the fineness of its grain it presents a very large total surface upon which the roots of the crop may feed, and to hold from loss soluble materials already present.

This soil (b) is so fine that to count the grains contained in a single gram, counting at the rate of one per second ten hours per day, three hundred thirteen days per year, would require five hundred twenty-five years. The grains in a cubic inch of the finest half of this soil, if laid grain touching grain would form three rows reaching from San Francisco to Boston, while the total surface of a cubic foot of this soil amounts to 173,700 square feet or nearly four acres. The average diameter of the soil grain in (b) is estimated to be .004956 mm. or 1-5000 of an inch.

Upon the proportion of fine and coarse grains in its texture depends the classification of a given soil, as to whether it be a sandy soil, a clay soil, a loam, a loamy clay, a clayey loam, and so on.

It becomes evident then that an accurate and ready means of physical analysis is desirable.

For very coarse soils the micrometer with the microscope, or the micrometer calipers may be used, and the average of a large number of measurements

taken as the average size of soil grains, or the size of the grains may be determined by counting and weighing, in which case the specific gravity of the soil must be known. But no soils of agricultural value can be measured in this way. For these, three general methods of analysis, or various combinations of these methods, have been employed. In each of these, the soil is separated into groups, the values of the grains in each group lying within definite known limits or depending upon certain definite conditions.

By one method this separation is accomplished by means of sieves of definite mesh. These sieves dinner in size ranging from three mm. to one-tenth mm.

By another method the soil is brought into suspension in water by shaking and stirring, and is afterwards allowed to settle for definite periods ranging all the way from ten seconds to forty-eight hours, and then pouring off the water with all soil still in suspension. In this case the time allowed for settling measures the value of the soil grain in any group. In another form of this method the settling is so timed that with the use of micrometer and microscope the groups obtained in the separation have their grains lying between definite measured limits.

By the third method the separation is accomplished by placing the soil in currents of water of different but definite rates of flow. In this case the rate of flow is the measure of the value of the grains in each group. But with this method also, with some forms of apparatus, it is possible to so regulate the currents that the sizes of grains of each group lie within certain definite limits.

The most satisfactory methods in actual practice combine the use of sieves with one or other of the water methods. By the method most common in this country at this time the grades are made as follows:

1. Gravel, with the size of grain ranging between 2 mm. and 1 mm.

2. Coarse sand with the size of grain ranging between .1 mm. and .5 mm.

3. Medium sand, with the size of grain ranging between .5 mm. and .25 mm.

4. Fine sand, with the size of grain ranging between .25 mm. and .1 mm.

5. Very fine sand, with the grains ranging between .1 mm. and .05 mm.

6. Silt, with the size of grain ranging between .05 mm. and .01 mm.

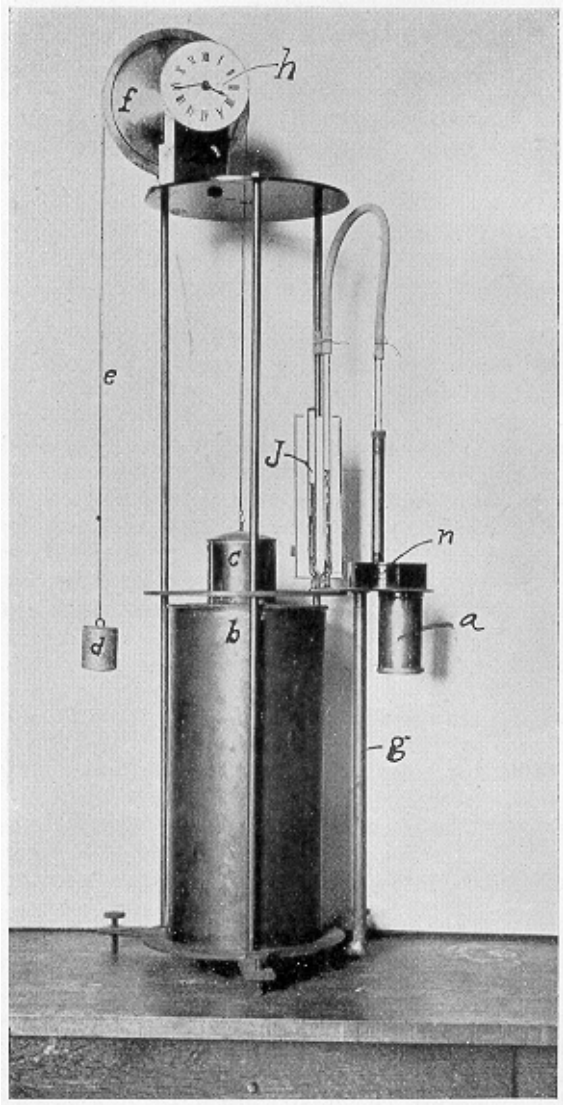
7. Fine silt, with the size of grain ranging between .01 mm. and .005 mm.

8. Clay, with the size of grain ranging from .005 mm. down to smallest particle.

The first three of these grades are made with sieves, the fourth partly by sieve and partly by gravitation or elutriation, and the last four by gravitation or elutriation.

But there are serious objections to the most satisfactory of these methods. The time required is great at best, days if the clay is separated from the silt. The soil must be prepared by boiling or other equally tedious and often unsatisfactory way. Flocculation of the soil particles must often be guarded against.

The results are not satisfactory in all respects. After the soils are separated into groups, there is no way of determining the average size of soil grains in the groups nor in the total soil. There is, therefore, no way of determining the size of the individual grains nor of estimating the total surface of the soil which is desirable in many of the problems arising in soils. The actual practice is to consider the mean of the extreme limits of any group so separated to be the average size of the grains in the group, which is mathematically incorrect, giving an average probably too small.



Aspirator for determining the effective size of soil grain.

These and other difficulties led Prof. King, in 1894, to undertake a line of study which resulted in his method for determining what he has been pleased to call the effective size of soil grain.

It had already been asserted that the rate of flow through sand was dependent upon the size of grain. Poiseuille had demonstrated, or it was thought he had, that the flow of liquids and gases through capillary tubes was proportional to the pressure.

It was found, further, that the weight of a given soil that could be packed in a given space was practically constant, and that therefore for a given soil the pore space was constant; and that fairly constant results were to be had in aspirating air through a given soil.

At this time Prof. King conceived the idea that the size of grain of a given soil might be determined in this way. The opinion of Prof. Slichter, Professor of Applied Mathematics at the University of Wisconsin, was asked as to the practicability of the plan, and so thoroughly did he believe in its possibility that he immediately set about developing a formula for making the necessary computation. He was so successful in this that measurements of soil grains have been made with an approach to accuracy that was at first hardly hoped for; and it is hoped that greater accuracy may still be secured as the method is further studied.

The apparatus used is the one before you [see plate], and is essentially the same as the one first used by Prof. King. It differs only in compactness of form. It consists of a soil tube (a), an aspirator of which (b) is the tank, and (c) the bell. The bell is lifted by the weight (d) by means of a cord (e) passing over the pulley (f). The tube (g) passes from the soil tube into the aspirator, and by way of this, air is drawn by the aspirator through the soil in the tube (a). The dial (h) performs the function of air meter, and is calibrated for one litre in this case. The minometer or pressure gauge (j) indicates the difference of pressure between the ends of the soil column in the tube, or conventionally speaking it indicates the pressure under which the air is drawn through the soil. It is connected with the air chamber (n) above (a). The height, cross section, inside volume, and weight of the tube (a) are carefully determined.

Before taking up the mode of operating the apparatus, let us consider briefly the points in Prof. Slichter's theory leading to his formula.

He considers a hypothetical soil having approximately spherical grains of nearly uniform size. The least pore space possible in such a soil occurs when the grains are so arranged that the element of volume is a polyhedron with face angles of sixty or one hundred twenty degrees. In this case each grain of soil is in contact with other grains at twelve points, and the pore space equals twenty-five and ninety-five hundredths per cent. When the grains touch each other at eight points, the element of volume is a cube, and the pore space equals forty-seven and sixty-four hundredths per cent. Between these limits of arrangement we have a similar range of pore space, and the face angle of the element of volume will be a function of the pore space and thus may be determined from it if the angle be known. The angle in actual practice cannot be known, but conversely the pore space may readily be determined and the angle determined from it.

The length of pore in the soil is greater than the length, or height, of the soil column through which the air is aspirated and depends upon the angle as well as the height of the soil column. The cross section of the pore has for one of its functions the angle as well as the size of the grain, and conversely the size of the grain will depend upon the cross section of the pore. The rate at which air may be aspirated through a soil will depend upon the size and length and number of its pores, upon the pressure under which it is forced through the pores, and upon the viscosity of the air which in turn depends upon the temperature of the air. The length of pore will depend, as before stated, upon the height of the soil column. The number of pores will depend upon the cross section of the soil column, whence we have derived the formula:

$$d^2 = K \frac{h}{spt} \quad [8.9431-10]$$

Where d is the diameter of soil grain,

K a factor dependent upon the per cent of pore space,

h height of soil column,

s cross section of soil column,

p pressure in c. m. of water,

t the time in seconds required to aspirate 5 liters of air at 20° centigrade, and [8.9431-10] is the logarithm of a constant.

Such a soil, however, as Prof. Slichter hypothecates is never found and probably seldom approached in nature. It is probably approached more nearly in form than in uniformity of size. But whatever the irregularities in a given soil, it is found, as has been partly stated before, that its minimum pore space and its power to allow the passage of a fluid through its pores are practically constant, and, as Prof. Slichter says: "It would probably be admitted that no matter how complex a soil may be there exists a certain ideal soil of uniform spherical grains that will transmit, under given conditions, the same amount of" fluid (he says water) "that would be transmitted by the complex soil. The size of the grain of this ideal soil of the same transmission capacity as the complex soil we shall call the effective size of grain of the complex soil." This is the term applied to the size of grain as determined by the new method.

THE MODE OF OPERATION.

To perform an analysis the soil is prepared by drying and pulverizing in a mortar, using a rubber pestle. It is then sifted through a 1 mm. mesh sieve to remove gravel.

It is then introduced into the tube (a), the end of which is provided with a tight fitting cap, and the tube held firmly upon some solid surface, and lightly tapped with a light mallet or stick. As the soil settles more soil is added, and this is continued until no further settling occurs. The surplus soil is stricken off, and that which remains is smoothed down with some plane surface. In Prof. King's laboratory a piece of ground glass is used for the purpose. The tube and contents are now weighed. Knowing the volume and weight of the tube, and the specific gravity of the soil, it is an easy matter to determine the pore space in the soil, and with the pore space determined, K (in the formula) is found by reference to a table.

On the other end of the tube (a) is now screwed a gauze cap, the tube is inverted, the solid cap removed, and the tube is screwed into place. The weight d is next suspended and this acting upon the bell causes the aspiration of the air through the soil, the minometer indicates the pressure under which the air is drawn through the soil. Usually the initial and final pressures are recorded, and the average of the two taken as p in the formula. The pressure should not much exceed three centimeters of water.

The initial and final time are noted and the time required to aspirate one or more liters of air through the soil is determined by subtracting the initial from the final time, and is expressed in seconds. If only one liter is aspirated then the time must be multiplied by five. Substituting these values in the formula, *d* is readily determined.

the question naturally arises how nearly do the determined effective size of soil grain compare with the actual size. Here is a classification of a series of determinations of sizes of sands made both by aspiration and by counting and weighing. This classification is taken from the 19th annual report of the United States Geological Survey, p. 224, with a column added to show the difference.

Number.	Methods of determination.		
	By aspirator.	By count and weight.	Difference.
Series I, water-worn sand:	Mm.	Mm.	Mm.
20	.4745	.4690	.0055
40	.1848	.1745	.0100
60	.1551	.1472	.0079
80	.1143	.1075	.0068
100	.0826	.0759	.0069
Series II, crushed glass, by J. A. Jeffery:			
20	.5928	.5365	—.0337
40	.2845	.3577	—.0732
60	.1868	.2329	—.0461
80	.1380	.1688	—.0308
100	.0797	.1050	—.0291

The sands were building sands, graded by means of soil sieves having 20, 40, 60, 80, 100 meshes to the inch, respectively.

It is seen that with graded sands fairly close results are gotten by the two methods. With the ground glass the marvel is that so nearly close results were obtained, since the particles were anything but spherical in form.

With the finer soils where counting and weighing are impossible we happen to have a check which seems to indicate that the effective size of grain obtained by aspiration is far more nearly the true size of grain than any size determined by any of the old methods.

Having given the size of spheres it is an easy matter to determine their surface.

In an experiment conducted by myself in thesis work, the total surfaces of weighed quantities of samples of clay soil were determined, first using the diameters of grains as determined by the old method, and second using the diameter of the grains as determined by aspiration. These weighed lots of soil were then subjected to the action of a standard solvent for about ten days, when the losses were determined. Theoretically the losses should be proportional to the total surfaces of the lots of soil. The losses were plotted as were also the surfaces as based upon the diameter determined by the two methods.

There was no apparent relation between the losses and the surfaces obtained by using the diameters obtained by the old method, while the curve of losses was not far from parallel to the curve of surfaces obtained by the aspiration method.

The results obtained by mixing a fine grade of sand with a coarse grade, varying in proportions, do not give results that agree with the theoretical value.

THE LIFE HISTORY OF A VOLCANIC ISLAND.

DR. A. B. LYONS, DETROIT.

The publication recently of an important paper by Prof. C. H. Hitchcock on the Geology of Oahu renders timely a discussion of the general subject of the life history of a volcanic island. Nowhere in the world can this subject be studied to better advantage than in the Hawaiian Islands. Every stage, unless it be the initial one, which necessarily must be unobserved, is here illustrated.

According to ancient Hawaiian tradition, Pele, the goddess of the volcano, dwelt first in the most northerly islands of the group. From time to time she moved her residence southward, occupying in succession Kauai, Oahu, Molokai and Maui, and finally taking up her abode on Hawaii. This is simply a mythological version of the scientific statement that volcanic action in the Hawaiian group has built up the islands in succession beginning at the most northerly, being confined today, as you all know, to the most southerly.

Hawaii, then, represents a volcanic island still in its period of vigorous growth. Mauna Loa, its active volcano, consists of a regular dome, the even curve of

its outline as seen in profile almost unbroken by subsidiary cones, its slopes not yet scored in any degree by erosion. The rain which falls copiously on some portions of its slope is absorbed as by a gigantic sponge. Ten or fifteen inches of rain in a day, in the Olaa region is not an uncommon record, yet the word freshet conveys no meaning to the Kamaaina. The water from such a down pour, where It falls on pahoehoe lava will flow down the slope of course, in a broad sheet (there are no water courses for it to follow), but even on pahoehoe it can go but a very short distance before it is sucked into the pores of the vesicular lava. If it falls on aa, it disappears at once.

Mauna Kea, the twin peak, represents the next stage in the life history of a volcano. The cone has been completed, its surface studded with numerous parasitic cones, characteristic of the later stages of volcanic activity. The cone as a whole is steeper than that of Mauna Loa, the later lava flows having consisted of less fluid material. The prevailing color of the lava is red rather than black. Pahoehoe is rarely if ever met with. Its material, judged by what appears at the surface consists of loose fragments. Of course the deeper structure is the same as in Mauna Loa—made up of successive sheets of lava five to twenty feet or more in thickness, intercalated with the fragmentary material from explosive eruptions, and traversed by dykes representing fissures through which the lava has reached the surface.

Mauna Kea, like Mauna Loa, has its rain belt, the mass of the mountain serving as a condenser for the moisture of the trade winds, but in this case we find the windward slopes of the cone scored deeply in their lower readies with ravines, carrying to the sea after every rain roaring torrents. The mountain is so high that heavy precipitation extends only about half way to the summit. Accordingly the upper part of the mountain shows as yet only shallow water courses, these being dry except immediately after rain or during a thaw at the mountain summit in winter.

The slope of Mauna Loa is continued in most places quite to the sea level. Where this is not the case, it is not because the sea has encroached on the base of the mountain. This, however, is on the leeward side of the island, where the coast is not subject to violent attack by the waves of the ocean. Mauna Kea, on the other hand, is washed at its base by a sea whose majestic swells roll in with an impetus gained under the incessant lashing of the northeast trade winds over a course of a thousand miles or more. That such an expenditure of energy should produce striking effects might be easily enough predicted, and yet when one sees the base of this new mountain eaten into apparently fully half a mile, the blue ocean dashing against the base of cliffs three or four hundred feet high, one is apt to be a little staggered in the belief that even such a force could be adequate to bring about such a result in so brief a time. We must remember, however, that this action must have begun while the mountain was still an active volcano—must have been in progress, indeed, from the day there was a mountain or an island at all, that it must have been over precipices like these that in ages past the lava floods poured themselves while the mountain was growing most rapidly. It is therefore not true that these escarpments represent the actual removal of a corresponding portion of the mountain's base.

So too the scoring of ravines in the sides of the mountain probably began long before volcanic activity wholly ceased. In one case, indeed, we find the bed of one of the deepest of the ravines occupied, with the lava of a recent flow. One would say that this particular lava flow probably occurred less than a thousand years ago, and may be considerably more recent even than that, but it would be safe also to venture the opinion that there have been few if any great lava flows from Mauna Kea within the last ten thousand years.

Hawaii has yet another volcanic cone, so ancient that the precipices on its windward exposure are 1,000 to 1,500 feet high, and yet a "young" mountain, its features still traceable more to the volcanic agencies which formed it than to the shaping of weather and storm. Molokai and West Maui show us volcanoes so changed by erosive agencies that one must restore them in imagination to recognize their original character, and in islands further north the ruins of the original volcanic structure are so crumbled that their rehabilitation is a task that can be accomplished only by prolonged patient study.

The beginnings of a volcanic island must be generally beyond the reach of scientific observation. Deep beneath the ocean lies the actual vent marking the crest of a fold in the earth's crust. Under stress of a titanic force, into whose origin we do not now seek to inquire, the crust is crumpled and is liable to become fissured where it is folded. A mile perhaps below the surface of the ocean, lava is forced out of such fissure. At this depth no explosion will result from contact of the molten rock with the water. The lava will be chilled very quickly, of course, but it will no doubt absorb a certain amount of water, if it has not already done so in its passage through the fissure, and so will remain fluid at a much lower temperature than it would otherwise. However, at best, the lava must congeal before it can flow to any distance from the vent.

Again and again lava will be emitted at or close to the original vent, building up thus a submarine mountain, much more steep than any subaerial lava cone. In time this is built up to a point where the diminished pressure permits the formation of steam, and now begins a new phase in the volcanic phenomena. The action assumes an explosive character. Repeatedly the top of the cone is blown to fragments and it is a long time before the lava can come to the light of day. By this time there will have been formed a platform of some size on which to build up the new island—a foundation, however, which must consist largely of fragmental matter, piled up at the steepest angle at which it will stand.

The time comes when a sufficient quantity of lava is forced out at once to build up a subaerial crater with a conduit through which the lava may reach the surface without meeting with water enough to produce a disastrous explosion. Often enough even after this explosions do occur and the island may be repeatedly destroyed thereby—the foundation platform made thus broader and more secure.

I need not describe in detail the process by which the island when once established grows, through successive eruptions. I wish, however, to impress the idea of instability in the original foundation, and to call attention to the consequences which must follow from the pouring into the sea of the molten lava. It is evident that this lava will be rapidly chilled and will pile up very close to the shore instead of continuing under water the low-pitch gradient of the cone as it appears above the water. The submarine portion of the island, so far as it is made from lava, must be of a most insecure structure, its material largely fragmental and piled at so steep an angle as to involve great instability. In many cases there will be also quantities of solid matter ejected in explosive eruptions, all fragmental and much of it in a fine state of division. This may be thrown to a considerable distance, and so may enlarge materially the foundation particularly on the leeward side of the island. The base may, indeed, sometimes be buttressed and strengthened by submarine extrusions of lava, which will certainly sometimes find the path of least resistance leading through this loose material.

The island as a product of eruptive activity is at last finished. It is a more or less symmetrical low dome, its slopes extending on the leeward side quite to the sea level, on the windward side terminating abruptly in precipitous cliffs. It is already clothed with forest vegetation on the portions receiving abundant rainfall provided there is other land near by whence seeds may be easily brought. It can hardly fail to have some luxuriant vegetation, if only of ferns. Probably only on the leeward side will there be lava flows on which plant life has not established itself. There may or may not be a summit crater. It is probable that there will be numerous parasitic cones and there may be also near the sea some tufa cones, but these are minor features, all destined to disappear without affecting the final result of the operation of denuding agencies.

What is of much greater consequence is the probability that already the insecurity of the foundation on which the island rests has been manifested in faults that mar the symmetry of the mountain, and which may profoundly affect the result of erosive agencies by giving unexpected direction to their action. It is this possibility which geologists have hitherto failed to take into account. Some most striking illustrations of such faulting exist in the Hawaiian islands, the significance of which came to me a few years ago as a most illuminating revelation.

To me, as to others with whom I had conversed, Waipio valley on the island of Hawaii had been a mystery. A gorge, apparently the work of stream erosion, half a mile wide, with level floor, extends back into the mountain five miles or more, then turns abruptly to the right, pursuing a course parallel with the coast perhaps eight miles, maintaining much of this distance its extraordinary breadth and nearly level floor. On either side the walls rise precipitously 2,000 to 3,000 feet, picturesque waterfalls coursing down at intervals from the mountain above, but occupying only insignificant gullies. From near the point where the valley heads, there starts a counterpart valley, which follows a course at first parallel with the shore line, then abruptly turns seaward, this valley also characterized by precipitous sides , throughout its course.

What does it all mean? There can be but one explanation. A section of the mountain, perhaps five miles wide and ten miles long, parallel with the coast has been split away by a fault, dropped down some distance and tilted bodily seaward. To all appearance, another slice external to this has slid off and disappeared completely in the deep sea. This has happened in a region of very abundant rain, and stream erosion has played its subordinate part in carving the valley into its present form. No doubt the excessive rain has had something to do also with causing the catastrophe, not as has been supposed by provoking a volcanic explosion, but by solvent action of the water on the constituents of the rock.

The example does not stand alone. Something very similar must have happened on the island of Molokai, where a somewhat similar valley terminates illogically in a, precipice perhaps 400 feet high over which pours the waters of a considerable stream which has not cut for itself a gorge in the cliff. What has taken place you comprehend when you see that this valley is parallel with a precipice marking a fault by which the whole northern portion of the island has been cut off, to disappear in the deep sea except for a few points that remain as little dots of islands just off the coast. The valley appears to have been formed by a splitting of the mountain by a parallel fault. In this case volcanic agency may have determined the catastrophe, since there has been built at the foot of the precipice a little shelf of land just above sea level consisting of obviously recent lava. But such an eruption may as probably have been a consequence as a cause of the catastrophe.

A still more striking illustration of the faulting I am speaking of is found on the island of Maui, where the immense dome of Haleakala has been split almost through its center, the windward half settling away from the leeward portion so as to submerge the old coast line. Such a fault as this will determine without doubt the whole future history of the mountain, erosive agencies henceforward centering about the two great gorges thus produced on its opposite sides. One recalls immediately the Olowalu pass on West Maui and the Nuuanu gap on Oahu, recognizing at once the analogy in the conditions. It is noticeable in each instance of faulting on this large scale that the catastrophe takes place in a region of

abundant rainfall, and also on a coast exposed to the trade wind swell of the Pacific ocean.

Returning to our newly finished island—we might better speak of it as an island on which work has just been begun—possibly it has already suffered from faulting, certainly erosive agencies have begun their work. The task these have undertaken will not be finished as long as a vestige of the mass remains visible. I need say nothing of the general principles which govern the action of these. There are, however, peculiarities in the nature of the mass that is attacked which may materially modify the results of their operation. The first point to note is the heterogeneous character of volcanic accumulations, even in the case of the basalt volcanoes of which I am especially treating. The lava of which such a volcano is built up often appears in section almost like a stratified rock. There is not greater difference in the thickness of the successive beds than in the case of stratified rock of sedimentary origin. The difference, however, in hardness and in resisting power toward disintegrating agencies is often very great. As the fresh lava varies extremely in vesicularity, so, after it has been compacted by pressure and the action of heat, there is no uniformity in its physical character or in its chemical reactions.

Much fragmental material is ejected even from basalt volcanoes, piled up into cinder cones some of which will become buried, in the bedded lava to leave material that will be quickly washed out when erosion begins its work. Near Silo there is a pretty illustration of my point in the natural arch left by the washing out at the base of a promentory of the material of an old buried tufa cone. Observe that fragmental material will be especially abundant in the vicinity of the principal vent, i. e., in the very core of the mountain, so that we must not be surprised to find this part gouged out as it were while the peripheral portions of the cone remain comparatively intact.

The material of laccolites and of dykes may be expected to have much higher resisting powers than the ordinary lava. The name dyke, indeed, comes from this peculiarity. On the other hand such material is much more likely to have a regularly jointed or columnar structure which may render it liable to be quickly washed out by wave or stream erosion. The Rainbow Fall near Silo owes its existence to the columnar structure of the basalt, and it is only one instance of many. Fingal's cave is a conspicuous illustration of the havoc the ocean makes with such material.

Again, volcanic cones are necessarily penetrated by vertical fissures through which water readily penetrates to great depths. If the water filters through such pores and crevices as it ordinarily finds in sedimentary rocks, it loses its dissolved oxygen and carbonic acid before sinking many inches into the rock. It is otherwise if it finds free passages, and so its power to do chemical work at considerable depths is greatly increased. The ducts which remain open in the center of a great lava flow—galleries, frequently six to ten feet in diameter and extending continuously it may be several hundred yards, serve also as subterranean conduits, and not unfrequently they determine the position of streamlets destined to cut deep ravines.

Volcanic rocks differ from most sedimentary and metamorphic rocks (calcareous of course excepted) in the completeness of their destruction by weathering. The sand used for building in the Hawaiian islands is all brought from abroad. There is sand of course on the sea shore at home, but it consists commonly of fragments of sea shells and corals. In some places you will And black sand, but on examination it will almost always prove to be simply fragments of the lava rock having no enduring quality like the grains of an ordinary quartz sand. More rarely you will meet with a sand composed of grains of chrysolite or of magnetite, the most enduring minerals that occur in the lava, but even these are chemically short-lived. The ultimate resultant, then, from the disintegration of lava is not sand grains but impalpable dust, so that our island cannot be expected to leave behind even a sand bank to mark its site when the elements shall have done their work of destruction upon it.

As illustrating this destructibility of the volcanic material, I call to mind an interesting formation I once found at tide level on Oahu, a conglomerate consisting of beach worn lava pebbles cemented together with calcium carbonate. The pebbles obviously represented the hardest and most enduring portion of the country rock, yet I found them eaten out from the cementing material which was one we customarily regard as particularly destructible. What was most interesting in this case was the fact that most of the pebbles had been eaten out in the interior leaving a shell of more resistant material, this quality of resistance apparently the result of the compacting of the shell by the pounding of the pebbles on the beach.

The lava when fresh is a sufficiently tough material. The geologist's hammer often suffers in controversy with some of the compact varieties of basalt, so long as these are sound—I was about to write new, but I call to mind some very refractory boulders I have tried to sample that came from eruptions that occurred certainly a thousand centuries ago. I have seen rocks no older, and probably originally quite as hard, which you might crumble to powder between your Angers. The first had never been exposed long to the action of water, the latter had long ago forgotten what it was to be dry. Moisture, then, is the all important factor in denudation where volcanic rocks are concerned.

Our hypothetical island stands in the path of the trade wind which condenses its moisture into clouds that hang perpetually about its summit or on its flanks, maintaining an altitude between 1,500 and 5,000 feet, keeping the rocks almost perpetually in a damp condition and drenching them at frequent intervals with tropical showers. One consequence is a luxuriant vegetation which flourishes in spite of the fact that the rain washes away soil as fast as it is formed.

At first, indeed, the vesicular lava sucks in the rain like a sponge, but it is not long before incipient decomposition of the rock supplies clay for puddling the surface and soon, geologically speaking, streamlets will begin to seek out the lines of least resistance on the surface and will then set themselves to remove the obstacles they find in their path. So stream erosion is begun. It proceeds slowly at first, for it has to act on a very tough material, but that which mechanical violence fails to accomplish, the magic of chemical affinity effects, and as soon as any channel at all is formed, this quasi solvent action of water is localized exactly where it will be most effective, in the rocks immediately underlying the bed of the stream.

Meanwhile vegetation is playing its important part, mosses and ferns wrapping the rocks to keep them wet, the roots of shrubs and trees penetrating every crevice with their powerful wedges, vegetable acids and products of vegetable decay making havoc of the molecular structure of the rock. All this is a very familiar story to you, no doubt. So too is the process next to follow, of scoring the slopes of the cone with ravines radiating from the center—begun at the base where the volume of water is greatest, passing through the various phases which result in the complex of knife-edge ridges separating deep and steep-walled valleys that characterizes the later stages in the life history of a mountain. That this succession of changes will proceed with extraordinary rapidity in material such as I have described, if conditions are favorable, it is almost superfluous to say. There are however a few points in connection with the progress of this denudation that are especially worthy of remark. Since the chemical effects associated with the presence of moisture are of vastly greater consequence than the mechanical action of the water, the valleys formed will retain in their lower stretches the character of canyons, narrow with precipitous sides and insignificant lateral valleys. The upper portion will assume the V-shape, with numerous V-shaped tributary valleys, or in the later period will take the amphitheater form. The portions of the lower slopes included between the canyons will therefore finally remain as isolated peaks—outliers—connected only by vestiges of the original ridges with the central mass. With this rationale in mind it is generally not difficult to reconstruct in imagination from the remaining fragments, even when these constitute an insignificant part of the whole, the original mountain.

The elevation of the mountain, especially in a region where the trade wind prevails, will have much to do with the dissecting of its mass by rain. If the mountain is more than about 7,000 feet high the clouds which form on the windward side will deposit rain only on that side, the leeward side not only receiving no rain but remaining generally free from cloud. Under these conditions the valleys on the leeward flank of the mountain will retain their canyon form even in their upper portions. If, as in the Hawaiian islands, occasional heavy rains occur near sea level on the leeward as well as the windward side of an island, the valleys may be broadened somewhat in the lower part, but these copious occasional rains have little effect after all in disintegrating the lava, which in the intervals lies exposed to a cloudless sun in a region bare of shrubbery.

If the mountain is less than 5,000 feet high, clouds will lie much of the time over the whole summit and a portion of the rain will fall on the leeward side of the mountain. If the elevation is barely 3,000 feet much the greater part of the rain will be discharged on the leeward side. There will be in each case a point of maximum rainfall, and here we shall find evidence of greatest activity in the work of erosion.

The island of Hawaii illustrates how even in the case of very lofty mountains, there may be an area of excessive precipitation on what would seem to be the sheltered portion of the island. There is here possibly a key to the apparent anomaly of the extraordinary weathering of the leeward side of the Kaala mountain mass on Oahu, but of this more hereafter.

The last stage in the life history of a volcanic island will be naturally a prolonged and uneventful one. Denudation has proceeded so far that little or no condensation of moisture is occasioned by the insignificant remaining ridges, which therefore weather very slowly, crumbling, however, little by little to dust, and carried finally by wind and rain back to the ocean from which it emerged.

I have recited with some fullness of detail this story of the normal life history of a volcano because it is only by a familiar acquaintance therewith that it is possible to read backward the same history from any stage except the very latest in a study of the ruins that remain. The data for such a study will not, however, be complete if we ignore the possibility that there may have been important changes in sea level, and often coincidently in climatic conditions, due to geological events in other parts of the world. The evidences of such changes will be easily enough found if we are alert to look for them.

Again there is the possibility—almost the certainty—that there will be repeated recurrence of volcanic action, which will build anew amid the ruins of the old structure but with no reference to its original plan.

The problems presented by the island of Oahu are peculiarly complicated in that the present island has been formed by the fusion of two volcanoes, one notably older than the other, and further because of the repeated and numerous volcanic outbreaks, not confined, as usual, to the peripheral portion of the island.

The paper of Prof. Hitchcock seeks to arrange in their chronological sequence the principal events in this very interesting history. Confessedly it leaves much for future students to verify and fill out. It presents a skeleton outline of what science has definitely established, giving in most cases convincing reasons for the conclusions drawn. The importance to future investigators of such a succinct and comprehensive statement of conclusions is manifest.

The actual geological history of the island of Oahu is to be reached by reading backward, as I have already said, the general story I have outlined, starting with the concluding chapter as its record is presented in the existing features of the island. The fringe of coral reef rock just above sea level all around the coast constitutes that last chapter, telling of a recent emergence of the land as a whole from the sea. Restore the old sea level and we shall see the island as it was in the immediately preceding stage, its land area materially less than at present.

The present surface of the island is encumbered with material discharged from recent volcanic vents, all this we must clear away in imagination. The scenery about Honolulu will be robbed thus of its most striking and distinctive features. The Tantalus group of sand hills must go first, laying bare once more sharp ridges corresponding with those on either side. The convenient grading up of Nuuanu valley from the city to the "pali" is an innovation not to be tolerated, we must restore the old valley bed, much more contracted than at present, and growing steeper as it is ascended according to rule. Picturesque Diamond Head may remain for a while, but it must go before long, with Punchbowl and Koko Head and the rest of the tufa cones of the peripheral region, and so must Rocky Hill and Kaimuki. I am not now indicating the precise order in which they must be banished but insisting simply that they must go from our mental picture.

Next we must restore flesh to the bones of our skeleton island, adding material at every point where we find erosion particularly active, exactly reversing thus the process by which the land has been shaped. The valleys on the leeward side must thus be filled first, the mountain tops raised until they form a barrier to keep back the rain, and then the work of rapid reconstruction must be transferred to the windward side. We must lift our island as a whole once more out of the water, restoring a condition which shall permit the growth of corals on its fringe where today the ocean stands at a level a thousand feet higher.

We must picture the Koolau mountain when it was almost a counterpart of what we see today on Molokai, its leeward side almost intact, its windward exposure eaten into by stupendous ampitheaters of erosion, and then we must call up from the depths of ocean the great slices of the old island that have parted from the mountain mass by faulting. We shall have a vision at last of a volcanic dome not less than 6,000 feet high, sloping gradually to the shore line on the south, resting against the Kaala mountain on the west and ending on the northeast in an escarpment of cliff somewhere beyond Mokapu point.

All this time we shall have seen only a slow progress in the restoration of the Kaala mountain, sheltered as it is from the trade wind by the Koolau mountain. But now we have to watch a reversal of the process by which this latter was built up. Once more we see the mountain blazing at intervals with the volcanic fires which have heaped up over its great dome hills of scoria and marked its surface with the blackened and desolated track of lava streams. The great eruptions which occasionally pour into the ocean rivers of molten rock now occasion on the neighboring mountain deluging rains from condensation of the steam thus produced. It is probable that the Waianae region is a center of electrical disturbance in connection with these eruptions, and that under the torrential rains accompanying them the mountain wastes like a snowbank in a March thaw.

So as our vision extends backward through the centuries, while the dome of the Koolau mountain grows ever lower, Kaala is filling up its outlines, gaining in altitude and slowly assuming in its turn the features of a recent volcano. The mountains are now separated by a channel of ocean, which widens and deepens as the Koolau mountain becomes swallowed up again in the deep sea, and Kaala stands as an island by itself, perhaps by this time an active volcano, and we have only to follow back the thread of the history step by step through a few more millenniums of time to see, where Oahu is now marked on our maps, only an unbroken expanse of blue ocean.

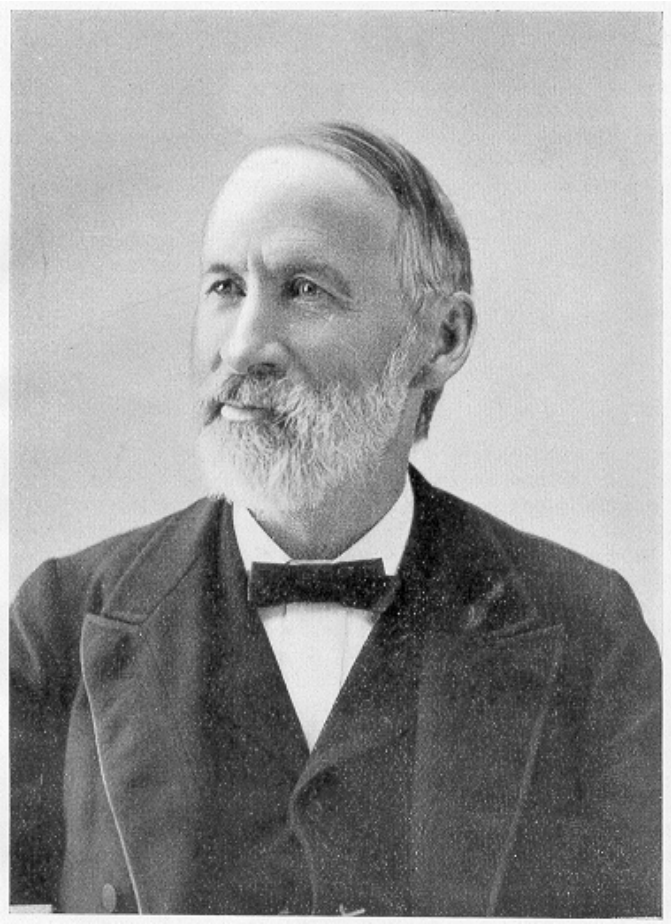
SKETCH OF MANLY MILES.*

To Dr. Manly Miles belongs the distinction of having been the first professor of practical agriculture in the United States, as he was appointed to that then newly instituted position in the Michigan Agricultural College in 1865.

Professor Miles was born in Homer, Cortland county, New York, July 20, 1826, the grandson of Manly Miles, a soldier of the Revolution; while his mother, Mary Cushman, was a lineal descendant of Miles Standish and Thomas Cushman, whose father, Joshua Cushman, joining the Mayflower colony at Plymouth, Massachusetts, in 1621, left him there with Governor Bradford when he returned to England.

When Manly, the son, was eleven years old, the family removed to Flint, Michigan, where he employed his time in farm work and the acquisition of knowledge, and later in teaching. He had a common school education, and improved all the time he could spare from his regular occupations in reading and study. It is recorded of him in those days that he was always successful in whatever he undertook. In illustration of the skill and thoroughness with which he performed his tasks, his sister relates an incident of his sowing plaster for the first time, when his father expressed pleasure at his having distributed the lime so evenly and so well. It appears that he did not spare himself in doing the work, for so completely was he covered that he is said to have looked like a plaster cast, "with only his bright eyes shining through." A threshing machine was brought on to the farm, and Manly and his brother went round threshing for the neighbors. Industrious in study as well as in work, the boy never neglected his more prosaic duties to gratify his thirst for knowledge. He studied

geometry while following the plow, drawing the problems on a shingle, which he tacked to the plow-beam. Whenever he was missed and inquiry was made about him, the answer invariably was, "Somewhere with a book." He was most interested in the natural sciences, particularly in chemistry and its applications to agriculture, and in comparative physiology and anatomy, and was a diligent student and collector of mollusks.



MANLY MILES

From photograph taken in December, 1891.

Choosing the profession of medicine, Mr. Miles was graduated M. D. from Rush Medical college, Chicago, in 1850, and practiced till 1859. In the meantime he became greatly interested in the subject of a geological survey of the State, for which an act was passed and approved in 1858. In the organization of the survey, in 1859, he was appointed Assistant State Geologist in the department of zoology; and in the next year was appointed professor of zoology and animal physiology in the State Agricultural college at Lansing.

In his work as zoologist to the State Geological Survey, in 1859, 1860, and 1861, he displayed rare qualities as a naturalist, so that Mr. Walter B. Barrows, in recording his death in the bulletin of the Michigan Ornithological Club, expresses regret that many of the years he afterward devoted to the development of experimental agriculture "were not spent in unraveling some of the important biological problems which the State afforded, which his skill and perseverance would surely have solved." He was a "born collector," Mr. Barrows adds, "as the phrase is, and his keen eyes, tireless industry, and mathematical precision led to the accumulation of thousands of valuable specimens and more valuable observations."

Mr. Bryant Walker, of Detroit, who knew Professor Miles well in later years, and had opportunity to review his zoological work, regards the part he took during this service in developing the knowledge of the fauna of the State as having been very prominent. "The catalogues he published in the report for 1860 have been the basis for all work since that time." He kept in correspondence with the most eminent American naturalists of the period, including Cope, Prime, Lea, W. G. Binney, Baird, and Agassiz, and supplied them with large quantities of valuable material. From the many letters written by these naturalists which are in the possession of his friends, we take, as illustrating the character of the service he rendered and of the trust they reposed in him, even previous to his going on the survey, one from Agassiz, of February 4, 1856:

"DEAR SIR: As you have already furnished me with invaluable materials for the natural history of the fishes of your State, I am emboldened to ask another favor of you. I am preparing a map of the Geographical distribution of the Turtles of North America, and would be greatly indebted to you for any information respecting the range of those found in your State, as far as you have noticed them, even if you should know them only by their common names, my object being simply to ascertain how far they extend over different parts of the country. If you could add specimens of them, to identify them with precision, it would be, of course, so much the better; but as I am almost ready for the press, I could not for this paper await the return of spring, but would thank you for what you could furnish me now. I am particularly interested in ascertaining how far north the different species inhabiting this continent extend." On the back of this letter was Dr. Miles's endorsement that a box had been sent.

A number of letters from Professor Baird, of 1860 and 1861, relate to the identification of specimens collected by Dr. Miles, and to the fishes of Michigan, and contain inquiries about gulls and eggs. Dr. Miles likewise supplied Cope with a considerable amount of material concerning Michigan reptiles and fishes.

While mollusks were the favorite object of Dr. Miles's investigations, he also made studies and valuable collections of birds, mammals, reptiles, and fishes; and he seems, Mr. Barrows says, "to have possessed, in a high degree, that strong characteristic of a true naturalist, a full appreciation of the value of good specimens. Many of his specimens are now preserved at the Agricultural college, and among his shells are many which are of more than ordinary value from having served as types of new species, or as specimens from type localities, or as part or all of the material which has helped to clear up mistakes and misconceptions about species and their distribution." Mr. Walker speaks of his

having done a great work in conchology. His catalogue, which contained a list of one hundred and sixty-one species, was by far the most complete published up to that time. "He described two new species—*Planorbis truncatus* and *Unio leprosus*. The former is one of the few species which are, so far as known, peculiar to Michigan, and is a very beautiful and distinct form; while the latter, although now considered as synonymous with another species, has peculiarities which in the then slight knowledge of the variability of the species was a justification of his position. He was also the discoverer of two other forms which were named after him by one of our most eminent conchologists—viz., *Campeloma Milesii* (Lea) and *Goniobasis Milesii* (Lea)." Mr. Walker believes that "in general, it can be truthfully stated that Dr. Miles did more to develop the general natural history of the State (Michigan) than any other man either before or since he completed his work as State Zoölogist."

As professor of zoölogy and animal physiology, Dr. Miles is described by one of his students, who afterward became a professor in the college and then its president, as having been thoroughly interested in the subjects he taught, and shown that interest in his work and in his treatment of his students. He labored as faithfully and industriously with the class of five to which President Clute belonged as if it "had numbered as many score." He supplemented the meager equipment of his department from his more extensive private apparatus and collections, which were freely used for class work; and, when there was need, he had the skill to prepare new pieces of apparatus. "He was on the alert for every chance for illustration which occasion offered: an animal slaughtered for the tables gave him an opportunity to lecture on its viscera; a walk over the drift-covered fields found many specimens of rock which he taught us to distinguish; the mud and the sand banks along the river showed how in the periods of the dim past were formed fossil footprints and ripples; the woods and swamps and lakes gave many useful living specimens, some of which became the material for the improvised dissecting room; the crayon in his hand produced on board or paper the chart of geologic ages, the table of classification, or the drawing of the part of an animal under discussion."

Prof. R. C. Kedzie came to the college a little later, in 1863, when Dr. Miles had been for two rears a professor, and found him then the authority "for professors and students alike on beasts, birds, and reptiles, on the stones of the field, and insects of the air," thorough, scholarly, and enthusiastic, and therefore very popular with his classes.

The projection of agricultural colleges under the agricultural college land grant act of 1862 stimulated a demand for teachers of scientific agriculture, and it was found that they were rare. Of old school students of science there was no lack—able men, as President Clute well says, who were familiar with their little laboratories and with the old theories and methods, but who did not possess the new vision of evolution and the conservation of energy, men of the study rather than the field, and least of all men of the orchard and stock farm; and they knew nothing of the practical application of chemistry to fertilization and the raising of crops and the composition of feed stuffs, of physiology to stock-breeding, and of geology and physics to the study of the soils.

With a thorough knowledge of science and familiarity with practical agriculture Professor Miles had an inclination to enter this field, and this inclination was encouraged by President Abbott and some of the members of the Board of Agriculture. He had filled the professorship of zoology and animal physiology with complete success, and had he consulted his most cherished tastes alone he would have remained there, but he gradually suffered himself to be called to another field. The duties of "acting superintendent of the farm" were attached to his chair in 1864. In 1865 he became professor of animal physiology and practical agriculture and superintendent of the farm; in 1869 he ceased to teach physiology, and gave his whole time to the agricultural branch of his work; and in 1875 the work of the superintendent of the farm was consigned to other hands, and he confined himself to the professorship proper of practical agriculture.

The farm and its appurtenances, with fields cumbered with stumps and undrained, with inadequate and poorly constructed buildings, with inferior live stock, and everything primitive, were in poor condition for the teaching or the successful practice of agriculture. Professor Miles' first business was to sec these things in order. Year by year something was done to remove evils or improve existing features in some of the departments of the life and management of the premises, till the concern in a certain measure approached the superintendent's ideal— as being a laboratory for teaching agriculture, conducting experiments, and training men, rather than a money making establishment.

In this new field, Professor Kedzie says, Professor Miles was even more popular than before with the students, and created an enthusiasm for operations and labors of the farm which had been regarded before as a disagreeable drudgery. The students "were never happier than when detailed for a day's work with Dr. Miles in laying out some difficult ditch or surveying some field. One reason why he was so popular was that he was not afraid of soiling his hands. His favorite uniform for field work was a pair of brown overalls. The late Judge Tenney came to a gang of students at work on a troublesome ditch and inquired where he could find Dr. Miles. 'That man in overalls down in the quicksands of the ditch is Dr. Miles'; the professor of practical agriculture was in touch with the soil."

Prof. Byron D. Halsted, of the New Jersey Agricultural College Experiment Station, who was an agricultural pupil of Dr. Miles in Lansing, characterizes him as haying been a full man who knew his subjects deeply and fondly. "In those days I am safe in writing that he represented the forefront of advanced agriculture in

America. Be was in close touch with such men as Lawes and Gilbert, Rothamstead, England, the famous field-crop experimenters of the world, and as for his knowledge of breeds of live stock and their origin, Miles' Stock-Breeding is a classic work. Dr. Miles, in short, was a close student, a born investigator, hating an error, but using it as a stepping stone toward truth. He did American farming a lasting service, and his deeds live after him."

While loved by his students, most of whom have been successful and many have gained eminence as agricultural professors or workers in experiment stations, and while receiving sympathy and support from President Abbott, Dr. Miles was not appreciated by the politicians, or by all of the Board of Agriculture, or even by the public at large. Unkind and captious criticisms were made of his work, and it was found fault with on economical grounds, as if its prime purpose had been to make money. He therefore resigned his position in 1875, and accepted the professorship of agriculture in the Illinois State University. Thence he removed to the Houghton Farm of Lawson Valentine, near Mountainville, N. Y., where he occupied himself with scientific experimental investigation. Be was afterward professor of agriculture in the Massachusetts Agricultural College, at Amherst. In announcing this appointment to the students, Dr. Chadbourne, then president of the institution, and himself a most successful teacher, stated that he considered Dr. Miles as the ablest man in the United States for that position. In 1886, shortly after Dr. Chadbourne's death, Dr. Miles returned to his old home in Lansing, Michigan, where he spent the rest of his life in study, research, and the writing of books and articles for scientific publications.

During these later years of his life he took up again with what had been his favorite pursuit in earlier days, but with which he had not occupied himself for thirty years—the study of mollusks—with the enthusiasm of a young man, Mr. Walker says, who being interested in the same study, was in constant correspondence with him at this time; "and as far as his strength permitted labored with all the acumen and attention to details which were so characteristic of him. I was particularly struck with his familiarity with the present drift of scientific investigation and thought, and his thorough appreciation of modern methods of work. Be was greatly interested in the work I was carrying on with reference to the geographical distribution of the mollusca, and, as would naturally be supposed from his own work in heredity in connection with our domestic animals, took great pleasure in discussing the relations of the species as they are now found and their possible lines of descent. Be was a careful and accurate observer of nature, and if he had not drifted into other lines of work would undoubtedly have made his mark as a great naturalist. As it is, his name will always have an honored place in the scientific history of Michigan."

When Professor Miles began to teach in the Michigan Agricultural College, the "new education" was new indeed, and the text-book method still held sway. But the improved methods were gradually taking the place of the old ones, and Professor Miles was one of the first to cooperate in them, and he did it with effect. He used text-books, "but his living word," President Clute says, "supplemented the book; and the animal from the farm under his knife and ours, the shells which he led us to find under rotten logs and along the rivers and lakes, the insects he taught us to collect and classify, the minerals and fossils he had collected on the geological survey of Michigan, all were used to instruct and inspire his students, to cultivate in them the scientific spirit and method."

Among the more important books by Professor Miles are Stock-Breeding, which had a wide circulation and has been much used as a class-book; Experiments with Indian Corn, giving the results of some important work which he did at Houghton Farm; Silos and Ensilage, which helped much in diffusing knowledge of the silo in the times when it had to fight for recognition; and Land Drainage. Of his papers, he published in the Popular Science Monthly articles on Scientific Farming at Rothamstead; Ensilage and Fermentation; Lines of Progress in Agriculture; Progress in Agricultural Science; and How Plants and Animals Grow. To the American Association for the Advancement of Science he contributed papers on Energy as a Factor in Rural Economy; Heredity of Acquired Characters (also to the American Naturalist); Surface Tension of Water and Evaporation; Energy as a Factor in Nutrition; and Limits of Biological Experiments (also to the American Naturalist). Other articles in the American Naturalist were on Animal Mechanics and the Relative Efficiency of Animals as Machines. In the Proceedings of the American Educational Association is an address by him on Instruction in Manual Arts in Connection with Scientific Studies. The records of the U and I Club, of Lansing, of which he was a valued member for ten years, contain papers on a variety of scientific subjects which were read before it, and were highly appreciated. This list does not contain all of Professor Miles' contributions to the literature of science, for throughout his life he was a frequent contributor to the agricultural and scientific press, and a frequent speaker before associations and institutes, "where his lectures were able and practical."

No special record is made of the work of Professor Miles in the American Agriculturist, but the correspondence of Professor Thurber with him furnishes ample proof that he was one of the most trusted advisers in the editorial conduct of that journal. The familiar tone of Professor Thurber's letters, and the undoubting assurance with which he asked for information and aid on various subjects, well demonstrate how well the editor knew whom he could rely upon in an emergency.

In all his work the great desire of Professor Miles was to find and present the truth. His merits were recognized by many scientific societies. He was made a corresponding member of the Buffalo Society of Natural

Sciences in 1862; a corresponding member of the Entomological Society of Philadelphia in January, 1863; a correspondent of the Academy of Natural Sciences of Philadelphia in 1864; a member of the American Association for the Advancement of Science in 1880, and a Fellow of the same body in 1890; and held memberships or other relations with other societies; and he received the degree of D. V. S. from Columbia Veterinary College, New York, in March, 1880.

His students and friends speak in terms of high admiration of the genial qualities of Professor Miles as a companion. The resolutions of the U and I Club of Lansing describe him as an easy and graceful talker, a cheerful dispenser of his learning to others. "To spend an hour in his 'den,' and watch his delicate experiments with 'films,'" says President Clute, "and see the light in his eyes as he talked of them, was a delight.'" "He was particularly fond of boys," says another, "and never seemed happier than when in the company of boys or young men who were trying to study and to inform themselves, and if he could in any way assist them he was only too glad to do so;" and he liked pets and children. Incidents are related showing that he had a wonderful accuracy in noting and recollecting the minutest details that came under his observation—a power that he was able to bring to bear instantly when its exercise was called for.

Dr. Miles kept up his habits of reading and study to the last days of his life; but all public work was made difficult to him in later years by an increasing deafness. He was tireless in investigation, patient, and always cheerful and looking for the bright side; and when one inquired of him concerning his health, his usual answer was that he was "all right," or, if he could not say that, that he would be "all right tomorrow."

No sketch of Dr. Miles is complete without a word of tribute to his high personal character, his life pure and noble in every relationship, his unswerving devotion to truth, and the unfaltering loyalty to his friends, which make his memory a benediction and an inspiration to all who knew him well.

He was married in 1851 to Miss Mary E. Dodge, who remained his devoted companion until his death, which occurred February 15, 1898.

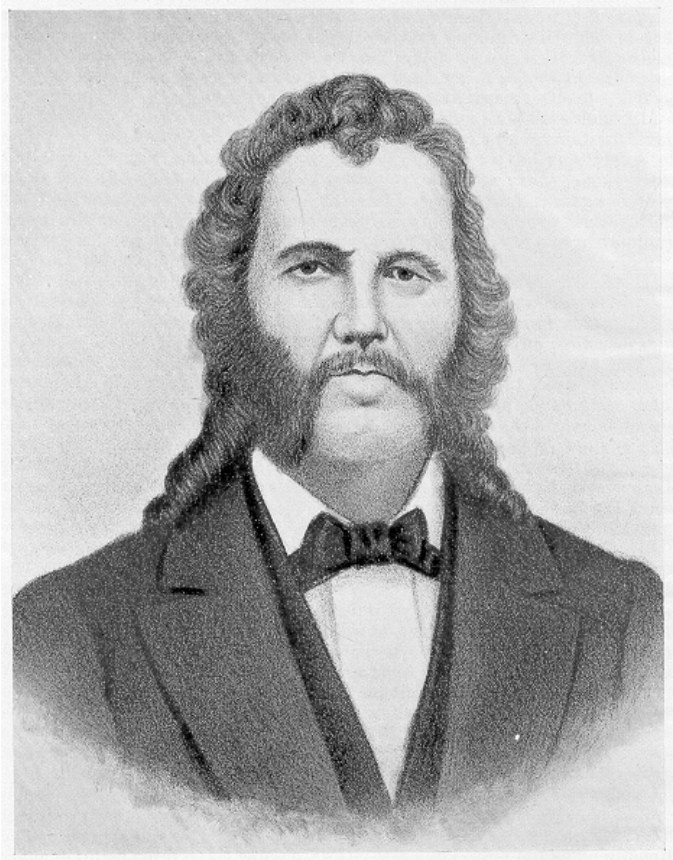
*Dr. Manly Miles was a charter member of the Michigan Academy of Science. The present sketch is reprinted, with some minor corrections, from the Popular Science Monthly, April, 1899. W. B. B.

SKETCH OF DR. DENNIS COOLEY.

W. J. BEAL, PH. D.

Dr. Dennis Cooley was born at Deerfield, Massachusetts, February 18, 1787; graduated at the Medical College of Berkshire in 1822; practiced medicine for five years in Georgia; moved to Macomb county July, 1827, locating in Washington township, where he resumed practice until 1856. He was a great lover of science, especially of botany, and for many years devoted much time to the study of the flora of his adopted county, accumulating a large and valuable herbarium of about 4,000 plants, which are now the property of the Agricultural College, where they are well mounted and well preserved.

Dr. Cooley married Elizabeth Anderson, of Deerfield, Massachusetts, by whom there were two daughters, both of whom died while young. In 1836, he married Clara Andrus, of Macomb county. He was of Scotch descent and a member of the Methodist church. He was appointed postmaster in July, 1836, and held the position continuously for 23 years. He died September 8, 1860.



DENNIS COOLEY, M. D.

SKETCH OF DANIEL CLARKE.

W. J. BEAL, PH. D.

Dr. Daniel Clarke was born in Danvers, Massachusetts, in 1812; graduated from Harvard University in the departments of arts and sciences and medicine, taking his degree of M. D. in 1835. In 1840, he came to Flint, Michigan, where he resided continuously until his death in 1884.

He was for most of his life an enthusiastic student of natural history, and was especially interested in botany, accumulating an herbarium of over 5,000 plants which finally came into possession of the State Agricultural College. He was one of the founders of the Flint Scientific Institute which won considerable renown in its day.

He took a very active part in the educational work of his city, where he was a member of the school board continuously for over a quarter of a century. The fine library of the Flint High School was well started through his personal efforts.

He was physician for the State School for the Deaf from the time of its organization until compelled to resign by reason of advancing age.

He was an authority on horticultural matters and his advice was frequently sought by fruit-growers in the vicinity of his home.

He was a modest and unassuming man, thoroughly unselfish, winning the respect and love of his fellow citizens. Always ready to give enthusiastic support to any enterprise which looked to the moral or educational interests of his city or State.

DANIEL CLARK, M. D.

Acknowledgments and exchanges for the Academy should be sent to the present Secretary, Dr. J. B. Pollock, Ann Arbor, Michigan.

W. B. B.

October, 1901.