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## I. DISTRIBUTION OF THE RESERVE MATERIAL OF PLANTS IN RELATION TO DISEASE.

BY D. P. PENHALLOW.

By reserve material we understand all those proximate constituents of plants which are either directly or indirectly the product of assimilation, and which are stored up in solid or liquid form to meet some future requirements of growth.

It is essential for us to bear in mind that, such material being the result of an assimilative function which is dependent upon the presence of chlorophyll and the action of sunlight, it can be found, primarily, only in those parts of green plants which grow under the normal influence of light; and, secondarily, also in those parts of green plants which are normally excluded from the light, and to which it has been transferred from the organs where it is formed by secondary processes. It follows from this, that all such material must be absent from colorless parasites, except in so far as they may have taken up the digested material of their hosts and redeposited it in their own tissues, and from all saprophytes. It will also follow that, whatever operates to influence the digestive process in green plants must have a direct bearing upon the amount of reserve material finally deposited, as well as the tissues in which it is stored.

We may consider all reserve material as occurring in two forms, the liquid and the solid. Of the former we have examples in the oils, sugars, inulin and allied compounds, although the two latter may also be obtained in a solid form under certain special conditions of treatment. Of the latter we have familiar examples in the various kinds of starch which, however, is most probably also a liquid at certain times, as when in process of transfer from one organ to another. We should also enumerate, among the solid forms of reserve material, those peculiar forms which protoplasm assumes when passing into the resting state, such as are to be found in the crystalloids, aleurone, etc., or in other words, in the so-called protein compounds of seeds.

It is not the purpose of this paper to discuss all, or even a large portion of these compounds, since the subject is altogether too large to permit of proper treatment within such brief limits, and I shall therefore confine my remarks to that one form of most frequent and conspicious occurrence, starch, since what is true of this in its distribution and relation to pathological conditions, is also true in a very large measure of the other forms of reserve material; and, moreover, it is in the distribution of this in health and disease with which our investigations have been chiefly concerned.

The leaves are the special organs of digestion for the plant, and to them we may consider this function wholly confined; except in cases where there is a green bark, as in all herbaceous plants and the young shoots of woody plants, or where true leaves are absent, and their function is assumed by other parts of the plant, as in the cacti. The products of digestion are in general the same in either case, as, also, must be their final distribution and use, so that what is true of the leaves in their relation to the digestive function must also be true of other green parts. The essential features of the digestive process, as we observe it in leaves, are the decomposition of $CO_2$ and $H_2O$ with recombination of their constituent elements, giving rise to starch as a solid product to be utilized in nutrition, while free O is liberated into the surrounding air whence the $CO_2$ was derived. This action may be regarded as continuing during the entire vegetative period, so long as chlorophyll is present and sunlight has free access to the leaves, and, therefore, under otherwise uniform conditions, subject only to a daily periodicity, due to alternation of day and night. As fast as formed, the starch is disposed of in two ways :—

(1) It is transferred in a soluble form to all the actively growing parts of the plant to meet the immediate requirements of growth. So long, therefore, as vegetation, or the extension of tissues is active, the bulk of all the starch produced is at once disposed of in this way, and there is therefore no excess, but all the tissues show a marked absence of it. This is particularly true during the first one or two months of spring and summer, the solution of the stored starch commencing at a period which antedates the first growth; but as the season advances, maturity of parts replaces rapid extension, and then there is a tendency for the starch to be formed in excess of the immediate demands of growth, and it therefore requires to be disposed of otherwise.

(2) The starch produced in excess of immediate needs is transferred in a soluble form to parts of the plant which have generally lost their power of growth and which contain no chlorophyll, and is there deposited until required by the growth of organs at some future period, generally before the leaves have reached that stage of development which will permit of their assimilating new material. In accordance with this it is generally found that there is comparatively small accumulation of starch in the leaves and other assimilating tissues, while any excessive development there becomes at once indicative of disordered function.

It is impracticable to place a quantitative limitation upon the amount of starch which may normally be present in tissues, and apply that law to all periods of vegetation; the limit can only be established as a matter of experience, since in early summer, when growth is most active—the requirements of tissue-formation keeping pace with the power to supply—the tissues all contain a minimum of starch; but toward the end of summer, as growth ceases, there is a tendency to greater accumulation in all the tissues. At the end of the season, as the leaves ripen previous to their annual fall, whatever starch they contain is either withdrawn to the permanent structure of the plant, or it enters into fatty degeneration. Such changes are normal. If, on the other hand, such accumulations or fatty degenerations occur at other than their normal period, or if in excess at this time, as fatty degeneration during the month of June, or excessive accumulation of starch in the bark during active growth, they at once become certain and most important indications of disease.

As in the early period of vegetation, the nutritive and assimilative functions are nearly balanced, there is no surplus material to be deposited. As the season advances, growth diminishes and the products of assimilation then become in excess, in which case they are stored up—most generally in tissues which have long since lost their power of growth—and are therefore designated as permanent, though sometimes in tissues still active, but specially modified as reservoirs of reserve material. These reservoirs represent different tissues and organs in different plants. In the potato, it is the tuber itself; in the lily, it is the modified leaves forming the scale of the bulb; in the carrot, it is the root; and in the century plant, it is each leaf, which becomes specially modified for that purpose. Our particular purpose, however, will be best illustrated by confining our attention to trees and other plants in which the woody structure is largely in excess. Here the distribution of the starch for storage is determined first of all to the pith, next to the medullary rays and woody cells, and last of all to the bark, thus being correlated to the activity of the tissues themselves. In trees, the deposition of starch may be regarded as commencing somewhat late in the season, and increasing, as growth diminishes, to the time when the function of the leaves ceases.

No law can as yet be stated concerning the amount of starch which should normally be deposited in the various tissues, but as the result of examinations into the histological condition of several thousand specimens taken from a great variety of trees and shrubs, examined at all seasons of the year, the following conclusions appear to be justified :—

1. While, in general, plants store reserve material at the close of the growing season, this law cannot find specific application in all cases and for all tissues.

2. Woody plants generally contain reserve material in their permanent structure during the period of active growth, but the presence of starch in the cortical tissues during this time is variable in different species, and depends upon the special physiological functions of the subject.

3. The reserve starch is least during active growth and greatest just after the fall of the leaves.

4. The amount of stored material is most variable in the bark, and least variable in the wood and pith.

5. Reserve material appears most abundantly in the oldest tissues and those which are most strongly lignified, least abundantly in the tissues where the vitality is greatest.

6. The storage of the carbohydrate is first in the old and lignified cells, and last in the most active structure.

7. The solution of the stored starch is first in the active parenchyma cells, and last in the permanent tissues.

8. There is a gradual solution of the stored starch during the period of rest.

9. Leaves normally contain an abundance of starch during the period of their greatest activity, but as they ripen the starch is replaced by oil.

In 1871, Nobbe and Schroeder demonstrated the influence which may be exerted upon this distribution by an abnormal food supply. Their experiments with buckwheat, to determine the specific value of chlorine and potash, were found to have an important bearing upon the products of assimilation. The potash, as is now so well known to be the case, was found to be essential in the first instance to the formation of the reserve material, while the chlorine was observed to bear a most important relation to its final distribution. Withholding the chlorine, the starch accumulated in the tissues where formed, so that the bark and leaves became abnormally charged with it, particularly in the young growth. At the same time there was marked atrophy, together with high discoloration of all the growing parts, showing a failure of proper nutrition and, therefore, of distribution of the digested material. Restoration of chlorine to the food-supply gradually effected distribution of the starch and restoration of the normal growth. This then shows what may be produced by artificial treatment, and clearly demonstrates the dependence of the physiological activity upon the presence of special elements and compounds. It also leads us to infer that similar abnormal conditions may develop whenever the plant is deprived of these special elements of food under conditions of ordinary growth.

Acting upon these suggestions, Dr. Goessmann and I have, for several years past, been endeavoring to determine the possible existence of similar conditions in plants growing under ordinary influences, and their relation to specific diseases. The results of our examinations show most conclusively, that in certain diseases, e.g., peach yellows, we have to deal with essentially the same histological characteristics as were artificially produced by Nobbe and Schroeder in the case of buckwheat, and not only that, but that the disease can be produced and cured at will.

In order to understand this, it will be necessary to deal with the experiments in both their chemical and botanical aspects.

In dealing with the chemical changes involved, it was deemed essential, first of all, to determine what mineral constituents normally enter into the composition of both fruit and wood in its healthy condition, and to compare these quantitatively with the constituents found in the ash of corresponding structures in a state of disease. The analyses obtained were as follows :—

| Fruit of Crawford's Early. | Healthy. | Diseased. |
|---|---|---|
| Ferric oxide.................... | 0·58 | 0 46 |
| Calcium oxide.................... | 2.64 | 4·68 |
| Magnesium oxide.................. | 6·29 | 5·49 |
| Phospheric acid.................. | 16·02 | 18·07 |
| Potassium oxide.................. | 74·46 | 71·30 |
| | 100·00 | 100·00 |

These results at once made it clear that in the diseased, as compared with the healthy, the ash contains more phospheric acid and lime, and less potash. Previous examinations and experiments with strawberries and grapes had already demonstrated the superior importance of potash in improving the qualities of these fruits, and the inferior value of lime, and it seemed possible that similar results might be obtained here in the case of the peach. Analyses were, therefore, made of the diseased wood, and acting upon the theory that potash and chlorine were probably the two elements most needed, a number of diseased trees were treated with muriate of potash. After the lapse of a few years, they lost all appearance of disease, and were restored to such a condition of health that, up to the present time, they have been most profitable in their production of fruit. An analysis of the wood was now made for comparison with that of the diseased wood. The results follow:—

| Wood of Crawford's Early. | Restored. | Diseased. |
|---|---|---|
| Ferric oxide | 0·52 | 1·45 |
| Calcium oxide | 54·52 | 64·23 |
| Magnesium oxide | 7·58 | 10·28 |
| Phospheric acid | 11·37 | 8·37 |
| Potassium oxide | 26·01 | 15·67 |
| | 100.00 | 100.00 |

This comparison shows the same deficiency of potash and excess of lime in the diseased, as previously noted, and what is of great significance, that the excess of lime in the one and deficiency of potash in the other, or the decrease of lime in the healthy and the corresponding increase of potash, stand about in the relation of equivalent value. Other analyses fully confirmed these results, and the final conclusions reached were, that, since in the diseased condition there was always an excess of lime and deficiency of potash, and as the relations of these could be changed by conditions of treatment causing increase of potash and decrease of lime, together with the promotion of a healthy organism, that, so far as chemical data could determine, the disease was caused by, or at least associated with, imperfect nutrition.

At this stage, it became most important to determine the relation of the reserve material to these various changes, and in order to arrive at a clear understanding of this, we must discuss the various external and internal indications of disease.

Among the external features which characterize the disease in peaches, we must take into consideration the formation of the fruit, the formation of the wood, the color of the bark and the color and size of the foliage.

The color of the bark is one of the first symptoms to develop. Instead of retaining the natural, reddish hue which all healthy trees possess until well advanced in years, the bark turns dark and has the external appearance of drying up. As the tree becomes more involved in disease, the foliage begins to show indications of the fact. The normal size of the leaf is from 15 to 18 cm. in length. The color is a rich leaf green. The outline is somewhat wavy, but the surface is uniform and not depressed by irregular curlings. As the disease advances, however, the leaves decrease in size, the chlorophyll undergoes modifications or is imperfectly formed, an abnormal red, yellow and green color is developed, and all these conditions continue to increase until the extremes are reached.

The last external characteristic is to be found in the abnormal development of the new wood. The branches of the new growth become more strongly atrophied as the disease advances, until they finally become of a very wiry character and develop upon the trunk and branches in clusters.

The internal features are as strongly marked as the external, and may generally be determined in very early stages of the disease. The first indication is to be found in the very dense accumulation of starch, not only in the pith and medullary rays, but particularly in the bark, from which it should normally be absent to a very large degree. This excessive accumulation of digested material in unusual parts, is at once indicative of an imperfect power of distribution to the growing parts and inability of the plant to convert it into tissues, so that the atrophy of structure appears in the first instance, not to be caused by want of material, but by the absence of certain chemical compounds by which the necessary chemical changes of direct nutrition may be accomplished.

This accumulation of starch increases as the disease progresses, while, at the same time, very important modifications in the tissues themselves, are developed, particularly in the bark. There the cells of the middle bark, or mesophlœum, become relatively thick-walled; the intercellular spaces decrease in size and number and thereby retard the proper respiratory function; the disposition of the cells becomes somewhat regular, the tendency being to the development of layers forming well-defined concentric rings, while the form also tends strongly to an elongated ellipse with its minor axis running in a radial direction.

Contrasting this with the normal, we find in the latter that both the internal and external features are markedly different. The leaves are a deep green, and of large size, as already shown. The young shoots, likewise, are of a lively green color, and two or three times the diameter and several times the length of the diseased. Internally, the starch, in comparatively small quantity, is confined almost wholly to the pith rays and wood, the bark containing but little. The structure of the bark shows that the intercellular spaces are large and frequent, the cells arranged without order, irregular in form and size, and with relatively thin walls.

We are now to inquire what relation, if any, these histological conditions bear to the chemical constitution of the ash already referred to, and particularly to the chemical results derived from an examination of the tree restored to health by treatment.

1st. In the normal plant, the full exercise of its functions of growth and a normal histological condition occur, when potash and chlorine are relatively in excess and lime is relatively wanting.

2nd. In the diseased plant, the imperfect nutrition and distribution of the reserve products, as also modifications of the cellular structure, are associated with deficiency of potash and chlorine and excess of lime.

3rd. We are to inquire as to the relation in which the restored tree stands to all of these.

The chemical analyses already referred to show that, when the restoration from abnormal to normal functional activity occurs, the chemical constituents change their relations to those observed in the normally healthy, i. e., the potash becomes in relative excess. At the same time, the histological conditions show a corresponding change, and as the new growth develops, the structure and also the cell-contents assume precisely the conditions of development and distribution found in the naturally healthy tree.

These results may be regarded as fairly conclusive so far as this particular disease is concerned, but we can as yet hardly apply generally the laws here determined. However, the fact here developed with reference to the distribution of the reserve material will not apply with equal force to other trees or plants, since there are very important variations in this respect, dependent upon the physiological characteristics of particular species, or at least of particular families of plants. Nor will the same chemical elements, or the same chemical compound, be equally efficient in all cases in determining a similar result, since here, also, the effect is determined by specific physiological peculiarities. This is well illustrated in the peach and the pear: both belong to the same family *Rosaceæ*, yet the peach belongs to the group *Amygdaleæ*, while the pear belongs to the group *Pomeæ*, indicating at once specific physiological differences. And while potassium chloride will exert a most beneficial effect in the peach. it is comparatively worthless when applied to the pear, for which the potassium sulphate appears to be the most efficient combination.

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## II. NOTES ON MOVEMENT OF WATER IN "ROBINIA PSEUDACACIA." *

BY MISS G. E. COOLEY.

The influence of transpiration in determining the upward movement of water in plants is fully recognized; but, apart from that force, another appears to act in conducting water to the leaves, the proper physical causes of which are not well understood as yet.

The root-hairs and other active cells of the root derive moisture from the soil through osmosis, and are thus brought into a state of positive tension, while the contained fluid is in a state of negative tension. Sachs† points out that the necessary release from this tension must be into adjoining cells as offering the least resistance. These are in turn made tense, and the action continues from the lower to the higher cells, thus conducting the water from the root to the stem. Root-pressure is the expression of this tension of tissues by which water ascends in plants, through osmosis acting as a primary influence. This force of root-pressure is very variable in plants of different species, but in general it is found in all plants with a well-developed root-system. That it is a strong and well-marked force can be readily shown, if the proper conditions are observed, by manometric measurements, when the amount is found to be considerable; as demonstrated by Clark ‡ in the case of *Betula lenta*, amounting to the equivalent of 68 inches of mercury or 77 feet of water, and of *Vitis æstivalis*, 78 inches of mercury or 88.4 feet of water.

Such a power, as this can be shown to be in actively-absorbing roots, must be an important factor in supplying the deficiency of water lost by transpiration; or, as often happens in some species

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* Observations made in the laboratory of Prof. Penhallow, Montreal, during the summer of 1885.

† Sachs' Text Book, p. 687.

‡ Phenomena of Plant Life, 1874.

of Aroideæ, where transpiration is comparatively weak, it may even exceed the evaporation from the leaves, and cause exudation in drops from their tips. This is by no means the rule, however; on the contrary, the loss caused by transpiration usually tends to produce a vacuum in the stems and lower tissues, which is only slowly compensated for by root pressure. This is shown by the well-known fact that if an actively transpiring plant be cut off a few centimetres above the ground and water applied to its cut surface, it is rapidly sucked in, and it is only after the lapse of some time that root-pressure predominates, but then water is forced up the stem and out at the cut surface in large amounts and even against pressure. This action will continue until the roots die, with a force, varying but generally increasing to the maximum, and then gradually decreasing until the force is exhausted.

It was to determine the movement of water, chiefly as exhibited in root-pressure under the influence of atmospheric conditions, that the following experiments were entered upon.

A mercurial manometer of the ordinary form, nine decimeters long and with graduations reading to mms., was set up in the open air beside the plant, and connection with the stump was made by a rubber tube bound with book-linen to prevent expansion under pressure. All the fastenings were made air-tight, and all air was removed from the water column connecting the mercurial column with the stump, and the tube was then pressed down over the stem, which was cut off four cm. from the ground, *i.e.*, below the lowest leaf. The plants selected were vigorous shoots of *Robinia pseudacacia* of this year's growth. All were from 6 to 10 decm. in height 0.5 and 0.7 cm. in diameter, and were situated from 15 to 20 ft. from the parent trees. An examination showed an intimate connection between the suckers and these trees. The running roots from the tree give rise to buds which develop into strong shoots having at first no root system of their own, the old root continuing its course and becoming the primary root of the new plant before the connection with the parent tree is severed. All the roots showed a swelling at the juncture with the sucker, and some of them exhibited signs of decay a few inches back of the swelling, but in most, the connection with the main root of the tree was perfect, as the results of the experiment will show.

## Robinia Pseudacacia No. I.

| Date. | Hour. | — Reading. | + Reading. | Differences. | Lbs. pressure per sq. in. | Temp. F. | Rel. Hum. | Mean Daily Temp. | Mean Daily Rel. Hum. | |
|---|---|---|---|---|---|---|---|---|---|---|
| July 18th... | 10.00a.m. | 1.65 | 2.25 | + .600 | + 1.16 | 64.4° | 50% | | | Temp. and R.H. taken at 11a.m. and 3 p.m. |
| " " .... | 10.30 | 2.08 | 1.83 | — .145 | — 0.28 | | | | | |
| " " .... | 10.45 | 2.12+ | 1.68 | — .440 | — 0.85 | | | | | |
| " " .... | 11.30 | 2.12+ | 1.40 | — .720 | — 1.39 | | | | | |
| " " .... | 12.00 | 2.12+ | 1.32 | — .800 | — 1.55 | | | | | |
| " " .... | 12.05p.m | 2.12+ | 1.24 | — .880 | — 1.70 | | | | | |
| " " .... | 12.15 | 2.12+ | 1.24 | — .880 | — 1.70 | | | | | |
| " " .... | 4.10 | 1.85 | 1.91 | + .065 | + 0.12 | 74.1° | 48.0 | 63.42 | 58.3 | [The scale is in decimeters.] |
| " 20th... | 10.00 a.m. | 1.97 | 1.93 | — .040 | — 0.07 | 73.9° | 55.0 | 71.22 | 65.7 | |

ROBINIA PSEUDACACIA NO. II.

| Date. | Hour. | — Reading. | + Reading. | Differences. | Lbs. per sq. in. pressure. | Temp. F. | Rel. Hum. | Mean Daily Temp. | Mean Daily Rel.Hum. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|
| July 20th.... | 12.00 | 2.950 | 2.950 | 0.00 | 0.00 | 73.9° | 55% | | | Temp. and Humidity taken at 11 a.m. and 3 and 7 p.m. |
| " " ... | 12.30p.m. | 2.300 | 3.600 | +01.3 | 2.51 | | | | | |
| " " .... | 12.35 | 2.950 | 2.950 | 0.00 | 0.00 | | | | | |
| " " .... | 3.30 | 3.030 | 2.870 | —0.16 | —0.177 | 77.1 | 49.0 | | | |
| " " .... | 3.45 | 2.985 | 2.915 | —0.07 | —0.136 | | | | | |
| " " .... | 4.00 | 2.985 | 2.915 | —0.07 | —0.136 | | | | | |
| " " .... | 4.15 | 2.980 | 2.920 | —0.06 | —0.116 | | | | | |
| " " .... | 4.30 | 2.975 | 2.925 | —0.05 | —0.090 | | | | | |
| " " .... | 5.15 | 2.960 | 2.950 | —0.01 | —0.019 | | | | | |
| " " .... | 7.50 | 2.940 | 2.960 | +0.02 | +0.038 | 72.9 | 70.0 | 71.22° | 65.7% | $H_2O$ in the tube. |
| " 21st.... | 11.00a.m. | 3.070 | 2.770 | —0.30 | —0.570 | 73.0 | 88.0 | | | Raining. |
| " " .... | 3.00p.m. | 3.350 | 2.500 | —0.85 | —1.640 | 77.0 | 77.0 | | | Clear, damp, warm. |
| " " .... | 4.00 | 3.000 | 2.900 | —0.10 | —0.190 | | | | | Light clouds. |
| " " .... | 5.00 | 2.960 | 2.930 | —0.03 | —0.500 | | | | | Clear. |
| " " .... | 5.45 | 2.945 | 2.955 | +0.01 | +0.019 | | | | | |
| " " .... | 7.45 | 2.935 | 2.965 | +0.02 | +0.038 | 72.5 | 93.0 | 70.07 | 88.20 | $H_2O$ replaced. |
| " 22nd .. | 10.00a.m. | 2.870 | 3.030 | +0.16 | +0.177 | | | | | |
| " " .... | 10.30 | 2.850 | 3.060 | +0.21 | +0.406 | | | | | [The scale is in decimeters.] |
| " " .... | 11.00 | 2.840 | 3.080 | +0.28 | +0.540 | 75.3 | 58.0 | 71.62 | 61.20 | |

An examination of the tables will show that the first action of the stump was that of suction,—the mercury, which had risen at the moment the tube was drawn over the stem, having quickly fallen. This we were led to expect from the rapid transpiration of the shoot, and the consequent exhaustion of moisture from the stem before it was cut. This suction continued and reached its maximum at the hottest part of the day, or when the parent tree was most actively transpiring, evidently pulling upon the water in the manometer through the root-stock of the sucker. After the maximum was reached, the action decreased until sunset, when a slight pressure was observed; and, if the records had been made during the night, it is probable that a still higher pressure would have been registered. In the second table, it is noticeable that during the rain of the morning, there was recorded only one third the amount of negative pressure that appeared at 3 p.m., when the air was warm and the sun shining. At the close of the experiment, the water in the rubber tube was replaced by air from the stem, and all fluctuations after that time were evidently caused, at least in part, by variations in the temperature acting upon the column of air above the stump.

The experiment is interesting as showing how vigorously a transpiring tree draws upon its roots even to the distance of 30 ft., and upon its young shoots, in opposition, to the more feeble draught of the sucker, as the moisture evaporates from its leaves. These stems wilt very quickly when cut down, showing, as did the manometric action, that the stems were almost empty.

From the fact that air in some cases finally replaced the water, it appears that, in spite of all precautions to the contrary, the apparatus, while air-tight for slight pressures, did not prove so for those of considerable increase; so that, the maximum of negative pressure permitted by the apparatus being reached, the mercury then fell back to a height which was within the limits of the instrument.

So far as we are enabled to determine from these results, it would thus appear :—

1st. That the influence of transpiration is felt in very remote parts of the plant.

2nd. That, in this case at least, root-pressure has but little value in supplying the wants created by transpiration.

It will be the object of further experiment to see how the roots are able to draw water from the sucker, which the experiment shows to be done, and, as a contrary function, to provide it with sufficient nourishment from the parent tree to make a healthy growth.

It is a fact worthy of note, that this plant takes unusual care to provide for its propagation. Most of the roots examined showed evidence of buds already formed for another year, and wherever the suckers had been cut down in previous seasons, two or more buds had taken their place. In one instance where worms were injuring the root, the expiring tissues redoubled their exertions, and eight shoots and twelve buds were produced in 4 inches of root. Such a state of affairs renders it exceedingly difficult to eradicate the undergrowth of the Robinia.

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## III. Ancient Insects and Scorpions.

Fossil scorpions have been known for some time as far down in the geological series as the Carboniferous, in which formation about twenty-five species of scorpions and spiders have been discovered, but until last year no discovery of this kind had been announced in any older rocks. In November last, Dr. Lindström of Stockholm, announced the discovery of a well-preserved specimen of a true scorpion, which he named *Palæophoneus nuncius*, in the Upper Silurian of Sweden; and in December of the same year, a similar discovery in Scotland was announced by Dr. Hunter. In July of this year, Prof. Whitfield of New York described and figured a third species in the Lower Helderberg series of the State of New York. Thus this form of life has been at one bound, and in three different localities, carried back from the Carboniferous to the Silurian, a remarkable instance of the nearly simultaneous discovery of new facts, in different places and by different observers. It is also of interest that the crustaceans of the genus *Eurypterus*, which have been called aquatic scorpions, appear in the same formations in which the scorpions have now been found, so that it would appear that the aquatic and aërial animals of this type of structure originated together, or were at least contemporaneous in the Silurian period. The Eurypterids, however, early became extinct, while the scorpions survive.

The insects had previously been traced back to the Devonian or Erian period, and the scorpions would now have antedated them, but for another discovery made in Spain by M. Donville, and communicated to the Academy of Sciences by M. Charles Brongniart in December, 1884. This is a wing of an insect in the sandstone of the Middle Silurian, probably equivalent to our Niagara series in Canada. This wing is shown by its venation to belong to the Blattidæ or cockroaches, a group already well-known in the Carboniferous, where they seem to have thriven on the abundant vegetable matter of that period. It differs, however, in some of the details of venation from any living or fossil species previously known. Brongniart proposes for it the name *Protoblattina donvillei,* and as the beds containing this insect are probably a little older than any of those containing the scorpions above referred to, this discovery makes the cockroaches, still so numerous and voracious a family of insects, the oldest known air-breathing animals. It is to be observed, also, that the group which thus has priority belongs to the insects which have an imperfect metamorphosis, and to the order *Orthoptera.* In connection with this, it seems that all the insects hitherto known in the Carboniferous period belong (with the exception of species uncertainly referred to the moths and the beetles) to the three closely allied groups of *Orthoptera*, *Neuroptera*, and *Hemiptera*, all having incomplete metamorphosis, so that in any case this group was the dominant one of insects in the Palæozoic period. With the exception of a few lycopodiaceous plants we know nothing as yet of Silurian land vegetation, but the Spanish *Protoblattina* suggests to us the existence of Silurian forests producing some kind of succulent and nutritious vegetable food, while it also furnishes an explanation of the possible means of sustenance of the carnivorous scorpions.

J. W. D.

## IV. Dance of the Prairie Chicken.

By Chas. N. Bell, Winnipeg.

At sunset on the evening of May 10th, 1873, near Saddle Lake (*Saw-gi-ah-gun Aspapowin*), which is twelve miles north of Upper or North Saskatchewan River, and ninety miles north-west of Fort Pitt, or in latitude 54° N. by longitude 111.40° W., I first had the good fortune to witness that most amusing dance indulged in during the spring season by the Prairie Chickens, when courting preparatory to mating for the summer. The Prairie Chicken, or Sharp-tailed Grouse (*Pedioecetes phasianellus*)*, the Pheasant of the Hudson's Bay Company residents, is called in the Cree, as well as in the Saulteau or Chippeway language, *akiskow* or *awkiscow*,—the Crees also using an alternative name for it, *pehayo*.

I had been without any food worth speaking of for some forty-eight hours, and was roaming about amongst the ponds and hills in search of game, feeling fairly used up with fatigue and hunger, when I heard a most peculiar sound, apparently coming from a great distance and resembling somewhat the murmur of many voices. At once taking cover in the willow brush, which grew in long patches in a depression between two rolls of the prairie, I quietly pushed forward in the direction from which the sound came. Every few yards I stopped to listen, thoroughly puzzled as to the cause of the extraordinary bursts of noise succeeded by perfect silence. Could it be Indians? A few Crees had passed my log wintering hut during the past week, and some of these might here be discussing a plan to rob the *moneass* ("stranger," or literally, "greenhorn") who was living alone forty miles from the nearest settlement.

I determined to find out what it all meant, so keeping my double-barrelled muzzle-loader in readiness, I dropped down on all-fours and quietly crept forward. For a few minutes all was very still and quiet, when suddenly, from a spot but a few yards a head, where I could see that there was an open space,

* The Prairie Chicken is a term applied to two different species of grouse—the Pinnated grouse or the *Tetrao cupido* of naturalists, and the Pintail or Sharp-tailed grouse of the text. In 1870, the Pintail only was to be found in the Northwest; but the Pinnated grouse advances with civilisation, replacing the Pintail.

there came a perfect babel of sounds. Creeping slowly forward I noiselessly pushed the willow boughs aside, when my glance fell on a covey of some fifty prairie chickens covering the top of a small dome-shaped mound. They were running about and per orming all sorts of strange movements. Every now and then, one would jump into the air for a foot or two, with all its feathers ruffled, the air-sacs on its neck inflated, and pouncing down, strike at another, who either stood his ground to receive the attack, or turned tail and fled, to be pursued by his antagonist. Here and there a hen was rushing through the throng, followed by two or three male birds, who stopped at intervals to combat with great fierceness.

The scene was indescribably funny. At times they gathered in a cluster near the centre of the hillock, struggling, fighting and making each others' feathers fly, all the time emitting a series of peculiar sounds, cooings and sharp angry cackles mingled with drumming. For a time they were motionless and quiet, when a single individual pranced out from the others and began strutting about, with his head bobbing up and down, his tail opening and shutting rapidly with a rustling noise. Suddenly he broke into a jumping, stamping, sort of jig-dance, beating a quick time on the ground with his feet, moving them so rapidly that a sound was produced like that resulting from the strumming on one string of a banjo, and joining to this a flapping of his wings and a rapid whirr of his tail. He then capered about, jostling against the others, for by this time the whole assemblage was imitating him, and it soon became a question of the "survival of the fittest." It was for all the world like an Irish cutting-out jig, or the celebrated Red River jig, only that, instead of two or three dancers taking part, the whole party took the floor. Suddenly, as if tired out, they separated and scattered over the mound, the hens apparently making for the brush and the cocks following, until two of the latter came together, when a pitched battle at once took place.

By the time they had once more gathered in the centre of the ball-room floor the pangs of hunger had again attacked me, so I gave up enjoying the sight, quickly levelled my gun and fired into the midst of the crowd, knocking over for one the floor-manager as he once more began to lead the dance. Consternation seemed to strike them motionless, and it was not until I rose upright that they began to scatter and fly off with an abrupt cackle, obtaining sufficient headway by a dozen flaps of the wings to sail thirty or forty yards at a stretch. As they rose in the air, I knocked down two more, thus securing an excellent meal. During the next day I laid out on the mound, which was beaten smooth by the trampling and stamping of many little feet, a set of bent rods, inserting the ends well into the earth, and suspending from the arches thus formed running nooses of buffalo sinew in the same manner as is followed in snaring rabbits. For several evenings and mornings these snares supplied me with from one to three birds; but they finally either mated or grew wary, for they refrained from indulging in their dance in that locality.

The fierceness with which they fought may be judged from the fact that in several cases when birds were snared, a lot of feathers were plucked from them, and the skin on the top of the heads was completely pecked off. The poor unfortunate bird, held fast by the sinew loop, was soon killed by his blood-thirsty companions.

## V. Some Prehistoric and Ancient Linear Measures.

By R. P. Greg.

I have for a considerable length of time been engaged on an investigation concerning the units of measure among certain ancient nations; and though there is not space, within the limits of a mere communication * like the present, to enter upon the whole ground gone over, which would moreover entail a considerable number of figures and illustrations, I will, as briefly as possible, recapitulate some of the leading results, about which, I think there is little reasonable ground for doubt, and which may lead to interesting results.

1. *Peru.*—From the measurements afforded, mostly by a number of small objects, it would appear that the ancient Peruvians of the time of the Incas employed the same inch and foot as did the Aztecs and Toltecs, and Central Americans: viz., a foot equal to $11\frac{3}{4}$ inches English, or say a fraction more than the old Roman or Solon's foot. This foot =·298 of a metre, and was

* Communicated as correspondence to *The Academy*, July 4th and 25th 1885.

divided into twelve equal parts. As with the Mexican foot, in reducing English foot measurements as given in books of travel and architecture, it is only necessary to add 2 per cent.; 100 English feet equal 102 Mexican and Peruvian.

2. *Mexico and Central America.*—From measurements of many small objects again, as well as from various other confirmatory methods it may be safely stated that the unit of measure employed by the ancient Mexicans was a foot of 12 inches, equal to $11\frac{3}{4}$ inches English. Since arriving at this conclusion, I have received a little pamphlet on the subject of ancient "American Linear Measures," by Dr. Daniel Brinton, of Philadelphia, in which he shows that the old Mexican *octacatl* was, "as deduced from the yard, or *Vara de Burgos*, equal to 9·84 English feet, which would make the *octacatl* a 10-foot measure, and a multiple of the length of a foot; as is proved by an analysis of the word." That result Dr. Brinton adds, "is as interesting as it is new, as it demonstrates that the metrical unit of ancient Mexico was the same as that of ancient Rome, *i.e.*, the length of the foot print." Mr. H. Seebohm says the Roman foot, or foot of Solon, was = ·296 metre, consequently Dr. Brinton's calculation is almost identical with my own, viz., ·298; which, moreover, is fairly deducible from the 4 palm foot of the Egyptian (royal) cubit of ·525 metre. Mr. Petrie's reductions of the Mexican foot of ·260, as well as of other old North American ones of ·170, ·315, and ·325, seem to be incorrect. My correction of 2 per cent. added in fact to Dr. Brinton's 9·84 ten-foot measure, would make the old *octacatl* almost precisely 10 old Mexican feet. The same correction also added to the 11-foot 9-inch diameter of the celebrated Mexican "Calendar" stone would show that a precise diameter of 12 feet was intended. Moreover, on that very stone, round a portion of the outside or rim, are 18 square divisions or cartouches, representative of the months of the Mexican year, each exactly a Mexican foot square. Curiously, the equally celebrated so-called "sacrificial" stone, probably once also a calendar, stated to be a few inches over 9 feet English in diameter, would, for 9 feet 5 inches, give 360 to 365 Mexican inches for circumference, probably intended as 1 inch for each day of the year. In Lady Brassey's fine collection of gold ornaments from graves in Antioquia, Northern South America, figured and described by Mr.

Bryce Wright, there is a gold band 23⅝ English inches long, evidently intended or cut off for 2 Mexican feet (= 23⅞ inches). A number of articles in the same collection measure exactly 1, 1½, 2, 2½, and 3 inches Mexican. A flat jade object, like a paper knife, with two holes for suspension, probably, to a workman's belt, measures precisely 6 inches Mexican, and may have been a half-foot measure.

3. *Mound-Builders of North America.*—Prof. Daniel Wilson, of Toronto, in the second edition of his "Prehistoric Man," p. 221, describes a curious stone tablet or implement, found in a grave mound at Cincinnati in 1841 (it is also figured or described in Squier and Davis, and other works). His figure is given ⅔ size, but is not quite accurate, for I have since received a rubbing from a cast of the original in the Blackmore Museum at Salisbury, and do not find that Dr. Wilson's figure is correct, nor the description of some of the details. This tablet has never been thoroughly explained. Some have thought it to be a calendar, others a measure, and some a mere stamp for printing textile materials. The greater part of its upper surface is covered with a scroll-like pattern, but at each end are scales, containing each two sets of divisions, evidently intended for some special purpose. Describing it best from the tracing or rubbing sent me by Dr. Blackmore, of Salisbury, it has at one end a series of 23 + 1 small nearly equal divisions, in connection with 7 larger ones, say 3⅛ small to each larger one; and at the opposite end a series of 6 larger divisions, in connection with 20 + 4 smaller ones, somewhat similarly disposed. The length of each scale is about 2¼ inches English. The longer sides of the tablet are curved to a 12 mound inch radius. The length and breadth of the stone tablet itself is very nearly 5 inches English by 2½ at the narrower middle part; consequently, almost exactly the same by Mexican measure. It struck me that this tablet looked very much as having something to do with a possible half-foot measure; and I further observed at each corner, not before noticed by any archæologist, two straight lines, evidently not forming part of the general ornamental scroll pattern, which I guessed might possibly have been intended to represent the mound builders' standard inch, or finger breadth. On scaling this as a foot of 12 inches I found I had obtained means of a measure for many North American

things described in books and museums, which has in other ways been curiously confirmed. It is even a unit of measure for the stone tablet itself. This mound inch is shorter than the English inch, in the proportion of 10 to 12; and it is evident that the mound foot was one divided into 12 inches, for the tablet itself is exactly 6 of its own standard inches in length, *i.e.*, doubtless half a foot, and exactly 3 inches in width at the middle or narrower part and 3½ across the wider ends. In Dr. C. Abbott's "Primitive Industry of America," Fig. 356, p. 375, there is figured and described what is called a "Slickstone": and noticing a number of small notches (about 8 or 10 to an inch) on it, I tried the length, and found it to be 6¼ inches long, but with a large corrective notch right across near one end, at precisely the 6-inch length. With often equal success I applied this, my mound-builder's foot-rule, to many objects described by Squier and Davis, and in Dr. Abbott's book more particularly, which I have no space at present to go farther into, but refer to Figs. 142, 192, 195, 362—particularly to Fig. 365, p. 388, a fish totem measure, of exactly 1 mound foot in length and nearly 3 inches in breadth. Also see Fig. 43, p. 71, representing a flattish stone of about 7 × 3½ inches, whereon are scratched a series of 15 small notches, exactly = 1½ mound inch, showing a decimal division, with four other larger notches, showing some other inch. It would appear, then, that the length of the mound-builder's foot was precisely 10 inches English = ·254 metre, and that there would be 7 mound inches to 6 Mexican inches. Entirely independently of my own results I have since found in Dr. Brinton's pamphlet, p. 11, "Colonel C. Whittesley of Cleveland, in 1883, analysed 87 measurements of these mound earth-works by the method of even division, and concluded that 30 inches (English) was about the length or was one of the multiples of their metrical standard,"—thus indirectly confirming my own discovery that the mound foot of 12 inches was precisely =10 English inches, at least so far that 30 is a multiple of 10. From about 200 mound measurements, I have found that 25 English, or 30 mound, feet are a probable standard unit for large measurements. Squier and Davis mention prehistoric North American garden plots 12½ English feet wide, which would =15 or $\frac{30}{2}$ mound feet.

Incidentally, I have also reason for supposing that the mound-builders' acre, or larger unit of superficial measure, was equal to $1\frac{3}{8}$ to $1\frac{7}{10}$ English acre with square-side of 300 mound feet (30 × 10), equal to 250 English feet, and that the favourite square and circle areas of 20, 27, and 40 (or 41) English acres meant 15, 20 and 30 mound acres respectively.

If the mound-builder's foot of 12 inches (finger breadths?) was equal to 10 English inches, it would follow that most mound measures expressed in English feet (as in Squier and Davis's "Monuments of the Mississippi Valley") would give for 250 feet, say 300; for 750, 900, for 835, 1,000; for 920, 1,100; for 1,000, 1,200; for 1,080, 1,300; though it is not impossible that Mexican feet for large measures may have been sometimes also used, in proportion of about 12 to 13; when 930 feet would be = 1,000 feet, or side of a favorite square area of 15 mound acres or 20 English acres.

4. *Prehistoric Measures of North America.*—Besides many objects found in the mounds of Ohio and Tennessee evidently giving mound-builders' measure, as well as in New Jersey, Massachusetts and New Hampshire, I had been much puzzled by measurements, evidently intentional and rather regular in their discordance, showing reference to some other scale of linear measure, and giving apparently evidence of a near accordance with the English foot. In trying them with the old Mexican foot and inch scale, I found some excellent accordances; and it may turn out, remarkable as it may seem and bearing important results, that at the time of the mound-builders, 1,000 to 2,000 years ago probably, there co-existed over large parts of North America at least two distinct sets of linear measures, probably used by different races of people; and that one of these was no other than the identical one we have shown to exist, probably at a somewhat later period, in Mexico and Peru. There is no space for me to go fully into this subject at the present time; but in part confirmation of it, I must go back to the Cincinnati stone tablet of measure, to which I have already referred. It struck me that the two sets of scales, one at each end of the tablet, might refer to these two scales, and prove to have been intended as a mode of comparison between them; and that solution of the question appears to be the correct one, after a protracted investigation of that curious and puzzling instrument.

Without a figure or drawing of the tablet, it is not easy to give a very clear description of it; but it may be stated that the six larger divisions on the left hand are in length precisely equal to two Mexicain inches, or $\frac{1}{6}$ of a foot, consequently each equals $\frac{1}{3}$ of that inch, and that they have attached to them a decimally divided scale of twenty smaller divisions, over and beyond which, at each end, are two more similar small ones, apparently so placed as a mere stop-gap, or for symmetry. On the opposite end are 7 larger divisions, each a trifle smaller than those on the other side, in connection with 23 smaller sub-divisions and one over. The first 6 of these 7 are precisely 2 inches, and therefore also $\frac{1}{3}$ of what I have little doubt had reference to another co-existent unit of measure, which I call the North American prehistoric unit, and which I have likewise found to measure with great exactness several objects, notably several stone tubes, some objects in Squier and Davis' museum at Salisbury, and also certain figures given in Abbott's "Primitive Industry" and the Peabody Museum Reports, as gorgets, pendants, etc., etc. Of this measure there are as nearly as possible 13 to 12 Mexican, and 11 to 10 English, and 6 to $6\frac{1}{2}$ of the smaller or mound inches, while $6\frac{1}{3}$ of the larger divisions on this scale are equal to the 6 larger Mexican ones on the opposite or left-hand side of the tablet. This prehistoric inch is intermediate, in fact, between the mound inch, as indicated by the tablet itself, and the Mexican inch. Whether 11 or 12 of these inches made the foot I cannot certainly say, though probably 11. That is, perhaps, a rather unusual multiple; but $5\frac{1}{2}$ inches exactly measure the tablet itself. Mr. Petrie gives 11.66 English inches as a Celtic and old Aryan prehistoric unit, also 22 inches, and I have found a unit pointing to 33 inches in Polynesia. There can be no reasonable doubt that this tablet was one of measure, and had reference to at least two distinct units of linear measure, used probably by the mound-building workmen. The tablet itself, of course, representing another and different one, the mound-builder's doubtless *par excellence*, with its own standard or unit inch, does not tally with the two scales referred to, engraved on its upper surface, one of which almost certainly represents the Mexican measure, the equivalent of the so-called Solon's foot. As 7 mound are just equal to 6 Mexican, it is not unlikely that reference was intended to that proportion;

the 7 larger divisions ( =23 ○ smaller) are as near as can be $=2\frac{1}{2}$ mound inches; but that multiplied by 2 or 3 does not, however, give an exact half-foot. It must be borne in mind, also, that as the mound-builders were skilled in square and circle mensuration and circumvallation, it is possible some reference to the well-known ratio of 3 to 1 might even have been intended in connection with circumferences of circles and their diameters, or possibly with diagonals and diameters; for opposite each of the larger divisions there are on an average $3\frac{1}{8}$ smaller ones. Supposing, say, that the fourth division meant 400 feet (of either scale), then $400 \times 3{\cdot}3$ might roughly have stood for the more exact 3 to 3·14. This is, however, a less likely explanation than the simpler one— viz., that the tablet was a half-foot measure, showing two or three different co-existing linear units of measure, used by several neighboring or allied peoples. The whole of this tablet is most curious and important, and so far has never been explained. On the reverse side of the stone are three large rough grooves, evidently made by the sharpening of some pointed tool. Involved with the scroll pattern on the upper side may be noticed seventeen small bosses or centres, many of which give, very exactly, distances apart of one inch, both mound and Mexican. The pattern itself may be semi-Mexican.

As no mound measures, so far, have been found in Central America, Peru, or Mexico, it would follow that in all probability the mound-builders themselves neither migrated there nor came from thence; and it confirms the opinion that the Toltecs and ancient Mexicans came in all probability from the North, as has generally been indeed supposed; but what is most interesting would seem to follow, viz., that the mound-builders, and the people allied to, or the ancestors of, the Toltecs, etc., must have, perhaps some two thousand years ago, coexisted and lived together in large parts of America, extending from New York to Ohio and Tennessee, and not been exclusively confined to the mound district *par excellence.* In fact, objects giving mound measures seem to occur in New Jersey and the New England States, and each set of people used their own peculiar standard of linear measure, consisting of twelve smaller or larger inches to a corresponding smaller or larger foot, probably employing also a 10 or 30-foot measure, and having a fixed acre with side of 300 mound feet, or

250-260 Mexican feet: unless, indeed, they may possibly have had for larger measures one and the same standard. But that may require further investigation. For convenience, I here append the length of the inches I have been referring to, along with the English:—

| | |
|---|---|
| ———— | Mound Inch, N. America, 12 to foot = a finger breadth, or 1 digit. Foot = ½ cubit (?). |
| ———— | Prehistoric N. American Inch, 11 to foot (?). |
| ———— | Mexican, Peruvian, and N. American Inch, 12 to foot = Solon's foot, or Roman.* |
| ———— | English Inch, 12 to foot. |

I have a gorget from Ohio precisely six Mexican inches in length. A number of objects mentioned in Dr. Abbott's "Primitive Industry" appear to give excellent Mexican scale measurements—pp. 144, 374, 383, 381, 373, 352, 330, 71, etc. The notches and distances of holes in gorgets, pendants, etc., will, I believe, often give either mound or Mexican inches. And, in fact, I hope that by means of these three scales or systems of measure for ancient America, when fully worked out, a flood of light may be thrown upon the habits and implements of her ancient peoples, possibly indicating how they may have been related to each other or to the Old World.

5. *China and Japan.*—There appear to be several different foot and inch measures in China and Japan. According to Mr. H. Seebohm, the Chinese and Japanese have a foot decimally divided, exactly equal to our English foot. According to Williams, a good authority, the *chih* = 13⅛ English inches, but others also = 14·1, 14·62 to 14.81. He elsewhere gives also an inch = $1\frac{2}{5} \times 10$ = 14·0 inches English. On an old foot rule (of bamboo) measure in the British Museum I find it so divided; and on a new Japanese foot measure the inch = 1½ English × 10 = 15 inches. There can be little doubt, however, that the best and oldest measure in China is the foot = 12 English inches, ·305 metre, decimally divided into 10 inches of 1·25 English. But what is of considerable interest, as showing that this unit was not recently borrowed direct from Europe, I have found that it must have been a measure employed without

* The Mexican inch is exactly $\frac{1}{12}$ of the foot (4 palms) of ·300 metre as derived from the Egyptian cubit of ·525 metre.

change two thousand years ago in the manufacture of what is called sword money! These appear generally to measure very precisely 6, 5, and $4\frac{1}{2}$ of these Chinese inches, and *it is a point* that will, I think, bear fuller investigation. The oldest round bronze *cash* that is in my own collection, said to be B.C. 200 measures precisely one old Chinese inch across. The old Chinese inch = 1·25 English; and Mr. Seebohm believes that this old Chinese, as well as perhaps the English foot itself, may be derived from an Assyrian or Babylonian cubit of ·533, as given by Lepsius, thus:—

$$\begin{array}{rl} (\text{Royal cubit } 6 + 1) = 7)\ \cdot 5330 & \\ \overline{\cdot 0761} & = \text{palm.} \\ 4 & \\ \overline{\cdot 3044} & \end{array}$$

Anything throwing light on the early connection between Babylonia and China or other countries cannot, at the present time, fail to bear good results.

6. *Mongol.*—At p. 316 of Col. Yule's "Travels of Marco Polo" is a description and figure half-size of a most important specimen of what is called a "Table d'or de Commandment," the *Paiza* of the Mongols. It is of the fourteenth or fifteenth century, having engraved on it letters in the Baspa character. This is described by Schmidt as measuring 12·2 inches long, by 3·65 wide; and by Ramusio as a cubit in length and 5 fingers wide, and as weighing between 24-32 ounces. This tablet was found in the Government of Yenesei in Eastern Siberia; and being so important an object, perfectly finished and of solid silver gilt, and running so near the old Chinese foot, viz., ·311 metre as against ·305, it should receive some attention as having been possibly cut or cast by the measure of the then existing Mongol foot, or as part of some cubit. This tablet measures 8 $\frac{8}{10}$ inches of the newer and larger Chinese measure.

7. *Hittite.*—In looking over the plates in Dr. Wright's "Empire of the Hittites," recently published, it struck me that the apparent regularity of the spaces and lines, which divided the rows or parallel series of enclosed hieroglyphs, might furnish indications of some fixed measure, possibly in connection with

the old Assyrian or Greek. Mr. W. H. Rylands, secretary of the Biblical Archæological Society, kindly sent me a number of these measurements from the so-called Hamath stones; those of the Jerabis stones I have not yet received. The results are interesting; the average space, with a few very irregular, exceptions, gives exactly $4\frac{1}{4}$ English inches. Multiplied by 3 this would give a foot of $12\frac{3}{4}$ English inches, or ·323 metre, probably derived from one of the old Assyrian cubits. Mr. Seebohm, who has thoroughly gone into the question of ancient cubits and feet, informs me that this is almost identical with a foot derived from the Olympic cubit, say of ·320 metre. The Hittite foot of $4\frac{1}{4} \times 3 =$ ·320, *i.e.*, 1-600 part of the Olympian stadium. Prof. Lepsius gives the Babylonian cubit as:—

$$\begin{array}{l} \text{Cubit} = .5333 \\ \qquad\qquad 6 \text{ rods or reeds} \\ \hline 3.2000 \times 60 = 192 \text{ stadia.} \end{array}$$

This, if treated as a decempeda, gives a foot of ·320. This, if fully confirmed, is of singular interest in connection with Babylonian, Assyrian, Hittite, and Greek civilisation and ancient inter-communication, a subject at the present time occupying considerable attention.

There was, I understand, from Mr. Seebohm (see also Mr. Petrie's "Inductive Metrology"), another old Assyrian cubit, equivalent to ·560 (? = the modern Persian), which, treated as a decempeda, gives another foot of ·325; and the same as what is called the Drusian, or Old Belgic, foot. Mr. Seebohm further alludes to Herodotus as stating that the foot = 4 palms out of the seven (*i.e.*, 6 + 1).

$$\begin{array}{l} \text{The cubit of } 7\ \underline{\cdot 560} \text{ palms} \\ \qquad\qquad\quad \cdot 080 \times 4 = \cdot 320. \end{array}$$

I hope at a future period to go more fully into these questions, and to give fuller illustrations and figures. In the meantime, I content myself with stating what appear to me to be sufficiently well authenticated results on somewhat novel ground.

8. *Buddhist and Indian.*—There would appear to be considerable uncertainty, as well as variety, in connection with units of measure in Persia and India, more especially in comparatively modern times, since the introduction of Mohammedism and the employment of European architects.

In Petrie's "Inductive Metrology," p. 129, there are given no less than fifteen varieties of the so-called *gaz*, *gueze*, or cubit, varying in length from 14·9 to 38·3 inches. In more modern times the $\frac{1}{4}$ *gaz* is also common = 6·93 inches. The *hasta* Mr. Petrie considers to be a very ancient Aryan measure, sometimes found in Greece and Asia Minor as = 17·9 inches; but in India it may be reckoned at about 18·4 inches. Another unit is 11·63 inches, which may, perhaps, be referred to the Roman foot in Mohammedan buildings in Turkey and Persia, where the Greek or Roman Empire extended.

Mr. James Fergusson informs me that no ancient buildings of India are set out with sufficient exactness to recover a measure from them, which may even apply to buildings of the time of the Mogul Empire, when Europeans were employed. It is nearly impossible to ascertain the length even of the Illahi *gaz*, and it might almost seem that the Hindoos never employed any other "rule" than the cubit or forearm of the reigning king. Mr. Petrie, however, gives the Illahi *gaz* = 34·1 inches English = 41 digits; and it has probably nothing to do with the digit of the early Hindus, which is connected with the *hasta,* though it would come to about the double of it.

It is difficult to suppose that the old Assyrian cubits of 19·04 and 19·97 inches did not find their way into India by way of Persia, either directly or indirectly, but they may have been modified, or carelessly applied; the sacred or royal cubits of 25·3 too were larger. I have taken from Mr. James Burgess's "Archæological Survey of Western India" about 250 measurements of from 2 feet to 100 feet; most from early Buddhist shrines, cells, temples, and caves, as those of Elora, Anka, Kaladgi, Badamj, Bhâjâ, Kuda, Gumli, Sana, Junagarh, Navalakha and Aurungabad, say A.D. 200 to A.D. 1200. On tabulating these measurements, I found a decided tendency to maxima and minima grouping of nearly five English feet; giving, say, for maxima, the Nos. 60, 56, 51, 47, 42, 37, 32, 27, 22, 19, $16\frac{1}{3}$, $12\frac{1}{4}$, $7\frac{1}{5}$, $4\frac{3}{8}$, and 2·7. After trying various cubit lengths, say, of 17, 18, 19 and 20 inches, I found that a cubit of almost exactly 19 inches suited best for a series of most likely cubits, giving, say, 38, $35\frac{1}{2}$, $32\frac{1}{2}$, 30, $26\frac{1}{2}$, $23\frac{1}{2}$, $20\frac{1}{2}$, 17, 14, 12, $10\frac{1}{4}$, 8, 6, $4\frac{1}{2}$, $2\frac{1}{2}$, and 1·7, apparently pointing to a series showing differences of 3 cubits, which would be best represented by the series of 39, 36, 33, 30, 27, 24, 21, 18, 16½, 13½, 10½, 9, 7½, 6, 3½, from 40 to 20 cubit lengths, where a half-rod might have been employed, and for the smaller lengths perhaps a quarter rod, or 1½ cubit measure. Here 4¾ English feet = 3 cubits = ½ rod, and 9½ = 6 cubits = 1 rod. From 45 special measures of dagobas, shrines and chakras, I obtained about the same 19-inch cubit.

It is, however, hardly to be expected that the same exact cubit or measure should have been constantly employed over a period of 700 or 800 years, even in the same part of India. In further corroboration of a probable earlier Buddhist unit of about a cubit of 19 inches, I may mention that Williams gives the Japanese *thuoc, chih* or cubit = 17·12 inches English, specially used by architects. This may have not improbably been introduced by the Buddhists more than 1,000 years ago. Again, in Java, I have got from Raffles' descriptions of old Buddhist or Hindu temples, probably free from European or Mohammedan influences, some 90 measurements, showing apparent favorite maxima numbers of about 3¼, 5½, 6½, 7¼, 10, 11½, 12¼, 16, 20, 21, and 30 English feet, which would again seem to suit best a cubit of 19·20 inches, giving roughly say 2, 3½, 4½, 6½, 7, 8, 10, 13, and 20 cubits. Here the smaller measures given by Raffles, *e.g.*, below 2 feet, of 12, 12, 14, 14, 16, 18, 20, 24, 26, 26 inches indicate a very regular gradation of 2 English inches, probably = 2½ digits. At the same time the old Indian *hasta* might also yield for 6½, 7¼, 10, 11¼, 12 and 20 English feet, very nearly the numbers 5, 6½, 7½, 8, 9, and 15.

From some measurements connected with the Amravati tope, Madras Presidency, I get a small *hasta* of 16·25 inches, for large measures, and of $\frac{32}{2}$ = 16·0, from a number of smaller measurements of plinths, tablets, etc., in the British Museum. The two large feet of Buddha from the same tope measure 20 inches in length. From some larger cave-temple measurements at Adjanta, second to tenth century, mentioned by Fergusson in his "Handbook of Architecture," I get a unit of 17·8 inches, probably the *hasta* of 17·82 as given by Petrie as a unit of some measurements at the Elora cave temples. One of the oldest Buddhist topes in North India, near Peshawur, is said to be about 20 feet in diameter, which might also indicate a small *hasta* of about 16 inches.

From 12 measurements of old buildings in Ceylon given by Fergusson, I deduce a unit of 22·1, which does not fit precisely any known measure, though near the prehistoric one of 22 inches, and an old Assyrian cubit of 21·30 as given by Petrie, but it might possibly fit equally well a *hasta* or *aratni* of 16·5 inches.

Of course a good deal in these matters must depend on the respective dates of the buildings themselves, and in what part of India they are situated. I have been attempting to deal rather with old buildings, prior to the twelfth century; and the general results appear to indicate a cubit of 19.1 inches, and a *hasta* of about 16¼ inches, very near Mr. Petrie's *aratni of about* 16·6 *to* 16·8 inches, and also, I believe, identical with Warren and Conder's latest determination of the old ordinary Hebrew cubit.

9. *Prehistoric Measures of Bronze and Stone Period.*—The entire question of prehistoric units, as distinguished from the older and more classical measure units of Egypt, Assyria, Greece, and Rome, requires a more thorough examination than it has yet received. Mr. Petrie, in his "Inductive Petrology," gives a very common and apparently well-established prehistoric (? Celtic) unit of from 21·30 to 22·50 as obtained from the ruder stone monuments of France and Britain, etc.; and for Irish bronze weapons 22·0 (as from 2·20 inch objects probably). The half of this would show a (? foot) measure of about 11·0, too small to agree with the old Roman foot of 11·60 to 11·70 not unfrequently found in Great Britain in connection with old Druidical remains, as even at Stonehenge. This unit, or half unit of 11·0, is, however, by no means, uncommon, and may prove to be of considerable importance. May not this old Aryan foot of about 11·0 inches, found in North Europe and elsewhere, prove to be the identical unit which in my first letter I called the North American prehistoric one? On scaling $\frac{22}{2} = 11$ into twelve equal parts the result is a foot, barely the one eighth of an inch less than my American one, as indicated by the Cincinnati double-scaled measure-tablet. I most unexpectedly came upon this conclusion from a quite independent investigation of objects from North Europe of the bronze period, described by Evans, Keller, Madsen, and Montelius, as well as from specimens in my own collection. It is, therefore, not by any means improbable that there was at a very early period, before the superior civilisation of

Egypt and Assyria had begun to extend itself to other parts of the globe, one, if not two, rather widely extended primitive units of linear measure in existence, which spread over the New World as well as the Old, but which also probably, as time advanced got modified or mixed up with other units.

I have likewise found rather strong traces of the North American mound foot of ·254 metres, as well as the Mexican or old Roman foot of ·268, occurring in North Europe in the bronze age. That the Roman foot is frequently met with in Europe, and occasionally even in the East, is a well-known fact, and easily to be accounted for.

The following is the analysis of some 360 measurements of bronze objects I have collected from various sources, and is, at least, curious; probably three fourths of the objects measured, or figures examined to scale, gave good results to one scale or the other, say, to very nearly round inches and half inche .

| | English Inches. | Mexican o. Roman. | Mound Inches of N. America. | Prehistoric Inches, N.A. |
|---|---|---|---|---|
| Scandinavian objects ....... ....... | 6 | 5 | 16 | 22 |
| Swiss Lakes ........................ | 13 | 9 | 9 | 17 |
| Evans's Bronze Age, British.......... | 14 | 16 | 25 | 29 |
| R. P. Greg's Collection, Miscellaneous.. | 33 | 30 | 50 | 68 |
| Totals........................ | 66 | 60 | 100 | 136 |

Mr. Petrie gives 2·20 as an average of Irish bronze objects, which would be almost exactly 2·5 of the prehistoric scale.

The large proportion agreeing with old American measures is very remarkable, making considerable allowance for accidental coincidences, and looks as though two, if not three, prehistoric standards of linear measure were once more or less prevalent over a very large area. The Mexican or Solon's Roman foot may have been derived from the Old World, very possibly from an Egyptian cubit, some thousands of years ago. I have largely tried decimal scaling, but do not find that the larger inches agree nearly so well as those taken by duodecimal division also, for bronze objects, a scaling from an Etruscan ur ; of ·230 mentioned by Petrie, but with very few accordances.

The few measurements I have been able to collect with reference to the stone and bronze age in India do not lead to great results, but may be worth giving. The remarkable and almost unique series of bronze celts found at Gungeria in Central India, and now in the British Museum, give lengths for the larger ones 17-27 inches; averaging about 21½, which comes very near Petries' 22·0 prehistoric unit before referred to. The smaller ones range from 4½–8¾ inches; the average being about 5½ inches, × 4=22; which again is in accordance. They have possibly been hammered out, or subsequently cut, acccording to Mr. Franks.

In Breek's account of the Primitive tribes (Todas, etc.) of the Nilgiris in South India are figured several cromlechs, on some of the upright stones of which are sculptured rows or series of figures in relief. The average width of these rows and divisions gives about 1·15 metre=45 inches, which divided by 2 would give 22½, again an excellent accordance with Petrie's 22·0 unit, and four times my prehistoric foot. I have also got 33 inches for a number of objects from modern Polynesia, which is, of course, a multiple of 11·0. The diameter of a hole at Kakusi, in India, in a *kistvaen*, is about 44 inches. It is doubtful if this apparently old Aryan and worldwide prehistoric unit of 11·0 inches has any connection with the *hasta* of 16¼ — 18½ inches.

Whether there is anything in common in the dimensions of Indian cromlechs, dolmens, and stone circles with those of Europe, I cannot at present say. The proportion for prehistoric as compared with English measurements should be as 12 to 11. Waring gives 19, 27, 45 and 66 English feet for some small stone circles in India, which would give in prehistoric feet a close approximation to the very likely round numbers of 20, 30, 50 and 70. Mr. Ferguson also, in his "Rude Stone Monuments," p. 474, gives two common dimensions of a class of small stone circles as 24 and 32 feet diameter, which would give 26½ and 35 prehistoric feet. The age, however, of this class of stone monuments is uncertain, and varies greatly, and may even not be pre-Buddhist; but it is very probable that there may have been some pretty accurate standard or standards of linear measurement going back to at least the commencement of the bronze period, which are well represented by some of the measures I have been considering.

10. *Oceania.*—From about 20 measures of old stone ruins in Microlesia and Easter Island, as given by Wallace and Palmer, I have obtained an apparent unit of either 8 inches, a probable span; or else one of about 12 English inches, or very near the Mexican foot, neither of which, however, would agree with my prehistoric foot of 11 inches. But from a few measures of somewhat similar ruins in the Sandwich Islands given by Ellis, Mr. Petrie obtained a unit of 44.65, which would be a good multiple of that foot.

P.S.—With reference to the Cincinnati tablet referred to in my first letter, I should have mentioned that there is a very slight difference in the length of the two supposed standard inches, amounting for 3 inches to $\frac{1}{8}$ of an inch. I fancy this must have arisen accidentally, and was hardly intentional, since, for a half-foot or foot, it is not nearly sufficient to give even the prehistoric foot, much less the Mexican, nor any of Mr. Petrie's. I therefore averaged the length of the two, which gives excellent results, so far as the tablet itself is concerned, and for various mound objects, such as tubes; and I may add that the 7th larger division of the right hand scale might have been added to fill up the smaller space, as compared with the six rather smaller divisions on the opposite end, meaning merely a seventh prehistoric inch, or $\frac{1}{8}$ of it. A foot of $7 \times 2 = 14$ mound inches would hardly be a likely one, though it would come within $\frac{1}{8}$ of an inch of Mr. Petrie's mound builder's foot unit of 12·60, and would fairly measure a very long stone tube of $12\frac{15}{16}$ inches in the Salisbury Museum, but no other object that I have come across.

With respect to Mr. Petrie's unit of 12·60 for the larger mound measures, I am now investigating it more particularly. It measures no small objects, however, and, so far, I think, with a few exceptions, does not give such good results as my own unit of 10·0 English inches. Mr. Brinton of Philadelphia states that, in 1881, Prof. McGee applied Mr. Petrie's arithmetical system of inductive metrology to a large number of mound measures of Iowa, with the result of a common standard of 25·716 English inches; that is=32 of my mound inches, or very nearly $10 \times 3 = 30$; agreeing pretty well with Col. Whittesley's conclusion that, for the

Ohio mound works, 30 inches was about the length, or was one of the multiples of the metrical standard employed. For various reasons it may even be doubted whether any small unit, or too strictly scientific method, will be found to give uniform satisfactory results for these mound measures of North America. The mere circumference or diameter must necessarily have varied with the height, as far as mere mounds were concerned, which ranged from 10 to 100 feet; it is not unlikely, too, that, in constructing their enclosed "sacred" areas, they may not have sometimes intended to construct a circle, say, to measure to a certain square area, or the reverse, in which case too much importance should not be attached to the circumstance that a circle diameter of exactly 1,050 feet should = 1,000 of Mr. Petrie's unit, on which he lays much stress, and which, according to my scale of 12 to 10 would show 1,300 feet—a less likely round number perhaps. There are, however, no fewer than eight cases, where no equal squares are in question, given by Squier and Davis as having the diameter of 250 feet, which would give exactly 300 of my mound feet, and a much more likely number than Mr. Petrie's unit would give, viz., 240. Quite probably, too, all North American mound measures cannot be dealt with by one unit of measure only. Those in the lower Mississippi Valley may be found, perhaps, to give more purely Mexican measures. The pyramid of Teotihuacan has a gallery of 157 feet long = 160 feet, springing from a height from base of 69 feet = 70-71 feet. That of Cholula, of 1,450 feet square, would give 1,500, and that of Sonora of 4,350 feet exactly = 4,500, according to Solon's foot unit.

I purpose to examine more thoroughly Mr. Petrie's units of 6·76 and 10·65 as applied to Mexican and Central American measures. Of those from Peru, Copan, and Palenque, I think that there Mr. Petrie's units may be the best. For Aztec Mexico itself, I do not find that they suit so well as Solon's foot of 11.70. The body of the great temple at Tiahuanaco, in Peru, is given by Squier as 388 × 445, which, with 2 or 3 per cent. added, would give 400 × 450. A circular stone building near Cuzco, in Peru, of 24 feet internal diameter, and one in Central America of 48 English feet, look very like 25 and 50 feet, by my Mexican measurement.

Dr. Brinton also states that Señor Almarez, in 1864, specially determined the probable old metrical standard for the ruins of Teotihuacan, and made it about 0·8 metre = 31·5 inches, which is not far from Mr. Petrie's for Central America and Copan, if 10·65 × 3 = 31·95; though it is also very near an even $\frac{1}{8}$ of the *Octacatl*, to which I have previously referred.

There is, doubtless, room for further investigation in respect to these old American measures.

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## VI TRADITIONS OF THE AINOS OF NORTHERN JAPAN.*

BY D. P. PENHALLOW.

Tradition is the unwritten history of a people, transmitted from one generation to another by word of mouth, and from its very nature is not altogether reliable, but in the absence of any testimony of a more exact nature, must be given some weight as affording an approximate clue to the history of the people concerned.

When traditions relate to historic periods, they may often be verified in many particulars; but when they deal with periods which antedate all written records of a contemporaneous people, verification is hopeless, and they must be accepted for what they are worth. Thus it is with the aborigines of Japan. Japanese history extends back to about B.C. 200 or B.C. 400, but many of the Aino traditions relate wholly to a much earlier period. Those which fall within the historic period of the Japanese can in many cases be verified by the history of the latter.

Handed down through a long series of generations, traditions, however well founded upon fact in the first instance, ultimately lose much of their value, and may often become wholly different in substance from those originally given. This is more conspicuously the case as time passes. Passing events must leave a certain impress upon the mind, which will, in the course of a few years be-

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* The Author was for four years resident in that part of Japan where the Ainos are now most numerous, and, in his journeys through the country, had numerous and exceptional opportunities of learning their habits and language.

come confounded with the traditions received and ultimately be repeated as a part of them. This is likely to occur when a people is isolated; but it is yet more likely to happen, when a dominant race intrudes and displaces the original inhabitant. His ideas will then be influenced to a perceptible degree by those who displace him. This result is manifest in many of the traditions held by the Ainos. Undoubtedly sincere in the belief that such statements were handed down as true facts of their own history, their holding them can be accounted for in no other way. Thus, the tradition of their origin from a dog, related in good faith by the Ainos themselves, is most undoubtedly, as many Japanese acknowledge, a fabrication of the latter to express their contempt for, and sense of superiority to, the former.

In spite of this, however, tradition must form not only an interesting but important part of ethnological studies, and it is for this reason that the following are here placed upon record, since they relate to a most interesting remnant of a people concerning whom but little has been written until within a few years.

According to their established traditions, the origin of the Ainos is traced to an outcast woman, who came from some country toward the West. Attempts to account for her ancestry generally credit her with being the daughter of a ruler of a not far distant country. One version, in which she is the daughter of an Asiatic ruler, makes her the persecuted object of her father's lust; and it is to escape from this that she seeks voluntary exile, by embarking alone in an open boat with a large white dog as a companion. The filial reverence of the child, however, gains the supremacy in her solitary exile; and owing to her cherishing the name of her father Kamui, and instilling thoughts of reverence for his name into the minds of her children, he becomes more and more an object of reverence, until he is finally deified, under the slightly modified name of Kamoi, which is now applied to all the Gods of the Ainos.

Another and very common version places Jinmu Tenno, the founder of the Japanese, as the primal ancestor. This, however, throws undoubted discredit upon the tradition, as proving its relatively modern origin. However, in this case, the daughter became the object of her father's displeasure, and was forced into unwilling exile by him. He had a rude boat constructed, and in this his daughter was placed, together with a sword * and some food. After drifting about for some time, generally said to be three days, she was finally cast ashore upon southern Yezo. Here she built a round house † and formed an attachment for a white dog. The Ainos were the result of the union. Interesting as it would be to know, tradition fails to enlighten us as to the name of this founder of the Aino race.

Other versions are not wanting, and at times they receive extended embellishment at the hands of writers, which materially alters their form. One such is given by Wood ‡ as follows:—

"Their story places a woman as the first of their race, and she came, as they say, from the West. This was soon after the world was formed out of the waters, which is the genesis of their cosmogony. The Ainos know of no land except islands; so that really this might be the form which tradition has taken since that remote period when the Isles of Japan and the Kuriles were forced up, as they appear to have been, by volcanic action from the Ocean bed. The Ainos tell how this woman, the first of their race, floated over the waves in a vessel freighted with bows and lances, with nets and lines, and with all things necessary for the chase and fishing. She landed on an island where was a beautiful garden, and in it she dwelt alone and happily for a long period of years. That garden still exists, say they, but no living man has yet been able to find it. The close of this reign of single blessedness, so long enjoyed by this first of the Amazons, was brought about by a singular circumstance, which, however, can scarcely be narrated here. There is not, as in most legends, the record of a broken commandment, though transgression of some kind is implied: the change being connected with the loss of the garden and the increase and dispersion of the race. These events

* A facsimile of this weapon, supposed to have been made under the direction of the ancestral mother and handed down by her, was obtained at considerable expense by me, and is now to be found in the collection at the Peabody Museum, Cambridge, Mass.

† Evidence that the early form of the Aino house was round is not wanting; such houses are said to be used occasionally at the present day, though I never saw one.

‡ Trans. Eth. Soc., New. Ser., Vol. 4, p. 34, etc.

followed after the advent of a self-imposed protector whom the lady of the isle had, in a period of weariness, permitted to enter and share her solitude." *

As her family increased, rules for their guidance were established even in the most trivial affairs of every-day life, while the Ainos held their ancestor in such reverence that, to this day, the laws first established by her and the directions then given are implicitly followed.

It is related that she generally wore long and flowing hair, but that she finally trimmed it by placing her head upon a block when the hair was cut to a uniform length all round, by use of the sword. In obedience to her commands and example, her children trimmed their hair in similar fashion, and this, in all its details of method and form, is practised at the present time. Thus may we account for the peculiar square-cut of the hair, which is so conspicuous in and uniformly characteristic of the Ainos.

A second command was to the effect that her children should follow the customs of the Japanese in all things. This is certainly in keeping with attributing their primal origin to the founder of the Japanese, though it certainly impresses one as more than a passing indication of the influence which a dominant people may exercise upon the thoughts of those directly subject to their control, and shows what influences have been brought to bear to keep the Ainos in subjection, and to impress them with a sense of their own inferiority.

Rather amusing is that tradition which attempts to account for the custom of tattooing the lips, so prevalent among the women. Evidently the ancestral mother had a strong inherent love for the sterner sex, which was not weakened by her father's displeasure, but was rather heightened by separation from him.

* This tradition appears to have been given variously at different times, since in my own experience in gathering information from old men of the various tribes, reputed to be well learned in all the customs and traditions of the people, I have been unable to hear of a garden or of a greater number of implements than those first mentioned. To my mind, simplicity of detail seems to commend the tradition, as more probably correct than that version which included so many statements so nearly and singularly in accord with the facts of our own history.

Observing the abundant growth of whiskers which her sons developed, while the daughters were entirely destitute of such desirable adornments, she commanded all her girls to paint their mouths, and thus simulate the appearance of their brothers. Tradition is not consistent in this account however, for at least two other equally reliable versions are given. One relates that, in olden times, when the people were more generally engaged in fishing, and at a time when the physical character of the country was far different from what it is now, many men and women were drowned, and as a ready means of identification, the custom of tattooing the lips was gradually adopted. Another version tells us that, before the Japanese began to settle in Yezo, they would often visit the island and carry off the women. The Ainos did not possess the means of successful physical resistance, and determined to resort to other methods. The women were therefore tattooed, in hopes that their appearance would thereby be rendered so repulsive as to deter the Japanese from their capture. This version certainly is more in accord with facts relating to the settlement of the island, and is doubtless to be accepted as more nearly representing the origin of the custom than any other given.

The men were commanded to wear earrings and whiskers, as is now generally the custom. The *ekoro*, or sacred sword, appears to have been copied by the ancestral mother, and the various copies, together with the original, handed down to posterity as sacred heir-looms. So strong is the belief in this, that it was found extremely difficult to obtain one. It is reported that only a few are in existence.

The complete isolation of the Aino family from other peoples, necessitated the adoption of intermarriages, which, however, with the increase of families, became abandoned for a somewhat more rigid, though still loose, system, which recognized marriage only between families of somewhat distant relationship, but permitted concubinage.

The Ainos believe their first settlement to have been at Saru on the south-east coast, and there are certainly many evidences which point to this as at least their chief, and possibly one of their earliest, settlements. From there, they are supposed to have spread in all directions, but chiefly southward into Honshiu, where they met the Japanese, and by them were repulsed and turned back into Yezo.

The belief seems to be general that the world is round, and that it is stationary, the heavenly bodies moving round it. The evidence they adduce in proof of this is that he sun and moon rise on one side and set upon the other. This tradition may have been borrowed from the Japanese, and obtained through the teaching of certain Buddhist priests; for although, until a very recent period at least, the idea was generally current among the Japanese that the world is flat, it has long been held by certain Buddhist sects that the world is round, and that the heavenly bodies alone move.

Volcanoes and earthquakes, and all manifestations of violent changes within the earth's crust, receive due explanation. The centre of the earth is supposed to be filled with water, and is generally regarded as an *inferno*, receiving, therefore, in allusion to its wet and undesirable character, the name of *Deni-Boko-nashi* or "wet hell." This region is presided over by a huge fish, called *dokushish*. As he swims about and violently lashes his tail, striking it against the walls of the earth, the tremors produced are recognized on the exterior as earthquakes. There are places in the earth, however, which communicate with the interior where the fish dwells, and the latter is thereby enabled to exert his influence upon human destiny. Lake Chitocie is firmly believed to be such an opening, and so implicitly do the Ainos believe in the presence of the dokushish there, and his power to exercise an evil influence over them, that none will venture out upon the deep water. In my experience of the Ainos, though a boat was kept on the lake all the time, no one could be induced to leave the shallow water of the shore, for, said they, "if we go far out, the big fish will surely destroy us." So if one wishes to cross the lake, a distance of some seven or eight miles, he must submit to a circumnavigation. The destructive tendency of this great marine monster is said to have been demonstrated at the expense of many boats and lives.

The Japanese have a tradition very similar to this, at least so far as the cause of the earthquake is concerned; with them, the active agent is the *namadzu*, or cat-fish. This appears to be the same as the Aino dokushish, a fish which is very abundant in certain localities.

The chief evidence that the interior of the earth is filled with water, is in the springs and rivers which flow without ceasing and must have an abundant and common origin within. It has not been possible, however, to obtain a satisfactory explanation, which would reconcile this belief with the equally well-established tradition that there is an abundance of fire in the earth, as volcanoes demonstrate. In fact, no explanation whatever, is offered. It appears, however, that it is the volcanoes themselves which led the Ainos to give the interior of the earth the character of hell, and that both fire and water are in the centre is demonstrated by the hot springs to be found in various parts of Yezo.

There is one tradition, repeated with but little variation, which whatever its origin may have been, seems to be strongly in agreement with known facts as they appear in evidence of a geological nature. The Ainos' conception of the world seems confined to formations of an insular character, and doubtless originally embraced Japan alone, since we find their word *Moshiri* signifying both "world" and "island," and constantly used in this double sense. Upon this special point, moreover, no well-defined tradition seems to be current. There is one, however, to which we have already alluded, which bears directly upon subsequent changes.

Formerly, the present Island of Yezo was divided into two parts. An arm of the sea from the west penetrated the interior and occupied the territory now known as the Ishicari Valley. This met a similar body of water, which penetrated from the east and occupied what is now the Tokachi Valley—the two meeting at the present divide between Ishicaridaki and Tokachidaki, two of the highest mountains on the island. The fact that fossil marine shells are found in abundance in the upper Ishicari Valley and its tributaries, shows that the ocean did once cover this area ; and whether or not the idea has been borrowed from the various foreign experts who have explored the island under government patronage of late years, the presence of these shells and the resemblance they bear to existing forms, is given by the Ainos as one of the strongest proofs in support of their tradition.

At the time of this separation, therefore, all the territory at present occupied by the Ishicari Valley and the two mountains south and east, was under water. The northern island was known as Maskishoya Ishicari, and extended from the present mountains bounding the Ishicari Valley on the north, to Shoya on the extreme north and Mombetsu on the east. The southern island was known as Mado-mai, and embraced the territory from Chitocie Lake on the north to Hakodate and Matsu-mai on the south. Tradition does not inform us as to the time which has since elapsed. After a time, however, there was a great earthquake, *and the earth became violently agitated*, *being thrown* up into great waves. This lasted for one hundred days. This unusual commotion caused the surface to be thrown up into great folds, and volcanoes and mountains to rise where plains had been known before. The first volcano to appear was that near Usiu, and known to the Ainos as Abouta. The second was Sawara, on the southern shore of Volcano Bay; while the third volcano was Tarumai on the south-east coast near Tomakomai and on the eastern shore of Lake Chitocie. This general commotion furthermore caused a general elevation by which the islands became united. The name, Mado-mai, formerly applied to the southern island, now became the name of the southern district, but more particularly of a town on its southern coast, and this name, once distinctly Aino, became subsequently corrupted by the Japanese into Matsumai, by which the former capital of the island is now known.

By some it is related that the Ainos were always friendly toward one another, but united in their antipathy toward the Japanese, for whom they had a well-defined dislike. This tradition evidently relates to a period subsequent to the union of the two islands. Such a change might naturally be conceived to bring about conditions favoring amity, where before jealous rivalry alone existed; and this would be the more probable, if there were a common enemy to combat. It is very difficult to obtain any account which points directly to open warfare with the Japanese in the past, and there is a reserve thrown about any narration of this sort, as well as about the conveyance of information touching matters of present moment, which indicates a strong and inherent dread of their conquerors. If we were to give these traditions the weight of truth, that relating to amicable relations among the various Aino tribes, and combined enmity toward the Japanese, would seem to indicate that the geological changes here spoken of must have occurred before the Japanese occupation, for wellversed members of different tribes, especially chiefs, related to me the tradition that, in very early times, the various tribes occupying the northern island were at war with those of Madomai. War parties frequently crossed from one island to the other on depredatory expeditions; but finally, when the land rose and united the islands, friendly relations were established among all the tribes.

With regard to the previous occupation of the country, I have found no tradition which bears directly upon that point. There is certainly no tradition crediting their ancestors with the construction of such mounds as are found at Otarunai and elsewhere. Neither is there any tradition concerning the manufacture of burnt pottery, and the general evidence seems to indicate that, the Ainos never possessed a knowledge of the art.

There is nothing relating to a language at all different from that now in use, and it is highly probable that written characters were never known or used. If they ever existed, they have been completely lost.

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## VII. Organic Siliceous Remains in the Lake Deposits of Nova Scotia.

By A. H. MacKay, Pictou Academy, N. S.

The siliceous deposits in the lakes referred to are, first, and most abundantly, of vegetable origin, consisting of the exquisitely sculptured cell-walls of the unicellular plants, constituting the order *Diatomaceæ;* and, secondly, of animal origin, consisting of the spicules which form the skeletons of that group of the fresh-water sponges known as *Spongillina.*

The investigation of the character of the lake deposits of Nova Scotia has only been commenced and much is yet expected to be brought to light. The explorations made during the last two summers include a large number of lakes throughout the province, varying from five miles in length to less than one half of a mile, and from 160 feet in depth of water to that of only six or seven. Deposits of some of the larger lakes have been examined, but no systematic survey of them has yet been made.

These deposits may be roughly classified as follows:—

*First*, earthy muds.

*Secondly*, black or brownish slimy muds.

*Thirdly*, whitish siliceous muds, consisting nearly entirely of the cell-walls of the diatomaceæ and the spicules of fresh-water sponges, which are found to be present in classes *first* and *second* also, although in less comparative abundance.

These three classes, of course, shade off into each other without any distinct line of demarkation.

In the first class there is a variable quantity of fine sand or clay introduced in times of freshets when the water becomes discolored from the earthy matter borne into it. Deposits of this class abound in lakes into which large streams that readily become turbid flow; and they form more rapidly, it is presumed, than those of the other classes. Soundings in the upper portions of the Lochaber, Garden of Eden, Forbes, Ainslie and Grand Lakes, for instance, bring up material of this class, all abounding to some extent with diatom valves and sponge spicules. The depths of these accumulations our primitive boring apparatus would not allow us to fathom.

The second class of deposits is found in abundance in lakes fed by small streams in the forest. In Calder and MacKay Lakes, Pictou County, the former being a full mile in length, the water in no place appears to be over 9 or 10 feet in depth, the average being 5 or 6 feet. In the central portions of these ponds a pole was driven down by the hand from a raft to the depth of 20 feet without striking hard bottom. Nearer the margin, the borer after passing through this deposit, generally took up a stiff clay, which has also been found underlying some peat swamps in the neighborhood. In some of these swamps analysis has shown a large percentage of the incombustible residue to be composed of diatomaceous and sponge remains, thus demonstrating their lacustrine origin. When the hard bottom of the above-named and other lakes was found to be undulating, the light slimy diatomaceous mud was found to be deepest in the depressions,—the mud surface being more conformable to the surface of the water than to the surface of its bed. In MacLean Lake, less extensive but nearly 30 feet deep, the same characters of the bed of the deposit were observed. In most of the other lakes, soundings, but no borings through the deposits, were made. The typical mud of this class is generally of some shade of a dark grey-brown color, having sometimes nearly the consistence of a very tremulous jelly, but pasty to the touch. Some specimens of this, dried so as to be so firm as to retain a moulded form, contracted to one tenth of its volume when perfectly dried, nearly 50 per cent. of which was estimated to be organic silica. While pieces of decaying wood, leaves, mosses, etc., are found in this material, its carbonaceous organic matter appears to have been to a great extent of algoid origin. The waters of these lakes are generally colored by the presence of organic matter in solution.

The third class of deposits has not been observed in such abundance as the other classes. In many cases it may have been formed from material of the second class, as is suggested by the deposits often shading off into each other in the same body of water For instance, in Macintosh Lake, some of the purest white material did not come from the greatest depth of the water, but from the vicinity of shallows, between an island and the mainland. A gentle motion of the water from an exposed side of the lake is produced by the wind over this flat, and the deposit alluded to is immediately to the windward of the said flat. This suggests the hypothesis that the change from the slimy mud to the purer siliceous deposit may have been, at least partly, due to the solvent action of the water on the decaying vegetable material. This solvent action has been plainly demonstrated to exist by the analysis of the waters of the lakes which supply the city of Halifax with water, made by George Lawson, professor of Chemistry in Dalhousie College and University. The waters of Long Lake, the largest and highest of the series, was conducted for a time through the lower Chain Lakes, in which there is a large deposit of diatomaceous slime. The analysis gave 2.13 grains of organic matter per gallon in the water of Long Lake, and 2.68 in that of the lower Chain Lake. This shows that each gallon of water may have dissolved out of the Chain Lakes about half a grain of vegetable matter.

Those lakes, so far as observed, which lie in the midst of granite drift, and have clear water, have also purer silicious deposits, the percentage of silica in the dried material approximating in some ases to between 90 and 100. Folly Lake is an instance in which much material of this kind is submerged, and near an affluent of Barney River is a good example of a deposit which is now left high and dry.

The greater proportion of this siliceous material is made up of the frustules or epiderms of about one hundred species of the diatomaceæ The following have been provisionally determined by comparison with the mounted types of Möller, the plates of Schmidt's Atlas, Van Heurck's Atlas with 3,000 figures of Belgian forms, figures and descriptions by Brun of Geneva in his "Diatomées des Alpes et du Jura," and the descriptions of Rahenhorst in his "Flora Europæa Algarum Aquæ Dulcis et Submarinæ."

1. Cocconeis pediculus, *Ehr.*
2. C. placentula, *Ehr.*
3. Gomphonema acuminatum, *Ehr.*
4. " " *var.* coronatum, *Ktz.*
5. " " *var.* laticeps, *Ehr.*
6. G. cristatum, *Ralfs.*
7. G. gracile *var.* naviculoides, *Grun.*
8. G. abbreviatum, *Ag.*
9. G. capitatum, *Ehr.*
10. G. intricatum, *Ktz.*
11. G. cistula, *Hemper.*
12. Epithemia turgida, *Ehr.*
13. E. gibba, *Ehr.*
14. " " *var.* parallela, *Grun.*
15. E. argus, *Ehr.*
16. Himantidium arcus, *Ehr.*
17. " " *var.* majus, *W. Sm.*
18. " " *var.* tenellum, *Grun.*
19. H. formica, *Ehr.*
20. H. pectinale, *Ktz.*
21. " " *var.* ventricosum, *Grun.*
22. " " *var.* minus, *Ktz.*
23. " " *var.* undulatum, *Ralfs.*
24. H. soleirolii, *Ktz.*
25. H. bidens, *W. Sm.*
26. " " *var.* diodon, *Ehr.*
27. H. præruptum *var.* inflatum, *Grun.*
28. H. polyodon, *Brun.*
29. H. polydentulum, *Brun.*
30. Amphora ovalis, *Ktz.*
31. A. affinis, *Ktz.*

32. Cymbella gastroides, *Ktz.*
33. C cuspidata, *Ktz.*
34. C. ehrenbergii, *Ktz.*
35. C. lanceolata, *Ehr.*
36. C. delicta, *A. Sch.*
37. C. cistula, *Hemper.*
38. C. heterophylla, *Ralfs.*
39. C. tumida, *Breb.*
40. Navicula crassinervis, *Breb.*
41. N. gracilis, *Ehr.*
42. N. cuspidata, *Ktz.*
43. N. ambigua, *Ehr.*
44. N. appendiculata, *Ktz.*
45. N. affinis *var.* amphirhyncus, *Ehr.*
46. N. transversa, *A. Sch.*
47. N. amphigomphus, *Ehr.*
48. " " *var.*..........?
49. N. limosa, *Ktz.*
50. N. firma, *Grun.*
51. " " *var.* hit(s)chcockii, *Ehr.*
52. N. legumen, *Ehr.*
53. N. dicephala, *Ktz.*
54. N. elliptica, *Ktz.*
55. N. radiosa, *Ktz.*
56. N. scutellum, *O'Meara.*
57. Pinnularia oblonga, *Rab.*
58. P. viridis, *Rab.*
59. " " *var.* hemiptera, *Rab.*
60. P. perigrina, *Ehr.*
61. P. nobilis, *Ehr.*
62. P. major, *Rab.*
63. P. dactylus, *Ktz.*
64. P. gibba, *Ehr.*
65. P. divergens, *W. Sm.*
66. P. interrupta, *W. Sm.*
67. P. mesolepta, *Ehr.*
68. P. nodosa, *Ehr.*
69. Stauroneis phœnicenteron, *Ehr.*
70. St. gracilis, *W. Sm.*
71. St. anceps, *Ehr.*
72. St. fulmen, *Breb.*
73. St. punctata, *Ktz.*
74. St. stauropheria, *Ehr.*
75. Surirella robusta, *Ehr.*
76. S. splendida, *Ehr.*

77. S. biseriata, *Breb.*
78. S. bifrons, *Ktz.*
79. S. turgida *W. Sm.*
80. S. linearis *var.* constricta, *W. Sm.*
81. S. slevicensis, *Grun.*
82. S. elegans, *Ehr.*
83. S. tenera, *Greg.*
84. S. cardinalis, *Kitton.*
85. Nitzschia amphioxys, *Ehr.*
86. N. elongata, *Grun.*
87. N. spectabilis, *Ralfs* (?)
88. N. sigmoidea, *Nitzsch.*
89. Stenopterobia anceps, *Breb.*
90. Fragillaria construens, *Grun.*
91. " " *var.* binodis, *Grun.*
92. F. capucina, *Desm.*
93. F. undata, *W. Sm.*
94. *Synedra ulna, Ehr.*
95. Meridion circulare, *Ag.*
96. Tabellaria floculosa, *Roth.*
97. T. fenestrata, *Lyngb.*
98. Cyclotella operculata, *Ag.*
99. C. comta *var.* affinis, *Grun.*
100. Melosira distans, *Ehr.*
101. M. arenaria, *Moor.*
102. M. orichalcea, *Mertens.*
103. M. granulata, *Ehr.*
104. M. crenulata *var.* valida, *Grun.*

This list is not exhaustive of all the forms found in any given locality, much less of all the species in the lacustrine deposits of *the province. Until the species have been more fully determined* in the whole range of deposits there will be little use in attempting to compare the forms of the lower deposits with those of the upper or more modern. Great variations are observed in many species of the diatomaceæ, concomitant with their stage of development, and also probably with their different environments. The conditions of environment also affect their distribution. It is remarkable in the Nova Scotian species, so far as observed, that while most of the forms determined are also found in the distant waters of the Alps and the Jura, some of the deposits taken from lakes but a few miles apart can be distinguished by the presence or absence of certain forms or by their relative abundance.

This induction is as yet based on too few a number of observations to be of any scientific value. But such instances as the following have been observed: *Melosira arenaria* (Moor) is abundant in the Earltown Lakes near the summit of the Cobequid range of mountains; while Gulley Lake, a few miles on the other side of the watershed, is distinguished by the presence of *Stenopterobia anceps* (Lewis) Bréb.; and Mackintosh Lake, separated only by a few miles of mountain ridge and forest from both, contains, apparently neither this species of *Melosira* nor *Stenopterobia;* and the deposits of Lochaber lake are characterized by the relative abundance of *Cyclotella.* Of course these lake deposits contain, not only the organisms which live in their own waters, but those which are swept into them by their tributary streams.

In addition to the remains of the diatomaceæ, the siliceous spicules of sponges abound in all these deposits, especially the long skeletal spicules. In some few places, the silica from this source is in excess of that from the diatomaceæ. A search for the origin of these having been made last summer no less than *nine* species in *four* genera have been found, and two of these are considered as new to science. These fresh-water sponges grow on submerged wood, plants, stones and even on sand. They are all of some hue of green when living and exposed to the influence of light. They vary in size from very small up to a specimen of *Meyenia fluviatilis*, growing in Garden-of-Eden Lake, which measured twenty-seven inches in length by four inches in diameter, surrounding a small branch as a core. In the winter season the flesh of these generally decays, and most of the skeletal spicules scatter and accumulate in the adjacent deposits. The reproductive gemmules with their characteristic spicules, also, in the course of time float away, or germinate next spring on the original site. The following are the species of siliceous sponges which have been identified as living in the lakes at present, and whose spicules abound in the deposits under consideration. These sponges, like the diatoms, have certain species characteristic of certain waters, while others are more generally distributed.

1. Spongilla fragilis, *Leidy.*
2. S. lacustris *var.* dawsoni, *Bk.*
3. S. mackayi, *Carter.*
4. Meyenia fluviatilis, *Carter.*

5. M. everetti, *Potts* and *Mills.*
6. Heteromeyenia ryderi, *Potts.*
7. H. argyrosperma, *Potts.*
8. H. pictovensis, *Potts.*
9. Tubella pennsylvanica, *Potts.*

The first of these was described by Bowerbank as *S. lordii.* The specimen came from British Columbia. It was first discovered in England last summer, according to Carter. It turned out on examination, that Leidy, of Philadelphia, first described it as *S. fragilis.* No. 2 was described by Bowerbank over twenty years ago as *S. dawsoni;* next, by Potts as *S. lacustroides.* I called Mr. Potts' attention to Bowerbank's description, and it has been generally conceded since to be an American variety of the European *S. lacustris.* No. 3 was described by Carter, of England, in the January number of the "Annals and Magazine of Natural History," London. Potts claims that it is the same as his *S. iglooiformis,* a description of which, we think, has not yet been published. No. 5 is remarkable, as the species has never been observed before except in a pond upon Mt. Everett in Mass., U.S.A., at an elevation of 1,800 or 2,000 feet above the sea. It appears to be plentiful in Nova Scotia. No. 8, provisionally named, is remarkable for the paucity of its statoblasts, which for some time prevented its classification, although its skeletal spicules are very distinctive. Further investigation is necessary for the elucidation of the character and life-history of this species. This classification and nomenclature has the approval of H. J. Carter, the greatest living English writer on sponges.

E. Potts of Philadelphia, our best American authority, has observed that the spicules of sponges undergo variations within a very considerable limit, and that these variations are generally concomitant with the variation of the altitude of their habitat. The spicules of several of these Nova Scotian sponges he considers as varying from the usual type, but considers them as conforming to his hypothesis. The extensive deposits of these siliceous remains must have come proximately from silica in solution in the water. The analysis of the waters of Halifax lakes by Prof. Lawson shows the presence of soluble silica as well as of alumina, lime and iron, all of which have been found to exist in diatomaceous earths analysed by Zeigler, Hoffman, and

Lossier. No less than from 2.13 grains to 2.44 per gallon of these inorganic substances were found in solution in the waters of these lakes.*

## VIII. The Classification of Natural Silicates.

By T. Sterry Hunt.

On pages 129 to 135 of the Record appears an abstract of a System of Classification of Natural Silicates, set forth by the writer in an extended essay "On a Natural System in Mineralogy, with a Classification of Silicates," presented to the National Academy of Sciences at Washington, in April, and to the Royal Society of Canada at Ottawa in May, 1885, and now in process of publication in the third volume of the Transactions of the latter. Accompanying the abstract, as printed in the Record, are three synoptical tables, which were but tentative, and, as the reader will have seen, not only incomplete but, as regards that of the Persilicates, in conflict with the text. These tables having been inserted in the abstract by an error, the present revised ones are given, which will shew more fully the system proposed.

Synopsis of the Order *SILICATE.*

| Sub-order. | I. Protosilicate. | II. Protopersilicate. | III. Persilicate. |
|---|---|---|---|
| Tribe. | 1. Hydroprotospathoid (Pectolitoid)..... | 6. Hydroprotoperspathoid (Zeolitoid).......... | 11. Hydropers-pathoid. |
| Tribe. | 2. Protospathoid...... | 7. Protoperspathoid....... | 12. Perspathoid. |
| Tribe. | 3. Protadamantoid.... | 8. Protoperadamantoid... | 13. Peradaman-toid. |
| Tribe. | 4. Protophylloid...... | 9. Protoperphylloid....... | 14. Perphylloid. |
| Tribe. | 5. Protocolloid (Ophitoid)....... | 10. Protopercolloid (Pinitoid)......... | 15. Percolloid (Argilloid). |

* This paper was written in answer to a request for the Author's observations on the diatomaceous deposits of Nova Scotia. It was simply given as a report of the progress of the Author's own work, which has since been extended to other portions of the Province, to New Brunswick, and Newfoundland. "Silliman's Journal," April, 1845, contains a list of twelve fossil infusoria determined by Professor Bailey in material sent from Earlton Lake by Sir J. W. Dawson. Of these, ten are now known as diatoms, and two as sponge spicules.

*Suborder* I.—PROTOSILICATE.

| m : si. | 1. PECTOLITOID. V=7·0—5·3 | 2. PROTOSPATHOID. V=6·7—6·0 | 3. PROTADAMANTOID. V=6·0—4·6 | 5. OPHITOID. V=7·3—5·5 |
|---|---|---|---|---|
| 1 : ½ | - - - - - - - - - - - | Danalite (7 : 6). - - - - - - - | Chondrodite. | |
| 1 : 1 | Calamine. Thorite. Cerite. - | { Willemite. Knebelite. Batrachite. Tephroite. Gadolinite. Helvite. } | { Monticellite. Chrysolite. Phenacite. Bertrandite. | |
| 1 : 1¼ | Chrysotile. - - - - - - | Leucophanite. - - - - - - - - | - - - - - - - - - - - - | Serpentine. Retinalite. |
| 1 : 1½ | { Gyrolite. Friedelite. Pyrosmalite. - - - - } | - - - - - - - - - - - - - - | - - - - - - - - - - - - | Deweylite. Genthite. |
| 1 : 2 | { Xonaltite. Plombierite. Hydrorhodonite. Dioptase. } | Wollastonite. Tscheffkinite. - - - | { Amphibole. Rhodonite. Pyroxene. Enstatite. - } | { Aphrodite. Cerolite. Chrysocolla. |
| 1 : 2¼ | Pectolite. - - - - - - - - | - - - - - - - - - - - - - - | Amphibole. - - - - - - - | Spadaite. |
| 1 : 2½ | - - - - - - - - - - - - - | - - - - - - - - - - - - - - | - - - - - - - - - - - - | Rensselaerite. |
| 1 : 3 | - - - - - - - - - - - - - | - - - - - - - - - - - - - - | - - - - - - - - - - - - | Sepiolite. Glauconite. |
| | | | | 4. PROTOPHYLLOID. |
| 1 : 3½ | Datolite. | | | |
| 1 : 4 | Apophyllite. Okenite. - - | - - - - - - - - - - - - - - | Guarinite. Titanite. | Thermophyllite (3 : 4). Talc (2 : 5). Talc (2 : 6). |
| 1 : 7 | - - - - - - - - - - - - - | - - - - - - - - - - - - - - | Danburite. | |

*Suborder* II.—Protopersilicate.

| m : m : si. | 6. Zeolitoid. V = 7·2 — 6·3 | 7. Protoperspathoid. V = 8·6 — 6·1 | 8. Protoperadamantoid. V = 5·8 — 4·7 | | 9. Protoperphylloid. V = 6·2 — 5·1 | |
|---|---|---|---|---|---|---|
| | | | | Tourmalines. | Micas. | Chlorites. / 10. Pinitoid. |
| 1 : ½ : n | - - - - - | Melilite. Eudialyte. - | Pargasite. Keilhauite. - - - - - - | | Phlogopite. - | A large group of hydrous magnesian species. (Chlorites.) |
| 1 : ¾ : n | - - - - | Wöhlerite. Ilvaite. - | Idocrase. Schorlomite (4 : 3). - - - | | Phlogopite. - | |
| 1 : 1 : n | Xanthorthite. | Gehlenite. Sarcolite. Milarite. - - - - | Garnet. Ægirite. Allanite. Beryl. - | | Biotite. - - | |
| 1 : 1½ : n | Prehnite. - - | Barylite. - - - - - | Euclase. Ardennite. Arfvedsonite. - | | Seybertite. | 10. Pinitoid. |
| 1 : 2 : n | Hamelite. Catapleiite. | Scapolites. Sodalites. | Axinite. Epidote. Zoisite. Jadeite. Acmite. - - - - - - - - - - | | Willcoxite. - | Jollyte. - |
| 1 : 3 : n | Zeolites. - - | Feldspathides. - - - | - - - - - - - - - - - | Coronite. | Zinnwaldite. | Fahlunite. Bravaisite. |
| 1 : 4 : n | Edingtonite. Sloanite. | Petalite. - - - - - | Spodumene. Sapphirine. Staurolite. - - - - | Schorlite. | Lepidolite. - | Hygrophilite (1 : 5). |
| 1 : 6 : n | Forestite. - | - - - - - - - - - - | - - - - - - - - - - | - - - - | Margarite. Muscovite. | |
| 1 : 8 : n | - - - - - | - - - - - - - - - - | - - - - - - - - - - | Aphrizite. | Euphyllite. | Pinite. |
| 1 : 9 : n | - - - - - | - - - - - - - - - - | - - - - - - - - - - | Indicolite. | Damourite. Muscovite. | Cossaite. |
| 1 : 12 : n | - - - - - | - - - - - - - - - - | - - - - - - - - - - | Rubellite. | Muscovite. | (Palagonite. Tachylite. Pitchstone. Obsidian.) |
| | | | | | (With other species). | |

*Suborder* III.—PERSILICATE.

| m : si. | 11. PERZEOLITOID. V = —— | 12. PERSPATHOID. V = —— | 13. PERADAMANTOID. V = 5·7—4·4 | 14. PERPHYLLOID. V = —— | 15. ARGILLOID. V = 6·5—5·4 |
|---|---|---|---|---|---|
| 2 : ¼ | - - - - - - - | - - - - - - - | - - - - - - - - - - - - - | - - - - - - - - | Schrötterite. |
| 1 : ⅓ | - - - - - - - | - - - - - - - | Dumortierite. - - - - - - - | - - - - - - - - | Collyrite. |
| 1 : ⅔ | - - - - - - - | - - - - - - - | { Topaz. Andalusite. Fibrolite. Cyanite. Wörthite (6 : 5). } | - - - - - - - - | Allophane. |
| 1 : 1 | Westanite. - - - | - - - - - - - | { Bucholzite. Xenolite. Lyncurite. Zircon. Malacone. } | { Pholerite. Talcosite (5 : 6). } | Samoite. |
| 1 : 1⅓ | - - - - - - - | - - - - - - - | - - - - - - - - - - - - - | Kaolinite. - - - - | Kaolin. Halloysite. |
| 1 : 1½ | - - - - - - - | - - - - - - - | Auerbachite. - - - - - - - - | | |
| 1 : 2 | - - - - - - - | - - - - - - - | - - - - - - - - - - - - - | Pyrophyllite. - - - | { Keramite. Wolchonskoite. } |
| 1 : 2½ | - - - - - - - | - - - - - - - | - - - - - - - - - - - - - | Pyrophyllite. - - - | { Montmorillonite. Chloropal. } |
| 1 : 3 | - - - - - - - | - - - - - - - | Anthosiderite. - - - - - - - | - - - - - - - - | Cimolite. |
| 1 : 4 | - - - - - - - | - - - - - - - | - - - - - - - - - - - - - | - - - - - - - - | Smectite. |

## IX. Orthography for Native Names of Places.

The Council of the Royal Geographical Society have adopted the following rules for such geographical names as are not, in the countries to which they belong, written in the Roman character. These rules are identical with those adopted for the Admiralty charts, and will henceforth be used in all publications of the society.

1. No change will be made in the orthography of foreign names in countries which use Roman letters: thus Spanish, Portuguese, Dutch, etc., names will be spelt as by the respective nations.

2. Neither will any change be made in the spelling of such names in languages which are not written in Roman character as have become by long usage familiar to English readers: thus Calcutta, Cutch, Celebes, Mecca, etc., will be retained in their present form.

3. The true sound of the word, as locally pronounced, will be taken as the basis of the spelling.

4. An approximation, however, to the sound is alone aimed at. A system which would attempt to represent the more delicate inflections of sound and accent would be so complicated as only to defeat itself.

5. The broad features of the system are that vowels are pronounced as in Italian and consonants as in English.

6. One accent only is used—the acute—to denote the syllable on which stress is laid.

7. Every letter is pronounced. When two vowels come together each one is sounded, though the result, when spoken quickly, is sometimes scarcely to be distinguished from a single sound, as in *ai*, *au*, *ei*.

8. Indian names are accepted as spelt in Hunter's "Gazetteer."

The amplification of the rules is given below :—

| Letters. | Pronunciation and Remarks. | Examples. |
|---|---|---|
| a | *ah*, *a* as in *father* .................... | Java, Banana |
| e | *eh*, *e* as in *benefit* .................... | Tel-el-Kebir, Olé-leh, Yezo, Medina, Levuka, Peru |

| Letters. | Pronunciation and Remarks. | Examples. |
|---|---|---|
| i | English *e; i* as in *ravine;* the sound of *ee* in *beet.* Thus, not *Feejee,* but | Fiji, Hindi |
| o | *o* as in *mote* | Tokio |
| u | long *u* as in *flute;* the sound of *oo* in *boot.* Thus, not *Zooloo,* but | Zulu, Sumatra |
| | All vowels are shortened in sound by doubling the following consonant. | Yarra, Tanna, Mecca, Jidda, Bonny |
| | Doubling of a vowel is only necessary where there is a distinct repetition of the single sound | Nuulua, Oosima |
| ai | English *i* as in *ice* | Shanghai |
| au | *ow* as in *how.* Thus, not *Foochow,* but | Fuchau |
| ao | is slightly different from above | Macao |
| ei | is the sound of the two Italian vowels, but is frequently slurred over, when it is scarcely to be distinguished from *ey* in the English *they* | Beirut, Beilul |
| b | English *b.* | |
| c | is always soft, but is so nearly the sound of *s* that it should be seldom used. (*Celebes* should be written *Selebes.*) | Celebes |
| ch | is always soft, as in *church* | Chingchin |
| d | English *d.* | |
| f | English *f. Ph* not to be used for the sound of *f.* Thus, not *Haiphong,* but | Haifong, Nafa |
| g | is always hard. (Soft *g* is given by *j.*). | Galapagos |
| h | is always pronounced when inserted. | |
| j | English *j. Dj* should never be put for this sound | Japan, Jinchuen |
| k | English *k.* It should always be put for the hard *c.* Thus, not *Corea,* but | Korea |
| kh | The Oriental guttural | Khan |
| gh | is another guttural, as in the Turkish | Dagh, Ghazi |
| l, m, n | As in English. | |
| ng | has two separate sounds, as in *finger* and *singer.* As the sounds are rarely employed in the same locality, no attempt is made to distinguish them. | |
| p | As in English. | |
| q | should never be employed; *qu* is given as *kw* | Kwangtung |
| r, s, t, v, w, x | As in English. | |
| y | always a consonant, as in *yard,* and should not be used as a terminal, *i* or *e* being substituted. | Kikuyu |
| | Thus, not *Mikindany, Kwaly,* but | Mikindani, Kwale |
| z | English *z.* | Zulu |

## X. Reviews and Book-Notices.

### A Text-Book of Botany.*

Those who regarded this book with so much favor at the time of its previous issue, eight years ago, will doubtless be gratified that the fifth edition, with important revisions and additions, is now accessible. That a work which has so well filled an important place in botanical education, both in Europe and America, should be kept well abreast of the most recent developments of the science it represents, is particularly gratifying to those who have realized that the former edition was in many respects sadly behind the requirements of the day, almost as soon as issued, and the name of the English editor is sufficient guarantee that all reasonable effort would be made in this direction.

The ground covered is extensive, dealing as it does with the whole range of botanical science from histology to geographical distribution; and to comprise so much within the narrow limits of an octavo of 480 pages has necessitated great abbreviation, often when it would seem exceedingly desirable that more detailed consideration should be given. Thus the very important results recently developed concerning the continuity of protoplasm, are dismissed (p. 31) with a brevity which must certainly leave a very unsatisfactory impression on the mind of the student. Again, concerning the movement of water, (p. 161) the student gains but a superficial knowledge of the forces actually at woık and the way in which they operate, when it is stated that: "The roots absorb a greater quantity of water than the plant requires, and this therefore exercises a pressure which drives the water that has been already absorbed, higher and higher up the stem,"—a statement which is much too general to be exact, and which, in the second place, gives the student no possible clue to the well-known fact, that this root-pressure is largely subordinate to other forces when the plant is in a condition of active transpiration. Also, one is not informed of the important distinction which must be made between the flow of sap which is purely mechanical and that which is of a more strictly physiological nature. Thus, the impression is given (p. 161) that the bleeding of trees is due to

* Text-Book of Structural and Physiological Botany. By Otto W. Thomé and A. W. Bennett. Fifth edition 8vo., pp. 480. Longman, Green & Co., London.

the special abundance of sap in spring, whereas it is now a well known fact that such bleeding occurs only when there is great variation in temperature; that it may occur at any time during the rest period, if the external conditions are favorable; and that it most generally occurs at a time when the tree contains its minimum of water, ceasing as soon as the leaves develop, and therefore not appearing when there is a maximum of water in the tissues and the greatest physiological movement of water to the leaves and growing parts. These faults, while they are serious for the student who desires to pursue an independent course of study, would largly disappear under the guidance of a competent teacher, but they should be eradicated as far as possible.

While we regret the exceeding brevity which seems to be forced upon the author, this finds some compensation in the remarks of the translator when he says: "It cannot be too strongly impressed upon the student that a mere book knowledge of this, as of any other science, is absolutely valueless. He must make himself practically acquainted with the aid of the microscope, and, if possible, under the guidance of a competent teacher, with the minute structure of plants, and with the life history of the various forms." This is the view which it is important to emphasize and impress upon students and also teachers of graded schools where such subjects find an important place in the course of study. In this light, the treatment of the various subjects may be considered to serve the purpose very well.

In classification many important changes have been made, bringing this subject fairly well abreast of recent developments. In the general morphology there is a tendency to the introduction of rather more technical terms than is wholly desirable, tending to create confusion in the mind of the young student.

Taken as a whole, this edition may be regarded as a useful addition to the general text-book series, and will doubless be found to meet a very general demand.

D. P. P.

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*The Report of the Kansas State Horticultural Society** is a most hopeful indication of what American horticulture is likely to become in the future. The contents are of a much more

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* Kansas State Horticultural Society, Annual Report. G.C. Brackett, 8vo., pp. 306. 1884.

substantial character than is generally found in such publications and embrace much that is of a valuable scientific nature. Many of the articles were presented at the New Orleans meeting of the American Horticultural Society, and are from the pens of men well qualified to bring scientific dignity to such discussions and publications. That science is gradually being more and more appealed to by such Societies, becoming daily more closely identified with their work, and more of a recognized necessity in meeting the practical problems of the horticulturist, is a source of great gratification, and progress in this direction cannot be made more directly and efficiently than by such efforts as are apparent in the Report now before us.

We have received a little reprint from the Tenth Annual Report of the Montreal Horticultural Society, *On the Establishment of a Botanic Garden in Montreal*, containing a large amount of useful information concerning botanic gardens in other parts of the world, of which it enumerates a total of 187. It is well worthy of careful perusal. Its chief object appears to be to supply arguments showing the necessity of a Botanic Garden in Montreal. The subject is dealt with in all its aspects, and, aside from the purely scientific value of such institutions, which it clearly demonstrates, not the least valuable is the very interesting influence which gardens of such a character are found to have upon the public, in establishing higher ideals of nature and a better moral sentiment.

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## XI. Obituary.

### H. Milne Edwards.

After a life of eminent service as one of the leading naturalists of his day Dr. H. Milne Edwards died at Paris, July 9th, in the eighty-fifth year of his age. He was elected an honorary member of Montreal Natural History Society in 1852.

Though resident in Paris from an early age, he was born at Bruges, Belgium, of English parentage, in the year 1800. His investigations began at an early age and led directly up to the crowning work of his life, his "Comparative Physiology and Anatomy," upon the completion of which, in 1881, he was presented with a medal, subscriptions to which were contributed by men of science in all parts of the world, as a modest tribute to his high scientific attainments. His well-recognized merits as a Zoologist resulted in his election to the chair of Zoology at the Museum of the Academy of Sciences, as the successor of Geoffrey St. Hilaire. His son, A. Milne Edwards, is following the same line of research as his father, with much of the ability and thoroughness which characterised the latter.

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## MISCELLANEOUS NOTES.

ANTHROPOLOGICAL.—*The Physical Characteristics of the Natives of the Solomon Islands.*—On June 23rd, at the Anthropological Institute of London, Mr. H. B. Guppy read a paper on the above subject, giving the results of observations made during the years 1881–1884. The typical Solomon Island native (male) is well-proportioned, with a height of about 5 ft. 3 in., a weight of 125 to 130 lbs., and a chest-girth between 34 and 35 in., whilst the color of his skin is a deep brown, corresponding with color type 35 of M. Broca. Considerable variety, however, prevails in the physical characters of these natives, and it was shown, by comparing the inhabitants of the islands of Bougainville Strait with those of St. Christoval and its adjoining island at the opposite end of the group, that in the former locality there exists a taller, darker, and more brachycephalic race, whilst in the latter mesocephaly prevails, and the average native is rather shorter and of a lighter hue. The color of the skin varies considerably throughout the group, from a very deep brown to a light copperish hue, the range being represented by color types 42 and 29, with their intermediate shades. The author arrived at the conclusion that, although mesocephaly and brachycephaly most frequently characterize these people, the form of the skull varies beteween too wide limits to allow of one particular type being referred to this group. The range of the cephalic indices calculated from these measurements is 69 to 86, and the greater number are gathered in two groups, one around the indices 74 and 75, and the other around the indices 79 and 80.—*Athenæum.* (R.W.B.)

*The Report of the Council at the Annual Meeting of the Folk-Lore Society of London,* June 27th, contained the following definitions of Folk-lore by different members, with suggested divisions of the subject:—Mr. Nutt, "Anthropology dealing with primitive man"; Mr. Hartland, "Anthropology dealing with the psychological phenomena of uncivilised man"; Mr. Gomme, "the Science which treats of the survivals of archaic beliefs and customs in modern ages"; Miss Burne, "the Science with treats of all that the Folk believe or practice on the authority of inherited tradition, and not on the authority of written records"; Señor

Machado y Alvarez, "(1) Demo-Psychology, or the science which studies the spirit of the people; and (2) Demo-Biography, which is the description of the mode of life of the people taken in the aggregate." The council also brought forword several suggestions made by Don Machado y Alvarez, (1) that an International Congress of Folk-lorists should be held in London in June, 1888, being the tenth anniversary of the foundation of the Society; (2) that a Committee should be appointed to study children's games and the language of children, for which the lady members might lend their assistance; (3) that photography should be applied to the games, festivals and popular types of all the districts of England.—*Academy*. (R.W.B.)

BOTANICAL.—*Chemistry of Chlorophyll.*—After separating the phyllocyanin and phylloxanthin by Fremey's method, the author points out the special reactions of the former. It is insoluble in water, petroleum, ether and ligroin, but soluble in alcohol, ether, chloroform, glacial acetic acid, benzol, aniline and carbon disulphide, the best solvent being chloroform. A very small quantity of the phyllocyanin imparts an intense color to all of these solvents, but when very largely diluted the solutions lose their opacity. Oxidising agents easily decompose it, yielding yellow, amorphous products, the solutions of which show no absorption bands, but it is more permanent than chlorophyll when exposed to the combined action of air and light. Phyllocyanin dissolves in concentrated sulphuric, hydrochloric and hydrobromic acids, yielding dark blue solutions, but these compounds are unstable, the addition of water precipitating the phyllocyanin unchanged. The latter has no tendency to combine with weaker acids, such as oxalic, tartaric, acetic, phosphoric, etc. Phyllocyanin readily dissolves in caustic potash or soda, from which precipitates of various shades of green may be obtained with earthy and metallic salts, such as barium chloride, calcium chloride, acetate of lead, acetate of copper, etc. Solutions in alkali involve some change in the phyllocyanin.—E. SCHENCK, *Nature*, xxxii. 217. (D. P. P.)

*Colorless Chlorophyll.*—C. Timiriazeff points out that he has quite recently determined that, when a chlorophyll solution is treated with metallic zinc and an organic acid, it is reduced through the agency of the nascent hydrogen generated in the reaction, the resulting substance being perfectly colorless and presenting no traces of the characteristic chlorophyll spectrum or fluorescence. It is only in coming in contact with air that it gradually acquires its green color and specific optical properties. He considers that this disco[illegible] is an additional proof in favor of a hypothesis announced by [illegible] in 1875, viz., that the green color of this substance is due to iron in the state of a $FeOFe_2O_3$ compound. Since the product of reduction is colorless and produces no dark line in the spectrum, he regards the reduction of chlorophyll, when $CO_2$ is dissociated through the agency of light, as sufficient reason why the transformation may not be attended by a visible change of its color and other optical properties.—*Nature*, xxxii. 217, 342. (D. P. P.)

*The Eucalyptus in Italy.*—According to a writer in the "Gartenzeitung" of Berlin, the plantations of the Eucalyptus in Italy have been far from realising the results that were anticipated from them, as a means of preventing malarious fever, and neither the soil nor the climate of that country appears to be favorable for the growth of this tree, and he recommends the *Quercus rex*, the *Laurus glandulosa*, and certain varieties of the maple as being far better suited for the purpose. Another authority, Dr. Dieck, recommends the *Acer californiense*, a tree of nearly as rapid a growth as the Eucalyptus, the *Acer macrophyllum* of California, the *Acer insigne* of the Himalayas, all of which are well suited forcultivation in malarious districts in Italy; the *Salix babylonica*, *Populus angulata*, *heterophylla*, etc., are all said to be preferable to the Eucalyptus, and more suitable to the climate, and contain similar properties to those of the Eucalyptus, to which it owes its efficiency as a preventive against the malaria. Dr. Dieck, however, considers that the root of the evil lies in the indiscriminate cutting down of the trees on the mountains, and that their re-wooding would do far more towards checking malaria than any measures taken in the marshes, which districts have been reduced to their present state by forestal mismanagement and neglect. (A.H.M.)

Chemical and Physical.—*Apomorphine as an Anæsthetic.*—Professor Ludwig, aided by M. Bergmeister, has instituted a series of experiments upon a great number of organic substances in search for a body possessing powers similar to cocaine. Their investigations were fruitless until they tried apomorphine, which drug they found to be almost, if not quite, equal to cocaine in point of local anæsthetic properties. Their experiments were made on cats with a 2 per cent solution of apomorphine hydrochloride. (A.H.M.)

*A New Reagent for Distinguishing Alcohols.*—As a reagent for distinguishing alcohol obtained from potato spirit from the pure alcohol obtained from corn, etc., Dr. Hager (*Pharm Central*, xxvi. 26) proposes a 10 per cent. solution of mercurous nitrate. One-part crystallized nitrate is dissolved in 10 parts distilled water and rendered clear by the addition of a trace of nitric acid and allowed to settle over some metallic mercury. When 3 drops of the solution are added to 3 cc. (about 50m.) of absolute or 94 per cent. alcohol, a milky mixture with a yellowish white tinge results upon agitation. Upon several hours' standing a pale yellow, pretty well defined precipitate falls to the bottom. Corn spirit, if free from acetic and other ethers, shows a similar behavior, and after standing six to nine hours the precipitation is still more marked, and the superior liquid is perfectly clear and as bright as pure alcohol. With spirit obtained from potatoes, and therefore containing amylic alcohol treated in the same manner, the mixture does not become nearly so milky, but is bluish white, and upon standing nine to twelve hours a very slight precipitation takes place, only about one third as much as in the former, and the precipitation is pure white in color. The liquid portion of the mixture is also not entirely clear or water bright, but shows bluish white opalescence of several hours duration. A spirit containing traces of acetic ether, in which the odor of the fusil oil is masked, behaves similarly. (A. H. M.)

*Application of Prof. Lodge's Electric Spark.*—A wonderful instance of the manner in which a scientific discovery can be turned to practical advantage has recently occurred. At the Montreal meeting of the British Association, Prof. Lodge gave a lecture on "Dust", and pointed out a new observation due to himself and Mr. J. W. Clark. These two gentlemen had made the curious discovery that the passage of electric sparks through a dust-laden atmosphere would quickly cause the dust to settle down. During the lecture alluded to, a bell-glass filled with magnesium smoke was subjected to experiment, and the contained air rapidly became clear when the sparks were passed through it. So much for the scientific discovery. Now for its application. The head of a firm of lead smelters in Wales read a report of this lecture. He knew what difficulty there was in retaining the fume of volatilized lead from the smelting works, and in preventing its escaping from the flues to poison the atmosphere outside, besides robbing the smelter. He determined to see whether the electric spark would not cause the fume to fall in the same way that it acted upon the dust. An experimental shaft made of barrels, with windows in it, and an electric machine by which sparks could be sent through the fume, soon demonstrated that the thing could be done. (A. H. M.)

*Cirsine.*—A notice of a new Alkaloid, which has been named "Cirsine," discovered by E. B. Shuttleworth, of Toronto, in the flower heads of the Canada thistle, *Cirsium arvense*, was read at the semi-annual meeting of the Ontario College of Pharmacy, held at Belleville, last month. The method of analysis was that of Drugendorff, and the Alkaloid was not found to be soluble in petroleum ether, but most readily in alcohol. It was stated that thistle flowers are an important constituent in a well-known patent medicine, and it is quite possible that the active principle, when isolated, may be found to have powerful remedial properties. (A.H.M.)