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CONTENTS.

THE DÉNÉS OF AMERICA IDENTIFIED WITH THE TUNGUS OF ASIA.

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(Read 2nd February, 1897.)

GUTZLAFF writes: "The Mantchoos, a Tongoosian race, have, since their conquest of China, become a civilized people. Those who remain in their original country form, nevertheless, a portion of the imperial forces. Every male is obliged to enlist under one of the royal standards, of which there are eight. Many thousands are dispersed throughout the whole Chinese empire, where they are either soldiers or hold the highest offices in the state. They were originally Nomades, in manner not unlike the Mongols, though inferior in courage. The inhabitants of the northern provinces are a miserable race, living almost exclusively upon dried fish." Klaproth says: "All the Tungusian stocks under Chinese sway bear the common name Mandju." The Mantchus, therefore, are simply a section of the Tungus, of whom Klaproth further remarks: "The Tungus have no common or national name, yet most who dwell in Siberia call themselves Boye, Boya or Bye, that is, men (Mantshu beye, body, self). Some give themselves the name Donki, people, whence the name Tungus appears to have arisen. * * * However this may be, it is acknowledged without doubt that the Tungus' name is already very old, for we find it among the Chinese as early as the birth of Christ, when they called this people the Tungchu." Among their tribes, which I shall enumerate later, are those called Djan, Donggo, Djanggia, Dunggia, Dung, and Djang.

Father Morice's able, interesting, and instructive monographs on the Dénés of the far Northwest have had the effect of reviving my interest in the extensive and widely scattered aboriginal population so-called. Just sixteen years ago, within a few days, for it was on the 17th of December, 1880, and I write now on the 22nd, of 1896, I read a paper before the Literary and Historical Society of Quebec, in which, among other things, a comparison was instituted between the Dénés of America and the Tungus of Asia. These peoples are so well differentiated in Asia and in America from neighboring tribes as to make the task of comparison void of much difficulty, the chief want being material on both

sides, although the labors of Fathers Petitot and Morice have done much to fill up gaps on the American side. Writers on Siberia have, unfortunately, acted after the fashion of former describers of the American Indian, by confounding the Tungus with the Tchuktchis and Yakuts, the Koriaks and the Kamtchadales. Apart from Father Morice, and the comparative vocabularies of the Dené dialects taken from the collections of Petitot, Bancroft, Dawson, Tolmie and others, my authorities are rather ancient, but their antiquity is really in their favor, as it represents the two stocks in a native state, unaffected by external influences. For the Tungus, I am indebted to Santini, Martin Sauer, Adelung, Klaproth, and Malte-Brun, and for the Dénés, to Mackenzie and Hearne. I shall have occasion, in making the argument cumulative, to repeat some facts stated by me in a paper entitled "Asiatic Tribes in North America," which was published in the Proceedings of the Institute of 1881, New Series, Vol. 1, Part 2, p. 171.

THE DÉNÉ TRADITION.

Sir Alexander Mackenzie says, concerning the Chipewyans or Chippewyans, who are now called Athapascans and Montagnais: "They have also a tradition amongst them, that they originally came from another country, inhabited by very wicked people, and had traversed a great lake which was narrow, shallow, and full of islands, where they had suffered great misery, it being always winter, with ice and deep snow. At the Coppermine River, where they made the first land, the ground was covered with copper, over which a body of earth had since been collected to the depth of a man's height." Father Petitot has a larger version. "In 1863, the Dénés of Great Slave Lake, whom I questioned as to the place of their origin, told me,' This is what we know: In the beginning, there lived a great giant named *Jakke-elt-ini* (he whose head sweeps the sky), who barred our entrance to this desert and yet uninhabited land. The men (Dénés), pursued him and killed him. His dead body fell across the two continents, became petrified, and served as a bridge over which reindeer have passed and repassed until our days, from one shore to the other. The feet of the giant rest on the west shore, and his head reaches to Cold Lake." Who does not recognize, under the allegorical form, the narrative of the arrival of the Dénés in America, and the struggles they had to endure there against the barrenness of the soil, and the harshness of the climate? For proof in support, the Dénés call the long Cordillera of the Rocky Mountains, *Ti-honan-kkwene* (the back-bone of the earth), which they observe to run down the length of the continent, and which they regard as the back of the giant that has served as a bridge to these

waves of humanity for passing from Asia to America. As a second proof, they call by the name, *Thi-lan-ottine* (the inhabitants of the top of the head), the Déné tribe which haunts the shores of Cold Lake, where, they say, the head of their giant lies. It is thus easy to see, that by this giant they meant to symbolize their own nation. * * * The Peaux de Lièvre have another version of their arrival in America. Formerly, they say, we dwelt on the shore of a western sea, and our enemies were on the east, but since the earth has changed sides we find ourselves in the east and our enemies in the west. By these enemies they now mean the nation of the *Mollouches* (? Kolush or Thlinket); but, in their tradition, they mention a powerful people who shaved the head, wore wigs, and reduced them to live in slavery."

Mr. W. H. Dall, in his article on "The Origin of the Innuit or Eskimos," published in the first volume of Contributions to North American Ethnology, favors the Asiatic derivation of some of our aborigines; and, from the fact that, at the present day, Behring Strait is frequently crossed by natives on the ice, infers that it constituted a highway for immigrants in the past. He quotes, somewhat disjointedly, from Mr. C. R. Markham's Arctic Paper, of 1878, presented to the Geographical Society of London, as follows: "During the centuries preceding the appearance of the Innuit in Greenland (1349 A.D.), there was a great movement among the people of Central Asia. The pressure caused by invading waves of population on the tribes of northern Siberia drove them still farther to the north. Year after year, the intruding Tartars continued to press on. Their descendants, the Yakuts, pressed on, until they are now found at the mouths of rivers falling into the Polar Sea. But these regions were formerly inhabited by numerous tribes, which were driven away still farther north over the frozen sea. Wrangell has preserved traditions of their disappearance, and in them, I think, we may find a clue to the origin of the Greenland Eskimos. The Yakuts were not the first inhabitants of the Kolyma. The Omoki, the Chelaki, the *Tunguses*, and the Yukagirs, were their predecessors. These tribes have so wholly disappeared that even their names are hardly remembered." Sauer found the Tungus between Irkoutsk and Iakoutsk, the latter being the centre of the Yakuts, whose tradition, reported by him, is that they passed by the Tungus, when migrating from the south, so as not to come into conflict with them. The Russians found this northern spur of the Turkish family in Iakoutsk in 1620. Mr. Dall corrects Mr. Markham in some particulars, and denies that the Yukagirs, Tunguses, etc., have disappeared. The fact that the Mantchus are Tungusic sufficiently disproves Mr. Markham's assertion, but the fact of

Mongol pressure and displacement since the days of Kublai Khan, in the latter part of the thirteenth century, and even before then, cannot be disputed. There was an old civilization at Lake Baikal, as archæological remains attest, long before Kublai's time, and its consequence was the expulsion of nomad, and especially of hunting and fishing, tribes, into the north and east. It is, therefore, most probable that a large body of the Tungus followed the Dakotas and the Eskimos into America over the ice-bridge of Behring Strait, and made their way through the latter to their present habitations, where they are known as the Dénés.

THE TUNGUS AND DÉNÉ TRIBES.

Sauer, towards the close of last century, said: "The Tungoose wander over an amazing extent of ground, from the mouth of the Amour to the Baikal Lake, the rivers Angara or Tungooska, Lena, Aldan, Yudoma, Mayo, Ud, the sea coast of Ochotsk, the Amicon, Kovima, Indigirka, Alasey, the coast of the Icy Sea, and all the mountains of these parts; constantly on the look out for animals of the chase." The names given their tribes by Adelung and Klaproth are largely derived from their places of abode and possessions or mode of life. Thus Klaproth's eleven vocabularies are those of Yeniseisk, the Tshapogirs, Mangaseya, Nertchinsk, Bargusin, Upper Angara, Iakutsk, Ochotsk, the Lamuts, Lower Tungusa, and the Mantchus. Here Tshapogir, Lamut and Mantchu cannot be taken as Tungus titles. The Russians divide them into Horse, Reindeer, Dog, and Foot-going Tungus. The Mantchu, or rather Tungus emperor, Tai-dsu, who overthrew the Ming dynasty, and took possession of the Chinese throne, left on record, through his chronicler, a list of the Tungusic tribes under his sway, about the year 1616 A.D. These are some sixty-five in number, and should be valuable for comparative purposes. The lists of the Mithridates and of the Asia Polyglotta are not quite the same, although Klaproth appears to have been responsible for both. The following table presents the tribal names in alphabetical order, the variants to the right being those of Adelung.

TUNGUSIC TRIBES IN 1616 A.D.

Akiran.....	Indachun-takurara-Golo..
Andarki-Aiman.....Andarki.	Kuala..... ....
Antshulaku.....Antschulaku.	Mardun .....
Antu-Gualgia.	Muren..... .....
Barde.....	Namdulu... ....
Chada..... .....(*Ch* hard.)	Neien..... ..Neyen.
Chesiche .... Cheshiche.	Nimatsha.....
Chingan ....Chinn'kan.	Noro..... .....
Chuifa..... .. ..Choifa.	Olchon ....Olcho.

TUNGUSIC TRIBES IN 1616 A.D.—*(Continued).*

Chuneche-Aiman	Chuneche.
Chuntshun	Chuntschum.
Churcha	
Chuye	Chuya.
Djaisian	
Djakuma	Dshakumu.
Djakuta	Dshakuta.
Djan	Dshan.
Djang	Dshann.
Djanggia	Dshann'gia.
Djetschen ni Aiman	Dshetschen.
Djoogia	Dshoogia.
Djusheri	Dshuscheri.
Donggo	Donn'go.
Dung	Dunn.
Dunggia	
Eche-Kuren	
Elmin	
Feneche	
Fiu	
Fodocho	
Giamucha	Giamuchu.
Gualtsha	
Gunaka-Kuren	
Omocho-Shoro	Omochossoro.
Onggolo	Onn'golo.
Sachalian-ni-Aiman	
Sachaltsha	Ssachaltsha
Sakda	Ssakda.
Sargu	Ssargu.
Sibe	Shibo.
Sirachin	Shirachin.
Sirin	Shirin.
Suan	Ssuan.
Suifun-Ningguda	Ssuifun; Ninnguta separate.
Suksuchu-Aiman	Ssukssuchu.
Tomocho	
Ula	
Urgutshen	
Usui	Ussui.
Usuri	
Wanggia	Fanggia.
Warka	Uarka.
Wedsi-Aiman'	Uedsi.
Yaran	
Yarchu	
Yeche	

Major J. W. Powell, in his elaborate and complete work on American Linguistic Families, gives the following statistics of the Dénés or Athapascans: "The present number of the Athapascan family is about 32,899, of whom about 8,595, constituting the northern group, are in Alaska and British North America, according to Dall, Dawson, and the Canadian Indian Report of 1888; about 895, comprising the Pacific group, are in Washington, Oregon, and California: and abont 23,409, belonging to the Southern group, are in Arizona, New Mexico, Colorado and Indian territory. Besides these are the Lipan and some refugee Apache who are in Mexico. These have not been included in the above enumeration, as there are no means of ascertaining their number." M. Malte-Brun, writing in 1878, gives no statistics of the Mexican group, but furnishes the names of tribes included in it. He says: "The Apaches or Yavipei constitute a barbarous nation which has no fixed abode. They wander through the northern provinces of Mexico, sometimes approaching the vicinity of Zacatecas. In their incursions they commit all sorts of depredations, destroying and burning the pueblos, haciendas, and isolated farms. They are divided into several tribes; the most important are those of the Navajos, Gilenos, Mimbrenos, Chafalotes, Faraons, Llaneros or Lipillanes, and Lipans. They speak the same language, which only varies in accent from tribe to tribe, so as not to hinder their being mutually intelligible. They have no connection in language or origin with the Comanches. The principal dialects of

Apache speech are: the Chimegue, the Yuta, the Muca-Oraive, the Faraon, the Llanero, and the Lipan.

Returning to Major Powell, we find him classifying fifty-three tribes in three divisions, or groups, Northern, Pacific, and Southern, the latter including most of Malte-Brun's Mexicans

DÉNÉ TRIBES IN 1888.

A.—*Northern Group:*

Ah-tena,	Kutchin,	Sluacus-tinnch,
Kaiyuh-khotana,	Montagnais,	Taculli,
Kcaltana,	Montagnards,	Tahltan,
K'naia-khotana,	Nagailer,	Una-khotana.
Koyukuk-khotana,	Slave,	

B.—*Pacific Group:*

Ataakut,	Kwalhioqua,	Taltuctun tude,
Chasta Costa,	Kwatami,	Tceme,
Chetco,	Micikqwutme-tunne,	Tcetlestcan-tunne,
Dakube tede,	Mikono-tunne,	Terwar,
Euchre Creek,	Naltunne-tunne,	Tlatscanai,
Hupa,	Owilapsh,	Tolowa,
Kalts'erea-tunne,	Qwinctunnetun,	Tutu-tunne.
Kenesti or Wailakki,	Saiaz.	

C.—*Southern Group:*

Arivaipa,	Lipan,	Navajo,
Chiricahua,	Llanero,	Pinal Coyotero,
Coyotero,	Mescalero,	Tchikun,
Faraone,	Mimbreno,	Tchishi.
Gileno,	Mogollon,	
Jicarilla,	Naisha,	

The only additions Malte-Brun makes to these are the Chafalotes Chimegues, Muca-Oraives, and Yutas. Some of Major Powell's names are not tribal; a few are English, French, Spanish, fancy and local terms. The Montagnais are the Chippewyans or typical Athapascans and their true name is Déné-Dindjié; the Montagnards are, I suppose, the Tenan-Kutchin; while the Slaves or Dogribs are the Thing-e-ha-dtinne. But the name Mountain Men is also applied to the Tutchone-Kutchin. The classifications of Mr. Dall and Father Morice for the Northern group are somewhat different, and that of the latter, who finds fault with Mr. Dall's, is obscured by English names that are confusing and of very little scientific value. Mr. Dall's list of tribes is as follows:

Abbato-tena,	Koyu-kukh-otana,	Tenan-Kutchin,
Acheto-tinneh,	Kutcha-Kutchin,	Tennuth-Kutchin,
Ahtena,	Nehauni,	Tukkuth-Kutchin,
Daho-tena,	Natsit-Kutchin,	Tutchone-Kutchin,
Han-Kutchin,	Tahto-tinneh,	Unakhotana,
Kai-yuh-kho-tana,	Tehanin-Kutchin,	Vunta-Kutchin.

Father Morice objects to this list, and maintains that the Kutchin tribes of Mr. Dall are, all but one, imaginary. But what shall we say of his own list, followed by the form in each case of the word for man?

Western Dénés:

Chilchotins.....toeni.	Nahanes .....téné.
Carriers.....toené.	

Intermediate Dénés:

Sekanais ... .toené.

Eastern Dénés:

Chipewayans.....dené.	Dog-Ribs .....duné.
Cariboo-eaters.....dené.	Slaves .....dené.
Beavers.....dané.	Bad People .....diné.
Yellow-Knives.....dené.	Hares .....dené, adené.

Northern Dénés:

Loucheux.....dindjyé.

The Carriers, we know, are Dr. Dawson's Takulli, or Teheili, Indians, whom Father Morice calls Tachelh; the Chipewayans are the Déné-Dindjiés; the Beavers are the Tsatens; the Dog-Ribs and Slaves are the Thingehadtinne; and the Bad People, or Mauvais Monde, are said to be of the same stock. Dr. Latham, however, calls the Mauvais Monde the Daho-dinnis, and makes the Hares, or Peau-de-lièvre, and the Slaves one people. The Yellow-Knives, or Copper Indians, are the Ahtena, and the Loucheux are the Kutchins, Father Morice's Tudukh; but who are Cariboo-eaters? I find them neither in Pilling nor Powell, Dall nor Latham, but, as they dwell east of the Chipewayans, they must surely be the Safisadtinne, or, as Latham has it, the See-eessaw-dinneh. Father Morice's deliberate avoidance of personal names has, doubtless, good reasons, but it is unfortunate that one so able to enlighten our darkness on this matter should decline to lift the veil.

As our present purpose is to find tribal names belonging to the Dénés, a series of twenty septs of the three important tribes called by Father Morice, Tsilkohtins, Takelnes, and Tsekehnes, is worthy of presentation.

Hwotsu-tinni,	Otzenne,	Tsat-qenne,
Lthan-tenne,	Saschut-qenne,	Tsekehne,
Nahane,	Takelne,	Tsekehneaz,
Nakraztli-tenne,	Tano-tenne,	Tselohne,
Natlo-tenne,	Tlaz-tenne,	Tsetaut-qenne,
Nazku-tenne,	Tleskohtin,	Tsilkohtin,
Netu-tinni,	Tlothenkohtin,	Yutsut-qenne
Nutca-tenne,	Totat-qenne,	

There are other terms which connect in some way with Déné nomenclature, found in the collections of Pilling and others. We must not be critical about these, for Father Morice, by his silence, forbids us to be so. Some of the names were given by strangers, perhaps; this need not trouble us any more than the titles Allemand, Dutch, and Welsh. Still, others, it is thought, may be Algonquin and even Eskimo words, which, if true, would be awkward. In each case, a resemblance would be mere accidental coincidence and no sign of relation. However, one must work with the material that is to his hand, and trust to the indulgence of truly learned critics, who can appreciate difficulties. The question is: Are the names of the Déné tribes Tungusic? This must be decided by a comparison of our two lists, one of which, it must be remembered, belongs to the early part of the seventeenth century.

Tungus.	*Déné.*
Akiran,	Gileno, Ugalenze,
Andarki-aiman,	Natlo-tenne,
Antshulaku,	Inkaliki,
Antu-Gualgia,	Nagailer,
Barde,	Nulato,
Chada,	Acheto-tinneh,
Chesiche,	Tchishi,
Chingan,	Quinctunnetun,
Chuifa,	Hupa,
Chuneche-aiman,	Kenesti, Nutca-tenne,
Chuntsun,	Knai-kotana,
Churcha, Yarchu,	Chiricahua,
Chuya, Yeche,	Saiaz,
Djaisian,	Tceme,
Djakuma,	Tchikun, Dakube,
Djakuta,	Tukudh, Ataakut,
Djan,	Toene, Otsenne, Suan,
Djang,	Tchanin-Kutchin,
Djanggia, Dunggia,	Dindjye,
Djetschen-ni-Aiman,	Tsatens, Tsatqenne,
Djoogia,	Daho-tena, Tahko-tinneh,
Djusheri, Usuri,	Coyotero, Jicarilla,
Dongo, Dunn,	Tana-tenne,
Eche-kuren,	Kaiyuh-kotana,
Elmin,	Lipan,
Feneche,	Henagi,
Fiu,	Yavipai,
Fodocho,	Hwotsu-tinne,
Giamucha,	Chimegue,
Gualtsha,	Koltshane,
Gunaka-kuren,	Unakhotana,
Kuala, Gualgia, Warka,	Kwalhioqua, Wailukki,
Mardun,	Naltunne-tunne, Nulato,
Muren? Mumren,	Mimbreno, Faraon,
Namdulu,	Natlo-tenne,
Neyen,	Nahane,
Nimatsha,	Navajo,
Ninguta,	Micikqwutme-tunne,
Noro,	Llanero,
Olcho, Olchon,	Wailakki, Lthau-tenne,

Tungus.	*Déné.*
Omocho-soro,	Mescalero,
Ouggolo,	Mogollon,
Sachalian-ni-aiman,	Tsekelne,
Sachaltsha,	Tcetlestcan-tunne,
Sargu,	Sluakus,
Sibi, Shibo,	Safisa-dtinne,
Sirachin,	Kcaltana, Tahltan, Taltuctun-tude,
Shirin,	Tselohne,
Suan,	Otzenne,
Suifun-Ninguda,	Chafalote,
Suksuchu-aiman,	Saschut-qenne,
Tomocho,	Tennuth-Kutchin,
Ula,	Willopah, Tolowa,
Urgutshen,	Ukitce-tenne, Tlatskanai,
Wanggia, Fanggia,	Vunta-Kutchin,
Wedsi-aiman,	Abbato-Tena, Hwotsu-tinni,
Yaran.	Faraon.

The above fifty-seven resemblances may not constitute in themselves proof positive that the present Dénés are the old Tungus tribes, but they clear the way for more definite evidence.

PHYSICAL FEATURES AND HABITS OF THE TUNGUS AND THE DÉNÉS.

Adelung quotes Dr. Redowsky as thus describing the Tungus : " They have flat faces, projecting cheek bones, little, sparkling eyes. The women are almost universally uglier than the men. The Tungus are for the most part, under medium stature and of a feeble bodily frame. They are very lively in conversation, and accompany all their utterances with gesticulations, that sometimes descend to the ludicrous. They are a good-natured, harmless people, quick to be angry, but, on the other hand, that as readily forgive offences. They do not trouble themselves about the future and are not industrious, so long as the necessaries of life—fish and skins—can be procured easily and without trouble. The objects of their luxury, tobacco and brandy, they obtain from the Russians. Of brandy, they are inordinately fond ; for a single beer-glass full they will often give ten and more minever skins." Santini's description does not always coincide. He says : " Their faces are round, the cheek-bones high, the lips thick, the eyes small and black, the fore-head small, the ears large, the teeth white, and the hair black. * * * The Tungus are generally tall, athletic and straight. They run with such velocity that I have often seen them overtake the swiftest animal in the forest. Corpulency and deformity of person are blemishes which are seldom seen among them, because from their youth they are trained to the chase and war." Sauer, so far as he goes, agrees rather with Redowsky than with Santini. " They are rather below the middle size and extremely active ; have lively, smiling countenances, with small

eyes, and both sexes are great lovers of brandy." Referring to his guides, he says: "I took leave of my Tungoose and their reindeer, and declare that I did so with regret; for I was now an adept in riding, and found them more easy and agreeable than horses; but, above all, I was enchanted with the manly activity of my guides, their independence and contentment. Satisfied with the limited productions of nature, where nature itself seems to forbid the approach of mankind, their astonishing fortitude, keeping in full force every lively sensation of the mind, and surmounting all difficulties, until they obtain the interesting object of their pursuit, inspired me with an ardent desire to participate in their dangers and delights." Elsewhere, he writes, "They are religious observers of their word, punctual and exact in traffic."

Martin Sauer goes on to say: "They seldom reside more than six days in one place, but remove their tents though it be to the small distance of twenty fathoms, and this only in the fishing season, and during the time of collecting berries in such solitary places as are far distant from the habitation of Cossacs. Here they leave their supplies of dried fish and berries in large boxes built on trees or poles, for the benefit of themselves and their tribes in travelling during the winter. Berries they dry by mixing them with the undigested food (lichen) out of the stomach of the reindeer, making thin cakes, which they spread on the bark of trees and dry upon their huts in the sun or wind." In a footnote Sauer remarks regarding their frequent removals: "They say that their tents contract a disagreeable smell from remaining long in one place." "They seem callous to the effects of heat or cold." "They allow polygamy; but the first wife is the chief and is attended by the rest. The ceremony of marriage is a simple purchase of a girl from her father; from twenty to one hundred deer are given,or the bridegroom works a stated time for the benefit of the bride's father. The unmarried are not remarkable for chastity. A man will give his daughter for a time to any friend or traveller that he takes a liking to; if he has no daughter he will give his servant, but not his wives."

Abernethy supplements Sauer's statement regarding marriage: "In the marriage of the Tungusi many ceremonies are used, but the principal and indispensable one is, the offering a plate of corn or some game to the bride by her intended husband. Among several tribes of the Tungusi, marriage is attended with dancing, music and a variety of games and sports, which sometimes continue for several days. There are others who do not exhibit any mark of rejoicing on these occasions. Their courtship is generally of a very short duration. Among some the contract is conducted by their parents, while others allow the lovers to

choose and come to an agreement. They frequently bestow presents on each other, in order to ascertain each other's minds, for the acceptance of these gifts is a sure mark of their consent. The husband generally takes his wife among his own relations, where she spends several weeks, and is entertained with kindness and hospitality." "If the husband be a hunter, which is generally the case, for the greater part of them procure their subsistence either by hunting or fishing, every domestic charge is devolved on the wife; still there are some who attend to agriculture and the rearing of cattle. Nothing can exceed the modesty which both the bride and bridegroom assume on the night they are wedded; and I have also been told that a separation frequently takes place a week or two after they are married, by reason of her desire to live four weeks in perfect continence. This, however, is not generally true, for I observed that chastity was very often violated among them before they are legally united."

Barrow, the author of "Travels in China," says: "The Mantchoo Tatars are scarcely distinguishable from the Chinese by external appearances; the Chinese are rather taller, and of a more slender and delicate frame than the Tatars, who are in general, short, thick and robust. The small eye, elliptical at the end next the nose, is a predominating feature in the cast of both the Chinese and Tatar countenances, and they have the same high cheek-bones and pointed chins. The native color, both of Chinese and Tatars seems to be that tint between a fair and a dark complexion, which we distinguish by the word brunet or brunette; and the shades of their complexion are deeper or lighter, according as they have been more or less exposed to the influence of climate."

Klaproth, and other writers, mention the fact that the Tungus, and especially the Tshapojirs, were wont to tattoo their faces after the prevailing Siberian fashion, with bars or straight lines on the cheek and forehead. In the matter of valour, the Tungus seems generally to have been the man of the receding area, save in China where the Mantchu is supreme. Adelung refers to the Mantchus of the Ssolan as a worthy and valiant people. All who have had to do with the Mantchu officials of China, civil or military, regard them as the *ne plus ultra* of falsehood and low cunning. Gutzlaff has characterized the Tungus tribes as deficient in valour; and Wood, in his "Uncivilized Races," describes them as good-natured but full of deceit. Yet Sauer gives an instance of the Tungusian's fidelity to his word. "An unchristened Tungoose went into one of the churches at Yakutsk, placed himself before the painting of Saint Nicholas, bowed very respectfully, and laid down a number of rich skins, consisting of black and red foxes, sables, squirrels,

etc., which he took out of a bag. On being asked why he did so, he replied, 'My brother, who is christened, was so ill that we expected his death. He called upon Saint Nicholas, but would have no sorcerer. I promised that if Saint Nicholas would let him live, I would give him what I caught in my first chase. My brother recovered, I obtained these skins, and there they are.' He then bowed again and retired." Sauer euphemistically deals with their begging propensities: "They frequently resort to the solitary habitations of the Cossacs appointed to the different stages, as they are there generally supplied with brandy, needles, thread, and such trifles as are requisite among them and their women, who always accompany them in their wanderings."

Turning now to the Dénés, we find Mackenzie saying: "The Chipewyans are sober, timorous, and vagrant, with a selfish disposition, which has sometimes created suspicions of their integrity. Their stature has nothing remarkable in it; but, though they are seldom corpulent, they are sometimes robust. Their complexion is swarthy, their features coarse, and their hair lank, but not always of a dingy black; nor have they universally the piercing eye which generally animates the Indian countenance. The women have a more agreeable aspect than the men, but their gait is awkward, which proceeds from their being accustomed, nine months in the year, to travel on snow shoes and drag sledges of a weight from two to four hundred pounds. They are very submissive to their husbands, who have, however, their fits of jealousy; and, for very trifling causes, treat them with such cruelty as sometimes to occasion their death. They are frequently objects of traffic, and the father possesses the right of disposing of his daughter. * * * Both sexes have blue or black bars, or from one to four straight lines, on their cheeks, or forehead, to distinguish the tribe to which they belong. These marks are either tattooed, or made by drawing a thread dipped in the necessary color, beneath the skin. * * * Plurality of wives is common among them, and the ceremony of marriage is of a very simple nature. The girls are betrothed at a very early period to those whom the parents think the best able to support them; nor is the inclination of the woman considered. Whenever a separation takes place, which sometimes happens, it depends entirely on the will and pleasure of the husband. * * * They are not remarkable for their activity as hunters, which is owing to the ease with which they snare deer and spear fish; and these occupations are not beyond the strength of their old men, women and boys; so that they participate in those laborious occupations, which among their neighbors are confined to the women. They make war on the Esquimaux, who cannot resist their superior

numbers, and put them to death, as it is a principle with them never to make prisoners. At the same time, they tamely submit to the Knisteneaux, (Crees), who are not so numerous as themselves, when they treat them as enemies."

"They do not affect that cold reserve at meeting, either among themselves or strangers, which is common with the Knisteneaux, but communicate mutually and at once, all the information of which they are possessed. Nor are they roused, like them, from an apparent torpor to a state of great activity. They are, consequently, more uniform in this respect, though they are of a very persevering disposition when their interest is concerned. * * * In their quarrels with each other they very rarely proceed to the greater degree of violence than is occasioned by blows, wrestling, and pulling of the hair, while their abusive language consists in applying the name of the most offensive animal to the object of their displeasure, and adding the term ugly, and *chiay* or stillborn. This name is also applicable to the fœtus of an animal, when killed, which is considered as one of the greatest delicacies. * * * The country which these people claim as their land has a very small quantity of earth, and produces little or no wood or herbage. Its chief vegetable substance is the moss on which the deer feed, and a kind of rock moss, which, in times of scarcity, preserves the lives of the natives. When boiled in water, it dissolves into a clammy, glutinous substance. that affords a very sufficient nourishment. * * * They are also of a querulous disposition, and are continually making complaints; which they express by a constant repetition of the word *eduiy*, "it is hard," in a whining and plaintive tone of voice."

My copy of Hearne's Voyage is a French translation, which will account for the variation of the extracts from the original. He says: "The Northern Indians are, in general, of medium stature, well proportioned, and strong; but they have little corpulence. They lack the activity and suppleness natural to the Indians whose tribes inhabit the western coast of Hudson's Bay. The color of their skin approaches that of dark copper. Their hair is black, thick and shiny, like that of other Indians. * * * The features of these Indians differ entirely from those of the other neighboring tribes, for their foreheads and eyes are small, their cheek bones high, and their nose aquiline, their face pretty full and their chin, as a rule, large. Their features vary but little in the individuals of the two sexes; but it might be said that nature has submitted to fewer abnormalities in the case of the women. These natives have an exceedingly soft and even skin, and when they

keep their clothes clean there is no people in the world that has less smell. All the Northern Indians, as well as those of the Copper River and the Cote de Chien, bear, on each cheek, from three to four parallel lines which they make with an awl or a needle inserted under the skin which they rub with powdered charcoal when the instrument is withdrawn. In general, the Northern Indians are very selfish ; I really believe that they have no word in their language to express gratitude. They speak incessantly of their poverty, and, during the whole time of their stay at the fort, there is not one of them who does not complain of a thousand needs."

" Each of these Indians hastens to make known his misfortunes, real or imaginary, and takes care to accompany his recital with sighs and tears. There are some, even, who pretend to be lame or blind, the better to excite pity. I know of no people so thoroughly masters of themselves on such occasions, and, in that respect, the women are superior to the men ; for, I can affirm having seen one, the one side of whose face expressed joy, while the other was bathed in tears. * * * Flattery is no less known to these Indians ; they make use of it as long as interest prescribes it but no longer. * * * If, at the end of a certain time, this conduct of theirs does not produce the effect intended, they break forth into invectives. * * * For the rest, their rage is only temporary, and they soon become reconciled with the man whom they had intended to dupe. 'He is not a child,' they end by saying among themselves, 'therefore he can't be taken in.' * * * In spite of these bad qualities, the Northern Indians are still the most easily managed of all those who frequent the Company's stores. As they drink little liquor, they keep their senses, and confine their violence to conversation. These Indians are, in general, very jealous of their wives, and I do not doubt that the same is the case with them ; but they are too much afraid of their husbands to dare exhibit the least suspicion. I cannot better compare the attitude of a Northern squaw before her husband than to that of European servants in the presence of their masters. The marriages of these people are accompanied with no ceremony. All the proposals and arrangements are made by the fathers and mothers or the nearest relations, and the women, under these circumstances, seem to be reduced to have no other will than that of their relations, who in their choice simply consult interest. * * * Divorce is very common among the Northern Indians. It arises often out of immorality, but more frequently still, from incompatibility of disposition or bad conduct When it takes place, the ceremony begins with a volley of blows from a stick which the husband applies to his wife, and ends with putting her

to the door, telling her to go and find her lover, if she has one, or, in the contrary case, her own family."

"The most remarkable dish of all the Indian tribes, whether of the north or of the south, is that composed of the blood and the half digested substances contained in the stomach of the cariboo, which they boil with a sufficient quantity of water to give it the consistency of broth. * * * Of all the larger animals, the cariboo is the only one the contents of the stomach of which the Indians who border on Hudson's Bay eat. They are so fond of it in winter, the time when this animal feeds on a tender white moss (lichen, *Ceenomyce rangiferina*), that I have seen them stop at the very spot where a deer had just been killed to devour the still palpitating entrails. They care less for this food in summer, if food it can be called, the moss then not possessing the same properties."

With these extracts from both hemispheres may be compared the more recent observations of one who has exercised keen insight during a period of ample opportunity, into the lives of the Déné tribes. Father Morice, in his papers contributed to the Institute, has the following statements, worthy, in this connection, of special consideration. "The American aboriginal type is too well known on this continent to require a description from me. Our Dénés, in spite of the characteristics which particularize them into various tribes, do not materially differ from it. Suffice it to say, that whilst the Chilxotins are generally of low stature, broad shouldered, and not unlike the Chinese in their physical features, the Carriers are, as a rule, rather tall and stout, without being corpulent, while most of them possess a fine physique. On the other hand, the Sekanais and Nah'anes, especially the former, are slender and bony, with hollow cheeks, and almond shaped eyes shining with ophidian brightness. Of course, tattooing prevailed everywhere. The face was particularly the object of would-be ornaments in the shape of incrusted crosses or birds on the cheeks, the forehead or the temples. But more commonly they consisted of parallel stripes, more or less numerous, on the chin or the cheeks, converging to the mouth corners. On exceptional cases, such as dances or 'potlatches,' the Dénés had recourse to charcoal to render themselves apparently more redoubtable. And the young folks had vermilion to enhance their natural beauty, and it may safely be conjectured that they did not use it sparingly." In the matter of painting, the Tungus custom was that of the Dénés, as will appear under the heads of Dress and Warfare.

Father Morice continues: "Washing may be said to be a European

custom introduced among them. They clean their hands only, which they wash by filling their mouths with water and then squirting it over them in intermittent streams." Now, the author's mind must have run partly in the direction of this paper, for he subjoins a note: "This reminds the comparative Sociologist of a similar custom prevailing among the Tartars or Moguls of the Middle Ages. William of Rubruck (St. Louis' envoy to the great Khan, 1253), says that, 'They never wash their clothes. Cleanliness is in no more favour with the men than with their ladies, and their mode of washing their faces and hands is by filling their mouths with water and squirting it over them." *Relation des Voyages en Tartarie, Bergeron.* Perhaps Chinese laundrymen, who sprinkle their washing in this fashion, obtained it from their rulers, the Mantchus.

"Considered in their social condition and daily pursuits, a portion of the Western Dénés are nomadic, and part may be described as semi-sedentary." I do not know that Father Morice anywhere refers to the Dénés' dislike of ancient smells, save in his "The Western Dénés; their manners and customs," where he says, "The Sekanais, owing to their dislike to fish, and their need of procuring fresh supplies of meat could never remain for any length of time at the same place." And again: "Even to this day they content themselves with circular coniferous branch huts or lodges, which they construct and abandon at a moment's notice, whenever their incessant peregrinations after food and peltries call therefor." In regard to moral character, Father Morice writes: "Making due allowance for their particular ideas of propriety, they are generally modest in deportment and chaste in privacy, despite the fact that several couples live together under the same roof and without partitions in the house. Should I have to sketch rapidly our Dénés' fmoral features, I think I could, by ignoring some necessary exceptions, give them credit for relative morality, great honesty, intense fondness for their offspring, and a general gentleness of disposition, not excluding, however, occasional freaks of irascibility. But to qualify their lives and give their true portrait, I should immediately add that they are prone to lying, addicted to gambling, naturally selfish, cowardly, and at times very lazy, especially the stronger sex." But, in his notes on the Western Dénés, the author says: "Our Western Dénés, who usually prove so cowardly against a human enemy, are so courageous when matched with almost any wild beast, that among them he would not be considered a man who would be afraid of a bear."

In the same notes he writes: "The Tse'kehne are slender and bony,

in stature rather below the average, with a narrow forehead, hollow cheeks, prominent cheek-bones, small eyes deeply sunk in their orbit, the upper lip very thin, and the lower somewhat protruding, the chin very small, and the nose straight. Go and inspect them, and, perhaps, out of every ten men, five who have long been fathers, will appear to you like mere children. I have never seen but one fat person among them, and none that was bald. Now, the Carriers are tall and stout, without, as a rule, being too corpulent. The men, especially, average 1m 660mm (about five feet five), in height. Their forehead is much broader than that of the Tsh'kehne, and less receding than is usual with American aborigines. Their face is full, with a nose generally aquiline, and in every case better formed than that of their heterogeneous neighbours ; their lips are thicker and their chin more prominent than those of the Tse'kehne. Their eyes are also much larger and of a very deep black. Baldness, though rare, is sometimes noticed among them, while a few are literally obese. I am very much mistaken, if two crania, one of an individual of each of these tribes, would not be pronounced by a craniologist as belonging to representatives of diametrically different races. The Tsilkohtin, on the other hand, are short in stature, broad faced and broad shouldered, with prominent cheek bones, heavy jaws, and a nose which is, not uncommonly, thick and flattish. They may be said to have some physical resemblance to the Chinese. This description applies also to the Babines, who might be considered as a branch of the Carriers. The only points in common between the three tribes are the dark eyes, the black, coarse, and straight hair, and the small hands and feet. Large hands and feet, however, are occasionally met with among Carrier men. I do not speak of the complexion, because it varies even in the same tribe, according to the occupation and food of the natives. A hunter will never return from a tour of two or three months in the woods without being considerably bronzed, while his fellow tribesman who has remained at home, without being as white as a European, will yet be fairer complexioned than most individuals of the Salish race in the South. Even in the matter of beard, a notable difference is observable, in as much as full beards, dark and coarse, heavy with hardly any shaving, are by no means rare among the Babine sub-tribe, while the rest of the Western Dénés are remarkable for the scarcity, or sometimes the total absence of facial hair."

"If we now consider the Déné nation from a psychological standpoint, the contrast between its divers branches will be still more startling. The Northern Dénés are generally pusillanimous, timid, and cowardly. Now can this be said of the Apaches? The Northern Dénés, are, moreover,

lazy, without skill or any artistic disposition. Is it so with the Navajos? Even among our Carriers, the proudest and most progressive of all the Western tribes, hardly any summer passes off but some party runs home panic stricken, and why? They have heard at some little distance, some 'men of the woods,' evidently animated by murderous designs, and have barely escaped with their lives. Thereupon great commotion and tumult in the camp. Immediately everybody is charitably warned not to venture alone in the forest, and after sunset every door is carefully locked against any possible intruder. Compare these puerile feats of the Carriers with the indomitable spirit, the warlike disposition of the 'terrible Apache.' Compare also, the rude, inartistic implements, the primitive industries of the same tribes, with the products of the Navajo ingenuity, their celebrated blankets and exquisite silverwork especially —and tell me if, in this case, psychology is a safe criterion of ethnologic certitude. A noteworthy quality of the Northern Dénés, especially of such as have remained untouched by modern civilization, is their great honesty. Among the Tse'kehne, a trader will sometimes go on a trapping expedition leaving his store unlocked without fear of any of its contents going amiss. Meanwhile, a native may call in his absence, help himself to as much powder and shot, or any other item, as he may need; but he will never fail to leave there an exact equivalent in furs. Now, compare this naive honesty with the moral code in vogue among the Apaches. Read also what is said of the Lipans, another offshoot of the Déné stock; they "live in the Santa Rosa mountains, from which they stroll about, making inroads in the vicinity to steal horses and cattle." While on this subject our author may be again quoted: "Intoxicating liquors unscrupulously proffered them have demoralized the unfortunate natives, while immoral relations between their women and the whites have engendered maladies previously unknown and which have deprived the former of that fecundity which was formerly their pride."

Martin Sauer has referred to the food of the Tungus in dried fish, berries, etc., and to the boxes on trees or poles in which they kept supplies of it. Father Morice says: "The staple food of the Western Dénés, before the introduction of civilization and its concomitants, may be described under three heads, fish, meat and berries, to which correspond the co-relative pursuits of fishing, hunting and collecting." He describes at length the curing of fish and the drying of berries, and, in his Notes on the Western Dénés, he furnishes an illustration of the *tsa-tcen* or provision store of the Carriers, in which "is stowed away the dried salmon, which is the daily bread of both Carrier and Tsilkohtin. He thus describes it: "It consists of two parallel frames planted upright

in the ground, the component parts of which are furnished in the middle with transversal beams, upon which rests the floor of the *tsa-tcen* proper. With the exception of the front end, the whole is made of heavy poles superposed one upon another or laid in close juxtaposition, as the case may be, and fastened to the frame of the building by means of *'ken* or high-cranberry bush wattle. The front end is entirely of boards. All the wall poles being laid with their larger ends in the same direction, a slight inclination results at the top, which constitutes the roof of the building. This is furthermore covered with spruce bark." This *tsa-tcen* is identical with the food-box of the Tungus, and differentiates the race on both continents from neighboring tribes who make *caches* in the ground.

In regard to marriage, Father Morice writes: "Marriage in the Christian sense of the term is rather a misnomer when intended to designate native unions such as were contracted before the advent of the Missionaries in the country. Co-habitation would better answer the purpose. In fact, it is the corresponding expression they employ themselves when referring to a man married to such and such a woman. They say, *yeroesta*, "he stays with her." For, as there was no valid contract, and no intention on either side to consider their union as a permanent connection, divorce resulted as a matter of course whenever one of the partners was tired of the other. * * * Among the Se'kanais nothing was simpler or more expeditious than the contraction of marriage. Whenever a young hunter had made up his mind on mating a fair child of the forest, with scarcely any previous courting, he would, in the day time, simply ask the girl of his choice: "*Will you pack my beaver-snares for me?*" To which, if she refused him, she would make answer: "No, there are plenty of women, ask another one." But, if agreeable to the maid, she would at once answer, without any conventional blushes: "Perhaps, ask my mother." Upon which, the lad would not ask her mother, but the girl would immediately tell her about it. Then, following her parent's advice, she would hasten to erect a branch lodge alongside their own primitive habitation, and, in the evening, the affianced youth (such was he after the proposee's answer), would, on entering it, hand her his "beaver snares." Without further ceremony they were man and wife. * * * The preliminaries, if not more complicated, were at least more difficult and tedious among the Carriers. According to their etiquette, the intended wife had absolutely nothing to say for or against the projected union. Whenever a youth of a different clan had singled her out to be his future wife, he would not exchange a word with her, even when proposing, but, installing himself

at her father's home, he would begin to work for him, not failing to present him or the girl's most influential relative with anything of value which might come into his possession, either by hunting or otherwise. Meantime, he would never tell them the reason of such unwonted liberality, neither would they ask him, but they easily guessed it. When, after one or two years' wooing to his intended wife's parents, he thought a well-deserved "yes" was likely to reward his efforts, he would demand her from her father or guardian, through the instrumentality of an obliging friend. If agreeable, the suitor was thereby married. If not, then the recipient of his favours was bound to return an equivalent in kind. * * * Polygamy flourished to a great extent among all of the tribes. The more exalted the man's rank, the more numerous would be his wives. * * * Nevertheless, there was always one, not necessarily the first in priority of co-habitation, who was regarded as superior to the others, whom she then called her younger sisters, receiving in return the title of elder sister from them. Even polyandria was in honor conjointly with polygamy among the Se'kanais; but remained unknown to the Carriers."

DRESS AND ORNAMENTS OF THE TUNGUS AND THE DÉNÉS.

Abernethy does not sufficiently distinguish between Siberian peoples, when he says: "The Tungusi, Coriaks, Kamschadales, and other tribes in the northeast parts of Asia are differently attired from what they were a century ago. Like every other rude nation in their original state, they covered themselves with furs and hides, like the shepherds of Spain and Italy, the upper garment consisting of one piece, with a hood and sleeves; it bears also some resemblance to the dress of Capuchin Monks, though not so long, for it reaches not further than the knee. From the knee downwards they are covered with leggins of deer or buffalo skin; their shoes, also, are made of the same. These robes were formerly dressed with the hair on, but the Tungusi, especially, and the Coriaks have made themselves so well acquainted with the art of tanning, that hair is not seen in any part of their dress, except the hood, the neck, and the cuffs of the sleeves of the upper garment. The tanned covering is generally painted with considerable taste. The figures represent those animals which have been chosen by each tribe as their distinguishing marks. In the summer season they wear a kind of petticoat round the waist which comes down to the knees; it is made of coarse linen or cotton, which they manufacture themselves. At this time they paint their bodies with a variety of colors. The process of thus adorning themselves consists in pricking those parts of the body which are not

covered, and rubbing them over with different colors. * * * The warriors paint their faces that they may appear more warlike. Others who are not engaged in hostilities, do the same, because, I suppose, they imagine they look more handsome. * * * They take great pains to dress their hair, which is generally long and oily, by reason of being smeared with grease. The pendants in their ears and nostrils are usually shells, which are painted on one side with a red, and on the other with a blue color; but they never consider themselves in their full uniform without a crown made of the plumage of a bird called the *rootoo*. Their women may be said to follow the same practices, although they pay very little attention to their hair."

Santini confines himself to the Tungus. "As to the dress of the Tungusi, like that of every barbarous nation, it is generally made of the skin of wild beasts. This dress is simply fitted to the form and shape of the body, or, it is adorned with various ornaments, according to the degree of civilization which these nations have arrived at. The Tungusi, in their orginal state of barbarity, were dressed in skins; they painted their bodies and faces with various colors; they bored their noses and ears, whence hung colored shells. For their head covering they had crowns made of the skin of a young deer, ornamented with the plumage of rare birds, especially the peacock. Every part of their dress was embellished with coloured porcupine quills; they had shoes particularly suited to the winter, in order to traverse the snowy plains more easily; their length was about two feet. From the lightness and structure of these shoes, they were able to perform long journeys. The soles consisted of a net made of strings of a raw hide. * * * I have always observed among the Tungusi, at least, among the greater number of the men, that, in their modern dress they wear two shirts, one next their skin, and the other over their waistcoat. I do not know the reason of this custom; nevertheless, some have told me that it originated from the motive of vanity."

Sauer's statement is brief. "Their tents are covered with shamoy, or the inner bark of the birch, which they render as pliable as leather by rolling it up and keeping it for some time in the steam of boiling water and smoke. Their winter dress is the skin of the deer, or wild sheep, dressed with the hair on; a breastpiece of the same which ties around the neck and reaches down to the waist, widening towards the bottom, and neatly ornamented with embroidery and beads; pantaloons of the same materials, which also furnish them with short stockings, and boots of the legs of reindeer with the hair outward; a fur cap and gloves. Their summer dress only differs in being simple leather without the hair." In

his account of the Yukagirs, he says: "Their dress is now the same as the Russians of these parts: it was formerly like that of the Tungoose, whose tailors they still remain, embroidering the ornamental parts of their clothing, for which they receive in return articles of dress, skins or furs." Again, in his illustration of a Tungus settlement, facing page 44, he represents a native clad with an inner garment of a light colour, descending like a petticoat, to the knee, and an outer one, much darker, like a sleeved but open overcoat, falling a trifle lower. The store-house represented is very similar to that pictured by Father Morice, and the huts are circular, with conical roof made of branches, rising from a low wall of stakes or boards.

Of the Dénés, on the other hand, Mackenzie writes: "There are no people more attentive to the comforts of their dress, or less anxious respecting its exterior appearance. In the winter it is composed of the skins of deer and their fawns, and dressed as fine as any chamois leather, in the hair. In the summer their apparel is the same, except that it is prepared without the hair. Their shoes and leggins are sewed together, the latter reaching upwards to the middle, and being supported by a belt, under which a small piece of leather is drawn to cover the private parts, the ends of which fall down both before and behind. In the shoes they put the hair of the moose or reindeer with additional pieces of leather, as socks. The shirt, or coat, when girded round the waist, reaches to the middle of the thigh, and the mittens are sewed to the sleeves, or are suspended by strings from the shoulders. A ruff or tippet surrounds the neck, and the skin of the head of the deer forms a curious kind of cap. A robe made of several deer or fawn skins sewed together covers the whole. This dress is worn single or double, but always in the winter, with the hair within and without. Thus arrayed, a Chipewyan will lay himself down on the ice in the middle of a lake, and repose in comfort. * * * The snowshoes are of very superior workmanship. The inner part of their frame is straight, and it is pointed at both ends, with that in front turned up. They are also laced with great neatness with thongs made of deer-skin." Hearne has little to say on the matter of dress, beyond mentioning the fact that the attire of the Northern Indians was made of Cariboo skin, ornamented with its hair, and thus a receptacle for vermin; he also describes their snowshoes as quite different from those of the Southern Indians or Crees.

Father Morice quotes the Rev. E. Petitot as follows: "Besides the blouse of white skin, with tail appendages, decorated with fringes and metallic trinkets, which was the primitive costume of the Déné-dindjiés,

and which the Loucheux still wear, the former, as well as the Hares, add to it trousers of the same material and as richly adorned, to which the foot-gear is sewed. It is worn by women as well as by men. The more southern tribes replace the trousers by thigh pieces fastened to the legs by garters, and by an oblong breech-clout of any kind of stuff. The woman's robe is very short and adorned with a profusion of fringes, tufts of wool, beads, and jingling trinkets. The common foot-dress is the moccasin, or shoe of soft skin, which imprisons and fits the foot as a glove does the hand. During the winter, the reindeer, the beaver, and the arctic hare are laid under contribution to furnish the inhabitant of the desert with clothes that are at once warm and light and convenient." This quotation is followed by a minute account of the various articles of Déné attire, for which, for brevity's sake, I substitute Father Morice's words in " TheWestern Dénés—Their Manners and Customs." "As for extraneous ornaments of every-day wear, they consisted mainly of *haliotis* earrings and nose pendants, often of enormous size, hanging from the perforated septum. These were common to both sexes. * * * In common with the Nazarenes of old, men and women parted their hair in the middle and wore it at full length (except when in mourning), the men letting it fall on their back, tied together in a knot when in repose, and rolled up like that of the Chinese when travelling, while women had it resting on the forepart of their shoulders in two skilfully plaited tresses, adorned with a species of small, elongated shell (*Dentalium Indianorum*), which was highly prized among the natives, and which they obtained from the coast Indians." Sauer says nothing of the Tungus' method of wearing the hair, but his picture, opposite page 320, of a woman of the Tchuktchis, near neighbours of the Tungus, represents her as wearing it exactly in the fashion here described, the two plaits hanging in front of her shoulders. To resume : " As for their wearing apparel, without being strictly uniform, it may be said that, in no case was it of a very complicated pattern. Besides the " pagne," or breech-cloth, which was seldom removed, they wore a sort of tunic or loose vestment of beaver, lynx, or marmot skin, with the fur next to the body. The outside was painted in variegated designs in vermilion, and adorned with numerous fringes to conceal the seams, and bands of dentalium or dyed porcupine quills. A pair of leggings reaching to the thigh, together with moccasins, which, in the case of the poor, were of salmon skin, completed their costume. Unlike their kinsmen of the Great Mackenzie Basin, they had no hood attached to their coat or tunic, but instead, wore a head-dress made of a small ground-hog skin, and fashioned somewhat like a Scotch bonnet. The women's wearing apparel differed only from that of the men by the length of their tunic,

which was ordinarily covered with a skin cloak or a woven rabbit skin robe falling to their feet."

WAR AND WARLIKE IMPLEMENTS OF THE TUNGUS AND THE DÉNÉS.

Mr. John McIntosh, author of "The Origin of the North American Indians," says: "When war is declared among the Tongusi, according to Abernethy, Santini, and others, the first ceremony, which is the same among the North American Indians, is *to hang the kettle on the fire*," Abernethy, speaking of warlike expeditions, says: "Some tribes among the Tungusi and Coriaks paint themselves black the day before they depart; this colour, however, is changed to red on setting off. * * * The Tungusi, in order to ascertain the courage, patience, and perseverance of their warriors, inflict many injuries and insults on the young people who never faced an enemy. They first reproach them with the names of cowards; they beat them with their clubs and even throw boiling water on them, and if they show on these occasions the least impatience and sensibility, they are reckoned as dastards who are not worthy of the name of warriors. They carry this practice of trying the young men so far that it would be too tedious to relate them. * * * When the day of departure is arrived, they are not at all void of those tender feelings which are always found among any civilized nation on occasions of this sort. They give mutual pledges as assurances of a perpetual remembrance. At their departure, the whole village meets at the cabin of the chief, which is now surrounded by warriors. On coming out of his cabin, he addresses them for the last time. After his speech, he again sings the song of death, and they all take their leave of their families, friends and relatives. * * * Their arms are bows and arrows, a javelin and a *head-breaker*. Their defensive armour consists of the hides of buffaloes, and sometimes a coat of pliable sticks, woven and pretty well wrought." Sauer has nothing to say of the Tungus in war, but states that they hunt with bows and arrows; but he has a picture facing page 321, of a Tchuktchi man in armour, to which he appends this note: "The armour is made either of lath-wood, with thin bone, or, if they can obtain them, iron hoops in preference; they are fastened together with the sinews of seals, so that they will bend both ways, and are covered over with leather which is bound on with thin slips of whalebone, which gives it the appearance of so many hoops. They are replete with loops and buttons, upon which they hang their bows, arrows, etc.; the upper part occasionally lets down." To return to Abernethy: "Innumerable ceremonies attend the entrance of the warriors into their villages on their return from the field of battle. The

Tungusi enter in great triumph. They send two messengers before to announce their approach and relate their success, if they come off conquerors. All their friends of both sexes are summoned to meet them, at some distance from the village, with provisions and other refreshments. Here they make a feast, during which everyone recounts his own exploits and heroic actions. After they amuse themselves with dancing and singing, they return home, where they are entertained with more sumptuous festivities which last for several days. The prisoners are contented with singing mournful airs, in which they implore the compassion of their conquerors. When captives are adopted among them, they fail not to show them that they are no less humane than they are ferocious when they inflict punishment."

Mackenzie describes the arms of the Slaves and Dogribs: "Their arms and weapons for hunting are bows and arrows, spears, daggers and pogamagans, or clubs. The bows are about five or six feet in length, and the strings are of sinews or raw skins. The arrows are two feet and a half long, including the barb, which is variously formed of bone, horn, flint, iron or copper, and are winged with three feathers. The pole of the spear is about six feet in length, and pointed, with a barbed bone of ten inches. With this weapon they strike the reindeer in the water. The daggers are flat and sharp pointed, about twelve inches long, and made of horn or bone. The pogamagan is made of the horn of the reindeer, the branches being all cut off except that which forms the extremity. This instrument is about two feet in length, and is employed to dispatch their enemies in battle, and such animals as they catch in snares placed for that purpose."

Hearne gives the details of an attack made by his Northern Indians upon a body of Eskimos. The expedition began by leaving the women and children and the baggage behind. "The separation then took place, but hardly were we on the march when they uttered lamentable cries, which were prolonged until the moment we lost sight of them. This heart-rending scene made so little impression upon the Indians who accompanied me, that they continued their march laughing, and I may even say that I never saw them more joyful." Several other Indians came to share in the glory of the expedition, concerning whom Hearne says: "Each of them, as well as my own Indians, had made shields for themselves before leaving the wood of Clowey. These shields, made of boards, were about three-quarters of an inch thick, two feet wide, and three feet long. They were intended to parry the arrows of the Esquimaux. * * * Arrived on the other side, each of my companions set himself to paint the face of his shield. Some depicted

the sun, others the moon, some birds and others beasts of prey. A large number painted imaginary beings, who, according to this poor people's belief, inhabited the elements, the earth, the sea, the air, etc. * * * I observed, as a singular fact, that my company, which seemed to have so far ignored all subordination, in this horrible circumstance exhibited the greatest uniformity of will and sentiment. Reunited among themselves for the same purpose, all the Indians were ready to follow Matonabbee wherever he wished to lead them. * * * Never in any assembly of men did private interest hasten more eagerly to make sacrifices for the public good than on this occasion, for, whatever an individual had in possession, he at once shared with him who was destitute of it. All that friendship, generosity, disinterestedness, could effect upon the heart of a Northern Indian was never developed so brilliantly. One would have said that there reigned in this people public spirit, a kind of national pride; and the barbarians meditated the most cowardly of crimes. * * * While we were in ambush, the Indians made their final preparation for battle. Some painted their faces black, others red, several a mixture of the two colours, and to hinder their hair falling over their eyes, they tied it in front, behind, at the sides, or cut it very short all round the head." When the massacre and pillage were ended "they betook themselves to the top of a neighbouring height, where, forming a circle, they sang several songs in honour of their victory, brandishing and clashing their spears. Often they interrupted the clangour to cry out *Tima? Tima?* in derision of the poor Esquimaux, who had taken refuge on a sand bank where the water was up to their knees." In Eskimo, *tima* is a friendly greeting. equivalent to: How do you do?

Father Morice enumerates the arms of the Western Dénés; their bows from four to five and a half feet long, their bone and flint arrow, dart, and spear heads, and their stone *casse têtes*. He also mentions their shields, "oval in form, like the Roman *clypeus*, and generally made of closely interwoven branches of amelanchier alnifolia. While on the warpath they also wore a kind of armour or cuirass consisting of dried sticks of the same kind of wood, arranged in parallel order and kept together with babiche lines interlaced in several places. This was common to the Haidahs and other coast Indians." The fact that this armour was found in Asia among the Tungus and the Tchuktchis, as attested by Abernethy and Sauer, proves that it was introduced to America by tribes of northern Asiatic derivation; yet, Washington Irving, in the twenty-second chapter of the second volume of his Astoria, mentions it as part of the defensive armament of the Tsinuks, and

Pickering, in the third chapter of his "Races of Man," assigns it to the Klamets or Lutuami of Oregon. Father Morice continues: "It would scarcely be proper to speak of war as an institution obtaining among the pre-historic Western Dénés. Although the various tribes despised and mistrusted each other, general fights were rare enough, and, as surprises constituted the main part of their system of warfare, it followed that success was, as a rule, on the side of the assailants. Sometimes the whole population of a village would be massacred in a single night. In that event, the victors would chant their hymn of victory, generally improvised on the spot and composed of the last words uttered by their victims. After their return from the fray, they would also repeat it dancing for several nights in succession. In no instance was scalping resorted to, at least, on this side of the Rockies." The wars of the Apaches and other southern tribes were more serious, but I possess no authentic details concerning them.

FUNERAL CUSTOMS OF THE TUNGUS AND THE DÉNÉS.

Abernethy remarks that, "the Tongusi evince a great deal of tenderness at the death of any of their family; their mourning sometimes lasts for a whole year. For several days they are commonly exposed on scaffolds within their cabins, and at other times near the place of interment. They bring them presents and food, which is consumed, they imagine, by their spirits." Mr. Macintosh quotes Santini and LaRoche as saying: "That the Tongusi and Coriaks mourn for the deceased for a considerable time and that the pits and graves where the dead are to be carried must first be fumigated or incensed, by burning, rosin or some dried aromatic herbs." He also quotes Santini to the effect "that it was customary among the Tongusi and Coriaks to bury along with the dead, everything that was dear to them while alive, especially their arms and family distinctions." Sauer's record is very brief. "They do not like to bury their dead, but place the body, dressed in its best apparel, in a strong box, and suspend it between two trees. The implements of the chase belonging to the deceased are buried under the box. Except a sorcerer is very near, no ceremony is observed; but, in his presence, they kill a deer, offer a part to the demons and eat the rest."

Of the Chepewyans Mackenzie says: "That they should not bury their dead in their own countrycannot be imputed to them as a custom arising from a savage insensibility, as they inhabit such high latitudes that the ground never thaws; but it is well known that, when they are in the woods, they cover their dead with trees. Besides, they manifest

no common respect to the memory of their departed friends, by a long period of mourning, cutting off their hair, and never making use of the property of the deceased. Nay, they frequently destroy or sacrifice their own, as a token of regret and sorrow." Hearne writes: "These people do not bury their dead. They abandon them in the place where they die, so that one must suspect they are eaten by wild animals and birds of prey. This is the reason why the Indians never eat the fox, the wolf, nor the crow, unless constrained by necessity. On the death of one of their near relatives, they strip themselves of their clothes and remain naked till someone comes to console them. The mourning for a father, a mother, a wife, a son, or a brother lasts a whole year. With the exception of shorn hair, nothing indicates this mourning in the costume of the Northern Indians. It consists solely in uttering cries almost incessant. Apart from time devoted to sleep and eating, whether they walk or rest, they emit at intervals a prolonged howl, which is often repeated in unison by all persons present."

Dr. Yarrow, in his "Introduction to the Study of Mortuary Customs among the North American Indians," says: "Tree burial was not uncommon among the nations of antiquity, for the Colchians enveloped their dead in sacks of skin and hung them to trees; the ancient Tartars and Scythians did the same." What he says regarding the Colchians is taken from Arrian, De Var. Hist. IV. 1, but I have a very distinct recollection of coming across similar facts in classical authors which I have not succeeded in verifying. It is unfortunate that Dr. Yarrow or his informant does not mention his authorities. However, I quote Dr. Yarrow at page 75 for the following: "W. L. Hardisty gives a curious example of log-burial in trees, relating to the Loucheux of British America. 'They inclose the body in a neatly-hollowed piece of wood, and secure it to two or more trees, about six feet from the ground. A log about eight feet long is first split in two, and each of the parts carefully hollowed out to the required size. The body is then inclosed and the two pieces well lashed together, preparatory to being finally secured, as before stated, to the trees.'" Mr. Dall, in his "Distribution and Nomenclature of the Native tribes of Alaska, etc.," has the following notes on Tinneh tribes: "*Unakhotana*—the bodies of the dead are always placed by them above ground in a box or wooden receptacle. *Kutcha-Kutchin*—They formerly burned their dead. *Tehanin-Kutchin*—They bury their dead in boxes above ground on which they pile up stones."

Father Morice's account is fuller than the preceding, and will be found in his paper, "The Western Dénés—their Manners and Customs." It sets forth the wailings of the relatives for a deceased man of note, the

announcement of his death to all concerned by young men of another clan who were rewarded for their pains, the singing and dancing of a mercenary alien clansman, to the assembled mourners, meeting for several nights. The remains were then provisionally placed under a bark roof-like shelter, near which the widow and children dwelt in a small hut of similar form. For two or three years the widow was the slave of her husband's relations, and bewailed him. Then his chief representative, having acquired much property, was prepared for the cremation of what remained of the corpse. In view of a large assembly the funeral pile was kindled, and attempts were made to burn the widow, after which the property was given away in a potlatch. This was the Carrier custom, but among the Sékanais it was different. "Supposing the deceased was an influential person, dear to the band, they would hollow a kind of coffin out of a large spruce tree, and suspend his remains therein on the forks formed by the branches of two contiguous trees. Some instances are also recounted in which the remains of such persons were closed up in a standing position in the hollow trunk of a large tree while in its natural state. The lid or door of these primitive coffins was usually formed of a split piece of wood, which, when strongly laced with long switches of red willow, held it to the trunk of the tree in its original shape."

PECULIAR ARTS OF THE TUNGUS AND THE DÉNÉS.

It has already appeared that the Tungus and the Dénés equally made use of porcupine quills and beads, or, in default of the latter, tubular shells, such as the dentalium, in the ornamentation of their dress. The snowshoe was common to both. This contrivance is, at least, as old as the Christian era, for Strabo found it in the Caucasus. "The heights are impassable in winter; in summer they are ascended by fastening on the feet shoes as wide as drums, made of raw hide, and furnished with spikes on account of the snow and ice." The toboggan, or sledge, was also a Tungus vehicle drawn by horses and reindeer, but more frequently by dogs, and not seldom by men or women. The Russians classified the Tungus in relation to it, as Horse, Reindeer, Dog, and Foot-going Tungus. This toboggan was called by the different tribes *natar*, *tolyoki*, *tolgoki*, *turki*, *sherche*, and *fara*. By a strange perversity, none of my vocabularies contain the Dené word for toboggan, and Father Morice, in his Notes on the Western Dénés, has nothing to say regarding it. Mackenzie, referring to the Chepewyans, as he calls them, remarks: "The sledges are formed of thin slips of board turned up also in front, and are highly polished with crooked

knives, in order to slide along with facility. Close-grained wood is, on that account, the best ; but theirs are made of the red or swamp spruce-fir tree."

Hearne writes : "In winter, the Northern Indians tie together skins of cariboo legs, which, in this condition, present the form of long portmanteaus. Stripped of their hair by being dragged over the snow, they become smooth as kid, and serve to transport the baggage of the Indians when they traverse the barren lands; but, in the first wood they meet, they make genuine sledges with planks of spruce. These sledges are of different sizes according to the strength of the persons meant to draw them. I have seen some that were no less than from twelve to fourteen feet long by fifteen to twenty inches broad ; but, generally, they are from eight to nine feet long and from twelve to fourteen inches wide. The boards of which they are made are not more than a quarter of an inch thick, and their width rarely exceeds five or six inches. Larger dimensions would not suit the implements of these Indians, which consist of ordinary knives, a little turned at the point, whence the Northern Indians give them the name *base-hoth*, and the Southern *mo-co-toggan*. These boards are bound to each other by parchment bands of cariboo skin, and crossed above by several bars of wood which serve to strengthen the sledge, and, at the same time, keep the baggage in place, which is fastened to them by smaller leathern thongs. The front of the sledge forms a semi-circle of from, at least, fifteen to twenty inches in diameter. This kind of front has for its object to hinder the sledge sinking in the snow, and, at the same time, to break down the hillocks produced by it on the plains and barren lands. The traces of these vehicles consist of a band of leather, the two ends of which are united and tied firmly together. The person charged with the drawing of the sledge passes it round his shoulders so that it adheres to his breast. Simple as this harness may be, I defy all the saddlers in the world to make a better." Finally, Father Morice says : "Another mode of travelling, proper to the cold season, is by means of light toboggans or sleds drawn by three or four dogs, trotting along in Indian file. These animals (which are now of different breeds), are very serviceable to the natives; for, even during the summer, when families are en route for their hunting grounds, their canine companions are compelled to assist the women in packing part of their master's baggage, firmly secured with lines to their sides."

The Tungus make extensive use of birch bark for covering their houses, for making various kinds of vessels, and for enwrapping the bodies of their dead. They also employ it in the manufacture of canoes

Mr. McIntosh quotes Pennant as saying: "The Tongusi use canoes made of birch bark distended over ribs of wood, and nicely sewed together. The Canadian and many other American nations use no other sort of boats. The paddles of the Tongusi are broad at each end; those of the people near Cook's River and of Onslascha are of the same form." We know that Pennant is right, for the Tungus have a special name for the birch bark canoe which they call *djalban-dyau*, the first word denoting the birch tree.

Mackenzie thus describes the canoes of the Dogribs: "Their canoes are small, pointed at both ends, flat-bottomed, and covered in the fore part. They are made of the bark of the birch-tree and fir-wood, but of so slight a construction that the man whom one of these light vessels bears on the water, can, in return, carry it overland without any difficulty. It is very seldom that more than one person embarks in them, nor are they capable of receiving more than two. The paddles are six feet long, one-half of which is occupied by a blade of about eight inches wide." Hearne's description is as follows: "The canoes of the Northern Indians are in form somewhat like a weaver's shuttle, having flat bottoms, straight sides and pointed end. The stern is always much larger than the bow, as generally intended to hold baggage and sometimes to be occupied by a second person, stretched at full length in the bottom of the canoe. The man and the baggage cross rivers and the narrower parts of lakes by means of these little crafts, which rarely exceed from twelve to thirteen feet in length and from twenty inches to two feet in their greatest beam. The bow of these canoes is elongated and narrow; it is covered with birch-bark which adds considerably to the weight without adding anything to its usefulness. Generally the Northern Indians make use of a single paddle, though some have a second, like the Esquimaux; but the latter is rarely employed, save to club cariboo when crossing rivers or narrow lakes." Father Morice says of the Carriers: "They use 'dug-out' canoes made of the hollowed out trunk of a large cotton-wood tree *(Abies subalpina)*. There is no artistic merit in their design, which is of rather a rough description, for we must not forget that 'dug-outs' are, among them, a recent importation from the East. In the beginning of this century they used only birch bark canoes."

RITES AND CEREMONIES OF THE TUNGUS AND THE DÉNÉS.

Abernethy states that "The Tongusi believe in the existence of a supreme being, according to whose will they shall either conquer or die. They call him the *god of hosts*, because on him, they

imagine, the fate of their warlike expeditions depends. They worship likewise an *infernal Demon*, whose attributes are wrath and vengeance; while they invoke him, they are influenced solely by fear, lest he may afflict or torment them, for they believe that from him all their calamities and misfortunes proceed. As to a future state, they are as charitable as the *Universalist*, for they cannot bear to hear of a future state of torment and damnation. On the other hand, they imagine that they are to enjoy all the pleasures after which they aspired in this world. They have their priests, prophets and physicians; and their sacrifices consist generally of those brute animals which they consider the greatest favourites of the evil spirit, for they seldom supplicate the *Great Spirit*, except before battle, as they deem him a benevolent Deity, who is disposed to favour, rather than torment them.

* * * By offering sacrifices to the malevolent spirit, for it is seldom that they worship the benevolent *deity*, they think that they can avert his wrath. I have often observed that the Tongusi, of all the other tribes of Siberia, are those who pay the greatest attention to this religious ceremony; for, whenever they labour under diseases or scarcity of food, they first offer a sacrifice and then set out to hunt, fully convinced of their success. Their mode of offering sacrifices is attended with many ceremonies which are performed by their bravest warriors. Having lighted a fire, they take a dog, and sometimes a bear, which they suspend above the fire by several poles, till the animal is totally consumed. It is customary among some Tongusian tribes to dance during the sacrifice; there are others, however, who stand silent and motionless till the offering is completed. Then a dance commences which lasts for several hours, as if rejoicing for appeasing the angry *demon*. Before they go to battle they never fail to make an offering. Then all their villages are assembled and they form a kind of procession. The women walk one after another till they arrive at the spot where the sacrifice is to be offered. This place is generally some elevated ground at some distance from the village. The warriors march in full uniform with their faces painted. Before the *dog* is committed to the flames, they whisper something in his ear, telling him, as I have been told, to obtain for them the assistance of the *great* or *benevolent* spirit in battle, and prevent the *evil* or *mischievous* one from punishing them."

"On the night previous to their departure a very singular entertainment is given by the chief, in which the *Potoosi*, or the *sacred pipe*, is introduced, for the purpose of binding the warriors to fidelity and bravery. The Potoosi, among all the Tongusian tribes, is considered a sacred instrument, which their fathers received from the *Great Spirit* or

God of War, to make vows by fuming tobacco. On the evening therefore, before they depart, the warriors are summoned to appear before the chief in their martial uniforms. The women also attend, and they are attired in their richest robes. Having formed a circle, the musicians stand in the midst. Their music is very simple, for it consists only of two instruments, which produce neither harmony nor order. The dancers, however, keep time to the cadence of the music. This dance, as usual, was a ring or circle in which they moved roundwards incessantly, till it was announced to seat themselves on the ground to partake of the feast, the principal dish of which consists of the flesh of a *white dog*. Before the dog is put into the *kettle* they perform several ceremonies in offering him while alive to the *Great Spirit*; for they imagine that no animal is more pleasing, in a sacrifice, than a white dog. All their feasts are supplied with the flesh of the dog, and they might as well be called *sacrifices* as *feasts*; because the offering of the dog to their Supreme Deity always precedes the feast. After the dogs are consumed they rise and renew their dances. The first thing, however, after the feast, is the offering of the *Potoosi* to the *Great Spirit* by the senior chief. The fumes of the pipe are directed upwards towards the Great Spirit. This ceremony resembles, in a great measure, the Asiatic offering of *incense*. When the Chief imagines that the *Deity* is fully satisfied with this act of adoration, every warrior in his turn takes the pipe, which is decorated with various ornaments, and, at every *quiff*, promises to adhere to his commander, and never fly from his enemy. At the same time he relates what he has done in favour of his nation, and he foretells his future achievements. The Chief takes the *Potoosi* a second time, and, at every quiff, he enumerates the various engagements in which he conquered his enemies. The whole assembly then join in applauding his bravery and undaunted spirit. The feast of the Potoosi is concluded with the *song of death*, in which they swear vengeance against their enemies. Then they retire to their cabins or huts, to prepare for their departure on the following morning."

Mr. McIntosh, referring to the festivals of dreams, which he compares to the ancient Saturnalia and modern Carnivals, remarks: "According to Abernethy, they paint and disguise themselves when they go abroad, without paying any respect either to morality or decency. Many of them, especially among the Tongusi, says the same author, consider this a favourable opportunity of revenging insults and injuries, because they imagine that they are not known to the sufferer. * * * Abernethy speaks of his having disguised himself on one of these occasions among the Coriaks for the sole purpose, as he himself tells us, of saving his life;

because he considered them actually deranged, and consequently his life in danger on account of being a stranger and a foreigner. Santini found himself in the same predicament among some tribes of the Tongusi, and would most likely have been grossly insulted, had not his converts, the Tongusian princes, interfered in his behalf."

Gambling is not a ceremony, but it may be considered here, being unworthy of a special treatment. Mr. Mcintosh says: "The game of the Patooni, which LaRoche briefly describes, was, from every appearance, originally the same as that of the *little bones* among the American Indians, although in Kamschatka sticks were substituted for bones." "It is surprising," says LaRoche "to witness the simplicity and superstition of some of these people while they play some games. Before they set out to hunt they frequently form a party to play the *Patooni*, which consists in throwing up in the air small sticks about the size of an orange, with four sides, and resembling the dice of the Europeans, because each side has a certain number. He who has the greatest number upwards when they fall to the ground, is conqueror, and expects to be the most successful in the chase. It is considered, therefore, to be a great favour to belong to the winner's party when they separate themselves into different companies, because they imagine that they cannot be utterly disappointed while they are the associates of him who is to kill the most." Abernethy observed this and other frivolous games, which he did not deem worthy of any notice. Santini, in speaking of a certain game, which he does not describe, says that the Tongusi, when they played, resembled madmen more than rational beings, from the way in which their feelings were excited.

In regard to the rites of the Déné-Dindjiés, Father Petitot says: "It is not easy for any European to discover the customs and ceremonies of this people, because they surround them with mystery and distrust strangers. A long stay among the Indians, and the confidence of the old men, from whom I derive knowledge of the Déné traditions and of a considerable part of their customs, have alone enabled me to make the discovery." This discovery amounts to the fact that the Dénés have a mythology with its gods and devils, that they believe in the immortality of the soul, and that, in lieu of priests, they have jugglers or medicine men, who practice confession, fasts and songs which are called incantations, and to whom they attribute the power of recalling spirits to earth. He also states that the Déné-Dindjiés abhor the dog and never eat its flesh. In his other particulars there is such an evident straining after Hebrew analogies as to make them doubtful guides.

Hearne represents the dog as the father of the Northern Indian race and of all creatures. Then he says: "The Indians have no religion, and though their sorcerers, by songs and long discourses, conjure beasts of prey as well as imaginary beings, by which they pretend to be helped in the cure of diseases, they are as deficient as their credulous compatriots of any religious system." He tells how his Indians had been rendered ceremonially unclean by killing the Eskimo, which condemned them to abstinence of many kinds. "When the time to put an end to these ceremonies arrived, the men, having carefully removed the women, lighted a fire at some distance from their tents and threw into it all their ornaments, their pipes and their eating utensils, which were soon reduced to ashes. They then prepared a feast, composed of everything that had been denied them during their time of expiation, and, when it was ready, they were all free to eat, drink, smoke and embrace their wives and children at will."

Mackenzie gives the story of creation somewhat differently, making the large bird, which, according to Hearne, produced all creatures from the fragments of the primitive dog, to call forth "all the variety of animals from the earth, except the Chipewyans, who were produced from a dog; and this circumstance occasions their aversion to the flesh of that animal as well as the people who eat it." The same author says: "They are superstitious in the extreme, and almost every action of their lives, however trivial, is more or less influenced by some whimsical notion. I never observed that they had any particular form of religious worship; but, as they believe in a good and evil spirit, and a state of future rewards and punishments, they cannot be devoid of religious impressions. At the same time, they manifest a decided unwillingness to make any communications on the subject. * * * They believe that, immediately after their death, they pass into another world, where they arrive at a large river on which they embark in a stone canoe, and that a gentle current bears them on to an extensive lake, in the centre of which is a most beautiful island; and that, in the view of this delightful abode, they receive that judgment for their conduct during life which terminates their final state and unalterable allotment. If their good actions are declared to predominate, they are landed upon the island, where there is to be no end to their happiness; which, however, according to their notions, consists in an eternal enjoyment of sensual pleasure and carnal gratification. But, if their bad actions weigh down the balance, the stone canoe sinks at once, and leaves them up to their chins in the water, to behold and regret the reward enjoyed by the good, and eternally struggling, but with unavail-

ing endeavours, to reach the blissful island, from which they are excluded forever."

Our author, in another place, thus refers to the dances of the Slaves and Dogribs: "During our short stay with these people they amused us with dancing, which they accompanied with their voices, but neither their song or their dance possessed much variety. The men and women formed a promiscuous ring. The former have a bone dagger or piece of stick between the fingers of the right hand, which they keep extended above the head in continual motion; the left they seldom raise so high, but work it backwards and forwards in an horizontal direction; while they leap about and throw themselves into various antic postures, to the measure of their music, always bringing their heels close to each other at every pause. The men occasionally howl in imitation of some animal and he who continues this violent exercise for the longest period appears to be considered as the best performer. The women suffer their arms to hang as without the power of motion." Finally, Mackenzie treats of the game of the Platter as played by the Beaver and Rocky Mountain Indians: "The instruments of it consist of a platter, or dish, made of wood or bark, and six round, or square, but flat pieces of metal, wood, or stone, whose sides or surfaces are of different colours. These are put into the dish, and, after being for some time shaken together, are thrown into the air and received again into the dish with considerable dexterity, when, by the number that are turned up of the same mark or colour, the game is regulated. If there should be equal numbers, the throw is not reckoned; if two or four the platter changes hands. * * * They carry their love of gaming to excess; they will pursue it for a succession of days and nights, and no apprehension of ruin nor influence of domestic affection will restrain them from the indulgence of it."

After the mention of certain feasts and dances, Father Morice adds: "Another observance, formerly in vogue among the Carriers, was the *the'-tsoelrwoes* (precipitate exit). This was analogous in character to, if not identical with, a practice of which we read as having existed among certain European and Asiatic nations, the *Lycanthropia* of the ancients, the *Loupgarou*, of France, the Persian *Ghoule*, the Teutonic *Wehr-wolf:* all, probably, the result of a simulated ecstasy of superstitious origin. In the case in question and on the occasion of a large gathering of aborigines, a band of men would suddenly run out of a lodge, and, simulating madness, would, amidst wild yells and incoherent songs, make frantic efforts to bite the passers-by, or, failing in this they would seize upon a dog and devour him on the spot. * * * Apart from the superstitious dances of which mention has been made in the preceding

paragraph, the Western Dénés observed no religious ceremonies. They made no sacrifices, worshipped no deity, and had no definite *cultus*, unless we dignify with that name the Shamanism of the Northern Asiatic races which obtained among them. True, they vaguely believed in a kind of impersonal and undefined Divinity, not quite pantheistic, but rather more so than individual, almost co-essential with the celestial forces, the cause efficient of rain and snow, winds and other firmamental phenomena. They called it *Yuttoere* (that which is on high), in Carrier. But they did not worship this power—they rather feared it and endeavoured to get out of its reach, or, when this was impossible, to propitiate it and the spirits who were supposed to obey it, with the help and through the incantations of the *nelhgen* or conjurer. This shaman was credited, when exercising his mysterious art, with the power of controlling the coming or departing of evil spirits. Even when not actually conjuring, he was believed to be able to kill by his mere will any objectionable person. His services were called into requisition in time of famine, to prevent tempests, procure favourable winds, hasten the arrival of salmon and ensure its abundance, but, more generally, in case of sickness, which they believed to be concrete (not unlike the microbes of modern chemists), and always due to the presence or ill-will of spirits." Elsewhere Father Morice says: "We find that the Navajos and Apaches still hold to their superstitious beliefs and ceremonies, and keep themselves aloof of any civilizing influence."

The mythology, rites and ceremonies of the Apaches and Navajos are very elaborate. Some of them are treated in the Fifth and Eighth Annual Reports of the United States Bureau of Ethnology, by Dr. Washington Matthews and Mr. James Stevenson. These tribes had altars and sacrifices, but whether they sacrificed white dogs, as formerly did the Dakotas, I have no present means of knowing. The eating of a live dog by the Carriers in their lycanthropy looks like the degradation of an original rite connected with the animal, and the almost universal tradition that derives the Dénés from a canine ancestor is too remarkable to pass over. In his Three Carrier Myths, Father Morice gives three such traditional stories, one of which is embalmed in the Dogrib name. One of the Tungusi tribes was called "Indachun takurara Golo," the region where dogs are kept. In a paper contributed to the Royal Society of Canada, Father Morice has illustrated the propensity of the Dénés to borrow foreign customs, and thus almost necessarily to lose their own. It is, therefore, hardly begging the question to ask whether the white dog sacrifice of the Tungus may not have been one of the Déné rites that have fallen into desuetude in the course of years.

THE LANGUAGE OF THE TUNGUS AND THE DÉNÉS.

An instance of the strange over lookingof things that lies immediately at one's hand is the conduct of Mr. Lucien Adam, of Nancy, who, the author of a Mantchu grammar and the analyzer of that of the Western Montagnais, failed to perceive the intimate relation of the two grammatical systems. The Tungus and the Déné exhibit the chief peculiarity of Northern Turanian languages, that is to say, they are postpositional, and place the genitive and accusative before their regimen. In these respects they agree with the Japo-Siberian tongues of Asia, and the Dakotan, Iroquoian, Muskhogean, and the American families of speech which I have classified as Khitan. But they are differentiated from the Khitan languages by marked peculiarities. Father Morice calls attention to the monosyllabic roots of Déné substantives, as Adelung and Vater did long ago in the case of the Mantchu. The former says: "A third process of a different nature, change of meaning by intonation or vocal inflection, obtains also among some—not all—of the Déné tribes. Some of these intonations are even proper to fractions of tribes only. Thus *ya*, which means 'sky,' in almost all the dialects, becomes 'louse' to a Southern Carrier when pronounced in a higher tone." Adelung has many illustrations of this supposed Chinese peculiarity in Mantchu, as when he says, "*Bi*, for instance, means I, to be, to have, to leave; *be*, we, to take, birds' food, uncle, axle, and handle." But he adds, "whether these different meanings are distinguished by the tone, I do not know." The two groups agree in the absence of the article in each, and in that of true gender, and the substitution for it of a distinction between names as intelligent or unintelligent, noble or ignoble, animate or inanimate; also, in the formation of the plural by affixing an adverb of quantity. The genitive is expressed in each by adding to the name of the possessor that of the thing possessed, preceded by the third personal pronoun. The incorporation of pronouns and postpositions marks equally the Asiatic and the American families compared. There is the closest affinity between the Tungus and the Déné languages in regard to the inumerable modifications of the verb and substantive to express variety and quality of action and being found in each. Both groups agree in prefixing the pronoun to the verb, thus differing from the Ugrian and Turkish order of pronominal affixes. So far as grammatical structure is concerned, it may safely be said that the Déné dialects are not Japo-Siberian, Mongolic nor Turkic, but Tungusic. Even their

polysynthesis is not that of the Koriak-Tchuktchi of Siberia nor of the American Iroquois, which is the same, but of the Tungus.

I append a list of over 170 words, comprising different parts of speech in the two languages. For the Tungus, I am indebted almost entirely to Klaproth's Asia Polyglotta. The Dené I have taken from a great variety of sources, including vocabularies of tribes from the Eskimo border on the north, to Mexico in the South. These I have copied in good faith, though, it is quite possible, they may contain erroneous equivalents of the English terms. I regret the deficiency of my vocabularies in particles, especially postpositions. The numerals on comparison show strange discrepancy, either indicating that those of the Dénés belong to an archaic Siberian system, or that, prior to their advent to this continent, they had borrowed from the Kamtchadale Koriaks. It is strange that their 3 and 4 should be the same as the Tungus 4 and 5. Father Morice has questioned the native origin of Dené government by *toenaz-as*, notables or chiefs ; but it is certain that the Tungus recognized the distinction between such and the common people, and the Tungusic forms for lord and master, such as *edshen*, *hunniu*, *ungiu*, *nyunga*, and even *turunbayo*, suggest the original of *toeneza*. He has also stated that pipes and tobacco were unknown to the Carriers and Tsé'kéhne before the arrival of Sir Alexander Mackenzie. It is, therefore, strange to find the Orotong Tungus word for tobacco-pipe, *tagon*, so near in form to the Dené *tekatsi*. There is little doubt that the pipe was originally a sacred instrument or incense burner, and as such is prehistoric in many lands, independent of tobacco.

A dialectic difference of the Dené as compared with the Tungusic forms of speech is the replacement of labials, including m, and of r, by other sounds. So far as labials are concerned, the same is true of the Iroquois dialects as compared with their Asiatic relatives. This evidence of phonetic decay marks an unliterary language in transition through changed circumstances, in which climate, no doubt, played a large part There appears, also, that interchange of liquids which is so common a feature in northern Asiatic and American dialects, as in the Tungus *halgar* and *halgan*, foot ; and even of less accountable variations, as in the forms for grass, *orokto*, *owokto*, *okokto*. A common Tungus term for the throat is *bilga*, but the Tshapogirs call it *nemgot*, both being derived from the same original root. Almost as great variations appear among Tungus words, as compared among the Asiatic dialects, as between them and those of the Dené forms of speech. It would be no matter for surprise to find the Dené *kliuthchu*, bread, in a comparative

vocabulary of the Tungus dialects, alongside the native *kiltora*; or *tiljkan*, day, with *tirgani*; or *hamiltu*, to give, with *omuli*; or *antonger*, to go, with *genigar*; or *dellin*, green, with *tshurin*; or *tulkun*, red, with *fulachun*. Some words in the two groups are quite irreconcilable, the result, in some cases, of borrowing, on the part of the Tungus from the Mongols and Koriaks, and on that of the Dénés from surrounding American tribes, although their dialects exhibit distinct traces of Koriak influence in an Asiatic habitat. The argument for the original unity of the Dénés and the Tungus is as convincing as that which joins the Indo-Europeans or Aryans in one family.

THE OTHOMIS OF MEXICO THE MOST ANCIENT TUNGUSIAN COLONISTS OF AMERICA.

The identification of the Dénés with the Tungusic stock has led to an important discovery, to wit, that the Othomis, supposed to be one of the oldest peoples of Mexico, are of the same family. Anthropologists have long called attention to their almost monosyllabic speech, and have compared it with the Chinese. In a few features of grammar and vocabulary the Othomi exhibits traces of Huastec-Mayá-Quiche influence, but in very few. I subjoin a comparative vocabulary of over a hundred and fifty words of different syntactical value, in which the Othomi is placed opposite Tungus and Déné equivalents, to its complete identification with these tongues. In the Othomi, therefore, we have the simplest and oldest extant form of Tungusic speech, as its primitive forms plainly indicate, and, at the same time, the language employed by Attila and his Huns in the middle of the fifth century. In one of the dated tablets from the Mounds, which I had the honour to submit to the Institute in December, 1894, that namely of Davenport, Iowa, the first authentic American record of the Othomis is found. It relates that Maka-Wala, or Wala-Maka, for both forms are given, was king of Atempa, and that he was overthrown in battle by Mashima, king of Tolaka, in 793 A.D. Now, the capital of the Othomis in Mexico was Otompan, and its American prototype was Atempa or Otempa, at present Ottumwa in Iowa. Otomo, or Odomo, was the name of a Japanese clan, the chiefs of which are conspicuous in the annals of the empire, some of them being at times found in revolt and punished with expatriation. The course of the Iowa moundbuilders must, judging by the purity of their Japanese record, have been from the Japanese Islands by sea to British Columbia, and thence to the Saskatchewan. This journey they might easily have accomplished within the century, so that

the advent of the Othomis, or the vanguard of the Tungus, to America may be placed about the year 700 A.D.

Malte-Brun says: "The Othomi, or Hiâ-Hiû, is one of the most widely spread languages of the Mexican republic, since it is spoken in all the State of Queretaro, and in part of those of San Luis de Guanaxuato, Michoacan, Mexico, Puebla, Vera-Cruz, and Tlaxcala. According to Clavijero, the country of the Othomis began in the northern part of the valley of Mexico, and extended as far as the mountains, which are about ninety miles from the capital. Among inhabited regions which were numerous is to be remarked the ancient and celebrated city of Tula, founded by the Toltecs, and that of Xilotepec, which, since the Spanish Conquest, became the Othomi metropolis. This nation is regarded as one of the most ancient in Anahuac; having retained its savage state during several centuries, it had the reputation of being the rudest of those of the land. The Othomis, says Father Sahagun, were naturally heavy, rude, and unskilful, and so celebrated for indolence, that it was customary to say instead of 'Ah! the clumsy fellow!'—'He is like an Othomi.'" It was only towards the fifteenth century that the Othomis began to live in society, as subjects of the kings of Tezcoco; they then founded several villages. A large number of those who had persevered in their savage ways gave much trouble to the Spaniards before they were subdued; this did not take place until towards the seventeenth century.

The Abbé Brasseur de Bourbourg writes: "There is reason to believe that the Othomis occupied the mountains and valleys of Anahuac a considerable time before the Nahoas and the tribes afterwards known by the name of Toltecs. Rude and barbarous in their persons as in their customs and language, leading a hard life, preferring the mountains to the plains, the Othomis have preserved, since the farthest removed period of Toltec tradition, the same manners and the same idiom, without ever becoming absorbed in the nations settled beside them, who persecuted them more than once, and have themselves passed away without leaving a trace behind. Their language, rough as themselves, is monosyllabic, embracing every kind of sound, but destitute of grace, exhibiting, nevertheless, in its simplicity something majestic that savours of antiquity. It calls itself 'Hiang-Hiung,' that is to say, the language that endures and is permanent, and the name 'Othomi' which those who speak it bear, expresses in a touching way, their condition of dependence and misery in the course of many ages 'never quiet.' Whence came the Othomi? Through what countries did they pass before descending to Mexico? What is this language

so different from others to which they give the name of the permanent hiang-hiung? All that is known to-day is that they preceded the Toltecs, and that they not only inhabited the province of Tula before the foundation of the kingdom of that name, but also a considerable portion of the regions of the Aztec table-land. Though rude and barbarous now, they are far from the state of mere savages, which seems never to have been their condition. Harsh mountaineers, they have always been known as an essentially agricultural people, acquainted with the same arts as the other peoples of Mexico. In their simple religion, deficient of the ceremonial and superstitious rites of the Toltecs, they seem to have preserved longer than others the purity of the ideas of natural law. They recognized only one God, creator of heaven and earth, to whom they gave the name 'Okha,' composed of O, which means remembrance, present notion, and of Kha, holy. For heaven they said 'Mahetzi,' from ma, place, he, extent, and tzi, in circumference."

"The first of their chiefs who had been their guide in Anahuac, named Otomitl, or Othon-Tecuhtli, in the Nahuatl tongue, received from them a sort of inferior worship. Two other less exalted heroes or divinities of their's are known, one called Atetein and the other Yoxippa. They showed most devotion to the last. His chief feast was celebrated in the fields; it lasted four days, which were passed in eating and drinking amid great rejoicings. They recognized also an evil principle which they said to be the author of all evil; they called it 'E' the malevolent. They attributed great power to their diviners and conjurers, and made use of their ministry to consult the gods and lay the souls of the dead. The chief of these diviners to whom the name Tecuhtlato was given, had the rank of high-priest, and enjoyed great reverence in his nation. The temple of Yoxippa was the chief sanctuary of Otompan; it differed essentially from the Toltec teocallis; for it had the form of a storied house with projecting roof, in the manner of Hindoo constructions, having an upper part sometimes crenelated that projected beyond the rest of the building. But it was on the heights that they preferred to offer their sacrifices; they prepared themselves by fasting and penance, like the Toltecs drawing blood from their ears with maguey thorns, and by ablution of the entire body, whatever the season might be. Up to the last years of Mexican monarchy, they were the only one of all the nations of these countries that continued the ancient calculation of time by lunations. Otherwise they had very nearly the same customs as the neighbouring peoples; they were dressed very similarly to the Mexicans, though with less grace and

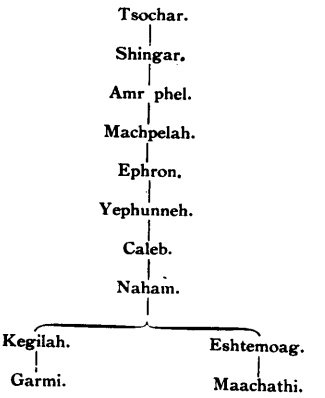
elegance; but one thing in which they differed from all others, is that they habitually shaved all the head, with the exception of a little tuft which they allowed to grow on the summit of the occiput like the Chinese."

Brasseur's translations of Hiang-Hiung and Othomi are more than doubtful. The forms remind one of the Hiong-nou and the Hiun-yu of Chinese historians, who fabulously place their invasions of China before the Christian era. Latham and others suppose them to be the Huns, although, by the few words of their language transmitted, they have been adjudged Tartars. The word is Tungusic, for the Tungus call themselves Even and Evenki. Vangia and Feneche were two of their tribes, answering to the Déné Henagi. They seem to have been among the earliest colonists of the chief of the Japanese Islands, for Niphon is a corruption of the Tungusic Even. Seven hundred years before Christ they gave their name to Van in Armenia; and in the time of Darius, 522 B.C., a body of them were the Paeones between Thrace and Macedonia. Herodotus says they were a colony of the Teucri of Asia-Minor. The Ramayana and the Mahabharata of India know the latter as the Tucharas, and they are represented along with the head-shaving Yavanas, who were no Ionians but genuine Vuns or Huns. The Tokari fought with the Egyptians, and at times served as mercenaries in the armies of the Rameses. Arrian finds the ancestors of the Takullys or Tsekelnes at Taxila on the Attock, during the Indian campaign of Alexander the Great, and relates that their king Taxiles led 5000 Taxiles in the train of the conqueror. Strabo names some of the Turanian tribes that deprived the Greeks of Bactria, and among them mentions the Tochari and the Dahae, to which latter belonged the Aparni or Parni.

The name Othomi, in Japanese Otomo or Odomo, means the great attendant or follower. Its Canaanitic equivalent, for the family was of this origin, is Eshtemoa, or Eshtemoag, and out of this all the Othomi, Tungus and Déné forms have been evolved. What the Egyptians called the Eshtemoans I do not know, but, on the lips of the Assyrians they were the people of Zamua and Mazamua. This Zamua lay on the Armenian side of Taurus in the vicinity of Dagara and Van, and is mentioned as far back as the time of Assur-nasir-pal in the first part of the ninth century B.C. This was, doubtless, the region called Odomantis by the classical geographers, who have also an Odomantis in Macedonia and Thrace in the immediate vicinity of the Paeones, and having Mount Orbelus for its centre. This Orbelus was a sacred mountain and was eponymous, for the Armenian Stephen, Archbishop

of Siounia, relates that there came to Georgia from China a noble family called by him Ouhrbelean, to which he belonged. These Orpelians were Huns, and their supposed mythic ancestor is the Olbale or Odelbale of the Dénés, a winged deity like the eagle headed men of the Assyrian sculptures. His original was Amraphel, king of Shinar, the contemporary of Abraham; and his Shinar or Shingar gave name to Sangura of the Assyrians, the Sangarius of the Trojans, Sangala of India where dwelt the Cathaei, and the Sunggari-ula of the Mantchus.

The genealogy of the Tungus family is given, in a scattered form, in the genealogies of first Chronicles, and is as follows:



Zohar or Tsochar gave the ancestral name Teucer, Tokari, Zagros, Tuchara, Tochari, Taxila, Tsekelne, and was Tigil, the god of the Kamtchadales. In Shingar we find Sangura, Sangarius, Sangala, and Sungaria. Amraphel furnishes Orbelus, the Orpelian name, Arbela, and Olbale. Machpelah is the original of the Davenport Maka-Wala and of the early Mexican hero, Mixcohuatl or Mixco-watl. Ephron gives name to Apolloniatis at the Zagros mountains, to Strabo's Aparni, and to the Faraons of Mexico. Yephunneh's name is the root of Yavana, Evenki, Hun, Japan, and Henagi. Caleb probably survives in Arivaipa and similar terms. But Naham was the ancestor of the Biblical Naamathites, of the African Nasamones, as well as of the Tungus Neyen, and the Dené Nehane. He was very likely the ancestral dog of the Dénés, for in Tungus a dog is *ninakin*. After him the family divided into at least two branches. The elder in Kegilah gives the division of the Hans or Huns who peopled Corea, called Kaoli and Kaokiuli. From his son Garmi came the name Ghirin, and

the Corean word for man, *saram*. But, in classical story, Kegilah is a nymph Acacallis connected with Garamas, the progenitor of those Garamantes who were neighbours to the Nasamones. Finally Eshtemog has given us the Zamuans, the Odomos, and Othomis, and, by the change of m to n, the Tungus and the Dénés; and his son Maachath was the ancestor of the Massagetae, whom Herodotus likens to the Nasamones, of the noble Japanese family of the Masakados, and of the Othomi class called Mazahui, Mazahua, and Matzahua.

Few races are more degraded than the Dénés and Othomis of to-day; but few have had a greater history. Of the particulars of the lives of Tsochar and his son Shingar we, at present, know nothing. But Amraphel fought under the banners of Chedorlaomer; Machpelah gave his name to an immortal cave; and Ephron, the Apollon of the Greeks, the Hittite conqueror of Hebron, acted the chivalrous gentleman towards the bereaved father of the faithful. Yephunneh was Paeon, the physician of the gods, and, with his son, Caleb, or Aesculapius, seems to have exercised his art in Egypt. Classical story has feeble reflections of Naham and his grandson Garmi as youthful scions of the Teucrian Apollo, called Nasammon and Garamas; while another descendant of Naham, called Zophar, talked not too wisely with the afflicted patriarch of the land of Uz. Next, we find the Tokkari, wearing a helmet wider at the top than at the base, divided into coloured strips with disks of metal attached to it, descending on the back of the neck and fastened beneath the chin, carrying round shields with spears and short straight sword, and fighting against the Egyptian troops of Rameses IV., while their wicker work, oxen drawn wagons hold their wives and children in the background. Again they come before us as the ruling Hittite tribe of Northern Palestine and Syria in the days of Joshua, for king Jabin who ruled at Hazor was of their line. Jabin and his city, a Japanese Katsoura, were smitten by the Hebrew leader. About a century later, a second Jabin of Hazor sent forth his general Sisera to quell the revolted Israelites with his nine hundred chariots of iron, but Barak overthrew them at the springs of Kishon, and Sisera fell a victim to the treachery of Jael the Kenite, a member of a related tribe.

In the time of David, king of Israel, a body of this race, called the Maachathites, dwelt to the east of the springs of Jordan between Palestine and Syria, and made common cause with other Syrian tribes and the Ammonites against the pious monarch, but Joab overcame them, and David and Solomon ruled over Maachah. But, at least, one Maachathite was numbered among David's chief captains. The author of the book of Samuel calls him Eliphelet, the son of Ahasbai,

the son of the Maachathite; but he of Chronicles gives his name as Eliphal, the son of Ur. Here is Olbale appearing in ancient history. After this the Tokkari made their way eastward, to appear, at different times, about the Zagros range east of the Tigris, where Apolloniatis and the Garamaei marked their presence; at Singara on the Chaboras in Mesopotamia, with Zagora near at hand; and at Van in Armenia. Men of their race may have sat on Assyria's throne, for Tiglath as a name was their original property. From the time of Assur-nasir-pal, in the beginning of the ninth century till that of Sargon, in the end of the eighth, when the Hittite power was broken, they warred not altogether unsuccessfully against the greatest monarchs of their day. One of their race, to judge by his name Sangara, became lord paramount over all the tribes of the Hittite confederacy, and measured his strength with Shalmanezer II. (860-825), who received his daughter and the treasures of Carchemish, when the war ended disastrously for the Hittite army.

After their final overthrow by Sargon, they scattered. As the Teucri they made their way into Asia Minor, and, whenever the siege of Troy took place, they had part in its defence, as they had in the great Indian wars celebrated in the Ramayana and the Mahabharata. But the Greek and the Indian epics related to times far more remote than those which followed Sargon, and to lands nearer the primitive seats of population than Asia Minor and India. Still, the Teucri of the first named region were Tsochari, and they crossed the narrow channel into Thrace and Macedonia, where later they met the Persian Darius in the regions of Paeonia, Orbelus, and the Odomantes. In the east they probably paid little regard to the Babylonian and Persian kings. Indeed, Herodotus informs us that the great Cyrus was slain by the Massagetae, oriental Maachathites of their race. Slipping away from the restraints of despotic power, they moved northwards to the Caspian, and further east into India, where Sangala and Taxila and Massaga, with many other memorials of theirs, existed long before Alexander the Great found Taxiles and the Cathaei of Sangala there. As the Tochari and Aparni, they wrested Bactria from Alexander's Greek successors in 150 B.C.; and the former in 124 B.C., defeated and killed Artabanus, king of Parthia, their kinsman or fellow Hittite. Their next appearance is as the conquering Hans or Hiung-nou of Chinese history, the chronology of which is entirely at fault. Then, in the west, in the fifth Christian century, under Attila, his predecessors and successors, they ravaged Europe, and disappeared into Asia. Under various names they governed the Chinese empire, as they do to-day; caused great displace-

ments in Siberia; occupied Corea, where they still remain; were probably the earliest occupants of Japan; whence, as the Othomis, they departed for America in the eighth century. Later waves of this fecund race, driven by stronger tribes into Eastern Siberia, crossed Behring Strait, and flowed over the Eskimo area, into the present abodes of the degenerate Dénés. It is doubtful that any other people whose history can be traced will exhibit a longer and more continuously eventful career.

I have said that, so far, we know nothing of the history of Tsochar, the ancestor of the Dénés, and, speaking strictly, this is true. But he was, no doubt, the Deucalion of the Greeks, a diluvian hero. His descendants appear to have separated during their abode in the Euphratean region, into a northern and a southern division. The fortunes of the former have already been before us. The latter became amalgamated with certain sub-Semitic Turanians, related to the original Amorites, Moabites and Ammonites, and, keeping a progressive eastern course along the Persian gulf and along the western and southern shores of India, arrived at last in the Malayan Archipelago. The Tagala language of the Philippines bears their name, but the well-known Polynesian god Tagala, Tangaloa, Tangaroa is the same personage as Tigil of the Kamtchadales. The southern Tsochari found their way to America as well as the northern, and appear in the central part of the continent as the Tzotzils and Cachiquels of the Huastec-Maya-Quiche family, whose great divinity was Tohil or Tockill. But their language, that of the ancient Huns, of the Othomis, the Mantchus, the Dénés, they had lost, and with it their modes of life. The Maya-Quiche records make what seem almost like prophetic allusions to this separation of the tribes and still more strange to their reunion in an American home. Echoes of the famous Tsochar may be found in all lands, from the Tigris to the Tigil, from the Greek Deucalion to the Maya-Quiche Tockill, from the Erse Declan to the Polynesian Tangaloa, and from an Assyrian Tiglath to a Déné Tsekelne.

APPENDIX I.

COMPARATIVE VOCABULARY OF THE DÉNÉ AND TUNGUS LANGUAGES.

English.	*Déné.*	*Tungus.*
above	yadege, D.	widalin T., dergi *Mantchu.*
all	kontlan, kwantlan.	gemu, gandzi M.
arm	nala.	ngala.
axe	taih.	tukka.
	shashill.	shuko.
	thenl, thynle, tsintli.	tabor.
bad	tschoolta.	kaniult.
bark	alah, uluz, latuz.	urta, arekte.
	ttuz.	notcho, ogdykon.
bear	sus,, sas, zus, yas.	ugshuki, uchikan, kuti.
beard	edara, tarra.	tshurkan, gargat, sala M,
beaver	tsah, sha, zah.	chattala.
belt	shoedh.	boyat.
belly	kagott.	chukito.
	boer.	ur, oor.
	paput.	chefeli M.
bird	kakashi.	gasha, gaskha M.
	tsoje, tshiasi, tshetsha.	doghi, doi.
black	tkhlsune, klazin.	sakhaliyan M., sachrin.
	tarzi, dulkus.	kara M., tshakarin, atra (dark).
blood	sko, skai, tah.	shosha, shoksho.
	shtule, tutkhl.	sugal, soogial.
blue	detleze.	tshurin.
boat	tsai, tse, ttsi.	dsau, dyau, djacha M.
	allachi, shaluzi.	yraktadjau.
body	skotit, chezukhtai.	gudige, ukit (belly).
	ezi.	beye M.
bow	nettuny.	nonga.
	klintun, alhtin.	lunga.
boy	tshil.	churkonon.
	taiyuz, tsiah, tazyuze.	adzighe (small).
	dinias, tinji, tenair.	kunga, kungakan.
bread	kliuthchu.	kiltora.
breast	tsoo, tthu, adsoh.	tsetchen M.
brother,	chah, kachaoch.	hau, aki, agi M.
	shona, schanga.	akin, kongakan, achun M.
buffalo	ahkik, yakkay.	ukur, hukur, kukur
	chasska.	chiukun.
	giddy.	geldak.
chief	nitzilin.	nyunga, noyon.
	buchahudry.	turun-bayo.
child	tshilaks, quelaquis.	uli, aljukan.
	beye.	buyadzui.
	is-chynake.	kungakan.
	astoque	chuto, kootian.
clothes	thuth, tsuda, tsthi.	teti, tetti.
	taiak, togaai.	etuku, tetiga, targaha.
	etlunay.	shun.
cloud	kkoh, kkswosh.	tukshu, taushu.

English.	*Déné.*	*Tungus.*
cold.	ktekchuly.	shakhorun, M.
	ssylitschitan.	serguen. M.
	oulecadze.	yellishin.
	nikkudh, hungkox, nasustli.	inginikde, ingynya, inginlan,
	kuatsakutowa, wuz-guz.	beichuen M.
to come....	chatchoo, udessay.	tschiki.
copper	tsantsan-ilthose, thetsra.	tshutsheni, tshirit.
dark	tsaholkus.	hakteryakde.
daughter	nitchit.	unadju.
	siskai.	ashadka.
day	tiljkan.	tirgani.
	drin, klut.	tirga.
	can, cheengo, janes.	ining, inenga.
dead	itini, tazan.	buden, buddan.
	tultlun.	edderen.
	kous, cheechwit.	kokan, chivren.
deer	nista, neistzee.	kandachan (elk).
	maytzi, motchish.	kumaka.
	batshich, vutzaih.	buchu.
	tlaytchintay.	ladacha (elk).
	edhuu, edthun.	tooki, toki.
	istsi, yestshi.	shodjo, shokdjo (reindeer).
dog	klin, sleing.	ninakin, kazikan.
	tkhlin.	indachun M.
door	theoball.	utshe, tuga M., urki, urkipura.
to drink	esdan.	undau,
	chidetleh, totasinlh.	choldakoo.
	mljchny.	umdal, kolymtsham.
eagle	ttschukulak.	ggarri, kyren.
ear	chetzeh, hutjah.	udak M.
	szulu.	korot.
	xonade.	shan.
earth.	tlis, kliuth.	turu, tukalagda.
	an, ni, nun, nunkit.	na, dunda.
	te, teye.	tukata.
	altnen.	usin M.
to eat	beha.	bishin.
	ishshan.	dsheme M.
	chesti, setse.	iebdau, jebdaka.
egg	pukka, weskiake.	umcha M, omukha.
elk	pitzi.	buchu M. (deer), byyun (reindeer).
eye	eta.	eha, esha.
	slida, slinda, kaljag.	esel, isal.
	chindar.	ashim-itshere (to see).
	sintaga, schindah	oshim-itshette (to see).
father.....	apa, appa, mama.	ama, ami.
fern	kokotlija.	okokto (herb).
fingers	inla-thale.	umukko-tshar.
fire.....	tasi, takak, takoua.	tua M, toh, tog, togo.
	kson, khong, kwun.	ghochsin (hot).
	tkhlkane.	chalchun M. (hot).
fish	telamachkur.	nimakha M.
	klo, kluk, lue.	ollo.
	cloolay.	olra.
	uldiah.	oldo, aldo.
foot	piuki.	betkhe M.
	skatlna.	halgan, chalgan.
	jetly.	bedal, bokdil.
	osha, chekeh, seka.	petche M.
forehead.....	kaintschit, tchunttsut.	onkoto.
	sekata.	olekat.

English.	*Déné.*	*Tungus.*
fowl.....	kanujak.	njungjaki (goose).
girl	getsi, tshekias.	ashatka, asatkan.
	quelaquis-chequoi.	uljukun-ashadka.
	slku-tsukaisla.	sarkan-dzui.
	keel, kernihl.	ghoorkan (daughter).
to give	besanesdi.	pu, bimbi M.
	hamiltu.	omul, omuli.
to go	eenio.	geneme M.
	antonger, kwniuhl.	genigar, yanakal.
	unnainduhl.	nendep.
	anahzonti.	gyndakun.
god	tihugun.	gheooki.
good.....	sutchom, nezun.	ssain.
grass	klo, klos, kkloh.	orcho, orokto, orat.
great	unshan, nintsha.	ekzsham, egdjon.
	wane.	amba M.
	tsho, tcha, tchos.	okdi, choydi.
green	dellin, tultsau.	tshurin.
	dulkluj, tahtloh.	tshorolty.
hail	neelo, heeloah,	shenilyan, shiggilgen (snow).
hair.....	nuntsera.	nioorit.
	hutzee, khotsusea.	ingakta.
hand	nilah, inla.	nala, nali.
	shlaa, kholaa.	djalan, ngal, gala.
	skona.	hanga.
hare.....	kah, koh.	ushkau, tuhaki, toksyaki.
hat	sackhalle.	machala.
	kakadalaiou.	kuratli.
head	edzai, tichih, ethi.	udshu, utshu M.
heart	bitsi.	mudzi-len M.
	chittri.	shelama.
heaven	eeyah, yaha, yas.	abkha M.
	yatakahonzo.	thaugsoha.
	yuyan.	nyangna.
hot	taouwechon.	yapushin, ghochsin.
	kunazul.	khalkhon.
	nidha, nahdesestka.	nemyakde.
	woela, azoomicullah.	nyamlan, nyamaldan.
house, tent	ye, zeh, jetz.	dju, dzu, dzsho.
	kune, kuin, konaugh.	gula, gulya.
	kuntukh.	momadjuk.
hunger	kutlakat.	yatahushara M., djalgarram.
husband.....	sukkun.	eigen M.
	etsayoh, ahoteey.	adi, ediu, adywu.
	dinnie, deneyu.	edin.
ice*.....	ttatz, thun, tun.	djuko, djucha.
iron.....	satsun, shatain.	tshutsheni, tshetshinma (copper).
	chitsih, ketic, atis.	djikta (copper).
	shlestay.	trirokta, alatya-tshirit (copper).
kettle	ussa, oshia.	ika, iko.
	monsai, nosai.	mutshen M.
	kluck.	kalau, okallan.
knee.....	chagutt.	chiegen.
knife	utteis, tish, tekhe.	utsh.
	kissaki.	chueji, koto.
	marsh, penlso.	parta, purta.
	tlay, rsih.	tsherkan.
	kakikltoun.	hurta.
lake.....	touey, taiotin.	tonar, tongor.
	vun, ping, pungut.	amundji.
	maigah, mithee.	amuzi, amatch, amut.

English.	*Déné.*	*Tungus.*
to laugh	lechlikal.	inyaktokal.
leaf	ata.	abdaha M.
	atan, chitun.	awdanna, awdanda.
leg	tinadsun, nakaitshun, keitshin.	chantshen (knee).
	gwashun, tsethan.	chyegen (knee).
	kin.	ongon (knee).
	chidudh, edzare.	tyshak (knee).
length	kuana.	ghonamin.
life	anna.	inni, inen.
	ghinnah.	innikin, veichun M.
	kondaih.	indyn.
	renah.	ergen.
light	attri, hutkhlin.	tirga, tirgani (day).
lightning	nahtunkun.	talkian M tapkıtan.
	kwntatlek.	bugani-utula.
lips	edanne.	aedjen.
man	payyahnay.	boye, bey, evenki.
	tengi, tingi, tenghie.	donki, donggo, dunggia.
	déné, dinay, tana.	djan.
	titsun.	djetschen.
	quaietai, akootinne.	oydzah, djakuta.
	djoogia.	tazeu, togoya.
	khanae, sikkanne.	chingan, chuntshun.
	tenalo, tinlay.	nialma, onggolo.
	tchelaqui, tschilje.	antshulaku, sachaltsha.
	takhkhile.	djusheri.
marten	thah, tshinih.	dyukon (otter).
moccasins	kinchee.	unta
	kihkot, keskut.	gulcha.
moon	altzi, ighaltshi, tlaltolla.	delatsha, dulyadja (sun).
	klanai, klaihonoi, tlakannu.	nultan, nyultan (sun).
	tschane.	shun, shigun (sun).
	haei, kacha.	bega.
morning	kadamatonah.	tematna.
	altkun.	erde M.
	vun, puneta.	unoki.
mother	amma.	eme M.
	nah, naa, anna, an, hun.	ani, oni, anya, enie.
mountain	ts-atl, tsutl, tidlkool.	tsolchon M.
	s-chell, klehl, tauri.	urra, ere, alin M.
	zeth, ddhah, chesh.	gokda, gokdakan, akatschan.
mouse	gloune, klounge.	tshalooktshan.
	tan.	tshyngirkan, singeri.
mouth	nazai, nizik.	angga M.
	ta, edha, huzzay.	aedjen (lips).
nails	nil-assut.	osta.
neck	wickkost, huckquon, hosewatl.	bilga, bilcha M.
	chekoh, schonite.	nikigi, nikin.
night	kleakut, kliltohl.	golban.
	hutlih, khutli.	aktera, atra (dark).
no	ossay, nokwa.	ako, aku.
	toh, ta, doo.	atcha.
nose	nenzi, ninintsis, mintshesh.	niqsha, onoktah.
	huntchu, chintsih.	ungata, ongot.
	hutchih, witchess.	ogot, oiokta.
old	ata, saiyidhelkai.	sakda, shagdi.
pain	iyah, tsin.	eyen.
pipe	tsikatsuh, tekatsi ; teka (tobacco).	tagon.
rain	tchandellez.	tekdol.
	tsin, naoton.	odan, uddun.
	alkun, alcorn.	shiggilgan (snow).
	natkhlhika.	oloksha, ulaksha (wet).

English.	*Déné.*	*Tungus.*
red	tulkun, dulkun.	chulgian, fulachun M
	tiltil, tigaltil.	sugel (blood).
	delicouse, delksozi, tkhlssewe.	kulani, ulaty.
river	suckener, towkahuntsha.	sekiyen M.
	hun, khanee.	eyen M.
	okox, ukokh.	okat.
	sekargut.	ulagir.
	kutnu.	okatshan.
salt	tedhay.	tak.
	totuzlkun.	turuka, davusun.
sand	chey, shay.	chulikton, serugi.
sea	eapashk.	amutsh, amuzi (lake).
to see	eshi, yussee.	itsheshim.
	utschtschiilia.	otschiawetshittal, etshikuerem.
	nestah, nentah.	oshinitschette.
	hunitlin.	ashimitschere.
	nhlin.	igoorun
to sing	shin, eschen, utshin.	ikan.
sister	chih.	oki.
	chidh, schutta, tatscha.	ashadka, asatkan.
to sit	dhintih.	teme M.
to sleep	namistce, nanistin.	amutshen.
	azut, tsetez.	adjikta.
	hoosh.	ukladai, ukladaku.
	ittern.	uklyarem.
small	netsul, unsul, nintsool.	nitkun, nitshukun.
	sul.	chulyokun.
	tsootah, astekwoo.	adzighe.
snake	nadudhi.	nogai.
son	ziazay, naskai.	hutta, dzui M.
soul	eyune.	weichun.
to speak	yatltik, yaltuck, katlijach.	goli, turateikta.
	kanna.	guken, chendumbi M.
spoon	schitl.	kuili M, tschinaka.
spring	olte, agoltsin.	obhilasha.
star	sii.	usikha M.
	klune, shlum.	haulen.
	sun, sum, ssin.	shen, shigun, shivun (sun).
	delgayhe.	dylega (sun).
	khatlatshe	delatsha (sun).
	kumshaet, keemshaet.	utamikta.
stone	luohla, tschayer, kulchniki.	djolo, dzshool.
	zeh, seh, chi, tscha, tse, tsi.	ja, hysha, veche.
strong	gunzun.	chusun M
summer	hongzil.	anganal.
	ssin, saner, tan.	dyoganni.
sun	ytlkun, taltohna.	tergani (day).
	chignonakai, chokonoi.	shigun, siguni.
	channoo, skeemai.	shun, shivun.
teeth	egho, howgo, howwah.	veihe, veike M.
	shti, esu, shigo.	itsh, ikta.
	sakoistli.	iktal.
thread	mo.	umi.
thunder	idi.	addi, akdi, ashdoo.
	titnaik, nahtuno.	akdjan.
to-day	ganneh, kuntsin, ganitzin.	enennngi, eshenang.
	antil.	ositirga.
to-morrow	katooman.	tumi.
	gambeh.	chimaka zimacha M.
	punti.	temanta.
tongue	tzula, natsol, thula.	tsholi.
	tljulja, szylio.	ilga

English.	*Déné.*	*Tungus.*
tongue.....	lasom.	ilengu.
	kanat.	yuiye.
tree.....	chooma	mo.
	tétshun, takun, techun.	budjan (forest) M,
	tsbalacooya.	mol (forest).
valley.....	dilakooi, tekalkulkul.	tala.
	konakon, kunatri.	koonta.
village	kohalai.	falan M.
	zekkeh.	tokso M.
to walk	ts-aiutl, gahheyail.	shurukel (to go).
	kaeendie.	gynakun (to go).
	yucko kuyyal.	yavkan yanakal (to go).
water	to, toh, toe, too, tkho.	tygda (rain).
	thunagalgus.	tekdol (rain).
	tchon, tonh, tahnahn.	udden, odan (rain).
	chu, kaja, ko.	agha (rain).
to weep.....	huntza.	shongodz.
white	kliyul, hlekul.	giltaldi, giltaldin.
	talkai, delksay	geltadi, wagdari.
	itesina.	shangiyen.
wife.....	sak, at, tsaiat.	aki, aji, asi, adjiu, atshiu
	zayunai, tsekunselin.	sarkan M,
wind...	atse, etsee.	eddyn
	tatsi.	tit (storm).
	nuntsi.	ayanedun (storm).
	eldo.	niltse.
winter	hongkazone.	togonni.
wolf	yess, yush.	gusko, gushko, gusika.
	nooneeyay.	nioche M
wolverine	naguiyai.	yentaki.
woman	tseke, shiko, ekhe, chaka.	heghe, cheche.
	etchagah, tseukeia.	adjiu, atshiu (wife).
	ttsekwi.	ashiwu (wife).
	salturn.	sarkan M. (wife).
wood	tetshun, dekin, dethkin.	budjan M. (forest).
	tsush.	shigi, ishig (forest).
	tsroh.	urae (forest).
wood, forest.....	teshintlan.	kenita.
to work	chakljtschejahga.	goorgalden.
to write	edesklis.	dokli, dokukal.
yellow	tatloh, dethore, tultsau.	tshurin.
yes	ha, hauh, ahuh, aho.	ya.
	ang, hum.	inu M.
yesterday	hulta, utlta, utlutltan.	acheltana (evening)
young	kechitedha.	asicha, ashcha.
	klatakoltinilla.	noolsoolktshan.
I	hwe.	bi.
Thou	shi.	ssi, si.
He	iye, iyi.	i.
	atinne, edinne.	tere.
	neyan, iyanuk.	nongenatsha.
We	wane.	be, boi
	ninkontlan, nachune.	nonganube
You	she, kajuku.	soue, sowe.
	hontail.	ellia.
They	tsii.	tese, tche.
this.	eyer.	ere.
that	tiri.	tere.
many, much	lai.	labdu.
who ?.....	nuntzui.	ni.
	mpelà.	we.

English.	*Déné.*	*Tungus.*
1	tahse, tashte, etscha, titsoh.	dysak, dishak, *Kamtchadale.*
	tihlagga, tathlai, kissleka.	attajlik, *Tchuktchi.*
2	naki, nake, nahkee, nekai.	niechtsh, *Koriak.*
	nankhay, nankuh, nankoh.	lianga M.
3	tahe, tage, takke, takei.	tsok, tshook, *Kamtchadale.*
		digin, digon, *Tungus* (4).
4	tang, dunkhe, tinike, tenki.	douin M.
		tonga, tongan, *Tungus* (5).
5	chwola, shwullak, schwallah.	komlch, *Kamtchadale.*
6	elketahey, ulkitake, kooslak.	kilkok, *Tungus.*
	tluz.	kylkoka, *Kamtchadale.*
7	tluzuddunkhe, ookaidingkee.	etgatonok, *Tungus.*
		etuchtunuk, *Kamtchadale.*
8	elkeedinghe, etsudeentay.	tshokotenok, *Tungus.*
		tsholudunug, *Kamtchadale.*
9	koostenekha.	tshakatonok, *Tungus.*
		tshakatanoch, *Kamtchadale.*
10	kaynayday, kwunesa.	kumechtuk, *Kamtchadale.*
		tshomkotak, *Tungus.*

APPENDIX II.

COMPARATIVE VOCABULARY OF THE OTHOMI WITH THE TUNGUS AND DÉNÉ LANGUAGES.

English.	*Othomi.*	*Tungus and Déné.*
afraid	ttzu.	nil-tshut D.
arm	ya, yani.	mayan T., hanga T. (hand); kiin, skona D.
axe	ttagi.	tukka T.; taih D.
bad	iho, hio.	ekhe T.
	hing, nantzo.	eiang T.; nuntzun D.
beast	baoni.	boyun T.; elloni D.
belly	bite, bombi.	boya T. (body); bitt, voet, paput D.
bird	ttzintey.	niungyaki T. (goose), doghi T.; tsihtsoh, dettani D.
black	boi, bode, bothi.	bochokon T. (dark).
blood	qui.	shosha T.; skai D.
blue	ccangui.	niochun T.
boat	mohtz-a.	omu, ongotscho T.; metaui D.
body	ghai, hanggiei.	ukyt T. (belly); ezi, nizi D.
bone	ndoyo.	nun-kwut D.
bow	za.	ka, kaza D.
boy	hy, iso.	huta, dzui T. (son); jay, eyaze D.
	bahtsi, butsi.	buyadzui T.; yaase, eyoze D.
to break	yaxkhi, sogi.	bekkeschiz D.
brother	cu, ida,, qhuada.	aki, deu, ekdau T.; chah, de, skitla D.
to call	da	
cane	sothi, hethyo.	tetquh D.
chief	hmu, nogue.	hunniu, nyunga T.; mowdish, toeneza D
cloud	gui.	tuhu, tugi T.; kkoh, kos D.
cold	tzaa.	shakhorun T.; edzah, azoo D.
to come	ehe.	dsi, ishi, dohi T.; yeudessay D.

English.	*Othomi.*	*Tungus and Déné.*
corn	detha.	djekta T.; djiye D. (fruit).
to dance	nei.	uznutti, noetai D.
day	pa.	shiwun T. (sun); vun, puneta D. (morning)
death	tu, du.	butscho, edderen T.; tatsai, itini D.
deer	phantehe, hoephani.	buchu, kandachan (elk), bayun (reindeer) T.; batshich, ed-hun D.
to descend	cai, gai.	
to do make	qha.	scha, kia, gia T.; ah-goshlah D.
dog	tzahtyo.	katshikan, indachun T.; tlika D.
door	gosthi, nyytti.	utsche, tugha T.; tathi D.
to drink	tzi, tzithe.	djebdau T. (to eat); esdan, chidetleh D
eagle	xyni.	kyren T.; datanni-tchos D.
ear	gu.	korot T.; ocho, zach D.
earth	hay.	na, usin T.; keia D.
to eat	tzi, tza.	dsheme T.; setze D.
egg	mado, doni.	oomta, omukta T.; pukka D.
enemy	noogui, ytzaqui.	enna, ats-choen D.
evening	nde.	yamdzi T.; naai, nachiai D.
eye	da.	eha, esha, tuambi T. (to see); eta, ente D.
to fall	tagi, dagi.	
family	qhai.	koh D. (house).
far	yanih.	antshun T.; nizat, nijah D.
father	ta, hta.	ata, tah D.
feather	sihui, sini.	tsuth, tshus, tah D.
female	nsu.	nechu T.; ttseyanne D.
field	batha.	pitema, bikan T.
finger	zaha.	simchun T.; slutska D.
fire	dehe.	toh, tua T.; tasi, takok D.
fish	hua.	ollo T.; lue D.
flesh	ngoe.	
flint	asdo, dotzbi.	
food	hme, thuhme, nhihuni.	omin, omekin T. (hungry); then, utsun D. (flesh, meat).
foot	gua.	eke, oca, cuh D.
forest	borza.	ure, mol, budjan T.; tsbalacooya D. (tree).
friend	ntybe.	unte D. (love).
from	nbepha.	noempa D.
fruit	doengahu.	djiye, njet; intzi D. (strawberry).
girl	ttixu, nxubahtsi.	ashatka, hettek, unadjikuto.T.; tshekias, dettsi D.
to giye	ra.	
god	oqha.	gheooki T.; tihugun D.
gold	ccaxtti.	djikta T. (copper); atis; chitsih D. (iron).
good	nho, manho, niza.	etnioo, sain T.; nuzzo, nezun, ienesou D.
grave	ha, yagi, otzei.	changar T.; tsungut D.
great	na, mannoho, ndi.	amba, hadyuga T.; wane, nintsha, unshaw, nitsih D
green	buethe.	owokto T. (grass).
hair	si, xta.	ingakta T.; zuga, itse, ethisa, hutsee D.
hand	ya.	hanga, gala T.; la, lah, law, skona D.
head	na, naxmu, nasinu.	onkoto, shengin T. (forehead); nuntse, muttsai D.
heart	myi.	mewan, mewam T.; se naiyitz, bitsi D.
heaven	mahetzi.	abkha, niengnya T.; yatakahonzo, nuntsi (air) D.
hot	pa.	yapushin T.; wuzul, wela D.
house	ngu, buy.	momadjuk, boo T.; konaugh, koh D.
hunger	thuhu.	djamushim, yuyun T.; tai D. (famine).
husband	dame.	edin T.; deneyu, dinnie D.
idol	hetqha, phetrigha.	yuttoere D. (god).
kettle	tzamqua.	mutshen T.; monsai, sehin D.
to kill	ho, hio.	kokan T. (death); uzeagha D.
knee	nahmu.	nyongi T.; nakaitshun D (leg).
knife	daquhuai.	chueji, koto T.; tekhe, texe D.
lake	mohe, posdehe.	omo, amuzi, amutt T. (sea); maigah, pungut D.

English.	*Othomi.*	*Tungus and Déné.*
to learn	padi, deji.	tatshin T.; udhestthan D.
life.	te, byi.	indyn, veichun T.; guttah, mainch D.
light	hiattzi.	tek, erde T. (morning); attri D.
lightning	nhuei.	nyama T. (flame); nahtunkun D.
lizard	matga, botga, ttzathi.	mogai T. (snake); nadudhi (snake), ttsale D. (frog).
to love	madi.	amuran T.; nute D.
male	ta.	edshe T.; ten D.
man	yeh, yehe, nanyehe.	bey, khiakha T.; sykka, enday D.
	dame.	edin, donki T.; dini, tana D.
month	zana.	men, nan D.
moon	zana, rzana.	shen T. (sun); tschane D.
morning	sudi, hiatzi.	tek, erde T.; katoomau D. (to-morrow).
mother	be, me.	eme T.; amma D.
mountain	tthehe, ganthe, xantle.	dabaga, gokda, yang, davan, emkir T.; zeth, ddhah, tzatl D.
mouth	ne.	anga T.; nazai, nizik D.
name	thuhu, thohr.	gorbi T.; kedetude, vorzih D.
near	guethua.	khantchi T; nihtuk D.
night	sui.	shikshe T. (evening); tsis, hkah D.
no.....	hinna.	mangga T.; owntuh D.
north	moby, mahuihgi.	
nose	siu, xiyv, xinu.	ogot, ongata T.; hutchin, hutchih, chintsih, nenzi D
now	nuya.	enenggi T. (to-day); ganneh D.
pain	dumyi.	choonatsh T.; tsin D.
rabbit	qhua.	tuhaki T.; koh D.
rain	ye.	agha T.; chu, ko, kaja D. (water).
rainbow	beccni.	bohre T. (bow).
red.....	ntheni.	ulatyn ; sengi T. (blood); dulkun D.
river	dathe.	okat T.; tesse, taseke D.
salt	u.	davusun, tak T.; tedhay D.
sea.....	munthe.	amundji T.; pungut D. (lake).
to see.	nu.	omnin T.; aiin, nentah D.
shoe	zethsi.	unta, gulcha; dootan T. (stocking); keskut, kinchi D.
sick	gehe, hienni.	eyen T.; eya, tinnetuh D.
sin.....	tzohqui, ttzogi.	kotat, ssui T.
to sing	tuhu.	ikan T.; shin, hutyhn, tsutshun D.
sister	nqhu, qhuhve.	nougu, ekmu T.
skin	si, siphri.	feri, ipree T.; uzuz, eve D.
to sleep	cha.	adjikta T.; azut, tzetez D.
small	ttygi, notzi.	adzighe, nitkun T.; astekwoo, nacoutza D.
snake	qqena.	meike T.; itini ; tanenuz D. (rattlesnake).
south	madatti.	
star	tze.	ujicha, otshikat T.; sii D.
stone	do.	djalo T.; tsi, tse, ttza D.
sun	hiadi, hindi.	dulyadja, shen T.; shethie, houtsah, channoo D.
to take.....	ha, hiani.	ghenoom T.; eneshi D.
teeth	tzi.	itsh, ikta T.; esu, shti D.
thunder	nyquni.	akdjan T.; indnaih, titnaik, nahtuno D.
to-morrow....	nisudi, rihiatzi.	tshaguda T. (after to-morrow); katooman, punti D
tongue	qhane.	inni, enga T.; kanat D.
tree	bay, rz-a, camrz-a.	mo ; yraakte (larch); obkomchora (juniper) T.; chooma, tsbalacooya ; tsroh (wood) D.
turtle	saha.	
to walk	yooni.	genembi T.; kaeendie D.
wall	ghoti, ghado.	
war	ncasi, tulmi, magagui.	chooniat, koosikatshin, dzshargamat T.; tatzuzan, taiatltzan (to kill) D.
water	dehe.	tygda (rain) T.; tu, toah D.
to weep	rzoni.	shongon T.; huntzah D.
a well	cyytzi.	yuukto, guiudzeren T.; kwtzil (wet land) D.
west	mayyi, yyhiadi.	

English.	*Othomi.*	*Tungus and Déné.*
white	ttazi.	geltadi T.; itesina D.
wife	datzu, ghada.	adjiu ; cheche (woman) T.; ts-aiat, at D.
wind	ndahi.	edden T.; nuntsi D.
wing	hua.	utah D.
wolf	muhu, tzute.	nioche, tshipkaku, gusika, galyuki T.; nun, nooneeyay, yes, tsheeonay D
to work	paphi.	
woman	nsu, nitsu, danxu.	nechu, djoanatkan (female) T.; kyssynj, ttseyanne D.
year	gheya.	angaui T.
yes	haa.	ya T.; ha D.
yesterday	mande.	yamdzi (evening) T.; pundata (morning); hulta D.
I	nuga, nugui, nugaga.	niyun, tsunuz D.
	di.	siit D.
Thou	nuy, nugue.	nannuk, nunuz, nin D.
	qui.	shi T.; shi D.
He	nunn, bi Y.	nongenatshe, i T.; unna, neyan, iye, iyee D.
We	nuguihe.	nongenoobe T.; noohee, nachune D.
You	naguegui.	sonwe T.; nahhinne D.
They	nuyu.	eyiniyu D.
1	na, ra, unra.	ennen *Koriak* ; inlase D.
2	yoho.	ytechgau K.; techa D.
3	hiu.	giech K.; kahyay D.
4	gooho.	sfigae T.; gyrach K.; teucheh D.
5	cytta.	soundeha T.; chiht-lukunli D.
6	rato.	lugae, kilkok T.; elkketase D.
7	yoto.	etgatanok T.; hoituhi D.
8	hiato.	djakun T.; etsudeentay D.
9	cyto.	dshugae, tshakatanok T.; coostenekha D.
10	ratta, ra-tta.	djulaka T.; atltshantai D.
100	cytta-te, nanthebe.	nemadje, ibai T.

SPATIAL THRESHOLDS OF COLOURS AND THEIR DEPENDENCY ON CONTRAST.

By W. B. Lane, B.A.

(Read 3rd April, 1897.)

If one takes any coloured object of small, definite size, say a piece of pigment paper, and gradually either removes himself from it, or causes it to be removed while he remains stationary, he will notice not merely that the coloured object decreases in its apparent size as its distance increases, but also that its colour becomes modified and even disappears as the object becomes to the sight extremely small. Ordinary illustrations of the same phenomenon are quite common in our daily experience. We have all noticed, probably, how across a stretch of two or three miles of water a small craft, say a skiff, painted green, has appeared to have, at first, no colour whatever, being merely a bright or a dark spot upon the blue surface of the water. But, on gradual approach it has become invested with a colour quality which is more than mere brightness or darkness, though it may appear at first in a colour, such as *red*, quite different from its true colour disclosed on still closer approach. Such, among the many other examples which probably suggest themselves in plenty, to anyone disposed to search his past experiences, serve to show that in this fact there is scope for a scientific inquiry to determine the minimum sizes at which the various colours are seen coloured in their proper tone. This is the problem of the Space Threshold of colours in a general way. Of course, in reckoning the sizes of the coloured objects we must consider their size as relative to the eye observing them, for their absolute size does not necessarily change when their size, as relative to the eye, may have changed greatly. The absolute size, indeed, may change and the object remain fixed in one place, which would equally, if the observer remained stationary also, produce an alteration in the size of the object relative to the observer's eye. We can, of course, obtain an exact expression for the relative size of objects to the eye by means of the visual angle which they subtend at the eye, which is the same whether the object be multiplied in size or merely decreased in distance in the

inverse ratio. There is a little difference caused by the aerial perspective according to which coloured surfaces of greater distance have to appear less saturated and even modified in colour on account of the imperfect translucency and bluish colour of the air. This applies to the ship. Consequently the Spatial Threshold of colours will always be measured by the visual angle of the coloured object, where we say it is at the threshold of discernment as such or such a colour.

We have mentioned the fact that a coloured surface at very small angles, gradually, in most cases, loses its characteristic colour and becomes coloured in another tone, and at smaller angles still, loses its chromatic quality altogether and appears as merely colourless light. It thus appears that there will be three distinguishable Spatial Thresholds for any colour. (1) The main one which we may designate the Characteristic Colour Threshold, where the colour is first seen correctly in its proper tone, (2) the Chromatic, where it is first visible in any colour whatever different from colourless light, and (3) the light or Achromatic Threshold, where a coloured object is first perceivable at all, not necessarily as coloured but as colourless light. It appears desirable to keep these three Thresholds separate, though, of course, they can quite easily be investigated concurrently, because, in determining the main Threshold as to the visibility of colours in their proper tone it is necessary, starting from zero, to pass through successively the two minor Thresholds. Hence, the one set of experiments can with care be made to exploit at the same time the three Spatial Thresholds of colours.

A moment's reflection will show us, moreover, that the problem of the Spatial Threshold of colours cannot be prosecuted except under the conditions of the phenomena of contrast, to a greater or a less degree. We never, as a matter of fact, can get our colours except as they are environed by surfaces which exercise a more or less effectual contrast influence upon them, whether it be merely a light contrast or a saturation contrast (*e.g.*, grey of equal intensity with the ground) or ordinary colour contrast, or a combination of two of them or of all three. But although apparently impossible to escape altogether from the conditions of contrast, it was, undoubtedly, a scientific desideratum to free our experiments from an irregular and uncontrolled participation of contrast influence. It is quite possible to eliminate large elements of a mixed contrast influence and to confine its operation to that of either simply intensity contrast, where colour contrast has been removed, or of colour contrast simply where intensity or light contrast has been removed. The former is possible by employing only colourless grounds on which our colours are seen, grey, white or black grounds; the latter is much

more difficult to achieve, but quite possible by using colour grounds and employing precautions to secure that the brightness intensity of the ground is the same as that of the colour examined. The devices and detailed means, used to secure this result, cannot be described at all in this preliminary paper, but will legitimately find place in a subsequent paper giving illustrations, detailed description of the apparatus used and our results attained. It may be noticed that a theoretical immunity from both colour and intensity contrast is possible by using a grey ground whose intensity is the same as the colour examined, but practically it is very difficult, next to impossible to achieve. For, in getting the two intensities equal and constant, you are forced to introduce a more or less influential colour element in the ground; and in seeking to remove the colour element wholly, it is difficult to avoid introducing an inequality of brightness intensities again. But, be that as it may, there is no question of the scientific desirability of an attempt to limit the influence of contrast phenomena upon the determination of the Spatial Thresholds of colours to specified kinds of contrast, colour contrast at one time and purely light contrast at another, so that the specific effect of each upon the Spatial Thresholds may be discernible from that of the other instead of both being massed in a joint influence in which the contributions of each kind of contrast are indistinguishable with any exactitude. It was, moreover, a matter of scientific importance to make the attempt to rule out the contrast influence, both colour and intensity, altogether, even though actually it may not have been absolutely successful in doing so. In any case, it will have reduced the contrast influence to a degree so small as to be a minimum up to date in the investigation of the Spatial Threshold of colours.

In the history of physiological and psychological science this problem of the Space Threshold of Colours has received but scant, almost cursory notice. Where there has been some approach to a scientific determination of it quantitatively, it has been marred by a twofold defect. On the one hand, the investigation has been carried on by means of appliances which are extremely crude and inaccurate, and on the other hand the inquiry has been wholly confined to exploiting only one kind of contrast influence, namely, light intensity, which may have a bearing on the Threshold. It has wholly ignored the roles which other kinds of contrasting environs, such as the various colours of our ordinary colour system may have, and practically do have, upon our perceptibility of colours, according to their size of exposure as relative to the spectator. It has, moreover, apparently, not seen the desirability of modifying extremes in light intensity contrast and of obtaining, if possible,

an environing ground which shall practically exercise a very small or even no appreciable contrast influence of any kind upon the examined colour. But it is evident that without so doing no approximation could be made to a discovery of the precise degree to which the influence of contrast modified the Spatial Threshold.

Quite early the phenomenon of the dependency of colour perception upon intensity and on the visual angle of the coloured surface was noted by Purknije in his Commentatio de examine organi visus 1823. Plateau shortly after in Poggendorff's Annalen, 1830, noted the disappearance of colour tone altogether at small visual angle. However, the problem was not dwelt upon, perhaps not appreciated by these early investigators. No effort was made to make an exact inquiry into the relation of visual angle and colour perceptibility until the time of Von Wittich and Aubert, both of whom made some important pioneer attempts in this direction. Von Wittich distinguished the two Spatial Thresholds which we have mentioned, namely, the light, or achromatic threshold and the chromatic threshold, and he sought to obtain a quantitative representation of the same. He conducted his experiments upon a black and white ground respectively, thus really taking into account the fact of a contrast influence in the determination of the thresholds. But apparently, as we have indicated, he did not appreciate the desirability of extending the enquiry to include other kinds of contrast. Much less did he think of determining what role the contrast, as such, played in the matter, by seeking to reduce it to a minimum or to remove it so far as intensity and colour contrast, altogether.

His experimental work on this question was crude in many other ways than in the scope of its attempt Its physical appliances, such as the means used to obtain colours and grounds,its measurement methods, were all of the crudest and are consequently unsatisfactory in the results yielded thereby. The colours which he experimented on were simply ordinary pigment papers which in these latter days, at least, are well-known not to be pure specimens of the colours which they are taken to represent. For the most part, on the contrary, they contain very many other colour elements obscurely fused with the one which, from its predominance, we call the colour of the pigment. In some cases the pigment paper may owe its special colour to the fact that it contains all the other elements of the colour system except the complementary of the colour after which we name it. For example, the most yellow pigments owe their colour to the fact that they contain the whole spectrum of colours except the blue, and even in somecases this

is present but much weakened. Moreover, a pigment may owe its colour to a combination of other coloured rays without having any of the kind after which it is named. For example, it is possible to find a violet pigment which sends forth no direct violet rays at all, but a combination of blue and red. Such being the case it was certainly a desideratum, which, by the way, our experimental handling of the problem has sought to satisfy, namely, to secure specimen colours which should be tolerably free from this adulteration by other colour elements, and fairly representative of the spectrally pure colour tones. In the absence of any attempt to obtain spectrally pure colours to operate upon, as was the case with Von Wittich, it is evident that the results must embody at least, a double unavoidable defect which renders them scientifically useless. On the one hand, since the colours experimented upon are actually, in each case, a congeries of many colour elements it cannot be determined, even approximately, what specific part each of the various colour constituents contributed to the determination of the Spatial Thresholds of the colour pigments employed. On the other hand, since no two pigments, even representing the same colour tone, will emit exactly, or even closely, the same combination of colour constituents because of the fact that a variety of colour combinations can produce the same aggregate effect, and since further, there are a great many pigments all differing in appreciable degrees which have equal claims to be taken as representative of any colour tone, it follows that experiments such as Von Wittich's, based upon the examination of colour pigments taken up at random, can have no general validity. They cannot be considered at all as representative results for the main colour tones which compose our colour system. They are, at best, only indicative of the thresholds of those particular pigment papers which Von Wittich used and which can never be reproduced with any surety for any one else's experiments, simply because there was no attempt made to secure, and hence, no record left of a diagnosis of their colour constitution.

A similar objection can be urged against his method of securing black (and also white) grounds, upon which the colours were placed for research. *Black* ground is a very indefinite quantity which may mean a great variety of black surfaces, all differing in the degree of their blackness. It is well-known that the surfaces which we ordinarily designate black in reality reflect a considerable quantity of light and are hence very far from being absolute black. Dr. Kirschmann has made some investigations along this line with the purpose of finding the relative brightness of different so-called blacks to white. His methods

are described in his article, "Ein Photometrescher Apparat Zu Psychophys. Zwecken," some of whose results described therein I subjoin :

I. PARIS BLACK :

(1) in lamplight (petroleum) is $\frac{1}{50 \cdot 0}$ or $\frac{1}{60}$ of white.
(2) in gaslight..... $\frac{1}{58}$ of white.
(3) in diffuse daylight . ..... $\frac{1}{57 \cdot 2}$ of white.

II. CHINA INK :

(1) in lamplight ..... $\frac{1}{28 \cdot 6}$ of white.
(2) in diffuse daylight ..... $\frac{1}{20 \cdot 2}$ of white.

III. GRAPHITE (Faber B.B. Pencil):

(1) in lamplight.. ..... $\frac{1}{6} \cdot \frac{1}{8}$ of white.
(2) in diffuse daylight ..... $\frac{1}{8} \cdot \frac{1}{9}$ of white.

IV. A specimen of black cardboard in sunlight was $\frac{1}{5 \cdot 2}$ of the intensity of white paper in sunlight.

It consequently follows that, unless we employ some means of specifying the particular black which is used in the ground, the results obtained can have only a private importance and not presume to be representative of the space threshold judgments of colours on a black ground. For it is evident that with two variables in regard to brightness, such as the colour pigment, and the unspecified black ground used must be, it would simply be impossible to know to what degree the influence of intensity contrast participated in the determination of the thresholds for any one colour, much more to what different degrees it entered in the determination of the thresholds of the other colours. It might appear that it is sufficient if only the colour and ground are subjected to the same illumination, for, at first sight, it might seem that this would secure a constant brightness relation between ground and colour. But a moment's reflection shows us that this would fail to ensure the constancy of this contrast relation throughout the various colours because of the fact that different pigments under the same conditions of illumination reflect light in varying degrees. Hence, if the illumination remained constant there would be a variation in the light intensity relation of colour to ground, for each of the colour pigments used, which would, of course, preclude the possibility of there being a quantitatively uniform contrast influence throughout, contributing to the space threshold determination of the various colours. This taken in connection with the fact that there is no clue to knowing the

specific character of the black ground used by Von Wittich, would render his results of small value for scientific purposes, because there is even no ground for forming comparison as to the relative magnitude of the space threshold for the various colours.

In our own experiments, I may say, we sought to remove these deficiencies in the work of Von Wittich by securing, on the one hand, an absolute black, or as near an approach as practicable, and on the other hand, by ensuring that the brightness intensities of the colours were so regulated that their relative brightness as compared with the ground was constant throughout their entire range. How this end was practically achieved we do not propose to describe at length in this present paper, but, suffice it to say, that we were successful in attaining an approximation to this constant intensity contrast relation which was substantially complete. This was done, on the one hand, by using a black ground which was black because of the exclusion of light from it, and was viewed through a long darkened tube with a diaphragm at the end, the inner surface of which diaphragm constituted the black ground, and the adjustable aperture of which became the coloured surface by reason of the coloured light entering through it. On the other hand, we refused to employ daylight illumination because of its uncontrollable and inconstant intensity, but used instead incandescent electric lamp illumination which by controlling the distances of the lamp from the different coloured surfaces illumined in such a way that their brightness was in each case judged equal to that of another standard illuminated surface, gave us a series of position marks of the lamp for the respective colours wherein their intensities as light were all equal.

After Von Wittich, Aubert took up this same problem, and, with a few improvements, followed largely in the footsteps of his predecessor, repeating to a large extent the same errors which we have noticed. Like Von Wittich he used ordinary pigment papers for his colours without any correction of the inaccuracies incident to their use, and for his black ground ordinary black cardboard. As we should expect, his results do not agree with those of Von Wittich at all, which only goes to show the truth of what we have already pointed out in reference to Von Wittich's results, viz.: that they are true only of the particular pigments which Von Wittich used, of private and not general validity.

The method of observation and measurement of the thresholds, employed equally by Von Wittich and Aubert, was also very crude. They took coloured objects and removed themselves gradually away

rom them until the colour quality of the objects began to change, and finally disappear from the spectator. Then they gradually approached again noting carefully their distance from the coloured object when it first became visible, and second, when it first became visible as coloured. Now it must appear that such a method of procedure, besides being subject to great inaccuracies in measuring the slight transitions of distance, often sufficient to cause a great change in the appearance of the coloured objects, is open to the serious objection of not providing for the influence of anticipation in lowering the threshold judgments of the colour as seen in their proper tone. According to this method the observer is familiar with the colour to expect, and this fact must of course materially modify the ease with which he detects the colour tone of the object gradually growing into view. In our work we avoided both these imperfections, viz.: of crude measurement methods and threshold modification from anticipation. We performed our experiments in such a way that the observer was quite in ignorance as to what colour in each case he might expect. The result was, of course, that the observer had to decide among the various spectral colours and their transitions quite upon their own merits and not according to information previously possessed as to what might be expected to appear. On the other hand, instead of employing the gradual departure or approach method of varying the visual angle of the coloured objects, we adopted the plan of keeping the distance between object and observer constant and varying the size of the coloured object through gradual transitions. In this way, by a very skillful contrivance described elsewhere, we were enabled to measure the transitions in size with minute accuracy to at least $\frac{1}{2000}$th of an inch, or even closer if desired.

As was to have been expected, our experimental results on the black ground, do not tally with those of Von Wittich or Aubert, who likewise do not correspond in results with each other. It would have been rather peculiar, in fact, if it had come about that our results corresponded with theirs, especially where peculiar care was taken to remove the several inaccuracies which we have noted in their mode of procedure. With the removal of the adulteration of tones in the colours experimented upon, and the regulation of a variable uncertain contrast influence, such as played an important, though unsuspected, role in their work, to the end that it became a constant quantity with us, and with the specially superior accuracy of our measurement apparatus, it would have been remarkable indeed had the results not differed materially from both Aubert's and Von Wittich's who took none of those

precautions. And, as a matter of fact, the divergence is quite according to the expectations we would naturally form in regard to the matter. In fact, so materially and in all points different were the conditions under which these investigations were carried out that it is scarcely instructive, scarcely worth while to institute any except the briefest comparison between their results.

However, before referring further to the results of a more accurate method, we will briefly notice a set of experiments which we made upon this problem, largely under the same crude conditions as Von Wittich and Aubert made theirs. We employed, as they did, uncorrected pigment papers for our colours, and daylight illumination. We had, however, a very fine specimen of black ground, approaching about as close as possible to an absolute black—which we attained, not by using a black cardboard illuminated by the same light as the colours, but a black surface from which all daylight and every other kind of light was rigorously excluded, so far as possible, by means of diaphragms. It was on such a black ground that our colours were viewed. With the exception of this difference, and the fact that we employed the accurate measurement apparatus referred to before, our results in this particular set of experiments were obtained under very much the same general conditions as Aubert's and Von Wittich's. However, we find, as we would expect from the impossibility of the actual duplication of the conditions of colour mixture in the pigment colours, and the exact reproduction of the precise contrast influences at work in the experimentation of Aubert and Von Wittich, that our results differ quite considerably from theirs, just as theirs mutually differ. In the main our results show a lower achromatic threshold than Von Wittich's, and generally quite as low as, or, with a few exceptions, even lower than the findings of Aubert. But the case is different with the chromatic and characteristic colour thresholds, in which we are somewhat higher than Von Wittich and Aubert. For example, Aubert's light thresholds on black ground vary from 1′ 14″ blue (ultramarine) down to 39″ orange, and red at 59″ which are rather low; while Von Wittich's light thresholds on the black ground are never lower than 1′ 4″ and though in that neighbourhood for the most part, yet, in the case of violet, reach as high as 3′ 26″. On the other hand our similar results show a fairly uniform tendency to have the light thresholds within the region between 46″ and 1′ with the exception of yellow and grey which reach 1′ 14″ and 1′ 17″ respectively. In regard to chromatic and characteristic thresholds Aubert has some very low, such as orange and red at 59″ and others that go up as high as 3′ 47″ and 4′ 17″, rose and blue respectively; while Von

Wittich's are mostly lower than 2', with the exception of dark *blue*, *violet* and dark *green* which are in the neighbourhood of 3' 26". Whereas our chromatic thresholds are mostly above 2', with exceptions such as red and orange which are at 55" and 48" respectively, *i.e.*, quite low, just as with Aubert's thresholds for these same. Our characteristic thresholds are frequently as high as 4' and 5', especially in the case of *blue* and *violet* and *green*, the same three colours by the way which had highest colour thresholds in Von Wittich's results.

Of the cause of the discrepancies between our results and Von Wittich's and Aubert's it is not difficult to form a feasible opinion from the nature of the conditions under which all three sets of experimental investigations were performed. When we remember the superior accuracy of our measurement apparatus we would ceteris paribus expect our threshold sizes to be somewhat smaller because of that fact. And this may be the reason why our achromatic thresholds are for the most part lower than theirs. But the explanation of the tendency of our chromatic and characteristic thresholds to be higher must be different from this. This seems very probably due in part to the fact that our experiments required choice to be made among a larger number of colours than did Aubert. We used more colours which would have a very effectual tendency to increase the difficulty of deciding which of them any specimen under examination while yet in the doubtful region near the threshold, might be. Accordingly, such an impediment would beyond question, contribute to the raising of our characteristic thresholds. However, this can only be an explanation in part, because, otherwise, we would expect a certain proportionality between the relation of the number of our colours and Von Wittich's and Aubert's, and the relation of the corresponding chromatic and characteristic thresholds of the respective investigations, But in fact we find no such regularity of correspondence between the number of colours used and the increase of the characteristic threshold size when we compare the results of Aubert, Von Wittich and ourselves. For example, Aubert exploits only a few colours, some four representative ordinary colour tones, and some two other commercial colours such as brown, whereas Von Wittich operated upon ten different colours, while we used ten also in our experiments of this kind. Hence, the discrepancy between our chromatic and characteristic thresholds and those of Von Wittich and Aubert cannot be solely due to the numbers of colours among which distinction had to be made, because we find our results prevalently higher than Von Wittich's who employed the same number of colours as we did. And we also find that neither our results nor Von Wittich's stand so much

higher than those of Aubert as the ratio 10:6 might indicate. There was in fact no such regularity.

However, there was in operation another influence which would materially modify the case and have a tendency to produce a comparative increase in the characteristic thresholds for experimentation. Such was the fact that Aubert and Von Wittich both permitted their observers to be aware by the very method of their procedure what colours to expect. The effect of such a mental preparation, undoubtedly, as is well known, would be to lower the point at which the colour could be known as such by counterbalancing that difficulty of decision among the various possible colours which placed our observer's judgment in suspense through a transitional region of no inconsiderable size, until the colour became so definite in its characteristics as to permit no further hesitation in judging it to be one colour tone as against all others. Such taken in connection with the obscure influences which we have noticed in the employment by the different observers of different representative colour pigments which are quite incomparable, and the varying play of contrast influences through the different investigations, will account for the main discrepancies between Von Wittich's and Aubert's and our experiments made under largely the same conditions.

So much for reference to our more carelessly executed experiments which were made solely for the sake of comparison with the results of Aubert and Von Wittich. We will pass on to a brief consideration of some of the results of less inaccurate experiment methods, wherein we secured fairly pure spectral colours and confined the contrast influence within definite channels and to fixed degrees equally distributed over the entire series of colours under investigation. We cannot, of course, give any lengthy discussion of the results in this preliminary paper, but must simply indicate their main trend, referring for fuller information regarding them to their subsequent presentation with tables and diagrams, whereby their significance can be more easily explained and more readily apprehended.

On black ground we obtained some rather interesting results. The light or achromatic thresholds show a quite decided tendency to be lowest in the region around the *blue* and *blue-green* with a slight tendency to be highest in the *red*. On the other hand, the chromatic thresholds though not with perfect unanimity show a tendency to be lowest in the *red* and highest at the other end of the spectrum. This fact is not contrary to what we might be naturally led to expect, because *red* is a colour which emerges as light, no sooner than it is visible

as *coloured*. This peculiar behaviour of *red* taken in connection with the fact that other colours are in minute sizes seen only as uncoloured spots, throws a side light upon component colour theories such as the Young-Helmholtz specimen. We would naturally expect according to this theory that, as the coloured surface became small its influence would be to stimulate only isolated minute areas in the retina, presumably areas so minute as to contain only the one class of nervous elements which respond to one of the original colour components *red*, *green* or *violet* (blue). But we find that this expectation is fulfilled in the case of *red*, and not in the case of *green* and *violet*, which would seem to contradict the theory. Especially is this convincing when we reflect that *green* and *violet* can be seen as *colourless light* of which they are supposed to be constituent elements, at smaller sizes than they can be seen as *green* and *violet*.

Our characteristic thresholds on the black ground displayed a degree of regularity and mutual agreement in tendency among the different observers' results, which was gratifying. They all coincided in having for the lowest space thresholds *red*, *yellow* and *blue* (to blue-green), and for the regions of highest thresholds those about (orange), *orange-yellow*, *yellow-green* and *violet*. The marked correspondence we have graphically presented in curves which will be given with the larger exposition of the problem and results subsequently.

On a grey ground wherein the light contrast influence was to all intents eliminated, we obtained results which, considered relatively, among the various colours with regard to their characteristic space thresholds, were well in agreement with the results obtained upon the absolutely black ground. That is to say, the colours of the lowest characteristic space thresholds were again *red*, the region around *yellow*, and that around *blue* and *blue-green*, while the regions of highest characteristic thresholds were as previously, the *orange*, *green* and *violet*.

It is not permitted us, in the scope of this brief paper, to pause to discuss these results. For this we refer to the paper which will appear later. Meanwhile, all we can do is to call attention to the fact which is noticeable, namely, that the colours which have the highest thresholds on these colourless grounds, are respectively just about the complementaries of those wherein the lowest thresholds obtain. Whether this is significant or insignificant, we cannot here debate, but at any rate, it is a balanced regularity of behaviour which adds a certain æsthetic interest to the findings of our experiments. There is no à priori reason which would lead us to expect that, of themselves, complementary colours,

on a black ground, should counterpoise one another in regard to the angular magnitudes at which they are distinguishable definitely in their proper tones. There is no prima facie ground for supposing that an *orange* and a *blue* of equal intensity as light and subjected to exactly the same environing conditions of colourless light, or absence of light, should display mutually inverse facility in rendering themselves visible as *orange* and *blue* respectively. Hence, that they apparently do so pair off in complementary doubles in regard to the characteristic space threshold, is a noticeable regularity whose explication is not contained analytically in the fact of their being complementary colours.

Our results on a green ground show a very prevalent tendency for the characteristic thresholds to be lowest in the *red* and *yellow* with a lowering somewhat in the *purple*. On the other hand, the regions of highest characteristic thresholds are the *orange*, *orange-yellow*, *yellow-green* and *blue-green*. We would naturally expect that the contrast influence of the green ground would dispose *purple* to have the lowest characteristic colour threshold of all the colours because of the fact that from the most minute surface magnitudes of the colour examined, it is continuously inducing thereupon a more or less influential disposition to purple. However, we find that *red* is the lowest in characteristic threshold, though, in case of one observer, we must state the purple was seen quite as low as the *red*.

But if we consider our results on *blue* and *red* grounds respectively we find a similar phenomenon with much more declared and precise features in contradiction to what we might be disposed to expect.

On the red ground we find an unequivocal unanimous tendency among all the observations for the lowest characteristic threshold to be at the *blue*, and for the colours on both sides in the spectrum to become higher in their characteristic thresholds. The highest mark is reached mainly in the *orange*, *yellow*, *green* and violet, while in the orange-yellow there is a disposition to a lowering though in no case does it reach the low mark of the *blue*. The *blue-green* is for the most part low also. Now it must at once strike us as peculiar that on a *red* ground the blue should be the colour of the lowest spatial threshold. We would naturally expect the blue-green or some of the greens in that neighbourhood to be most easily seen as such and such, and hence to have the smaller threshold because it is the so-called complementary of the red. Being complementary, and therefore having the co-operation of the contrast influence of the red ground to emphasize its peculiar quality of colour we would think it should have a certain primacy over

the others in the facility with which it makes itself known. But the facts are not as we would expect. They are on the contrary arrayed with striking uniformity in flat contradiction of these natural expectations, as is displayed nicely in the curves which we have prepared, but are unable to embody in this paper.

If we consider in connection with this our characteristic threshold results on a *blue* ground, we will find more material for wonder. On the blue ground we find the lowest threshold marks are not in the orange as we might have expected from the complementary relations of *blue* and *orange*, but they are uniformly at the *red*. The next lowest points are respectively *purple* and yellow-green; whereas the highest points are the *orange* and the *blue-green*, and the *green*. It may be noticed that so far from the orange being seen earliest, as we would expect, and at smallest space threshold, it was generally not distinguished as orange at all, even at the fullest opening of the diaphragm apparatus at a visual angle of something in the neighbourhood of 2°. It is from the first called *red*, and remains so generally throughout the subsequent transitions in surface size, quite in violation of our natural supposition that the orange should be seen easiest on a blue ground. We must note also that not only did the entire range of observations made by many different observers agree in the fact that on the *red* ground *blue*, and on the *blue* ground *red* had the lowest thresholds, but the agreement was striking and uniform to such a degree that the various curves representing the several observers' results came almost to one point (the lowest of all), at the *blue* and *red* in the case respectively of the *red* and *blue* grounds.

In short, it will be noticed, if we consider the blue ground results and *red* ground results together, that *red* and blue act in both cases as we would expect true complementaries should act, viz.: the blue ground seems to facilitate the minute distinguishability of *red* more than the remaining colour elements, and the *red* ground acts similiarly upon the blue. What the significance of this singular phenomenon may be it is perhaps difficult to say, but it seems to indicate, at least, that there is a disturbance of the ordinary complementary relations of the various members of the colour system when the colour surfaces are reduced to small sizes.

Whether such is the case or not we wish to call attention to a very striking coincidence between the facts here disclosed and a similar complementary behaviour of *blue* and *red* in the case of a very remarkable colour blind (dichromate) investigated by Dr. Kirschmann and recorded

in his article "Beitrage für Kenntnisse der Farbenblindheit," in Vol. VIII, of Philos. Studien, p. 199. It was the case of Prof. A., numbered case V, in the forementioned article—a man whose left eye was perfectly normal in its colour sensibility, but whose right eye was colour blind, not by accident or disease, but congenitally. The right eye for this subject was a dichromate, *i.e.* possessed of only two main colours in its colour system, namely, *red* and *blue*, and these behaved throughout for that eye as complementaries, as shown by the after image tests. It is rather a peculiar fact that in the normal eye, as our experiments have shown, for small angular sizes of coloured surfaces the same complementary relation of blue and red appears to obtain, as was evinced in the abnormal eye of Prof. A. Whatever the reason may be accounting for the fact, the coincidence at any rate is somewhat striking, the more so because the peculiar tendencies of the *red* and *blue* were so uniquivocally established so far as our experiments at least were concerned.

It may be noticed in closing this paper that this peculiar behaviour of *blue* and *red* in regard to their characteristic space thresholds when respectively under the other's contrast influence seems to form a serious difficulty to Hering's colour theory which explains all colour phenomena by means of a threefold antagonism of fundamental colour processes in which *black* counterpoises white, *red* counterpoises *green*, and *yellow*, *blue*. This theory would claim that the *red* process which signifies the destruction of nervous elements of a certain kind should originate the green process, both in the recuperation of those same elements and in the neighbouring ones also, which have been disturbed. In other words specifically applied to our apparatus a *red* ground when looked at for the emergence of another colour within its limits as would occur in the central opening of a red coloured diaphragm to permit the entry of other coloured light, should tend to induce upon that element in the red surface a *green* color; because, according to Hering's theory the great activity of those retinal elements stimulated by the red ground, should tend to induce a neighbouring antagonistic activity in the retinal elements which are free from the stimulation of the red ground, namely, those upon which the emerging light of the diaphragm aperture falls. But our experiments show a quite contrary state of things. Instead of the *red* ground inducing the *green*, and the *blue* ground the *orange* or yellow which the Hering theory demands, we actually find as before indicated the *red* ground inducing *blue*, and the *blue* inducing *red* quite in defiance of what that theory pronounces should be. Perhaps the adherents of Hering's theory might be inclined to try to explain the phenomenon by irradiation or what Hering calls

light induction or negative contrast. But such an explanation will not suffice. For it is clear that if the spreading of the red stimulation around the small (aperture) surface counteracts to a certain degree the green induction, what we would expect to issue is not *blue* by any means but *colourless light*, because it is a case of the counteraction of complementaries (red and green), which of course, would produce colourless light. But even if we suppose that the negative induction is not sufficient in degree to completely counteract the positive induction (green), what we would expect from this is a *green* of weakened saturation and not under any circumstances *blue*, as was the case in our experiments. For the influence of the negative contrast would simply be to neutralise the positive colour quality of some of the green induced by the *red* environs, which would, unless a case of complete counteraction where colourless light is the outcome, leave less green light interfused with much grey light produced by the mutual neutralisation of positive and negative inductions, and this is tantamount to saying the result is a *green* of poorer saturation instead of *blue*. So that the question remains over for the Hering theory quite as awkward as ever. Even if we admit the possibility of a gratuitous deviation from that which the theory would lead us to expect and suppose, that in some way or other this negative contrast influence might succeed in producing some other colour result than green, we have yet to explain why it should not as likely be some colour on the *yellow* side of *green*, as one on the *blue* side. We can find no à priori reason for any presumption that the *blue* should obtain the favoured lot of this fortuitous birth. It might just as well be *yellow*, and the fact that *blue* actually obtains is a phenomenon which to our minds has not been and cannot be explained by recourse to negative induction or any such device born of the exigencies of a desperate theory.

In fact, so far as I can see, Hering's theory makes no provision for any such disturbance in the ordinary complementary relationships of the members of our colour system such as the remarkable colour blind case cited seems to demand, and which our space threshold experiments corroborate as possible not merely for abnormal cases but for the normal eye also at small visual angles.*

*Also the very ingenious but somewhat complicated theory of Ebinghaus does not give account of these facts and we may suggest that such a case as Prof. A., where the colour blindness was not only monocular but where the subject was at the same time an expert opticist—a coincidence which will not frequently occur—such a case should not be disposed of in the summary way in which Ebinghaus treats it in his article—Zeitschrift fur Psychologie, Band V, Page 215.

ORDER OF THE COLOURS WITH RESPECT TO CHARACTERISTIC SPACE THRESHOLDS.

(a) ON BLACK GROUND.

Lowest.	*Highest.*	*Medium.*
Red.	(Orange), Orange-Yellow.	Purple.
Yellow.	Yellow-Green.	Green.
Blue and Blue-Green.	*Violet.*	

(b) ON GREY GROUND.

Lowest.	*Highest.*	*Medium.*
Red.	Orange and Orange-Yellow.	Purple.
Yellow.	Yellow-Green and Green.	
Blue and Blue-Green.	Violet.	

(c) ON GREEN GROUND.

Lowest.	*Highest.*	*Medium.*
Red.	Orange-Yellow.	Violet.
Purple.	Yellow-Green.	Blue.
Yellow.	Blue-Green.	

(d) ON BLUE GROUND.

Lowest.	*Highest.*
Red.	Orange.
	Yellow.
Purple.	Orange-Yellow.
	Blue-Green.
	Green.
	Violet.

(e) ON RED GROUND

Lowest.	*Highest.*	*Medium.*
Blue.	Yellow-Green.	Green.
Blue-Green.	Orange.	Orange-Yellow
	Violet.	
	Purple.	

JOSEPH BRANT IN THE AMERICAN REVOLUTION.

By Capt. Ernest Cruikshank.

(Read 3rd April, 1897.)

Among the few remarkable persons known to history, produced by his race, a place in the first rank must naturally be assigned to Joseph Brant as being equally distinguished in the council and in the field. Energetic, brave, and skilled in all the arts and devices of partisan warfare, his numerous expeditions were marked by almost uniform success. A burly and muscular frame and perfect health enabled him to endure extremes of privation and fatigue. His shrewdness and undoubted eloquence and argumentative skill gained him even greater reputation and influence among the whites than with his own people. He possessed the valuable faculty of displaying his talents at all times to the best advantage and impressing nearly every white man he met with perhaps an exaggerated idea of his consequence and ability. From the close of the American Revolution until his death in 1807, he was universally regarded as the most eminent and powerful of his race and was constantly courted and caressed by the officials of both governments and was at the same time equally feared and distrusted by them, as a necessary result of his tortuous and disquieting line of policy. His biography was written at considerable length by Mr. Stone some fifty years ago; but the materials at the disposal of the author were so imperfect that it abounds in errors and misstatements. Quite recently documents have become accessible which render it possible to correct these and construct the narrative of his career on a more secure foundation.

He was born in the year 1742, at the upper Mohawk village of Canajoharie. Sir William Johnson's relations with his sister Mary, induced him to take notice of the young Indian, who displayed at a very early age remarkable readiness in learning to read and write his native language under the instruction of a native Indian schoolmaster maintained in his village by the "Society for the Propagation of the Gospel in Foreign Parts." By Sir William, he was then sent to an English school of reputation at Lebanon, Conn., where

he remained for several years. His marked proficiency in reading and writing English and the aptness he manifested in translating from the various Indian dialects procured him employment as an interpreter in the Indian Department before he reached the age of twenty. In this service it was an easy matter for him to gain distinction, as the majority of his fellow interpreters were rather illiterate and dull-witted men, and and at the same time he secured the warm approbation of successive missionaries by his exemplary conduct as a Christian. The Rev. Samuel Kirkland, a Presbyterian, and later on, a fierce advocate of the revolutionary movement, said "he endeavours to teach his poor brethren the things of God in which his own heart seems much engaged. His house is an asylum for the missionaries in that wilderness." Mr. Stuart, the Church of England missionary, engaged him to translate a large part of the New Testament into Mohawk, as well as the church catechism and a number of sermons, a task which was performed to his satisfaction.

Brant's own tribe, the Mohawks, once the most numerous, always the most warlike and aggressive, had been so diminished by its losses in the late wars with the French that it had become the smallest of the Six Nations, although still regarded as first in rank and reputation. There were now but two small villages known as Canajoharie, or the Upper Mohawk town, and the Lower Mohawk town, containing together barely 400 inhabitants and these were quite surrounded by populous white settlements. There were, in addition, some twenty families, equally isolated, living in the valley of Schoharie.

"Nothing less than manifest injury, in my opinion," Governor Tryon had declared with emphasis, in 1772, "will drive the Mohawks from their steady attachment to His Majesty's interest. They appear to be actuated as a community by principles of rectitude which would do honour to the most civilized nations. Indeed they are in a civilized state and many of them good farmers." Sir William Johnson had been received into this tribe by adoption and had for many years taken a keen interest in its welfare. He founded schools, built churches, and bought black cattle and agricultural implements for its use. There was already a strong strain of white blood in the veins of many of its members and he endeavoured earnestly to strengthen the ties which united the races in every way. The Annual Register for 1767, records the fact that "eighteen young white women have lately been married to as many young Indian chiefs. Sir William Johnson gives all possible encouragement to intermarriage with the Indians which has long been practiced by every nation in America but the English."

The fertile plots of bottom lands occupied by the Mohawk had

greatly increased in value as the white settlements extended, and the land-hunger of their neighbours at length became so powerful that they had recourse to the most shameful expedients to dispossess the Indians. When Tryon received the Mohawks of Canajoharie at Johnson Hall on the occasion of his visit to that part of the valley, Brant, addressing him in their name, said: "We have often been deceived and defrauded of large tracts, but that which at present gives us most concern is the little tract which surrounds us, on which we live, and of which we are now likely to be deprived. It was surveyed one moonlight night and a patent procured for it, by Mr. Livingston, without our knowledge."

The property of the Lower Mohawks was menaced in a very similar manner. The singular old charter of the town of Albany authorized that Corporation to take a thousand acres of land from the Mohawks. This claim had remained in abeyance for half a century, but it was now revived and put forward as a pretext for seizing the very lands they cultivated and had built their dwellings on.

Sir William Johnson's death in 1774 removed the chief barrier against the aggression of the whites. These claims were then pressed with greater vigour, and the Indians became sensible that unless they could secure the intervention of the Crown their prospect of retaining their lands would be slender. They also perceived that as the province became more disturbed and the royal authority grew weaker, the activity of their enemies increased.

Brant had not remained a careless spectator of the fierce revolutionary agitation seething around them and threatening their ruin. His friend, Colonel Daniel Claus, has described his attitude in a highly characteristic passage. "At the commencement of the unhappy disputes between Great Britain and her colonies, he made shrewd and strict enquiries into the reason of the complaints of the Americans, among whom he chiefly resided, and from whom he heard nothing but forging of chains and intended tyranny against them, at the same time seeing no apparent alteration or putting such complaints of tyranny into execution of it, agitated his mind so far as to determine on a voyage to Great Britain in order to try what he could find out there of the matter, plainly foreseeing how much the Indians in general were concerned in such a quarrel, well knowing how ignorant they were as to the disputes in question."

The first trace of actual activity on his part is discovered in a letter written by him in the name of Aaron, John, and another Mohawk chief, in May, 1775, to the chiefs of the Oneidas urging them to come to the assistance of Colonel Guy Johnson, who had succeeded his uncle, Sir

William, as superintendent of the Six Nations. Johnson had been warned of the existence of a plot to carry him away a prisoner to New England, and had hastily summoned a party of Mohawks to his house to protect him. This letter was intercepted and as the Oneidas failed to appear, Colonel Johnson, accompanied by the officers of his department and his faithful body-guard of Mohawks marched rapidly up the valley and disappeared in the recesses of the Indian country. In July, he held a council of the Six Nations at Oswego. This was attended by nearly 1,500 Indians. The superintendent advised them to be faithful to their engagements with the Government and not to molest the inhabitants of the border settlements in any way, but he requested them to guard and keep open the trade-route from Albany to Oswego, and to prevent any interruption of the navigation of the St. Lawrence and Lake Ontario as the only channel by which the garrisons of Niagara and Detroit could be supplied. This they agreed to do, and he selected a small party of picked warriors to accompany him and aid in the defence of Montreal, then threatened from Lake Champlain. Wild and baseless rumours of the sinister designs of the Indians convulsed the frontier settlements with terror after his departure, and in these Brant was constantly named as one of their principal and most active leaders. His share in the short campaign in Canada which followed is not recorded. Claus states that he served faithfully. It seems extremely probable that he was present with other Mohawks at the repulse of the Americans before St. John's and also at the action on the Island of Montreal in which Ethan Allen was taken prisoner by his nephew Peter Johnson.

In November, 1775, Guy Johnson sailed from Quebec for England, taking with him Joseph Brant, whom he terms in his journal "a faithful young chief," as the representative of the Mohawks of Canajoharie, and his friend John Deseronto, to speak for those of the lower village. On the 28th of February they were presented to the King, at St. James's and according to the Annual Register, "graciously received." On the 14th of March, they had an audience of Lord George Germain, to whom Brant related the tale of the grievances of their tribe. During their stay in England they were shown the Tower and other places of interest, in and about London, by the direction of the Government, and received many attentions from persons of note. Foremost among these were the Earl of Warwick and James Boswell. Brant's portrait was painted by Romney, then at the height of his reputation, and the fashionable artist of the day, at the request of the former, and a sketch of his life was published in the *London Magazine* through the agency of the latter. He found himself one of the lions of the season. We are

informed by Claus, who was in London at the time, that "he made himself acquainted with gentlemen on both sides of the question, soon finding out there was an opinion in favour of the Americans in England, and his penetrating genius soon saw into the motives of that opposition, and plainly discovering that there was no reason of such complaint he was told of in America, and all they and the Americans aimed at was to be sole masters of America, an event so destructive of the liberty of the Inds and their country, and being convinced of the anxiety the Americans for some years showed to dispossess the Inds of the country, had not the Crown interfered. * * * Several gentlemen, of distinction and fortune, took notice of him and used him very kindly, and although some of them were friends of the Americans and argued in their favour, he listened to their arguments with calmness and answered with discretion."

At length, having received a promise from Lord George Germain that the grievances of their people would be redressed, for which they thanked him with due solemnity, and assured him of their attachment, Brant and his companion sailed with Colonel Johnson from Falmouth for New York in the packet *Harriet*, early in June, 1776. During the last three weeks of their voyage (which continued nearly two months), they were repeatedly chased by American privateers and forced out of their course. When near the Bermudas they were overhauled by one of these vessels mounting fourteen six pounders, besides several swivels, and showing a great number of men. The *Harriet* carried only twelve three pounders and was very weakly manned. Colonel Johnson and his officers armed themselves and joined the crew at their quarters. The two Indians having new brass rifles, presented to them by Lord Townshend, distinguished themselves by picking off several persons on board their assailant, whom they supposed, by their dress and actions, to be officers, and after a very hot and close engagement, lasting nearly two hours, the privateer sheered off and sailed away leaving the packet much damaged in masts and rigging, but having only the surgeon of the Indian department and five others wounded. Owing to this, and other disasters, it was not until the 29th of July that they entered the port of New York.

They arrived at a stirring and critical time. On the 2nd of August, Sir William Howe's army landed at the Narrows, nine miles from the city. On the 27th the battle of Long Island was fought, in which Brant took part as a volunteer. By his bravery and skill as a marksman he not only attracted the notice of Earl Percy, who commanded the main body of the British army, but of General Howe himself. On this

occasion the Americans brought a body of Indians into the field some of whom were taken prisoners in the pursuit. Brant entered New York with the victorious army and witnessed the incendiary fires by which one-fourth of the city was laid in ashes.

He had at first formed the project of proceeding up the Hudson as far as Albany; whence he hoped to be able to make his way to the villages of his tribe, which he learned was quite inactive, apparently waiting for instructions or overawed by numbers. He lingered at New York nearly two months longer in the hope that a passage might be opened for him in that direction, but finding then that there appeared to be little prospect of this, he requested General Howe's permission to attempt to penetrate through the enemy's country to the Susquehanna where the nearest villages of the Six Nations were to be found, a distance of more than 200 miles. This would have been a dangerous undertaking for a white man; it was doubly dangerous for an Indian. Although he warmly approved of the service which Brant proposed to render by this daring journey, Howe is said to have given his consent very reluctantly owing to the evident risk attending it. All his instructions were given verbally for fear of capture, and Colonel Johnson authorized him to have a belt of wampum made as soon as he reached his destination, which he was to speak upon and deliver in his name.

It was not until nearly the end of November that Brant left New York accompanied by Captain Gilbert Tice of the Indian Department. They crossed the Hudson at Kingsbridge, adroitly passed the enemy's lines in the dark, and struck directly for the Susquehanna. But as they had a great extent of hostile country to pass through, swarming with patrols and armed parties of the enemy, they were forced to conceal themselves during the day and travel by night only, until they reached the Indian village of Oquago on that river. They were warmly welcomed by the inhabitants to whom Brant was already well known. Upon learning his wishes they almost unanimously agreed to put themselves under his command and act against the Americans. He next went to the Delaware settlement on the west branch of the Susquehanna where he was equally successful. Four days journey then took him to Chenussio (Genesee), the first village of the Senecas. Here again he was well received and promised assistance. After a march of three days from Chenussio, he arrived at Fort Niagara which he designed to make his base of operations. From Colonel Butler, the acting Superintendent of the Indians, he met with rather a chilling reception, probably due to the fact that that officer had received peremptory instructions to prevent the Indians from making any attack or committing the slightest

depredation on the frontiers of the revolting colonies, and to employ them solely for purposes of defence. Brant's ardour was not cooled however, for he lost no time in preparing a war-belt of wampum and carried it from village to village and from tribe to tribe throughout the Six Nation Confederacy. Finding that the Oneidas had practically entered into an alliance with Congress, he boldly went to the village of Canaghsoragy near Fort Stanwix, which was inhabited partly by Onondagas and partly by Oneidas, and invited the remainder of the latter tribe to meet him there. Most of them complied, but with evident reluctance and ill-will. As his custom was on such occasions, he told the story of his travels and dwelt upon the power and wealth of England. Then he described the rout of Washington's army which he had witnessed on Long Island, and argued how improbable it was that the rebellion would be successful. The Oneidas however, declared that they were friends both to the King and the colonies, and after an angry discussion the meeting terminated without any definite result. Undaunted by this rebuff, Brant determined even to seek the assistance of those Indians of the Iroquois League, resident at St. Regis and the Lake of Two Mountains, and, as he found it impossible to visit them he sent a written message in which he apparently allowed his zeal to carry him beyond his instructions, and which caused him to fall foul of an unexpected and powerful adversary.

To my brothers the Indians of the Lake of Two Mountains:—

"I am just arrived at Niagara. I acquaint you of this as I intend going down on an expedition this year early in the spring—I expect you will let me know if you will come up and join me. I intend to go with the Indians to deliver my brothers, the Mohawks, from the hands of the rebels, and you may depend upon having your own way of making war. I do not think it right to let my brothers go to war under the command of General Carleton, as General Carleton expects and tries to have the Indians under the same command as the regular troops, but it will be the best method for us to make war in our way. This is my reason for acquainting you that any of you that wish to come up, may come up and join me. This is all I have to say, but I wish your answer as soon as possible."

JOSEPH BRANT.

This letter must have been conveyed to Carleton almost as soon as it was received, and he at once put his foot resolutely upon a movement

so much at variance with his established policy. As early as the 9th of February he wrote to Butler on this subject :—

"I transmit to you the copy of a letter which has been sent to the Indians of the Two Mountains and St. Regis, by Joseph, who is said to have arrived at Niagara, late from New York.

"I beg you will exert every means in your power to stop the Indians of your neighbourhood, as has already been done by those above mentioned, from joining in an enterprise which, besides the inhumanity of it, cannot fail to be attended with consequences very detrimental to His Majesty's interest, and I beg you will use your utmost efforts to engage all the savages of every tribe you can communicate with to join the King's armies early in the spring where they can be supplied with officers and proper persons to direct their efforts to the proper objects, and to prevent the impolicy as well as cruelty of confounding the innocent with the guilty, which must unavoidably result from a war such as is proposed by the letter circulated among the Indians of this country. The force of the savages may be employed under proper management to promote effectively where it is necessary, and this must answer every end of this equally well, while it serves so much better the King's cause."

Addressing Captain Lernoult, the commandant at Niagara, on the same day, he said :—

"However proper and justifiable it may be to make use of the Indians in a defensive war, or to chastize the real criminals, yet true humanity forbids an indiscriminate attack such as is intended by the savages wherein women and children, aged and infirm, the innocent as well as the guilty, will be equally exposed to their fury. I desire therefore, that all means may be used to prevent this, and to turn the force of the Indians to the use which will be most for the King's interest and their own good, by acting in concert with the troops."

Brant spent most of the winter at the Cayuga village in the heart of the country of the Six Nations, animating the Indians and preparing them by every means in his power to take the field early in the spring. But when he returned to Niagara, in high spirits over his success, to procure arms and ammunition, he was amazed and enraged to find not only that he was refused both, but that every obstacle was thrown in the way of his expedition by Colonel Butler and Captain Lernoult, without any explanation being offered. As Carleton's instructions were unknown to them, Butler's conduct was not unnaturally attributed by Brant and

his friends to petty spite or even worse motives. "But here," Claus wrote bitterly soon after: "Jealousy and envy, the monsters of all discord and mischief, showed their heads, and the person who was left there in 1775 by the Superintendent to assist the Commanding Officer at that post in Indian matters was an officer of equal employ with Mr. Brant, only of less importance as to Indian matters and acting in a more servile line, this person having with flattery and cunning (being bred and born in New England), insinuated himself into the favour of Sir Guy Carleton and procuring himself thereon to the office upon the strength of that, lavished immense sums without doing the least service to Government since the beginning of the Rebellion, but allowed the Rebels to establish themselves at Fort Stanwix in the midst of the Six Nation country. This person then imagining to please Sir Guy in slighting and disregarding Sir Wm. Howe, and the Superintendent, besides, apprehensive Mr. Brant should do anything that would expose his inactivity and willing backwardness, received him very cooly and indifferently, although under Superintendent's immediate employ and appointment, having nothing separate from Sir Guy, even denied him the quantity of ammunition he demanded for opposing the Rebels that were assembling again, and he was obliged to purchase what he could get among traders out of his own pocket, and returned very much discouraged from Niagara."

Within a month, information of Brant's successful and alarming activity among the Indians reached the ears of the New York Convention which promptly employed a Colonel Harper, in an attempt to kidnap him. Harper went quietly with a few men to Oquaga on this business but found that Brant was absent on his second visit to Niagara, and the Indians residing there assured him that he intended to settle at the Onondaga Castle on his return.

Whatever disappointment Brant may have felt at Butler's treatment of him, and it was no doubt keen, it did not affect his political sentiments or cause him to relinquish his design of bringing off the remainder of his own tribe from the valley to which they have bequeathed their name. With that intention he collected nearly 200 Indians early in the spring of 1777 and advanced to Unadilla close to the border settlements of New York. General Herkimer at once assembled an armed force of four times that number to bar his further progress. Leaving half of his party in reserve at Cherry Valley, Herkimer advanced into the Indian territory with the remainder and demanded a meeting. Confident of his strength, there seems little reason to doubt that he intended to kill or capture Brant on this occasion and it is said, had specially detailed a

party of men to shoot him when a favourable opportunity offered, but the wily Mohawk was on his guard and his followers were too watchful and well armed for them to risk the attempt. Brant openly declared that "he had taken sides with the King," and even demanded the release of the Rev. John Stuart and Mrs. Butler who were detained by the Americans as hostages. Angry words were soon exchanged with some of Herkimer's officers who had been concerned in the disgraceful plot to deprive his people of their lands; threats were uttered, and, at a sign from their leader the Indians seized their weapons and a conflict was only averted by the hasty retreat of Herkimer and his men.

He then continued his agitation with even greater success than before for the Indians warmly resented this ill-advised invasion of their country. Writing from New York on the 7th of July, Guy Johnson was able to announce to Lord George Germain that he had received a letter from the Chiefs of the Six Nations "written by Joseph," assuring him that with the exception of the Oneidas they were "ready to act as one man."

Shortly after Herkimer's abortive attempt at coercion, Brant received a message from Colonel Butler, acting under fresh instructions, requiring all the Indians to join him at Oswego to co-operate in an expedition against Fort Stanwix. He obeyed so promptly that he arrived at that place some days in advance of Butler himself, bringing with him not less than 300 warriors. His party was at once pushed forward to support Lieut. Bird who had gone on with a few men to reconnoitre the enemy's position, and the investment of the fort was accomplished with little opposition.

Three days later a message, hurriedly borne by an Indian runner along a bye-path, came from his sister, Molly, who was then living in the Mohawk village of Canajoharie, warning him that a body of nearly a thousand militia, under Herkimer, were on their march to relieve the garrison. Sir John Johnson and Colonel Butler with eighty white men and 400 Indians were detached to meet this force which they waylaid and routed in the woods at Oriskany, a few miles distant. Claus, who was present, said, "Mr. Brant signalized himself highly by advancing on the rebels rear, and harassing their retreat, and making a great slaughter chiefly with spears and lances." The same authority adds that Brant and the Seneca Chief, Sangerachta, were eager to follow up the blow by a descent on the settlements on the Mohawk River, but Colonel St. Leger refused permission from motives of humanity. However, when it was finally determined to raise the siege, he consented that Brant should attempt the execution of his long cherished plan of

delivering the Mohawks in course of a flying march down that historic valley, and then endeavour to join Burgoyne's army which was known to have reached the Hudson River. In carrying out this project, he was obliged to pass around an American army and march for a hundred miles through a hostile country studded with forts. In one skirmish, his favourite companion, Captain John, falling to the rear was surrounded and "being determined not to surrender, had a whole charge of buck-shot fired into his left breast and arm and, notwithstanding, made a miraculous escape." At the lower Mohawk village, they were joined by about a hundred of its inhabitants, after which they continued their hurried flight towards Saratoga. When at length almost within sight of the British camp, Brant "had an encounter with the rebel party which he soon put to flight and arrived safe with Gen. Burgoyne who received and treated him according to his merit."

The arrival of his party is noticed by Anburey when at the Batten Kill on the 24th of August.

"The Mohawk nation," says that author, "which are called Sir William Johnson's Indians, as having their village near his plantation, and who in his lifetime was constantly among them, were driven from their village by the Americans, and have joined our army; they have come with their squaws, children, cattle, horses, and sheep, and are encamped at the creek from whence this place takes its name. When the army cross the river, the squaws and children are to go to Canada and the men to remain."

Like all the other Indians, the Mohawks soon became impatient under the restrictions imposed upon their movements by the presence of so large a regular army, and they deserted Burgoyne some time before the catastrophe of Saratoga.

Claus relates in his "Anecdotes" that Brant "procured encouraging messages from the Canada Indians that remained with Gen. Burgoyne and accordingly attended a general meeting of the whole confederacy at Onondaga where he spared no pains to prepare and harangue them against the shock of Gen. Burgoyne's disaster, of which they soon after had a most exaggerated account from the rebels, the only channel they could get it then, who at the same time with threats invited them to join their cause with a large belt of wampum and a war axe worked in it. However, Mr. Brant, counteracting and using the most urgent arguments such as the loss of brave chiefs and warriors at Fort Stanwix and what subjection and slavery they must be exposed to if the rebels got

the better as their behaviour for many years past clearly pointed out, in which he was joined by his faithful co-adjutor, Sakayenguarghton, the Seneca Chief above mentioned, and in reality carried his point at last so far as to make the whole Confederacy firmly resolve to act most vigourously against the rebels."

Claus was certainly inclined to exaggerate the extent and value of Brant's influence and possibly his statements should be accepted with some reserve. A private letter from a German officer to his family, shows, however, that his movements had become already a topic of common talk in Canada and that he was suspected of entertaining designs scarcely less ambitious than those of the renowned Pontiac whose deeds were still a matter of recent history.

"Now, however, they (the Indians) greatly desire to be independent, and as faithful allies and friends to fight for the King, without being commanded by English generals and officers, and an *Iroke* named Joseph, who has spent some time in England and naturally knows something of the English and savages, desires to achieve for himself a name as chief of an army of Indians. Every means will be tried to prevent this, for God help those colonists who are their near neighbours, should this scheme be carried into effect."

In another place, Claus acknowledges that Brant was ably seconded in his efforts by the tears and prayers of his sister Molly, who had been driven from her home by the enraged Americans soon after the battle of Oriskany.

"She was obliged to leave her home and flee for her children's safety among the Five Nations, where she was assisted by her brothers people, and proceeded to take asylum among the Five Nations, every one of whom pressed her to stay among them, but she fixed upon Cayuga as the centre, and having relations among them, by whom she was kindly received. After General Burgoyne's affair she found them, in general, very fickle and wavering, in particular the head man of the Senecas, called Cayenguarahton, with whom she had a long conversation in council, reminding him of the great friendship between him and the late Sir William Johnson, whose memory she never mentioned without tears which strikes the Indians greatly, and to whom she often heard him declare and engage to live and die a firm friend to the King of England and his friends, with other striking arguments, which had such an effect on this chief and other sachems present that they promised henceforth truthfully to keep up their engagements to her late friend, for she is

considered and deemed by them as his relict, and one word from her goes further with them than a thousand from any white man whatever, who must generally purchase their friendship and influence at a high rate. They desire her advice much more than that of her brother, Joseph, whose zeal and activity rather occasion envy and jealousy with many."

But to Mr. Knox, Secretary to the Committee of the Lords on Trade and Plantations, he wrote of Brant, on the 6th of November, 1777, in terms of unqualified praise.

"Joseph, since his arrival," he said, "has shown himself the most faithful and zealous subject His Majesty can have in America, and deserves to be noticed as such. He is now busy among the Six Nations and has been with them for several weeks past. He is perfectly acquainted with Mr. Butler's sentiments, and disapproves of them, for which the latter dislikes him. I have fully wrote him and given him my opinions and sentiments how to act with the Six Nations, and I am persuaded he will bring them to action before Colonel Butler gets among them."

Before the end of the same month Brant was again at Niagara, and a trusty messenger was sent out on the perilous journey to the British outposts on the Hudson, bearing the following letter from Butler, which after many weary weeks of wandering, he carried safely into New York:

"To Major-General Clinton, Sir William Howe, or officer commanding on Hudson's River.

"SIR,—Joseph and myself are ready to await your orders. We wish to know your situation, and when we can be of use to you and where; we only wish to know the time and place, as we are confident of being well supported; our friends are determined to be so in the worst of times."

A few days later Colonel Bolton informed Haldimand that "Joseph had been of great service and deserved every favour he could show him."

Nothing further is then heard of Brant until the 23rd of January, 1778, when he wrote from Niagara to Claus:

"I shall go from this place to Cayo-Kwen. I intend to remain there during the winter. Twenty odd men go with me from here, and all my particular friends also who are ready to join me through the Nations.

All the Nations are in good spirits and more united now than they have been since the trouble began, except the Oneidas and some few others."

A few days later Butler reported that Brant was then preparing to go to the frontier villages to repel an attack threatened against them from Wyoming. "Mr. Brant," he said, "is very deserving of the character of an active and intelligent man, and very willing to do everything in his power for the public good. * * * He is very deserving of your favour." In the following May he announced that he had detached Brant and Lieut. Barent Frey, of the Rangers, to bring away the remainder of the Mohawks from the "rebel country," after which the Indians meant "to strike in a body." When this was acomplished, Brant returned to his old quarters at Oquaga and Unadilla, where he soon after received a contemptuous message from the inhabitants of Cherry Valley challenging him to leave his fastness in the woods and meet them in the open where they would quickly change him from a "*Brant* into a goose."

The struggle had now become a war of unsparing retaliation. Many loyalists had been plundered of everything they possessed, and driven into the woods to perish or find their way in a starving condition to the nearest British post. Nameless indignities had been practised even upon their helpless women and children. Those who survived, burned for revenge, and opportunities were not long wanting.

Brant replied to the taunt by leading a foray, not upon Cherry Valley, but upon the more distant and seemingly secure settlements on the Cobus Kill and Schoharie River, while Butler was at the same time engaged in his famous raid upon Wyoming. Accounts of his movements are rather vague and incoherent. Several American writers mention the disastrous defeat of two detachments of their troops with the usual circumstances of surprise and ambuscade, followed by the distruction of several outlying hamlets, and name Barent Frey as still being associated with Brant in command of the Indians. Brant's own account does not appear to have been preserved, and Butler, possibly owing to the agonizing disease which drove him to seek relief at Niagara, did not allude to his operations in detail. Guy Johnson and Claus agreed in considering them very important. Johnson said in a despatch to Lord George Germain, "Another division under Mr. Brant cut off 294 men near Schoharie and destroyed the adjacent settlements with several magazines, from whence the rebels derived great resources, thereby affording encouragement and opportunity for many of the friends of the government to join them." Claus enters into further detail, and is even

more emphatic in his praise. "Mr. Brant opened the campaign by attacking a party of Continental troops, joined by nearly 300 militia, who immediately were put to flight, and the Continental troops cut to pieces all but an officer and four privates taken prisoners, and the country laid waste, distinguishing at the settlement of loyalists, and not molesting a woman or child of the rebels. This occasioned such an alarm that all the inhabitants farther down the river fled towards Schenectady and the rebels were obliged to send several battalions to oppose Mr. Brant's operations, and the harvest about Schenectady, Cherry Valley, and adjacent places being thereby neglected, proved very detrimental to the supplies of the rebel army, that being the best grain country they depend upon; and, in short, Mr. Brant was the dread and terror of the whole country."

Even General Haldimand, lately appointed to succeed Carleton as Governor-General of Canada, who was ordinarily reserved in his judgments, expressed warm approbation. "Butler's success in harassing the enemy," he said, "must be greatly attributed to the Indian, Joseph Brant, whose attachment to government, resolution, and personal exertions makes him a character of a very distinguished kind, and I humbly consider him entitled to some particular mark of the King's favour."

In August, Butler states that Brant was again at Oquaga with Captain Caldwell, whom he had left in command of his rangers, engaged in scouting towards the Delaware River, "as low as the Minnesinks and Schoharie, as well to annoy the enemy as to gain intelligence." None of Butler's letters indicate the least trace of that pronounced dislike towards the ambitious young Indian which Claus attributes to him; on the contrary he constantly refers to him in terms of the frankest approval. Thus, a few weeks later, he informed Haldimand that "Mr. Joseph Brant, whose activity during the summer is really deserving of praise, stayed at Aughquaga with Captain Caldwell, where he has not only been very attentive and vigilant, but at the same time, from his perfect knowledge of the country, particularly serviceable in directing the routes of their parties who are constantly moving about and alarming the enemy's frontier."

He next accompanied Caldwell in a raid on Burnetsfield, at the German Flats, which resulted in the ruthless devastation of a rich tract of couutry for ten miles on either side of the Mohawk River. They rushed upon that place in the grey light of a September morning, hoping to surprise the forts which were known to be well garrisoned. There was little bloodshed, as the inhabitants had been warned of their approach,

and had taken shelter within those posts, whence they watched their blazing homesteads with impotent fury. The harvest had been wonderfully abundant, and the barns were bursting with grain. The church was the only building spared. A number of large New England oxen were taken from the cattle-pens within pistol-shot of Fort Dayton, where they were kept for the use of its garrison, and with the cattle of the settlement, were carried off in one huge drove.

A newspaper of the time relates that sixty-three dwellings, fifty-seven barns, three grist-mills and two sawmills were burnt, and that 235 horses, 229 horned cattle, 269 sheep, and ninety-three oxen were driven away.

With truly astonishing activity, Brant appears a month later as the leader of an expedition towards Minnesink, more than a hundred miles distant in another direction. Our knowledge of this foray is entirely derived from a letter addressed by Taylor and Duffin, merchants at Niagara, to Colonel Claus. It says: "Brant wrote to Pollard on the 25th of October, that with about eighty white people, and with but a few Indians, he marched to Pick Pus, a very pretty, small settlement, where the rebels had three forts, one of which he took, and demolished, and all the houses. He took six prisoners, two of them officers, and killed six. He surrounded the other two forts, but his ammunition being nearly exhausted he was obliged to come away and leave; all the rivers being high, and he thought as he proposed joining Captain Butler to see the last service this season theywould retard him too much. He complained much of Captain Butler's usage of him, and thought of quitting him and going to Canada, but the Indians would not hear of it, and asked did he not know Captain Butler had command of the Rangers only. He had cheerfully complied to attack Cherry Valley."

This last mentioned place had been from the first a hot bed of revolutionary feeling, and it is probable that Brant had not forgotten the insults offered to him by its inhabitants, for an Indian has a long memory. As soon as he returned, Walter Butler, who had superseded Caldwell in command of the Rangers, began his march with 200 men of that corps, a few volunteers from the 8th, and 321 Indians. The garrison of the place he was about to attack had been ascertained to consist of 300 Continentals from Massachusetts and 150 local militia. The Continentals occupied a stout log fort, and had been warned of impending danger by friendly Indians. By a forced march, during a stormy night, Butler gained the outskirts of the settlement unperceived, and at break of day rushed upon the fort and barracks. The principal

officers and about thirty privates of the Continentals were killed or taken in their quarters, besides many of the militia. The remainder scurried into the fort and hurriedly shut the gates upon their pursuers. A block-house close by was taken and burnt, but it was useless to attack the fort itself without artillery.

With mingled dismay and horror Butler then beheld many of the Indians break away from their officers and disperse in all directions, killing numbers of the miserable inhabitants and plundering and burning their houses. This wretched misconduct forced him to draw together his little party of white troops to overawe and hold in check the exasperated garrison, who, by a bold sally, might easily have revenged all their losses. Seizing a spot of high ground near the fort, he was obliged to remain on guard the whole day, exposed to a ceaseless, chilling rain, while revolting scenes of slaughter were being enacted in the settlement around. When night at length descended upon this dismal tragedy, Butler retired a mile and rescued some of the survivors, who were placed under a strong guard to protect them. Already most of the buildings throughout the length and breadth of the valley had been destroyed and many cattle killed or driven off. In the morning Captain John Macdonnell (afterwards the first speaker of the Legislative Assembly of Upper Canada), with a party of Rangers, and Brant with fifty Indians, returned to complete the work of desolation, covered by Butler himself, with the main body of the Rangers, while the remainder of the Indians were sent away in disgrace.

"I have much to lament," Butler frankly admitted, in his report to Colonel Bolton, "that notwithstanding my utmost precautions and endeavours to save the women and children, I could not prevent some of them falling victims to the fury of the savages. They have carried off many of the inhabitants and killed more, among them Colin Cloyd, a very violent rebel. I could not prevail on the Indians to leave the women and children behind, though the second morning Captain Johnson (to whose knowledge of the Indians, and address in managing them, I am much indebted), and I got them to permit twelve who were loyalists, and whom I had concealed, with the humane assistance of Mr. Joseph Brant and Captain Jacobs, of Ochquaga, to return. The death of the women and children on this occasion may, I believe, be truly ascribed to the rebels having falsely accused the Indians of cruelty at Wyoming. This has much exasperated them, and they were still more incensed at finding that the colonel, and those who had then laid down their arms, soon after marching into their country intending to destroy their villages, and they declared they would be no more falsely accused

of fighting the enemy twice, meaning they would in future give no quarter."*

During the following winter Brant visited Quebec where he was warmly received by General Haldimand. The meeting in no way diminished the very favourable opinion the Governor had previously formed of his talents and services, and Brant on his part appeared very much affected by the marks of attention he received. But he had not yet forgiven Butler for thwarting his original scheme of uniting the Indians under his leadership and seemed discontented and reluctant to serve any longer under his directions. Real or fancied slights to which he had been subjected still rankled in his mind. The assistance and advice he had received from Claus, he said, had alone enabled him to perform whatever service he had rendered, when the "jealousy and envy" of his enemies were throwing obstacles in the way. Mindful of "his good character and faithful disposition," Haldimand suavely urged him to forget past disappointments, and in April Brant set out on his return to Niagara in company with Captain Brehm, the Governor's aide de camp.

Haldimand's recommendation, already cited, in conjunction with frequent mention of his services in letters from Claus and Johnson caused the Ministry to decide upon a quite unexpected, and in fact highly embarrassing, mode of rewarding them which Lord George Germain announced in a letter of the 10th of April, 1779.

"The astonishing activity and success of Joseph Brant's enterprises and the important consequences with which they have been attended, give him a claim to every mark of our regard, and which you think will be pleasing to him, what has occurred to me as most likely to gratify him has been done, and enclosed herewith you will receive a commission signed by his Majesty appointing him a Colonel of the Indians, and on board the Three Brothers storeship is a box with prints taken from Lord Warwick's picture of him which he was particularly pleased with, some of which you will send into his nation and dispose of the others as you think most honourable for him as a memorial of his services."

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*A poet of the present day has unconsciously paraphrased these words of the Indians:

"Let us rest to-morrow, fellows, since to-day we have fought amain;
Let not these men we have smitten come back on our hands again,
And say, 'Ye Wolfing warriors, ye have done your work but ill,
Fall to it now and do it again, like a craftsman who learneth his skill.'"

—*William Morris, The House of the Wolfings.*

This despatch was not received by Haldimand before the second week of September when he promptly replied with characteristic shrewdness and penetration, "I have received his Majesty's commission for Joseph Brant and Your Lordship observes very justly that his conduct merits every mark of our attention and regard, but Joseph's situation amongst the Six Nations is very different from the idea those who are not acquainted with it, must, from his superior talents, conceive. To speak in their style, he has been very lately known on the war path. He is now distinguishing himself in that line, but it will be some time before he is acknowledged by them even upon a footing with very many (as they conceive), more experienced and greater warriors, besides the notice that has been taken of him by us, in consequence of his connection with Sir William Johnson, his being civilized, and now particularly for his good services, has from a jealousy paramount in the Indians, procured him as many enemies of his own people as friends. Amongst this number is Schenderachto, King of the Senecas, and by many degrees, the most leading, and the man of the most influence in the whole of the Six Nations, and by whose interest and intrigues, Major Butler has been able to carry through many essential points. He is brave, prudent, and perfectly attached to Government, more willingly so since the alliance with the French, to whom he has a most unconquerable aversion. Were so great a mark of distinction, as is proposed for Joseph, to pass him, it might, and I am sure it would, be productive of very dangerous consequences, for which reason, I must take it upon me to suppress the commission and likewise the pictures until I have His Majesty's further pleasure. I should hope this affair has not been so publicly mentioned at home as to reach Joseph's knowledge, which from the part I find necessary to adopt, would equally prejudice the service.

"Every favour and attention in my power, Joseph has experienced, and always shall, but, for the above reasons, I am obliged to do it with address. His sister, who lived many years with Sir William Johnson, by whom he had many children, and to whose influence he was much indebted in his successful management of the Six Nations, was driven from her home and took refuge at Niagara. Her situation there not being as comfortable as could be wished, she brought her family to Montreal by my desire where I settled her to her satisfaction; but upon hearing of the rebels advancing into the Indian country, thinking she might be of use in encouraging the Indians to preserve their fidelity, she returned to Niagara."

At Carleton Island, Brant was overtaken by Walter Butler also returning to Niagara from Quebec. Thanks to the Governor's soothing

speeches, they now greeted each other with a show of cordiality. There too, Brant learned with much distress that the Americans had burned the Onondaga village and carried off one of his children among their prisoners. This did not, however, diminish his zeal, for as soon as he arrived at Niagara, he volunteered to accompany Captain Butler to Detroit in the hope of inspiriting the western Indians to rally for the defence of that place. They were already upon their way to Fort Erie where they intended to embark in a sailing vessel, when they encountered a runner bearing the alarming intelligence that the enemy was advancing against the Cayuga village. Brant hurried off to the assistance of his friends, but on learning that it was a false alarm, made a rapid march through the woods to Venango and Pittsburg where an expedition against Detroit was reported to be in preparation. Having accomplished his object of alarming the American garrisons in that quarter, he wheeled sharply about and taking a wide circuit through the country returned to his former post of observation at Oquaga. A formidable army was then assembling at Wyoming with the evident intention of invading the Indian country, and another was reported to be forming at Otsego Lake for the same purpose. Butler with 300 rangers was watching their movements from the Indian village of Canadasaga. The Indians themselves were starving and Butler's men were living on salted provisions brought from England. In the hope of diverting the attention of the enemy to the defence of their own frontier and at the same time obtaining cattle for the subsistence of his followers, Butler sent one party under Captain Macdonnell to attack the settlements on the west branch of the Susquehanna while Brant with another was simultaneously instructed to descend the Delaware as far as Minnesink.

On the 29th of July, the latter was back at Oquaga where he penned this direct and modest account of his incursion which had terminated in a sharp encounter with a pursuing force:

"I arrived here last night from Minnesink, and I was a good deal disappointed, I could not get into that place a little before day as I wished to do, I did not arrive till noon, when all the cattle were in the woods, so we could get very few of them. We have burnt all the settlement called Minnesink except one fort, which we lay before about an hour and had one man killed and one wounded. We destroyed several small stockades and forts and took four scalps and three prisoners, but did not in the least injure women and children. The reason we could not take any more of them was owing to the many forts about the place into

which they were always ready to run like ground-hogs. I left this place about 8 o'clock next day and marched fifteen miles. There are two roads, one through the woods, the other along the river. We were coming up this way the next morning, and I sent two men to examine the other road, the only way the rebels could come to attack us. These men discovered the enemy's path, not far from our camp, and discovered they had got before us to lay in ambush. These two rascals were afraid when they saw the path, and did not return to inform us, so that the rebels had fair play at us. They fired at the front of our people when crossing the river. I was then about four hundred yards in the rear. As soon as the firing began, I immediately marched up a hill in their rear with forty men, and came round on their backs. The rest of my men were all scattered on the other side; however, the rebels soon retreated, and I pursued them until they stopped upon a rocky hill round which we were employed, and very busy, for nearly four hours before we could drive them out. We have taken forty odd scalps and one prisoner, a captain. I suppose the enemy have lost near half their men and most of their officers; they all belonged to the militia and were about 150 in number. I have sent my party to Shimong to remain till I join; I am now setting off with eight men to the Mohawk River in order to discover the enemy's motions. In the last skirmish we had three killed and ten wounded. John, the Mohawk, is dangerously wounded, and three more nearly as bad."

American accounts corroborate Brant's in every essential particular. His party is stated to have consisted of sixty Indians and twenty-seven Rangers. The pursuers originally numbered 150, and were joined on the march by a few more. Two colonels and many officers of lesser rank were among the killed, and of the entire force not more than thirty are said to have escaped from that disastrous field.

This desperate struggle occurred at a ford near the mouth of the Lackawaxen branch of the Delaware on the 22nd of July. On the 2nd of August, with his usual celerity of movement, Brant appeared unexpectedly on the Mohawk, at the head of his small scouting party, took a few prisoners, alarmed the inhabitants, and disappeared.

On his return he wrote to Colonel Bolton, at Niagara: "After I took the two prisoners, the militia followed me, and in time came up, when I received a wound in my foot by a buckshot, but of no consequence, and am now almost as well as ever. However, I took care to bring off my prisoners. * * * I am a little afraid we shall have hard work to

drive the enemy back, for our friends are too slow in joining us. However, most of the chief warriors are in high spirits and not discouraged; they think we shall beat the enemy provided they soon all assemble here in time. * * * I request you will drive all the Indians from Niagara and not suffer a man of them to go to Canada."

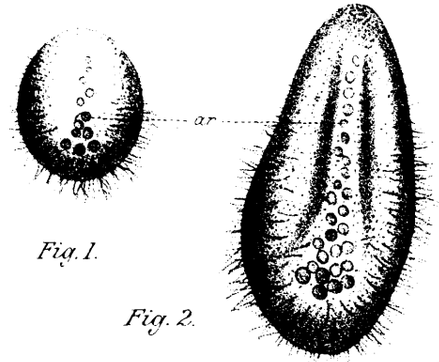


Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

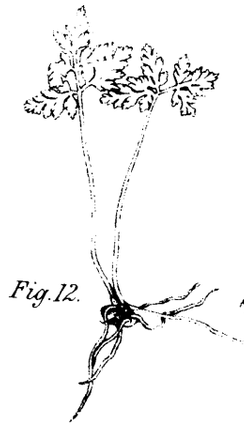


Fig. 12.

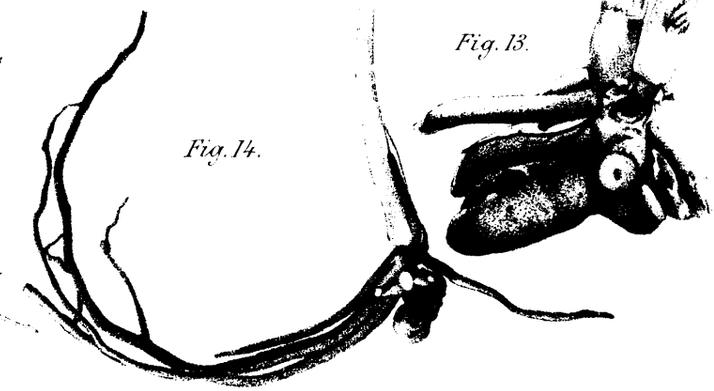


Fig. 14.

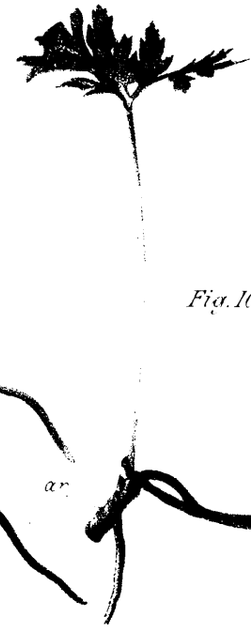
Fig. 13.

Fig. 5.

Fig. 6.

Fig. 7.

Fig. 8.



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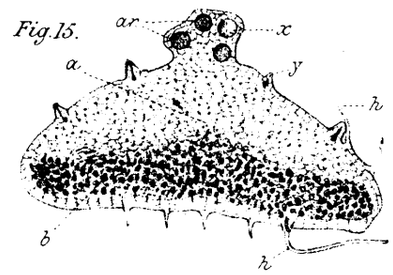

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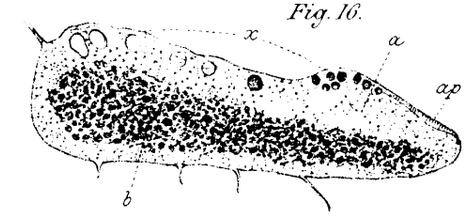

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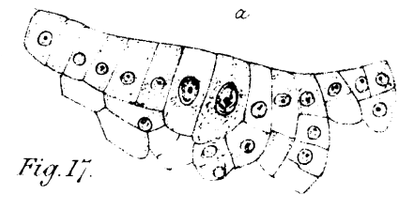

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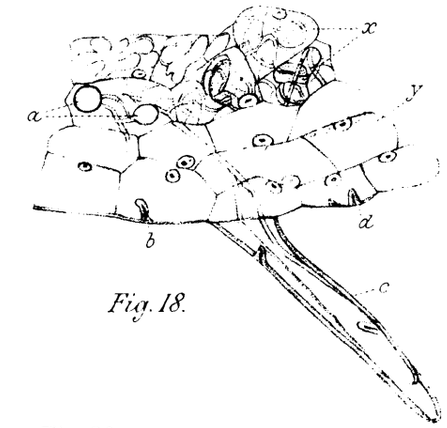
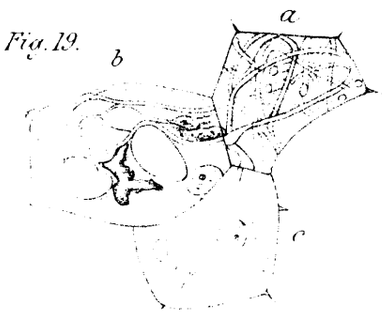


Fig. 18.

Fig. 9.

Fig. 11.



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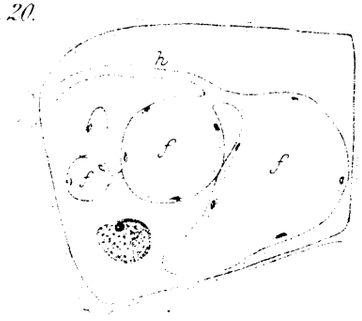

Fig. 20.

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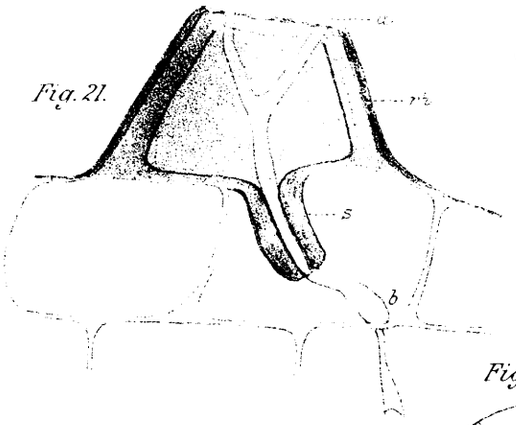
Fig. 21.
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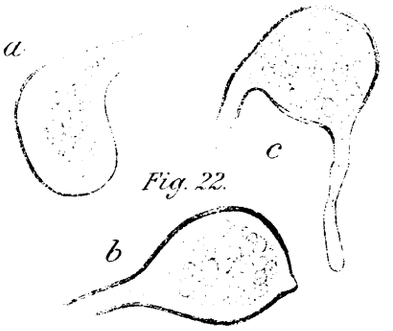
a
c
Fig. 22.
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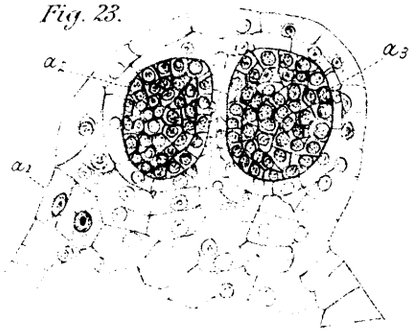
Fig. 23.
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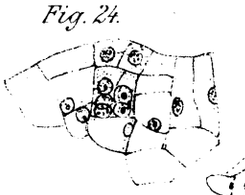
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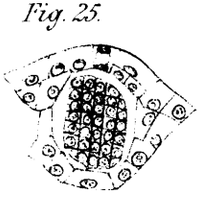
Fig. 25.


Fig. 26.
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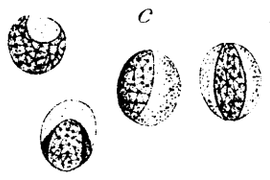
c


Fig. 27.
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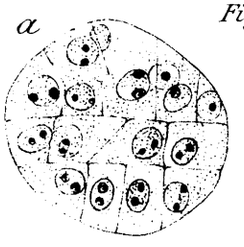
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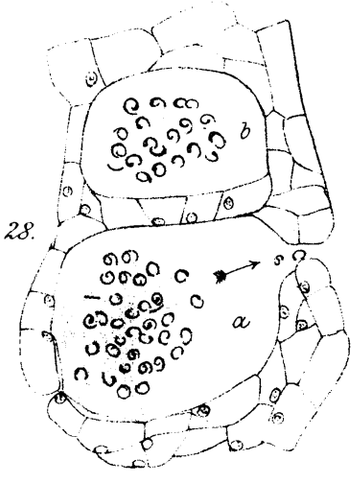
Fig. 28.
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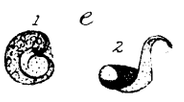
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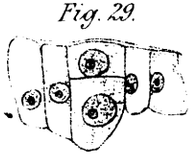
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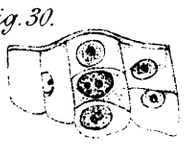
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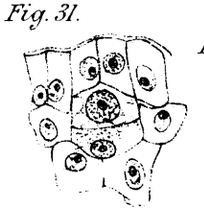
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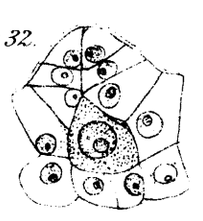
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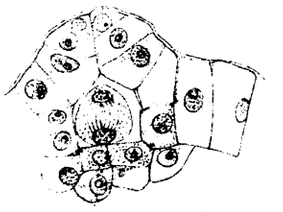
Fig. 33.

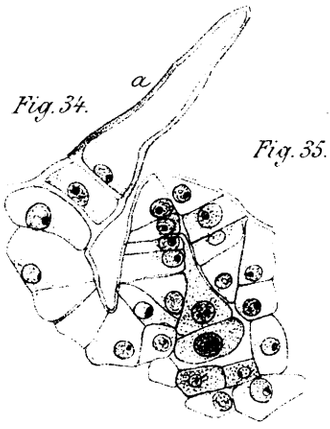
Fig. 34.
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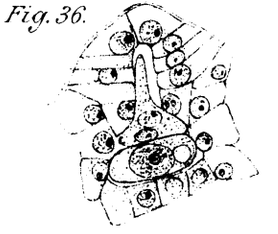
Fig. 35.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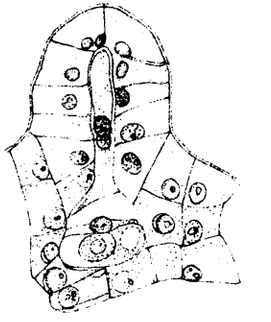
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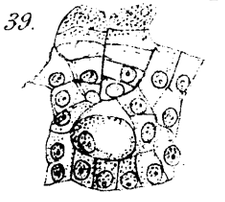
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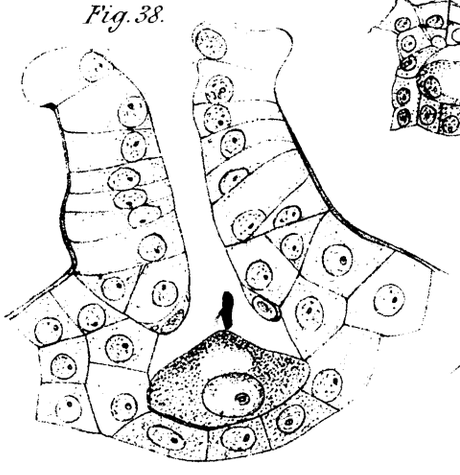
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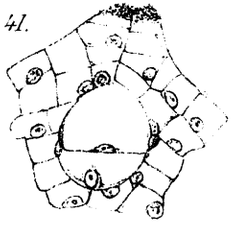
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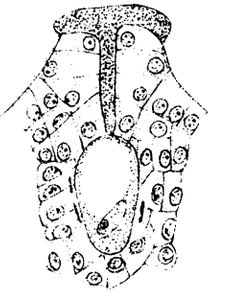
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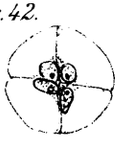
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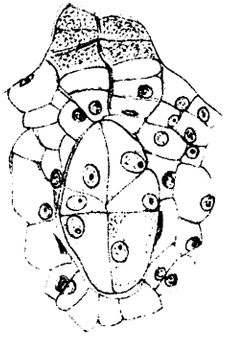
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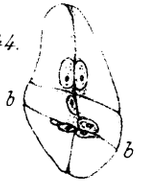
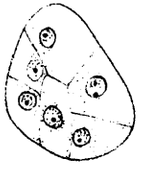


Fig. 44.
b
b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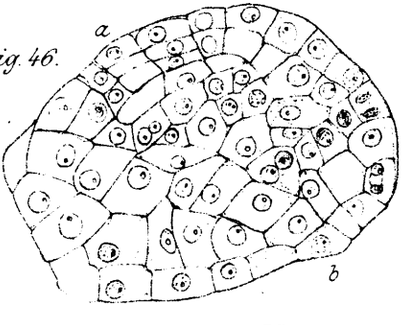
Fig. 46.
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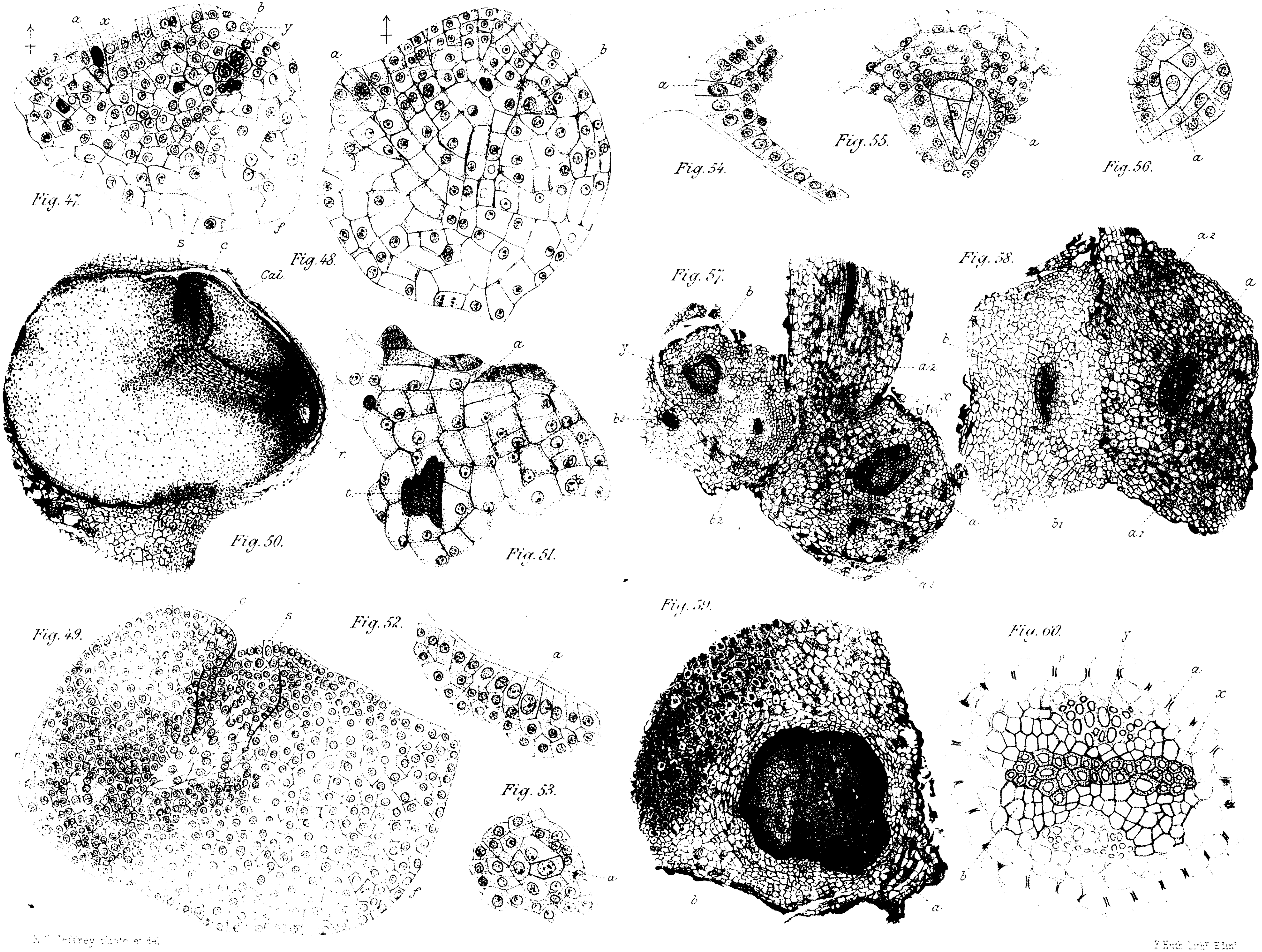

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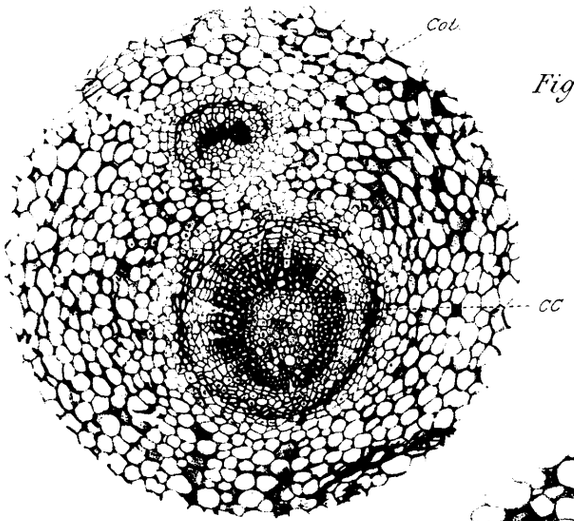
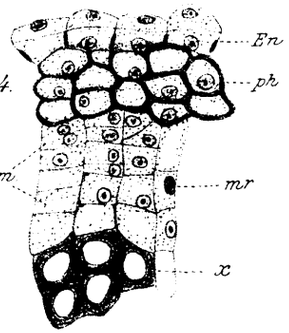


Fig. 61.



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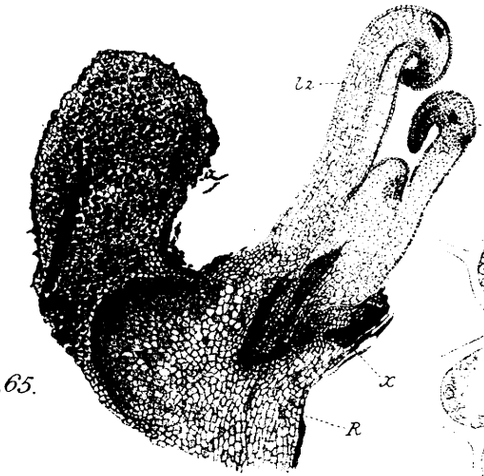

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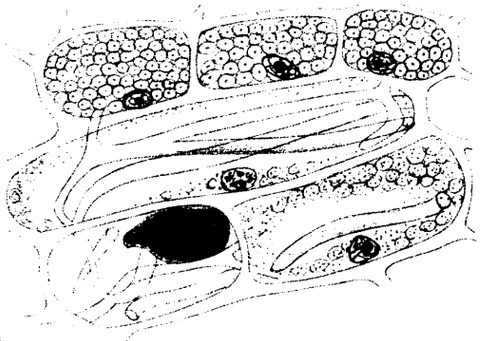

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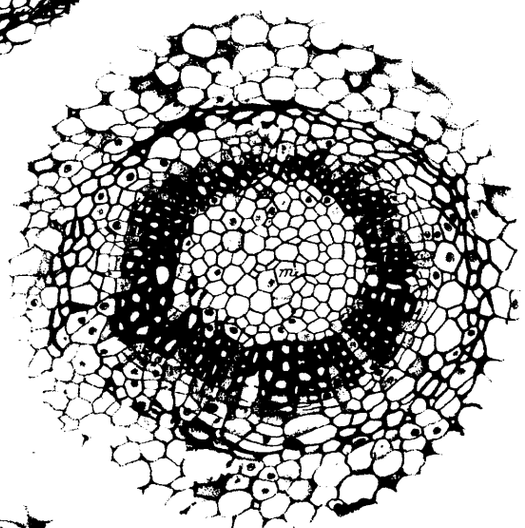

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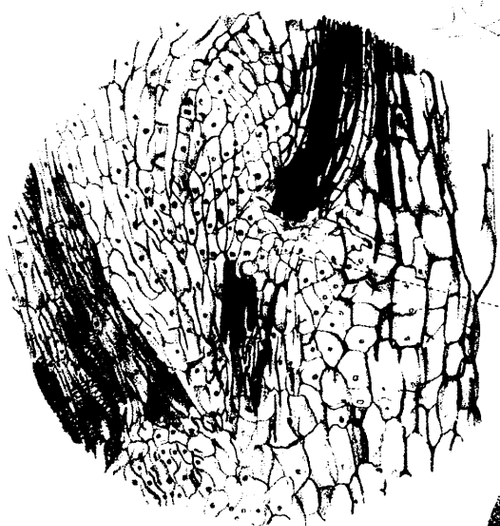

Fig. 66.

Fig. 63.

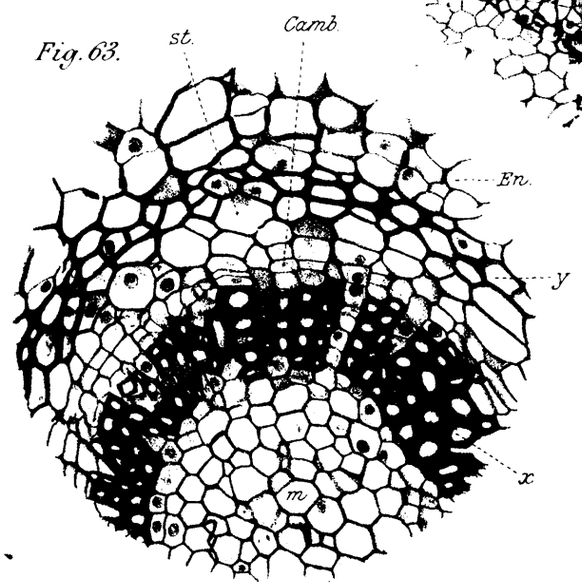

Fig. 67.
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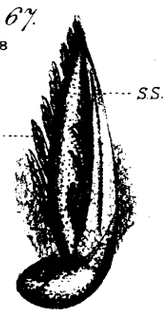


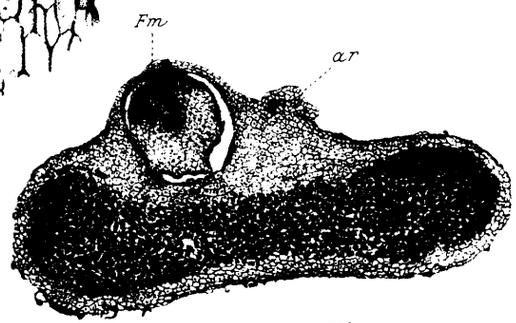
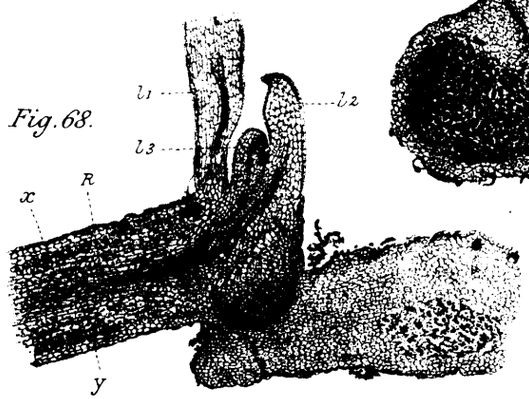


Fig. 70.

Fig. 68.



THE GAMETOPHYTE OF BOTRYCHIUM VIRGINIANUM.

By Edward C. Jeffrey, B.A.,

*Lecturer in Botany, University of Toronto.**

(Read 21st November, 1897).

I.

On account of their subterranean and inconspicuous prothallus and the slow germination of their spores, the literature on the subject of the sexual generation of the *Ophioglossaceæ* is somewhat scanty.

ERRATA.

Instead of "latter" in 19th. line of page 268. read "former."
Instead of "*phlegmaria*" in 29th. line of page 268. read "*Phlegmaria.*"
Instead of "Rhabenhorst" in foot-note of page 274. read "Rabenhorst."
Instead of "*phlegmaria*" in 17th. line of page 276. read "*Phlegmaria.*"
Instead of "hypobasal" in 3rd. line of page 290. read "epibasal."
Figures 7, 8, 9, 10, 11, 12, 13 and 14 are all lithographed from photographs.

sporophyte appeared on the lower surface of the prothallus. The root grew out first, indeed two roots often made their appearance, before the first leaf became visible. The latter was bract-like and colourless. The two following leaves resembled it, but they had, either one or both of them, green tips. The fourth frond conformed to the usual type, and probably made its appearance in the next period of vegetation. From the situation of the embryo on the lower surface of the prothallus, the

* Most of the material for this investigation was secured by means of a grant from the Elizabeth Thompson Scientific Fund.

1. Abhand, d k. Sächs. Gesellschaft d. Wissch. Bd. ii., pp. 657-662.

growing shoot was forced to make a half turn to assume its normal, negatively geotropic position.

In 1856, Mettenius[2] published an account of the sexual phase of *Ophioglossum pedunculosum*, which he found in considerable quantities, in the earth of the pots containing the adult spore-plants. Attempts to germinate the spores, under observation, failed also in this case. The youngest prothallia were tuber-like in shape, and one to three millimetres in thickness. Out of the tuber grew subsequently a conical process which elongated considerably (four to fifty millimetres), and sometimes branched. At the tip of the outgrowth, or of its ramifications, was found an apical cell, sometimes at least, of triangular pyramidal shape. The cylindrical portion of the prothallus grew upwards towards the surface of the soil, but, on reaching the light, became green and died away at the apex, or divided into two or three lobes which flattened out on the earth and developed no further. The tuber was composed of starch-laden parenchyma. In the process some textural differentiation was found, there being an axial, elongated, starch-free strand, surrounded by short starch-bearing cells. Both kinds of sexual organs were found in the same plant and not arranged in any definite order, but generally situated on the cylindrical process. The *antheridia* were large in size and their wall was generally two layers of cells in thickness. The antherozoids were large also, and composed of one and a-half to two spiral turns. The *antheridium* opened by a pore produced by the breaking away of two superimposed cells in its wall. The aperture was generally situated in that part of the wall nearest the apex of the prothallium. The spermatozoids swarmed out of the mother cells and about in the cavity of the *antheridium* before making their way out. The *archegonia* originated from two superficial cells, the upper of which gave rise by repeated divisions to a neck of three to five tiers of cells; the lower formed the axial row, which were not, however, made out individually by this writer. On account of the small number of embryos found, it was impossible to follow stage by stage, their development. Nothing was noted in regard to the formation of the first dividing walls. The youngest embryo was oval in shape and already segmented into a number of cells. The older ones were similar in configuration, but of larger size. The anterior end of the elliptical embryo grew through the tissues of the prothallium towards its apex, and bursting forth sooner or later, became the cotyledon, green in colour, and lanceolate in outline. The root developed more slowly and bored its way directly outwards. A rounded protuberance at the

2. Filices Horti Botanici Lipsiensis, pp. 119-120.

junction of the cotyledon and root, probably the foot, fastened the young sporophyte to the base of the *archegonium*. The apical bud appeared sometimes at the point of union of root and leaf, and sometimes further down on the root, thus simulating the adventitious buds arising from the roots of the adult plant.

The most recent contributions to our knowledge of this group is due to the discovery of the gametophyte of *Botrychium virginianum* by Professor Douglas Campbell[3] at Grosse Isle, Michigan, in 1893. The prothallia were unfortunately, like those of Hofmeister's *Botrychium Lunaria*, which they resembled in appearance, although larger in size, too old for the study of the development of the sexual organs and embryo. They are described as being flattened tubers with folded upper margins, covered with root-hairs and bearing the reproductive organs on the superior surface. Brown externally, white in section, the lower part of the gametophyte harboured an endophytic fungus. The *archegonia* had rather long and straight necks, while the *antheridia* were quite endogenous like those of *Equisetum* and *Marattia*. No young embryos were found, but only advanced young sporophytes, bearing already the first or a subsequent leaf.

Professor Campbell was the first to bring about the germination of the spores in this group. The process is exceedingly slow, requiring, even in the warm climate of California, for *Botrychium virginianum*, eighteen months or more, and for *Ophioglossum pendulum*, somewhat less than that time. The most advanced stages yet obtained by him, had only undergone two or three divisions. Chlorophyll was found in the young prothallium of *Botrychium virginianum*, and a suspicion of chlorophyll in that of *Ophioglossum pendulum*. This may have been due merely to the fact that germination took place in the light.

As there has been a tendency in recent years to associate the *Ophioglosseæ* with the isosporous *Lycopodineæ*, it is necessary to state briefly what is at present known concerning the gametophyte in the latter group. Fankhauser[4] discovered in 1872 the brown subterranean prothallus of *Lycopodium annotinum*. The examples found by him were lobed, tuber-like, and marked by numerous ridges and depressions. *Antheridia* and fully formed sporophytes were found on them, hence the prothallia must have been monœcious. In 1884, Bruchmann[5] found some much younger prothallia. These were of oval and flattened form,

3. Trans. British Association, Oxford Meeting, 1894. Structure of Mosses and Ferns, 1895, pp. 224-228

4. Bot. Zeitung. 1873. No. 1.

5. Bot. Centralblatt. Bd. i., 1885, pp. 23-28.

the superior margin being raised so as to produce a depression in the centre. The *antheridia* occupied ridges in the bottom of this basin. No *archegonia* were present, nor did the plants show a definite apical meristem. The same observer remarked that the inferior cells of the prothallus were occupied by an apparently symbiotic fungus, the *mycelium* of which communicated with the outside by means of the root-hairs with which the plants was provided. He referred the symbiont to the genus *Pythium*. More recently Treub[6] has published a description of the prothallium of *Lycopodium cernuum*. Here the gametophyte, as in *Ophioglossum pedunculosum*, starts from a primary tubercule, and divides subsequently into green lobes. The sexual organs have no definite arrangement and are monœcious. The *archegonia* possess a single uninucleate canal-cell. The large *antheridia* have a single-layered outer wall and produce biciliate moss-like antherozoids. The embryo is peculiar in the possession of a rudimentary suspensor. The stem in the young sporophyte is at first represented by a parenchymatous mass which has been designated the primary tubercule. The first division in the embryo is transverse and gives rise to the epibasal and hypobasal cells. The latter originates first the cotyledon; the stem-apex apparently not developing till after several leaves have grown out. The first root also is derived from this segment, but only after a number of foliar organs have unfolded. The prothallus in this case was likewise occupied by a symbiotic fungus, which was considered by the author to be a species of *Pythium*.

Goebel[7] about the same time described the sexual phase of another species, *Lycopodium inundatum*. It closely resembled *Lycopodium cernuum* in structure, and also harboured a fungus resembling *Pythium*. Treub[8] has also published an account of another form, viz: *Lycopodium phlegmaria*, which is slender, much branched, and entirely subterranean. It is especially interesting on account of the occurrence of a number of canal-cells in the *archegonium* and from the presence of paraphysis-like growths among the *antheridia*.

II.

In 1895, the writer came upon a large number of prothallia of *Botrychium virginianum* in a Sphagnum-swamp behind the village of Little Metis, in the Province of Quebec. The presence of these plants was revealed by the greenish-yellow cotyledons appearing above the surface

6. Etudes sur les Lycopodiacées. Annales du Jardin botanique de Buitenzorg. Tome iv., v., vii. viii., 1884-1890.

7. Bot. Zeitung. 1887. No. 11-12.

8. Op. Cit.

of a slight depression in the moss. On removing some of the overlying vegetation, numbers of the larger prothallia were easily obtained. It required, however, careful sorting of the peaty soil with the fingers to secure the younger and more interesting stages. Nearly a week was spent in working over about half the bed, the result being several hundred examples in all stages of development, of the gametophyte and attached sporophyte. Subsequently, in another season, a week was spent on the spot, and all the plants which careful sifting of the soil would yield, were removed. The second harvest amounted to over six hundred specimens, by far the larger number of which, however, were much too old for study. During the same summer, other and older plants were found in rich woods about two miles back of Metis. In the spring of 1896, additional discoveries were made in Foster's Flats, below the Whirpool, on the Niagara River, and on the east branch of the river Don, a few miles from Toronto. The last mentioned spot proved rich in interesting examples of older stages of the attached sporophyte. Most of these were removed last autumn (1897).

III.

One of the greatest difficulties in the way of the present research, was the proper preservation of the prothallia. They are singularly impermeable to fixing reagents on account of the thick external cuticle, and must be cut at intervals with a razor, to allow the preserving medium to penetrate. The presence of oil in large quantities in the tissues, also renders aqueous fluids useless, as they scarcely make their way in at all. A saturated solution of picric acid in thirty per cent. alcohol, gave fairly good results; but the best fixation was obtained by using a mixture of three parts of a saturated solution of corrosive sublimate in ninety per cent. alcohol, and one part of saturated solution of picric acid in the same menstruum, diluted with distilled water to reduce the alcohol to thirty per cent. strength. The same reasons which rendered the material hard to preserve, made it difficult to embed. Paraffine was mainly used, and the most satisfying results were obtained by infiltrating with benzole, in a vertical tubular dialyzer with a chamois leather diaphragm, revolved slowly by means of clockwork. It was found that the ordinary type of stationary dialyzer was quite unsuitable for these very delicate objects. When the prothallia in alcohol were placed in the top compartment, and the benzole below, the osmosis was exceedingly slow; and, if the position of the media was reversed, the weight of the benzole carried it through too rapidly, and injurious shrinkage was the result. The continued reversing of the

relative positions of the two liquids by the clock movement, and the accompanying agitation, were found to overcome these inconveniences. Unfortunately, this device was hit upon only after numerous experiments, and when the investigation was almost completed. The transference from benzole to paraffine was effected in a stationary dialyzer, or by evaporating off the benzole in a water-bath, from a ten per cent. solution of paraffine in benzole. Celloidin embedding has also great advantages, but as the material has to be cut into slices not thicker than two millimetres at most, and as the prothallia were often nearly twenty millimeters in length, it was only employed for sections through certain regions of the gametophyte, and for the much less impenetrable young sporophyte. The stains chiefly used were either a combination of alum-cochineal and eosin, or aqueous saffranin, made by dropping a small amount of saturated alcoholic solution of equal parts of Grübler's alcohol and water soluble saffranins. This last method seems worthy of a wider application.

IV.

The youngest prothallia obtained were already two millimetres in length by one and a-half in breadth. As may be seen from figure 1, they are of flattened oval shape, and covered with hairs. The growing point is at the narrow thin end, and the prothallium thickens and widens from thence backwards. *Antheridia* alone are found at this stage, and are entirely confined to the upper surface of the gametophyte. They form a cluster at the older end, but thin out into a narrow median row as they extend forward towards the growing point, figure 1, *ar.* In somewhat larger and older plants, the median row of *antheridia* is raised on the crest of a distinct ridge, and the *archegonia* begin to make their appearance upon its sides, figure 2. The antheridial ridge is a marked feature of most of the older prothallia, and must have the same significance in the process of fertilization as the inferior archegonial prominence possesses in the leptosporangiate *Filicineæ.* In more mature individuals the ridge is obliterated, especially in the posterior region of the prothallus, by the more rapid growth of the sides of the latter, which seems to be a provision for the nourishment of the fertilized *archegonia.* This phenomenon probably is the cause of the antheridial ridge not being noticed by Campbell [9]. Figure 3 shows a plant in which an embryo, *em.*, has already reached a considerable size. The antheridial prominence is still very marked; the root-hairs, however, have largely disappeared. In figure 5, we have a somewhat younger stage with the rhizoids still abundantly present, especially in the

9. Op. Cit.

younger anterior region of the prothallus. Figure 4 is of a lobed gametophyte; figure 6 shows a similar condition in which two embryos, *em.* 1, *em.* 2, are to be seen. The depression of the antheridial ridge in the posterior region by marginal growth is particularly well-marked. These lobed forms are quite abundant among the Metis specimens, but the Toronto plants did not manifest this peculiarity. I am inclined to believe that the conditions of life in the two cases may have been the cause of this difference. The Metis specimens were found in wet, peaty soil. The Toronto plants, on the contrary, grew in rich, yet rather dry, forest mould. Older lobed prothallia have almost invariably two sporophytes attached to them. In figure 7, is represented an example in which the first root of the young sporophyte has reached a considerable size. At this stage the axis of the young sporophyte, which, in earlier phases, is nearly always at right angles to that of the prothallus, becomes often more or less oblique, as in the example figured. This rotation of the axis is probably due to the continued growth of the prothallium after the formation of the embryo. Figure 8 shows a prothallium in which two roots of the attached sporophyte have grown to a considerable length, although the cotyledon is short and still unfolded. In figure 9, we have a small gametophyte with only one root, and yet having the cotyledon fully expanded. The first leaf may expand either after one, two, or three roots have been formed, according to the vigor of the plant, and may always be recognized by its seeming to grow out of the proximal end of the first and stoutest root. Figure 10, is of a strong plant with three precotyledonary roots. The lamina of the cotyledon is not bilaterally symmetrical, as in most of the *Filicineæ*, but of the palmate type represented by *Ophioglossum pedunculosum*. As may be seen from figures 9 and 10, the first leaf varies considerably in complexity in accordance with the greater or less robustness of the plant from which it originates. In the next drawing, figure 11, is represented a lobed prothallium, on which are two older sporeplants, deprived of the leaves of the year of their collection. Figure 12 shows a Toronto specimen, bearing two well-advanced sporophytes. Figure 13 is a representation of a bifurcated sporeplant, two examples of which have been found. Figure 14 is interesting, for it represents a sporophyte which has already developed the fertile ventral segment, and is yet still attached to the mother prothallium. The sporeplant in this case is eight years old, as indicated by the number of foliar lacunæ in the fibro-vascular cylinder. There seems to be little danger of error in drawing this inference, for a considerable acquaintance with the young sporophyte enables me to state positively, that never more than one leaf is developed at a time, and in all

probability, only one in a year. Attached sporophytes, five or six years old, are sufficiently common, as has been already stated in the preliminary notice.[10]

The prothallia described in the foregoing account were from two to twenty millimetres in length, and from one and a-half to fifteen millimetres in breadth. The gametophyte of *B. virginianum* is thus considerably larger than any geophilous prothallus which has yet been described. Attempts have been made to germinate the spores of this species, but although these are still undecayed, no signs of growth have yet made their appearance after eighteen months. Professor Douglas Campbell got them to sprout in less time than this, but doubtless the warmer climate of California had some influence in hastening the process. He found a few large chloroplasts in the young plants; but it seems probable that the presence of chlorophyll here is accidental, and depends on the spores being sown contrary to the natural conditions, in the light. An analogous phenomenon occurs when potato tubers are grown under conditions of illumination. Most of the prothallia collected by the writer were found ten centimetres or more below the surface of the soil. Mature sporophytes have been dug up, with the foot-tubercle still intact, and buried often thirty centimetres in the ground. These facts make it very difficult to imagine that the tubercular, deeply subterranean, gametophyte of *B. virginianum* can have been preceded by a green aerial phase as are the quite superficial, colorless, gametophytic buds of *Vittaria*, *Trichomanes* and *Hymenophyllum* described by Goebel, or the larger tuberlike, resting phase of the liverwort *Geothallus* recently studied by Campbell. It is perhaps worth while to suggest that the slow germination of the spores in the case of Pteridophyta, with subterranean prothallia is an adaptation to enable the former to reach a favorable depth in the substratum, before beginning their growth.

V.

A cross-section of the prothallus, such as is represented in figure 15, reveals a number of important features. The antheridial ridge, *x.*, is seen above, containing several *antheridia*. On its sloping sides are the *archegonia*, *y*. Multicellular hairs are often found attached to the ridge, to its flanks and to the base of the prothallium. The position of several of these is indicated in the figure at *h*. The internal cells, *a.*, of the upper part of the plant appear light in color, and contain protoplasm and small quantities of starch. The lower cells, *b.*, both in fresh and stained sections, are dark-colored, and in their natural condition, filled

10. Can. Inst. Proceed. Vol. i. Pt. 1, p. 10. Annals of Botany. Vol. xi., p. 485.

with a heavy oil which is not readily soluble in alcohol. They are likewise occupied by a filamentous fungus which is presently to be described. Figure 16 illustrates a median long-section of the prothallus. At *x.* is seen the antheridial ridge cut lengthwise, and showing the *antheridia* in various stages of development. The younger ones are found nearer the anterior, sloping, apical region, *a.p.* The distribution of the fungiferous tissue is represented in this figure. It is to be noted that it extends forward gradually, as the prothallus increases in length, by the activity of the apical meristem. The fungus never occupies all the cells on the lower side of the prothallus, but leaves free always a few of the lower tiers. Above, as has been already stated, there is a considerable mass of cellular tissue underneath the reproductive organs, quite free from infection and containing a small amount of starch. The symbiont is always present, as it has never been missed in the four or five hundred plants which have been minutely studied. It is not possible to state whether it is indifferent or beneficial to its host; it certainly does not seem to be injurious. The infected cells do not apparently suffer, and perhaps the presence of oil in them, may be interpreted as an indication of improved nutrition. Only experimental cultures can settle this important question.

The growing region of the prothallus is always on the upper side, figure 16, *a.p.* It is marked by the presence of a superficial layer of high columnar cells like those found at the base of the apical incision of the leptosporangiate gametophyte. These are represented in figure 17. One of the columnar cells, *a.*, is in all probability, the initial cell. It is very difficult to secure exactly horizontal sections of the apical region except in very young plants, of which my supply was somewhat limited. These were all used up for longitudinal and transverse series, and I am accordingly unable to describe the horizontal configuration of the initial cell.

The root-hairs are from one to four millimetres in length and are often multicellular, especially when they arise from the crest or flanks of the prothallium. Those which originate from the base are unicellular and longer than the others. These rhizoids are generally about twenty micra in width and are more or less completely cutinized. It is chiefly through them that the symbiotic fungus makes its way into the prothallium. The passage of the fungal *hyphæ* through the cutinized wall of the root-hair, is marked by the formation of thick sheaths which surround the *hyphæ* for ten or more micra of their course. These sheaths are apparently only formed where the fungus has to penetrate an already cutinized wall, and one does not find the phenomenon repeated as the *hyphæ* pass successively through the walls of the internal cells of the

host-plant. Figure 21 represents a broken root-hair, the basal wall of which has become cutinized and consequently forms a sheath where the *hypha* is passing through. The penetration of the next cell-wall inwards is unaccompanied by this phenomenon. In figure 18 can be seen part of a root-hair, *c.*, on the lateral walls of which are two sheaths, and the hair in this case being intact, sheaths are not formed in the uncutinized basal wall. In the same figure sheaths can be seen at *b* and *d*, where the fungus has passed in through ordinary superficial cells of the prothallus. This is apparently of rare occurrence.

After penetrating about two or three layers of cells, *y*, the symbiotic filaments, which are from two to four micra in diameter, begin to grow luxuriantly, and fill the succeeding strata of cells, *x*, with a much-coiled *mycelium*. If this be examined with a good apochromatic objective, it is possible to discover that it is by no means always filamentous, but that in many cases, the *hyphæ* expand into large thin-walled vesicles, which are often so abundant that they fill the cells with a botryose mass resembling a *Completoria*, figure 19, *b* and *c*. In other cells the filaments prevail, *ibid. a*. It is not difficult to satisfy oneself that the *hyphæ* and vesicles belong to one and the same *mycelium*, figure 19, *b*. Frequently some of the vesicular structures become ruptured and shrivel up, *ibid.* Figure 20 shows a freshly infected cell of the prothallus, highly magnified, in which the vesicular structures have just begun to form. Often the advance of the symbiont through the prothallus is marked by the penetration of filaments or by a mixed growth of *hyphæ* and vesicles into new cells. Another kind of organ is also found in the *mycelium*, viz., *conidia*. These are thick-walled and from fifteen to twenty micra in diameter. They are generally formed at the end, but sometimes, though rarely, in the course, of a *hypha*, and are filled with a dense, coarsely granular protoplasm. The contents of the *conidium* are not separated from the filament by a septum and thus resemble the *conidia* of the subform *Aphragmium*[11] of the genus *Pythium*. The *conidium* germinates *in situ*, forming a tube which often makes its way into the adjoining cells of the host-plant. I have never been able to detect the formation of zoöspores from these *conidia*, and indeed it is difficult to imagine how they could serve as a means of distribution for so completely endoparasitic a fungus. The stages of formation and germination of the *conidia* are shown in figure 22, *a*, *b* and *c*.

It will be seen from the above account that the symbiont of *Botrychium virginianum* presents several rather remarkable characteristics. In its mode of penetration it resembles *Completoria complens*, as described by

11. Rhabenhorst, Krypt, Flora. Fischer, Phycomyceten, p. 397.

Leitgeb[12] in the prothallia of *Pteris cretica*, *Aspidium falcatum*, and other ferns; the formation of the dark brown sheath from the cell-wall of the host-plant being very characteristic. Atkinson[13] has described a similar phenomenon for a *Completoria* found in the same species of prothallia in America. In the filamentous portion of the undivided *mycelium* as well as in the formation of its *conidia* it markedly resembles a *Pythium*. In the botryose vesicular masses completely filling the cells of the host, it again strikingly simulates *Completoria*. It may perhaps fairly be considered as a form uniting the genera *Pythium* and *Completoria*. If, on further investigation, the above view proves to be correct, it may possibly be necessary to remove *Completoria* from the vicinity of the *Entomopthoracæ*, where it has been placed on account of its ejaculatory *conidia* by Nowakowski and Thaxter, and toreplace it with the *Peronosporaceæ* where Leitgeb, as a result of his careful investigation, considered it to belong.

The endophyte of the prothallium of *Botrychium virginianum*, unlike that of *Lycopodium cernuum*, described by Treub,[14] and that of *L. annotinum*, described by Bruchmann,[15] is always intracellular and never becomes intercellular, in the deeper layers of the host-plant. Treub's description is somewhat brief, but from the fuller account of Bruchmann, the structure of the *mycelium* in the symbiont of *Lycopodium* seems to be quite different from that of the form found in *Botrychium virginianum*.

Only further study of the fungus can settle whether it is a distinct species of *Completoria* or *Pythium*, or, on the other hand, an intercalary species. Before leaving this subject, there is one more interesting fact to record. In older prothallia bearing well-advanced sporophytes, the symbiont is shrunken and dead. Whether this state of affairs is rightly comparable to the similar phenomena observed by Frank in the *mycorhizæ* and *mycodomatia* of various Phanerogamia, at the time of flowering or seeding, and is to be considered as a digestion of the symbiont by its host, must for the present be left in suspense. The prothallia often continue to live long after the death of the endophyte. Nothing of the nature of an *oögonium* has yet been observed in any stage of development of the fungus.

VI.

The *antheridia* arise, after the first basal cluster has been formed, figure

12. Sitzungsberichte d. Akad. d. Wissch. Wien. Math.—Natwissch. Classe. Bd. 84. Abth. i., 1881, p. 291 and p. 307.

13. Bull 94. Cornell Experimental Station, p. 52, 53.

14. Op. Cit. i., p. 124.

15. Op. Cit. pp. 310-313.

1, always on the crest of the antheridial ridge, figure 23. The older *antheridia* are found generally higher on the ridge than the younger ones, figure 23, a^1, a^2, a^3. The first indication of the male organ is a richly protoplasmic superficial cell, which divides transversely, giving rise to a shallow outer cell and a deep inner one, figure 23 a^1. The former becomes transformed into the outer wall of the *antheridium*, and the latter originates by repeated divisions, the mother-cells of the antherozoids. In figure 24 is represented a young stage in which both the inner and outer cells have already undergone several divisions. When the *antheridium* attains about a third of its ultimate size, its outer wall is doubled by periclinal divisions. In figure 25 these are represented as just beginning. Subsequently, the mass of spermatocytes is shut off internally from the prothallium cells by further periclinal divisions, figure 23, a^2, a^3. Often the *antheridia* are accompanied by short multicellular hairs, resembling those found on the rest of the surface of the prothallus and comparable to the paraphyses described by Treub in *Lycopodium phlegmaria*, figure 26, *par.* The more primitive mother-cells of the antherozoids possess large nuclei with numerous nucleoli, figure 27, *a.* After a number of simultaneous divisions of the spermatogenic tissue, the definite spermatocytes are formed. In these the reserve chromatin in the form of nucleoli has disappeared. The filar chromatin is arranged in what appears to be a true *reticulum.* When the formation of the antherozoids begins, the nucleus contracts somewhat and the bars of the chromatic *reticulum* become thickened, figure 27 *b.* The nucleus then assumes a lateral position, and begins to flatten out, figure 27 *c.* This process is continued, and by the lengthening out of the nucleus, the condensation of its chromatin, and the curvature produced by its position in the cell, the antherozoid is formed, figure 27 *d.* The interesting structure to which Webber[16] in his recent studies on the antherozoids of the *Cycadeæ*, has applied the name *blepharoplast*, and which he compares with the cilia-forming body lately discovered by Belajeff[17] in the *Filicineæ* and *Equisetineæ* has been looked for in the developing antherozoids of *Botrychium virginianum*, but has not been made out. This is probably due to the fact that osmic acid fluids could not be used as fixing reagents on account of the oil in the tissues, and because the stains employed were not those used by Belajeff, but either a combination of alum-cochineal and eosin, or aqueous saffranin alone. The material illustrative of spermatogenesis was somewhat limited in amount, and it was not thought advisable to risk the series by removing their covers

16. Bot. Gazette. Vol. xxiv., p. 233.

17. Ueber Nebenkern in Spermatog. Zellen u. d. Spermatogenese d. Farnkräutern. Berichte d. deutsch. Bot. Gesell. Bd. xv , pp. 337-339. Idem—Die Spermatogenese d. Schachtelhalm. Ibid. Bd. xv. pp. 339-342.

and re-staining with the reagents employed by Belajeff. The writer hopes to secure more young prothallia in the coming summer, in which event it will be possible to come to a decision on this important point.

The fully developed antherozoid forms a spiral of one and a-half turns and has the structure usual in the *Filicineæ*. The cilia come off from the attenuated, anterior end of the spiral. I could not decide, from the preserved examples which were the only ones I had the opportunity of examining under high magnification, the exact length of the ciliary region. The antherozoids, like those of *Ophioglossum pedunculosum* described by Mettenius[18], escape from the mother-cells while still within the *antheridium*. They swim about freely in its cavity, figure 28, *a* and *b*: sometimes still retaining their protoplasmic vesicles and in other instances being already freed from them, figure 27, e^1 and e^2. The spermatozoids make their way out by means of an aperture formed by the disappearance of two superimposed cells of the outer wall of the *antheridium*. They do not escape all at once, as is quite generally the case, but seem to be voided in several swarms, at intervals, under undiscovered conditions. The cavity of the *antheridium* is filled with a thin gelatinous matrix, resulting, probably, from the disintegration of the spermatocytic walls, figure 28, *a* and *b*.

VII.

As has already been stated, the *archegonia* originate on the flanks of the median ridge of the prothallia, figure 15, *y*. The youngest stage of the *archegonium* is a single, richly protoplasmic, superficial cell, which, as in the *antheridium*, divides subsequently into an outer shallow cell and an inner deeper one, figure 29. The former gives rise to the neck of the *archegonium*, and the latter to its axial row of cells. The next stage is the horizontal division of the inner rudiment which separates from it the large basal cell, figure 30. The superficial rudiment subsequently begins to divide, first, by anticlinal walls, figure 31; and then by periclinal ones, figure 32; thus forming the neck. The richly protoplasmic basal cell divides, figure 32, and then the upper axial cell undergoes a division, which results in the formation of the cervical canal-cell and the ventral cell; figure 33 and figure 34. In the latter figure is seen a paraphysis, *a*, which is in reality, only one of the multicellular hairs common over the whole surface of the younger parts of the prothallium. In figure 35, the nucleus of the cervical canal-cell has divided, and as may be seen in the next figure 36, the nuclear division

18. Op. Cit.

is not followed by the formation of a cell-wall, such as has been described by Farmer and Campbell in *Angiopteris*, *Marattia*, and *Osmunda*. From the study of many hundred *archegonia* in this stage of development, the statement is made with some confidence that such a wall is never present in *Botrychium virginianum*. In figure 37, is represented an *archegonium* in which the ventral canal-cell has made its appearance. One very rarely finds this canal-cell intact, as it quickly disintegrates and in preserved material, at any rate, is represented by an indistinct mass thrust against the wide base of the cervical canal-cell. In figure 38, is seen a ripe *archegonium* which has ejected its canal-cells. The apical cells of the neck are, as is usual in the Pteridophyta, thrust outwards. At the same time one frequently notices chromatolysis in the nuclei of the upper cells of the archegonial neck, figure 37, although this phenomenon is by no means invariably present.

The mature egg is large and possesses a very dense protoplasm, which however, generally encloses a hydroplastid. The free surface of the oösphere rises into a median elevation, the receptive prominence. Figure 38, was drawn from a preparation in which a single spermatozoid had entered the canal of the *archegonium*. It has not been possible to follow the stages of union of the sexual nuclei. After fertilization, the canal is generally occluded by the closing together of the neck cells, figure 39, although this is by no means invariably the case, figure 40. The oöspore grows to many times its original size before the first division takes place. Figures 39 and 40, represent two stages of the yet undivided oöspore. In figure 41, the first segmentation has occurred, and the basal wall is horizontal, as in the other eusporangiate Pteridophyta. In figure 42, the embryo has become divided into quadrants by the median wall, which is the next to appear, and which, in the majority of cases at least, is parallel to the long axis of the prothallium. The transverse wall next makes its appearance at right angles to the other two. In figure 43, is represented an embryo which has already undergone further divisions. The upper octants have been sub-divided before any similar activity has appeared in the lower segments. There is no indication of a suspensor, and as the lower part of the embryo is not loaded with food materials, it seems probable that the earlier divisions in the upper octants, are for the purpose of thrusting the young sporophyte deep into the prothallium, that it may be more easily nourished and attain its characteristically large size without exposure to injury. The divisions are not always so regular, as in the case of the embryo represented in figure 43. In some instances, the basal wall is rather oblique, and corresponding differences exist in the orientation of

the ensuing divisions, figure 44. Quite often, too, no regular course of segmentation can be made out at all, as in figure 45. When the embryo is only a little larger than those figured in 43, 44 and 45, the basal, median, and transverse walls are quite obscured by subsequent divisions. It is not possible to detect any indication of apical initials such as commonly occur in the early phases of the leptosporangiate sporophyte, and such as have also been described in some, at least, of the eusporangiate Pteridophyta. The next phase which is chosen for representation, is that in figure 46. Although no apical cells could be made out in this preparation and others of the same age, there is in the example figured, a very considerable formation of periclinal walls in the upper internal region of the embryo. The whole lower portion of the young sporophyte forms the foot, figure 46 *f*. In figure 47, is shown an embryo in which the root and shoot have already become differentiated. The periclinal activity already referred to, has led to the formation of a large amount of tissue in the upper portion of the embryo, and this is supported on the broad basis furnished by the foot. A high merismatic epidermis has already become differentiated at *x*, the cells of which are very rich in protoplasm and have the elongated columnar configuration of the shoot meristemeta of most of the Pteridophyta. Among these, the one marked *a* seems to be the initial cell. At *y*, is a protuberance which is the outward indication of the first root. Within this, at *b*, is the apical cell of the root, distinguished by its darkly-stained protoplasm, and by the fact that it has just undergone its first periclinal division. The condition of the embryo of *Botrychium virginianum* at this stage, is remarkable in that the stem-apex appears before the first leaf. The cotyledon is consequently derived from the shoot meristem, just as the later leaves are, but as in the case of the latter, it is not possible to follow the changes in the meristem leading to the formation of the foliar rudiment. The difficulty is greater in the case of the cotyledon, on account of the comparative paucity of younger embryos which have been cut exactly axially. For this investigation nearly three hundred series o prothalli, from two to twenty millimetres in length, have been sectioned. In spite of this not inconsiderable labor, less than twenty per cent. proved to be of value, either because no embryos were present, which is very commouly the case; or being present, they were not cut in a truly median plane. The surface of the gametophyte presents such irregularities that the proper orientation of the younger phases of the embryo is entirely a matter of chance. So far as I am aware the embryo of the *Equisetaceæ* presents the only other case yet described, in which the primitive foliar organ is secondarily

derived from the shoot-apex. Sadebeck[19] makes the following statement concerning the equisetaceous embryo:—"Nach meinen Untersuchungen bin ich vielmehr zu dem Resultat gekommen, dass die obere Hälfte des noch zweizelligen Embryo ganz unmittelbar die primäre Axe darstellt, aus welcher sich in gleicher Weise, wie später bei der erwachsenen Stammknospe die Blätter erzeugen."

The embryo of *Isoëtes echinospora*, as described by Campbell,[20] also resembles in a measure that of *B. virginianum*. It has a large foot originating from *both* the hypobasal quadrants, which by its position and size, at least, somewhat strikingly resembles that of *Botrychium*. In the case of the latter, it is quite impossible to state from which of the primitive divisions of the fertilized egg, the foot takes its origin. A resemblance also exists in the formation of the root and shoot from the upper part of the embryo. In *I. echinospora*, however, the cotyledon is the first shoot-organ to appear, and the stem-meristem does not definitely develop until later, although there is an indication of its existence from the first.

It is not to be supposed, however, that these resemblances are in any way to be considered as indicative of relationship, for the development of the embryo may vary greatly in the same natural group. In the *Marattiaceæ*, for example, both *Angiopteris* and *Marattia*, as described by Farmer[21] and Campbell,[22] are distinguished by the precocious development of the cotyledon. In *Danæa*,[23] on the other hand, it is the root which first shows considerable development. A somewhat similar state of affairs has been observed by the writer in the *Equisetaceæ*. *Equisetum arvense* and *E. hiemale* have a precocious root, whilst *E. limosum* and *E. palustre* develop first the shoot-organs. Among the *Ophioglossaceæ* themselves, in *Ophioglossum pedunculosum*, the cotyledon is the first organ to rupture the *calyptra*. In *Botrychium virginianum* and *B. Lunaria*, the root is prior in appearance.

In figure 48, is represented an embryo, which, although larger, is yet younger than that in figure 47. At *a* and *b* are probably the root and shoot initials. Figure 49 is an older stage than figure 47. The root, *r*, is already well advanced and its apical region is fully developed. Behind

19. Die Entwick. d. Keimes d. Schachtelhalme. Pringsheim. Jahrbucher f. Wiss. Botanik. Bd. xi., p. 582.

20. Annals of Botany, vol. v., p. 244.

21. Annals of Botany, vol. vi., p. 265.

22. Annals of Botany, vol. viii.

23. Brebner, G. On the Prothallus and Embryo of *Danea simplicifolia*. Annals of Botany, vol. x., p. 103.

its terminal meristem are elongated cells which, later, give rise to fibro-vascular tissues. The cotyledon, *c*, is also for the first time visible, and beside it is the stem-meristem, *s*. Below is the very massive foot, *f*. Figure 50, lithographed from a photomicrograph, represents a still later stage of development. Here the root is almost ready to burst the *calyptra*, *cal*. The cotyledon is distinctly seen, and at this stage, for the first time, covers over the stem-apex, which now lies on the side of a transverse fissure. No vascular tissue appears till the root has grown to a length varying from five to twenty millimetres, and has burst the *calyptra*. The first tracheides arise in the proximal region of the root after it has emerged from the prothallium. Subsequently they make their appearance in the cotyledon and the stem-axis.

Before referring to the further developmental changes in the nascent sporophyte, it will be well to consider an interesting abnormality. In figure 51 is represented part of a prothallus in which tracheides are present, near a region of superficial decay. The decayed spot probably marks the position of an embryo which has been injured and in consequence has rotted away, So far as I have been able to learn, by reference to the literature on the subject, such prothallial tracheides are the invariable accompaniment of apogamy. Their presence was first described in connection with this phenomenon by Farlow[24] in the apogamus prothallia of *Pteris cretica*. They have since been seen by many observers under similar conditions. Lang[25] has recently found them in the interesting reduced, apogamous, sporangiferous sporophytes of *Lastræa dilatata*, Presl, var. *Cristata gracilis*, Roberts and *Scolopendrium vulgare*, L., var. *ramulosissimum*, Woll. According to Bower, tracheides also occur in the prothallia [endosperm] of certain Cycads. In view of the recent discoveries of antherozoids in the pollen-tubes of this group, it would be interesting to know if the Cycads also manifest the phenomenon of apogamy.

The example figured is the only occurrence of prothallial tracheides which has come under my notice in examining a large number of gametophytes. In this case both *antheridia* and *archegonia* were present. Recently an example of apogamy in *Pteris aquilina* has come under my observation in which an apogamous and a normal embryo were produced side by side on the same archegonial pad. The former was accompanied by a single prothallial tracheid. The apparent rarity of the phenomenon in *Botrychium virginianum* may be due to the conditions under which the Metis specimens, which I have almost exclusively

24. Quarterly Journal of Microscopical Science, vol. xiv., N.S., p. 266.

25. Annals of Botany, vol. xi., pp. 157-168; also, Proc. of Royal Society of London.

investigated, grew. They were found as has been already stated, virtually submerged in a peat-bog, and as a consequence, absence of proper water supply which has been noticed as a predisposing cause of apogamy, would not make itself felt. Possibly prothallia from the rich, rather dry soil of the Don valley might yield a greater number of examples. If we may infer apogamy from the presence of prothallial tracheides, the gametophyte of *Botrychium virginianum* is unique among the eusporangiate vascular Zoidogama, in this respect; unless the phenomenon is shown to be present in the tracheid-bearing Cycad endosperms described by Bower, and apogamy can no longer be considered as peculiar to the leptosporangiate *Filicineæ*.

Returning to the young sporophyte, the shoot-organs and the root possess fairly well marked apical cells, as is shown by Campbell[26] to be true also of the mature spore-plant. Figure 52 represents the terminal meristem of the young stem in vertical section. At *a* is probably the apical cell. In figure 53 the same region is shown in horizontal section. In figure 54 is the apex of the cotyledon in longitudinal section. Figure 55 represents a long section of the apex of the first root in an embryo which has not yet broken through the *calyptra*. A large primary segment is found on the side of the *pileorhiza*, a state of affairs rarely seen in later stages of the root, as subsequently the small cells of the inner part of the root cap abut immediately on the apical cell. This is possibly to be explained by the comparatively slight development of the *pileorhiza* which consequently requires only very occasional contributions from the apical initial. The root of *Botrychium virginianum* is an endotrophic *mycorhiza* and, as has been shown by Frank, there is a tendency to degeneracy in the root-cap of roots of this type. The apical cell is much more active on its flanks although even here it divides slowly, compared with the apical initial of the leptosporangiate *Filicineæ*. In figure 56 the root-apex is seen in transverse section, and unlike that of the stem, its initial cell is triangular in this plane.

Figure 57 shows an interesting case of polyembryony corresponding to that described by Treub[27] in *Lycopodium cernuum*. It was first noticed after a series had been made of what appeared externally to be a bifurcated embryo. The central cylinders of two plants, *a* and *b*, are shown; *a* is larger and much more abundantly supplied with reserve food-materials, which cause it to stain more intensely; *b* is smaller, less developed, and in a condition of malnutrition as is indicated by a corresponding paleness of hue; a^2 is the second root of embryo *a*, and is

26. Campbell. Mosses and Ferns; pp. 232, 235.

27. Etudes sur les Lycopodacées; Extrait vi., p. 11.

quite fully matured ; a^3 is the foliar trace of the cotyledon, which is just being separated by a layer of decidual periderm ; x is the central cylinder of a, with the trace of the second leaf just making its appearance ; b^2 is the still embryonic second root of the smaller embryo b ; b^3 is the young cotyledon and y is the central cylinder. Figure 58 represents a lower section in the same series with the same lettering as before ; a^1 is the primary root of the better developed embryo, and b^1 is that of the smaller embryo. At a^2 is a prominence indicating the point of origin of the second root of the larger embryo. Figure 59 is of a section still lower down and passes through the common foot of the geminal sporophytes. The staining alone indicates the boundary between the two plants. Their central cylinders are separate throughout, but the fundamental tissues appear to be in textural continuity. A quite sharp demarcation, however, is produced by the different condition of nutrition of their cells ; those on the side of a being loaded with starch ; those of b, on the other hand, containing only a very small amount. Unwillingness to sacrifice the series prevented the use of the ordinary methods of demonstrating protoplasmic continuity for the purpose of discovering whether the protoplasm of the two was in reality continuous. The phenomena of nutrition would seem to negative such a supposition. Figures 57, 58 and 59 have been lithographed from photomicrographs.

The first root of the young sporophyte is sometimes diarchous, but just as often triarchous. There seems to be no relation between the vigor of the root and the number of protoxlyem-strands ; as depauperate plants sometimes have three strands, and, on the other hand, robust individuals often have only two. I have not found a single example of a monarchous root in the large number of specimens which I have examined. Figure 60 is a drawing of a section of a diarchous primary root in aqueous analinsulphate. The endodermis a is quite distinct, and shows plainly the characteristic radial lignified zones. Between it and the vascular tissue are one or more layers of pericycle cells. The protoxylem tracheides, x, are reticulate in their sculpture and not ringed or spiral as is generally the case. The metaxylem elements almost always meet in the centre. The bast, y, is made up of thick-walled elements, some of which are sieve-tubes and the rest elongated parenchyma cells. Between the bast and the vessels, is a considerable amount of wood parenchyma. Often two or three diarchous roots are formed, but sooner or later triarchous, and finally tetrarchous ones are produced.

The central cylinder of the stem becomes fully differentiated below the point of origin of the cotyledon. From the very first it has a well-

marked pith, figure 61 *m*. The pith communicates with the external fundamental tissue through a gap caused by the exit of the cotyledonary trace, as has been described by Van Tieghem[28]. The internal endodermis discovered in the younger portion of the stem of *Botrychium Lunaria* and others of the *Ophioglossaceæ* by Van Tieghem[29] and Poirault[30], is not present in this species, although the external endodermis is well-marked, only disappearing opposite the foliar gaps. The bast-tissue originates first in the young central cylinder and seems never to have any secondary additions from the activity of the *cambium*. Graf zu Solms[31] has thrown doubt on the existence of secondary wood in the *Ophioglossaceæ*, but in this species there can be no uncertainty as to its presence; in fact, the wood is practically all secondary, as may be learned from the radial arrangement of its matured elements and by following the course of its development, figure 63 *x*, and figure 64 *x*. The first-formed wood-elements are reticulately sculptured and are never of the ringed or spiral type. In this respect they resemble those of the stem of the *Marattiaceæ*, and, in fact, also those of the *Osmundaceæ*; for the groups of typical protoxylem elements found in the upper region of the bundles of the latter, really belong to the leaf-traces. It is more than probable that the absence of typical primitive tracheary tissue in all these cases, is due to the very slow growth of the stem, a phenomenon which renders their presence unnecessary. The writer has noticed the absence of these elements in the slowly growing stems of species of so-called polystelic *Primulæ*, viz :—*P. Auricula* and *P. farinosa*.

During this investigation, the rather interesting observation has been made, that the periderm-tissue first described in the *Ophioglossaceæ* by Russow[32] and Holle[33], is formed in *Botrychium virginianum* at the bases of defunct leaves, and thus is merely an abciss-layer. Figure 65, from a photomicrograph, shows a young sporophyte still attached to its prothallium; *r* is the first root and *x* the base of the cotyledon; l^2 and l^3 are developing leaves. As may be seen from the figure, the course of the cotyledonary bundle *x*, has been interrupted by the interca lation of a layer of periderm. Figure 66 shows the tissues in question under a sufficiently high magnification to make clear the details of periderm formation. By the continued growth of the latter the distal part of the

28. Remarques sur la structure de la tige des Ophioglossées. Journal de Botanique, iv., Année; p. 407

29. Op. Cit.

30. Recherches sur les Cryptogames vasculaires. Annales de Sci. Nat. Bot. Tome xviii.; p. 170.

31. Fossil Botany, p. 223.

32. Mém de l'Acad. Imp. des Sciences de St. Petersbourg. vii. Serie. Tome xix., No. 1, p. 117.

33. Bot. Zeit. 1875. Ueber Bau u. Entwicklung der Ophioglosseen, p. 12.

leafstalk is forced continually outwards and eventually decays, leaving no trace of its existence. This is the reason that, in transverse sections of older stems, the foliar bundles of fallen leaves apparently disappear before reaching the external cortex. The periderm formation of *B. virginianum* is thus connected with the occlusion of the leafstalks, and is probably to be explained as an adaptation for protecting the subterranean stem from infection by the fungi of the soil.

In a transverse section through the older region of the stem, the periderm is never found to form a continuous investiture as in the higher plants, but is strictly localized in areas representing the points of origin of former leaves. The writer has not yet had an opportunity of investigating whether the mode of cork formation obtaining in *B. virginianum* is common to the whole group, but it seems probable that this may prove to be the case. Periderm is also often formed both in the sporophyte and in the gametophyte where surface injuries have occurred: a striking case of correspondence between the two generations.

The cotyledonary trace originates from the central cylinder as a single strand, figure 61, *cot.*; but separates shortly after reaching the petiole into two approximately collateral bundles. These pass upwards through the long leafstalk into the lateral lobes of the lamina, one of them giving off a bundle for the median lobe, exactly as in the postcotyledonary leaves of many *Filicineæ*. The endodermis is never quite continuous on the inner side of the cotyledonary trace, and in subsequent leaves becomes less and less marked, till at the stage in which there are four petiolar bundles, it is entirely absent. Figure 67 represents the laminar portion of the ninth leaf of a sporophyte which was still attached to its prothallium. The fertile segment, *f. s.*, of the lamina is already present. This plant was at the same time the oldest sporophyte still in connection with the gametophyte, and the youngest already producing spores, which has come under my notice during the present investigation.

In figure 68 is a still attached young sporophyte. Its prothallium is infected with the already defunct symbiont, *a*. The spore-plant still bears its cotyledon l;[1] and two younger leaves, l^2 and l^3 are in the process of formation. In the primitive root, *r*, can be seen at *x* and *y*, certain dark spots which are cells occupied by the sporophytic endophyte. There is no resemblance between the latter and that of the gametophyte as its mycelial filaments are much larger, being generally about eight micra in diameter. There are no vesicles nor *conidia* present, and in fact the sterile *mycelium* is uniformly filamentous in character. These features are reproduced in figure 69. The occurrence of a symbiont in the roots

of the *Ophioglossaceæ* has long been known, and is mentioned by Russow and Holle in the works already cited. The latter refers to its presence or absence, the varying number of protoxylem groups in the larger and smaller roots of *Botrychium matricariæfolium*. In *B. virginianum* this explanation cannot be accepted, as, although the first formed roots vary greatly in the number of archixyles, it is only in rare cases like that figured in 68 that the fungus is present.

VIII.

The results of this investigation may be summarized as follows :—

(1). The gametophyte of *B. virginianum* is entirely subterranean, without chlorophyll and probably symbiotic. It is from two to twenty millimetres in length by one and a-half to fifteen millimetres in breadth, and oval in outline, whether viewed from above or from the side.

(2). The whole surface of the plant is beset with rhizoids, which are generally multicellular. The upper part of the gametophyte is occupied in most prothallia, which have not yet produced embryos, by a median ridge. The reproductive organs are found exclusively on the superior surface, the *antheridia* being situated on the crest of the ridge, and the *archegonia* on its flanks.

(3). The gametophyte grows by a well-marked apical meristem which is situated on the upper side, anteriorly, and apparently originates from a single initial cell.

(4). There is present in the lower part of the prothallus, an endophytic fungus, possessing characteristics which will perhaps, on further study, justify its recognition as a form intermediate between the genera *Pythium* and *Completoria*. The symbiont is accompanied by a large amount of oil, and probably advantageously affects the nutrition of the prothallus. The fungus dies after one or more embryos have reached a considerable size.

(5). The *antheridium* originates from a single superficial cell and is characterized by possessing a double outer wall. The antherozoids are of the ordinary filicineous type and are rather large in size.

(6). The *archegonium* likewise takes its origin from a single superficial cell. The neck consists of seven or eight tiers of cells. The cervical canal-cell is binucleate, but is never represented by two cells. A stratum of basal cells is present.

(7). The first division of the fertilized egg is transverse, as in the other eusporangiate Pteridophyta. The identity of the octant walls which are

formed in the usual way, is early lost, and the embryo grows to a relatively large size before the organs make their appearance. The root and shoot originate from the upper part of the embryo; and it may perhaps be inferred that, like those of *Isoetes echinospora*, they are derived from the upper octants. The foot is formed from the whole of the lower region of the embryo. The cotyledon is apparently derived secondarily from the shoot meristem.

(8). The root, the stem, and the cotyledon grow by the segmentation of a single apical cell, as in the adult plant. The root develops more rapidly than the other organs; and the second or third root may make its appearance before the cotyledon unfolds. The latter is green and capable of assimilation, as in *Ophioglossum pedunculosum*.

(9). The root-system of the young sporophyte is soon occupied by a symbiotic fungus, which differs in the size of its filaments and in several other respects, from that found in the gametophyte.

(10). Evidence of apogamy has been found in the form of prothallial tracheides.

(11). One example of polyembryony was observed.

(12). The sporophyte remains for a long time attached to the gametophyte. It is an open question whether this is a primitive characteristic, or merely an adaptation. The fact that the young sporophyte of the much less robust *B. Lunaria*, according to Hofmeister's account remains for a very short period attached to its gametophyte, would seem to justify the latter assumption.

IX.

In coming to any conclusions as to the bearing of this research on the phylogenetic position of the *Ophioglossaceæ*, due weight should be given to the fact that the present species is the only one which has been somewhat fully investigated; and the results of recent observations on the *Marattiaceæ*, *Lycopodiaceæ*, and *Equisetaceæ* show that a very considerable variety of development may exist even within the same natural group. Moreover the saprophytic habit of the gametophyte of *B. virginianum* has in all probability more or less profoundly modified its structure.

It will be convenient to consider first the position of *B. virginianum* in regard to the other representatives of the *Ophioglossaceæ* which have been studied. Its prothallus resembles very closely that of *B. Lunaria*, and shows indications of being only a more specialized type. That this

is the case is rendered probable by the strict localization of the *antheridia* on the antheridial ridge, and by the occurrence of the reproductive organs on the upper surface of the gametophyte. It is interesting in this connection to note the scattered disposition of the *antheridia* in the very young prothallus; for this is probably to be regarded as a primitive feature. An embryological comparison between the two forms is not possible, as the embryology of *B. Lunaria* is at present unknown. The young sporophyte of *B. virginianum*, in that it is attached to the upper surface of the prothallus, and has a completely developed and assimilatory cotyledon, differs from the sporophyte of *B. Lunaria*. The young spore-plant also remains much longer attached to the gametophyte than is the case in the latter species. *B. virginianum* seems, of all the representatives of the genus in Canada at least, to be the most completely adapted to modern conditions; for it is everywhere abundant in rich woods, and always outnumbers the other species.

The prothallus of *Ophioglossum pedunculosum* does not very closely resemble that of *B. virginianum*. The presence of a primary tubercle and the formation of green prothallial lobes are its characteristic features. It should be remembered, however, that within the single genus *Lycopodium*, *L. annotinum* resembles in its prothallus *B. virginianum* and *B. Lunaria*, whilst *L. cernuum* and *L. inundatum* have a gametophyte like that of *Ophioglossum pedunculosum*. It is possible that a species of *Botrychium* may yet be found in which the prothallus is like that of *Ophioglossum pedunculosum*. The *antheridia* and antherozoids of the present species quite exactly resemble Mettenius' description of those of *Ophioglossum pedunculosum*. The *archegonia* correspond, too, in so far as the earlier description offers points of comparison. In the development of the embryo, the account of Mettenius is rather too meagre to allow of any exact inferences in regard to points of likeness in the successive phases of segmentation. The young sporophyte of *Ophioglossum pedunculosum* develops its cotyledon early, and the primary root is slow in pushing its way out, which exactly reverses the course of events in *B. virginianum* and probably also in *B. Lunaria*.

Bower[34] has recently fully discussed the relationships of the *Ophioglossaceæ* to the other groups of the Pteridophyta. He comes to the conclusion that the ventral fertile leaf-segment of the *Ophioglossaceæ* is the morphological equivalent of the single ventral sporangium of the homosporous *Lycopodineæ*, and derives it from the former by a process of septation and branching. He also compares the two groups in

34. Studies in the morphology of spore-producing members. Part 2. *Ophioglossaceæ*, p. 56, et seq.

regard to the structure of the vegetative organs of the mature sporophyte, and finds that in this respect they also show a marked resemblance to one another. Lastly, the organization of the gametophyte and the development of the sporophyte, are discussed in the same connection with a like conclusion.

It is only necessary in considering the results of the present investigation, to examine the latter features. In regard to the structure of the prothalli, the two groups certainly do present marked likenesses; *e.g.*, the gametophyte of *Ophioglossum pedunculosum* to those of *Lycopodium cernuum* and *L. inundatum*, and the gametophytes of *B. Lunaria* and *B. virginianum* to that of *L. annotinum*. It is quite possible, however, that the resemblance in these cases is due to a similarity in environment.

The male organs of the two groups are in some important features quite different. The *antheridium* has a double outer wall in the *Ophioglossaceæ* and the antherzoids are spiral and multiciliate. In the homosporous *Lycopodineæ*, the *antheridium* has a simple outer wall, and the antherozoids have the general configuration and the two cilia of the antherozoids of the Bryophyta.

The *archegonia* of *B. virginianum* at least, resemble those of the *Filicineæ*, (excluding *Isoetes*, which probably does not belong here), in having a basal cell and a single binucleate canal-cell, or at most two neck canal-cells. On the other hand the *Lycopodineæ* and *Equisetaceæ* are without the basal cell and have a decided tendency to increase the number of cervical canal-cells. Too much importance should not, however, be attached to these structural features of the *archegonia*.

The embryo of *B. virginianum* and apparently that also of *O. pedunculosum*, lacks the suspensor and primary sporophytic tubercle which are so characteristic of most of the isosporous *Lycopodineæ*, and in these defects resembles the *Filicineæ*. So far as the facts in the case of *B. virginianum* go, it seems probable that the *Ophioglossaceæ* are much more closely allied to the eusporangiate *Filicineæ* than to the isosporous *Lycopodineæ*, although they may be possibly the nearest of the megaphyllous Pteridophyta to that group. In all probability, the *Ophioglossaceæ* are more primitive than the *Marattiaceæ* which they in some respects resemble.

As a result of the fuller knowledge in recent years of the segmentation of the embryo of the Pteridophyta, it is scarcely possible to retain any longer the conception of octants propounded by Leitgeb and others when the leptosporangiate *Filicineæ* were practically the only ferns in which

anything of the embryology was known. In the homosporous *Lycopodineæ* the apex of the stem, the cotyledon, and the root, are all according to Treub's description, derived from the hypobasal half of the embryo. In *Isoetes, echinospora,* the same three organs, according to Campbell's account, originate from the epibasal octants, the foot being formed from *all* the hypobasal octants. No recent complete investigation of the embryology of the *Selaginelleæ* is available, but the phases of development described by Pfeffer can only be harmonized with the octant theory by something like a *tour de force.* In the *Equisetaceæ,* according to Sadebeck, the shoot originates from the upper octants, and the root and foot from the lower octants, the primitive leaves being derived secondarily from the shoot meristem. The *Ophioglossaceæ,* as represented by *B. virginianum* resemble embryologically *Isoetes echinospora.* The segmentation of the *Marattiaceæ* alone, agrees fairly well with the stages of development found in the leptosporangiate *Filicineæ,* and it is not very difficult in this group to refer the organs to definite pairs of octants. But of all the eusporangiate forms, the *Marattiaceæ* come closest to the leptosporangiates, and this probably is the explanation of their embryological agreement.

If we are to accept the hypothesis that the eusporangiate Pteridophyta are primitive, and if we follow Bower in deriving their sporophytic phase from the progressive sterilization of the potential sporogenous tissue of intercalary sporogonium-like forms, the axis is certainly to be regarded as primitive, and the leaves and roots must be considered as secondary outgrowths from the axis; either by eruption as Bower surmises, or by some other undiscovered process. According to this conception, foot and shoot are the primitive organs, and leaf and root are subsequently derived from the latter. This view of the matter harmonizes with what is known of the embryology of the lower eusporangiates. In the highly specialized leptosporangiates on the other hand, a process of acceleration and rearrangement has been carried out and the organs appear precociously, in definite relation, to the earlier segmentations of the embryo.

In conclusion, the writer wishes to express his special obligations to Professor G. L. Goodale of Harvard University for very kindly putting at his disposal the books of the Gray Herbarium.

EXPLANATION OF PLATES.

PLATE I.

FIG. 1.—Youngest prothallium found, *ar*. antheridial ridge. × 8.

FIG. 2.—An older stage in which the antheridial ridge has become more marked. × 16.

FIG. 3.—A considerably older gametophyte on which is a developing embryo, *em*. The antheridial ridge, *ar*, is particularly prominent. This prothallium is lithographed from a photomicrograph. × 7.

FIG. 4.—A lobed prothallus from a photomicrograph. × 4.

FIG. 5.—From a photomicrograph; represents a younger phase in which the root-hairs are abundant. × 8.

FIG. 6.—A lobed prothallus lithographed from a photomicrograph, and bearing two embryos, em^1 and em^2. × 4.

FIG. 7.—A young sporophyte showing the first root. × 8.

FIG. 8.—A young sporophyte showing two roots; the cotyledon is still unexpanded. × 4.

FIG. 9.—A young sporophyte with the primary root and the cotyledon. × 1.

FIG. 10.—A stouter sporophyte with three roots and the cotyledon. × ⅔.

FIG. 11.—A lobed prothallus bearing two advanced sporophytes. × 1.

FIG. 12.—A prothallus bearing two further advanced sporophytes. × ¼.

FIG. 13.—A bifurcated sporophyte still attached to its prothallium. × 4.

FIG. 14.—An eight year sporophyte still attached to its prothallium. × ⅔.

FIG. 15.—A cross-section of a prothallus showing the antheridial ridge, *x*; the fungiferous cells, *b*; and the uninfected cells, *a*. At *y* are the archegonia, and *h*, root-hairs. × 16.

FIG. 16.—A long-section of the prothallus; lettering the same as in the preceding figure. *ap*, apical region. × 16.

FIG. 17.—Apical meristem. *a*, apical cell of prothallus. × 250.

FIG. 18.—Showing the penetration of the fungus into the gametophyte. *c*, root-hair; *b* and *d*, superficial cells, in which the cutinized sheaths have been produced; *x*, fungiferous cells; *y*, uninfected cells; *a*, conidia. × 250.

FIG. 19.—Fungiferous cells; *a*, with purely filamentous mycelium; *b* and *c*, mixture of filamentous and vesicular mycelium. × 600.

FIG. 20.—Cell showing the formation of vesicles, *f*, as outgrowths from a hypha, *h*. × 1,000.

PLATE II.

FIG. 21.—Base of a broken root-hair; *s*, cutinized sheath; *b*, hypha of penetrating fungus. × 1,000.

FIG. 22.—*a*, formation of conidium; *b*, ripe conidium; *c*, germinating conidium. × 1,000.

FIG. 23.—Antheridial ridge showing three antheridia in different phases of development, a^1, a^2, and a^3. × 250.

FIG. 24.—An older antheridum. × 250.

FIG. 25.—A still older phase in which the outer wall is undergoing division. × 250.

FIG. 26.—Antheridial ridge showing the formation of paraphyses, *par.* × 90.

FIG. 27.—Development of antherozoids; *a*, young sperm-cells. × 500. *b*, definite spermatic mother-cells; *c*, a later phase of the same, the nucleus is beginning to become crescentic; *d*, young antherozoids within the mother-cells; *e*, ripe antherozoid. In e^1, the protoplasmic vesicle is still retained; in e^2, it has disappeared. × 1,000.

FIG. 28.—Matured antheridia showing the doubled outer wall; within, the antherozoids are swimming in a gelatinous matrix. In *a*, they are escaping. × 250.

FIG. 29.—First stage in formation of the archegonium. × 250.

FIG. 30.—A later phase showing formation of the basal cell. × 250.

FIG. 31.—Anticlinal division of the cervical rudiment. × 250.

FIG. 32.—Periclinal divisions of the cervical portion of the archegonium. × 250.

FIG. 33.—Nuclear division of the axial cell. × 250.

FIG. 34.—The same completed. A paraphysis at *a*. × 250.

FIG. 35.—Nuclear division of the cervical canal-cell. × 250.

Fig. 36.—The same completed. × 250.

FIG. 37.—Ripe archegonium, showing the ventral canal-cell. × 250.

FIG. 38.—Opened archegonium with penetrating antherozoid. × 500.

FIG. 39.—Fertilized egg. × 250.

FIG. 40.—The same older and larger. × 250.

FIG. 41.—First division of the embryo. × 250.

FIG. 42.—Formation of the median wall of the embryo. × 250.

FIG. 43.—An older embryo in which anticlinal divisions are present in the upper octants. × 250.

FIG. 44.—Another embryo of the same age, with oblique walls. × 250.

FIG. 45.—The same age as the foregoing, showing irregular segmentation. × 250.

FIG. 46.—A more advanced phase showing periclinal activity in the upper cells of the young embryo at *a*; *b* is the foot region. × 250.

PLATE III.

FIG. 47.—An older embryo ; *y*, the root ; *x*, the shoot ; *f*, foot ; *a*, initial cell of shoot ; *b*, initial cell of root. × 250.

FIG. 48.—A younger, but larger embryo than the foregoing, with the same lettering. × 250.

FIG. 49.—An advanced embryo ; *r*, root ; *c*, cotyledon ; *s*, shoot ; *f*, foot. × 160.

FIG. 50.—From a photomicrograph. Lettering as before ; *cal*, calyptra. This embryo is considerably older than the foregoing. × 50.

FIG. 51.—Part of a prothallium containing tracheides ; *a*, decayed spot where an embryo has probably disappeared ; *t*, tracheides. × 250.

FIG. 52.—Apical region of the shoot in vertical section ; *a*, the initial cell. × 250.

FIG. 53.—The same, in horizontal section ; *a*, the apical cell. × 250.

FIG. 54.—Longitudinal section of the apex of the cotyledon ; *a*, apical cell. × 250.

FIG. 55.—Apical region of the primary root ; *a*, apical cell. × 250.

FIG. 56.—Tranverse section of the same ; *a*, apical cell. × 250.

FIG. 57 Transverse section of two united embryos, *a* and *b*. a^2 is second root of *a* ; a^3, cotyledon of *a* ; *x*, central cylinder of *a* ; b^2, second root of *b* ; b^3, cotyledon of *b* ; *y*, central cylinder of *b*. × 50. (From a photomicrograph).

FIG. 58.—The same, a section through a lower region. Lettering as in the previous figure. a^1, first root of *a* ; b^1, first root of *b*. × 50. (From a photomicrograph.)

FIG. 59.—Section through the foot-region of the same embryos. Lettering as before. × 50. (From a photomicrograph.)

FIG. 60.—Transverse section of a diarchous primary root : *a*, endodermis ; *x* xylem ; *y*, phloëm ; *b*, parenchyma. × 250.

PLATE IV.

FIG. 61.—Transverse section of the young stem, above the exit of the cotyledonary trace : *cot.* cotyledonary trace ; *c.c.*, central cylinder ; *m*, medulla. × 50. (From a photomicrograph).

FIG. 62.—The same, more highly magnified. × 160. (From a photomicrograph).

FIG. 63.—Part of the central cylinder of the foregoing, more highly magnified ; *en*, endodermis ; *y*, phloëm ; *x*, xylem ; *camb*, cambium ; *s. t.*, sieve-tube ; *m*, medulla. × 220. (From a photomicograph).

FIG. 64.—Part of central cylinder of quite a young plant ; *en*, endodermis ; *ph*, phloëm ; *camb*, cambium ; *x*, xylem ; *m.r.* medullary ray.

FIG. 65.—Longitudinal section of an attached sporophyte ; *r*, primary root ; *x*, remains of cotyledon ; l^2 and l^3, developing leaves. × 20. (From a photomicrograph).

FIG. 66.—The base of the cotyledon from the preceding, more highly magnified, showing the formation of abciss-periderm at *j*. × 160. (From a photomicrograph).

FIG. 67.—Lamina of an attached sporophyte, eight years old, showing the fertile segment, *f. s.*, and sterile segment, *s. s.* × 8.

FIG. 68.—Longitudinal section of an attached young sporophyte; l^1, cotyledon; l^2 and l^3, developing leaves; *r*, primary root; *x* and *y*, endophytic fungus of the sporophyte. × 20. (From a photomicrograph).

FIG. 69.—Cells of the primary root, containing the fungus of the sporophyte. × 420.

FIG. 70.—Transverse section of a prothallus: *ar*, antheridial ridge; *em*, an embryo. × 20. (From a photomicrograph).

THE PICTS.

By Rev. Neil MacNish, B.D., LL.D.

(Read 10th April, 1897).

The question, Who the Picts were, and what the language was which they spoke, still continues to evoke attentive interest. Mr. Nicholson, Bodley's Librarian in the University of Oxford, published about a year ago, a little book to which he has given the designation: "The Vernacular Inscriptions of the Ancient Kingdom of Alban." His aim is to prove, and he has been very successful in establishing his contention, that the Pictish Inscriptions which he has examined and deciphered, indicate that Gaelic was the language of the Picts. He is correct in stating that three theories have been held with regard to the language of the Picts. It has been maintained that that language is closely akin to Irish and Scottish Gaelic It has also been contended that it has a strange resemblance to the Cymric branches of the Celtic language. Further, there are those who are of the opinion that the language of the Picts is neither Celtic nor even Aryan, but that it has a strong likeness to the language of the Basques. It is unfortunate that no literary remains of any description have come down to our time from the period in the history of the Picts which preceded their union with the Scots in 844, to form henceforth one kingdom. It is with the sculptured stones of the Picts that Mr. Nicholson concerns himself. He avers that there are eighteen Inscriptions, that they are all cut on stones, that several of them are now in the National Museum of Antiquities, Edinburgh, and that with three exceptions they are written in Ogam letters. Professor Rhys of Oxford, who has devoted great pains on the decipherments of Pictish Inscriptions, advances the conjecture that the Ogam characters were invented by a "Goidelic native of Siluria or Demetia, who having acquired a knowledge of the Roman alphabet and some practice in a simple system of scoring numbers, elaborated the latter into an alphabet of his own, fitted for cutting on stone and wood." The Ogam alphabet is confined to the British Isles. No Ogam Inscriptions are found elsewhere. Numerous Inscriptions in that character have been discovered in Ireland, in portions of Scotland, including the Shetland and Orkney Isles, in the Isle of Man, in Wales and in England. In the Book of

Ballymote, which was compiled towards the close of the fourteenth century, and which is now in the Library of the Royal Irish Academy, there is a special tract wherein the different styles of Ogamic writing and the value of the letters are explained. Whether Mr. Nicholson received any material assistance from the tract in the Book of Ballymote in his laudable determination to interpret the Pictish inscriptions or not, it is quite manifest that he has brought great ability and acumen and industry to bear in the interpretation of those strange Inscriptions. He has constructed an alphabet in Ogam characters, consisting as it does of "strokes—almost exclusively straight strokes—written in a line commonly called the stem-line, which is normally straight." Mr. Nicholson is well aware that, as he has not inserted in his book a photograph of every Inscription to which he refers, or of which he gives an interpretation, he cannot expect as ready an appreciation of his labours and as extensive an acquiescence in his deductions on the part of competent scholars, as would undoubtedly be the case, were every intelligent reader of his book enabled to compare for himself the Ogam Inscriptions with the explanation of them which he has been successful in discovering and which he accordingly communicates. He assigns certain reasons which have prevented him from publishing photographs and fac-similes of the Inscriptions which he has undertaken to decipher and explain. It is evident that Professor Rhys, whose scholarship is well-known, is in active sympathy with Mr. Nicholson in a common desire to shed all the light that may be possible for them, on these curious Ogam Inscriptions that connect us in a certain sense with a past which, however interesting it may be for many reasons, has few trustworthy records whereby an acquaintance with its peoples and doings and political circumstances can be obtained by us. It does great credit to Mr. Nicholson that he has studied carefully the best authorities that are available for understanding the few specimens of early Celtic literature which have been transmitted to us from the early centuries of the Christian era. He has made himself familiar with Zeuss' Grammatica Celtica and with the Goidelica and other books which Whitely Stokes has edited. There is no exaggeration in the praise which Ebel, the editor of the second edition of the Grammatica Celtica bestows on those two great Celtic scholars: "Post ipsum conditorem ac parentem grammaticæ Celticæ haud facile quisquam invenietur, qui melius meritus sit de omnibus hujus doctrinæ partibus quam Whitleius Stokes." Mr. Nicholson has conclusively shown that the language of these Pictish Inscriptions is Gaelic, and that so far as the argument which is thus available is concerned, it goes to uphold the theory that the Picts were Gaels, and that their language was Gaelic. He does not overstate the value of his interpretation of the

Pictish Inscriptions when he remarks: "But that the language of those inscriptions is simply old Gaelic is a fact which will not henceforth be doubted by any Keltic scholar who reads this book," etc.

It has been wisely asserted, that "it is a long time ago since the first Celts crossed the sea to settle in Britain. Nobody knows how long, and the guesses which have been made as to the date are hardly worth recording. And when they did come, the immigration was not all over in one year or even in one century. The Goidels were undoubtedly the first Celts to come to Britain, as their geographical position to the west and north of the others would indicate, as well as the fact that no trace of them on the Continent can now be identified. They had probably been here for centuries when the Brythons or Gauls came and drove them westward. The Goidels had done the same with another people, for when they came, they did not find the country without inhabitants. Thus we get at least three peoples to deal with—two Celtic and one pre-Celtic."

In his Life of Agricola, Tacitus thus writes; "Namque rutilæ Caledoniam habitantium comæ. . . . Silurum colorati vultus, et torti plerumque crines, et posita contra Hispania, Iberos veteres trajecisse easque sedes occupasse, fidem faciunt." Isaac Taylor has the authority of Tacitus on his side when, in his Origin of the Aryans, he thus writes, (p. 76): "There can be little doubt that the Iberian race was dark in complexion, with black hair and eyes. As to the Celtic race, it is almost certain that they were fair with red or yellow hair and blue or blue-grey eyes. The Iberians were plainly the primitive inhabitants of Britain. The Celts were later invaders who were not only a more powerful race but possessed a higher civilization. The Iberians extended over the whole Spanish peninsula as well as over the coasts and islands of the Mediterranean. The Celts when they invaded Britain, found the country in possession of the Silurian race whose descendants can be traced to Denbighshire and Kerry."

The account which Bede gives in his Ecclesiastical History of the Inhabitants of Great Britain and Ireland, possesses a peculiar importance. "This island at present contains four nations—the English, Britons, Picts and Latins. At first this island had no other inhabitants but the Britons. The nation of the Picts from Scythia arrived in the northern coasts of Ireland, and desired to have a place granted them in which they might settle. Acting on the advice of the Scots who occupied Ireland, the Picts sailed over to Britain and began to inhabit the northern parts thereof. In process of time Britain, besides the Britons and the Picts,

received a third nation, the Scots, who migrating from Ireland under their leader Reuda . . . secured to themselves those settlements among the Picts which they still possess. From the name of their commander they are to this day called Dalreudius, for in their language Dal signifies a part." It is added in a footnote: "Hence Dalrieta or Dalreuda may be explained Dal-Ri-Eta, the portion of Reuda or Rieta, *i.e.*, King Eta."

In his De Bello Gallico, L. 5, Cæsar thus writes: "Omnes vero se Britanni vitro inficiunt quod cæruleum efficit colorem atque hoc horridiore in pugna aspectu." We may infer on the authority of Cæsar that the inhabitants of Britain in his time painted themselves with a dye that they extracted from woad. The designation *Picti* or painted men, would thus be applicable to all the tribes of Britain of whom Cæsar had any knowledge. It was about the year 360 A.D., that those who were subsequently known as the *Picts* of Scotland received the distinctive appellation of *Picts* to distinguish them from the Scoti or Scotti. In his Dissertation on the Poems of Ossian, MacPherson contends that it is absurd to suppose, that the name of Picts was given by the Romans to the Caledonians, who possessed the east coast of Scotland, from their painting their bodies. According to MacPherson, "Britons who fled northward from the tyranny of the Romans, introduced painting among the Picts. Owing to that circumstance, it has been held that the Picts were thus designated for the purpose of distinguishing them from the Scots who never had that art among them, as well as from the Britons, who discontinued it after the Roman conquest." The Picts called themselves Cruithne. Their original settlements appear to have been in the Orkneys, the north of Scotland, and the north coast of Ireland or the modern counties of Antrim and Down. A certain writer affirms that the Scots came originally to Ireland, one of whose names from the sixth to the thirteenth century was Scotia. It was called Scotia Major, after part of northern Britain had acquired in the eleventh century the same name. The transfer of the name Scotia to what is now known as Scotland was ultimately due to the rise and progress of the tribe called Dalriad, which migrated from Dalriada in the north of Antrim to Argyll and the isles in the beginning of the sixth century. A difference of opinion obtains as to whether the habit of painting their bodies prevailed among the Scoti of Ireland as well as among the Picts of Scotland. Cruithne or Cruithing involves the root Cruth which signifies form. Cruithneachd, the Gaelic word for wheat can easily be regarded as compounded of *Cruth* form and *sneachd* snow, the word thus signifying etymologically the form or appearance of snow, out of regard, doubtless, to the whiteness of the flour which is extracted from wheat. Professor Rhys, with

apparent correctness, derives Cruithing and Prydd from Cruth and Pryd respectively, which mean form, and as Duald MacFirbis believes, "a people who painted the forms (Crotha) of beasts, birds and fishes on their faces, and not on their faces only, but on the whole of the body."

Scoti was supposed to be identical with Scuit or sguit, a wanderer, and therefore to indicate the erratic life or nomadic life which the Scots pursued. An ingenious etymology has recently been advanced which finds the true explanation of Scoti in the Welsh word ysgwthr, a cutting or carving, and ysgythru, to cut or prune. Examples occur, it is maintained, where the Welsh word means to dye or to paint. If that derivation be adopted, the term Scoti or Scotti would mean painted men, or at least, those who were cut or scarred. The Scoti were largely confined to Antrim and Down in the north of Ireland. The Scoti crossed over from that portion of Ireland, and founded in Argyllshire the Kingdom of Dalriada, Dal Riada, or Righ Fhada. Fergus, the son of Erc, with two of his brothers, led the colony of the Dalriads into Argyllshire and founded the Scottish monarchy there in 503 A.D. His successor was his son, Domangart, who was followed by his son Comgal, the father of Conal that gave the Island of Iona to St. Columba. The Scoti in Dalriada were separated from the northern Picts by Drumalban, the Dorsum Britanniæ. The southern Picts occupied the eastern portion of Scotland from the Firth of Forth towards Aberdeen and the Grampians. The inference can be drawn from the Anglo-Saxon Chronicle that the Picts were warlike and powerful. "In 443 A.D., the Britons sent over the sea to Rome and begged for help against the Picts. In 449 A.D., Vortigern, king of the Britons, gave land to Hengist and Horsa on condition that they should fight against the Picts. In 565 A.D., Columba, a mass priest, came to the Picts and converted them to the faith of Christ. They are dwellers by the northern mountains. And their king gave him the island which is called Ii. In 681 Tumbert was consecrated Bishop of Hexham and Trumwine of the Picts; for at that time they were subject to this country." Columba, himself a descendant of Niall of the nine hostages, was nearly related to the royal family of the Scoti of Dalriada, and was instrumental in placing Ædan, the great-grandson of Fergus Mac Erc, on the throne. These statements are made by Bede in his Ecclesiastical History regarding St. Columba: "In 565, Columba came into Britain to preach the word of God to the provinces of the northern Picts, who are separated from the southern parts by steep and rugged mountains. The southern Picts, who dwell on this side of those mountains, had long before embraced the truth by the preaching of Ninias. Columba came into Britain in the ninth year

of the reign of Bridius, who was the son of Meilochon and the powerful king of the Pictish nation, and he converted that nation to the faith of Christ by his preaching and example; whereupon he also received of them the aforesaid island for a monastery. Now, Columba was the first teacher of Christianity to the Picts beyond the mountains northward and the founder of the monastery in the island Hii which was for a long time much honoured by many tribes of the Scots and Picts." It is said that the dominion of Brude or Bridus extended from the Forth to the extremity of Caithness and the Orkneys. Brude died in 586, having reigned thirty-eight years. His successor Garnard and all the following kings of the Picts were Christians. Columba founded many monasteries in Ireland. He was the teacher of the British Scots and the apostle of the northern Picts. He became the chief ruler both of the Scottish and Pictish church and at the same time exercised great authority in Ireland.

The Book of Deer possesses a unique importance in Gaelic literature. It was discovered and secured by Bishop Moore of Norwich, whose library was presented to the University of Cambridge some hundred and fifty years ago. The Librarian of that University found it in the library, and through him it was brought to the knowledge of the literary world. In addition to its other contents, it has an account of the foundation of the old monastery of Deer. An edition of the Gaelic portions at least of the book has been published by the Spalding Club, under the able supervision of Dr. John Stuart. Whitley Stokes, in his Goidelica, gives a translation of the six Gaelic entries in the book, believing as he does that the philological value of the book lies in the Gaelic portions of it. The first sentence of the entry that narrates how the monastery was founded, is to this effect: "Columcille agus Drostan mac cosgreg adalta tangator ahi marroalseg dia doibh gonic abbordoboir agus bede Cruthnec, robo mormaer buchan araginn agus efse rothidnaig doibh ingattirag sain insaere gobraith o mormaer agus o thosec," *i.e.*, Columcille and Drostan, son of Cosgrach, his pupil, came from Hi (Iona) as God had shown to them, to Aberdeen; and Bede, the Pict, was grand steward (or Mormaor) of Buchan before them, and it was he that gave them that town in freedom for ever from Mormaor and toiseach."

The Gaelic which the Book of Deer contains is unmistakably the Gaelic of the Highlands of Scotland. It is difficult to determine with accuracy where the book in question was written. At any rate, whether it was written in the ninth century or not later than the twelfth century, it must be regarded as setting forth the tradition in reference to the founding of the monastery of Deer. In his elaborate work, *Celtic Scotland*, Skene traces the gradual growth and subsequent power and

importance, of these officials who are mentioned under the appellation of Mormaor or grand steward and toiseach or chieftain. No valid reason is available to dispute the accuracy and consequent reliability of the tradition that St. Columba and Drostan founded the monastery of Deer in the manner which is detailed in the book. The language, though partaking of the peculiarities which attach to all the oldest specimens of Gaelic that are extant, is purely Gaelic, and, as the book purports to give and reproduce the very words of Columba, *e.g.*, "Rolaboir Columcille bedear ainm o huun imace," the inference is plausible enough that Gaelic was the language which Bede, the Pict, and the Picts spoke who resided in that part of Scotland, and with whom, in virtue of his position as Marmaor, he had intimate relationship. Cruithne, the ordinary term which was applied to the Picts in the sixth and subsequent centuries, is in the Book of Deer applied to Bede, the Mormaor, who made a present of the town to Columba. The fact that certain proper names occur in the Gaelic portions of the book, which are not known otherwise in Gaelic nomenclature, does not invalidate the argument which can be deduced in favour of the contention, that the language of the northern Picts, who were contemporary with St. Columba, was Gaelic, identical with the language which the Gaels of Scotland have always spoken. Than Skene, the talented and painstaking author of Celtic Scotland, no one can speak with greater authority in connection with all questions affecting the Picts and Scots. His emphatic language is: "We cannot point to any spoken language in the island which can be held to represent Pictish as a distinctive dialect. The Cruithnigh to the beginning of the seventh century, formed with the Picts of Scotland, one nation. During the whole of their separate existence, the Irish annals do not contain a hint that they spoke a language different from the rest of Ireland."

It is unnecessary to follow the political fortunes of the Dalriads and the Picts, until they were united to form one kingdom under Kenneth MacAlpine in 844. It has been reasonably held, that the union of the Picts and Scots under one sovereign formed an important era in the history of Scotland. The whole of Scotland, north of the Firths of Forth and Clyde, was welded into one kingdom which was never afterwards broken up into separate principalities. The life of the Scottish court flowed on amid many diversities of fortune, and Gaelic continued to be the language of the court until the reign of Malcolm Canmore, who married the Anglo-Saxon Princess Margaret in 1070, and transferred the court and capital from Scone to Dunfermline, thereby terminating the honourable position which the Gaelic language hitherto possessed as the

language of the kings and queens of Scotland. Malcolm had little or no education. He acted as interpreter between Queen Margaret and his Gaelic subjects, seeing that he was able to converse with equal facility in English and in Gaelic. It is with some Gaelic elements of sadness to be admitted, that the reign of Malcolm was in reality the commencement of a revolution in the language and people as well as in the laws and manners of northern Britain. The Albanic Duan is an important relic of Gaelic literature. It is to be found in the Chronicles of the Picts and Scots. It is supposed to have been taken from the MacFirbes MS. in the Royal Irish Academy. It is said to have been sung by the Gaelic bard of the royal house at the coronation of Malcolm Canmore. It narrates in detail the names of those who preceded Malcolm in the kingly office in Albion. It is the oldest and most authentic record of the Scottish kings. Its Gaelic is very similar to that of the Book of Deer. This reference to the Cruithne occurs in it :

Cruithnigh ros gabhsad iarrtam,
Tar ttiachtain a h-Erean mhuigh.
X righ tri fichid righ ran.
Gabhsad diobh an Cruithean chlar.

The Cruithne took it (i.e. the land of Alban) after that
On coming out of Erin of the plain,
Seventy noble kings of them
Took the Cruithnean plaid.

May not the consideration that the Albanic Duan, setting forth as it does the genealogy and names of the kings of Scotland, is written in Gaelic, lead of itself to the strong presumption that all the kings, whose names and lineage are mentioned spoke Gaelic, and that Gaelic was the language of their court and people down to the time of Malcolm Canmore ?

Pictish words survive, that reveal their Gaelic lineage at a glance. Much used to be made of Peanfahel which Bede mentions as being the name of Abercurnig (Abercorn), in the Pictish language.

Peanfahel can readily take on a Gaelic garb, and appear as Ceann â bhalla or the head of the wall. P and c are convertible letters in Gaelic, and so are b and f ; and such being the case, there is no reason whatever for hesitating to regard Peanfahel as a purely Gaelic word. Such Pictish words as Bede, Bred, Brude, Canaul, Cartit, Cruithneach, Ceannaleph, indicate a very close affinity, if not an absolute identity, with the normal Gaelic of Albion. Ceannfota is Ceannfada or long head ; Cinnoch cinic, is Cinneach tribe or nation : Donnel Domhnull is Donald ;

Domelch Domnach is Domhnach, Sunday; Elfin is Alpin Alp fhonn, the country of the hills; Fingean appears, in MacKinnon, MacFhingein. Flocaid, Fodla, Atholl, Atth Fodhla, the ford of Fodhla; Fodhla was an ancient name of Ireland. Loc is laoch, a hero; Mailcun is Maoilchon, the servant of Conn; Nectan appears, in MacNaughton; Onnist and Unnist appear in Aonghas, Angus; Scolofthe appears in Sgalag, a farm-servant. Salen is to be found in Salen, a topographical word in the Island of Mull, Argyllshire, which means Sail fhonn, or the land or place of the salt water. Uven seems to find its counterpart or equivalent in Eoghann, the Gaelic word for Hugh or Evan. Were it possible to discover many more words of an unmistakably Pictish character, it may, with no small assurance, be presumed that they would reveal a much closer similarity to Gaelic than to Welsh, or to any other language whatsoever. Who, then, were the Picts, and what was the language which they spoke? They belonged undoubtedly to the Gaels or Goidels, who were the first among the Celts to come from the Continent of Europe into what is now known as Great Britain and Ireland. There is no evidence that is worthy of any serious consideration, to prove, that they belonged to a later invasion, and that their appearance in Albion is to be traced to a much later date than that of the Gaels and Cymru. Rather it is to be asserted with no feeble certainty, that the Picts of Scotland are to be regarded as the descendants and representatives of the earliest Gaels who entered Albion and who absorbed or incorporated with themselves whatever people, if any, whether Iberian or otherwise, who preceded them in the occupation of Albion during the infantile days of human immigration. The brave Caledonians who, under the leadership of Galgacus, fought against the Romans under Agricola, might with abundant propriety have borne the designation Picts as well as Caledonians. No better etymology can be advanced for Caledonia than Dun nan Gaidheal, or the hill or fortification of the Gaels, a name which is perpetuated in Dunkeld. Scholars from whom better things might, in all reasonableness be expected, have allowed themselves to be confused and led astray by separate names, by means of which, whether with or without reason, a people that was virtually one and the same amid all political vicissitudes, came to be described and recognized at various stages in its history. It is difficult at this distance of time to realize how in the far off days, what are now known as Scotland and Ireland, were peopled by Gaels, who owned the same lineage and who spoke an identical language, and between whom there was a constant inter-communion, as if in very truth they lived in one and the same country. All the evidence that is available, and that can be adduced, goes to prove that the Picts were

Gaels—Gaels in language, Gaels in character, and Gaels in their rightful determination to regard Albion as their ancestral home, and to act on the belief, when they fought and put forth their prowess in the strife of arms, that they were in very truth fighting pro aris et focis. Mr. Nicholson, by his indefatigable labours and by his wonderful success in interpreting the Ogam Inscriptions which are to be found, so far as Scotland is concerned, in localities where the Picts are known to have had their homes in the days of old, has done much, and very much, for which he is entitled to receive the gratitude of Gaels everywhere—to furnish corroborative evidence of a very rare and cogent character that the Picts were Gaels, that Albion was the country of their ancestors, that their language and traditions were purely Gaelic, and that their position among the historical peoples of Great Britain and Ireland, is very honourable, by reason of its very antiquity, is illustrious owing to their being the descendants of the earliest Gaelic occupants of those countries, and is henceforth to be acknowledged as the position of a people that was Gaelic in language, in traditions, in country, and in everything that is characteristic of the Scottish Gael of several centuries ago.

THE FUNCTION OF INDIRECT VISION AND THE USE OF COLOURED AND SMOKED EYE GLASSES.

By A. Kirschmann, Ph. D.

(Read April 24th, 1897).

The proposition that the sensibility of the retina decreases from the *fovea centralis* toward the periphery is still seen now and then in text books on Physiological Optics. This statement shows not only a careless misrepresentation of facts which can be observed in our daily experience, and an entire lack of understanding of the extremely elaborate adaptation of this sense organ to the difficult function which it has to perform, but it also involves a logical error, for those who make such a statement either do not see that the retina has different functions to accomplish, thus requiring a special sensibility in each of these functions, or they assume that if the peripheral retina is less sensitive for one quality of the impressions it must be less sensitive for all. They also seem to assume that the conditions which prevail on the eccentric retina are of the nature of an imperfection, or a less complete development.

The negligent way in which indirect vision has hitherto been treated, even in the most celebrated works on Physiological and Psychological Optics, has borne evil fruit of which I may here give a simple example. In Germany they are about to replace the customary German type with the Roman, on the ground that the latter has simpler forms and can therefore be more easily distinguished. This contention contains the silent assumption that all reading is done by means of direct vision, that is, that all single letters are successively projected on the *fovea centralis*. This, however, is not at all the case, for we do not let the fixation point wander from letter to letter as a child does in its first reader, but the fixation point jumps from word to word, fixing in each a letter at random and seeing all others indirectly. (This circumstance accounts also for the fact that we overlook mistakes in printing so easily, especially when the subject matter is familiar to us). Thus we see that reading does not require direct vision only, but it depends even for the greater part on indirect vision. In fact, with indirect vision alone with a little practice we could manage to read tolerably well, but

with direct vision alone the reading could never exceed a slow spelling of the letters. Hence, if we speak of the use of certain kinds of type we have to ask not only which forms are the most easily recognized when viewed directly, but we have also to examine at what distance from the fixation point they can be recognised. Some rough trials which I made some time ago showed that the Roman capitals with their marked simple geometrical configuration are decidely superior to the peculiarly shaped German capitals. But, on the other hand, the small German letters, although they are more complicated in their forms, seem to be, on account of their marked prominences, and their cornered appendices above and below the line, superior to the Roman letters. The latter are too much rounded and at a short distance from the centre nearly all look alike. Further, in the German letters, the different forms of "s" at the end and at the beginning of root syllables and special combinations for "st" and "sz" give greater variability. It seems to me also, that the repetition of forms in the small Roman letters is too great, "b," "d," "p" and "q" are exactly the same form placed in the four quadrants of rectangular co-ordinates, in a plane.

The above misrepresentations concerning the function of indirect vision have their origin with those Scientists, who in trying to make the results of Science digestible to the public, are inclined to state everything as "explained." As a consequence of this, things which are not understood are very often said to be imperfect. Such has certainly been the case when the "imperfection" and "inferior development" of the eccentric retina are spoken of. Some even go so far as to say that the peripheral retina is undeveloped because of a lack of exercise of its activities. Those holding this view do not see that it is very questionable whether an eye whose retina had not the difference between direct and indirect vision would be more serviceable than one which had these differences. I think such an eye would be a very imperfect sense organ, and this is in accordance with the general principle which is observed everywhere in nature—viz: The higher an organism is developed the more the qualitative division of labour is applied in its constituents. In certain cases we seem to find a deviation from this principle in higher organisms, for example, in the fact that we have two eyes; but a closer examination will show that this same principle is fundamental in these cases also. Binocular vision is not for the purpose of securing twice as much light intensity as one eye could give. This is clearly proven by Fechner's paradox experiment, which shows that when one eye sees the full light, the intensity of the sensation is *diminished* when a certain amount is

added from the other eye. Further, the function of Binocular vision is not especially to increase the vision field; it is rather for the purpose of seeing objects from two different standpoints.

The principle of the qualitative division of labour is, however, directly demanded by the general constitution of consciousness. The facts of consciousness at any time are not all equally prominent, for while all sensations present are *perceived*, only a very limited number are *apperceived*, that is, but few are in the "gravitation point" of our attention. Since sensations of sight play the foremost rôle in the presentational side of mental life it is almost imperative that the manifoldness of light impressions given at any moment should conform to this general constitution. We might, therefore, assume *a priori* that a highly developed visual organ cannot have an arrangement of its elements like the facetted eyes of the insects (which are a striking case of quantitative division of labour), but rather an arrangement in which each element is to perform its functions in a way different from the other elements. We may then expect that the central part of the retina will be superior to the peripheral regions in some respects and inferior in others.

Our sense of sight has to apprehend brightness, (light intensity), colour quality, space configuration (shape and size), and changes of the latter, *i.e.*, movement. It is well known that eccentric is far inferior to central vision in the distinction of discrete points and the perception of spacial forms, and also it is known that the manifoldness of colour qualities gradually decreases with the approach to the periphery until a zone is reached in which no colours are perceived at all. It must be noticed, on the other hand, that in the detection of movement, indirect is far superior to direct vision. This is the reason that moving objects so easily draw our attention, even when the objects are small and the movement slow. The most striking case of the superiority of indirect vision, however, is found in its greater sensitiveness to light intensity. In this case indirect vision is physically at a certain disadvantage as compared with direct vision. If we have a number of lights of equal brightness at equal distance from the eye, but in different parts of the vision field, the retina images of them will not be of equal brightness, but will be brighter the nearer they are to the *fovea centralis*, for the light which becomes effective in each case is a pencil of rays whose angular value is measured by the projection of the pupil on the plane which is normal to the incidence, in other words the intensity of the retinal image is proportional to the cosine of the angle of incidence. The more oblique these cones stand in relation to the pupil the less light

they represent. Thus we see that physically considered the eccentric retina receives less light than the central part, and yet we do not notice anything of this deficiency. If we look at a uniformly illuminated surface it does not appear to us as it should according to the optical nature of the retinal image, that is, darker at the edges and brighter in the centre, but it appears uniformly bright. On closer examination it has been shown that the light intensity becomes even a trifle greater toward the periphery. Thus the eccentric retina, as compared with the centre, seems to have a greater sensitiveness to light, which not only makes up for the physical decrease in the brightness of the retinal image, but even over-compensates the latter a little. This over-compensation has been experimentally ascertained by myself for ordinary conditions of illumination,* and in the case of adaptation for the dark by Dr. A. E. Fick.† Now this over-compensation is by no means an accidental affair, as its high proportionate value proves, it certainly serves a certain purpose. Our eye is not only a most accurate optical apparatus, but it is also a motory mechanism of the highest precision. Motion is of the very nature of the eye, and the qualitative division of labour of the different parts of the retina, to which corresponds the gradual differentiation of indirect vision from the fixation point outwards, seems to be established chiefly with regard to these motor functions. As a rule we pay attention to that part of the vision field whose image is projected on the *fovea centralis* and its immediate surroundings. To this fact Wundt has given the name "coincidence of apperception and fixation." This rule, however, is transgressed in every case in which we give our attention to a point in indirect vision, or, in other words, whenever we change the direction of our attention. Whenever a change of light intensity or of space configuration occurs in indirect vision there is a tendency to bring the new impression into the fixation point. This function of the visual organ will be more perfectly carried out the more prompt the peripheral regions of the retina react. Thus the greater sensitiveness of indirect vision will not only foster the efficiency of the motory mechanism of the eye, but it will, so to say, condition it. It is, therefore, the greater sensitiveness of the eccentric regions of the retina for light intensity and movements, which makes the eye respond so readily to even the slightest changes in configuration or brightness occurring in eccentric parts of the vision field.

We, therefore, recognize on the one hand, the superiority of the

*Kirschmann—Die Helligkeits Empfindung in Indirecten—Sehen. Philosophische Studien, Vol. V., p. 417ff.

†A. E. Fick—Studien uber Licht und Farben Empfindungen. Pfluger's Archiv, Vol. 43, p. 441ff.

central retina for the perception of forms and colours, and on the other the superiority of the eccentric retina in sensitiveness to light and to changes in space. These supplement each other to make the eye what it is, and injury to either is equally harmful to the efficiency of the sense of sight. The peripheral retina *must* be more sensitive to light, and if we prevent it from exercising this function we will injure the motory mechanism in the most vital way. Such injuries will be induced by all those artificial optical arrangements which give advantages of any kind to direct vision at the expense of the light intensity offered to indirect vision. All kinds of smoked and blue or otherwise coloured glasses which absorb the rays destined for direct and indirect vision in unequal ratio, must be classed as harmful arrangements of this character This is especially the case with concave glasses which are smoked or coloured throughout. The rays which are transmitted through the centre of these glasses to the central regions of the retina suffer less absorption than those rays which, coming from the side, have to pass through a considerably greater extent of absorbing medium. The indirect vision in this case, is, therefore, at a disadvantage, and its movement-inducing function will be greatly damaged, for the peripheral parts do not get the necessary amount of light to give the characteristic impulses for directing the eye towards the objects concerned. Therefore *concave glasses which are coloured throughout should* NEVER BE USED, *aud the prescription and sale of them should be prohibited.* If, however, correction of the refractive state of the eye, and protection against high intensities are required at the same time, the two conditions should either be met by separate glasses, or, if this be impracticable, the glasses should not be coloured throughout, but should be composed (after the manner of achromatic lenses), of a perfectly colourless concave part of the proper refraction power, and a coloured part with parallel surfaces, having the refractive power zero.

COUNTING AND TIME RECKONING.

By John Thorburn, LL.D.

(Read April 24th, 1897).

N.B.—As some of the letters and characters meant for this paper are not in common use, it has been found necessary to use others approximately like them.

The system adopted by different nations for recording events prior to the introduction of what are generally known as the Arabic numerals varied greatly, and, as might naturally be expected, was in most cases extremely primitive, and not unfrequently complicated, especially when the art of writing was unknown, or but partially practised. Nor can we wonder at this, for in comparatively recent times, we find uncivilized tribes whose knowledge of numbers is so limited that it is difficult to imagine how, except for a very brief period, they can keep trace of past events. The faculty of counting seems to be one of the last to be exercised and developed, and hence we find that, even among nations well advanced in civilization, and with a considerable amount of intellectual advancement, their range of using numbers is comparatively restricted. As has been well said, the power of accurately estimating and correctly expressing any considerable numbers is one of the most striking evidences of civilization, and complications of words in the expression of small amounts must be deemed evidence of great intellectual inferiority.

Sir John Bowring, whose work on the decimal system contains a large amount of curious information, and to whom I am largely indebted for matters relating to this subject, mentions that the method of employing the fingers, hands and feet can be traced in the numerals of many of the aboriginal tribes, both on this continent and elsewhere, and that, owing to the complex and cumbrous character of their languages, they were prevented from extending their numerical calculations beyond a very limited range, and we are not surprised, therefore, when we are told that one of the tribes on the Amazon break down when they come to 3, which they call *paettarrarorincoaroac.* Probably the main reason why, among rude and uncultured nations, so much use is made of the fingers and toes, and why they play so important a part in expressing numbers, is because they are at all times ready at hand and available to make

calculations. Not unfrequently, at the present day, we see persons making use of their fingers in adding numbers. Our word digit, in its Latin signification, as is well known, has both the meaning of finger and of an arithmetical number, and in German *zehen* means both tens and toes, indicative of the fact that, no doubt, the Romans and the ancestors of the Germans at one time made use of this primitive method of counting. Dr. S. R. Riggs in his Dakota Grammar says that the Dakotas use their fingers in making their calculations, bending them down, one after another, as they proceed, till they reach 10, when they turn down a little finger to remind them that one ten has been disposed of, and then commencing again, they go through the same process till they again reach 10, when down goes another finger and so on. When they wish to express 11, they say *wickcemna sanpa wanzidan*, literally "ten more one;" 12 would be *wickcemna sanpa nonpa*, that is "ten more two," and so on till they reach 19, which is *unma napcincoanka*, "the other nine;" 20 is *wickcemna nonpa*, meaning "ten two" or "ten again;" 21, *wickcemna nonpa sanpa wanzidan* $=(10\times 2)+1$. Their mode of expressing the year 1897 would have been: *kektopawinga opawinga sahdogan sanpa wickcemna napcinwanka sanpa sakowin* $=1000+(100\times 8)+(10\times 9)+7$. We are told that, in early times, the native tribes of Australia could only count as far as 3, and when they wanted to express a larger number, they had either to raise their hands or make use of a term meaning "multitude." Dr. Peacock gives examples of similar cases among tribes on this continent. He states that the Betoi, who formerly dwelt on the banks of the Orinoco, used the word *edojojoi* for 1; for 2 their word was *edoi*, signifying "another;" 3 was expressed by *ibutu*, "beyond;" 4 by *ibutu edojojoi*, "beyond one;" 5 was *rumoscoso*, signifying "hand." We are also told of another tribe, who are said to have been able to count as high as 30, but in doing so, they used combinations of the first four numbers, and of the words for hands and feet to express the higher numbers. Thus with them 1, was *petey*; 2, *mocoi*; 3, *inbohassi*; 4, *irundi*; 5, *irundi hae nirai*, that is "four and another," or *ace popetai*, "one hand;" 6, *ace popetei hae petei abe*, "a hand and one besides;" 9, was *ace popetei hae irundi abe*, "a hand and four besides;" 10, *ace pomocoi*, "two hands;" 20, *mbo mbi abe*, "hands and feet besides;" 30, *mbo mbi hae pomocoi abe*, "hands, feet, and two hands besides." It is difficult to imagine how, with such complicated modes of expressing numbers, these nations could have had any intelligible system of chronology. The Dakotas in reckoning time were said to have counted their years by winters, such and such an event having happened so many winters ago. Another peculiarity with them was, when they

wanted to say how long they would be absent, or when a thing would happen, they would say so many nights or sleeps, not so many days—their months being counted by moons. They had the idea that when the moon was full, a large number of mice attacked it, nibbling away at it till the whole was eaten up. When the new moon again made her appearance and became full, the same nibbling process recommenced. Five moons were apportioned by them to the winter, and five to the summer, whereas the spring and autumn had only one each. January had with them a name signifying "the hard moon;" February, that of "the racoon moon;" March, that of "the sore eye moon," and so on. As the twelve lunations did not fill up the year, they would, no doubt, find it difficult to decide what month it was, and probably had heated discussions over the question.

The Kaffirs of South Africa also regulated their years by the moon, and indeed, this was usually the case with all rude and uncivilized nations. They kept count of time by notches cut in pieces of wood, and their recorded dates, we are told, seldom extended beyond one generation, or at most a comparatively limited time. It would seem as if the exchequer tallies, formerly used in England, and which were abolished by 25 George III., were a survival of this ancient practice of assigning numerical values to these scores or notches.

According to Dr. Brinton, the Algonkin nations usually preserved their myths, chronicles and important events by means of marked sticks. The name, it appears, given to these records or tally sticks was among the Crees and Chipeways, *massinahigan*, which is now their common name for book, but it originally meant a piece of wood marked with fire, from the verb *masinakisan*, "I burn a mark on it." In subsequent times, instead of burning marks on sticks, they painted them, drawing figures upon them to which they attached distinguishing conventional meanings. Dr. Brinton further states, that the practice of using such sticks painted or notched was in common use among the Southern tribes of North America, and that the natives of South Carolina transmitted their records by means of bunches of reeds of different lengths, having various distinctive marks which only the initiated could understand.*

We are told by Brantz Mayer, that the Aztecs and other early inhabitants of South America made use of picture writing in recording events which were supposed to have some special interest or importance. The Spaniards, however, when they landed among them ruthlessly destroyed these wherever found, looking upon them "as symbols

* "The Lenape and their Legends," by Dr. Brinton.

of a pestilent superstition." This we are told was done with the sanction and under the direction of Zumaraga, the first Archbishop of Mexico, who doubtless considered them as devices of the evil one, and thought that, by consigning them to the flames, he was doing good service to the cause of religion. It is greatly to be regretted that these interesting records had not been carefully collected and preserved, as they would no doubt have thrown much light upon the history of those early times among that interesting people. Fortunately, however, a number of them escaped the general destruction, and were deposited in several of the European Libraries.

According to Mr. Murdock in his notes on counting and measuring among the Eskimo, they must find it difficult to keep track of time. They are not in the habit, we are told, of using numbers above 5. 6 and all higher numbers are called *anadraktuk*, signifying "many." When they wish to express 6, they say "five and once on the next hand;" 7 is "twice on the next;" 9 is *kodlin oteila*, probably meaning "that which is not ten," (ten being *kodlin*, signifying "the upper part," referring to the digits on the hand). They reckon the year by moons, commencing with the first one after the freezing over of the Elson Bay, when the women begin to sew deer skins. This first one is called *Shud-le-wing* "the time for working." Their third one, which nearly corresponds with December, is called *Kai-wig-win*, "the time for dancing." When anything has taken place more than four or five years before, they are in the habit of saying *aipani*, that is "in the other" (time). From this it will be seen, as Mr. Murdock justly remarks, the expressions used by them for past time are too vague to make it possible to learn the date of any event in their history. So far as I can learn, our Indians in the Northwest, prior to their coming in contact with the whites, were in an equally benighted condition, having had no system whatever for recording past events, except what they were able to retain in their memory, and that could only be for a comparatively limited period.

The ancient Peruvians had a curious method of recording events by knotting strings, or as they were called *Quipos*, meaning cords. 1, was represented by one knot on a thread; 2, by putting the end of the thread through a second time, making what we would call a double knot; 3, was expressed by a treble knot; 4, by a certain kind of loop; 5, by the same kind of loop with an additional twist; 6, had a second twist given to the loop, and so on, by some new contrivance in the process, till 100 is reached, a new knot being used at every third numeral, the two following ones being expressed by additions at the

clinch, or part where the whole is tightened. As may be easily imagined, before this happened, the knots became extremely complicated. It was the duty of persons in every province called *Quipucamayus*, or keepers of the historical *Quipos*, to preserve by these string records the memory of public events, and there were public buildings filled with these threads.* According to Dr. Brinton this method of recording events and of counting and distinguishing their sheep is still in use around Lake Titicaca, the sex and other characteristics being indicated by different colours.†

Dr. Peacock gives an interesting account of how time is recorded by means of Mexican hieroglyphics. He says that they had only distinct characters for 1, 20, 400 and 8,000, yet by a peculiar process of combination they were able to express any number. 1, was represented by a small circle; 20, by a standard shaped as a parallelogram; 400 by a feather, and 8000 by a purse, supposed to contain the same number of grains of cocoa. By dividing the parallelogram or hieroglyphic for 20 into four squares, and giving each a separate colour, they were able to represent 5, 10, 15, and by taking half a feather they could express 200. Their usual method, however, of representing the units from 1 to 19 was by so many small circles, and I believe they had other and more direct ways of expressing their numerals. By the system referred to above, the year 1897 would be given thus:—

The Assyrians and other Eastern nations which used cuneiform characters expressed their numbers from 1 to 9 by upright strokes, thus, 1, by ^{I}; 2, by ^{II}; 3, by ^{III}; 4, by $^{III}_{I}$; 5, by $^{III}_{II}$, and so on. 10 was expressed by ‹; 11, by ‹^{I}; 12, by ‹^{II}, 20, by ‹‹; 50 was $^{‹‹‹}_{‹‹}$; 100 was ‹^{I}–; 1,000, ‹‹^{I}–; the year 1897 would be thus expressed

$$\underset{18}{<^{IIII}_{IIII}} \quad \underset{100}{<^{I}-} \quad \underset{90}{^{‹‹‹‹‹}_{‹‹‹‹}} \quad \underset{7}{^{IIII}_{III}}$$

Probably the simplest way of writing numbers is well seen in Babylonian inscriptions, where from 1 to 99 are obtained by a repetition of the vertical arrowhead $^{I}_{V}$ = 1, and a barbed sign ◁ = 10. When a smaller number was put to the right of the sign for 100 ($^{I}_{V}$–), it was added and, what seems singular to us, when it is put to the left, it gives the number of hundreds. Thus $^{I}_{V}$ – ◁ = 110, but ◁ $^{I}_{V}$ – = 1000.

Among the peculiarities in the notation of the Ancient Egyptians may be mentioned the following, that whereas the hieroglyphic characters were written from left to right, in the hieratic, or more modern

* See "Westminster Review" vol. ix. 1820.

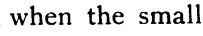
† Dr. Brinton, in "Science," January 24, 1896.

form, they were written from right to left. In the hieroglyphics, the units were represented by upright strokes from 1 to 9; 10, by the character ∩, like an inverted u; hundreds by ; thousands by , and so on. Thus, 1897 would have been expressed by . They are said to have regulated their year by the changes of the seasons without reference to the changes of the moon. It contained 365 days, divided into twelve months, but they appear to have found a difficulty in disposing of the five supplementary days at the end of the year. This is not at all to be wondered at.

In more modern times, the Mayas or ancient inhabitants of Yucatan whose system of recording events, as shown by Dr. Brinton, was very complicated, commencing their year on July 16th, divided it into 18 months or moons, of 20 days each, making only 360 days. Their year, however, was 365 days; so to harmonize this discrepancy, they allowed five days, which were called "days of pain or peril" to intervene between the last month and first of the next year, which were not counted. Other South American tribes were troubled with the same difficulty. In the annals of the Cakchequels, it is shown that their year began on the 11th or 12th of February, that it was not measured by lunar months, as was the case with hunting tribes, but it was a solar year, consisting of 20 months of 18 days each. This deficiency of five days, for there were 365 days in their year, was called "days of evil or days of fault." The Mexicans in getting over a similar difficulty used a term signifying "insufficient." *

The Greeks originally expressed their numbers by using the first letters of words. Thus, 1, expressed one, being the initial letter of ἷος, the Epic form of εἷς, which signifies one; π, five, from πέντε; Δ, ten, from Δέκα; H, 100, from Ἑκατόν; X, 1,000, from Χίλιοι; M, 10,000, from Μύριοι; with a Δ in its bosom thus: |Δ| was 50; with H, it was 500. All the Greek inscriptions, prior to the time of Alexander, expressed the numbers by the initial letters of words. Subsequent to this, their dates appear to have been expressed by the letters of the alphabet used as symbols. This was also the case with the Hebrew alphabet. In the notation of both these languages, the letters were taken and used mainly in their alphabetical order, and in many respects resemble and closely correspond to each other. By the Greeks, the year 1897 would be expressed, thus, ,αωϞζ. By placing an iota under a letter, as will be seen from the example given, its value is increased one thousand fold; by putting the letter M under it the value is increased ten thousand fold; for these letters, however, single or double dots were substituted as more convenient.

* Dr. Brinton on "The Maya Chronicles."

Probably the most familiar use of letters, as numerals, was found as practised by the Romans. With them C, which was the initial letter for Centum, stood for 100, and M from Mille represented 1,000. There seem, however, to have been older forms in use instead of these. Thus, a circle divided vertically (|) stood for 1,000, and horizontally ⊖ for 100. From the sign for 1,000, disparted thus, (|), still occasionally found in prints, comes D for 500. Another symbol used by them for 100 was Ⅼ which has been suggested as the mode of cancelling ten X's, just as X, in the same manner, may have been the way the ten upright strokes for ten were cancelled, thus,  . The bi-section of this symbol for 100 (Ⅼ) gives Γ, or L for 50, and of X, V for 5. Further improvements in course of time were introduced ; IV being used for IIII ; IX instead of VIIII ; XL for 40 ; CD for 400 ; CM for 900, etc. Here, as will be seen, when the smaller number is placed in front, it has a subtractive force ; when placed behind the larger it has an additive force. By the multiplication of the symbol for 1,000 (C|Ↄ), we get CC|ↃↃ = 10,000 ; CCC|ↃↃↃ = 100,000, and the bi-section of these, |ↃↃ = 5,000, and |ↃↃↃ = 50,000. In a Clavis Homerica which I have, the date of publication is given thus, C|Ↄ |Ↄ CIV, being 1604. On the 11th May, 1850, an inscription on a brass plate inserted in the foundation stone of New College, London, has this date C|Ↄ DCCCL.

The introduction of the Arabic numbers worked a marvellous revolution in the modern systems of notation. It is now generally agreed that they were of Indian origin and not Arabic, and were invented by the Brahmins some time before the Christian Era. The Arabs themselves lay no claim to the honour of having invented them, but ascribe them to the Hindoos, while we are told that the Hindoos ascribe the invention of the nine digits (*anca*) to the beneficent Creator of the universe. They were probably first introduced into Europe in the 10th or 11th Century, but it was long before their use was sufficiently appreciated. In manuscripts of the 14th Century, these "new numerals" (called *Gobar*), seem to have been only partially understood, as we find Roman and Arabic numerals hopelessly mixed together, nor was the value of zero (0) at that time known. Thus, we have X, X1, X2, X3, etc., for 10, 11, 12, 13, and we find in regular sequence XXX, XXX1, 302, 303, for 30, 31, 32, 33. We come across also such combinations as X4 for 14, and MD58 (1558), and MDX47 (1647). The first calendar in the English language in which the Arabic numbers are used has the date 1431. The first English book which bears its date in the Arabic numerals was printed in 1478. We find also a curious practice of dividing 8 so as to

make 4, which seems unaccountable, as both were equally well known. Thus, on a calendar on vellum, we have the date in this form ıϱΛ2, (1472), and on a seal the date is ıϱϱϱ (1484). These, and other peculiarities which might be given in the use of these "new numbers," show that our forefathers, in these early times, were very human, and were somewhat careless and, possibly, somewhat blameworthy in mixing things up in this way.

I may here state, that what led me to think of writing this paper was the fact that, in consulting a number of old documents I brought with me from Scotland, I found dates given which were different from any I had ever seen. These documents consist of charters, receipts, bonds, leases, instruments of sasine, etc. Some of them are in Latin, others are in Scotch as then used, which presents many peculiarities to a modern reader in spelling, contractions and form of letters now obsolete. What, however, particularly struck me was the way in which the centuries were given. The cabalistic letters used puzzled me. I consulted books on palæography, but these at first, so far as I could make out, afforded no help. Fortunately, however, I found the key in some of the receipts which contained the peculiar method referred to, as well as the modern way of expressing dates. For example, the date in the body of one of the receipts showed that rent was paid for the year Jajbi℔ eighte sex yeres, that is 1686, whereas, "thes pts, (presents) were rend (rendered) and subt, (subscribed) 1687. In another document, signed by the Earl of Wigton, the date is given thus, Jajbıᶜ threscoir yeirs, corresponding to 1660.

In a *carta confirmationis*, signed also by the Earl of Wigton, the date in the body of the document, 1673, is given in the common Latin form, thus: *millessimo sexcentessimo septingentessimo tertio.* Whereas, in the endorsation, it is given in the modern form 1673. In an instrument of sasine, the date 1640, is given Jajbi℔ fourte yeires. In a receipt, both Jajbi℔ nyntie and 1691 are found; the former for what the receipt was given, the latter when the money was paid. In a lease, or as it was called in Scotland a "tack," the date is given Jajbij℔ and fiftie five, that is 1755. In another tack, 1774 is expressed by Mvij℔ and seventy four. In the two following dates 1709 and 1710, it will be noticed that there is a deviation from the ordinary method; the former being Jajbııᶜ℔ nine; the latter Jajbııᶜ℔ ten. Here c as well as that peculiar character (℔) are both used. At this early period in Scotland, it does not appear that there was any well-established system of writing dates. Sometimes, as has been shown, they are given in Arabic numbers, at other times in Latin, again in Roman characters, and most

frequently in the quaint form now under consideration. I have not met with this last class of dates after the close of the 18th century. The last one I have in my possession is 1799. It is an instrument of sasine, and what is rather singular, the body of the document is written in English; it is certified in Latin by Joannes Wilson, clericus, and the certificate of registration is in English, signed by John Boyes, Jr., "fifth day of April Mvij℔ and ninety nine years." I have corresponded with a number of gentlemen regarding the meaning of these letters, but I find there is quite a diversity of opinion, no two of them agreeing in all respects. An Edinburgh gentleman, who is an expert in deciphering old manuscripts, says that taking Jajvij℔ for 1700, the first three letters a rea corruption of the original Runic form of M = 1,000, then the vij, or as it is given in most of these old writings bij, is 7, and the twirl at the end is a C for centum. Not having a sufficient knowledge of Runic characters, I am not disposed to dogmatize, but I have very grave doubts as to the correctness of this explanation, and I think other evidence will show that I am justified in making this statement. In a letter received from Dr. Dickson, who has only recently retired from the Registry House in Edinburgh, and who is a recognized authority in matters of this kind, he says:—"Your question is one that is very often asked, and yet I do not remember to have seen it explained in any book; of the explanations you suggest, the second is substantially correct. The number 1,000 written ȷ̇ᵐ was by a slight change in the form of the ᵐ written ȷ̇ʲ. Ignorance then interposed and put a dot over the last stroke of ʲ, and closing up the first part of it, made the whole jaj; bijᶜ is simply vijᶜ, with an unmeaning terminal flourish (℔), common in the 17th and 18th centuries." He further states that these letters are constantly heard used in law offices, read phonetically. With all due deference to Dr. Dickson's superior knowledge of matters of this kind, unless I have misunderstood his statement, I feel disposed to question the sufficiency of his explanation, as he makes no reference to the origin of the first letter (j), and for the following reasons:—In palæographic writings of the 17th and 18th centuries the m is written thus ᵐ, without the j preceding it, and by the change suggested by Dr. Dickson, when writers did not know its origin, it might readily become aj. In confirmation of this view, subsequent to receiving Dr. Dickson's letter, I found in the Scottish National Manuscripts, a copy of which is in the Toronto Public Library, a copy of the oath taken by William and Mary on their acceptance of the crown of Scotland, concluding as follows:—"Signed by us at Whitehall the eleventh day of May jajbi℔ four score nyne years." WILLIAM R. MARY R.

In the accompanying printed form of the above, 1689, the date when the oath was taken is given thus j^{m}vi^{c}, etc. I also found other examples of this in the *Acta Parliamentorum Caroli 1*, (the Acts of the Parliament of Charles I.). Here is one act in favour of Dame Margaret Graham: "at Edinburgh the ffirst day of ffebruar the yeir of God Jmvjc';" another on page 65 is given thus: "Band to the gñal (general) of Artellierie. Forasmeikle as the commissioneris of the comoun burdens by this their act of the date the nynteenth of August Jmvic' fourtie twa yeers," etc. From this it would appear that the j is merely meant for the number 1. This view appears to me to be confirmed by the dates previously given, viz.:—Mvij^{c} and ninetynine years for 1799, and Mvij^{c} and seventy four years for 1774. In a communication from Bernard Quaritch, bookseller, London, I find that he holds this view.

What are we to say about the twirl (^{c}) at the end? Is it meant as the Edinburgh expert says for C, the initial letter of centum a hundred, or is it as Dr. Dickson calls it "an unmeaning terminal flourish?" It would appear from the large majority of cases where this flourish is not associated with C, that probably it was meant to take the place of C, and where it is found coming after C, it may be used, as has been suggested, to prevent further addition or the altering of the date.

In the history of "Biggar and the House of Fleming" there is an inventory of silver work and garments and other things which belonged to Dame Elizabeth Ross, Lady Fleming, and signed by her brother-in-law John Earl of Athol, in 1578, which ends as follows:—"We Johne Erle of Athole, Chancellor of Scotland, etc., Scrivit w^{t}o^{r} hand in Edinburgh ye XXVIII day of october the zeir of God(jav&^{c}) thre scoir auchtene zeiris, Erll of Atholl." If this is a correct transcription, it will be seen that there is a difference between it and the other dates previously referred to, the j, which should follow *a*, is wanting and the position of the C is changed. The terminal flourish after the v is also different from the one (^{c}) generally found used, and for these reasons, I confess that I can suggest no explanation except that a mistake was made in transcribing the date.

It is interesting to know that a similar mode of expressing dates was used by the French in the seventeenth and eighteenth centuries. Thus I find that in the "Judgments et Deliberations du Conseil Souverain de la Nouvelle France," 1675 is given gbic soixante quinze, and 1700 gbiic. In this publication, Monday, February 1st, 1700, has gbiic for the last time; in the subsequent dates the modern method is used. The g

here is seemingly only a modified form of ℳ = m. I am not aware that any other country besides Scotland and France has adopted this method of expressing dates, and as to which of these two belongs the credit of having originated this composite form of chronology, it is probably impossible at this late date to decide. In the history of "Biggar and the House of Fleming," there is a curious protest of Robert Fleming against the sentence of death and forfeiture which had been pronounced against his father, Sir Malcolm, written partly in Latin and partly in vernacular Scotch of the time, where the date of 1440 is thus given, M^mo CCCC^mo and fourty zeris. Mons. Silvestre, in his work on "Universal Palæography," mentions that Agnes Sorel who received gifts from Charles VII., gives a receipt as follows:—le XVIII^me jour d'Avril l'an mil cccc quarante huit, that is 1448; the sum received is given thus, ij^c LXXV, l.t. (deux cens soixante quinze livres tournois), and on the tomb containing her remains, the date is le IX jour de fevrier, l'an de grace MCCCC, XLIX (1449).

In the National MSS. of Scotland, there is a Gaelic contract with the date 1614 given in a very peculiar way and probably is unique. It is as follows:—Mil 6. c. ⸗. 4. X. It will be seen that the 4 coming before X contravenes the established usage, as a smaller number preceding a larger one usually lessens the larger one. The character ⸗ is probably a modified form of &, "and."

Sir John Bowring gives some curious examples of how the reform of the Calendar in 1700 was recorded on many medals struck at the time. One has Gere*C*htes *L*oboper *D*enk *M*ah*L*, "The record of merited gratitude;" the larger letters used giving the date thus, MDCLL; another: Geen*D*erten *C*a*L*en*D*ers *D*enkzah*L*. "In remembrance of the reformation of the Calendar, DDDCLL." One has Hoert doch, wunder! Im Jahr MDCC. wusten de leuthe nicht wie alt sie waren. "Listen to a wonder, in the year 1700 people did not know how old they were." The taking by the Spaniards of Ostend in 1704 is thus commemorated in Latin:—*I*tane F*L*an*Dr*I*a*M* *LI*beras *I*ber, the large letters giving the date MDLLIIII. "Is it thus Spaniard that thou freest Flanders." Another celebrating the peace of 1678 has:—*A* *DoMI*no *Ven*I*ens* pop*VLI*s pa*X* *L*aeta ref*VL*get $\left(\frac{\text{MDLL}}{1600}, \frac{\text{LXVV}}{70}, \frac{\text{VIII}}{8}\right)$ translated thus:—"Peace, which is the gift of heaven brings gladness to the people." These are what are called chronograms, a fanciful device used by the later Romans and subsequently introduced during the renaissance period where the larger letters formed the inscription. The following is constructed from the name of the Duke of Buckingham who was assassinated by Felton at Portsmouth:—Georg*IV*s *DVX* B*VC*k*I*nga*MI*aê, date $\frac{\text{MDC}}{1600}, \frac{\text{XVV}}{20}, \frac{\text{VIII}}{8}$, 1628.

The following are added to show what a diversity there was in former ages in recording dates:—VICLXXXIIII = 684; M^mo. CCCC^mo. = 1400; MCCCCVIII = 1408; mil trois cens XXXViij = 1338; L'an de grace MCCCCXLIX = 1449. The following curious advertisement is taken from an old Almanac:—" Prognostycacyon of Mayster John Thybault, Medycyner and Astronomer of the Emperyall Majestie of the year of our Lorde God MCCCCCXXXiij (= 1533); comprehending the iiij partes of this yere and of the influence of the mone, of peas and warre, and of the syknesses of this yere, with the constellacions of them that be under the Vij planettes, and the revolucions of kyngs and princes and of the eclipses and comets," d.cccc.LXXXVIIII = 989. Mr. Gladstone's visiting book has an entry made by the Archbishop of Syra and Paros, given thus:— $\frac{17}{30}$ $\frac{29}{\text{Javragh}}$ $\frac{\text{Δεκεμβριαν}}{}$ $\frac{1869.}{1870}$

In a charter signed by Rogers the first Norman King of Sicily, we have the date 1130 given thus, MCtricessimo indic (tione) VIII. Here as will be seen, is introduced a new element, that of indiction, which was a period or cycle of 15 years. It represented the time during which the annual tax on property was paid on the basis of what was its value at the beginning of each quindecennial period. This system began to be used in reckoning time, chiefly by ecclesiastical historians during the middle ages, and its introduction has been attributed to Constantine the Great. Beginning with indiction 1, it went up to indiction 15, when the series began again. Owing to the fact that the indiction commenced with different days in different countries, there have been various indictions used, such as that of Constantinople, calculated from September 1, 312; that of the Imperial or Cæsarian indiction (commonly used in England and France), beginning September 24, 312; another was that of the Roman or pontifical indiction, commencing January 1st (or December 25, when that day was taken as the first day of the year), A.D., 313. The indiction of any year of the Christian era could be found by the following rule:—Add 3 to the year (because A.D. 1 = indiction 4) and divide by 15. If nothing remains the indiction will be 15; if there is a remainder it will be the number of the indiction. Manuscripts during the middle ages were dated in various ways—as for example:—By the year of the Christian era, by the regnal year of the reigning sovereign or pontiff, etc., etc. In England, it was the usual practice to date charters and other legal documents by the saint's day or festival nearest which the deed was executed and the year of the king's reign. A great deal of confusion has arisen, not only as I have said, owing to the different days on which the year commenced, but

also to the fact that in many cases these were changed. Thus, in England and Ireland, from the 6th century to 1066, the new year commenced with December 25th, and sometimes from March 25th. After the Norman conquest to the year 1155, it began with January 1st, and between 1155 and 1751, the new year began again with March 25th. In Scotland, down to the close of 1559, it was reckoned from March 25th, but the year 1600 began with January 1st. It is said that Pope Pius the second, during his pontificate of six years (1458-1464), commenced the year sometimes on December 25th; sometimes on January 1st; and at other times on March 25th. The execution of Charles I, was reckoned to have taken place on January 30th, but while England made it the year 1648, Scotland made it 1649. This was owing to the fact that when he was beheaded, the new year began in England on March 25th, and by the Scots on January 1st. To obviate this confusion, and to concur with the practice which had been adopted by continental nations, an Act of Parliament 24 George 2nd, 1751, was passed regulating the commencement of the year, discontinuing the practice of beginning the legal year on March 25th, and adopting the 1st of January instead.

The Gregorian or reformed calendar, now known as the "New Style" was introduced the same year, whereas in most Roman Catholic countries it had been adopted in 1582, and in Protestant countries it was generally adopted to begin in the year 1700. England, then as now, showed her conservative spirit by postponing it till 1751. In countries under the Greek church the old style of the Julian Calendar is still in use. In England, as we have seen, the new year began in 1752, on January 1st, and continued to December 31st, but was reduced by 11 days in the month of September, by calling the day after the 2nd the 14th. We are told that when this took place, the work people paraded the streets demanding back the 11 lost days which had been taken from them.

LATE FORMATIONS AND GREAT CHANGES OF LEVEL IN JAMAICA.

By J. W. Spencer, M.A., Ph.D.

(Read February 5th, 1898).

CONTENTS.

INTRODUCTION.

This paper has for its object the special study of erosion features and the character of the later geological formations of Jamaica, and the characteristics of the adjacent seas which throw additional light upon the great changes of level of the region. The investigation refers only to the insular region, and is a sequel to the "Geological Evolution of Cuba," and "the Reconstruction of the Antillean Continent," wherein there has been collected evidence of the great changes of level of land and sea in recent geological times, producing mutations of the physical geography of a large portion of the American continent, the consequent changes in climate and the effects on the distribution of life. This paper is mostly descriptive, and strongly confirms the doctrines set forth in the earlier papers.

GENERAL TOPOGRAPHY.

Jamaica is 135 miles long with a maximum breadth of 50 miles, but with slightly submerged banks increasing its width to 60 miles (Map,

page 328). Physical maps show a mass of mountains intersected by narrow valleys. This is true in a general way, yet structurally or geomorphically, it is a plateau between 1,000 to 2,000 feet above the sea. Some deep valleys almost cross the island and are reduced to gentle gradients (Fig. 1, Plate I.), even before leaving the mountain masses. The margins of the table-lands are usually steep mountain slopes dissected by deep valleys. In the interior, the elevated valleys are often broad or form the savannas which appear to be the remains of former base levels of erosion, not yet reduced to the modern plane of denudation. The dissection of the margins of the higher land is progressing rapidly with the warm tropical rain which sometimes amounts to ten inches a day,* and the gradients of the streams are such that the widening of the valleys is no more rapid than the deepening of the ravines. On the table-lands, many of the ridges are only the remains of the former plains, but in the centre of the western two-thirds of the island there are mountains 3,000 feet high.

The eastern third of Jamaica is characterized by a mountain mass of much higher altitude than the plateaus of the western two-thirds of the island; and it culminates in Blue Mountain which rises to 7,335 feet above the sea. The rapid deepening of these valleys descending from this high mass may be considered as gigantic washouts a thousand feet deep; and these are sometimes situated so close together that their summit divides are scarcely more than knife edges (Fig. 2, Plate I.). Still it is remarkable to observe the human occupation and cultivation of sloping hillsides as steep as it is possible for the earth to hold to.

In front of the coastal range of mountains on the northern side of the island, which rise from 1,000 to 2,000 feet, the plains are almost wanting, excepting at the mouths of the valleys (see Fig. 1, Plate II., page 335). On the southern side of Jamaica, the coastal plains may have a breadth of four or eight miles in some embayments indenting the plateau region (see Fig. 4, page 337). These plains may rise from 100 to 600 feet before abutting against the mountain ridges.

In Jamaica there are the remains of three conspicuous old base planes of denudation which give rise to the features of the island as shown in Figure 1. In some cases the lower plains approach the structure of terraces, while those of the higher elevations are often only represented by successions of ridges or remnants of eroded surfaces of the same altitude. As the streams leave the highlands, they usually flow through

*At Port Antonio situated upon the northern side of the Blue Mountain mass, which locally condenses the moisture from the north-east trade winds, thirty-two inches of rain fell within three days, in December, 1894.

FIGURE 1.—The broader portions of Wagwater Valley almost reduced to the base level of Erosion.

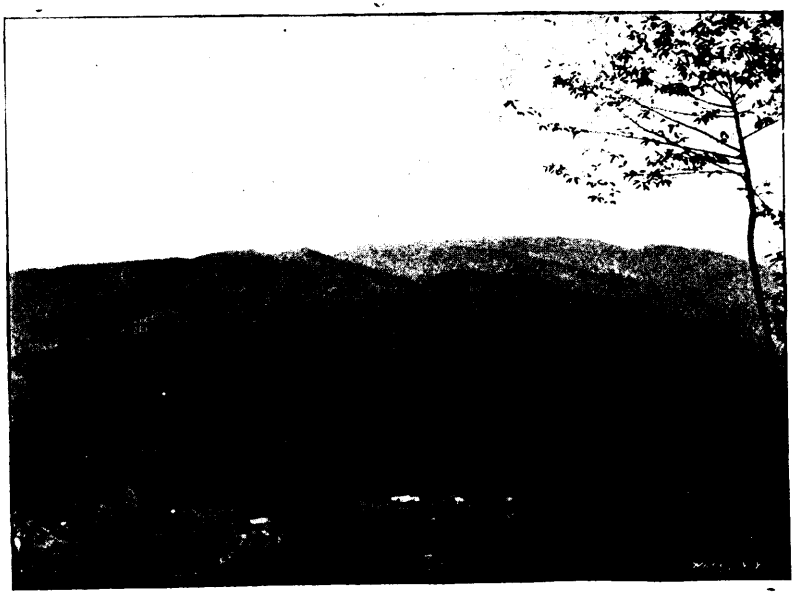


FIGURE 2.—Upper part of Wagwater Valley, showing the mountains dissected by deep washouts. The broad floor of the valley has almost reached the base level.

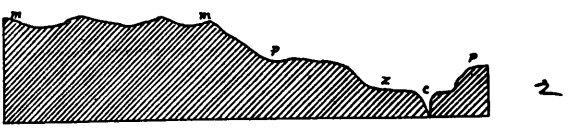


FIGURE 1.—Section illustrating a succession of base levels of erosion :—*m m*, an old plain now represented by only fragments of plains and ridges of similar elevation ; *p p*, a newer base level less defaced ; *z*, a later plain only incised by a *canyon* (*c*) of a stream cut since last elevation of the district.

canyons a mile or two in length which have been excavated since the last elevation of the island. The different phases of erosion will be further considered in connection with the characters bearing upon this physical investigation.

HYDROGRAPHY OFF THE COAST.

The northern side of the insular mass of Jamaica descends as abruptly beneath tide level as the mountains drop down to the sea. With a few exceptions the sea bottom increases to a depth of 600 feet within the distance of a mile from the shore, so that even the delta deposits cover small areas and have not filled the broader bays formed by the washings of the coastal regions when the land stood at higher altitudes than now. From the mouths of existing rivers (while some have changed their courses), channels though sometimes partly obstructed can be traced across the submerged shelf of the island, whether of coral reefs or of mechanical deposits. Even where the insular fringe is not covered with more than from 50 to 250 feet of water, the transverse trenches or *canyons* may be 600 or 700 feet deep. The descent of these submerged channels has a similar slope to that of the valleys which may reach to 500 or even 1,000 feet in a mile. The same narrow fringe extends around both the eastern and western ends of the island, but it becomes broadened to eight or ten miles upon the southern side of Jamaica.

A few examples of the deep channels crossing the insular fringe may be given :—Thus the submerged channel of Plantain Garden river has a depth of 612 feet at a mile from the shore, where the adjacent shelf is covered with only 156 feet of water ; so also at the mouths of the streams entering Hope, Buff, Falmouth, Montego, Lucea, Port Morant, and Morant bays, channels over 600 feet can be traced across the submerged fringe. Beyond that depth the successions of soundings have not been made by which the trenches can be followed to the deep sea of 12,000 feet and more to the north of the island.

Annatto is one of the widest bays along the northern coast, with a breadth of four miles between the outer headlands. Into this indenta-

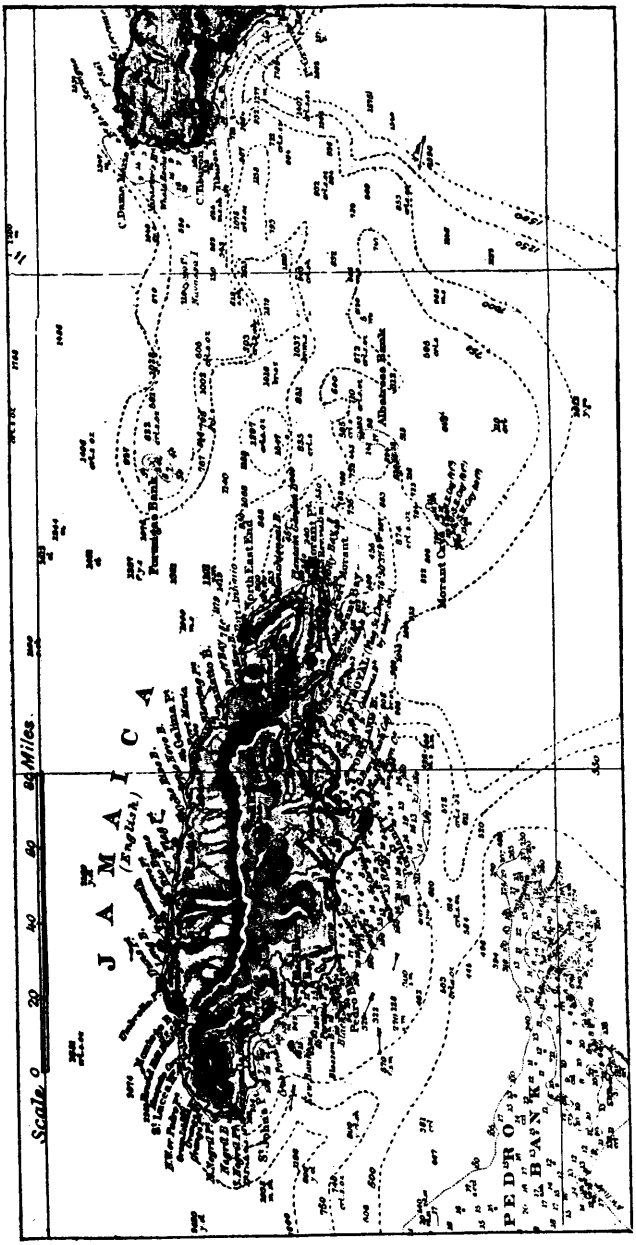


FIG. 2.—Map of Jamaica and adjacent sea, showing the adjacent submarine plateau dissected by deep Valleys. Sounding in fathoms of six feet. (From Hydrographic Office Chart).

tion the Wag Water, perhaps the largest river of the island, discharges, and during floods it carries great quantities of silt, yet the bay is not filled up, and at only a mile from its head, the channel is 624 feet deep. Dry Harbour is another kind of basin, only a mile across (and surrounded by an amphitheatre of hills), having a depth of 204 feet with the outlet now obstructed by a bar covered with less than 18 feet of water. These short, deep bays are like the valleys forming the amphitheatre indenting the margins of the table-lands of Mexico and other plateau regions (also illustrated in Fig. 2, Plate II., opposite page 335).

The broad shelf upon the southern side of Jamaica is only a continuation of the sloping coastal plains. It has a breadth reaching eight or ten miles from the shore, and it is covered with from a few to nearly a hundred feet of water. This submerged plateau appears to have extended from the end of the Blue Mountain chain, in St. Davids, across the Kingston embayment and thence to the mountains beyond Savanna la Mar. However, the two ends of the submarine shelf have almost disappeared, but there are outlying remains of it preserved in the banks or shoals. Thus the water, at less than a mile from the shore in the Kingston embayment, is over 600 feet deep, and at three miles 2,300 feet, but increasing so that at ten miles, opposite to the California bank, the depth of water is 4,662 feet (see Map, page 328, and Fig. 4, page 337). The Savanna la Mar embayment, at the western end of the shelf, had a depth of 1,974 feet near the shore, and 2,010 at the mouth opposite to the bank eight miles distant. Both of these embayments are submerged reproductions of the broader valleys, indenting the table-land of the southern side of the island, which are covered with the later alluvial deposits.

Across the shallow banks the channels of the rivers can be traced.

Unlike the Honduras sea, upon the northern side of Jamaica, which rapidly descends to abysmal depths, the Caribbean sea to the south deepens gradually for many leagues; consequently there are no drowned valleys near the insular mass deeper than 5,000 feet. Extending south-westward from Jamaica, there is a broad plateau reaching to the Pedro bank which is covered with from 3,000 to 4,000 feet of water. From the north-western side of this plateau there is a deep channel of 7,128 feet, or 2,400 feet below the platform, beyond which the Honduras sea reaches to abysmal depths (see Map, Fig. 2, page 328), of 15,000 feet. Pedro bank is again connected with the banks extending to the Honduras coast by a broad plateau now drowned beneath 3,000 feet of water.

A similar plateau connects Jamaica with Haiti. This is generally submerged to a depth of 5,000 feet. However, it is dissected with channels reaching down to 7,000 feet, and there are small basins probably connected, so as to form a channel extending to a depth of over 9,600, or more than 5,000 feet below the surface of the drowned plateau (see Map, page 328).

While the soundings are very numerous in many localities, they have not been made in directions for discovering the valley-like channels; nevertheless, many have been more or less revealed, but for the fuller exposition, the soundings should often be taken along other lines and closer together. In off-coast soundings, while the depths are accurately determinable, there may be errors of locations on the charts of two or four miles which may give rise to the impression of the occurrence of deep holes, where there is no reason for other depressions than portions of channels. However there are very few of these small basins suggested within the Antillean plateau.

GEOLOGICAL BASEMENT OF JAMAICA.

The stratigraphy and older geology of Jamaica have been partially described by the former geologists of the island,* so that only a few of the characteristics which have produced effects upon the later geomorphy need be considered.

The nucleus of the island, as may be seen in the higher mountains, consists of some metamorphic shales and igneous rocks of a syenitic, dioritic, and porphyritic nature which are usually decayed and covered with very deep soil. Round these accumulations, compact Cretaceous limestones succeeded by Cretaceous sands and marls occur in narrow belts. The igneous rocks are however younger than the Cretaceous series, for dykes of them cut into this formation. The easy atmospheric degradation of these rocks covered with loose soil suggests the comparatively recent great elevation of the higher mountains, thus favouring the uncovering of the older formations. These formations are next succeeded by a great thickness of what the Jamaican geologists called "Lower Tertiary or Conglomerate Series," consisting of sandstones, grits, shales and massive conglomerates. Whether this series be entirely Tertiary, or partly older, is immaterial in this study, for we shall not attempt to reconstruct the geography of that date, or to determine the sources whence the fragments of the crystalline rocks and mechanical deposits of the island came.

*Geology of Jamaica, pp. 1-339, 1869. By James Sawkins, J. P. Wall, Lucas Barrett, Arthur Lennox, C. B. Brown, and Robert Etheridge.

The succeeding "Yellow Limestone Formation" consists of yellow sands, and marls with layers of limestone. In the middle part of the series, the marls are replaced by Orbitoidal limestones. This formation has been classed as of Miocene age, but the presence of Orbitoides correlates it with the Eocene of the northern continent. Moreover, at the base of the overlying "White Limestone," fossils have been collected belonging to the Eocene period. Above the Orbitoides bed, the marls contain numerous foraminifera, as seen at Folly's Point just east of Port Antonio, and may indicate a deep water origin.

Remnants of marls rich in Pteropod remains were found at two or three localities upon the north-eastern coast of Jamaica up to an altitude of 300 feet. The Pteropod marls indicate moderately deep water origin. They are among the highly disturbed strata, apparently at or near the base of the "White Limestone." They are unimportant in the study of the recent topography.

All the formations thus far referred to are greatly disturbed, and there are several unconformities. The various deposits usually occur in isolated tracts cropping out from beneath the overlying "White Limestones" on account of the enormous denudation of the latter series which even now covers five-eighths of the island.

OLDER MIOCENE HISTORY—"THE WHITE LIMESTONES."

This widespread series is white or light-coloured, impure Tertiary limestone, with some arenaceous and marly beds. The structure varies from thick massive beds to thin layers, sometimes soft and marly, again a fine-grained rock with an earthy appearance, in which some strata are brecciated or flinty. Where not washed off by the tropical rains the residual soil is a red earth similar to the residual products of Tertiary limestones of Cuba, and other West Indian lands. Some of the beds are very much honeycombed and caverns abound in them. This structure becomes so exaggerated on the highlands of the northwestern part of the island, that a large area is rendered uninhabitable, owing to the numerous sinks called "cockpits," two or three hundred feet or more in diameter and deeper than they are wide. The remains of this formation reach a thickness of more than 2,000 feet according to the Jamaican geologists, and occur at altitudes up to 3,000 feet. It is this series which forms the starting point of the present researches.

These limestones cover the larger portion of the western two-thirds of the island, and form the coastal range of mountains which rises abruptly from 1,000 to 2,000 feet above the sea. Indeed, it is probable

that this series once covered even a much larger area than at present. In spite of the great thickness of the limestones, simple or complex valleys from one to five miles wide have been cut through them; and the seaward margins of the highlands have suffered so much denudation that the lower beds of the formation have been exposed even where they dip outward from the plateau. The solvent action of the tropical rains produces a much more rapid degradation of the rocks than occurs in the temperate latitudes. The exaggerated amount of erosion of these limestones is referred to in order to point out the improbability of ever finding the higher beds of the series, though some must have been deposited, and thus the stratigraphical gap in the geological succession is greater than the interval of time which the break represents. Accordingly, as there is only the older portion of the series preserved, it is necessary to look for a somewhat later date in order to determine the period when the land was first raised high enough to suffer denudation. This elevation was the last uplift accompanied by any considerable disturbance of the horizontality of the strata. Indeed, the "White Limestones" have their beds highly tilted and often occur in sharp folds, with occasional faults. This structure is shown in many canyons of the streams crossing the formation. These physical disturbances occurred immediately before the Mio-Pliocene period of denudation.

However characteristic the name, it is confusing, for the term "White Limestones" has been given to different formations on various islands and the continent. The Jamaican geologists were contradictory as to the age of the "White Limestones." However, these strata represent a physical and almost a lithological unit. They have close analogies in Cuba, Santo Domingo and elsewhere, and they are the last great development of limestones in the West Indies, although unconformably succeeded by other accumulations. It is from the physical standpoint that the formation is most important in this study. From the appearance of the contained fossils, the series is doubtless complex, and probably separable into Eocene and lower Miocene or (Oligocene) formations. While in places the Eocene beds may not have been deposited at the base of the great mass of rocks, in other localities the overlying beds have been so removed as to expose the lower formation, but the older Miocene (or Oligocene) beds seem to prevail.

In this geomorphic study, the important feature is that the great denudation of the island was subsequent to the disposition of these older Miocene limestones.

It was the prevailing impression among the Jamaican geologists that

the "White Limestone Formation" was Miocene. In the few cases, where they gave lists of fossils in the local descriptions, their catalogues have been considered by Dr. W. H. Dall to represent the lower Miocene epoch, or what he now calls American equivalent of the Oligocene beds, which occur in Florida and the Southern States. So also in the list of fossils by Mr. Etheridge, he identifies the same formation, but unfortunately the localities were not given. Again, Mr. Charles T. Simpson collected at Bowden, near Port Morant, in the marly beds (probably in the lower part of the series at that locality), about 500 species which Dr. Dall has only partly studied, yet, sufficiently to pronounce them as belonging to what has been usually called Lower Miocene or Oligocene. At that locality the fossiliferous marl bed is only about a foot and a-half thick.

East of the Turtle Crawl Harbour, a few miles from Port Antonio, Mr. Eugene Baker collected a quantity of fossils, and of the same species the writer collected more specimens near the base of the great limestone series. The fossils are entirely in casts, but of these Dr. Dall has determined the following genera, and pronounces them as apparently of Eocene age:—

Xenophora.	Velates.
Turritella.	Conus.
Strombus.	Natica.
Ampullina.	Spondylus.
Turbinella.	Terebellum, two species.

Both the Eocene and (old) Miocene fossils occur in the succession of limestones forming a physical unit. The older Miocene is extensively developed in Santo Domingo as shown by Dr. W. M. Gabb.* In the Windward group, where the rocks have been particularly exposed to erosion, Mr. P. T. Cleve† found fossiliferous Eocene beds at the surface.

From personal studies in Jamaica, Cuba and the Southern States, and from all the information obtainable from other sources, the writer is led to the conclusion that the great denudation of the West Indies and the adjacent regions commenced rather late in the Miocene period and did not culminate until in the Pliocene period, for over a very wide region the same long continued erosion leaves only the older Miocene without any remnants of newer Miocene or older Pliocene or even Mid-Pliocene beds. This same absence of Mio-

*"On the Topography and Geology of Santo Domingo," by William M. Gabb, Trans. Am. Phil. Soc. vol. xv., pp. 49-259, 1872.

†"Outline of the Geology of North-Western India Islands," by P. T. Cleve; Annals, N.Y., Acad. Sc. vol. ii., pp. 185-194, 1882.

Pliocene formations appears to prevail generally in Cuba, in the South Eastern States, and in the Windward Islands, while beds of that period occur on the Tehuantepec Isthmus in Mexico. The degradation was of long duration for the streams reduced their valleys to base levels of erosion far inland on the continent, and their courses were marked by broad valleys. On some of the lands which now form islands, the same is true, for where not entirely removed the limestones often remain only in fragmentary outcrops.

The preservation of the older base levels of erosion, imprinted upon the limestones, shows that the tablelands were not relatively as high as at present, but the question of the late unequal terrestrial movements becomes important in determining the Pliocene area of what are now the islands.

That the time of the elevation commenced somewhat earlier in one locality than in another distantly located, and also ended in the same manner, is probable. Where we find overlying accumulations resting on the limestones, there we can judge of the relative duration and character of the first period of denudation succeeding the early Miocene deposits; but at higher altitudes in Jamaica the period of degradation has continued since the first elevation after the formation of the limestones, consequently the erosion features represent the combined characteristics of successive epochs of denudation.

THE MIO-PLIOCENE HISTORY.

Epoch of Elevation.—The Mio-Pliocene period in Jamaica was characterized by the elevation and dislocation of the "White Limestones" and the subsequent long period of atmospheric degradation of the existing land surfaces followed by a comparatively short one of the formation of new beds of marine accumulations.

The denudation of the old Miocene land surfaces which covered five-eighths of the island, represents the erosion in progress, more or less continuously, since the first elevation of the Miocene strata, whether before or after the middle of the Miocene period. Dr. W. H. Dall informs the writer that he has seen no collection of Miocene fossils from the West Indies which represent beds newer than the lower part of the series (or the Oligocene). In making correlations between the physical features and the fossiliferous strata, whose time divisions are based upon the percentage of living forms only (and without such a break as that on the northern continent, where the older Miocene beds are characterized by a tropical fauna, while the later assemblage of

FIGURE 1.—Mountains south-east of Port Antonio, showing deep valleys dissecting them.

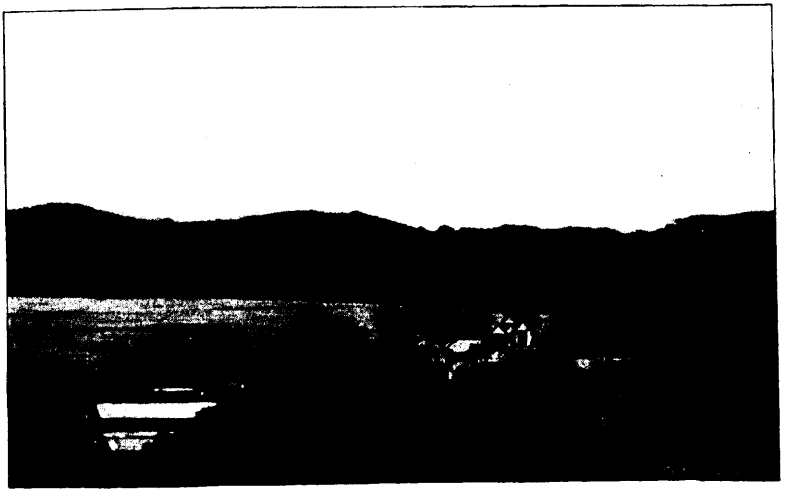


FIGURE 2.—Lucea Bay, a drowned amphitheatre indenting the margin of mountain plateau.

fossils, only occurring further north, belong to temperate waters), the exact epoch of change is not determinable. However, the succession of physical breaks can be established beyond doubt, without impairing the value of the determinations, even if the terrestrial movements commenced a little earlier in one locality than in some other. In the physical history of the West Indies, a wonderful degree of uniformity, over vast regions, characterizes the later geological periods.

As the upper Miocene fauna of the northern continent belonged to temperate, in place of tropical forms of the earlier epoch, some great physical cause must have produced the change, and thus we may suggest that the elevation of the West Indies occurred before the later Miocene period; consequently the great erosion of Jamaica seems to date to an epoch before the Pliocene period. The physical changes in the island were accompanied by great dynamical disturbances, which not only elevated the land but also folded, distorted and fractured the heavy bedded "White Limestones." While these derangements of Miocene strata also occurred in Cuba and San Domingo, the corresponding beds in Florida and Georgia are not dislocated or upturned.

Late Pliocene (?) beds rest upon the Miocene surfaces, which are now often eroded below sea level. At that time the relative elevation of the interior of the island, compared with the coastal regions, appears to have been much less than at present. As there are marine accumulations, referable to the late Pliocene epoch, preserved, it becomes possible to form some idea of the different characteristics of erosion during the Mio-Pliocene elevation, and the degradation, subsequent to the accumulation of the Layton beds, which are provisionally referred to the end of the Pliocene period.

In the highlands, the general denudation has reduced the old Miocene surfaces so that the limestones form ridges or mountains, and elevated base planes of erosion, largely completed during the Pliocene elevation (as shown at m m Figure 1, page 327). The degradation of the island since the late Pliocene (?) deposits is characterized by the formation of deep valleys, often broad (Fig. 1, Plate II, opposite), and dissecting the older base levels of erosion. The broad embayment-like valleys, several miles wide (see Figure 3, page 336), among the mountains upon the southern side of the island, are largely features of the Pliocene denudation, more or less modified in later times. Of the same character are the fewer coastal indentations on the northern side of the island such as at Annatto Bay, Montego Bay, and Lucea Bay

(see Fig. 2, Plate II.). The character of the embayments referred to, is that of valleys surrounded by highlands, and which rapidly increase from less than a mile to five or ten in width, where several streams have their valleys united before leaving the plateau district.

These reëntrant valleys have been largely broadened by the rains and small streams entering the rivers, which mostly act as carriers of the *debris* off the land, for they have almost reached their base levels of erosion, the floors of which are gently undulating plains The location of these embayments is independent of the orographic structure of the district, at times occupying the hollows in the mountain folds, and again crossing them at all angles. Fragments of gradation plains terminating abruptly at high elevations, suggest that the plateau mass of the interior has been elevated since the excavation of the valleys at lower base levels. The valleys indenting the mountain mass

FIGURE 3.—Plan of a low base-level valley indenting the margins of the highlands of Clarendon Parish,

which is illustrated in Figure 3, bear a close resemblance to the submarine embayments, with the same character of floors as shown off Kingston and Savanna la Mar, where the sea is now from two thousand to over four thousand feet deep, with the submerged plateaus extending to Haiti on the east, and to Honduras on the west, having much the same depth, although traversed by deeper channels, but with the higher portions of the drowned plateaus having the appearance of old

base levels of erosion (see Map, page 328 and Figure 4). The deeper channels belong to a later date. This resemblance suggests that the submarine plateau with embayments reaching into the insular mass of Jamaica, such as that south of Kingston, was a land surface during the Mio-Pliocene elevation. The abrupt descent of the northern side of the island suggests great dislocations off that part of Jamaica, and that the forces which squeezed up the island, also rammed down the sea floor to the north. However, it must be emphasized that all the disturbing forces whether acting on what are now land surfaces or those submerged have not generally obliterated the ancient

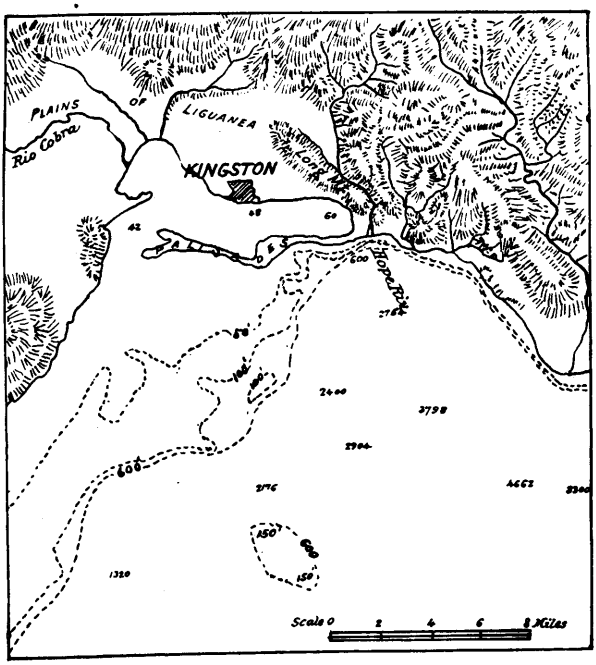


FIGURE 4.—Map showing the character of the embayments off Kingston Harbor; and the coastal plains back of the city.

drainage. It may be noticed that the writer assumes that typical valleys with open drainage are the result of atmospheric denudation. This problem has been discussed in both the "Reconstruction of the Antillean Continent," and in the "Geographical Evolution of Cuba."* It will be again referred to in succeeding pages after describing the local characteristics of the different geological periods, as the physical features of Jamaica have their counterparts on the other islands.

*By J. W. Spencer, Bull. Geol. Soc., Am., vol. vii., pp. 103-140, 1894; and Ib. vol. vii., pp. 67-94, 1895.

The Layton Formation.—After the long Mio-Pliocene elevation, Jamaica sank to about 500 feet below sea level, accordingly up to that elevation, a newer series of beds is now found. These rest unconformably upon the eroded surfaces of the "White Limestones;" but as they form only fringes about the high plateaus, and have been very greatly denuded, they occur only in isolated fragments where protected in some embayment of older date. A well-preserved fragment may be taken as an example of the formation.

Between Hope Bay and Great Spanish River there are the remains of the Low Layton volcano (see Map, Figure 6, page 345), which is called the Black Hill, rising to an altitude of 700 feet, which dates back to the Pliocene period, but considerably anterior to the formation of the marls which lie upon its denuded surface. This hill has protected the marls more or less against the marine erosion upon the sides of the sea. Just after crossing Swift River, which enters Hope Bay, some dislocated beds of shale are seen along the roadside, appearing from beneath the base of the "White Limestones," whose beds are always more or less distorted. On the eroded surfaces of the limestone there occurs a heavy deposit of marls, in colour from white to yellowish, or nearer the old volcano of gray tint, on account of the inclusion of volcanic ashes. The western end of the volcano is shown in Fig. 1, Plate III. The beds are laminated and are not seen to undulate with a dip of more than seven degrees, but as a whole, the formation may be considered as horizontal. The laminations are distinct in places, while in others they are represented by lines of pebbles or rounded gravel commonly not more than three inches long, but the pebbles may be double that length. These are composed of white limestones which form the adjacent coast range, or nearer the volcano, some of the pebbles are water-worn volcanic bombs or other fragments. Scattered through the marls, there are blocks of white limestones, sometimes having a size of from ten to twenty cubic feet, in part derived from the adjacent mountain, and in part from the volcano. These large blocks are dependent upon local conditions, but it is of primary importance to note that the marl is largely a mechanical accumulation, derived from the degradation of the white limestones. The formation rises to an elevation of about 475 feet above the adjacent Honduras sea, but its maximum thickness cannot be specified as it rests unconformably on the "White Limestones," and its own surface was subsequently greatly denuded; and afterwards succeeded by a minor formation.

This locality may be considered as a typical remnant of the forma-

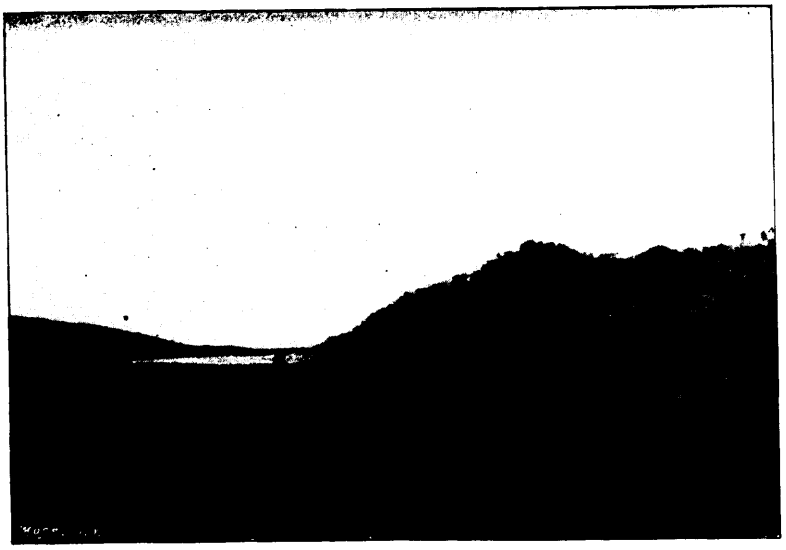


FIGURE 1.—The western end of "Black Hill,"—the remains of the volcano of Low Layton, now unconformably covered by the Layton Series and the Liguanea Series.

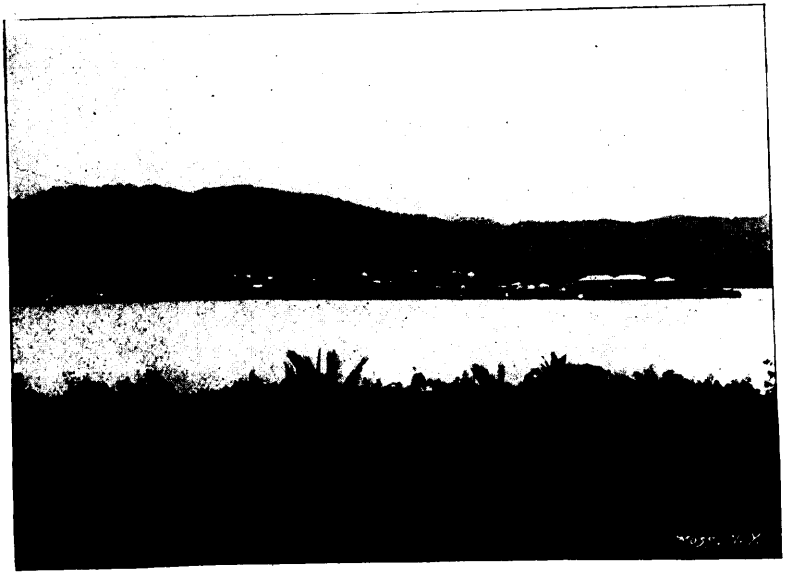


FIGURE 2.—Mountain back of Port Antonio, which town is situated on an elevated base level, forming a terrace.

tion (except the inclusion of volcanic rocks), as the underlying unconformability is apparent, and also the occurrence of another uncomformable series overlying its eroded surface.

A few poorly preserved fossils have been found in the marls apparently belonging to modern species of *Cardium* and *Ostrea*. In the volcanic beds some remains of fossil trees occur along the coast.

At Port Antonio, on the terrace where the town is built, the upturned strata of White Limestone are succeeded by a bed of yellowish-white marl, from two to five feet in thickness, containing rounded pebbles which occur in the Layton series. (Figure 2, Plate III).

Two or three miles west of the old Low Layton volcano, Great Spanish River enters the sea after having excavated a valley more than a mile wide in the coast range of mountains. Here the greatly eroded hillocks of gravel and loam rise from 40 to 100 feet above the sea. The gravel often occurs only as layers scattered through the loam. The beds may undulate and dip at as much as five degrees, or the undulations are similar to those in the Layton marls. They lie upon the older eroded surface as do the marls, but in places even the White Limestone was entirely removed before their deposition. These gravel beds have apparently the same age as the marls, being equivalent to the calcareous accumulations, at localities where the streams have brought down the mechanical *debris*. The same phenomenon of the replacement of the mechanical marls by gravel where the materials are derived from the valleys, is a frequently recurring feature.

Two sources of difficulties arise in identifying the Layton formation; (*a*), when the unconformity between the White Limestones and the marl is not observable, the one formation may be mistaken for the other, but this is in part corrected by the common inclusion of rounded pebbles in the Layton marls whether of limestone or some silicious rock, a character that does not commonly belong to the White Limestones; (*b*), when the unconformity between the Layton loams and gravels with the overlying mechanical deposits of the same character is not shown, there is a liability to error, but this is often corrected by the appearance of the greatly eroded surfaces, or even only fragmentary remains of the Layton gravels, for the denudation since the deposition of the newer gravels, to be noticed hereafter, has been comparatively slight. This later degradation of the land forms an important feature to be noticed again.

Some half a dozen miles east of Kingston, the Hope River *canyon*

enters a broad valley excavated out of the mountain mass of the White Limestones. At various altitudes up to 150 feet above the sea, there are horizontal beds of water-worn gravels, resting upon the surfaces of the White Limestone. The pebbles are more or less composed of the White Limestones, and in size usually less than four inches long. While these gravels occur up to an elevation of 50 feet or more above the floor of the valley, they are only fragmentary remains of a deposit which probably filled the valley. Above the gravels there are some marls, which appear to be higher beds of the same series, as it is characteristic of this formation and its equivalents in Cuba that the lower beds are apt to contain the greater quantity of pebbles, and the same is true of the equivalent loam and gravel series.

On the road between the mouth of the Hope River and Kingston, at the end of Long Mountain, where it almost projects into the Caribbean Sea, there is a conglomerate loosely held together, composed of mostly subangular gravel of White Limestone derived from the adjacent mountain. The bed dips at 10 degrees towards the sea, and rises to an elevation of 150 feet, overlying the surface of which there is an unconformable bed of sand and gravel. This conglomerate is a fine exposure of the mechanical character of the Layton formation, which is also here succeeded by a newer formation. It further indicates the more recent elevation of the mountains. Between the mouth of the Hope River and this point, along the roadside, there are several exposures of gravel and loam of which the pebbles are sometimes one or two feet long, covered by blocks of the White Limestone, occasionally four feet long, which are cemented into a bed four or six feet thick. All of these gravels and loams are quite unlike the upper deposits which will form a distinct topic. Some of the older alluvium described by the Jamaican geologists belong to this horizon; but the relationship of the latter divisions of the geological scale were not considered by them.

Crossing the island again, to Montego Bay and going westward to Lucea Bay, the post-Miocene formations may again be seen near the coast. At Hopewell, a few miles west of Montego Bay, occupying an embayment in the White Limestones there is a marl containing modern fossils, upon whose eroded surface rest some gravel deposits, which are surmounted by the modern limestone of the region. The lower marls are thought to have the same position as the Layton series farther east. At twenty and a-half miles west of Montego Bay, apparently the same beds recur, but as there are no overlying deposits resting upon them, there is always the danger of mistaking them for the more modern limestones of the coast, as the fossils have no determinative

A Promontory of Pleistocene Limestones dissected by a large valley now refilled and forming plains in foreground of the illustration. Near Hopewell west of Montego Bay.

value. At this locality the following modern species were found by the writer, and kindly determined by Mr. Charles T. Simpson :—

Cardium serratum (L.)	Arca Sp.
" laevigatum (L.)	Tellina fausta (Don.)
" muricatum (L.)	Zoripes edentula (L.)
" sp.	Levona pica (Gm.)
Lutricola interstriata (Say.)	Strombus gigas.

Corals were not determined.

Near Orange Cove, west of Lucea Bay, resting on an eroded ridge of White Limestone, only 300 feet wide, there is a deposit of gravel with small boulders of ten inches diameter, with marl above, the same as at Hopewell.

On Mrs. Roger's hill at Lucea Bay, at an elevation of 80 feet above the sea, resting on the eroded shales, for all of the White Limestones had here been removed, there is a deposit of from four to eight feet of marl resembling the Layton series of the region, in being subsequently greatly eroded and in containing small water-worn pebbles, but as no overlying formation was seen it cannot positively be asserted to be the equivalent although resting on the denuded old foundation. From it the following fossils were obtained, and Mr. Simpson also kindly determined them :—

Strombus pugilis (L.)	Turbo castineus.
Pecten nucleus (?), (B.)	Pleurodonta jamaicensis.
Arca noae.	Cardium lævigatum (L.).
Lucinea jamaicensis.	Venus cancellata (L.)
Arca (like) lienosa (perhaps extinct).	Pleurodonta lucrina (Muel), var.
" jamaicensis (Gm.)	towards acuta.

From the paleontological standpoint, all of the fossils from the series, such as are probably the equivalent of the Layton beds, belong to modern species, but the enormous amount of denudation and other changes which have occurred since their deposition places the formation a considerable length of time ago.

Of the Jamaican geologists, Mr. C. B. Brown* seemed to most nearly appreciate the importance of the later deposits. He describes extensive beds of marl, of a mechanical origin derived from the White Limestones, as covering considerable areas in southwestern Jamaica, and in many places he notes the scarcity of fossils, but nearer the sea, the shells are better preserved, and belong to modern species. These deposits are preserved in the embayments reëntering the highlands of the "White Limestone," and are noted up to an elevation of 200 feet. The term

* Geology of Jamaica, pp. 208-210, and p.p. 228-230.

marl has been used for some of the beds of White Limestones, as well as for the newer formations, so that it would require further investigations to know how much of his marl formation is referable to the Layton series, and how much to the "White Limestones." Perhaps a portion of it may be even more recent.

The Layton series occurs as a veneer up to elevations of 500 feet. While often not more than ten or twenty feet thick, it may reach 200 feet in depth when occupying older valleys which it has partly filled.

The Layton series is the first formation occurring in Jamaica subsequent to the "White Limestone," (Older Miocene). The fossils are few in number and it is not certain that there are any extinct species among, to say the least, predominating modern varieties. The mechanical character, even where the deposits are mostly composed of marls, may in part account for the common absence of fossils. The denudation following the Layton epoch has in a great measure carried away the formation. Upon the resulting weather-worn country, another mantle also largely mechanical, was laid down. The surface of this latter accumulation has suffered a less degree of erosion than the Layton series, but sufficient to frequently expose the remains of that deposit.

Comparison of the Layton Series with the Matanzas of Cuba, and the Lafayette of North America, and its Age. — In Cuba the same mechanical marls or limestones occur, containing water-worn pebbles, and resting upon similar white limestones of old Miocene or Oligocene age, whose surfaces had been greatly eroded. These mechanical marls in Cuba have been designated the Matanzas series* by the writer. The fossils are usually scarce, but they are modern species and quite unlike the Miocene fauna. On the continent the old Miocene accumulations are very much eroded, so that they are often removed from the valleys, and succeeding them (except in Southern Florida), there are the Lafayette red loams and gravels, the latter, where present, usually forming the lower part of the series. The thickness of the whole series, except in the valleys, does not usually exceed twenty feet. This formation so extensively surveyed by Prof. W. J. McGee† occurs over a broad belt of the Atlantic and Gulf states, and the writer has seen it even as far as the southern side of the Gulf of Mexico. In place of being derived from the White Limestones of Jamaica and Cuba (of Tertiary age), the materials of the American Lafayette formation have been derived entirely from the residuum of the decay of rocks of

* "Geographical Evolution of Cuba," by J. W. Spencer, Bull. Geol. Soc. Am., vol. vii., pp. 67-94, 1895.

† "The Lafayette Formation," by W. J. McGee, 12th Rept. U.S. Geol. Surv., pp. 347-522, 1892.

various age from the Tertiary, in very small part, to the Archæan, and also from other rocks as well as from limestones. Although the sources of the materials were so varied, yet the formation presents a remarkable degree of uniformity, such as indeed arises from the decay of most rocks.

Owing to like successions in the geological scale, with the same breaks above and below, the writer desires to strongly emphasize the apparent equivalency in separated regions, between the Layton of Jamaica, the Matanzas of Cuba, and the Lafayette of the Southern States, with corresponding series in Santo Domingo and the Windward Islands. The varied succession of events which has occurred since the Layton epoch, places it a long way back in actual time; and the physical successions and interruptions continued alike in Jamaica, Cuba, and the Southern States.

On the continent, there are indications that some of the marine beds of Florida and the Lafayette loams and gravels are of the same age, but derived from different sources. Prof. W. J. McGee, the great exponent of the Lafayette formations, and Dr. W. H. Dall, as well as the writer, all provisionally classify the Lafayette as belonging to the close of the Pliocene period, especially as the formation is older than the glacial deposits, where first they occur in contact in New Jersey. From this consideration the Layton epoch has been placed at the close of the Pliocene period. The sequence of events will be better understood as we proceed. But, if others prefer to regard the Layton series, on account of its recent fauna, as belonging to the Pleistocene period, it is physically immaterial and only suggests a greater duration of Pleistocene time; and they can transfer the author's references from the late Pliocene to an early Pleistocene epoch. The submergence of the Lafayette, Matanzas, and Layton epochs may have commenced a little earlier in one locality than another, and also ended later, but the formation seems to constitute a geological unit.

The absence of the Mio-Pliocene formations from Jamaica, and indeed from the West Indies, followed by the Layton series, is manifestly due to those general elevations preventing their accumulation, for older Pliocene deposits occur on the Tehuantepec Isthmus of Mexico, which should have theoretically been depressed at the time of the West Indian elevation; and such has been found to have obtained.

PLEISTOCENE HISTORY.

Epoch of Elevation.—After the Layton epoch of submergence, there was a long period of high elevation, during which most of the Layton series, forming fringes along the steep mountain sides close upon the coast, was removed by denudation. Thus the formation does not occur continuously round the island, and is only preserved in protected districts or in some indentations entering the highlands. In the typical locality, about Low Layton, the Layton series is greatly denuded, and upon the eroded surfaces the Liguanea formation is deposited. In many places the series appears to be covered by the succeeding loams and gravels, without being exposed by later erosion.

Apart from the degradation of the Layton formation, there was a marked change in the character between the post-Layton and the earlier epochs of erosion. This difference is represented by the deep and more or less widened valleys, which dissected the old base planes of erosion among the plateaus of White Limestones, and thus gave rise to much of the ruggedness of the island. This feature is illustrated in Figure 5. The higher margins represent portions of an elevated plateau, which has been denuded so as to form numerous prominences of similar height, separated by broad, undulating troughs and valleys, indicating lower base levels than at present. The rocks are composed of the Old Miocene "White Limestones." They have been subjected to denudation since their first elevation. Lower down the plateau, there are two

FIGURE 5.—Section across the Hope valley (east of Kingston), about three miles long, as viewed from the north:—*m L* (Long mountain, (*L*) 1528 feet above tide), old "White Limestone" topography; *p p*, remains of early Pleistocene base-level outlines; *l l*, base-level terrace formed during Liguanea epoch; *c*, *canyon* of recent date being cut below the Liguanea level (which is 550 feet above the sea).

distinct base levels of more recent erosion, besides the modern gorge, The stream is still deepening its channel, owing to the recent elevation of the land. (See Plate vi., page 350).

The feature of primary and secondary valleys and *canyons* is well represented in the coast range plateau from Port Antonio to Annatto

Bay, which may be partly illustrated in Map, Figure 6. At the ends of the district shown on the Map, the White Limestones have been

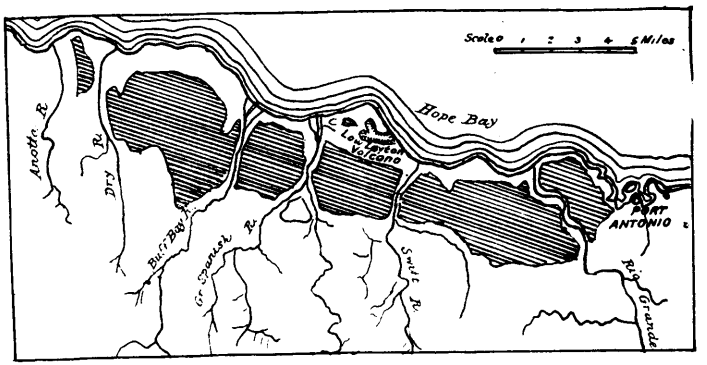


FIGURE 6.—Map from Port Antonio westward; showing the erosion of gorges through the mountain plateau, ("White Limestone," shaded portion), 700-1,000 feet above tide.

removed for distances of three or four miles, with the formation of compound valleys in the older strata. Along the rivers, shown on the Map, (Figure 6), there are the remains of upper broad valleys deepened into narrow *canyons* along the streams, the relative sections of which are shown in Figure 7.

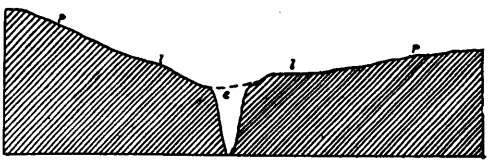


FIGURE 7.—Section of natural proportions taken from a photograph of the outlet of Swift River (near Hope Bay). Higher part of mountain about 1,000 feet; *canyon (c)* (concealed by its windings from the exterior view), whose bed is only from 50 to 150 feet wide; *p p*, the section of the valley formed during its post-Layton or early Pleistocene base level; and *l l*, that formed during the Liguanea base-level.

The secondary valleys are not broad undulating plains and ridges, such as characterized the Mio-Pliocene erosion, but such as result from the widening of old gorges by rains and streams as shown in Figure 7. Behind the coastal highlands of White Limestones (as in Figure 6), there are large valleys bearing a relationship to the depressions across the rocky highlands (such as l. l. in Figure 7). These are surrounded by amphitheatres of hills, all showing gradients which in part reach to several hundred feet per mile—in short, like gigantic washouts. While the *canyons* record the amount of recent elevation, yet the valleys above them indicate that the higher work of the streams dated back to the great post-Layton or Pleistocene elevation.

Turning now to the submarine plateaus adjacent to Jamaica (Map, page 328), the soundings indicate the general character to be that of a submerged table-land now 3,000 or 4,000 feet beneath the surface of the sea. Across this submarine plateau, there are several deep trenches like those of the Jamaican highlands but of greater magnitude, for obvious reasons. Thus a few miles southwest of Jamaica, where the edge of the shelf is covered by 4,800 feet of water, there is a drowned channel 2,400 feet deeper. South-east of the island, before reaching Morant Bay, another narrow valley is depressed to 5,000 feet, or 2,000 feet below the adjacent level of the plateau. The Kingston embayment already shown in Figure 4, is another example. On approaching Haiti, a characteristic embayment of great depth, surrounded by steeply sloping sides, reaches to a depth of 4,000 feet below the floor of the plateau, or 11,000 feet below the surface of the sea. Upon the northern side of this same plateau, for a distance of over a hundred miles, the drowned valley is conspicuous, having a breadth increasing to twenty miles, and a depth of nearly 7,000 feet, with depressions suggesting that it may generally reach to nearly 10,000 feet, while the northern ridge is submerged only 4,000 feet. The head of this drowned valley approaches the embayment near Haiti, and the trench connecting them is considerably deeper than the general surface of the submarine table-land. These deep channels dissecting the drowned plateaus have very much the same ratio of their parts, but from two to four times as great as the deep valleys of Jamaica, and they also receive tributaries from various directions. The topographic forms suggest a similar origin for the plateaus in the same general Mio-Pliocene period, (whether above or below the surface of the sea), with the subsequent post-Layton, that is to say, early Pleistocene, elevation of great proportion.

A comparison of the erosion features before and after the Layton epoch may admit of further explanation. The earlier erosion was characterized by broad undulations (the period of the formation of the plateau surface), proving the general degradation of the country, lasting for a long period at base level of erosion, thus requiring a lower altitude for the plateau on its great extension seawards. Probably both conditions obtained, for a portion of the elevation of the interior district appears due to a comparatively recent squeezing upward of the plateau and mountain mass, as has been definitely observed in other islands. Whether the terrestrial and submarine plateaus represent entirely different steps of the Mio-Pliocene erosion features, or in part were once a continuous base level, subsequently dislocated and modified, can hardly be determined at present. Similar features are more perfectly

seen in Mexico, where the table-lands more than 6,000 feet above the coastal plains demonstrate their own recent elevation, and yet, had the lower coastal plains rising now to 1,700 feet above the sea, been formed, with the high escapement behind them exposed to denudation so far above the base level of erosion, the plateaus would have been dissected by valleys penetrating the highland mass infinitely farther than those of the present border. Thus it is suggested that the plateau region may have received upward thrusts, bringing side by side features of old worn down topography, and others of the most recent date. Accordingly similar features in Jamaica, but with the plateaus more degraded than in Mexico, suggest that the land and submerged plateaus of Mio-Pliocene age were moulded when the base levels of the two regions were more closely related than at present.

The great deep channels, whether above or below the sea, *canyons* or valleys, and fjords, alike dissect the plateaus of which those beneath the sea have the greater magnitude with consequently greater incisions. These features represent a period or epoch subsequent to base leveling of the plateau surfaces. These deep valleys upon the land and upon the border of the sea, are of post-Layton Age, as the deposits of that epoch have been penetrated by the subsequent erosion. This feature suggests their origin generally at the more recent date, rather than of pre-Layton Age with the valleys partly refilled and again reopened. This last view in part might be considered, but it would necessitate two epochs of enormous elevations, yet of much shorter duration than the period of Mio-Pliocene base leveling; one before and one since the Layton epoch of submergence. Moreover, the epoch of greatest elevation on the continent is post-Lafayette, with the consequent enormous amount of excavations of the valleys. Consequently the writer is not inclined to regard the developments of the very deep valleys as reopened pre-Layton channels, as he was disposed to do at an early period in his West Indian studies.

The Liguanea Formation.—After the epoch of Pleistocene elevation just described, Jamaica sank so that the coastal region was depressed to 600 feet more or less, and loams and gravels were deposited upon the floors of the drowned lands. To these accumulations the name of Liguanea, being that of the coastal plain from Kingston for twenty-five miles westward, has been given. This formation is essentially a mantle of 20 feet in thickness, or more in the buried valleys, which is unconformably deposited in places upon the Layton ruins, and where these are removed, as is often the case, upon older formations. The Liguanea

formation embraces much of what the Jamaican geologists call the alluvium without further designation. Its principal development is on the southern side of the island, as the mountains come close to the sea upon the northern side, but even there it occurs at many places. It has been seen at all altitudes below 600 feet, but it may not in every district reach so high. The stratification of the loam is often indistinct, or it may be characterized by lines of pebbles, especially in the lower portion of the series. Yet, in the sections exposed by some of the streams, the stratification is shown, and in the delta where the Hope River leaves the mountains, it is over 100 feet thick, with a large amount of the material composed of stratified gravel, often coarse, with even large boulders from the mountain valley deposited along the bed of the streams. The pebbles are all water-worn, and where not wanting, constitute the lower part of the formation. They are in places composed of both White Limestones and older rocks brought down by the streams.

The loams vary from grayish to reddish, according to the sources of the materials. The redder loams are apt to contain great quantities of pellets of oxides of iron. The loams are derived from the residual soils, accumulated upon the decay of the White Limestones being washed down to the sea. Such materials may also be commingled with disintegrated shaly or sandy rocks brought from the interior by the streams. Back of Kingston, (see Figure 1, Plate V.), the formation forms a mantle occurring up to an elevation of 550 feet on the Mono estate, and somewhat higher nearer the delta where the Hope River leaves the mountains. At this locality the river has cut through and exposed nearly 150 feet of loams, gravels and boulders. The location may be seen in Map, (Figure 4, page 337). The Liguanea plains slope a hundred feet in the mile, but outside the gorge of the Hope, the surface is seldom deeply channeled by the running waters. The surface appears to have been originally in steps which are now generally reduced to a nearly uniform grade. In St. Thomas-in-the-Vale, the Liguanea gravels and loams were noticed at elevations between 300 and 400 feet. On the seaward side of Long Mountain, east of Kingston, the Liguanea formation rests unconformably upon the Layton series at an elevation of 150 feet.

Overlying the volcanic rocks and also the Layton marls, where not eroded upon the seaward side of the volcanic hills of Low Layton, the stratified Liguanea gravels occur. The formation was seen to an elevation of nearly 450 feet. This is illustrated in Figure 2, Plate V.

FIGURE 1. Portion of the Plains of Liguanea behind Long Mountain whose base is dissected by the Hope *Canyon*.

FIGURE 2.—The Liguanea formation resting upon the eroded surface of the Layton Series at the volcano of Low Layton.

Some marls and coast limestones noticed farther west may be the local equivalents of the Liguanea loams and gravels. In the embayments of low plains entering the southwestern highlands, this formation seems to be quite extensively represented in the alluviums described by Mr. Brown. On the northern side of the island, the development of the coastal plains is so slight that only fragments of the formation are there preserved. When seen by the writer, no fossils were found in the loams, although a few are reported in some "alluviums."

Comparison of Liguanea Series with the Zapata of Cuba, and the Lafayette of North America.—In Cuba, the Zapata red loams and gravels* of the same general character and development as the Liguanea, and occupying the same general position on the eroded surfaces of the Matanzas, equivalent to the Layton (or late Pliocene?) formation, appear to be the representatives of the Jamaican deposits.

So also the Columbia loams and gravels, covering 150,000 square miles of the Atlantic and Gulf states, as described by Prof. W. J. McGee,† appear to be the correlative of both the Liguanea and Zapata formations of Jamaica and Cuba. The same formation extends along the eastern side of Mexico to at least as far as the Tehuantepec Isthmus; and Gabb describes a formation in Santo Domingo that may be included here, and apparently the same formations occur in some of the Windward Islands. The Columbia and Lafayette formations are very widespread, and show some unequal elevations of the land, but no discordance in the succession of physical changes throughout the extent of their development, along the margin of the continent for at least 2,000 or 3,000 miles in length. So also the general uniformity, where known, throughout the encircled Antillean region has a similar character. Although the magnitude of the terrestrial oscillations varied somewhat, and may have commenced and ended earlier in one locality than in another, yet the Liguanea, Zapata and Columbia formations appear to be an expression for the same formation in separated localities.

That the Liguanea formation is very often seen well stratified at considerable elevation near the sea shore, seems sufficient evidence of its origin at sea level, as there could have been no barriers to exclude the oceanic waters, although marine fossil remains in it are not certainly established. In this respect, the character is identical with the Columbia formation of the continent. It is possible that some of the isolated

* "Geographical Evolution of Cuba," by J. W. Spencer, Bull. Geol. Soc. Am., vol. vii., pp. 67-94.
† Cited before.

marls with modern fossils seen on the north-western coast may belong to this series.

MODERN HISTORY.

Epoch of Elevation.—At the close of the Liguanea epoch, the land rose to an altitude of not merely the height of the Liguanea series, but to an elevation of 120 feet more. At this time an epoch of considerable erosion was commenced, which is characterized by all of the rivers leaving the highlands through freshly excavated *canyons*, where the streams are still deepening their channels. The *canyon* epoch was more recent than the Liguanea formation, as this last is dissected by them. The evidence of greater elevation than at present is preserved in the valleys and channels crossing the submerged shelf upon the southern side of the island. On the northern side, the evidence is scarcely available on account of the narrow submarine fringe; but in the little valley of Dry Harbour, which is submerged to a depth of over 200 feet with a bar in front of it less than 18 feet below the surface, which could easily be formed by coastal currents as the district has since been sinking, there may be evidence of somewhat greater recent depression than is recorded on the southern side of Jamaica. The occurrence of the large swamp formations at the mouths of many of the rivers, as well as the drowned channels, also indicates the depression subsequent to the modern post-Liguanea elevations of 120 (or 200) feet.

Hope River leaves the mountain regions opposite the northern end of Long Mountain (see Map, Figure 4, page 337), and its former course was over the Liguanea district, not apparently in modern days, but before the Liguanea epoch, during which time the channel became obstructed to an elevation of about 600 feet above the sea. Upon the post-Liguanea emergence, the Hope River turned across the neck of Long Mountain (see Figure 1, Plate V., page 349), and has since made a *canyon* three miles long. This neck was about 550 feet above the present sea level. The floor of the upper part of the gorge is now 150 feet deep, or about 400 feet above the sea. In the three miles it descends 300 feet and abruptly enters a broad valley. The width of the gorge at its base is from 50 to 75 feet, although it is often reduced to 20 feet (Figures 1 and 2, Plate VI.). This *canyon* represents the amount of post-Liguanea erosion, and throughout its length, it is excavated out of the "White Limestone." The post-Liguanea elevation was thus sufficiently long ago to permit of the formation of *canyons* three miles long, and from 150 to 500 feet deep.

All the other rivers crossing the "White Limestones" have similar

FIGURE 1.—Hope *Canyon*. The narrowest portion only about twenty feet wide along bed of stream.

FIGURE 2.—Hope *Canyon* (from 200 to nearly 500 feet deep). Excavated since the Liguanea period.

canyons, such as those along the streams shown in Map, Figure 4. Above the *canyon* sections, there are benches marking the former floors of the valleys, before the post-Liguanea uplift (as represented by the base levels shown in section at l.l., Figures 5 and 7, and z in Figure 1).

Terraces.—Remnants of terraces are common, but they are usually very much denuded by the tropical rains which may amount to ten inches fall within twenty-four hours. It is almost astonishing that any loams and gravels resist such washes. Under these conditions the torrents rise to great heights in the gorges, so that large boulders commonly five feet and occasionally ten feet in diameter are carried down the channels for many miles from their original beds.

Back of Kingston the Liguanea plain rises 350 feet in three and a-half miles, and near Hope Toll Gate to about 600 feet; but this is upon the edge of the delta of the Hope River, where it leaves the mountains. A short distance away, on the Mono estate, there is a beautiful terrace plain at 550 feet (bar.), and lower terraces at 500 and 460 feet. Below this level the river enters the *canyon*. These are true terrace steps, each marking the lowering of the base level of the erosion of the river. Through the *canyon*, which is more recent, there is no terrace, but at the lower end where it expands to a broad valley, another terrace at 150 feet is seen. The floor of the valley is here 100 feet above tide, but the bottom merges into lateral terraces of about the same height along the lower reaches. Other terraces at 50 and 25 feet also occur.

Terraces, corresponding to those of the broader parts of the Hope River valley, ought to be engraved upon the Liguanea plain, but they are only faintly recorded. These open plains which have been exposed not only to the tropical rains, but to the cultivation of 350 years, would naturally have the faces of the terraces, of which only the more striking have been noted along the Hope, graded down to a somewhat uniform slope; but even now some of these steps are still recognizable. On the southern end of Long Mountain, there is a bench cut in the White Limestone at an elevation of about 550 feet, corresponding in height to the Mono Terrace (at l l., Figure 5, page 344).

Along the line of the railway, west of Old Harbour, terraces of gravel, etc., were noticed at 275, 250, and 175 feet, and beyond Porus Station at 400 feet. Still farther, the Melrose valley appears to be a terrace floor protected in a cove among the mountains. In St. Thomas-in-the-Vale, back of Spanish Town, terraces are well shown at

altitudes of from 300 to 400 feet, but these may have been due to a dam near Bog Walk.

Along the Rio Grande, back of Port Antonio, remains of valley terraces were noticed at Unity Hall, Golden Vale, and near Windsor, at elevations up to nearly 275 feet; and along the Foxes, a tributary of the last stream, at 375 feet. Along the coast in this region, there are remnants of baseplanes or terraces at 50-60 feet. On the neck of the ridge connecting the Low Layton volcanic hills with the coast range where the road crosses between two streams, there are the remains of an old terrace at about 375 feet above the sea. At many points westward, there is a bench or terrace between 50 and 80 feet, as beyond Buff Bay and Montego Bay. Indeed, there is a fine terrace at the last named place at 50 feet, and several higher benches are engraved upon the point north-east of the bay. Along the northern side of the island, the lower bench of coast limestones commonly rises from 10 to 25 feet.

South of Montego Bay, along the Grand River, there is a broad valley, which, below Cambridge, has an altitude from 400 to 500 feet

FIGURE 8.—A rock island in Great River valley about 100 feet high.

above the sea. Here there are distinct terrace steps, showing the lowering of the base levels of erosion. In another valley, near Anchovy, there are terraces between 675 and 700 feet. Nearer the edge of the mountain region above the Bay of Montego, there are benches at corresponding heights.

In the valley of Great River, there is a peculiar feature in that there are many islands of rocks rising from 100 to 200 feet above the floor, which is from 400 to 500 feet above the sea. Some of them may be more than half a mile long, but many are shorter and comparatively narrow, occupying only a few acres. The sides are precipitous as shown in Figure 8. Their surfaces are substantially remnants of a previous floor of the valley (or base level, probably of Layton age), which must have been between 600 and 700 feet above the sea. A thin coating of

tufaceous deposit is common on these rock islands. Sea caves excavated in the walls of these islands were also seen. These terraces in part mark the pauses in the post-Liguanea elevation of Jamaica.

Coral Reefs.—As has been pointed out, the post-Liguanea elevation reached an altitude of 120 feet, or possibly 200 feet on the northern side, higher than now, as the streams cut channels to this depth, which have since been drowned, (see page 350). Then followed the episode of depression to about 25 feet below the present altitude, when coral reefs and modern limestones began to be formed, which since then have been raised from 10 to 25 feet, or locally more. The narrow reefs occupy a considerable portion of the coast line on the northern side of the island, and were specially studied to beyond Montego Bay. Where the corals form the coast line, there are no beaches, except in coves. The floor of Montego Bay is covered with a beautiful garden of corals, of both massive and branching varieties. In part, the coral reefs which are raised to form the coast limestone, may be replaced by shell beds (Brown), and it is possible that some of the low fossiliferous shell bearing marls seen west of Montego Bay belonged to this modern episode, that is those beds which were not succeeded by other late formations. Still some of the coast limestones are the remnants of the older formations, such as those near Orange Cove and Hopewell.

Beaches.—The formation of the beaches is an interesting feature, as they are the exact reproduction of the deserted beaches of the Great Lake region of North America, but unlike the sandy Atlantic beaches at least south of New York, and many other places noticed north-east of that city. They form ridges from three to five feet above the sea, with depressions behind them, and in composition they are made up of sand and gravel, often somewhat coarse, derived from the harder portions of the White Limestones, or older rocks brought down by the streams. Along the Atlantic coast, all of the gravel has been ground to sand or very fine material, before reaching the present coast, and the beach ridges are not so sharply defined as in Jamaica. The Jamaican ridges appear to be due in part to the presence of the gravel in large quantities, and also to the almost complete absence of tides. In the Lake region the gravel has been derived from the boulder clay. The ridges are often not more than 25 feet, or they may be 200 feet across their crests. They are well developed between Hope Bay and Low Layton volcano, also west of Buff Bay and at Annatto Bay. West of Buff Bay a good representative of raised beaches may be seen.

Another interesting beach is that in front of Kingston Harbour,

(Figure 4, page 337), which is called the "Palisades," with a length of about eight miles. The depth of the water inside reaches to 60 feet. Before the district sank subsequent to the post-Liguanea elevation, Kingston Harbour was only a continuation of the Rio Cobre. When the land was depressed so that the coast line occupied the location of the eastern end of the beach, a bar was thrown across the valley, and the beach slowly developed as the land continued to sink. The mouth of the harbour was subsequently changed to the present outlet.

Alluvium.—Owing to the late elevation of the land, the slopes of the streams have not been reduced sufficiently to allow the deposition of much alluvium along their courses. However, at the mouths of many of the rivers, especially along the southwestern end of the island, there are extensive marshes. Indeed, from their broad character, a late subsidence seems to have occurred, if not in progress at present. The sinking of Port Royal (at the end of the Kingston Palisades) in 1697, from earthquake action cannot be taken as evidence of changes of level of the coast line.

A Review of Erosion Features since the Miocene Period.—The features of denudation have formed prominent diagnostics in the present researches, and consequently had to be separated and partly considered in several connections. In these erosion features, the records of the history of the land are as clearly told, as in the fossils is the history of the sea. Owing to changing conditions from terrestrial to marine, and back again, both departments of geology have to be considered, and each makes the other study the more valuable. The Mio-Pliocene denudation was enormous, but it was effected with the land near the base level of erosion. This condition need not imply that the land was actually low, but the sea may have been much farther from the modern plateau than now, as is suggested from the submarine banks, only in the elevation of the land Jamaica may have been abnormally lifted above the now submerged plateau; and the seaward margins, from which even the "White Limestones" had been mostly denuded, were depressed. Since the early Miocene period, the "White Limestones" themselves have been raised 3,000 feet. The Mio-Pliocene period was one of erosion affecting the island beyond its present margins; and this long period of denudation was ended by the Layton submergence. The post-Layton degradation, (that is the early Pleistocene), was also of considerable duration, and represented very great elevation with the formation of deep valleys, but the country was not ground down to the base level of denudation as during the long Mio-Pliocene elevation. The later, or post-Liguanea, erosion has been

of vastly smaller proportions than the previous, and is represented by the *canyons* not yet widened into valleys. The higher mountains are covered with deep soil, the result of the decay of the rocks. This loose material subjected as it is to the heavy tropical rains washing the very steep slopes, suggests that they must have been thrust abnormally high in very recent times, for such material could not long resist the atmospheric action. The descent of the mountain streams may be from 500 to 1,000 feet in a mile.

Faulted (?) Basins.—On referring to the map, (Figure 6, page 345), the belt of White Limestones, from 700 to 1,000 feet in altitude above the sea, occurs in front of several deep valleys. The higher portions of these valleys correspond to depressions across the limestones, but the lower portions are too low, and yet so large that they could hardly have been excavated since the *canyons* have cut through the White Limestone belt, which rises from 200 to 500 feet above the inner valleys. It is suggested that these valleys, although erosion depressions, have been obstructed by recent faultings. The feature is repeated in Cuba, where the writer found the evidence of very late faulting, which brought up the barrier in front of the large Yumuri Valley, near Matanzas.

St. Thomas-in-the-Vale is a valley about six miles long and from three to five broad, and surrounded by high mountains. At its upper end it has an elevation of 700 or 800 feet, which gradually declines, so that near Bog Walk it is not more than 300 feet above the sea. It is plainly an erosion valley, from which the higher portions could have been drained across the depression in the mountains back of Spanish Town, yet such could not have been the case with the lower level that is now drained by a narrow post-Liguanea *canyon.* Some have regarded it as having been drained by underground channels. But for such a large valley, this explanation seems somewhat inadequate, and its origin by the uplift of the mountain barrier to the south, accompanied by faulting, is suggested.

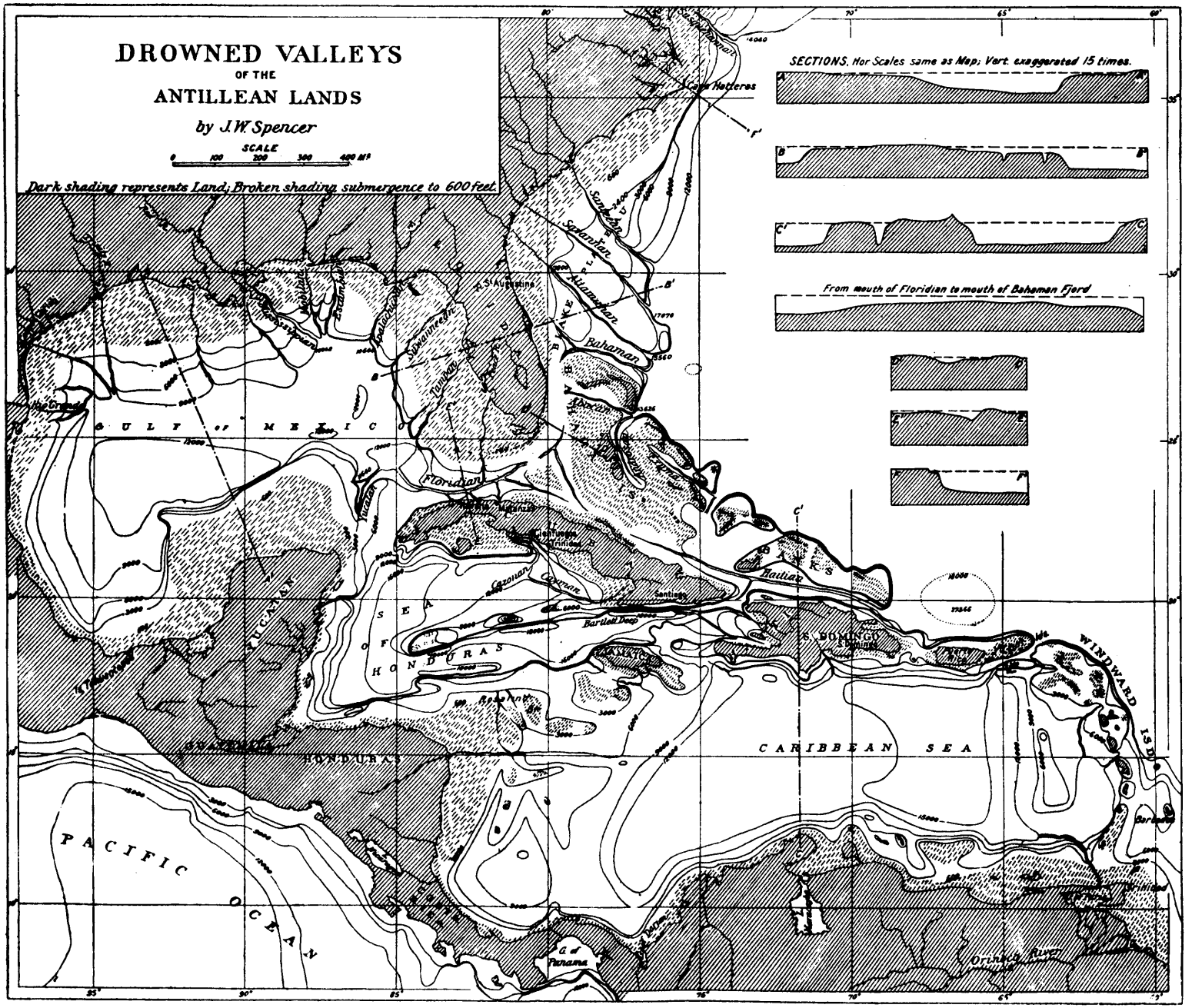
The Terrestrial Oscillations.—Complex as it may seem, there have been numerous oscillations since the early Tertiary days. After the abysmal subsidence of the Pteropod marls, about the early Miocene days, the elevation did not culminate until in the early Pleistocene, when it reached 7,000 to 10,000 feet, as shown by evidence adjacent to the island. The Mio-Pliocene elevation was of moderate porportions, with the Layton submergence, of a few hundred feet, about the close of the Pliocene period. Then the great post-Layton elevation was succeeded by a depression of the land to a few hundred feet lower than now; another

considerable upward oscillation of 120 to 200 higher than now occurred, with the following depression a few feet lower than now ; again a slight elevation represented by the modern raised Coral reefs, but we do not say whether the movement of the present day is one of rising or sinking. Thus we absolutely find, commencing with the Mio-Pliocene broad lands, no less than four epochs of elevation separated by those of subsidence. But most of these movements have been of small amounts, every one in each direction having reached gigantic proportions. These numerous terrestrial changes are also recorded in Cuba and on the Continent.

TABLE OF THE GEOLOGICAL SUCCESSION AND OSCILLATIONS IN JAMAICA.*

SYSTEMS.	FORMATIONS AND THEIR MOVEMENTS.
Modern	Modern coral terraces; elevation 10 to 25 feet. Formation of coralline limestones; submergence 10 to 25 feet. Formations of channels over banks; elevation 120 (+) feet, equals maximum modern elevation; *canyon*-making epoch. Formation of terraces; submergence 550 (+) feet, (representing post-Liguanea emergence).
Pleistocene	Liguanea formation (red loams and gravels); subsidence 600 (+) feet. Unconformably on various formations. Post-Layton elevation; an epoch of enormous erosion; altitude from evidence within the submerged Jamaican plateau, from 7,000 to 11,000 feet; Strata not deformed at this time, but with the mountains higher than in the earlier periods. Great deep valleys.
Pliocene.....	Layton formation (marly beds, and also loams and gravels); subsidence 450 (+) feet. Unconformable on White Limestones, etc. Pliocene, or Mio-Pliocene elevation; an epoch of long duration and great amount of erosion; altitude inferior to that in the post-Layton elevation, but high enough for the removal of the Miocene limestone below sea-level. This was a period of general elevation of the land, and erosion to broad base-levels.
Miocene and Eocene....	Series not physically separable, and the upper beds may be entirely removed; no beds newer than the older Miocene remain. The prominent beds constitute the "White Limestones" with a thickness of 2,000 feet; subsidence 3,000 feet; Foraminiferal marls occur below the "White Limestones."
Eocene, Cretaceous, and perhaps older formations.....	Slates, sandstones, conglomerates, limestones, igneous and metamorphic rocks constituting the dislocated basement of the "White Limestones" of the interior of the island.

* Altitudes refer to elevations above or depressions below sea level.



NOTE.—Soundings are in feet. This map (reproduced from "Reconstruction of the Antillean Continent"), shows the relationship of Jamaica to the sunken continent and the positions of the drowned valleys referred to in "Resemblances between the Declivities from High Plateaus and the Subterranean Marine Antillean Valleys."

RESEMBLANCES BETWEEN THE DECLIVITIES OF HIGH PLATEAU AND THOSE OF SUBMARINE ANTILLEAN VALLEYS.

BY J. W. SPENCER, M.A., PH.B.

(Read February 5, 1898).

In the "Reconstruction of the Antillean Continent,"* the writer brought together a vast number of data showing that everywhere crossing the southeastern coastal plains of North America, the rivers flow over deeply-buried ancient channels before entering the sea, thus indicating a submergence of the land. The direction of these rivers is mostly transverse to the mountain range as well as to the coast lines. Beyond the sea shores, and amongst the West Indian Islands, there are extensive submarine plateaus, regarded as Mio-Pliocene plains, now submerged at various depths between 2,500 and 5,000 feet. These are dissected by fjords, or drowned valleys, of great depth, which are found to be continuations of the land valleys. They are traceable to depths of more than two miles, and receive tributaries converging from all possible directions. These submerged river systems are recognizable in all portions of the Antillean basins, and the more important of them are described in the "Reconstruction of the Antillean Continent." They are shown upon the accompanying map.

In the previous paper on "Late Formations and Great Changes of Level in Jamaica,"† the drowned plateaus adjacent to that island, and their dissection by the deep channels, are described. The phenomena show the recent extension of continental lands so as to include the Jamaican mass, as illustrated on the accompanying map. The dissection of these plateaus is of much more recent date than the formation of the drowned plains. Upon the adjacent lands these channels dissect the Lafayette formation of America, the Matanzas of Cuba, and the Layton of Jamaica, which appear to be local equivalents of widespread accumulations, resting unconformably upon the old Mio-Pliocene land surfaces; consequently, these drowned *canyons* and deep

* Bull. Geol. Soc. Am., vol. vi., pp. 103-140. 1894.

† Trans. Can. Inst., vol. v., pp. 325-357, 1898.

valleys date from the earlier Pleistocene epoch, even if in part they should be of greater age, refilled with these last named deposits, which were largely carried away by subsequent denudation during the epoch of great elevation.

In the original paper on the "Reconstruction of the Antillean Continent," the declivities of the land valleys were scarcely compared with those drowned beneath the sea. Indeed, in order to draw the analogy it was necessary to make a study of the slopes of the valleys dissecting the margins of the high table-lands of Mexico* and the Western States, and such comparison is offered in the following pages.

In the Appalachian mountains some of the valleys are from ten to twenty miles across, occupying in places anticlines in the structure of the formations, or extending over many anticlines and synclines alike, or crossing the trends of the beds, for there the strata are usually much folded or upturned. The valley of Lookout Creek varies from two to four miles in width, and it is bounded by table-lands from 500 to 1,000 feet above it. Even at the divide between its head and that of Will's Creek, flowing in the opposite direction, its breadth is more than two miles, and the bounding escarpments 500 feet high. The average declivity of the valley is over ten feet per mile.

The Mississippi system is a representative of great streams flowing over a continental plain, which is now so reduced in height above the sea level, that there is comparatively little deepening of the channels, and indeed, the valleys of all the larger branches are more or less deeply silted over with river deposits. Above the mouth of the Ohio, the Mississippi River flows through a valley from three to eleven miles wide, bounded by rocky escarpments, commonly of limestone, rising from 100 to 500 feet above the floor. The length of this reach is about 700 miles, although over 800 miles, if the winding of the valley be more closely followed. The mean gradient of this section is six-tenths of a foot per mile. From the mouth of the Ohio River to the Gulf of Mexico, the direct distance is 550 miles, although the river is twice as long. The mean slope of this portion of the valley is five-tenths of a foot per mile, while that of the river is only half as much. The Mississippi River now flows over a buried valley, the floor of which is from 100 to 200 or 300 feet below its surface, so that the declivity of the ancient channel below the mouth of the Ohio is over one foot per mile. The river throughout this portion of its course, wanders over alluvial flats from forty to eighty miles wide, and

* "Great Changes of Level in Mexico and the Interoceanic Connections." Bull. Geol. Soc. Am., vol. ix., pp. 13-34 1897.

these flood-plains are bounded by high bluffs of soft or incoherent rocks of Cretaceous and early Tertiary ages, and later superficial deposits, in contrast to the hard Paleozoic formations of the upper section of the valley. The difference of width of the upper and lower portions of the valley is mostly due to the rainfall acting upon the more readily yielding strata during a long period of base level of erosion. The lower part of the buried valley reaches to the great depth of about 1,000 feet below the Gulf of Mexico.* If the region should further subside† by 300 feet, the river would become an estuary like that of the St. Lawrence.

The Colorado River of the West forms another type of valleys. It flows from elevated plateaus, some of which have altitudes of 8,000 or 10,000 feet above the sea. From Echo Cliff, the Marble *canyon* extends sixty-six miles to the mouth of the Little Colorado River, below which the gorge of the Grand *canyon* reaches 195 miles to Grand Wash, but the *canyon* is twenty-five miles longer. The gradient of the river is commonly between seven and eight feet per mile, although reduced in parts to five feet, or increased to twelve feet in others, and locally it is nowhere more than twenty-five feet. The mean slope is accordingly 8.5 feet per mile. (These slopes are illustrated in figure 2, page 364). The inner *canyon* may have a breadth equal to the depth, or from 3,500 to 4,000 feet, but the outer *canyon* has a width of from five to over twelve miles, with bounding escarpments 2,000 feet above the higher floor. The outer valley suggests that the region was at a lower base level, when the altitude could not have been at more than a slight elevation above the sea, like that of the modern Mississippi valley.

The gorge of the Niagara River is seven miles long, and although the volume of water is very large, the mean declivity is about sixteen feet per mile; but locally there are great rapids and eddies.

Equally important, with the study of the slopes of the great valleys and rivers, is that of the gradients of their short tributaries. These are often hardly more than stupendous washouts, forming great amphitheatres. The gradients of these short valleys may be from 400 to 600 feet per mile for a few miles, but this is greater near its head, and less along its lower portions. The declivity is never less than 200 feet per mile (Dutton‡).

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* The depth has long been known to exceed 600 feet, but lately Mr. E. L. Corthell has found by borings that it reaches to about 1,000 feet.

† Mr. Corthell has also found that the region about New Orleans is sinking at the rate of five feet a century. "Geographical Development of the Lower Mississippi." Communicated to the British Association, Toronto, 1897.

‡ The measurements were taken from the "Tertiary History of the Grand *Canyon* District" (of the Colorado of the West), by C. E. Dutton (1882).

Another class of valleys may be seen between Vera Cruz and the edge of the table-land, by following the route of the Mexican railway from the coastal plain, just below Atoyac, to Esperanza, a town situated upon the margin of the plateau, at an elevation of 8,000 feet above the sea. The section is shown in figure 5, page 365, or on a scale less vertically exaggerated in figure 1. The valley may be considered as an

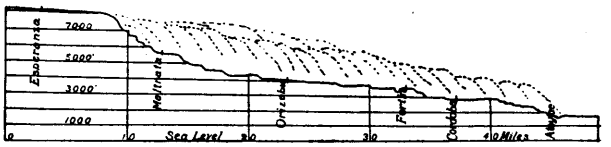

FIGURE 1.—Section between Esperanza and Atoyac, showing the descent of the valley by gradation steps, or a succession of base levels of erosion.

abrupt incision in the floor of the plateau. It is about forty miles long, although the railway has a much greater length on account of its windings. The upper four miles, forming the amphitheatre heading the valley, have a mean descent of about 600 feet per mile (although the uppermost mile represents a descent of a thousand feet). If reaches of eight or ten miles be taken, the mean slope is 150 feet per mile, except below the city of Orizaba, where the declivity is about half as great. The analysis of the slopes shows that they consist of very gently declining, or almost level, steps, with abrupt frontal margins. Often several steps coalesce so that, in places, they form one, several hundred feet in height. In such cases, the platforms are dissected by short *canyons*, such as may be seen at Atoyac, near Fortin, below Maltrata, and at other places. The *canyons* characterizing the edges of the steps, or terraces, are narrow and deep, and they are less than half a mile long, representing the small amount of work since the last elevation of the late base level of erosion.

The more or less buried valleys crossing the coastal plains of the southeastern part of the continent are frequently from two to four miles wide, at distances of 100 or 200 miles from their mouths, and from six to ten miles wide upon nearing the coast, which varies from fifteen to nearly 300 miles from the edge of the continental shelf. It has been already stated that the Mississippi valley is from forty to eighty miles wide, and that the upper terrace plain of the Grand *canyon* of the Colorado is from five to twelve miles wide, with bounding escarpments 2,000 feet high. The St. Lawrence is a partly drowned valley, seventy miles wide for the last hundred miles of its course, before reaching Anticosti Island, and about thirty miles in breadth for the next hundred

miles above. It is reduced to fifteen miles in width only, near the mouth of the Saguenay, which is 325 miles above Anticosti.

Upon the edge of the continental plateau, the Bahaman Channel (extending from the Straits of Florida, along the northern side of the Bahama Islands*) or drowned valley, has a breadth of seventeen miles, (although its depth is 11,898 feet) where the adjacent shelf is submerged 5,650 feet. The deeper part of the drowned valley of the Mississippi has a breadth of twenty. The broader plain-like floors of the Floridian Channel (the drowned valley extending from the shallowest part of the Straits of Florida to the floor of the Gulf of Mexico. See Map), are rarely forty miles wide, and the deeper ones may be reduced to ten miles. Among the Bahama banks, the deep valleys have a breadth of ten or fifteen miles, while the broader and shallower portions near the surface of the sea may reach from forty to sixty miles in breadth. There are numerous short amphitheatres, indenting the margins of the submarine plateaus, which relatively have no greater magnitudes and declivities than their counterparts which are tributary to the Colorado, or others indenting the margins of the Mexican table-lands.

From a vast number of examples studied, of which these given are only types, the conclusion is that the magnitude of the submerged valleys under the varying conditions is no greater than that of the valleys upon the surface of the continent.

The gradients of the submarine valleys, if considered without their analysis, would be wholy misleading, just as it would be to suppose a uniform descent for the valleys dissecting the border of the Mexican table-lands. Of the various submerged valleys, the Floridian channel offers one of the most complete subjects for study, and its slopes are illustrated in figure 2. For purposes of comparison, the declivites of the Floridan valley, and those of two other valleys (figures 5 and 6), descending from the table-lands of Mexico, are drawn to the same scale as shown on a following page, but the scale of the land valleys is too small to illustrate the numerous terrace steps. Other examples of the submarine gradients are shown in the sections of the Bahaman and Abacan (figure 3), and Cazonan (figure 4), channels, the last of which in magnitude closely resembles the Atoyac valley. If the declivities of the valleys, descending from the Mexican plateau be taken as a whole, the slopes will be observed to be more precipitous than the greater steps now known in the descent of the Floridian channel, or of the channels amongst the Bahamas.

*See Map reproduced from the "Reconstruction of the Antillean Continent," opposite page 357.

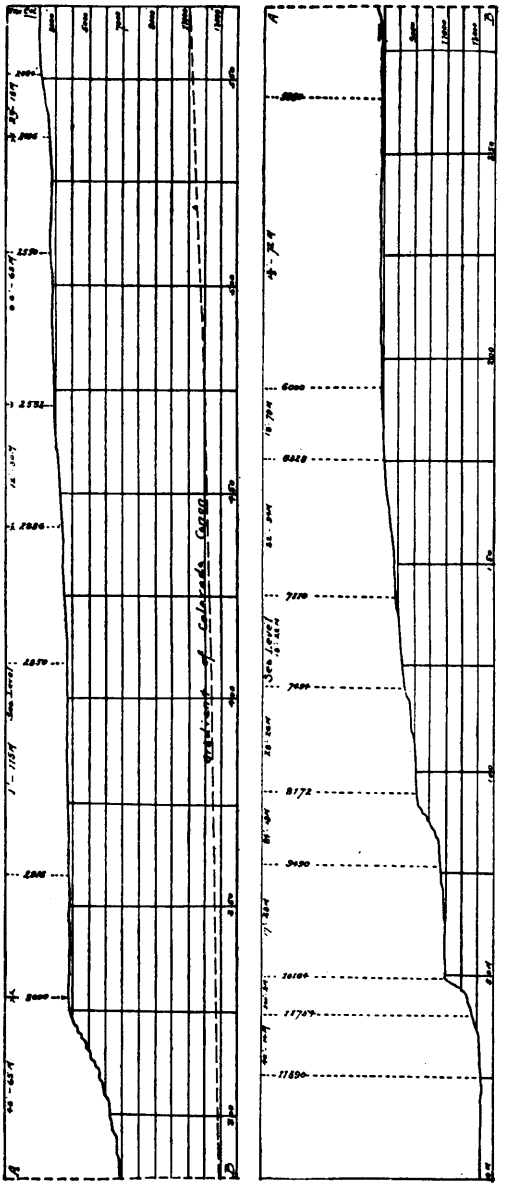

FIGURE 2.—Section of the Floridian Valley (the two parts to be joined at the broken line A B.).

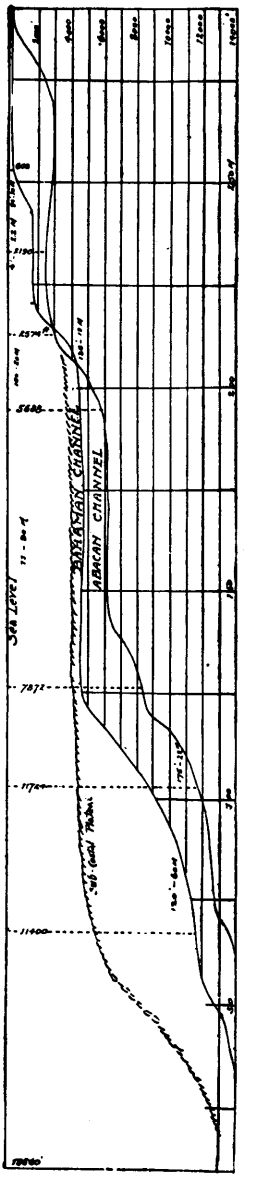

FIGURE 3.—Sections of the Bahaman and Abacan Channel.

Figures 2 and 3 illustrate the descent of three great channels rom the *col* of the Straits of Florida to the floors of the Mexican and Atlantic basins, (for their locations see Map). They show a succession of steps like great base levels separated by precipitous slopes. The soundings have been made where the figures are shown in feet. The gradients are given in feet, for distances expressed in miles. The descent of the Colorado *canyon* is illustrated in figure 2.

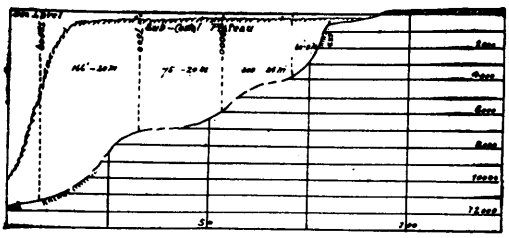

FIGURE 4.—Sections of the submerged Cazonan valley (south of Cuba). It is much shorter than the other sections shown, and somewhat resembles a great ampitheatre.

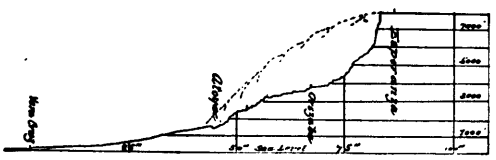

FIGURE 5.—Section showing the descent of the valley descending from the Mexican plateau and emerging on the coastal plains at Atoyac.

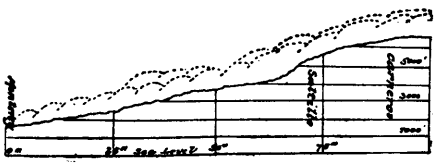

FIGURE 6.—Section of a Mexican valley descending to Monterey.

These sections of valleys descending from the Mexican plateaus are drawn on same scale as those submerged. The sections of submerged and land valleys are here brought together for purposes of comparison.

The long reaches of the Floridian Channel resemble base levels, and may be seen to have much more gentle slopes than those of the Colorado *canyon* (shown on Figure 2). Indeed, some of the drowned stretches have gradients as low as, or even lower than those of the buried channel of the Mississippi. Thus along portion of figure 2, for a distance of 115 miles, the gradient is only one foot per mile; and along another part, for 65 miles, the declivity is reduced to six-tenths of a foot. Even on the abrupt slopes between the nearly level reaches, for example a distance of 65 miles, the descent averages only 43 feet per mile; and if the Mexican valleys can be taken as guides in interpreting the submarine features, it is probable that more detailed soundings would show the descent of the floor to be made up of almost level reaches separated by steps more precipitous than those shown. Comparing this drowned valley with the valley above Atoyac, it may be observed that for stretches of eight or ten miles, the mean descent of all the

steps of the land valleys amounts to 150 feet per mile, and for the last four miles, at the head of the amphitheatre even 600 feet per mile. Similar declivities have also been pointed out among the tributary amphitheatres of the Colorado River. The slopes of the drowned valleys (as illustrated in figures 2 and 3), are thus seen to be a succession of flat reaches, like base levels, and the margins of all are characterized by steep slopes in all respects resembling the land valleys, (figures 5 and 6) descending from high table-lands. The great stretches of low gradients found amongst the drowned valleys, agree more or less with the submerged plateaus, and appear to have been formed when they were at base level of erosion, before their subsidence.

If the Mississippi valley were elevated, the processes of *canyon* and valley making would gradually dissect the margins of the newly elevated table-land. Such appears to have been the case, at the time of the formation of the now buried valley, discovered near New Orleans to a depth of 1,000 feet. On the other hand, if the Mexican plateau were reduced to base level, the valley above Atoyac would be a short fjord, like that of the Gulf Cazonas (Figure 4), or like the buried valleys of the lower Mississippi.

If the analogy be complete enough, and numerous other phenomena could be further cited in support of it, a most important geological history can be interpreted from the submarine valleys. It has been found that terrestrial movements are not uniform; and although over some continental regions the variation has been so slight as not to disturb the course of the drainage, in others it has been affected. In some cases barriers have been thrown across the valleys by the warping or tilting of the earth's crust; such as that closing Lake Ontario and other lakes and confined sea basins. The greatest amount of terrestrial movement occurs in the mountain regions; and the least on the plains. There are also indications that the greatest rate of depression takes place upon approaching the oceanic abysses. These exaggerated movements named are usually parallel to mountain ranges, and consequently most of them are transverse to the courses of the submerged valleys, and consequently the terrestrial oscillations have not materially affected their depths, though they may have somewhat increased their slopes; yet not to so great an amount as to prevent the depths of the valleys dissecting the submarine plateaus (and producing banks and islands) from being used as yard sticks for measuring the extent of changes of level of land and sea. In the valleys parallel to the mountain folds, it appears that the terrestrial movements have given rise to deep basins.

The valleys beneath the Antillean seas have, in part, been excavated out of disturbed strata, as is suggested by the exposures of the formations on the adjacent islands, and also in part out of undisturbed beds, which last occurrence is generally the case on the coastal plains of the continent. The formations immediately adjacent to the drowned valleys belong everywhere to late geological periods.

The characters of the submarine valleys—in their magnitude; in their declivity; in their being extensions of existing rivers; in their receiving tributaries from various directions, like modern streams; and in the long reaches of their floors, with low gradients, resembling gradation plains and base levels of land valleys—are so strongly analogous to land features, as to more than indicate their common origin. Indeed, the likeness is so strong as to suggest a satisfactory explanation of the submarine valleys off the south-eastern coast of North America, and those of the West Indies, that is to say, they appear to be drowned valleys of atmospheric origin. With the occurrence of the submerged valleys thus explained, it follows as a conclusion that the West Indian region and the margin of the continent stood once nearly as high as the drowned valleys are traceable, which feature extends nearly to the floors of the Antillean basins. This implies a late elevation of the region to a height of two or three miles, which altitude is greater than that generally assumed in late geological times. But the recent extraordinary depression of the Antillean plateau does not extend to the western boundary of the region. Between the east and the west there was a zone of diminished terrestrial movements. The broad valley which is now the floor of the Gulf of Mexico, has its counterpart setting into the continent from the Pacific side, but the Mexican barrier between the two oceans has only been recently elevated—in part to 8,000 or 10,000 feet. This seems then to be a physical compensation for the sinking of the Antillean plateau of the east, and illustrates stupendous movements in the opposite direction, in late geological times.

Many writers have regarded the West Indian Islands as remnants of mountain ranges submerged, but no standard was found for measuring the amount of depression, until the application of geomorphy to the drowned valleys was suggested by the writer. It might have been formerly supposed that the West Indian basin alone sank, while there was no considerable change of continental elevation; but such a hypothesis is now opposed by the analysis of the character of the valleys. Nor have ocean currents greatly deepened the channels, for even the

cols beneath the Gulf stream are hundreds of feet above the submarine plateaus on both sides of it. To that channel there are several tributaries from directions which oceanic currents could not affect.

Lyell, the great geological teacher, impressed upon his followers the instability of the land and sea. The drowned valleys are only measuring sticks for determining the amount of change.

SPECIAL NOTICE.

The Council of the Canadian Institute regret to learn that some of the recent publications of the Institute, although mailed in the usual way, have failed to reach their destination, in particular, so far as can be ascertained, the following numbers :—

TRANSACTIONS, No. 9.....October, 1896.
PROCEEDINGS, No. 1.....February, 1897.
" " 2..... May, 1897.
" " 3.....September, 1897.

Members and Exchanges will please, immediately on receipt of this Notice, inform the Secretary by letter or post card, which, if any, of the above numbers they have not received, so that the Institute may supply those missing so far as may be possible.

As 1899 will be the Semi-Centennial Anniversary of the foundation of the Institute, it is in contemplation to issue a special Memorial Volume appropriate to the occasion.

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