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CANADIAN NATURALIST

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Quarterly Journal of Science.

ON THE ORIGIN OF SOME AMERICAN INDIAN TRIBES.

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SECOND ARTICLE.

In the former paper I indicated the existence of a broad line of distinction dividing the aboriginal languages and peoples of this continent into two well-defined groups, the one Malay-Polynesian, the other Turanian in origin. It is with the latter that I now propose to deal. The Turanians of America stand in geographical relation to Canada chiefly through the Wyandot-Iroquois family, two important divisions of which, the Hurons and the Six Nations, occupy no inconspicuous position in the early history of the country. Originally this family extended as far south as the Carolinas, and the isolation of the northern Iroquois in the midst of an Algonquin area is due to that intrusive character and love of conquest which made the warlike Mohawk and his fellows the terror of other Indian tribes. The Assineboins or Stone Indians, whose name is Algonquin, are also Canadian, dwelling upon the banks of the Red River and its tributaries, but they are Dacotahs belonging to the great family commonly known as Sioux, most of whose tribes are found west of the Mississippi. Mr. Lewis H. Morgan, who has investigated many questions relating to the aboriginal population of America, maintains that the Wyandot-Iroquois and the Dacotahs are branches of the same original stem, and all that I know of the two families confirms his opinion. A third great family which has no representative in the Dominion is brought into relation with the Iroquois and Dacotah classes by Dr. Latham, who, for comprehensiveness of view and extent of knowledge, has found no superior in the field of American ethnology. This is the Cherokee-Choctaw family, whose tribes, among which Dr. Latham counts the Catawbas, Woccoons and Caddos, originally extended from Tennessee to Florida. I unhesitatingly state that the Iroquois, Dacotahs and Cherokee-Choctaws are of Turanian or Northern Asiatic origin.

Commencing with grammatical forms, these families agree in making use of postpositions exclusively, thus differing from the Algonquin and its parent Malay, and agreeing with all the varieties of Turanian speech. In the order of the verb, a second point of difference from the former, and of accordance with the latter languages equally marks Iroquois, Dacotah and Choctaw; the temporal index follows the verbal root. The accusative precedes the governing verb in Dacotah and Choctaw, and, as I have already stated, the same principle finds illustration in Iroquois. This is one of the radical distinctions which characterize the Turanian as contrasted with the Malay grammatical system. Once more, the Iroquois, Dacotah and Choctaw languages prepose the genitive to its governing noun, which, as Dr. Edkins says in China's Place in Philology, is essentially Turanian. In the use of postpositions, the postposition of the temporal index to the verbal root, the preposition of the accusative to its verb, and of the genitive to its nominative, four important features in a grammatical system, the Iroquois, Dacotah and Choctaw languages cut themselves off from all Malay Polynesian relationship and claim affinity with the great Turanian family. But the great Turanian family is very large and very widely spread over Europe and Asia. Its Finnic class includes the Finn, Lapp, Esthonian, Vogul, Mordwin, Magyar, and other European and Western Asiatic dialects. In its Turkic class we find the Turk, Uigur, Kirghis, Bashkir, Yakut, and many more. The Mongol contains the Mongol, Khalkha, Kalmuk, Buriat, &c.; and the Tungusic, the Tungus, Lamute and Mantchu. Then in Thibet, Hindostan, and the Indo-Chinese area, many classes are found, the most important and best known of which is the Dravidian, embracing the Tamil, Telugu, and other dialects of southern India. Leaving the Siberian Samoyeds, Yukahiri and Yeniseans out of account, we find in north-eastern Asia an extensive group of languages spoken by the peoples whom Dr. Latham has classed as Peninsular Mongolidæ, languages that in all their leading features are Turanian. Such are the Koriak-Tchucktchi, the Kamtchatdale, Corean, Aino and Japanese, concerning which Dr. Latham says: "they have a general glossarial connection with each other; the grammatical structure of only one of them, the Japanese, being known." He also adds: "What applies to the language of the Peninsular tribes applies to their physical appearance also."

It being granted that the Iroquois, Dacotahs and Choctaws are Turanian, to which of the Turanian classes, Finnic, Turkic, Mongolic, Tungusic, Dravidian, or Peninsular, do they belong? Were they very ancient peoples like the Peruvians, grammar could not settle the question, owing to changes that have taken place in the systems of some Turanian languages. These changes principally affect the pronoun. Thus Dr. Edkins points out the fact that in the Mongol class alone the Buriat renders "I kill" by *alana-p*, while with the Eastern Mongol it is *bi-alana*; the pronoun being in the one case terminal, in the other a prefix. Dr. Edkins regards the latter as the older form, but, apart from the analogous case presented in a comparison of the Latin with its modern representatives, the occurrence of the *alana-p* form in the ancient dialects of Peru seems to give it the prior claim to antiquity. Now the Iroquois, Dacotah and Choctaw systems prefix the personal pronouns. In the Finnic, Turkic and Dravidian Turanian classes the pronoun is terminal, as in the Quichua of Peru. In some of the Mongol dialects, in the Tungusic and Peninsular classes, the pronoun occupies the same initial position as in the North American languages of Turanian origin. But Dr. Latham says "in his most typical form the American Indian is not Mongol in physiognomy"; and certainly none of the tribes we are now considering have anything in common with the Tungus, apart from a common grammatical system. Once more I quote Dr. Latham: "In the opinion of the present writer, the Peninsular languages agree in the general fact of being more closely akin to those of America than any other." Many writers on the Tchuktchi-Koriaks of the Peninsular area have compared them with American tribes, such as Von Matiushkin, who says: "They are distinguished from the other Asiatic races by their nature and physiognomy, which appears to me to resemble that of the Americans." Mr. Baldwin, in his Ancient America, asserts that "Our wild Indians have more resemblance to the nomadic Koraks and Chookchees found in Eastern Siberia, throughout the region that extends to Behring's Strait, than to any people on this continent. Those who have seen these Siberians, travelled with them, and lived in their tents, have found the resemblance very striking; but I infer from what they say that the Korak or Chookchee is superior to the Indian." Mr. J. Mackintosh, whose book on "The Discovery of America and the Origin of the Indians," was published at Toronto in 1836, exhibited many interesting parallels between the American Indians and the Koriaks, but as he considered the former as one people and united the latter with the Tungus, his parallels are practically useless. So common is the statement that the languages of the Tchucktchis and Esquimaux are virtually one, that in my article on the affiliation of the Algonquin languages I was misled by the universal consensus into a homologation of it; but the exploring expeditions undertaken by the United States government have proved that the statement is unfounded, and that the Tchucktchis of Asia differ from the Esquimaux physically as well, being taller and thinner, with redder complexions and more prominent features, in every respect a superior body of men. The error arose in confounding the Aleutans and Kadiaks with the Esquimaux or Innuit, for the identity in language of these peoples with the Tchucktchis is beyond doubt.

While the Iroquois traditions, according to Dr. Oronhyatekha, assert the autochthonic origin of that people, those of the Dacotahs and Choctaws, as related by Catlin and others, refer to a migration from the north-west, where they dwelt for a time amid snow and ice. It is evident that the original home of Dacotahs and Choctaws was that also of the Wyandot Iroquois, and that the autochthonic theory is of a piece with the same doctrine among the ancient Greeks, a mere form of national vanity. Iroquois, Dacotah and Choctaw grammar agrees in all points, even to the preposed pronouns, with that of the Peninsular languages. The tall muscular form, red complexion and prominent features of the Tchucktchis agree with the physical appearance of the three American families. The encroaching, warlike, indomitable spirit of the Koriaks, of whom the Tchuktchis are a branch, can find no better parallel than among the three warrior peoples of North America. Some of the Koriak tribes flatten the head; so did the Choctaws, the Catawbas, and some of the Dacotahs. I know of no Mongolic or Tungusic peoples—the only others with whom grammatical forms permit us to compare the Iroquois, Dacotahs and Choctaws—who practised this artificial compression of the skull. All these facts tell powerfully in favour of a peninsular derivation. Add to this the fact that the three American families were sun worshippers, and that their religion thus agrees with that of the Koriaks, Ainos and Japanese; that Arioski, the Koriak war-god, corresponds to the Wyandot-Iroquois Areskoui, and the Japanese Jebisu, to the Choctaw or Muskogulge Eefeekesa, and the evidence becomes irresistible.

In one of the families under consideration, tribal names serve to confirm the connection with Peninsular peoples. This is the Cherokee-Choctaw. In the Cherokees we readily recognize the Koriaks, who call themselves Koraeki, and in the Choctaws it is not hard to find the Tshekto, as the so-called Tchuktchi are properly designated. Now the Koriak-Tchuktchis and the Choctaws agreed in flattening the head, as we have already seen. They also agree in being great lovers of manly sports, and I cannot but think that "the game resembling prisoners bars" with which Martin Sauer in his account of the Tchuktchi connects "their dexterity in throwing stones from a sling," is the well known "ball play" or "lacrosse," in which the Choctaws specially excel, but which is also common to the Iroquois and Dacotahs. A game closely resembling lacrosse is played in Japan.

There are many Koriak-Tchuktchi words in Choctaw and Cherokee, such as the Tchuktchi *ischtamat* 4, *tahlimat* 5, *awinljak* 6, *kolle* 10, in which we recognize the Choctaw *ushta, tahlapi, hannali* and *pokoli.* Others are *annakh* father, the Choctaw *unky*; *ikahlik* fish, the Choctaw *kullo* and Cherokee *agaula*; *ijuk* foot, the Choctaw *iyi*; *nujak* hair, the Choctaw *nutakhish*; *unnjuk* night, the Muskogulge *nennak*; *kiuk* and *wegim* river, the Choctaw *hucha, okhina*; *matschak* sun, the Chickasaw *neetakhasseh*; *utut* tree, the Muskogulge *ittah*; *aganak* woman, the Cherokee *ageyung*; *imagh* sea, the Cherokee *amaquaohe*; *unako* tomorrow, the Choctaw *onahe*, &c. But so far as I am able to judge from the materials at my disposal, the Cherokee-Choctaw vocabulary has greater affinity to the Japanese and Loo Choo than to the Koriak-Tchuktchi. Thus, in Japanese the words denoting bone and boat or canoe are nearly identical, the former being *fone*, the latter *fune*. Now in the Choctaw, strange to say, *foni* is bone and *peni* boat. The day is *nitchi* in Loo Choo and the sun is *nitji* in Japanese, and these correspond to the Choctaw *neetak* and the Muskogulge *neetahusa*. Man is *hito*, *otoko* in Japanese, and *hatak* in Choctaw; while woman is *tackki* in Loo Choo and *tekchi* in Choctaw. The Choctaw *eebuk* and the Chickasaw *skoboch* head, find their equivalents in the Loo Choo *bosi* and the Japanese *kubi*. So, house is *chookka* in Choctaw and *chukutsche* in Japanese; rain being *ema* in the former and *ame* in the latter. These instances will suffice to indicate, what I have more fully set forth in the Canadian Journal, the radical unity of the Cherokee-Choctaw and Peninsular vocabularies. What better proof of a common origin could be demanded than that which is presented in a comparison of the Japanese *otoko-no-fone*, "the man's bone," with the Choctaw *hatak-in-foni*; or of the Loo Choo *takki-noo-eebee*, "the woman's finger," with the Choctaw *tekchi-in-ibbak*? The Japanese past tense in *ta* and the Loo Choo in *tee*, which find their equivalent in the Choctaw *tok*, illustrate the final check that marks the *ibbak* of the latter as compared with the *eebee* of the former, and refer the philologist to the allied Koriak Tchuktchi which abounds in such terminations. While it is true that the Koriaks have been frequently regarded as the parent stock of American tribes in general, I am not aware that any writer has ever specifically placed them in relations with the Cherokee-Choctaw confederacy. To find Koriaks in Alaska has been deemed a reasonable enough thing, but snow in harvest would have been thought as likely a phenomenon as Tchuktchis in Tennessee. Thus we find Chateaubriand gravely asserting that the Chickasaws, a Choctaw tribe, came from Peru at the time that the Natchez immigrated from Mexico. Tennessee and Mississippi are the elephant of the Chickasaws and Natchez, Peru and Mexico their tortoise, but we ask in vain on what does the tortoise stand, for of all American populations the Mexican is the hardest to affiliate. I willingly admit that the Chickasaws, with all the other members of the Cherokee-Choctaw confederacy, belong to the same parent stock as the sun-worshipping Peruvians, but, inasmuch as this parent stock is found in the north-west, evidence of no common character would be required to render probable a retrograde movement from South to North America. To sum up the argument for the Peninsular Asiatic origin of the Cherokee-Choctaw family, we have found it to be proved by language in its grammatical and verbal forms, by tribal designations, physical features, moral character, religion, and at least one peculiar custom.

For the Wyandot-Iroquois family I have so far found no tribal designations in the Peninsular area that correspond, but the identity of the two war-gods Arioski and Areskoui undoubtedly links them with the Koriaks proper. This is confirmed by the many resemblances that are found to exist between the Cherokee (Koraeki) and Iroquois vocabularies, some of which are indicated in the Mithridates. Such are the Cherokee *gahnee* and the Cayuga *kanoh*, arrow; *oostekuh*, child, and the Tuscarora *yetyatshoyuh; choosu*, die, death, and the Mohawk *keahheyouh; keira, keethlah*, dog, and the Onondaga *tschierha* and Tuscarora *cheeth*; *cheela, cheera*, fire, and the Caughnawaga *ojechlah* and Tuscarora *ot-cheere; atseeai*, man, and the Minekussar *itaatsin*, and Mohawk *ratsin; naune*, mountain, and the Wyandot *onontah*; *yahnogah*, tongue, and the Iroquois *honacha; ageyung*, woman, and the Tuscarora *ekening*. The relations of Iroquois and Peninsular words are numerous and close. The following is not a selection but a chance collation of them:

	Wyandot-Iroquois.	Peninsular.
arm	onentcha *Iroquois.*	oondee *Insu.*
axe	askwechia "	kvasqua *Kamtchatka.*
bad	washuh *Tuscarora.*	wasa *Loo Choo.*
	hetken *Iroquois.*	khatkin *Koriak.*
boat, canoe	gahonhwa "	cahani *Aino,* huni *Loo Choo.*
boy, son	yung *Oneida.*	iegnika *Tchuktchi.*
brother	jattatege *Onandaga.*	ototo *Japanese.*
child	kotonia *Iroquois.*	kodoma "
earth	ohetta "	ttati *Corea,* tjidsi *Japanese.*
eat	hiquekeh "	ewa *Japanese.*
egg	onhonchia "	ngach *Kamtchatka.*
father	ata *Tuscarora.*	atta *Tchuktchi,* teti *Japanese.*
	hanee *Seneca.*	annakh *Tchuktchi.*
	lahkeni *Oneida.*	illiguin "
fire	yoneks *Tuscarora.*	annak "
fish	keyunk *Mohawk.*	sakkana *Japanese.*
foot	auchsee *Tuscarora.*	assi "
	achita *Wyandot.*	gitkat *Tchuktchi.*
come	karo *Mohawk.*	kuru *Japanese.*
go	higue *Iroquois.*	yuki "
hair	ahwerochia "	kurrazzoo *Loo Choo.*
hand	chotta "	settoo *Kamtchatka.*
	osnonsa "	soan *Corea.*

	WYANDOT-IROQUOIS.	PENINSULAR.
heart	hahweriacha *Iroquois.*	kokurro *Japanese.*
heaven, sky	toendi *Wyandot.*	ting "
	kiunyage, *Seneca.*	khigan *Koriak.*
man	eniha *Nottoway.*	aino *Aino.*
moon	kanaughquaw *Cayuga.*	kounetsou *Aino.*
	kelanquaw *Mohawk.*	geilgen *Koriak.*
mother	anah *Tuscarora.*	anak *Tchuktchi.*
mouth	agwaghseno *Mohawk.*	ekigin "
nose	yuungah *Wyandot.*	chynga *Tchuktchi*, honna *Loo Choo*
river	joke *Nottoway.*	kiuk *Tchuktchi.*
small	ostonha *Iroquois.*	uicinan *Kamtchatka.*
snow	ouniyeghte *Mohawk.*	anighu *Tchuktchi.*
sun	hiday *Tuscarora.*	tida *Loo Choo.*
	onteka *Iroquois.*	nitji *Japanese.*
tongue	ennasa "	nutshel *Kamtchatka.*
water	hohne:a "	mok, nouna *Tchuktchi.*
white	kearagea "	sheeroosa *Loo Choo.*
woman	yonkwe "	innago "
	otaikai *Wyandot.*	taekki "
	ekening *Tuscarora.*	aganak *Tchuktchi.*
sister	akzia *Onondaga.*	zia *Aino.*
finger	oniage "	ainhanka *Tchuktchi.*
basket	atere *Iroquois.*	teeroo *Loo Choo.*
tail	otahsa "	dzoo "
kill	kerios "	korossu *Japanese.*
write	khiatons "	katchoong *Loo Choo.*
copper	kanadzia "	kanujak *Tchuktchi*, sintju *Japanese.*
nail (finger)	ohetta "	kouda *Kamtchatka.*

Such are a few of the resemblances which lie on the surface, in connection with which, and this will equally apply to the Cherokee-Choctaw languages, it may be said that the Iroquois dialects are more closely related through their vocabularies to the Peninsular tongues than are the English and the German to one another. Like the Cherokee-Choctaw family, the Iroquois have also been found to agree with the Asiatic peoples in their grammatical forms, physical features, and religion. The sun or chief divinity, *matschak* in Tchuktchi, *nitji* in Japanese, and *neetakhasseh* in Choctaw, has appeared as *onteka* in Iroquois; and the Catawba *noteeh*, the Adahi *nestach*, the Cuchan *nyatch*, the Peruvian *inti*, and the Araucanian *antu*, *antuigh*, carry on the sun-worshippers of north-eastern Asia far into the southern continent. The warlike, intrusive Koriak, who has driven his relative the Kamtchatdale to the south of his peninsula, and almost exterminated the Yukagir, is, apart from all other considerations, the fittest Asiatic with whom to compare the similarly warlike and intrusive Iroquois.

The third family of North American Turanians, but really the first of the three in geographical order, and therefore probably the last in chronological, is the Dacotah. Some of its tribes contain the finest specimens of native humanity on the continent, and some have exhibited a degree of culture much in advance of other northern aborigines. They are essentially landsmen like the Iroquois and Choctaws, and, like them, never dreamed of an insular heaven. The past few years have shewn that even now they retain their old indomitable spirit, for they are to the United States what the Koriaks are to Russia. They have their traditions of a deluge, like the Iroquois, Choctaws, Cherokees and Caddos, traditions that do not appear in the Algonquin and Malay-Polynesian areas, but which flourish in Kamtchatka and other Peninsular regions. They are in fact unadulterated Turanians. Nor can they have long been occupants of American soil, for their language bears traces too clearly defined of a Peninsular origin to have stood the wear and tear of many centuries. Lieut. Clifford, R.N., in his short preface to the Loo Choo vocabulary in Basil Hall's voyages, calls attention to the fact that the infinitive or simple form of the verb in that language ends in *ng* preceded by a vowel, as in *coyoong* bite, *ooyoong* break, *nintoong* die, *simmatong* dwell, *katcheeming* shake, *irreechang* bake, &c. This is precsely what we find in the Dacotah proper or Sioux, as in *opetong* buy, *dowang* sing, *manong* steal, *nahong* hear, *echong* make, *asniyang* heal, &c. But in Kamtchatdale the simple form of the verb ends in *tsh*, a totally different form. Thus *kwatshquikotsh* is to see, *koogatsch* to cry, *kassoogatsh* to laugh, *ktsheemgutsh* to sing, *kanhilkitsch* to lie down, *kowisitch* to go, *koquasitch* to come, &c. But here again, in spite of the apparent diversity of the form from that of the Dacotah, evidence of relationship is manifest, for the Assiniboin, a Dacotah dialect, exhibits the Kamtchatdale form. Examples are *wunnaeatch* go, *eistimmatch* sleep, *aatch* speak, *wauktaitch* kill, *waumnahgatch* see, *aingatch* sit, *mahnnitch* walk, &c. This double identity in the form of a part of speech establishes a closer connection than that which is afforded by a common syntax, and links the Dacotahs unmistakeably with the stock to which the people of Loo Choo and the Kamtchatdales belong. Nor is the vocabulary wanting in confirmation of such a connection, as may be seen from the following brief comparison:

Dacotah.		Peninsular.
arm	ada *Hidatsa.*	ude *Japanese.*
shoulder	hiyete *Dacotah.*	kada "
bad	shisha "	kuso "
bone	hidu *Hidatsa.*	cutsi *Loo Choo.*
boat	wata *Dacotah.*	agwat *Koriak.*
boy, son	ceneek *Winnebago.*	icgnika *Tchuktchi.*
blood	idi *Hidatsa.*	tji *Japanese.*
bull, buffalo	bisha *Upsaroka.*	woushe *Loo Choo.*
child	waheheesh *Dacotah.*	vassasso *Insu.*
cold	sinnee "	anu *Tchuktchi.*
ice	cagha "	cigu *Koriak.*
day	cang "	gaunak *Tchuktchi.*
dog	shong *Assiniboin.*	ing *Loo Choo.*
ear	akuhi *Hidatsa.*	qui *Corea.*
father	ate *Dacotah.*	atta *Tchuktchi.*
fire	pytshi *Winnebago.*	pangitsh *Kamtchatka.*
fish	ho *Dacotah.* poh *Mandan.*	eo *Loo Choo.* iwo *Japanese.*
foot	siha *Dacotah.* itsi *Minctaree.*	assi. atschi *Japanese.*
good	shusu *Mandan.* uohta *Dacotah.*	jukka *Japanese.* hota *Corea.*
hair	pahhee " nijihah *Quappa.*	bode *Corea.* nujak *Tchuktchi.*
head	pahhih *Quappa,* nahsso *Winnebago.*	bosi *Loo Choo.* naskok "
heart	cangte *Dacotah.*	sing *Japanese.*
hot	dsashosh *Mandan.*	attisa *Loo Choo.*
man	wica *Dacotah.*	uika *Tchuktchi.*
	oeeteka "	otoko *Japanese.*
moon	minnatatche *Upsaroka.*	mangets "
mother	enah *Dacotah.*	anak *Tchuktchi.*
mouth	iiptshappah *Minctaree.*	jeep *Corea.*
neck	apech "	kubi *Loo Choo.*
night	hangyetu *Dacotah.*	unnjak *Tchuktchi.*
small	ecat *Upsaroka.*	ekitaehtu "
star	peekahhai *Otto.*	fosi *Japanese.*
sun	wee *Dacotah.*	fi "
water	midi *Hidatsa.*	meze *Loo Choo.*
	ninah *Winnebago.*	nouna *Tchuktchi.*
wife, woman	enauh *Osage.* wingy *Dacotah.*	innago *Loo Choo.*
	tawicu *Dacotah.*	takki "
	wakka-angka *Dacotah.*	aganak *Tchuktchi.*
lake	tehha *Winnebago.*	tonga "
leaf	ape *Dacotah.*	ba *Japanese.*
grass	pezi "	phee *Corea.*
sick	yazang "	yadong *Loo Choo.*
white	ataki *Hidatsa.*	attagho *Kamtchatka.*
make	echong *Dacotah.*	ootchoong *Loo Choo.*
write	akakashi *Hidatsa.*	kaku *Japanese.*
die, death	tche *Hidatsa.* tha *Dacotah.*	tokok *Tchuktchi.*
2	dopa *Hidatsa.*	dupk *Aino.*
3	none *Otto.*	nee *Loo Choo.*
5	kihu *Hidatsa.*	goo "
6	thata *Ioway.*	ittitse *Japanese.*
7	shagoa *Assiniboin.*	siz "
8	dopapi *Hidatsa.*	duhpyhs *Aino.*

In the above, as well as in other verbal comparisons made in these papers, it must be remembered that the scanty materials in my possession prevent anything like a full representation of the agreement between the languages compared. This is especially the case with the Assiniboin and Kamtchatdale, which have been found to agree so remarkably in the simple form of the verb. Sufficient evidence, however, has been afforded of the Peninsular origin of the Dacotahs.

The question naturally occurs, "At what point did the Turanian Americans first appear upon the continent?" That point can be no other than the termination of the Aleutan chain, which extends from the coast of Kamtchatka to the peninsula of Alaska or even to Cook's Inlet. There we find at least four different Indian families. One of them is the Esquimaux or Innuit, whose dialects do indeed contain many Peninsular (Tchuktchi, &c.) words, but whose affinities are greater with the Greenlanders on the one hand and the Asiatic Samoyeds on the other, the very word Innuit being the Samoyed *ennete*, man. Next come the Thlinkeets or Koljush, a people in some respects superior to the Esquimaux, in whose language the termination in *l* and *tl*, so characteristic of the Nahuatl or Mexican, first makes its appearance. These I would incline to associate with the Yukahiri of Siberia, and with the mask-using tribes of the Aleutan chain. Following the Thlinkeets appears a vast family of tribes extending from the Yukon to Mexico and from Cook's Inlet to the Algonquin Cree region about Hudson's Bay. These are the Tinneh Indians, whose name, derived from the word denoting man, language, physical appearance, character, dress and appliances, religion, manners and customs, connect them with the Siberian Tungus. And, lastly, we find in the north-western part of this same area a number of tribes known as American Tchuktchis, Tchugaz, Aliaskas, &c., who have generally been regarded as part of the Esquimaux stock, from which, however, they are well differentiated. These American Tchuktchis or Tchugaz possess a language identical with that of their Asiatic namesakes and constitute one family with them, the connecting links being found in the Aleutans proper, the Unalashkans and and the Kadiak tribes. A sketch of Aleutan grammar furnished by Governor Furnhelm, is contained in the first volume of Contributions to American Ethnology, but as it is so vague as to supply absolutely no information in regard to cardinal points of syntax, the vocabulary must be our test of relationship between the Aleutan and Peninsular languages. In numerals the Asiatic Tchuktchis agree with the Kadiak and Tchugaz of America.

	Tchuktchi	American.
1.	ataschok	attutschik *Kadiak*. *Tchugaz*.
		atakan *Aleutan*. atoken *Unalashkan*.
2.	malgok	mallok. ulcha *Kadiak*, atlcha *Tchugaz*,
		allak *Aleutan*, arlok *Unalashkan*.
3.	pingaju	pingaiun *Kadiak*, pingaijua *Tchugaz*,
		kankus *Aleutan*, kankoo *Unalashkan*.
4.	ischtamat	schtamu *Kadiak*. tschitaami *Tchugaz*,
		setschen *Aleutan*. seecheen *Unalashkan*.
5.	tatlimat	tadlimu *Kadiak*, talliimi *Tchugaz*,
		tschan *Aleutan*. chaan *Unalashkan*.
6.	awinljak	agvinligin *Kadiak*. achoinlign *Tchugaz*,
		atun *Aleutan*. atoon *Unalashkan*.
7.	malguk	malchungin *Kadiak*, malchomin *Tchugaz*.
		olung *Aleutan*, ooloon *Unalashkan*.
8.	pigajunga	ingeljulin *Kadiak*, *Tchugaz*,
		kaltschin. kamtshing *Aleutan*, kancheen *Unalashkan*.
9.	agbinlik	koljungojan *Kadiak*, *Tchugaz*.
		schyset *Aleutan*. seecheen *Unalashkan*.
10.	kulle	kollin *Kadiak*, koln *Tchugaz*, hasuk *Aleutan*.

The ordinary vocabulary exhibits the near relationship of the transitional Aleutans and their American cousins with the Peninsular family.

	Peninsular.	Aleutan, etc.
arm	ude *Japan*. setto *Kamtchatka*.	tsha *Aleutan*, aiigit *Kadiak*.
arrow	eea *Loo Choo*.	kio *Aliaska*.
belly	ksoch *Kamtchatka*.	aksyek *Kadiak*.
blood	auka, aukwe *Tchuktchi*.	auk *Kadiak*, auku *Tchugaz*.
	messou *Kamtchatka*.	amgyk *Aleutan*.
boy, son	paca, pahatsh "	abagutaga. awakutta *Kadiak*.
	iegnika *Tchuktchi*.	anekthok *Aleutan*. tanoghak "
black	tanjachtu "	tannechtuk *Kadiak*, tannacktok *Tchugaz*.
brother	kiodai *Japan*.	choyotha *Aleutan*. ooyitaga [*Kadiak*.
	ani "	angaga *Kadiak*.
copper	kanujak *Tchuktchi*.	kanujak *Aleutan*. *Kadiak*, kannah [*Tchugaz*.
cold	kanjukakok "	kinakak *Aleutan*.
ice	cigu *Koriak*. tshikuta *Tchuktchi*.	caguk *Tchugaz*, tsiku *Kadiak*.
death	tokok *Tchuktchi*.	tokok " tokook "
day	gaunak, aghynak *Tchuktchi*.	achanak " chanak "
dog	kossa *Kamtchatka*.	uikuk *Aleutan*. aikok "
earth	nana *Tchuktchi*.	nuna *Tchugaz*. *Kadiak*.
	nutenut *Koriak*.	tannak *Aleutan*, tannok *Unalash*- [*ka*.
	tjidsi *Japan*.	tshekak *Aleutan*.
eat	kamoong *Loo Choo*.	kaangen "
eye	lilengi *Koriak*.	ingelak *Kadiak*.
egg	manni *Tchuktchi*.	manneck "
father	atta, attaka "	ataga *Kadiak*, ataaka *Tchugaz*.
		athan *Aleutan*, adan *Unalashkan*.
fire	eknok *Tchuktchi*. finoko, *Japan*.	kignak " knok *Kadiak*.
fish	ikahlik *Tchuktchi*.	ikalljuk *Kadiak*.
foot	ijuk *Tchuktchi*, atschi *Japan*.	iuch, idchuk "
	gitkat "	kita *Aleutan*.
give	tunni "	tunnu *Kadiak*, tuneechoo *Tchugaz*.
	ozagadi *Loo Choo*.	agada *Aleutan*, akatscha *Unalash*-
good	matschinka *Tchuktchi*.	matschiskuk *Aleutan*. [*ka*.

	Peninsular.	Aleutan, etc.
girl, daughter	pannika *Tchuktchi.*	punniaka *Kadiak.*
hair	nujet "	noget " nuett *Tchugaz.*
beard	ugnit "	ugnit " ungit "
head	naskok "	naskok " *Tchugaz.*
life	inotji, *Japan.*	anghogikoo *Aleutan.*
man	otoko "	toioch "
	uika *Tchuktchi*, ickkega *Loo Choo.*	ugig *Aleutan*, uika *Kadiak*, &c.
moon	tsuki *Japan.*	tugidak *Aleutan.*
	tankuk *Tchuktchi.*	tangeik *Tchugaz.*
mother	anak "	anak *Aleut.* annaga *Kadiak*, *Tchugaz*
night	unnjuk "	amgik " unuk " "
no	poodong *Corea.*	pedok *Kadiak.*
nose	chynga *Tchuktchi*, kaankaang *Kamtchatka.*	anghosin *Aleutan*, knak *Kadiak.*
woman	innago *Loo Choo.*	angagenak *Aleutan.*
	aganak *Tchuktchi.*	aganak *Kadiak.*
	nulliak "	nulcka "

Such examples may be multiplied indefinitely. From those that have been given it appears that the Aleutan and Unalashkan, while differing in some respects from the Kadiak and Tchugaz, still exhibit ample evidence of a common derivation with them from the Peninsular family. Many of the words in all of these languages are found in the Innuit or Esquimaux dialects, but in spite of this it may be said that there is between the Aleutan-Kadiak and the Esquimaux a radical difference in vocabulary. Still they have largely influenced each other, and traces of this influence are not wanting in the Dacotah and other southern languages of Turanian origin. Thus the Dacotah *tipi*, Yankton *teepee*, Assiniboin *teib*, house or tent, is undoubtedly the Esquimaux *topek*, *tupek*, and many like examples of Innuit influence might be afforded.

The relations of the Transitional Turanians, as we may term the Aleutans, Kadiaks or Kaniagmutes, &c., with the Dacotahs, admit of ample illustration from the vocabulary.

	Transitional.	Dacotah.
bad	kabigwaskak *Kadiak.*	kubbeek *Upsaroka.*
boy, son	awakutta "	skakatte "
	anekthok *Aleutan.*	eeneek *Winnebago*, &c.
cold	tshikok *Tchugaz.*	tasaka *Dacotah.*
	kinakak *Aleutan.*	shinechush *Mandan.*
	potsnatok *Kadiak.*	oisnaitch *Assiniboin.*
day	chanak "	cang *Dacotah.*
	hunnukhpak " (to-day)	aungpa *Yankton*, anipa *Dacotah.*
dog	piuchta *Tchugaz.*	biska *Upsaroka.*
eat	pittooaga *Kadiak.*	wota *Dacotah*, wautah *Assiniboin.*
eye	thaek *Aleutan.*	eshtike *Dacotah.*
father	ataka *Kadiak.*	ate "
	athan *Aleutan.*	tantai *Minctaree.*
foot	itiat *Kadiak.*	itsi "

	Transitional.	Dacotah.
good	assiktok *Kadiak.*	itsicka *Upsaroka.*
great	taangoellik *Aleutan.*	tangka *Dacotah.*
	angoch *Kadiak.*	honska "
hand	shuwanka "	onka *Mandan.*
head	naskok "	nahsso *Winnebago*, naso *Otto*, &c.
heart	kanogh *Aleutan.*	cangte *Dacotah.*
husband	oogeen "	eekunah Winnebago.
knife	mina *Miaska.*	meena *Yankton.*
man	uika *Kadiak*, ugig *Aleutan.*	wica *Dacotah*
	toioch *Aleutan.*	oeeteka "
mother	annak "	enah "
night	unuk *Tchugaz.*	hangyetu "
nose	padzsheeguak *Kadiak* (nostril)	pute, pasu *Dacotah*, peso *Otto.*
rain	kedak "	hade *Hidatsa.*
tree	kunnakat "	cang *Dacotah.*
wood	opohak "	pazu "
woman	angagenak *Aleutan.*	wingyan "
name	assia *Aleutan*, atcha *Kadiak.*	caze *Dacotah*, dazi *Hidatsa.*
die, death	tokok *Tchugaz.*	tehe *Hidatsa.*
see	tangha *Kadiak.*	tongwang *Dacotah.*

Similar relations appear in the Wyandot-Iroquois.

	Transitional.	Wyandot-Iroquois.
boat	kaiyakh *Kadiak.*	gya *Huron.*
mother	choyotha *Aleutan.*	caukotka *Tuscarora.*
	ooyitaga *Kadiak.*	jattatege *Onondaga.*
copper	kanooyat "	kanadzia *Iroquois.*
come	taieerhook "	dagne *Iroquois.*
day	ukhno "	egnisera *Mohawk.*
drink	taangatha *Aleutan.*	uttanote *Seneca.*
fire	kunok *Tchugaz.*	yoneks *Tuscarora.*
foot	kita *Aleutan.*	achita *Huron*, sita *Iroquois.*
give	akatsha *Unalashka.*	wahetky *Iroquois.*
go	itsha *Aleutan.*	yehateatyese *Mohawk.*
	achook *Kadiak.*	higue *Iroquois.*
hand	shuwanka, aiigit *Kadiak.*	sesnonke *Mohawk*, chotta *Iroquois*
head	angloon "	onoalagone *Iroquois.*
leg	irrahka "	orusay *Tuscarora.*
life	anghogikoo *Aleutan.*	yonhe *Mohawk.*
moon	eghaloak *Kadiak.*	kelanquaw "
nose	anghosin *Aleutan.*	enuchsake *Cayuga.*
river	kuik *Tchugaz.*	kaihyohakouh *Mohawk.*
snow	kanneek *Aleutan.*	ouniyeghte "
speak	yukhten *Kadiak.*	hagnotaa *Iroquois.*
star	sthak *Aleutan.*	ojistok *Mohawk.*
tongue	aghnak "	honacha *Iroquois.*
tooth	choodit, hutuka *Kadiak.*	otoatsch *Tuscarora.*
	noontinga *Tchugaz.*	onotchia *Iroquois.*
water	nunak "	ohneka "
	taangak *Aleutan.*	tsandoosteek *Huron.*
wind	kaiyaik *Kadiak.*	gao *Iroquois.*
woman	aiyagar *Aleutan.*	eehro "
	angagenak "	onheghtye *Mohawk.*
	aganak *Kadiak.*	ekening *Tuscarora.*
god	aghugach *Aleutan.*	ocki *Huron.*
salt	attagook *Kadiak.*	hotchiketa *Iroquois.*

The same are found in the Cherokee-Choctaw.

	TRANSITIONAL.	CHEROKEE-CHOCTAW.
arm	ipik *Kadiak.*	sakpa *Muskogulge.*
blood	auk "	issish *Chickasaw.*
	amgyk *Aleutan.*	homma *Choctaw.*
boy, son	abagutaga *Kadiak.*	pooskoos "
bird	cissu *Aleutan.*	hushi "
goose	llak "	shilaklak "
mother	angaga *Kadiak.*	nocksish "
child	ooskulik *Aleutan.*	ulla "
dog	pewatit *Kadiak.*	opho "
ear	tottusak *Aleutan.*	istchuchtsko *Muskogulge.*
fish	ikalljuk *Kadiak.*	kullo *Choctaw*. agaula *Cherokee.*
go	annowa "	angya *Choctaw.*
good	assiktok *Tchugaz.*	seohstaqua *Cherokee.*
head	ischigi *Aleutan.*	ceau *Muskogulge.*
man	tsioch "	atseeai *Cherokee.*
moon	tangoik *Tchugaz.*	teenoenentoghe "
mountain	ingajek *Kadiak.*	nunichaha *Choctaw.*
night	unuk "	nennak *Muskogulge.*
river	kuik "	hucha *Choctaw.*
sun	madzshak "	neetakhasseh *Chickasaw.*
tongue	aghuak *Aleutan.*	yahnogah *Cherokee.*
	ooloo, uloka *Kadiak.*	soolish *Chickasaw.*
death, die	aschalik *Aleutan.*	selle, illi *Choctaw.*
tooth	noontinga *Tchugaz.*	noteeh *Muskogulge.*
wood	opohak *Kadiak.*	upi *Choctaw.*
woman	aganak "	ageyung *Cherokee.*
shoes	ihlhuchik "	shulush *Choctaw.*
to-morrow	wunnaho "	onaha "
sea	immak *Tchugaz.*	amaquaohe *Cherokee.*

The Kadiak and Tchugaz numerals being almost identical with those of the Tchuktchi, exhibit intimate relations with those of the Choctaw. The Aleutans, Kaniagmutes, Tchugaz, Unalashkans, &c., may therefore be regarded as the latest wave of the Peninsular tide of migration, which from a remote period has been pouring in no stinted flow into the American continent, from the time when the Fuegians of the Chileno family in the far south first left their Asiatic home till the present day.

Within the limits of this article I have space barely sufficient to give an outline of the argument which carries the Peninsular family far into South America. The sun-worshipping Natchez of Mississippi, and the Cuchan, Maricopa and Dieguno tribes of New Mexico, as well as the Catawbas, Woccoons, Adahis, Uches and Caddos, to whom I have already alluded, all belong to the line of Peninsular migration, and the extinct mound-builders, if extinct they be, as sun-worshippers must have been of the same parent stock. But for the present I must pass them by as ethnologically of less importance than the South American members of the family. In New Granada we meet with the Muyscas of Bogota, a sun worshipping race whose solar hero, the god Pesca or Bochica, is the Muskogulge Eefeekeesa and the Japanese Jebisu or Zhizobogats. But their solar deity proper is Zuhe, the same as the Huron Iouskeha and the Aleutan Agugux. They also worship Toca, the Huron Atahocan, and, perhaps, the Kamtchatdale Hutka; as well as Aghajun, the Koriak Anggan. Their tradition of the deluge is well defined, and agrees with that of the Kamtchatdales, Dacotahs, Iroquois, Cherokees, Choctaws, Uches, Caddoes and Peruvians. The Muysca verb ends in *scua* or *suca*, and is thus not unlike the Kadiak in *ok* or *tok*. In the use of postpositions; the order of the verb, as 1st. pronoun, 2nd. verbal root, 3rd. temporal index; the preposition of the accusative to the verb and of the genitive to its governing noun: the Muysca completely accords with the Peninsular and allied North American languages. For the agreement of its vocabulary with those of the Peninsular, Dacotah, Iroquois, Choctaw and Peruvian languages, I must refer to the comparative tables in the Canadian Journal. More important than the Muysca are the dialects of Peru, the Quichua, Quitena, Aymara, Cayubaba, Sapibocono, Atacamena, &c., and they deserve more than a passing notice.

The Peruvians, one of the oldest and perhaps the most civilized of native American peoples, have long been known as *par excellence* the sun worshippers of America. The sun, Inti among the Quichuas or Incas, is the same god as the Japanese Nitji, the Loo-Choo Nitchi, the Iroquois Onteka, the Cherokee Anantoge, the Choctaw Neetak, the Catawba Noteeh, the Adahi Nestach, the Coco-Maricopa Nyatz, and the Araucanian Antu, Antaigh. This name seems to have been the peculiar property of the Turanian worshippers of the solar orb. Another Peruvian god, like Pesca or Bochica of the Muyscas the hero of a deluge, was Apachic or Pachacamac, and in him we recognize the Muskogulge Eefeekesa and the Japanese Jebisu. Eruchi was the Sapibocono, and Huiracocha the Quichua war-god, and these again recall the Iroquois Areskoui and the Koriak Arioski. The Peruvian Chinchas practised the artificial compression of the skull like the Choctaws, Catawbas, Natchez and Koriaks. The Quichuas and other Peruvian tribes embalmed their dead like the Ainos. The umbrella was a mark of dignity in ancient Peru as in Japan. The astronomical system of the Incas was virtually that of the

Muyscas, concerning which Dr. Hawks, in his Narrative of Commodore Perry's Expedition to Japan, says, alluding to the Japanese system: "We cannot leave it without the remark that on a comparison of it with that of the Muiscas, an ancient, semi-civilized and now extinct race that once inhabited the plains of Bogota in New Granada, the resemblances were so striking that they produced on our mind a conviction that the astronomical systems of the two peoples were substantially the same." There can be no doubt that the ancient civilization of Peru was that of Japan, and that the connecting links between the two countries are to be found in the mysterious mounds that mark the line of Peninsular migration in America. In confirmation of this I may state that Mr. Donald of this Society has recently called my attention to the fact that similar mounds have lately been discovered in Japan. Physically, so far as we have the means of judging, there seems to have been little in common between the Peruvians and the North American Turanians, and the skull of the former has been shown by Dr. Daniel Wilson of Toronto and other craniologists to be almost without parallel for smallness of capacity, a peculiarity that links it in some degree with that of the Kentucky mound-builders. But language in such a case must be our main test of relationship. In regard to grammatical forms, we find that the Peruvian languages employ post-positions, and that they place the possessive before its governing noun and the accusative before the verb, thus agreeing with all the languages that have so far occupied our attention. The Quichua has been said to differ from other American tongues in the possession of a full declension of the noun, but the same may be found in the Japanese and all its related languages, if we regard the postposition as inseparable from its regimen. The Quichua case terminations are simply cohering post-positions. The Aymara genitive answers perfectly to that of the Loo Choo, as in "the man's head," which is *chacha-na-ppekei* in the former, and *ickeega-noo-bosi* in the latter. In the Peruvian dialects, however, the place of the pronoun is terminal instead of initial as in the Japanese, so that the Quichua verb, as the Rev. Richard Garnett has shewn, corresponds with the Dravidian and thus with the Finnic and Turkic in its order of verbal root, temporal index and pronominal suffix. The Peruvians, therefore, must have separated from the Peninsular stem when the verb in the Japanese and its allied languages was still in the Ural-Altaic stage of development. The Peruvian vocabulary confirms the theory of a Peninsular origin.

	Peruvian.	Peninsular.
all	kuna, *Quichua.*	ignea, *Loo Choo.*
bread	canco, "	gamga, *Kamtchatka.*
dark	tutayasca "	dochsac. "
brother	hauquey "	wiki *Loo Choo*, aki *Tchuktchi.*
child	huahua "	qua *Loo Choo.*
clothes	acsu *Atacama.*	chouk-a *Corea.*
die, death	huanhu *Quichua.*	gang *Loo Choo.* sinu *Japanese.*
day	chine *Sapibocono.*	gaunak *Tchuktchi.*
ear	aike *Atacama.*	qui *Corea.*
earth	idatu *Canubaba.*	ttati "
dust	turo *Quichua.*	duro *Loo Choo.*
eye	naira *Aymara.*	netra *Japanese.*
	nahui *Quichua.*	ni *Loo Choo.*
father	tayta "	teti *Japanese.*
	itica *Atacama.*	attaka *Tchuktchi.*
fire	nina *Quichua*, &c.	annak "
fish	challua "	ikahlik "
	kanu *Aymara.*	'sakkana *Japanese.*
forehead	mati *Quichua*, emata *Sapibocono.*	omote "
goat	paca *Aymara.*	fija *Loo Choo.*
hair	naccuta "	nujet *Tchuktchi.*
hand	tachlli "	tatlichka "
head	ppekei "	bosi *Loo Choo.*
heart	sonceo *Quichua.*	sing *Japanese.*
knife	calhua "	khul *Corea.*
man	kkari " &c.	guru *Kurile.*
	kosa "	quaskoo *Kamtchatka.*
	chacha *Aymara.*	ickkeega *Loo Choo.*
	hake "	okkai *Aino.*
moon	quilla *Quichua.*	geiligen *Koriak.*
mother	mamay "	umma *Loo Choo.*
mouth	khaipe *Atacama.*	jeep *Corea.*
nose	cenca *Quichua.*	chynga *Tchuktchi.*
sun	inti " &c.	nitji *Japanese.*
water	unu "	nouna *Tchuktchi.*
white	yurac "	sheeroosa *Loo Choo.*
year	huata "	hiout *Tchuktchi.*
honey	muski " &c.	mits *Japanese.*
learn	yachachi "	kicku "
sister	nana "	ane "
raise	haka *Aymara.*	aghe "
month	quiz *Quichua.*	gwautsee *Loo Choo.*
strike	takay "	taksu *Kamtchatka.*
copper	anta "	sintju *Japanese.*
sea	mamacocha "	mok, imagh *Tchuktchi.*
tiger	uturunca "	tora *Japanese.*
shoes	usuta "	kwutsu "
breast	nunu "	mune *Loo Choo.*
	huntux *Atacama.*	ingatah *Kamtchatka.*
flesh	aycha *Quichua.*	shishi *Loo Choo.*
yellow	carhua "	cheeroo "
leg	chanca "	shanna "
ice	casa "	cigu *Koriak.*
grass	cachu "	coosa *Loo Choo.*
lip	sirpi "	seeba "

In the vocabularies published in the Canadian Journal, to which I have had so often to refer, will be found, together with a fuller illustration of the agreements between the Peruvian and Peninsular languages, others as complete with the Transitional Aleutan, &c., the Dacotah, Iroquois, and Choctaw-Cherokee. They are all members of one family. Finally the Chileno languages, embracing the Araucanian of Chili, the Puelche of the Pampas, the Patagonian and Fuegian, have all their grammatical and verbal relations with the Peruvian, and thus connect with the Peninsular stock of Asia. These dialects, like the Peruvian, exhibit evidence of great antiquity, although mere geographical position cannot determine that they are spoken by earlier immigrants than the civilized Quichuas, across whose lines they may possibly have passed on their way to a more southern home. They also were worshippers of the sun, and their gods Ngen, Eutagen, Pillan, and Toquichen, are the last representatives of the Koriak Anggan, the Kamtchatdale Hutka and Billukai, and the Huron Atahocan, the latter appearing also in Peru as the Quichua Atahuanca. Their Toquis or Governors are the Tokoks or Chiefs of the Aleutans, terms recalling the Tagus or chief magistrate of the ancient Thessalian States. The Araucanians also are the Koriaks and Iroquois of South America, indomitable warriors, the memory of whose valour is embalmed in a Chilian epic poem, thus preserving the martial character of one branch of the Peninsular family, as the Peruvians did the civilization of another. The Kamtchatdale and the Fuegian may perhaps illustrate a third and degraded class of tribal characteristics. But on the whole the family is a noble one, worthy of a better fate than that which has overtaken all its American representatives, if we except the Cherokee-Choctaw confederacy, which has risen to higher things.

It may be asked whether the Peruvian dialects, seeing that their grammatical forms agree with those of the Ural-Altaic and Dravidian languages, should not be connected with these rather than with the Peninsular tongues. Now it is true that in the Peruvian and Iroquois numerals there are Finnic and Turkic forms, such as the Peruvian *pisca* and Iroquois *wish*, *wisk*, 5, which are the Turkish *besh* and Yakut *bes*, as well as the Finnic *viisi*, the Esthonian *wiis*, and Tcheremissian *vis*. The Aymara *ppekei* head, also is the Turkish *bash* and Yakut *bas*, and the Finnic *poja* and Maggar *fej*, while the Iroquois presents in the two remarkable forms *iokennores*, rain amd *kanadra*, bread, the undoubted equivalents of the Turkish *yaghmur* and the Magyar *kunyer*. But in spite of these resemblances, which it cannot be denied do attest connection if not relationship, a careful comparison of the Peruvian and Iroquois vocabularies with those of the Ural-Altaic languages has convinced me that the connection is one which must be established through the Peninsular forms of speech, with which the American languages have relations vastly more intimate and numerous than with the Finnic or Turkic classes. The Iroquois again is in no respects a Tartar, nor is there any native Finnic or Turkish civilization with which that of the Peruvians may be compared. As for the Turanians of southern Asia, even in the valuable comparative tables of Hyde Clarke, but a distant resemblance to the Peruvian appears in their vocabularies, and we possess not a shred of evidence to show that they ever became a maritime people or occupied the line of Malay immigration to the coasts of America. Dacotahs, Iroquois, Choctaws, Muyscas, Peruvians, Chilenos, were not maritime peoples but essentially landsmen, who, but for the stepping stones of the Aleutan chain, never would have found their way to this continent.

All the American tribes of Turanian origin came originally, therefore, from the north in successive waves, which gradually overflowed the northern continent and poured their tide into the south. They came in at least two different forms or types of national character; the civilized Japanese, represented by the Muyscas and Peruvians, and in a minor degree, if these were not the Peruvians in progress southward, by the mound-builders, the miners of Lake Superior, the potters and weavers of the Ohio valley, by the Dacotah Mandans and the Natchez; and the uncivilized warriors of Koriak blood, from whom a succession of Araucanians and Cherokee-Choctaws, Iroquois and Dacotahs, have descended. And to tell the story of migration and make it plain so that all the world may understand, and the baseless fabric of an autochthonic American race may melt before it, the process still goes on across the bridge that spans the northern ocean from Kamtc. atka to Alaska, over which so many generations have passed to an American home. There Aleutans and Unalashkans, Kaniagmutes and American Tchuktchis link the populations of two continents, and, with the facts that prove the advent of the intrusive Malays, who, wedge-like, entering from the west, split into many fragments the once solid Turanian phalanx, answer the oft-repeated question—"Whence came American man?"

PRE-GLACIAL FORMATION OF THE BEDS OF THE GREAT AMERICAN LAKES.

By Prof. E. W. Claypole, B.A., B.Sc. (Lond.) of Antioch Coll., Ohio.

In a paper by the writer of these lines which appeared in the *Canadian Naturalist* in April, 1877, under the title "Pre-Glacial Geography of the Region of the Great Lakes," an attempt was made to shew that the beds of those inland seas of North America are not results of glacial erosion during the ice age, but that they antedate the ice age altogether, and are due to the action of fresh water streams which flowed in the region at an earlier time, and when the land, especially to the northward, stood at a higher level compared with the sea than at present. The beds of Lakes Huron, Erie and Ontario were attributed to the action of a pre glacial Mohawk having its sources somewhere in the basin of the first named lake, and flowing past Detroit, where a deep channel is known to exist, into the basin of Lake Erie, thence through a similar old and lost channel somewhere near Niagara, into the Ontarian basin, and thence through a yet deeper but now filled up passage near Syracuse and Lake Onondaga into the valley of the Mohawk, and through that and the present Hudson into the Atlantic. In like manner it was maintained that the bed of Lake Michigan was a valley formed by the upper waters of a river whose later course was through a deep but buried channel running southward through Illinois, and which has been traced as far as Bloomington, where it is at least 200 feet deep. The bed of Lake Superior, it was also suggested, may be the valley formed or occupied by the head waters of a river which flowed away at some point east of Marquette, and traversed the State of Wisconsin along the lines of Lakes Winnebago and Horicon and Rock River, until it met the Mississippi near where Rock Island now stands.

Many of the facts upon which the opinions then expressed were founded were derived from the Geological Survey of Ohio, and the whole tenor of the paper was largely in accord with many passages from Dr. Newberry's pen, though in some points the writer was at issue with the distinguished director of the Ohio Survey, and in others he went beyond any conclusions reached in that work. Since the publication of the paper, Dr.

Newberry has however expressed his entire dissent from the writer's views in the following words (Geol. of Ohio, Vol, III. p. 46): "The considerations which oppose this theory" (that the beds of these lakes are only portions of the valleys of pre-glacial rivers blocked up in the ice period by beds of drift) "are so apparent and formidable that it never could have been proposed or accepted by any one who had carefully studied the problem." While yielding to none in due respect for Dr. Newberry's labours and his contributions to the geology of the Western and Midland States, without which the very materials for the paper in question would not have been attainable, the writer must maintain that his theory was not hastily put forward and that in his opinion, for reasons hereinafter given, the objections urged by Dr. Newberry are not valid, and further that Dr. Newberry's own position is not tenable. These objections are as follows:

1st. "The lakes occupy a series of boat-shaped *rock*-basins which have almost nothing in common with river-valleys. The notion that the valley of a river could be beaded in this way by the broad excavation of such portions as lay in soft rock and the formation of *canons* through hard strata, has no warrant in any facts yet observed on the earth's surface."

It may be quite correct technically to speak of the beds of the great lakes as basins, but the impression generally produced by this use of the term is far from accurate. As was pointed out in the paper referred to, if the water were drained away their beds would appear not as deep valleys nor to the eye as valleys at all, but as wide almost level plains. The bed of Lake Erie would show a slope from its north and south shores to its middle averaging about ten feet to the mile. Lake Michigan, with a depth of 900 feet and breadth of 90 miles, would become a vast plain sloping only 20 feet in the mile. Such slopes would be utterly undiscoverable by the eye, and consequently the lake-beds would appear as immense prairies rather than basins. Now such broad slightly sloping vales are precisely what large rivers form when flowing for long ages through a region of the softer rocks. If at any spot cliffs of such material are ever formed, the weather ere long destroys them and reduces all to a smooth outline. It is for this very reason that a practised eye can to a great extent read the geology of a country by observing its surface. One portion consists of smooth, rounded hills, sloping down into wide, shallow valleys; another, of different structure, shows a rugged outline of cliff and gorge, of plateau and canon. In the former case erosion is so rapid that the streams are unable to carry away the material as fast as it is broken down by the weather. The erosive agents surpass the transporting. In the second the rocks afford less material than the streams can remove, and the transporting power exceeds the eroding. Hence come the two great types of surface-contour, the rugged and the smooth, the former characteristic of resisting, the latter of yielding material. It must therefore evidently follow that a river flowing through regions composed of rocks of both kinds will produce alternately the broad open vale and the deep narrow chasm.

But apart from theory, Elisée Réclus (The Earth, p. 132) says: "Some valleys present a succession of rounded basins separated from each other by narrow passes. In the Pyrenees, the Jura and the calcareous regions of the Alps, valleys of this kind are very numerous." "The variations in the shape of valleys may be explained by the different natures of the rocks which the waters have had to hollow out. Wherever the materials operated upon—gravel, sandstone, granites, schists or lavas—are of analogous composition, and thus everywhere present an equal resistance to the action of the water, the latter is able to pursue its normal movement and adopts a meandering course. On the contrary, where the rocks consist of strata of unequal hardness, or are traversed by obstructing walls, the water is necessarily compelled to spread out into a lake-like accumulation, in the meantime eating away the banks in a lateral direction, until the barrier being at length penetrated, the sheet of water is poured down to some lower level. In this way there has been formed during a course of ages *a series of basins* one above another, some of which are still partially filled with water, others entirely empty, all being linked together by *narrow defiles* through which pours the mountain torrent."

In years past the writer resided on the banks of the Avon in England. This river affords a remarkable illustration of the same phenomenon. In its upper course it flows over the Oxford clay in a wide open vale or plain, but before reaching the city of Bath it comes upon the harder beds of the great oölite through which its course lies in a deep valley bordered by high hills of that formation, to which the city owes much of its attractiveness.

and beauty. Emerging from the great oölite, the Avon wanders at will over a wide plain or open valley of the Keuper marls and alluvium until it reaches a spur of hard Carboniferous and Devonian rocks through which it has cut the romantic gorge of Clifton more than two miles long and in some places 300 feet deep between almost vertical walls. With its suspension bridge of 800 feet span, no more exact counterpart of the Niagara rift as seen from the Canadian namesake of the English "Clifton" can well be found, except that in the latter case the work of erosion is still in progress, while in the former it is complete and the cataract has disappeared.

But coming nearer home, our own rivers in Ohio supply many similar instances. The Little Miami in its upper course flows through a wide shallow valley of glacial drift of depth unknown. But on reaching the village of Clifton (Greene Co.) it comes upon a ledge of the hard Niagara limestone through which it has long been and is still engaged in cutting a deep narrow chasm, in some places about 60 feet in depth and less than 20 feet from side to side with overhanging walls. Lower down the stream where the gorge is older, it is more than 100 feet deep and 200 feet from bank to bank. After leaving the Niagara formation, the river comes upon the soft shales and thin stone beds of the blue limestone of the Cincinnati group, where the valley again widens out until its sides are more than a mile apart with smooth and gentle slopes.

Numerous other examples might be quoted to show that this "beaded" appearance of the channel of a river flowing for long ages over rocks of various powers of resistance is not by any means an uncommon phenomenon on the earth's surface. Not only should it occur in theory but it does frequently occur in reality. There is therefore no improbability in the supposition that this pre-glacial Mohawk cut for itself such a channel.

2nd. Dr. Newberry says: "The great and unequal depth of the lake-basins renders it impossible that they can have been excavated by a continuous flowing stream." "Lake Huron is 800 feet in depth, while the buried channel which connects it with Lake Erie is not more than 200 feet deep." "Lake Erie is generally very shallow, and while its bed is no doubt traversed by an old river channel which is very much deeper than most parts of the lake itself, it is incomprehensible that it should not have been cut as deeply by the old river as Lake Huron was, since the rocks to be removed were the same."

In this connection it must be borne in mind that the theory which Dr. Newberry is here criticising is founded on the fact, generally admitted by geologists, that before the glacial era and at the time when this old river existed, the relative levels of land and sea were not the same as now, but that the land was higher, especially to the northward. Of this it is scarcely necessary to adduce proof (see Dana's Manual, 1874, p. 540). Prof. Newberry himself says (Geol. of Ohio, Vol. I, p. 44): "The rocky bottoms of these gorges," in N. E. Ohio, "are deeply buried, and the erosion which produced them began before the ice period and was mostly accomplished during an interval of *continental elevation*." Again (p. 172): "This excavation was anterior to the drift period, when the *continent was raised several hundred feet higher than now*." Again (p. 433): "It is easy to see that the erosion" of Mill Creek valley in Hamilton Co. "could not have been effected under existing conditions. It can only be explained by a higher altitude of the continent." Again (Vol. II. p. 6): "At the commencement of the ice period this continent must have stood several hundred feet higher than now."

Facts gathered from North American and European geology show that the elevation was not uniform but increased towards the north, and the only assumption in the paper already alluded to was that this northward elevation was at the rate of three feet per mile. Now if this estimate be applied to Lake Huron and the buried channel at Detroit, we have the following results:—The central part of Lake Huron then lay about 540 feet higher than now, or 260 feet below the present surface. The buried channel at Detroit has been explored to the depth of 200 feet, but its bottom has never been reached. Dr. N. says (Vol. II, p. 13): "Its greatest depth is unknown." This places the bed of Lake Huron at the time in question only 60 feet below the bottom of the deepest known boring (not the real bottom) in the Detroit channel, and removes all serious difficulty from this part of the subject.

A similar argument will meet the objection urged in the case of Lake Erie and quoted above. Lake Erie lying to the south of Lake Huron, has been relatively less depressed since that time and may actually have then been more deeply eroded than the latter.

3rd. "Lake Ontario is again a deep basin, being 450 feet deep, with a surface level of only 234 feet above the ocean. Every-thing indicates that the basin of Lake Ontario is connected by a buried channel with the Hudson, but we have no proof that this pre-glacial channel is cut as low as the rock-bottom of the basin."

The buried channel at Onondaga, to which allusion is here made, has not, it is true, been proved as deep as the bottom of Lake Ontario at present. But it has been explored to the depth below the lake level of "414 feet, and we are not certain that rock was reached in this boring." (Vol. II, p. 16.) Nor, it may be added, can we be sure that this bore was made in the deepest part of the channel. The buried channel at Onondaga has therefore been explored almost to the level of the bottom of Lake Ontario at present in its deepest part. But on the estimate mentioned above of the elevation of northern land, the bed of Lake Ontario at the time in question was relatively to the buried channel 100 feet higher than now, and in that case the channel was many feet below the lake bed, and the flow of the pre-glacial Mohawk from the Ontarian vale to the Hudson river was both possible and easy.

4th. "The bottoms of some of the great lakes are now several hundred feet below the ocean level," and "their rock bottoms may be covered with a great depth of mud." "They could not have been drained into the ocean when it stood at its present level. It is true that the continent was 500 or 600 feet higher than now at the time the old buried channels were cut, but even this does not afford sufficient fall for a stream which should wear the rock-basins of Lakes Michigan and Huron to their bottoms. They are undoubtedly" (?) "1000 to 1200 feet below the water surface, and reach nearly to the old ocean level, a relative depth far too great for rivers to excavate rock a thousand miles from their mouths."

The very basis of this objection is a supposition of which no proof is given, that the beds of Lakes Michigan and Huron are covered with 200 to 300 feet of deposit. In this way they are brought down nearly to the level of the pre-glacial Atlantic. But with any more moderate estimate they lay considerably higher, and if this deposit is disregarded, were more than 300 feet above that level. If we halve Dr. Newberry's figures and allow 150 feet of deposit in the beds of Lakes Huron and Michigan, the former was between 300 and 400, the latter between 200 and 300 feet above the ocean. These heights would give ample fall for the old Mohawk river in its course of 1000 miles, and it need scarcely be added that where there is fall enough for a river to flow, there erosion will take place. It must moreover be remembered that even allowing Dr. Newberry's supposition to its full extent, the objection has no force, for it can only apply to the lowest points of the lake beds and the latest days of our pre-glacial rivers. The geological destiny of every river is to cut its bed down to the ocean-level, and time enough being given every river will fulfil its destiny. The greater part of the lake-beds, even on Dr. Newberry's supposition, must have been so far above the old ocean as to give an ample fall, and in all but its latest years the old river must have been equally high. It is not surprising that a stream which, so far as we can judge, flowed through that region for many ages, should ere its day of extinction came, have so far fulfilled its destiny as to leave what we may call its death-bed but little elevated above the contemporary ocean. It would be more surprising were the result otherwise. On either view therefore little force lies in the objection.

Similar arguments apply to Lake Michigan. Though the lake is 900 feet deep, and the greatest *known* depth of the buried channel, *whose bottom has never been reached*, is only 200 feet, yet the latter is about 240 miles south of the middle of the lake, and in the time of pre-glacial elevation the depth of the lake was diminished by 720 feet, and its outflow along the line previously indicated through the State of Illinois not only possible but probable.

The above arguments seem fully to meet the objections urged in the third volume of the Ohio Survey. Let us advance a little further. Dr. Newberry agrees with the writer in admitting the existence of the pre-glacial river to which allusion has been so often made. He says (Geol. of Ohio, Vol. II, p. 77): "Previous to the glacial period, the elevation of this portion of our continent was considerably greater than now, and it was drained by a river system which flowed at a much lower level than at present. At that time our chain of lakes—Ontario, Erie and Huron—apparently formed portions of the valley of a river which subsequently became the St. Lawrence, but which then flowed between the Adirondacks and Appalachians, in the line of the deeply buried channel of the Mohawk, passing through the trough of the Hudson and emptying into the ocean 80 miles south-east of New York. Lake Michigan was apparently then a part of a river course which drained Lake Superior and emptied into the Mississippi."

But while asserting the existence of the old and lost river along the whole course indicated, Dr. Newberry does not allow that the excavation of the lake beds is due to its action. He inclines to the view that though a small and shallow or narrow channel existed previously, yet the formation of these broad hollows in which our great lakes lie was the work of another and later agent. He says (Vol. I, p. 49): "The basin of Lake Erie in all its length and breadth—as well as the smaller but deeper one of Lake Ontario, and the broader and far deeper ones of Lake Michigan and Lake Huron—has been excavated by mechanical force from the solid rock. The agents were the same that have produced all the great monuments of erosion seen elsewhere—*water* and *ice*, and of the two that which was by far the more potent, and that which alone could excavate broad boat-shaped basins such as these, was *ice*."

To this view there are many formidable objections, some of which are very evident. Allusion was made to one of them in the former paper, which may however be repeated here. Speaking of the glacial markings in the basin of Lake Erie, Dr. Newberry says (Geol. of Ohio, Vol. VII, p. 10): "The glacier which moved from the east westward in the lake basin, following the continental glacier, was a local glacier of later date, and the one by which the excavati n of the lake basin was principally effected." But on the same page we read: "In this portion (N.W.) of the State, a series of glacial marks which have a nearly north and south bearing are obliterated (nearly ?) by the stronger, fresher, and more numerous grooves, of which the bearing is nearly east and west."

As was before remarked, it seems utterly impossible to attribute the excavation of the bed of Lake Erie, which means the removal of about 1000 feet of rock, to a glacier which was evidently unable to remove pre-existing grooves upon the surface over which it flowed.

Again (Vol. III, p. 47) Dr. Newberry quotes from a paper published by Mr. G. J. Hinde, in which that writer mentions having traced glacial furrows at the eastern end of Lake Ontario from one hundred feet above the lake to the water's edge in a southwesterly direction, and also having found similar striæ at the south-western end of the lake running the same course. "This striking instance of glacial action seems to me," he adds, "to furnish strong proof of the basin of this lake at least having been excavated by *ice*."

The evidence here given completely fails to support the conclusion drawn. Instead of inferring from the presence of glacial grooves in the bed of Lake Ontario that that lake-bed had been entirely formed by the action of ice, the only logical inference is that it was occupied by ice long enough to allow time for the production of these marks. It would be as correct to argue from the presence of the scratches made by sandpaper upon an ornamental moulding that the whole of it had been worked out by the carpenter by that means.

This reply may be carried a step farther. Admitting just for the sake of argument that the beds of Lakes Erie and Ontario were filled for a longer or shorter time towards the end of the great ice age by a local glacier, we may fairly ask, "What caused these local glaciers to exist there and move from east to west? A narrow gorge such as that at Niagara would not deflect a glacier. It would be filled with glacial drift, and the ice would then pass over it as if it did not exist. This has happened in numerous instances both in east and west and in north and south gorges. To deflect a glacier the depression must be wide enough to allow the ice to sweep or scrape its bottom clear of deposit. We need in fact a wide open valley not a deep ravine for this purpose, and if such deflection of the margin of the continental glacier really occurred, the valleys of Erie and Ontario must have been valleys of this kind, in fact nearly what they are at present. It would have been more logical to assume the existence of these valleys as the cause of the diversion of the local glacier, otherwise the fact of this diversion remains without apparent cause. The excavation, to whatever cause due, was earlier than the glacier which filled it. To suppose otherwise is to make the glacier produce its own cause. But further: "Is it possible to admit the existence of these local glaciers in the beds of Lakes Ontario, Erie, Huron and Michigan?" Without the pre-existence of the lake beds this question may be answered promptly and decidedly in the negative. That the edge of the great continental ice-sheet was not regular we may consider certain. That it stretched farther southward on low ground than on high ground, may be assumed, it being quite in accord with the phenomena of recent glaciers. But that it was capable of throwing out long narrow tongues of ice where scarcely any depression of surface existed, is incredible. It is contrary to what we know of the physics of ice to believe in the existence of an ice tongue 200 miles long and 40 miles wide occupying for ages the place of Lake Ontario and only connected with the ice sheet at its eastern end. The same is true of the glacier supposed to have excavated the bed of Lake Erie. Yet more incredible is the theory that would require us to accept the existence of a glacier tongue 350 miles long by 80 miles wide occupying the site of Lake Michigan and employed in scooping out that lake-bed. For be it remembered these are not Alpine glaciers lying in deep narrow valleys hemmed in by rocky walls which prevent all escape and bar all progress except downward. These glaciers must have lain upon the level or nearly level surface of the continent, and towered above it for hundreds of feet in order to possess the weight necessary to grind or scoop out the lake-beds as the theory of Dr. Newberry requires. Such a phenomenon, so far as the writer knows, is without parallel on earth, and moreover its existence is opposed to what we know of the physics of ice. Such a mass must move either by its own weight or by a propelling force behind it. The former is excluded, because a glacier tongue thus extended would lie not in the zone of accumulation but in the zone of waste, and must be maintained by supplies of ice from behind it. But ice thus supplied from behind *would find much less resistance at the sides of the mass and* would consequently spread out laterally instead of urging forward the ice in front, and would thus form a wide semicircular sheet rather than a long and narrow tongue. To suppose such a glacier occupying the site of Lake Michigan for so long a time as to scoop it out to the depth of 900 feet is therefore contrary to the principle of dynamics, which maintains that when a glacier moves it moves in the line of least resistance.

If however we admit the existence of the lake beds to nearly their present depth and width before the ice age, we may without difficulty admit that as the continental glacier was retreating, a short projecting tongue would be found occupying each of them in part and extending a small distance southward or westward from the main body of the ice. This would not necessitate the persistence of such glaciers long enough to fill the whole valleys at once or to scoop them out to their present depth, but only long enough to produce those superficial east-west scratches which Dr. Newberry admits have not always effaced the earlier north-south grooves made by the great continental ice sheet. On this view we have a reason for the deflection of the ice, ample depth to retain a glacier of sufficient mass to produce such markings, and moreover we are not driven to violate any law of glacial physics in trying to explain the phenomena.

The argument, however, is not yet quite complete. Supposing we admit all the premises which Dr. Newberry lays down—that the continental glacier during its retreat was capable of extending tongues of ice several hundred miles long and only 40 to 80 miles wide, and that these tongues of ice lying on a nearly level surface and rising above it to a height of several hundred feet without side walls to confine them, persisted in pushing forward their ends where the resistance was greatest instead of spreading laterally where it was less—let us enquire next whether these tongues could possibly accomplish the task assigned to them.

In a lecture on New York Island and Harbour, published in the Popular Science Monthly for October, 1878, Dr. Newberry estimates the mass of material worn off the surface of that part of the State during the ice age and by the action of the ice as not improbably "one hundred feet." This estimate seems rather high, especially as that region consists of the hard primitive rocks. We have no reason to believe that so large an amount was removed from the surface of northern Ohio by the same agent. Probably the ice age in Ohio did not last quite so long as in New York, New England, and Lower Canada. We have fortunately, however, a gauge, though at present a somewhat rough one, of the amount eroded in this region. Deposition is the true measure of erosion, and if we can form an estimate with tolerable accuracy of the mass of the drift clays, &c., that cover our own and neighbouring States, we shall then have to that extent a key to the amount of degradation they suffered at the hands of the northern ice. Observation shows that as a rule the material was not transported very far, but that what was eroded from one locality was pushed on to another a little south or southeast of it. The deposit on one spot may therefore be used to a great extent to measure the denudation a few miles to the northward. Now it is on the whole very rare to find the drift much exceeding 100 feet in thickness in this or adjoining States. Such districts are never very extensive. The bulk of the transported material was not carried on the top of the ice but shoved along underneath it, constituting a ground moraine. There can have been few spots to the northward from which superficial moraine-matter could be obtained during the greatest extension of the glacier. Accordingly we find the greater part of the drift in any county consists of material brought from the counties to the northward, mixed with a smaller quantity from a greater distance, and some metamorphic boulders or pebbles from Canada. It becomes thinner as we go southward, probably because the propelling power of the ice became less with decreasing thickness. By noting the depth of the glacial drift in the northern part of the State, therefore we take it at its maximum, and we deal with material brought for the most part from the region of the great lakes. We can thus obtain approximately the amount of erosion which that region suffered during the glacial era. The following figures from the Geological Survey of Ohio show us the thickness of the drift through the three northern tiers of counties.

Table shewing the thickness of the drift in Northern Ohio :

Williams	127	Vol. I,	page	546
Fulton	85–146	" I,	"	546
Lucas	65–89	" "	"	"
Ottawa	50	" II,	"	233
Lucas (Toledo)	100			
Erie	thin	" II,	"	185
Lorain	not given	" II,	"	209
Cuyahoga	238 *	" I,	"	175
Lake	110	" I,	"	517
Cuyahoga	12	" I,	"	197
Ashtabula	90	" I,	"	489
Defiance	7–118	" II,	"	435
Henry	8–72	" II,	"	421
Wood	75	" II,	"	383
Sandusky	100	" I,	"	606
Huron	42+	" III,	"	298
Ashland	12 ?	" III,	"	525
Medina	?	" III,	"	362
Summit	60	" I,	"	204
Portage	10–100	" III,	"	137
Summit	220 *	" I,	"	205
Trumbull	?	" I,	"	493
Paulding	45	" II,	"	345
Putnam	22–94	" II,	"	395
Hancock	30–80	" II,	"	366
Seneca	60+	" I,	"	623
Richland	10+	" III,	"	321
Wayne	18	" III,	"	531
Stark	10–100	" III,	"	155
Mahoning	45	" III,	"	799

*This thickness is measured in the deeply excavated and buried channel of the Cuayhoga, and is therefore far above the average.

These figures shew plainly that we have no grounds for making any enormous estimates of the erosion of our State and the lake district by the continental glacier. Omitting the two measurements in Summit and Cuyahoga counties, which as shown above in the note are altogether exceptional and accidental, and taking the mean depth wherever two extreme limits are given, we find that the average thickness of the drift over all these northern counties of Ohio scarcely exceeds 50 feet. The thinning out to the southward of the clays and sands of which it is composed is moreover easily noted even in the list above quoted, the upper names being those of counties near the lake and the lower of those more distant.

From the facts and figures now given we may draw the inference that as the mass of deposited glacial matter in northern Ohio does not exceed fifty feet in average thickness, and as this matter was mainly derived from the region lying immediately north of Ohio, therefore the average thickness of surface-erosion accomplished by the great ice-sheet during its whole duration did not overpass this limit.

It may be urged that some of this material has since been removed by streams. This amount, however, except in the stream-valleys is not large. On the uplands and plateaux this factor in the problem may safely be disregarded, and these are not the places in general where the greatest depth is found. Moreover an allowance in the opposite direction must be made for that portion of the drift which was brought from land yet farther north in Canada. Though not very large in comparison with the whole it is large enough to form an important offset to the portion removed by the action of fresh water.

Returning now to the line of argument followed above, we may conclude if the great continental glacier prevailing over the lake region and Ohio for so many ages, possessing a thickness of many hundred feet (which can scarcely be doubted) and probably moving at a rate (for a glacier) exceedingly rapid, could only remove from the surface a layer of earth and rock (surface soil included), not exceeding fifty feet in thickness, that the local glaciers in the lake-beds, thinner and smaller by far, shorter-lived and probably less rapid in movement, must have been utterly powerless to scoop out those beds to their present depth. Is it rational to believe that one of these puny ice-tongues lying on the site of Lake Ontario, could excavate in a short time to the depth of 450 feet, those rocks from which its gigantic ancestor of longer duration could only scrape off at most some fifty feet?

And with yet stronger reason we may ask, "Is it possible that similar ice-tongues—a mere fringe of the great Canadian ice-sheet—could cut out the valleys of Michigan and Huron 800 and 900 feet below their present water surface and more than 1500 feet below much of the surrounding land, and thus perform from sixteen to thirty times as much work as the massive grinding continental ice-sheets have performed?" Surely this is varying the effect inversely with its cause.

Summing up the results thus obtained we find:—

1st. That the objection founded on the beaded nature of the old Mohawk valley is overruled by high authority in Physical Geography and by the phenomena of existing rivers.

2nd. That the objection drawn from the great and unequal depth of the lake-beds is answered by appealing to the elevation of the northern part of the continent at the time referred to.

3rd. The same reply meets the objection drawn from the want of sufficient fall for the old river in question.

4th. That Dr. Newberry's own theory of the origin of these lake-beds is open to the following very serious objections, if not indeed altogether untenable.

a. The evidence afforded by glacial striae in the bed of Lake Erie is not sufficient to prove the excavation ot the whole of that valley by the action of ice.

b. The same is true of similar markings in the bed of Lake Ontario.

c. Instead of attributing to the action of local glaciers the excavation of the deep vales of Michigan, Erie, Huron and Ontario, we are compelled to assume the pre-existence of these valleys as the only possible cause of the local glaciers; for the existence of such local glaciers without the lake-beds, *and perhaps with them*, is incompatible with the laws of the motion of ice.

d. We cannot assume the erosion of the great continental ice-sheet at more than 50 feet over the lake district.

e. Granting for the sake of argument the existence of these local glaciers it is utterly impossible to suppose them capable of eroding broad valleys 500 to 1000 feet deep, for this would be to suppose them capable of accomplishing many times as much work as their more massive continental predecessor had performed.

APPENDIX.

As any contribution however small to the Preglacial Geography of the lake region and the course of the old Mohawk must possess some value I add the following:

During the summer of 1877 when on the St. Lawrence I met one of the inspectors on the new Welland Cannal. In the course of conversation he mentioned that some difficulty had been found in choosing a site for Lock No. 1, Port Dalhousie. Visiting the spot soon afterwards he explained to me that where it was at first intended to construct this lock no rock could be found by probing the soil except at the southern end. It was consequently determined to remove the site back from the lake about the length of the lock in order to place it on a solid foundation. Lock No. 1, therefore now stands upon the very edge of a buried cliff, its north-western corner projecting beyond the line and being supported on piles. The same gentleman also informed me that at the distance of a few feet from the lock-sill towards the lake a rod was sunk to the depth of forty feet through soft ooze or peat without finding anything solid.

It may be that we have here another small link in the chain of evidence which will some day map out for us the Preglacial Mohawk. This buried cliff it should be remembered is below the water level of Lake Ontario and consequently more than 300 feet below the surface and about 100 feet below the bottom of Lake Erie, and of the buried channel of Detroit. It would therefore appear as if there may have been a swift current or possibly rapids between these valleys in Preglacial times as there is now.

NOTE ON RECENT CONTROVERSIES RESPECTING *EOZOON CANADENSE.*

By Principal Dawson, LL.D., F.R.S., &c.

In a recent article, published in the *American Journal of Science*, I have remarked that

"*Eozoon Canadense* has, since the first announcement of its discovery by Logan in 1859, attracted much attention, and has been very thoroughly investigated and discussed, and at present its organic character is generally admitted. Still its claims are ever and anon disputed, and as fast as one opponent is disposed of, another appears. This is in great part due to the fact that so few scientific men are in a position fully to appreciate the evidence respecting it. Geologists and mineralogists look upon it with suspicion, partly on account of the great age and crystalline structure of the rocks in which it occurs, partly because it is associated with the protean and disputed mineral Serpentine, which some regard as eruptive, some as metamorphic, some as pseudomorphic, while few have had enough experience to enable them to understand the difference between those serpentines which occur in limestones, and in such relations as to prove their contemporaneous deposition, and those which may have resulted from the hydration of olivine or similar changes. Only a few also have learned that *Eozoon* is only sometimes associated with serpentine, but that it occurs also mineralized with loganite, pyroxene, dolomite. or even earthy limestone, though the serpentinous specimens have attracted the most attention, owing to their beauty and abundance in certain localities. The biologists on the other hand, even those who are somewhat familiar with foraminiferal organisms, are little acquainted with the appearance of these when mineralized with silicates, traversed with minute mineral veins, faulted, crushed and partly defaced, as is the case with most specimens of *Eozoon*. Nor are they willing to admit the possibility that these ancient organisms may have presented a more generalized and less definite structure than their modern successors. Worse, perhaps, than all these, is the circumstance that dealers and injudicious amateurs have intervened, and have circulated specimens of *Eozoon,* in which the structure is too imperfectly preserved to admit of its recognition, or even mere fragments of serpentinous limestone, without any structure whatever. I have seen in the collections of dealers and even in public museums, specimens labelled "*Eozoon Canadense*," which have as little claim to that designation as a chip of limestone has to be called a coral or a crinoid." *

These statements were called forth by the appearance of a learned and well illustrated paper, disputing the animal nature of *Eozoon*, by Prof. Karl Moebius of Kiel, and in which, on the evidence of several specimens given to him by Dr. Carpenter and myself, he assumes that he has "investigated more closely and described more minutely" than any other naturalist, its forms and structures, and that by his labours *Eozoon* has been "successfully eliminated from the domain of organic bodies."

Since the appearance of this memoir, and of my criticism upon it, Moebius has published in the same Journal a reply, which has appended to it a note by the principal editor, closing the controversy in so far as that Journal is concerned, by stating that the editor had pledged himself that no rejoinder would be permitted. This, of course. excludes the advocates of the animal nature of *Eozoon* from any farther argument, in so far as the principal organ of scientific opinion in the United States is concerned; and it is partly for this reason that I appear at present in the attitude of a defender of *Eozoon* on its own soil, instead of, as heretofore, carrying the war into the enemy's country.

Still later than this reply of Moebius, are two additional papers of still more remarkable character. For, while Moebius is content to take up a purely negative position, these undertake to account for the structures of *Eozoon* by other causes than that of animal growth, and by causes altogether inconsistent with one another. The first of these is an abstract of a memoir "On the origin of the mineral, structural and chemical characters of Ophites and related rocks," presented to the Royal Society of London by Professors King and Rowney. The second is a quarto pamphlet of 96 pages with 30 plates, by Dr. Otto Hahn, entitled "Die Urzelle,,' the "Primordial cell."

I confess I do not regard either of these papers as of any scientific value, in so far as *Eozoon* is concerned, but as they are at least bold and confident in their tone, and emanate from quarters which may be supposed to give them some little influ-

* Amer. Jour. of Science. March, 1879.

ence, I think it well to notice them along with the reply of Prof. Moebius.

Moebius has thought proper to take advantage of the security guaranteed to him by the Editor of the American Journal, to reply to my courteous and somewhat forbearing criticism, in a manner which relieves me from any obligation to be reticent as to his errors and omissions. I shall, however, confine myself to those points in his rejoinder which seem most important in the interest of scientific truth.

1. With reference to the geological and mineral relations of *Eozoon*, I cannot acquit Moebius of a certain amount of inexcusable ignorance. More especially, he treats the structures as if they consisted merely of serpentine and calcite, and neglects to consider those specimens which, if more rare, are not less important, in which the fossil has been mineralised by Loganite, Pyroxene and Dolomite. If he had not specimens of these, he should have procured them before publishing on the subject. He neglects also to consider the broken fragments of *Eozoon* scattered through the limestones, and the multitudes of *Archæospherinæ* lying in the layers of deposit. Nor can I find that he has any clear idea how the structures of *Eozoon* could have been produced otherwise than by living organisms. Still farther, he makes requirements as to the state of preservation of the proper wall and canal system which would be unfair even in the case of Tertiary or Cretaceous *Foraminifera* injected with Glauconite, how much more in the case of a very ancient fossil contained in rocks which have been subjected to great mechanical and chemical alteration.

2. In his reply he reiterates the statement that *Eozoon* is so different from existing *Foraminifera*, that, if this is a fossil, we must divide all organic bodies into "1. Organic bodies with protoplasmic nature (all plants and animals); and 2. Organic bodies of Eozoonic nature (*Eozoon*, Dawson)." Without referring to the somewhat offensive way in which this is stated, I need only say that Dr. Carpenter has well replied that the structures of *Eozoon* are in no respect more different from those of modern *Foraminifera* than those of many other old fossils are from their modern representatives. All palæontologists know, for example, that while we cannot doubt that *Receptaculites*, *Archæocyathus*, and *Stromatopora* are organic, and probably Protozoan, it has proved most difficult to correlate their structures with those of modern animals.

3. I took occasion to mention certain errors of Prof. Moebius, due to his limited information on the subject of which he treats. He admits two of these, which were particularly pointed out, but taunts me with not producing others. This, however, would not have been difficult had I been disposed to enter in detail into a task so ungracious. Another example may be taken from his plate XXXV, in which he represents together, and obviously for comparison, portions of the pores or tubuli of the modern *Polytrema*, and an imperfect fragment of the proper wall of *Eozoon*, and this more especially, as appears in the text, to show the comparative fineness of the latter. But the specimen of *Eozoon* is magnified only 75 diameters, while that of *Polytrema* is magnified 200 diameters, or in the proportion of 5625 to 40,000. Again he has affirmed and repeats in his reply that the casts of the canal systems of *Eozoon* do not present cylindrical forms but are "*flat* and *irregular* branched stalk-like bodies." If they appeared so to him, he must have possessed most exceptional specimens. Some canals, especially the larger, no doubt have flattened forms, particularly at their points of bifurcation; but this is comparatively rare, more especially in the vastly numerous minute canals which are more frequently filled with dolomite than with serpentine. I have indeed been able to detect only a few out of very numerous specimens in which the majority of the casts of canals are not approximately round in cross section, even in the case of the larger canals. It is a question also if some flattening may not be due to pressure; and there are flat stolon-like tubes which can scarcely be called canals.*

It occurs to me here to remark that Moebius seems to have overlooked the extremely fine canals injected with Dolomite that fill the upper and thinner calcite walls of the better preserved specimens, and which in the thinner walls are nearly as fine as the tubuli of the proper wall, into which in many cases they almost insensibly pass where these last are themselves filled with dolomite. Possibly these structures have not been present in his specimens, or may have been destroyed or rendered invisible by his methods of preparation, and if so this would account for

* The forms of the canals are perhaps best seen in decalcified specimens; but Mr. Weston, who has done so much toward this investigation, has managed to cut slices so accurately at right angles to the general course of groups of canals, as to show their round cross sections with great distinctness.

some of his conclusions. These fine canals are best seen in well-preserved serpentinous specimens free from chrysotile veins, and etched with very dilute nitric acid. They have scarcely been done justice to in any of the published figures either of Dr. Carpenter or myself, and do not appear in those of Prof. Moebius.

4. In reply to my objection that he has confounded the proper wall of *Eozoon* with veins of chrysotile, and that both are represented in his figures, he challenges me to point out which of the latter are chrysotile and which proper wall. Of course doing so will be of little importance to the argument, but I may indicate his figs. 18, 43, 44 and 48 as in my opinion taken from portions of proper wall, and fig. 45 seems to show the proper wall along with chrysotile. I may farther now point out to him that even Profs. King and Rowney in their recent paper admit that the proper wall is not continuous chrysotile, but consists of "aciculæ separated by calcareous interpolations," though they try to account for this structure by complicated changes supposed to have occurred in veins of chrysotile subsequently to their deposition.

In truth, the chrysotile veins cross all the structures of *Eozoon*, and those specimens are best preserved which have suffered least from this subsequent infiltration of chrysotile into cracks formed apparently by mechanical means. This has been amply shewn in figures which I have already published, but I have now still more characteristic specimens which I hope may yet be engraved.

5. Prof. Moebius sneers at my statement that when the proper wall of *Eozoon* is merely calcareous and not infiltrated, its structures are invisible, and that in many cases it has become opaque, while in thick slices its structure is always indistinct; but he should know that this is the case with all fine organic tubuli or pores in fossils penetrated with mineral matter, and eminently so with fossil Nummulites, as the researches of Carpenter have long ago demonstrated, and as any one possessing slices of these fossils can see for himself. I may add that in some decalcified specimens in my possession, where the proper wall has been wholly of calcite, it is indicated merely by an *empty band* intervening between the serpentine cast and the supplemental skeleton filled with casts of canals.

6. Lastly, he seems to think that no offence should be taken at his insinuation that the figures printed by Dr. Carpenter and myself are idealized or untruthful representations, and he repeats the accusation in the following terms: "The individual peculi-

arities of diagrams should not exceed the limits of the known variability of the real specimens, but in the *Eozoon* diagrams of Carpenter and Dawson these limits are exceeded." There could not, I think, be a more plain charge of wilful falsification, and this is made by a naturalist who discusses *Eozoon* without having taken the pains either to study it *in situ*, or to avail himself of the large collections of specimens which exist in England and in Canada. I can only reply that while I have been unable to figure all the peculiarities of the canal systems of this complicated and often badly preserved fossil, I have endeavoured to select the most characteristic specimens; and that my representations are principally, nature-prints, photographs, and camera tracings, some of the latter by artists in no way interested in *Eozoon*. Dr. Carpenter's representations appear to me to be equally truthful. Neither of us have taken the trouble to represent badly preserved or imperfect specimens, any more than we should do so in the case of any other fossil, when better examples were procurable.

In connection with this, Moebius seems to think that in my criticism I should have gone into all the details into which he enters. This was unnecessary, except to expose his principal errors or mis-statements. It could not have been done without publishing a treatise as long and as expensively illustrated as his own; and this I should prefer to do in some other form than as a mere reply to him; and with reference to much larger and more varied collections than those at his command. It is to be hoped that his expectations will be satisfied in this respect by a monograph which Dr. Carpenter proposes to undertake.

He is good enough to add that if I will send him more and better specimens, he will willingly "forgive" me for "disappointing" him and other naturalists. I must say that I cannot purchase forgivenness on such terms, but if he will take the trouble to visit Canada and inspect my collections, he shall have every opportunity to do so.

I think it is only due to the interests of palæontological science to add here, that I attach more blame to the editors of the German publication "Palæontographica," in which his memoir appears, than to Prof. Moebius himself. We have been in the habit of regarding this publication as one in which the matured results of original observers and discoverers are given, and when it devotes 40 costly plates to the labours of a naturalist who is not of this character, in so far as *Eozoon* is concerned, and who has not even studied the principal collections on which other naturalists equally competent have based their conclusions, they incur a responsibility much more grave than if they were merely the conductors of a popular scientific journal, open to cursory discussions of controverted points. They cannot relieve themselves from this responsibility till they shall have published a really exhaustive description of *Eozoon* by some one of the original workers on the subject. This is the more necessary, since if *Eozoon* is really a fossil, its discovery is one of the most important in modern palæontology, and since its claims cannot be settled except by the most full investigation and illustration.

The second paper referred to above contains little that is new, being a re-habilitation of that hypothesis of "Methylosis," or chemical transmutation, which the authors have already fully explained in the Transactions of the Irish Academy and elsewhere. Its bearing on *Eozoon* is simply this:—that if any one acquainted with geological and chemical possibilities can be induced to believe that the Laurentian limestones of Canada are "Methylosed products," which originally "existed as gneisses, hornblende schists, and other mineralised silacid metamorphics," he may be induced also to believe that *Eozoon* is a product of merely mineral metamorphism.

When we consider that these great limestones have been so fully traced and mapped by Sir William Logan and his successors on the Geological Survey; that some of them are several hundreds of feet in thickness and traceable for great distances, that they are quite conformable with the containing beds, and themselves exhibit alternating layers of limestone and dolomite, with layers characterized by the presence of graphite, serpentine, and other minerals, and subordinate thin bands of gneiss and pyroxene rock, the idea that they can be products of a sort of pseudomorphism of gneisses and similar rocks, becomes stupendously absurd, and can only be accounted for by want of acquaintance with the facts on the part of the authors.

To explain the structures of *Eozoon*, however, even this is not altogether sufficient, but we must suppose a peculiar and complex arrangement of laminae, canals. and microscopic tubuli or fibres simulating them, to be produced in some parts of the limestones and not in others; and this by the agency of several different kinds of minerals.

In other words we have to suppose a conversion on a gigantic scale of gneiss into dolomite, limestone, graphite, serpentine, and other minerals, consisting for the most part even of different elements, and this at the same time or by still more mysterious subsequent changes, producing imitations of the most delicate organic forms. The mere statement of this hypothesis is, I think, sufficient to show that it cannot be accepted either by chemists or palæontologists, and it only serves to illustrate the difficulties which *Eozoon* presents to those who will not accept the theory of its organic origin.

Dr. Otto Hahn regards the matter from an entirely different point of view. He has himself visited Canada, has collected specimens of *Eozoon*, and now proposes to effect an entire revolution in our ideas of the palæontology of the Eozoic rocks.

In a former paper he had maintained that *Eozoon* is altogether of mineral origin, that its serpentine is hydrated olivine, and the canal system merely cracks in calcite injected by the expansion of this mineral. This hypothesis he now finds untenable, and he regards *Eozoon* as a vegetable production, or rather as a series of such productions. He regards the laminæ as petrified fronds of a sea-weed, and the canal systems as finer algæ of several genera and species. Not content with this, he describes as plants other forms found in granite, gneiss, basalt, and even meteoric iron, and others found included in the substance of crystals of Arragonite, Corundum and Beryl. All these are supposed to be algæ of new species, and science is enriched by great numbers of generic and specific names to designate them, while they are illustrated by thirty plates representing the quaint and grotesque forms of these objects, many of which are obviously such as we have been in the habit of regarding as mere dendritic crystallisations, cavities, or impurities included in crystals.

Among other curious discoveries the author refers to a plant which he honours me by naming *Photophoba Dawsoni*, and which he discovered in certain "amoeba-like" nodules of flint found in the Silurian of Montreal, and used to adorn the grounds of McGill College. I was puzzled for some time by this, until it occurred to me that at the time of the Doctor's visit some English gravel had been laid on our College terrace, and that several heaps of large irregular flints from this gravel had been gathered in front of the buildings. These had apparently afforded the new plant in question. Some other plants stated to be found in hornblende from Montreal mountain, and in limestone said to be called "fancy stone," are more difficult to account for.

All this plant theory, advanced with the utmost confidence, has no evidence whatever except the assertion of the author and his belief as to the imperfect character of the observations of his predecessors. The following extracts, kindly translated by our colleague Dr. Sommer, will serve to show his mode of treatment:—

"I was convinced of the inorganic nature of Eozoon, or at least of the fact that it could not be an animal. But the fine "canal systems", as Dr. Carpenter had named them, were the source of much anxious thought on my part, and this was necessarily augmented by the following consideration, of which I could not rid myself. "Gneiss is formed by water and therefore a sedimentary rock. Its layers of limestone must contain the first organic enclosures; for, life cannot begin with the silurian rocks." This is a hypothesis, but, like many others that are true, one of which I have not yet rid myself."

"It happened, then, that I had to go to Canada, in consequence of an invitation from the Canadian Government.* I visited Dr. Dawson and thence went to Côte St. Pierre, Petit Nation, there I saw the stratified layers and obtained a great number of pieces of Eozoonic Limestone and of Eozoonic specimens. On my return I examined the material. The result of my examinations I publish here: *the Limestone of the Laurentian Gneiss of Canada, the oldest sedimentary strata of our earth, contains a plant organization belonging to the family of the Algæ.*"

"Till now there have been but few new species established different from the modern; but, I am persuaded, that by continual researches, the number will soon be increased. All these plants, I found enclosed in the *true* "Eozooic Rock," which I shall henceforth call *Eophyllic Limetone.* I shall draw attention to the words that my honorable friend Dr. Dawson also used: "all is not Eozoon!" †

Then follows a description, condensed from Canadian reports, of the Laurentian formation, after which occur the following statements:—

"It is incomprehensible that on looking upon this form, a plant did not occur to the mind, at once. It can only be explained thus. that, at first, when such pieces were not yet discovered, they were so prepossessed by the idea of Foraminifera, that it pervaded all their investigations; while the opponents, (myself included) arrived at once at the obvious conclusion; namely that not being animal it was therefore mineral."

* Dr. Hahn seems to have been employed on some mission connected with emigration from Germany.

† This, I suppose, refers to the fact that I warned Dr. H. that he would find the greater part of the Laurentian limestone to be destitute of distinguishable Eozoon.

"I found the species which I first called *Eophyllum* in a piece of *Eozoon*, in the first white band of limestone overlying a layer of serpentine; in other words between two layers of serpentine. Then first this question occurred to me: Are not the whole lumps of Eozoon plants? I was forced to yield to the inference after I had exposed, by applying Hydrochloric acid to the limestone, some larger lamellæ which were in connection with serpentinic layers; indeed, the forms are so permanent and so constantly reappearing that they cannot be explained otherwise. Of course with this there was gained the best argument against the animal theory; for, hitherto the discovered species of Algæ have never been found in either stones or shells. This plant belongs to the family of the Algæ. They either rest immediately upon dolomite and gneiss, or, are found in the proper Eophyllous limestone, i. e. in the layers of serpentine limestone, between the large strata of dolomite and serpentine. They are, however, not only to be found in the limestone, but also in the serpentine of the strata. No plants or but few, are found in the thick layers of serpentins which enclose the Eophyllous limestone; certainly none in the lowest. Some of them may be seen with the naked eye, while with the microscope, we come to the smallest conceivable forms. Being replaced by silicates, they may be exposed by the application of acid to the limestone. This done, the plants make their appearance as shining white stems, calyxes, and leaves. In thinly ground plates, they appear a yellowish brown. This, probably, is the reason that Mobius describes their color as being a light brown. In reality, it is the refraction of the light in the opaque masses."*

"There was scarcely ever a more difficult task given to natural science, than the determination of the nature of "*Eozoon*." When I made my first announcement of *Eophyllum* in the "Ausland" I little thought that the large ribbons of serpentine were also plants. I had already half-finished this work after my original plan, when I came across a defective specimen of rock, in which, in consequence of its defectiveness, the serpentiue parts were very clearly distinguishable.

"I looked at it over and over again, till it struck me that the sarcode-chambers were nothing but cells of plants. Thus the fate of the microscopist is decided. What others can see with the naked eye he does not see at all. Then came the more difficult part: the examination of the case. Now, I had no more doubt. And in this manner only facts become clear. The ribbons of serpentine which constitute that which is called *Eoxoon*, belong to an alga with broad leaves—if the expression is permitted—which radiating from one point arranges itself in regular form^. The basal-cell rests upon serpentine or dolomite. Roots I found only in one case, of which, however, I am not sure. The limestone is the replacing-material. The germ-cells

* Thus far, the author refers principally to the serpentine casts of the canal system.

are still visible in it, for in ground pieces for the microscope they still shine through. This may be proved by dissolving the limestone by means of acid. Here the leaves are perfectly covered with germ-cells, the "warzenansatze" of Gümbel. This is still clearer where'er the plant has been altered into dolomite. The brood-cells are then visible without the aid of the microscope. There appear, also, calyx-like cells, clear as water, which have weathered out upon the dolomite.

"But by far the most beautiful are the limestones in which the plants are changed, partly into serpentine, and partly into mica. The same cells are observed in a spar, changed into copper and malachite, visible to the naked eye. The canal-systems, therefore, of the "intermediate skeleton" are the microscopical plants which, partly, are simply of a limestone nature or have grown firmly upon large algæ, or are deposited there, dead. As I remarked in the beginning, a key to this new creation is, at all events, necessary. I say new, for it is entirely new to our imagination. The microscopical forms constitute this key. Now from these safe premises we may easily come to a conclusion; but I must here caution against the exclusive use of ground microscopical plates.* It is only by mere accident that, by this means, a view is gained; hundreds of them may be made, but only a very trained eye can decipher them."

It seems scarcely necessary to criticise the above statements, as it is probable that very few naturalists will be disposed to accept the supposed plants described by Dr. Hahn as veritable species. It may be observed, however, that in regarding the thick plates of serpentine, interrupted, attached to each other at intervals, penetrated by pillars of calcite, and becoming acervuline upward, as fossil algæ, he disregards all vegetable analogies; while in supposing that the calcite is a filling, and that the delicate fillings of canals contained in it are fine thread-like algæ, he equally asserts what is improbable. Farther, no vegetable structure or remains of carbonaceous matter have been discovered in the serpentine. Had he discovered these supposed vegetable forms in the graphite of the Laurentian, this would have been far more credible.

Hahn's paper, however, suggests one or two points of interest respecting *Eozoon*, which have perhaps not been sufficiently insisted on. One of these is the occurrence of rounded "chamberlets" in the calcareous walls. These are his "germ-cells,"

* If this is intended to apply to Canadian and English students of *Eozoon*, it is quite inaccurate, as they have always employed decalcified specimens as well.

and they sometimes present the curious character that they are hollow vesicles of serpentine filled with calcite, and when these have been cut across in making a section, and the calcite has been dissolved out with an acid, they present very singular appearances. They may in some cases have been germs of *Eozoon*, or smaller foraminifera of the type of *Archæospherinæ*, overgrown by the calcareous walls. It is farther to be observed, as I have also elsewhere remarked, that the serpentine filling the larger spaces between the calcareous laminæ sometimes shows indications of deposit as a lining of the cells, and in some specimens this lining has not filled the original space but has left a drusy cavity afterwards filled with calcite.

Again, in parts of the canal system, especially when filled with dolomite, there occur little disc-like bodies or trumpet-shaped terminations of canals. These, I fancy, are the calyx-like objects figured by Hahn. Their precise significance is not known, further than that they may represent the expanded ends of canals. Another appearance deserving of notice is the occurrence of portions of specimens of *Eozoon* in which little or no serpentine occupies the chambers. In this case the laminæ have either been pressed close together, or the chambers have been filled with calcite not distinguishable from the walls, in which, however, the casts of groups of canals often occur, and might then be more readily mistaken for algæ than when they occur between laminæ of serpentine.

Lastly, I have recently found in a specimen of *Eozoon*, structures which may possibly indicate contemporaneous plants. I have previously remarked the occurrence of deep pits or cylindrical cavities in some specimens of *Eozoon*, and have supposed that they might be of the nature of oscula. Those now referred to are, however, more definite than any previously observed. They are cylindrical perforations penetrating the whole thickness of the mass, and filled with calcite. One of them is simple, another seems to bifurcate. They are about an eighth of an inch in diameter, and present indications of alternate swellings and contractions. In approaching them the plates of serpentine split into two, and then unite, forming a continuous close wall of sarcode. This proves that these tubes are not perforations of any boring animals. They must be either definite canals penetrating the mass while living, or must represent cylindrical stems of algæ or other perishable organisms, around which the *Eozoon* has grown. As they are only exceptionally seen, the latter supposition is perhaps the more probable. Peculiarities of this kind, to which perhaps heretofore too little attention has been given, are of some importance with reference to the controversies respecting *Eozoon*.

It may be said, in connection with the attacks in question, that if *Eozoon* is an object of which so many and strange explanations can be given, it is probable that no certainty whatever can be attained as to its real nature. On the other hand it is fair to argue that, if the opponents of its animal nature are driven to misrepresentation and to wild and incoherent theories, there is the more reason to repose confidence in the sober view of its origin, consistent with its geological relations and microscopic characters, which has commended itself to Carpenter, Gumbel, Rupert Jones, Sterry Hunt, and a host of other competent naturalists and geologists. For my own part the arguments adduced by opponents, and the re-examination of specimens which they have suggested, have served to make my original opinion as to its nature seem better supported and more probable; though of course I would be far from being dogmatic on such a subject, or claiming any stronger conclusion than that of a reasonable probability, which may be increased as new facts develop themselves, but cannot amount to absolute certainty until the discovery of Laurentian rocks in an unaltered state shall enable us to compare their fossils more easily with those of later formations.

In point of fact, the evidence for the organic nature of a fossil such as that in question, is necessarily cumulative, and depends on its mode of occurrence and state of mineralisation, as well as on its general form and microscopic structure; and it is perhaps hopeless to expect that any considerable number of naturalists will be induced to undertake the investigations necessary to form an independent opinion on the subject. It may be hoped, however, that they will fairly weigh the evidence presented, and will also take into consideration the difficulty of accounting for such forms and structures except on the hypothesis of an organic origin.

PROCEEDINGS OF THE NATURAL HISTORY SOCIETY OF MONTREAL.

The first regular meeting for the Session 1879-80, was held in the Society's Rooms on Monday evening, Oct. 27th. The minutes of the last meeting were read and confirmed. An eagle presented to the Society by J. J. Gibb, Esq. of Como, and mounted by Mr. Passmore, was exhibited and carefully examined.

There being a very small attendance, owing to some misunderstanding as to night of meeting, a general discussion of the affairs of the Society was held, after which the meeting adjourned.

The second meeting was held on the evening of December 1st, the President, A. R. C. Selwyn, Esq., F.R.S., in the chair. The minutes of last meeting being read and approved, the following gentlemen were elected members of the Society:—Dr. Angus MacDonnell and Messrs. Wm. Crowther, L. Bamburgher, and W. J. Morris.

Principal Dawson then read a paper entitled "Recent Controversies respecting *Eozoon*." In this paper the Principal discussed the memoir of Prof. Karl Moebius, of Kiel, published in the "Palæontographica," and a reply by Moebius to a previous criticism; also an abstract of a memoir presented to the Royal Society of London by Professors King and Rowney, of the Queen's University of Ireland, and a memoir lately published by Dr. Otto Hahn in Germany. He referred to the points in which the several writers in question had misapprehended the structures and relations of *Eozoon*, and illustrated these by specimens and drawings.

At the close of the paper, Dr. T. Sterry Hunt stated that inasmuch as Principal Dawson had mentioned his name in connection with the subject of *Eozoon*, he might be permitted to say that he thought quite too much notice had been taken in the paper of the views of Hahn and others, whose statements with regard to *Eozoon* were really too absurd to be worthy of consideration. On the occasion of his recent visit to Europe (in 1878) he had carried with him a collection of specimens of *Eozoon*, placed in his hands by Principal Dawson. The collection had been studied by Zirkel and Renard, and both these most distinguished observers in the field of microscopic petrography had expressed their belief in the organic character of *Eozoon Canadense*.

(Principal Dawson's paper appears in full in this number of the *Naturalist.*)

There was also exhibited during the evening a collection of rocks forwarded by Albert J. Hill, Esq., C.E. These are an extensive series of rock specimens representing the cuttings on the Canada Pacific Railway between Kaministiquia and the English River, a distance of ninety-three miles. They consist of a variety of gneisses, hornblende schists, and other highly crystalline rocks, with clay slates, quartzites, chlorite slates and serpentine, and belong to the Huronian and Laurentian series of that region.

NOTES ON A FEW CANADIAN ROCKS AND MINERALS.

By B. J. Harrington, B.A., Ph. D.*

I.—On some of the diorites of Montreal.

There are probably few regions of such limited extent that furnish a greater variety of interesting eruptive rocks than Montreal and its vicinity. This fact long ago attracted the attention of Dr. Hunt, and though many of the rocks were ably described by him, there still remains a wide field for investigation, both as regards the character of the rocks and their relative ages. Numerous facts bearing upon these points have recently been accumulated, but many additional details are required before the subject can be fully discussed.

In the *Geology of Canada* the intrusive rocks of Montreal are described as dolerites, trachytes and phonolites, the first af these constituting the main mass of Mount Royal as well as numerous dykes, while the others occur only in dykes, which are stated to cut the dolerites in some instances. No mention is, however, made of the numerous dykes of diorite which occur, and which,

* From the Report of the Geological Survey of Canada for 1877-78.

in some cases, have also been observed to cut the dolerite of the mountain. These diorites vary considerably in their characters, ranging in colour from light to dark grey, and in specific gravity from 2·75 to over 3.* They are usually medium to fine grained in texture, and often porphyritic with crystals of hornblende. Sometimes, too, they are amygdaloidal, the cavities containing calcite, zeolitic minerals, and rarely epidote. They all appear to contain carbonates, the quantity of which, however, varies in different cases. Their principal constituents are hornblende, a triclinic feldspar, and titanic iron; but they commonly contain other minerals, the most important of which is, perhaps, mica. Augite is also sometimes present. The mica is occasionally so abundant that the rock becomes the mica-diorite of some lithologists.

A dyke occurring in the reservoir extension consists of what may probably be regarded as a typical variety of the diorites referred to above. It is dark grey in colour, rather fine grained, but still showing, without the lens, quantities of acicular prisms of a black mineral which proves to be hornblende. The dyke was about two feet thick and very homogeneous, showing neither porphyritic nor amygdaloidal texture. Specimens sliced and examined with the microscope are seen to consist essentially of hornblende, a triclinic feldspar, and numerous opaque grains of titanic iron. Mica, apatite, calcite, and a little of a green chloritic mineral, are also commonly present. The hornblende appears mostly fresh, though in places slightly altered to the chloritic mineral just mentioned. It is of a rich brown colour and strongly dichroic. In cross sections the cleavage of the prisms is often beautifully displayed. The feldspar is in part altered, but in places fresh. It is triclinic, and judging from the unusually basic character of the diorite, must be a feldspar low in silica. The black mineral occurs mostly in irregular grains, but here and there in curious fantastic forms after the manner of titanic iron ore. That it consists mainly of this mineral, and not of magnetite, is evident from the considerable proportion of titanium dioxide shown by the analysis, and also from the fact

* The following are the specific gravities of a number of specimens:

2·749	2·94	2·923	3·005
2·889	2·97	4·947	....
2·805	3·07	2·927	....

that when the rock is pulverised the magnet removes almost nothing. The specific gravity of different fragments of the rock varied from 2·927 to 3·005. An analysis was made some time ago, and, as the composition appeared unusual, search was made for descriptions of similar rocks from other localities, but none could be found. Since then, however, Mr. G. W. Hawes has described rocks of wonderful similarity from Campton, in the State of New Hampshire.* An analysis, by Mr. Hawes, of one of these diorites is given under II. for comparison with I., which is an analysis of the diorite from Montreal just described :—

	I.	II.
Silica	40·95	41·94
Alumina	16·45	15·36
Ferric oxide †	13·47	3·27
Ferrous oxide	....	9·89
Manganous oxide	0.33‡	0.25
Titanium dioxide	3.39	4.15
Lime	10.53	9.47
Magnesia	6.10	5.01
Potash	1.28	0.19
Soda	4.00	5.15
Phosphoric Acid	0.29	...
Carbon dioxide	...	2.47
Loss on ignition	3.84	3.29§
	100.63	100.44

On boiling I. with hydrochloric acid for several hours, and filtering, the insoluble residue after ignition amounted to only 51.80 per cent. Although the amount of carbon dioxide was not determined, it must constitute a large proportion of the loss which the rock sustains on ignition; for acetic acid dissolves 4.02 per cent. of lime and 0.67 of ferrous oxide, and these bases, if calculated as carbonates, would require 3.57 per cent. of carbon dioxide. The basic character of the rock, and the extent to which it is dissolved by hydrochloric acid, seem to indicate a feldspar of the nature of anorthite. In that case a considerable proportion of the alkalies must belong to the hornblende; but

* *Geology of New Hampshire*, Part IV, p. 160. *American Journal of Science*, 1879, p. 148.

† All the iron is calculated as ferric oxide, the ferrous oxide not having been determined.

‡ With a little cobalt. § Water.

this is not improbable, as some varieties of hornblende are known to contain several per cent. of alkalies.

Another dyke, occurring within a few yards of that just described, is also of much interest. It is dark grey in colour, and, like the last, shows numerous acicular prisms of hornblende penetrating the mass in all directions. Here and there macroscopic scales of dark brown mica are seen, and the rock is dotted with numerous spots—occasionally as much as a quarter of an inch across—of a glassy, colourless to white mineral, which, on analysis, proves to be analcite. The specific gravity of the analcite is 2.255, and its composition as follows:—

Silica	53.29
Alumina	23.33
Ferric oxide	trace.
Lime	0.64
Magnesia	trace.
Soda	14.54
Water	8.47
	100.27

The mineral was examined for potash, but none found. Before the blow-pipe it fuses easily to a colourless glass. When thin sections of the rock are examined with the microscope the analcite appears very transparent and shows but few inclusions. It is traversed by numerous reticulating cracks, but displays no characteristic cleavage. The feldspar is mostly dull, but here and there is sufficiently transparent to show its triclinic character with polarized light. The hornblende and titanic iron appear exactly similar to what occurs in the ordinary diorites of the locality. No augite has been observed, but one slide shows numerous green crystals, which are evidently pseudomorphs of serpentine after olivine.

In so far as its constituents are concerned, this rock appears to be somewhat similar to that which Tschermak, many years ago, called *teschenite*, after Teschen in Austria. Tschermak regarded the analcite as one of the normal constituents of the rock, and this it may possibly be in the present instance. On the other hand, the general similarity of the other constituents of the rock to those of the ordinary diorites of the vicinity would lead one to infer that the analcite is a secondary mineral, and that the rock is simply an altered diorite.

The diorites described above traverse not only the Lower

Silurian limestones, but also the dolerite of Mount Royal. Rounded masses of the diorite of precisely similar character occur in the Lower Helderberg conglomerate or breccia of St. Helen's Island. Those, therefore, who would classify eruptive rocks according to age, would say that Mount Royal is a diabase and not a dolerite. Admitting such to be the case, how is it, the question may be asked, that dykes of *phonolite* are abruptly cut off by the diabase, when phonolite, according to the chronological theory, ought to be of Tertiary or more recent age? It may be that future investigations will solve the difficulty, but, in the meantime, the eruptive rocks of Montreal do not seem to fall into their proper place in a classification based upon age.

II. PYROXENE AND URALITE.

Of all the mineral associates of apatite in the Ottawa region, pyroxene is the most constant and the most abundant. In one form or another it is probably present in all the apatite deposits, excepting, perhaps, some of the calcareous veins with imbedded apatite crystals. The most common variety appears to be an aluminous sahlite or lime-magnesia-iron pyroxene, but a light-coloured variety, probably diopside or malacolite, is also common. Less frequently a beautiful black kind may be observed, excellent examples of which have been obtained from the thirteenth lot of the eleventh range of Templeton. It is here associated with green apatite, white orthoclase, scapolite, graphite and small grains of titanite. The pyroxene crystals often contain little round or irregular mases of the orthoclase as well as scales of graphite, and their surfaces are sometimes coated by broad plates of the last-named mineral. The crystals differ from those of the more ordinarily occurring sahlite not only in colour, but also, to a certain extent, in chemical composition and form, having the faces of the inclined rhombic prism usually much more fully developed than the clinopinacoid, and presenting rather different pyramidal terminations. The observed planes are those of the inclined rhombic and rectangular prisms ∞ P. ∞ P∞. [∞ P∞], combined with the pyramidal faces P. 2 P.–P. and the clinodome [2 P ∞]. The faces of the rhombic prism are often developed almost to the exclusion of the ortho- and clinopinacoid. In some crystals the pyramidal planes are pretty equally developed, but in others much distorted. In the specimens examined the basal plane oP. is absent, but there is a very distinct basal cleavage.

The fracture varies from uneven to conchoidal. The colour is mostly black, but in some specimens blackish-green. On the edges or in thin splinters the mineral is translucent, and by transmitted light appears deep bottle-green. The lustre is vitreous, and sometimes almost splendent. The hardness is about six, and a crystal, of which the following is an analysis, was found to have a specific gravity of 3·385 :

Silica	51·275
Alumina	2·821
Ferric oxide	1·317
Ferrous oxide	9·164
Maganous oxide	0·329
Lime	23·334
Magnesia	11·612
Loss on ignition	0·174
	100·026

The analysis shows that this is an aluminous lime-magnesia-iron pyroxene, and its composition and other characters seem to connect it with the variety sometimes called fassaite.

Examples of other varieties of pyroxene may be met with at almost any of the apatite mines. They vary much in colour, usually being of some shade of green or grey, but sometimes white or brown. Lower down the Ottawa, in the augmentation of Grenville, a beautiful lilac pyroxene occurs, the crystals of which are sometimes imbedded in a pale lemon-yellow scapolite.

Now and then crystals of large dimensions are obtained. One, for example, from the township of Templeton is eleven and a half inches in circumference, nine inches long, and weighs eight and one-third pounds. Large crystals have also been found on the sixth lot of the first range of Portland township, and a portion of one now in the museum of the Geological Survey weighs about twelve pounds. Some of them, though dull outwardly are glassy within, and of a pale bottle-green colour.

The simplest forms observed are crystals of sahlite showing the following combination: $\infty P \infty . \infty P . [\infty P \infty] . P\infty . P$. Other planes are, however, frequently present, and among them $2P . 3P . -P$. and oP. Sometimes the crystals of sahlite are striated longitudinally, and they are often much flattened in the direction of the orthodiagonal. One, for example, having a width of an inch and eight-tenths, measured only seven-tenths of an inch in thickness; another, an inch and a half wide, was five-eighths of an inch thick, while a third measured two and a quarter inches by eight-tenths of an inch—giving an average width of over two and a half times that of the thickness.

In the township of Templeton well crystallised pyroxene is often found in veins unaccompanied by apatite, for which mineral, however, it has frequently been mistaken. As affording a good example of this, a vein occurring on the twenty-fourth lot of the ninth range may be mentioned. Good crystals of more or less glassy, subtranslucent green pyroxene are here imbedded in a pale flesh coloured calcite. They vary in length from a couple of inches downwards, and are often well terminated at both ends. They are almost invariably flattened in the direction of the clino diagonial, and show the following planes: ∞ P. [∞ P∞]. ∞ P ∞ . P∞ . P. 2 P.–P. oP., and sometimes [2 P∞]. The specific gravity of a crystal was found to be 3·232. Scales of mica sometimes coat the crystals, or are enclosed in them.

On lot thirteen in the eighth range of Templeton a white to greyish-white or greenish-white pyroxene occurs, small quantities of which were at one time mined under the supposition that the mineral was apatite. The crystals exhibit the same planes as those just described, but are less frequently flattened in the direction of the clinopinacoid.

The enclosure of mica in pyroxene crystals, which has already been alluded to, may frequently be observed, and in some instances the scales or crystals of mica may be seen to be more or less symmetrically arranged with reference to the planes of the pyroxene. On the seventeenth lot of the ninth range of Templeton large crystals were observed, showing a central portion of dark green pyroxene surrounded by a zone of minute scales of mica, while the outer portion of the crystal was pale green pyroxene. Other inclusions also are common, and among them calcite, apatite and orthoclase. Not infrequently also pyroxene crystals are rounded as if by the action of some solvent, but this is much less common than in the case of apatite. Sometimes they have been cracked or broken in two, and the spaces between the pieces filled up with calcite, apatite, or some other mineral. In one case, a crystal four inches in diameter was observed which had been fractured and re-cemented with apatite.

The most interesting peculiarity observed, however, is the tendency which the pyroxene in some localities exhibits to become altered into a kind of uralite. This name was long ago given by Gustav Rose to crystals possessing the form of pyroxene but cleavage and other characters of hornblende, and first observed by him in certain rocks from the Urals, which he termed uralite porphyries. The larger crystals were found to frequently contain a kernel of pyroxene, which in the smaller ones had entirely disappeared. In the case of pyroxene from Arendal in Norway also, Rose observed a perfect transition from lustrous crystals showing no apparent trace of hornblende within to others with drusy surfaces, in which no trace of augite could be detected.*

Crystals of pyroxene from Traversella afford another example of a change of this kind. The unaltered crystals are described as transparent and glassy, but on being altered become opaque, and often assume a silky lustre. In this opaque portion fine fibres running parallel to the principal axis begin to be developed, and, as the change advances, distinctly recognizable individuals of hornblende are formed, also parallel to the principal axis and looking like actinolite.†

Of late years, by the aid of the microscope, it has been demonstrated that the development of uralite has taken place in many crystalline rocks, not only in Europe but on this side of the Atlantic. In the case of diabase, the change of this kind has been described by Rosenbusch as follows: ‡—" The alteration processes to which the augite of diabase is subject is one of most varied character. Ordinarily, they begin with the formation of a vertical fibrous structure. At the same time the fibres often take the form of well-defined uralite, and in this case the process commonly begins from the entire periphery of the augite, and proceeds thence towards the centre, in general more rapidly in the direction of the vertical axis than at right angles to it. So long, then, as the process is not wholly completed, there remain in the interior portions of augite with irregular outline. Less frequently, or rather only in exceptional cases, the formation of uralite does not begin along the whole circumference, but attacks only single narrow strips in a vertical direction, so that thin columns of augite and uralite, parallel to the vertical axis, alternate with one another. The uralite itself passes, on still fur-

* Bischof, *Lehrbuch der Geologie*, 1864, pp. 623, 624.

† *Lehrbuch der Geologie*, Bischoff, 1851, p. 539.

‡ *Mikroskop. Physiogr. d. massigen Gesteine*, 1877, p. 330.

ther alteration of the rock into chlorite, and this finally into a mixture of brown iron ore, quartz and carbonates.*"

The above facts have been cited because of interest in connection with what now follows concerning the alteration of certain pyroxenes in the apatite region of Quebec. The best examples were observed at the mines of Mr. Breckon, on the twenty-third lot of the thirteenth range of Templeton, where crystals have been obtained showing perfectly the transition from pyroxene to what may be called uralite. The crystals are mostly flattened in the direction of the orthodiagonal, and while some of them are apparently quite unaltered, others have been converted into hornblende for a greater or less depth from the surface; others, again, are entirely changed to hornblende, and show no trace of pyroxene even when sliced and examined microscopically. In the first stage of alteration the pyroxene, which in its original condition is glassy and of a grey color, becomes more or less dull and greenish or greyish-white, still, however, retaining the cleavage of pyroxene. In this pale portion acicular prisms of green hornblende begin to be developed, gradually increasing until in some cases, all trace of pyroxene is obliterated. The change appears to have always begun at the surface of the crystals, extending inwards more rapidly in some parts of the crystals than in others, but although the hornblende prisms at the surface appear to be mostly parallel with the principal axis, within they are seen to run in every direction, or in some cases to be arranged in radiating groups. Intermingled with the hornblende prisms a little calcite occurs in places.

Even when the crystals have been entirely changed to hornblende the pyroxene angles remain perfectly distinct, and one crystal with terminal planes shows the following combination: $\infty P \infty$. ∞P. $[\infty P \infty]$. $P \infty$. $-P$. $2P$. The crystal is an inch and seven-eighths wide and a little over half an inch thick. The remaining portion of another crystal, which has lost its terminal planes, is three inches wide and an inch thick, and apparently wholly uralite. The crystal which supplied the material for the following analyses was about an inch and three-quarters wide and an inch thick. The centre consisted of glassy grey pyroxene, surrounded, however, by the dull and pale material described

* For other interesting details concerning uralite see Zirkel, *Mik, Beschaff, d. Min. u. Gest.* p. 178. Also Rosenbusch, *Mik. Physiog. d. Min.*, p. 316.

above, and this was surrounded in turn by an aggregation of hornblende prisms. These three portions may be called respectively A., B. and C. A. resembled in appearance much of the ordinary pyroxene of the region, from which also it probably does not differ much in composition. The specific gravity was found to be 3·181, and it gave on analysis the following results:

A.

Silica	50·868
Alumina	4·568
Ferric oxide	0·970
Ferrous oxide	1·963
Manganous oxide	0·148
Lime	24·438
Magnesia	15·372
Potash	0·497
Soda	0·218
Loss on ignition	1·439
	100·481

This is the composition of an aluminous diopside or malacolite, and, except in the larger proportion of iron, resembles that of pyroxene from Grenville and Bathurst.* The following analysis of B., the white portion of the crystal, shows that, chemically, no great amount of change had taken place. The specific gravity (3·205) was also about the same as that of A:—

B.

Silica	50·898
Alumina	4·825
Ferric oxide	1·741
Ferrous oxide	1·358
Manganous oxide	0·152
Lime	24·392
Magnesia	15·268
Potash	0·150
Soda	0·076
Loss on ignition	1·200
	100·060

It will be observed that although the total amount of iron in A. and B. is almost identical, more of it exists as ferric oxide in B. than in A. The quantity of alkalies is also only about one-third of the amount found in A.

* See analysis, Report of Progress, 1874-75, p. 302, and Geology of Canada, 1863, p. 467.

If now we pass to C., the uralitic portion of the crystal, the changes are much more striking, as will be seen from the following analysis:

C.

Silica	52·823
Alumina	3·215
Ferric oxide	2·067
Ferrous oxide	2·709
Manganous oxide	0·276
Lime	15·389
Magnesia	19·042
Potash	0·686
Soda	0·898
Loss on ignition	2·403
	99·508

The specific gravity in this case was only 3.003. Comparing C. with A. and B. we find that the lime is diminished by about nine per cent., while there is a gain of about four and a-half per cent. of magnesia. The ratio of loss and gain, however, is not that of the molecular weights of lime and magnesia; that is to say, for a molecule of lime lost a molecule of magnesia has not been gained. A portion of lime has been lost without its place being *taken by magnesia. At the same time there is a slight* increase of silica relatively to the other constituents, and, as would be expected, a decrease in density.

It is well known that pyroxene commonly contains more lime and less magnesia than hornblende, and in the present case loss of lime and gain of magnesia would appear to be the principal cause determining the change to hornblende. The larger proportion of alkalies in the uraltic or hornblendic proportion of the crystal is also worthy of note, because hornblende is commonly richer in alkalies than pyroxene. On the other hand, it is interesting to observe that there is less alumina in the hornblendic product than in the original pyroxene, for, as a rule, hornblende is apt to contain more alumina than pyroxene. This subject has recently been discussed by Mr. G. W. Hawes in his valuable report on the mineralogy and lithology of New Hampshire. He there gives some interesting analyses to illustrate the differences in the composition of pyroxene and hornblende, and seems to regard preponderance of alumina as the principal cause determining the formation of the latter species. At the same time, however, he does not lose sight of the fact that pyroxene usually contains more lime and less alkalies than hornblende.

III. ON THE OCCURRENCE OF OLIVINE IN CANADA.

The occurrence of olivine in the eruptive rocks of Rougemont, Montarville and Mount Royal, as well as in a doleritic dyke cutting the Hudson River formation at St. Hyacinth, and in the dolomitic conglomerate or breccia of St. Helen's Island, near Montreal, was described by Dr. Hunt many years ago, and an analysis of that from Montarville given. Recently it has been found in a number of other localities, and a few facts concerning its occurrence at some of these are of sufficient interest to be given here.

Owing to the difficulty of navigating the Ottawa River below the railway bridge at Ste. Anne's during the time of low water, communication with a deeper channel than the one ordinarily followed was deemed necessary, and was finally effected by cutting across a ridge of rock in the bed of the river. Coffer-dams were built enclosing the required area, and when the water was pumped out an excellent opportunity was afforded of seeing the bottom of the river. The rocks exposed were sandstones and conglomerates of the Potsdam formation, striking nearly east and west and dipping to the south $\angle 3\frac{1}{2}^{\circ}-4^{\circ}$. Traversing these beds with a course of N. 20° W., a vertical dyke about three feet thick was found. It consisted of a rather fine grained ground mass holding large plates of mica sometimes an inch or more across, irregular masses and occasionally large crystals of black augite, and angular masses of olivine occasionally more than an inch in diameter. The last-named mineral gives the rock a very striking appearance, as much of it is of a bright red colour. An analysis of this red olivine gives the following results:—

Silica	38·560
Magnesia	44·369
Ferric oxide	1·361
Ferrous oxide	12·649
Manganous oxide*	0·112
Water (ign.)	2·914
	99·965

It is, therefore, a variety with much less iron than that from Montarville, which, according to Dr. Hunt's analysis, contains—Silica 39·17, ferrous oxide 22.54, magnesia 39·68 = 99·39.

When thin sections of the olivine from Ste. Anne's are examined with the microscope, the usual fissured or cracked appear-

* With a little oxide of cobalt.

ance is seen. Along some of the cracks an alteration to serpentine has taken place, while along others a little red oxide of iron is visible. Although the amount of this peroxide is small as shown both by the microscope and by analysis, it is nevertheless, evidently the cause of the general red colour which the mineral has assumed.

Another locality in which olivine has recently been found is a short distance to the south-east of Mount Albert, just south of the south second fork of the Ste. Anne River, Quebec. The explorations of Mr. Richardson during the past season have shown that it there forms important rock-masses close to the serpentines of Mount Albert, which have evidently been produced by the alteration of the olivine. A specimen of the rock collected by Mr. Richardson is fine-granular, slightly friable, and pale yellowish to greyish-green in colour. It shows a few minute black grains, probably of chromite, and rarely a little of a fibrous mineral which resembles enstatite. Altogether, the rock looks *remarkably like one variety of that from North Carolina, which* was many years ago described by Genth, and regarded by him as the source of the serpentine and talc of the same region.*

. . . .

The origin of such olivine rocks as those of Carolina and Mount Albert is a difficult and disputed question, but one which still remains, whether we believe that the serpentines which accompany them where derived from them or not. In opposition to the view that they owe their origin to chemical precipitation, Clarence King suggests that they may represent accumulations of olivine sands like those now occuring on the shores of the Hawaiian Islands.† Whether such accumulations did take place in the earlier geological formations we do not know, but there is certainly nothing unreasonable or unlikely in the view that magnesian precepitates may then, as in later times, have been formed and subsequently altered to olivine.

A thin section of the olivine rock or dunite from near Mount Albert, when examined with the microscope, presents the appearance shown in Fig. 1 *a*. It is seen to consist almost entirely of *granular olivine, with occasional black grains of chromic iron.* Owing to an alternation of layers with finer and coarser texture,

* *American Journal of Science*, Vol. XXXIII.; 1862, p. 199.

† United States Geological Exploration of the Fortieth Parallel. Vol. I., p. 117.

it shows a more or less banded structure. As observed above, an enstatite-like mineral may occasionally be seen in the hand specimen, but none of it happened to occur in the portion sliced.

FIG. 1.

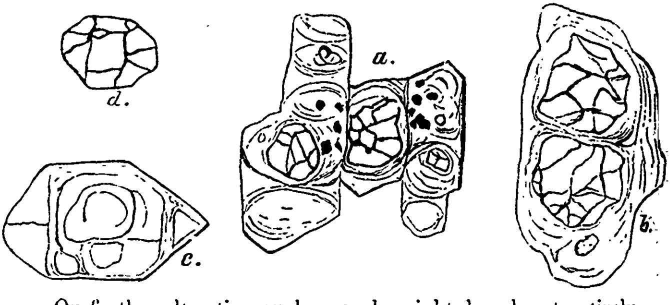
a *b*

Fig. 1 *b* is drawn from a section of one of the so-called serpentines occurring near the dunite. Its relation to the latter is evident, for it still contains numerous grains of unaltered olivine. In some specimens the change has not advanced so far as here, but in other cases the olivine has almost, if not entirely, disappeared. The chromite, however, always remains.

Another example of the occurrence of olivine is to be found in the case of a dark grey dolerite occurring near South Lake, in Antigonish County, Nova Scotia. When a section of the rock is examined with the microscope, it is seen to consist of a beautifully banded triclinic feldspar, brownish augite, magnetite, and very numerous irregular grains, or occasionally rude crystals, of olivine. The olivine resembles that sometimes seen in gabbro. It is traversed by the usual cracks or rifts, which in this case appear very broad and black, and also contains great quantities of black and opaque microlites, which are probably magnetite, and which are sometimes so abundant as to render the mineral almost opaque. Some of them are arranged in parallel rod-like shapes, while others occasionally assume star-like or other more or less symmetrical forms.

Olivine has also been detected in several of the eruptive rocks of British Columbia. One of these, of Tertiary age, from Kamloops, affords most beautiful examples of the alteration of olivine to serpentine. It is massive, rather fine-grained, and of a very dark olive-green colour. The examination of a slide with the microscope shows that originally the rock must have consisted of crystals and grains of olivine, augite (mostly in crystals) and a small proportion of plagioclase feldspar and magnetite. But while the augite mostly remains fresh, a large part of the olivine, which appears to be the most abundant constituent of the rock, has been altered to serpentine. Most of the olivine crystals and grains retain a nucleus of the unaltered mineral, showing the characteristic rifts, and the outlines of many crystals which are partly or entirely converted into serpentine are still perfectly sharp. In the accompanying figure (Fig. 2) *a* represents a group of crystals which are mainly composed of serpentine, but show nuclei of olivine and a few opaque grains probably of magnetite; *b* is an irregular mass also partly changed to serpentine; *c* represents a crystal which has been entirely converted into serpentine; while *d* is an almost perfectly fresh crystal of olivine.

Fig. 2.



On further alteration such a rock might be almost entirely converted into serpentine. Such a change has been observed elsewhere, as, for example, in the case of many of the Wurtemberg basalts, which are said to be "little more than serpentine rocks containing some magnetite, since the olivine and augite which composed the basalt are changed into serpentine."

In this country we have other examples than those already given of the production of serpentines by the alteration of other rocks. That such is the origin of many of the serpentines of the Eastern Townships there can be little doubt. The fact of their being commonly chromiferous suggests that at least they may have been derived from such peridotic rocks as lherzolite, dunite, olivine-gabbro, &c.

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