THE

PROCEEDINGS AND TRANSACTIONS

OF THE

Nova Scotian Institute of Science

HALIFAX, NOVA SCOTIA

VOLUME XV

1918-1922

HALIFAX

PRINTED FOR THE INSTITUTE BY THE ROYAL PRINT AND LITHO LIMITED

1923

CONTENTS OF VOL. XV.

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(Vol. XV, Part 1)

57TH ANNUAL BUSINESS MEETING.

Physiological Lecture Room, Dalhousie College, Carleton St., Halifax, 18th November, 1918.

THE PRESIDENT, DR. D. FRASER HARRIS, in the chair.

Other members present: PROF. C. L. MOORE, DR. E. MACKAY, G. W. T. IRVING, and H. PIERS.

The President delivered a brief address, in which he reviewed the society's work during the past session, and also referred to the death of two members, Prof. Ernest Haycock and Maynard Bowman. (See biographical sketches on pages xvii, xviii.)

The Treasurer, MR. IRVING, presented his annual report for the year ending November, 1918, showing that the receipts during the year were \$987.00, the expenditure \$582.65, and the balance on hand \$404.35. The report was received and adopted.

It was resolved that steps be taken to purchase a \$500 Victory Bond.

The Librarian's report was presented by MR. PIERS, showing that 1,163 books and pamphlets had been received

First Ordinary Meeting.

Physiological Lecture Room, Dalhousie College, Carleton St., Halifax, 10th March, 1919.

The President, Dr. Bronson, in the chair.

It was reported that there had been received on March 3rd as a gift to the Institute, from the estate of the late Dr. Charles J. Gossip of Halifax, a framed oil portrait of one of its earlier Presidents, William Gossip, which had been painted some time before his death, by Mrs. Henry Rogers, an artist who then resided in Halifax. On motion of Mr. Piers and Dr. A. H. MacKay it was resolved that the thanks of the Nova Scotian Institute of Science be conveyed to the estate of the late Dr. C. J. Gossip, for the gift of a portrait of its fourth President (1878-1880), William Gossip, a donation which the society very highly appreciates.

It was reported that Lieut. Ralph V. Westwood, R. N. V. R. Naval Control Office, Halifax, had been elected an ordinary member on 5th Dec., 1918.

Professor John Cameron, M. D., D. Sc., F. R. S. E., of Dalhousie University, read a paper entitled "A Craniometric Study of the Micmac Skull in the Provincial Museum of Nova Scotia." (See Transactions, page 1). The subject was discussed by the President, Dr. A. H. MacKay, W. H. Prest, H. Piers, Dr. Fraser Harris, and Dr. E. MacKay.

Second Ordinary Meeting.

Physiological Lecture Room, Dalhousie College, Carleton St., Halifax, 21st April, 1919.

The President, Dr. Bronson, in the chair.

It was reported that Frederick C. Churchill, Wolfville, N. S., had been elected an associate member on 3rd April.

Captain J. H. L. Johnstone, R. E., Ph. D., M. B. E., Halifax, read a paper on "Artillery Observation Methods," which was discussed by the PRESIDENT, DR. E. MACKAY, H. PIERS, PROF. FINLAYSON and DR. A. H. MACKAY.

THIRD ORDINARY MEETING.

Physiological Lecture Room, Dalhousie College, Carleton St., Halifax, 12th May, 1919.

The PRESIDENT, DR. BRONSON, in the chair.

It was announced that BASIL R. COYSH, Halifax, had been elected an ordinary member, and PROFESSOR P. B. PERKINS, Mt. Allison University, Sackville, N. B., an associate member, on 1st May.

On motion of H. PIERS and DR. A. H. MACKAY, it was resolved that the Nova Scotian Institute of Science, at its meeting held at Halifax, 12th May, 1919, learns with deepest regret of the death of its last surviving original member of 1862, and one of its former vice-presidents, MAJOR GENERAL CAMPBELL HARDY, R. A., the talented author of "Forest Life in Acadie," which occurred at Dover, England, on 11th April, in the 88th year of his age. He possessed a splendid Christian character, was a good naturalist and an admirer of Nature, a fine sportsman, and was gifted with an accomplished pen and a brush which portrayed local scenery with skill and fidelity. The Institute extends its sympathy to his family, to whom a copy of this resolution shall be transmitted by the secretary. Further resolved that a biographical sketch of the deceased gentleman be prepared for the forthcoming part of the society's Proceedings. (See Proceedings, page vii.)

DR. E. MACKAY read a letter from the Society of Chemical Industry, dated 25th April, 1919, urging that the Government of Canada be requested to take over the German patents relating to dyes and other chemicals which have been registered in Canada. On motion of DR. E. MACKAY and DR. FRASER HARRIS it was resolved that with a view to the future protection of the Canadian chemical industry, this society strongly urges that such legislative action be taken before the signing of peace as will empower a Canadian foundation company to control enemy patents registered in Canada. It was directed that a copy of this resolution be forwarded to Sir Thomas White.

A paper by PROFESSOR P. B. PERKINS and H. H. YORK, on "The Use of X and Gamma Rays in the Stimulation of Fungi occurring in Soil," was read by title.

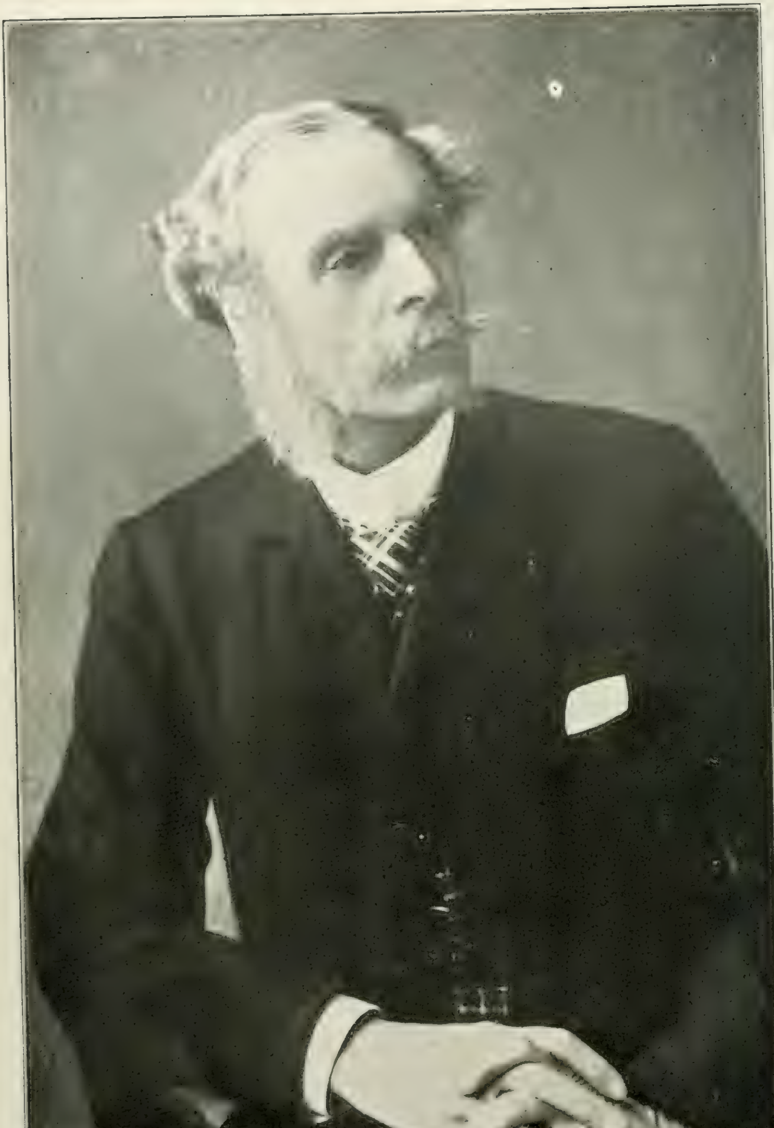
A paper by DR. A. H. MACKAY, "Phenological Observation, Nova Scotia, for 1918," was read by title. (See Transactions, page 49.)

A paper by PROF. H. J. M. CREIGHTON, Ph.D., Swarthmore, Penn., U. S. A., on "A Method of Making Methyl Violet," was read by DR. E. MACKAY. (See Transactions, page 57.)

PROFESSOR JOHN CAMERON, M. D., D. Sc., read a paper entitled "Demonstration of a Racial Map of the World, founded upon a New Craniometric Method." The subject was discussed by DR. FRASER HARRIS, DR. NICHOLLS, W. H. PREST, H. PIERS, and DR. A. H. MACKAY.

WALTER H. PREST read a paper on "Eskers in Nova Scotia." (See Transactions, page 33.) The paper was discussed by PROF. MCINTOSH, H. PIERS, and DR. A. H. MACKAY.

HARRY PIERS,
Recording Secretary.



Major-General Campbell Hardy, R. A., Sportsman, Naturalist, Artist and Writer; Author of "*Forest Life in Acadie*," etc.; last surviving original member of the Nova Scotian Institute of Science. Born 1831; Died 1919.

See Biographical Sketch, pp. xii-xvi.

OBITUARIES.

Major General Campbell Hardy, R. A., Sportsman, Naturalist, Artist and Author; last surviving original member of the Nova Scotian Institute of Science; born 1831, died 1919.

By Harry Piers.

The passing of General Hardy, the last surviving original member of the Nova Scotian Institute of Science, and a gentleman of unusual talent, calls for special notice, as he was a notable man who had taken the deepest interest in this province, and who did much through his writings to draw the attention of sportsmen and naturalists to this field.

Campbell Hardy was born at Norwich, Norfolk, England, on 10th October 1831, and was the eldest son of the Rev. Charles Hardy, M. A., of Whitewell, Hertfordshire. In the earliest years of the nineteenth century the latter had been a chaplain on one of King George's frigates on the North American station, and had visited Nova Scotia. Young Hardy was educated for the military profession at the Royal Military Academy, Woolwich. He entered the Royal Artillery as ensign on 19th Dec., 1849, and became lieutenant on 11th Aug., 1851.

To live and camp in the great backwoods of Canada had been his ambition in early youth, and in Feb. 1852, at the age of twenty, he came to Halifax, and remained here till August 1867, a period of fifteen and a half years. Being stationed in Nova Scotia throughout the entire period of the Crimean War, he was debarred from participation in active service. Like very many other military men of the period, he was a most enthusiastic sportsman, and being keenly interested in all he met with in forest and field, he became a good naturalist, and his skilful pencil enabled him to delineate with much truth the scenes and objects about him. In Andrew Downs he found a field naturalist who could assist him with knowledge of the animal life. He immediately began to take advantage of the sport which the New World offered in abundance, and was particularly attracted by the king of our game, the moose.

He was present at the inauguration of the Provincial Association for the Protection of the Inland Fisheries and Game of the Province of Nova Scotia, under the presidency of Capt. Chearnley, at Halifax in March 1853, and was one of the original members.

The following mention of some of his principal sporting trips during his first three years' sojourn here, will give an idea of his activity in this respect. In July 1852 he made a twelve-days' salmon fishing trip on the Nepisiquit River, New Brunswick. In the winter of 1852-3 he was on an unsuccessful moose-hunt with the veteran guide, Joe Cope, in the neighbourhood of Petite (Walton). On 26-28 Feb. 1853, he and a companion again went moose-hunting with that most noted of Indian guides, John Williams, and Francis Paul and his son Joe, at Ship Harbour Big Lake, Halifax County, but saw no moose. They then moved camp, and were from 1st to 3rd March at Fish Lake (now Scraggy Lake) in the Ship Harbour backwoods, and there on 4th March he got his first moose, a fine bull, nearly 7 feet to the shoulder and weighing 1100 or 1200 lbs., and the whole party brought down six moose in one day. In May, 1852 or '53, he was trout fishing at Frederick's Lake, St. Margaret's Bay Road, with the eccentric Charles Frederick; and June found him fishing sea-trout at the head of Musquodoboit Harbour, Halifax County. From 19th Aug. to 10th Sept., 1853, he was on a canoe voyage in New Brunswick, from Bathurst up the Restigouche River, fishing salmon, and down the St. John River to Fredericton. In Sept. of the same year on his return from New Brunswick, he was moose-calling with Indians Christopher Paul and Tom Phillips at Long Lake, Ponhook Lakes, Halifax and Hants Counties, and in Oct. 1854 he and a friend were again moose-hunting at Fish Lake (Scraggy Lake), with guide Joe Paul and another Indian. These trips he fully described in his first book.

As a result of these various shooting and fishing expeditions, and with the knowledge he had gained of our forests, trees, plants, mammals, fish, and of the Micmac and Malecite Indians and their legends, he wrote his first work, "Sporting Adventures in the New World, or Days and Nights of Moose-hunting in the Pine Forests of Acadia," published in two volumes of about three hundred pages each, at London in 1855, with two colored illustrations from his own sketches.

Particulars are given of the flies and fishing tackle required, and of the methods pursued in moose-hunting, etc., and the work concludes with a catalogue of the birds of Nova Scotia, with scientific names, 121 land birds and 83 water birds, in all 204 nominal species. No doubt his friend Downs assisted him considerably in the compilation of this list.

These racy and well-written sketches of sport and natural history attracted much attention, and soon made their young author well known in England as well as in Canada. His was the first comprehensive account of moose-hunting in this province, the attractions of which had hitherto only been made known in a limited manner by letters from officers on this station. This first work of Hardy is apparently fairly scarce.

On 6th June, 1855, he married, in the Garrison Chapel, Halifax, Matilda Sydney Stotherd, eldest daughter of the late Lt. Col. (afterwards General) Richard John Stotherd, C. B., Commanding Royal Engineer on this station, and subsequently Colonel Commandant of Royal Engineers at Dover, England. By this marriage he had the following children: Col. ——— Hardy; Capt. Campbell Edward Hardy, of the Royal Marines, died 17th Aug. 1889 in his 29th year; Capt. Ernest Clifford Hardy, R. N.; Major Francis Hardy, Miss Hardy, Miss Lucy R. Hardy, Miss Maud Hardy, Miss Mary Hardy, and Mrs. Ivor Thomas. Of these, Capt. E. C. Hardy, of the hydrographic department at the Admiralty, who was born here about 1862, is a student of birds, and about 1912 found a new bird in West Africa which the British Museum authorities named *Sylviella hardyi*. He saw service during the Egyptian War of 1882. Mrs. Hardy and these children, except Capt. E. C. Hardy, are still living.

After his marriage he resided in a house, still standing, surrounded by trees, on Camp Hill, at southwest corner of Robie and Shirley streets, now No. 368, about which countless flocks of plover came during the autumnal rains. On 23rd Feb. 1856 he was promoted to his captaincy, having some time previously served as adjutant of his corps.

On 31st Dec. 1862, he and other kindred spirits, such as J. M. Jones, Thos. Belt, Dr. J. B. Gilpin, Capt. Lyttleton, R. G. Haliburton, and others, were present at the inaugural meeting of the Nova Scotian Institute of Natural Science, and he was elected a member of the first council. Regarding the foundation of the society, he wrote me a few years ago: "I remember well the friendliness and hearty cooperation of our efforts to set forward the development of local knowledge of the natural history and resources of the province. We were a band of enthusiastic lovers of nature—hunters and woodsmen, zoologists and geologists, botanists and fishermen, historians and antiquarians, each zealous of improvement in his own particular sphere of knowledge or science."

At the first ordinary meeting, held 19th Jan. 1863, he read the second paper communicated to the new society, on "Nocturnal Life of Animals in the Forest," which gives a delightful account of our forest life at night. Then followed each year other papers by him, which are listed at the end. He served as second vice-president from Oct. 1863 to Oct. 1864, and then was first vice-president for three years, till Oct. 1867, he having by that time departed from the province.

On 2nd June, 1863, there were published in London by Day & Son, two large finely-colored lithographs, 11¼ x 16 inches, after his watercolour paintings of "The Forest Road: Summer and Winter," the former a camping scene, the latter with a horse-sled in the foreground. They are still among the best published representations of our woodland scenery, and are scarce.

He was caribou-shooting and salmon-fishing in Newfoundland in the summer of 1863, and returned to Halifax in July. He was an able artist and keenly interested in art, and in Nov. of that year, he, Capt. Lyttleton (a fine artist) and Capt. W. Chearnley brought together a picture exhibition in the drill-room at Halifax, at which he showed his two beautiful watercolours beforementioned, which had just been engraved in London, and other sketches, principally relating to moose-hunting. It may be mentioned that he considered Lyttleton our best local artist of that period.

In Aug. 1866 he, with an Indian, Glode, journeyed by canoe to Tobiaduc Brook, several miles westward of Lake Rossignol, Queens Co.,* and made a careful investigation of beaver houses there, from which he constructed two beautiful models,

* From an expression in a lecture of Gen. Hardy, one is led to believe that his last night in our woods was when they camped at the outlet of Lake Rossignol on this expedition.

with sketch, and samples of cuttings, foodsticks and bedding, one of which is in the Provincial Museum, Halifax, and the other he presented to the Zoological Society of London. The Halifax model was shown at the Exposition Universelle, Paris, in 1867, and attracted marked attention. In Dec. 1866, he read an able paper on the Beaver in Nova Scotia. (See Trans. N. S. Inst. Nat. Sc., vol. 2, pt. 1. pp. 17-25; also "Forest Life in Acadie," 1869, p. 172). From time to time he also contributed sporting sketches to "The Field" and "Land and Water."

For five and a half years he had been Inspector of Warlike Stores and Firemaster at Halifax, and subsequently in 1866 and 1867 was Inspecting Officer of the Nova Scotian Militia Artillery. In August, 1867, to the great regret of all who knew him, he finally left Halifax to return to England, at the age of thirty-six, after fifteen and a half years' residence here. He took with him many trophies of the chase, mounted by Andrew Downs. He always considered his sojourn here as the most eventful and pleasant period in his life, and his mind never ceased to dwell upon the impressions he had then gained.

With his heart still deep in our pine forests, he published in 1869 at New York, his most familiar work, and the one in which he is at his very best, "Forest Life in Acadie: Sketches of Sport and Natural History in the Lower Provinces of the Canadian Dominion," with twelve plates, all but one from his pencil, but not done justice to by the engraver. In this delightful volume his style leaves nothing to be desired, for it is a fine literary work apart from its other qualities. It still must rank as the best-written book that has yet appeared on woodland sport in Nova Scotia, and has a charm about it which is derived from the fine character and talents of its author.

The volume contains sketches of the country, of the forests and streams, of the moose and caribou and the hunting of them; careful accounts of the beaver, otter, and other important animals, of the fish and fishing, camping, the progress of the seasons, and other miscellaneous valuable observations on natural history, the nocturnal life of animals in our forest, etc. There is an interesting account of a moose hunt with old Joe Cope, about Big Indian Lake between the Head of St. Margaret's Bay and Mount Uniacke, also of a caribou hunt, in December, to the north of Parrsborough, and of moose-calling near Beaver Bank, being guided by John Williams on the two last expeditions. Some of the chapters had originally appeared, over the nom-de-plume "Alces," in "The Field" and "Land and Water." He refers frequently, under the name of "The Old Hunter," to that king of local sportsmen, Capt William Chearnley, whose name is indelibly associated with the history of sport in this province; and in after years he carried on an extensive correspondence with Chearnley until the latter's death in July 1871.

After leaving Halifax in 1867, he was stationed at Dover, Gibraltar, Chatham, Aldershot, and Queenstown. He obtained his majority on 5th July, 1872, and his lieutenant-colonelcy on 16th Jan., 1875, and was promoted to colonel on 16th Jan., 1880, finally retiring on full pay, 29th May, 1880, with the honorary rank of major-general. He then went to pass the concluding years of his life at 3 Victoria Park, Dover, England, and resided in that garrison town until his death.

There he took a foremost part in all good works. In 1901-02, during the latter part of the South African War, he and his daughter Lucy were intimately connected with a convalescent home at Dover, at which invalid Colonial soldiers, mostly Canadians (about 90), from Shorncliffe Camp, went to recuperate. They again did a vast amounc of good work among the soldiers and invalids of the Great War.

About 1900 Lord William Seymour told me that General Hardy was still alive and keenly interested in Nova Scotia and our Institute, and desired to be remembered to some of my family with whom he had been associated in sport. This renewed an acquaintance by correspondence, which evidenced how vivid were all his recollections of those old days. He still cherished an earnest desire to revisit Nova Scotia, to see its forests and rivers and other well-remembered scenes, his surviving friends and the Indians, and to once more fish and shoot here; but this wish he was not able to gratify. On 30th Oct., 1903, he renewed his connection with the Institute, being elected a corresponding member in consideration of his past services and continued interest, and as being its last surviving original member.

Latterly he lived a rather retired and often invalid life, his health being somewhat broken by a severe attack of influenza in March, 1913. For some years before the late war, his work had been almost entirely connected with the topic of nature study and attempts to promote it as a most useful factor in the education of a child's mind. To this end he had yearly gatherings and exhibitions at St. James's Parish Hall, Dover. He also occasionally lectured, and about 1910 delivered a most interesting and instructive address, now before me, entitled "In Evangeline's Land," which contained vivid descriptions of Nova Scotia, its productions, scenery and sport, and of its Indians and their legends, interspersed with anecdotes.

Being a talented artist, much of his time was devoted to painting scenes connected with Nova Scotian forests and lakes, their wild life, and the pursuit of sport; and his annual Christmas card was one of his sketches, accompanied by a booklet on some meditative subject. He was closely associated with St. James's parish, Dover, and took great interest in the restoration of the old Castle Church.

On the outbreak of the Great War in 1914, the residences in Victoria Park were taken for military purposes, and he moved to 40 Leyburne Road. There, after having been in indifferent health for some months, he passed away on 11th April, 1919, in his eighty-eighth year, but in entire possession of all his faculties, and with still his characteristic sunny boy-like disposition, which made him beloved by everyone who knew him. Up to the very last he wished he could "go back" to Nova Scotia. The same day died his great friend, Col. Samuel Parr Lynes, R. A., who as a lieutenant in the gunners, had fished and hunted and paddled with him in Nova Scotia in 1857 and 1858, and who corresponded with him regularly. Hardy's remains, covered with the nation's flag, on which were his busby and sword, were borne on a six-horse gun-carriage, and laid to rest in a moss- and flower-lined grave in St. James's Cemetery, next to his deceased son. A cross of birch-bark and porcupine-quill work, made by the widow of his favourite Indian guide, John Williams, is appropriately placed to his memory in the parish church.

Summing up his character, we find he was a devout Christian gentleman, of a deeply religious mind, always doing philanthropic and other good works; and his gentle courteous manners were those of the old school. As has been stated, he never lost the spell which Nova Scotia had cast upon him. In fact, he always cherished affection for places and persons with which he had been associated, and never forgot an associate, however humble. His old Micmac guides, the noted John Williams,* Joe Cope, Francis Paul, Christopher Paul, and others, were never forgotten and often referred to, as well as those of his own class. The Indian welcome as he paused at the wigwam's entrance, "Come in, Hardee, bon soul", echoed sweetly in his ears for fifty years, with the remembrance of the weird night-cry of the loon on the lake, and the spiritual evensong of the hermit thrush.

He was a keen sportsman of the clean English school, elated by the excitement of the chase, but never taking an unfair advantage of an animal. His chief delight was moose-hunting and fly-fishing for salmon and trout. His name will go down in our sporting annals with those of his friend Col. W. Chearnley, Dr. J. B. Gilpin, Charles Hallock, Lt. Francis Duncan, Dy. Asst. Com. Gen. F. C. Blunt, F. H. D. Vieth, F. W. Blaiklock, Capt. Champagné L'Estrange, Hon. Charles Alexander, E. G. Stayner, Charles A. Stayner, Dr. B. W. C. Deeble, the erratic Lt. J. M. Macgowan, A. P. Silver, some relatives of my own, and other well-known local sportsmen, men of varying temperament but each with the deep-seated love of clean sport.

As is often the case with true sportsmen, an intense love of all nature seems to have been very largely at the bottom of Hardy's love for sport and the forest. Sport without its wild surroundings would have been much less attractive to him. Through all his books runs that love of Nature—not for sport alone, but for herself—which was always a power in his life, and remained so till death. His opportunities for studying the habits of animals in the forest were second to none, and he described with rare discrimination and the utmost accuracy what he observed. He was thus an accurate field naturalist, but he had not the skill in drawing up technical descriptions which Dr. J. B. Gilpin possessed. He was

* Honest John Williams, most expert of Micmac guides, died at the Indian Reservation near Shubenacadie, N. S., about 1890 or 1893. He was one of the guides selected to go to the woods with Prince Arthur in 1869.

rather prejudiced against such popular American writers as Long, Roberts, and Thompson-Seton, considering them to be "animal romancers" and their writings valueless to the true naturalist. His knowledge of the Indian, his character and his legends, was remarkably thorough.

He was an amateur artist of most distinct talent, working in watercolours, oils, and pencil, but mostly in the first, and continuing to do so to the very last. As his subjects, he took mostly woodland, lake and river scenery in the wilds of Nova Scotia, and sporting incidents, largely relating to the moose, all most truthfully represented and with distinct artistic skill in composition. The engraved examples in his books do not at all do justice to his brush; and the best published specimens of his work are the two fine, coloured lithographs published in 1863. I have a photograph of a camp scene on a lakeside which is remarkably good.

As a writer he possessed a charming, polished style, which lends a literary flavour to his sporting sketches, and makes some of them almost classics in their way. The accounts of his adventures are entirely free from traces of the boastful strain so common in some writers in modern American sporting magazines; and he tells of his failures, as well as of his successes, in a manner devoid of egotism. No doubt "Forest Life in Acadie," his more mature work, shows him at his best. He occasionally essayed poetry, and his unpublished stanzas, "A Brook of the Northern Woods," as usual referring to this country, show considerable merit.

Although Hardy was in Nova Scotia before my time, yet his name and that of the hot-headed but warm-hearted Irishman, Col. Chearnley, were constantly heard by me as a boy, from veteran sportsmen of my family, when anecdotes and reminiscences of forest and stream were being narrated, until I grew to have a veneration for them; and it now gives me distinct gratification to put on record these few notes on Hardy's life. His son, Capt. E. C. Hardy, has his journals and other papers, and will no doubt prepare a memoir that will do full justice to his accomplished father.

Writings of General Campbell Hardy.

1855.—Sporting Adventures in the New World; or, Days and Nights of Moose-hunting in the Pine Forests of Acadia. 2 vols. 12 mo. London, Hurst and Blackett, 1855.

Vol. 1, xii + 304 pp., with coloured frontispiece, "Moose-hunting" (his first moose at Scraggy Lake, March, 1853); Vol. 2, viii + 299 pp., with coloured frontispiece, "The Bivouac" (camp at Scraggy Lake, March, 1853). "A Catalogue of the Birds of Nova Scotia," pp. 291-299.

1863.—Nocturnal Life of Animals in the Forest. (Read 2 Feb. 1863). Trans. N. S. Inst. Nat. Sc., vol. 1, pt. 1, pp. 11-19, Halifax, 1863.

Notes on nocturnal life of animals and birds in Nova Scotia.

1864.—On the Capelin (*Mallotus villosus*). (Read 7 Dec. 1863). Trans. N. S. Inst. Nat. Sc., vol. 1, pt. 2, pp. 4-13, Halifax, 1864.

Describes this fish and its habits as observed in Newfoundland in 1863.

1864.—Sketches in Our Neighbourhood: an afternoon with Downs. Acadian Recorder (newspaper), Halifax, 1864.

The first published notice of Andrew Downs and his zoological garden at head of Northwest Arm, Halifax. Reprinted in Hardy's "Reminiscences of a Nova Scotia Naturalist," pp. xiii-xx.

1865.—On Provincial Acclimatization. (Read 5 Dec., 1864). Trans. N. S. Inst. Nat. Sc., vol. 1, pt. 3, pp. 15-30, Halifax, 1865.

Deals with a subject which has not received much attention of late, but which at that time was much discussed, and for forwarding which there were societies in London, Paris, etc.

1866.—Nova Scotian Conifers: Part 1. (Read 3 May, 1866). Trans. N. S. Inst. Nat. Sc., vol. 1, pt. 4, pp. 120-130, Halifax, 1866.

Describes the Black Spruce, White Spruce, Hemlock Spruce, and Balsam Fir. Part 2 never appeared.

1867.—On the Beaver in Nova Scotia. (Read Dec., 1866). Trans. N. S. Inst. Nat. Sc., vol. 2, pt. 1, pp. 17-25, Halifax, 1867.

Description of beaver dam and houses at Tobiaduc Brook, Queens Co., N. S., Aug., 1866, and of the general habits of the animal, from careful personal observation.

1869.—Forest Life in Acadie: Sketches of Sport and Natural History in the Lower Provinces of the Canadian Dominion. Sm. 8vo, ix + 371 pp.; 11 plates and vignette (all after Hardy's drawings, except the coloured plate of trout by Dr. J. B. Gilpin). New York, D. Appleton & Co., 1869.

> His best-known and most scholarly work. Contains some papers contributed to "The Field" and "Land and Water," in the '60's, over the nom-de-plume "Alces."

1908.—Reminiscences of a Nova Scotian Naturalist: Andrew Downs. (Read 11 March, 1907). Trans. N. S. Inst. Sc., vol. 12, pt. 1, pp. xi-xxix, Halifax, Aug., 1908.

Provincial Museum, Halifax, N. S.,
28th January, 1921.

Professor Ernest Haycock; 1867-1918.

Professor Ernest Haycock, M. A., was born at Westport, Digby Co., Nova Scotia, on 29th May, 1867, and died at Wolfville, N. S., on 13th April, 1918, aged 51 years. He came of United Empire Loyalist stock, and was a son of Maurice and Eliza (Peters) Haycock. He secured his early education in the public schools, and for a time sailed on a fishing vessel. He attended Acadia University, Wolfville, where he graduated B.A. in 1896, and then went to Harvard University, where he obtained his B.A. in 1897 and M.A. in the next year, being instructed in geology by Prof. W. M. Davis.

From 1898 to 1910 he was instructor in chemistry, mineralogy, and geology at Acadia University; and in the latter year was appointed professor in the same subjects, succeeding Prof. Coldwell, and held that chair with ability until his death.

He became an associate member of the Nova Scotian Institute of Science on 17th May, 1899, and in April of the succeeding year read his first paper, "Records of Post-Triassic Changes in Kings County, N. S.," which was soon followed by a number of others, all of which showed him to be a systematic, well-trained observer, a good geologist, and a clear writer.

On 29th May, 1901 he organized the Kings County Branch of the Nova Scotian Institute of Science, which was formed primarily to meet the needs of such Kings County members as were unable to attend meetings of the parent society, and who believed that much personal encouragement and stimulus could be derived from the meetings of such an affiliated society. Prof. Haycock was its president during its existence, and was the moving spirit in all its activities, until it held its last session in 1903-4. (See Proc. N. S. Inst. Sc., vol. 10, pp. xcviii and cix.)

In the summer of 1902 he was engaged, under Arthur Webster, in field-work for the Geological Society of Canada, on the western coast of Vancouver Island, B. C., from the Strait of Juan de Fuca to within a short distance of the northern end of this island, on which he prepared a report. (Rept. Geol. Sur., 15, 76-92A). In the summer of 1903 similar work was done under Dr. Ells in Charlotte Co., N. B., (Rept. Geol. Sur., 15, 150AA); and in the seasons of 1904, 1905 and 1906 he was engaged in filling in the geology for the mining and topographical maps of the Lièvre River and Templeton phosphate district in Labelle and Wright Co's, Quebec, and preparing a report thereon. (Rept. Geol. Sur., 16, 232-250A). Subsequent to that he seems to have restricted his activities to university work.

In 1897 he married Miss Annie Priscilla Hall of Granville, N. S., who had encouraged him to take a university training, and by whom he had a son, Maurice. She died on 16th April, 1904, a loss which he deeply felt. On 27th Feb. 1913 he married Mrs. Mabel Patriquin (*nee* Card).

H. P.

Maynard Bowman; 1843-1918.

Maynard Bowman, B.A., public analyst, of Halifax, was born at "Spa Springs," Windsor, N. S., on 11th Jan., 1843, and died suddenly at 146 South St., Halifax, on 20th Aug., 1918, in the 76th year of his age. He was a son of Charles Broughton and Elizabeth (Maynard) Bowman, and on his father's side came of a prominent Windsor family, while on his mother's side he was a grandson of Capt. Thomas Maynard, R.N., of "Grenadier Fort," Halifax.

He was educated at Thomas Curren's school, the Collegiate School, and King's College, receiving his B.A. degree in 1862. At King's he was under the instruction of one of the most able chemists we have ever had in this Province, Prof. Henry How He then took an eighteen months' course in chemistry at Glasgow University, Scotland.

At first he entered business in Halifax, and then was employed in the office of the Dept. of Railways and Canals, Ottawa. On 29th March 1882 he became official public analyst for Nova Scotia and Prince Edward Island, which position he occupied with ability for thirty-five years. Latterly he became recognized in England and America as an authority on testing wood-pulp.

He married in 1864 Ann Elizabeth, daughter of James DeWolfe Fraser of Windsor, He left five children, the sons being Charles B. of Lethbridge, Alberta, Maynard J. F. of Halifax, and Rev. Benjamin A. of Bermuda.

In Jan., 1884, he was elected a member of the Nova Scotian Institute of Science, and at the time of his death was the oldest ordinary member. On 8th Oct. 1884 he became a member of the council, and served in that capacity continuously for thirty-two years, until 13th Nov. 1916, when his health was failing. He was librarian for thirteen years, Oct. 1889 to Nov. 1903, at a period when the library was beginning to grow rapidly; and treasurer for nine years, Nov. 1907 to Nov. 1916. In recognition of his services he was elected a life member. Although he contributed no papers to the Institute, yet he always took a very deep interest in its work and was a constant attendant at its meetings.

He was a very devout member of the Church of England, and his name will always be associated with St. Luke's parish and that of All Saints', which succeeded it. He will be remembered as a man of sterling qualities of character, genial and kindly, with a quiet demeanour and a fine courtesy, which made him respected and heartily liked. His noticeably dark hair gave him a youthful appearance, which made it hard to realize he had reached three-score years.

H. P.

TRANSACTIONS

OF THE

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(Vol. XV, Part 1)

A CRANIOMETRIC STUDY OF THE MICMAC SKULL IN THE POVINCIAL MUSEUM OF NOVA SCOTIA. — By JOHN CAMERON, M. D., D. Sc., F. R. S. E., F. R. S. C., *Professor of Anatomy,* Dalhousie University, Halifax, N. S.

(Read 10 March, 1919).

The Micmac Indians are generally regarded by ethnologists as a branch of the important and influential Algonquian group which once held sway over a considerable area of North America. They constitute the aboriginal inhabitants of Nova Scotia, Prince Edward Island, and the northern portions of New Brunswick, while there is evidence to indicate that they even extended at one time to the neighbouring western portion of Newfoundland, and came no doubt into intercourse with the Beothuck aborigines of that island.[1] Jacques Cartier,[2] the French navigator, appears to have been the first European to have cast his eyes on the Micmac Indians whom he mentions as having seen on the shores of Chaleur Bay, New Brunswick, in 1534. Since that time much has been written on the subject of this interesting people, and an excellent bibliography up to 1911 will be found furnished by Mr. H. Piers[3] in Vol. XIII of these Transactions. A general survey of these memoirs indicates, however, that the history, customs, manners, beliefs, language and literature of this tribe have been the subjects mainly dealt with, and, as Mr. Piers[3] himself states,—"no data are available regarding measurements of Micmac skulls, etc., whereby we might compare them with those of other tribes." Hrdlicka[4] in his elaborate memoir on the Physical Anthropology of the Eastern Indians of the United States likewise makes the significant statement, that "Much also remains to be done with respect to the Algonquians. The Canadian tribes have scarcely been touched as yet."

The Micmac Skull which forms the subject of this memoir is the only specimen in existence in the Nova Scotia Provincial Museum, and also as far as I can ascertain, in the Province. The writer wishes to express his indebtedness to Mr. H. Piers, the Curator of the Museum, for the privilege of having examined the skull, and also for being granted permission to make a mesial sagittal section, in order to investigate the various important basal angular measurements.

The descriptive label attached to the specimen briefly states that it is the "skull of a Micmac Indian, killed at Four Mile House, Bedford Basin, near Halifax, during the construction of the railway to Windsor in 1854." It was presented to the Museum in 1872 by the late Dr. William H. Weeks of Dartmouth, N. S., who was then a coroner of Halifax County. Mr. Piers informs me that the original label of this Micmac skull, in the writing of Dr. Honeyman, former curator of the Provincial Museum, merely states that it is a "Micmac's skull." Dr. Honeyman, however, told Mr. Piers, that it was the skull of a Micmac who had been killed at Four Mile House (now Rockingham) during the construction of the railway there. The railway from Halifax to

Windsor was being built in 1854. The fuller label was attached to the specimen by Mr. Piers in accordance with this information. Dr. Honeyman in his Museum report for 1872 states that the skull was presented by Dr. Weeks in that year. Weeks graduated in 1859, so that he must either have obtained the skull in his early student days; or, if he obtained it during the time he was coroner, the date when the man was killed must have been later than 1859, and the accident then must have occurred during repairs to the railway. Now a point of difficulty at once manifests itself, for it is a well recognized fact that there was in the early colonization days a certain degree of intermingling of Micmac and French Acadian blood. In the midst of these difficulties, we possess no record as to whether this skull belonged to a full blooded Micmac Indian or not. Fortunately, however, this is just where Science is able to bridge across the *hiatus* and demonstrate to us that many of the indices and other cranial measurements of this specimen suggest Mongoloid affinities which the skull of the North American Indian in general tends to manifest in some degree or other. On the whole therefore, I am inclined to believe that this skull was that of a pure blooded North American Indian. It is a matter for deep regret that the physical anthropology of the aboriginal inhabitants of Nova Scotia is represented in the Provincial Museum merely by a single skull. My main purpose therefore, in writing this paper is to direct attention to an obviously anomalous condition, and at the same time to appeal to those interested in anthropology to endeavour to rectify this state of affairs by collecting specimens. I would personally be most grateful for any information regarding the location of genuine old Indian burial sites for purposes of exploration. There is admittedly a certain degree of antipathy towards disturbing the dead and desecrating their graves in a search for relics and other remains,yet, in the absence of adequate literature, one must not allow the records of the manners, customs, and beliefs of this ancient race to vanish into oblivion. The human memory is notoriously short, and that is just where our Museums subserve their functions as monuments of the past, and keep reminding us of the aboriginal inhabitants, and the ancient history of our Province, "lest we forget." It is to be clearly understood that the various measurements and indices of this skull are not to be taken as representative of the craniology of the Micmac Indian. This can only be ascertained after examining hundreds of specimens, hence my earnest appeal for initiating the collection of suitable material, the authenticity of which is beyond all dispute.

In Dawson's *Acadian Geology*(22) are two illustrations representing a Micmac woman and her son. Although these are not modern photographic reproductions they convey a fairly good impression of the average type of facial feature that characterized this Indian tribe. The features of the woman are regular and exhibit no evidence of prognathism, though the brow is rather low and receding. The features of the man, who probably had a slight admixture of French-Acadian blood, are also well modelled, though the lips, are somewhat heavy and pouting. The forehead looks higher than that of the woman and is better developed on the whole. It is good to have these racial types represented on the pages of a standard scientific work, as they permanently represent a race that has been condemned, or at any rate foredoomed by civilisation, either to die out, or lose its individuality by becoming merged in the white population through intermarriage

General Description of the Skull.—The outer table had evidently been artificially darkened by some unknown means as it was almost coal black in colour. The skull was rather delicately moulded, and tended in fact to suggest the female type. The superciliary ridges were faintly marked and the supraorbital margins rather sharp in outline. The mastoid and styloid processes and the curved lines of the occipital were poorly shown, so that the individual had evidently not possessed much virile muscular development. In reference to this fact it is significant to note Hrdlicka's[4] remarks on his extensive series of Lenape North American Indian skulls in which he found no "massiveness, no heavy supraorbital arches or crests, no heavy jaws. It was plain that they did not belong to a tribe of great hunstmen or warriors."

A large slice of bone had been cut out from the right half of the cranial roof for some unknown reason, so that it was impossible to estimate the cranial capacity in the usual way (See Fig 13). The bones of the skull were rather thin, being not more than 4 or 5 mm. in thickness. I could not detect any Wormian bones. There was no metopic suture and the frontal did not articulate with the temporal bone on either side. The lower portions of the temporal fossae were rather deep, the space between the inner surface of the zygoma and the great wing of the sphenoid measuring 24.5 mm., which is more than the average in the modern Canadian skull and is nearly as extensive (25.5 mm.) as in a Melanesian skull It is indicated of course that at any rate the temporal muscle showed robust development, no doubt in accordance with a vigorous and unethical mode of mastication that had been adopted by the individual. The lower jaw was unfortunately awanting. The teeth had all dropped out of the upper jaw but all the alveoli were present and of normal depth, although some of their front walls had become broken away (see Fig. 11). The frontal air sinuses were rather small as was to be expected from the feeble degree of development of the superciliary ridges. (See Fig. 11). The various foramina for emissary veins were well represented. Both mastoid and both posterior condylar foramina were present. The parietal foramen and the inconstant emissary foramen of Vesalius were exhibited on the left side. The foramen caecum was well shown.

The approximate Age of the Skull.—The sutures were practically obliterated on the internal surface of the skull, which would suggest an individual somewhat beyond middle life. The coronal and the sagittal sutures were all synostosed externally, and therefore rather indistinct. The lambdoidal suture was, however, still definitely marked along its whole length, while the squamous suture was likewise quite apparent. It is a striking fact that the synostosis of these latter sutures usually follows that of the coronal and sagittal. The teeth had all dropped out of their sockets so that no evidence as to age could be ascertained from that criterion.

The Cranial Measurements.

Cubic capacity of skull (approximate)	1495	cu. cm.
Maximum length	182.5	mm.
Inion-glabellar length	173.5	mm.
Maximum breadth	147.5	mm.
Basion-bregmatic height	133.5	mm.
Basion-nasion length	104	mm.
Basion-alveolar length	104	mm.
Nasal height	51	mm.
Nasal width	25.5	mm.
Orbital height	40.5	mm.
Orbital width	46	mm.
Minimum post-orbital breadth	105.5	mm.
Inter-stephanic breadth	112.5	mm.
Inter-zygomatic breadth	135	mm.
Horizontal cranial circumference	53.34	cm.
Vertical transverse circumference	44.15	cm.
Maxillo-facial height	63.5	mm.
Inter-malar width	119	mm.
Palato-maxillary breadth	64.5	mm.
Palato-maxillary length	57.5	mm.
Dental length	47.5	mm.

Antero-posterior diameter of foramen magnum	36	mm.
Calvarial height	98.5	mm.
Bregmatic angle	60°	
Spheno-maxillary angle	95°	
Spheno-ethmoidal angle	157°	
Foramino-basal angle	146°	
Glabella-bregma chord	100.5	mm.
Maximum distance of chord from frontal cranial arc	20	mm.
Bregma-lambda chord	109.5	mm.
Maximum distance of chord from parietal cranial arc	26	mm.
Lambda-inion chord	62	mm.
Maximum distance of chord from occipital cranial arc	10.5	mm.
Maximum depth of temporal fossa	24.5	mm.

THE CRANIAL INDICES.

Cephalic index	80.8
Height index	73.09
Breadth-height index	90.5
Alveolar index	100
Orbital index	88.04
Nasal index	50.
Maxillo-facial index	47.03
Stephano-zygomatic index	83.3
Fronto-parietal index	71.5
Calvarial Height index	56.7
Palato-maxillary index	112.1
Dental index (approximate)	45.6

The Horizontal Cranial Circumference.—This was measured over the glabella, according to the plan of Turner,(5) and proved to be 53.34 cm., which was practically the same as the average for 108 male Scottish skulls, namely 53.1 cm., as found by Turner[7] in his classic research on the Craniology of the people of Scotland. This result was likewise found to accord almost exactly with the corresponding measurements of two low-grade Melanesian skulls recently recorded by the author in Vol. XIV of these Transactions.(7) It is evident, then, that there is a very slight inter-racial range of variation in this cranial measurement, even between the highest and the lowest types of modern Hominidae. As I pointed out in the above mentioned memoir, the horizontal cranial circumference clearly does not possess much craniological significance, though it shows that the cranial roof situated above this level is the essential portion of the skull that has been forced to expand in order to create more space for the evolving brain in the higher races of mankind.

The Vertical Transverse Circumference.—This was measured according to the plan of Turner(5) and was found to be 44.15 cm., which closely approximates to 43.4 cm., that being the average ascertained by Turner in 103 male Scottish skulls.(5) As a matter of fact this circumference must have been a little greater in this Micmac skull, as the missing section of the cranial roof would slightly reduce the measurement. In any case this cranial measurement (see Fig. 11) clearly was almost exactly the same as in the modern European type of skull.

The Capacity of the Cranium.—This could not be estimated in the usual way owing to the large gap in the right half of the cranial roof, previously referred to. A sagittal section of the skull was therefore made just to the left of the mesial plane in order to preserve the nasal septum. The gap was then closed from the inside by plaster and the cubic capacity of each half of the cranium estimated by filling it with sand the foramen magnum being meanwhile closed up to the level of the sagittal section. The capacity of the left half was 690 cu. cm. That of the right half was of course rather larger and proved to be 805 cu. cm. The total cranial capacity was thus estimated to be approximately 1495 cu. cm. This was slightly above the average for 73 male Scottish skulls, estimated by Turner to be 1478 cu. cm. Still it should be mentioned that 33 of these had a capacity of over 1500 cu. cm.

The Cranial Length.—The most posterior point of the skull as shown in Fig. 7 was found to be about midway between the lambda and the inion. The measurement from the glabella to this proved to be 182.5 mm. The distance from the glabella to the inion was 9 mm. less, namely 173.5 mm. These measurements were less than the mean of 117 male Scottish skulls which was found by Turner [6] to be 186.6 mm. Contrast this, further, with the mean glabella-inion length of 100 aboriginal Australian skulls, which was found by Berry and Robertson [8] to be 179.5 mm., (unsexed) and the mean glabella-inion length of 44 aboriginal Tasmanian skulls [9] which was found by the same two observers to be 173.1 mm. It is also significant to contrast this cranial length with 190 and 199 m m. which were the measurements found by the author in two markedly dolichocephalic New Hebridean skulls.

The Maximum Cranial Breadth.—This measurement proved to be 147.5 mm., which was just below the average for 114 male Scottish skulls[6], but was much greater than the mean maximum breath of 100 Australian skulls which was 130.7 mm., (unsexed) according to Berry and Robertson, [10] and also much greater than the maximum breath of two Melanesian skulls recently recorded by the writer [7]—122 and 128 mm.

The Cephalic Index.— This was calculated to be 80.8, a result which practically accorded with the figure estimated by Mr. H. Piers, the Curator of the Nova Scotia Provincial Museum, and noted by him on the descriptive label attached to the skull. The cranium was thus definitely brachycephalic, which I was always taught to accept as the prevailing type of skull amongst North American Indians. However, Hrdlicka's [4] recent work on the crania of the Eastern Indian tribes of the United States has quite dispelled that idea, for he found that only 10.9% of the male skulls of his series showed a brachycephalic condition. Still there is no doubt that the broad headed type according to Hrdlicka's map[4] was fairly prevalent amongst the more Western Indian tribes, which merged southward into the high indices of the ancient Incas of Peru, and westward across the Pacific into the comparatively broad headed Polynesians and Mongolians. On investigating this question in the case of other aboriginal inhabitants of the Western Hemisphere, I was much struck by the remarkably broad headed character of the wonderful Muniz collection of ancient Inca skulls. [1] In Fig. 1. I prepared outlines of two[] of these (Crania Nos. 15 and 18) examined from above, for comparison with the Micmac skull (which is shown in the middle of the Fig.). All these were drawn to exactly the same scale, so as to make the degree of resembance still more striking. This result is all the more significant when compared with the average British cephalic index which is 76, thus placing it in the sub-dolichocephalic class of Broca [7] Again, it is possible that the Beothuck aborig'nal Indians of Newfoundland [1] were genetically related to the Micmacs in some way, and in reference to this point it is of interest to note that Mr. Prest [15] found the cephalic indices of two aboriginal Beothuck Indian skulls in the Museum, St. Johns, Newfoundland to be 78.45 and 80.2, both of which were comparatively high. It is a well known fact that there was a considerable intermingling of French Acadian and Micmac blood, so that the high cephalic index of this Micmac cranium may be of some help there, as the predominant type of skull in France, in the British Isles, and in extreme

1) None of these exhibited the artificial deformity frequently seen in the Inca skull. I wish to express my grateful thanks to Dr. J. W. Fewkes, Chief of the Bureau of American Ethnology for permission to publish outline tracings of these two crania from the sixteenth Annual Report of the Bureau of American Ethnology, 1894-1895

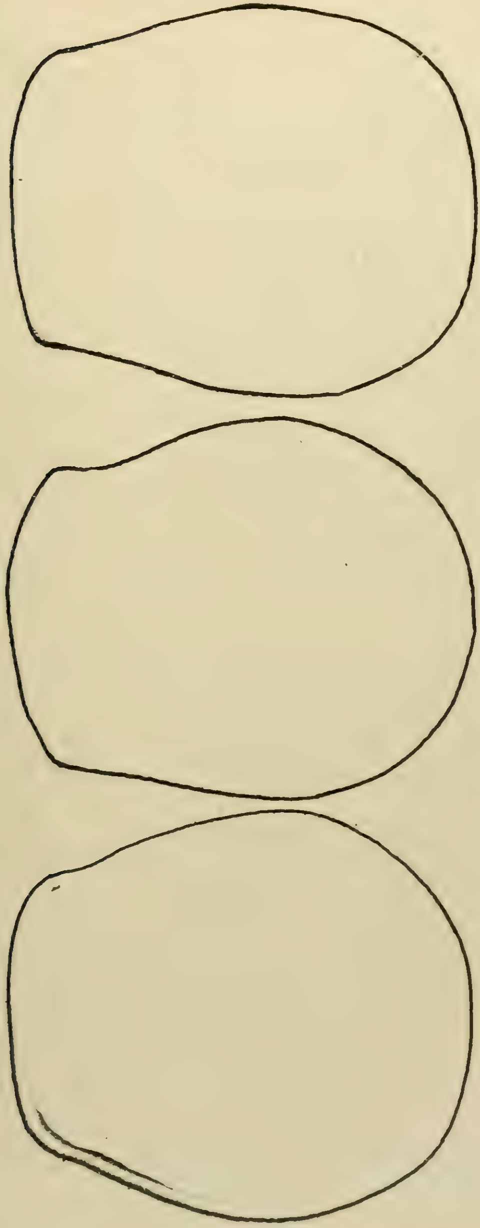

Fig 1. Exhibits the outlines of three crania seen from above. That in the middle represents the Micmac specimen, while the others are outlines of Crania Nos. 15 and 18 from the Muniz collection of ancient Inca skulls, copied by the kind permission of Dr. J. W. Fewkes, from the 16th Annual Report of the Bureau of American Ethnology. The three are drawn to the same scale. It will be observed that all three are brachycephalic and exhibit a certain degree of similarity of cranial outline.

Western Europe generally is mesaticephalic. Before leaving the discussion of the cephalic index, it is however, just as well to repeat a note of warning I have given in previous papers; and it is this, that the same race may show examples of the extreme limits of variation of this index. For example Turner [illegible] found brachycephaly in 35 out of 174 Scottish skulls Therefore though one found a single Micmac skull with a marked degree of brachycephaly, one could not make the assertion that the whole tribe was brachycephalic. Hence my appeal for further material in order to ascertain the racial range of variation of this index. It may be mentioned here that the cephalic index and the configuration of this Micmac cranium closely correspond to those of the "Burlington County skull" described by Hrdlicka.[23]

The Index of Cranial Height.—This was found to be 73.09, thus placing the skull in the metriocephalic class. This figure is in striking contrast to 65.5 and 68.1 which were the indices of cranial height recently recorded by the writer in two Melanseian skulls, [7] thus locating these skulls at the lowest limit of the tapeinocephalic class. It may be noted in passing that the index of cranial height for the British type of skull is 71, [8] which locates it at the upper end of the tapeinocephalic group.

The Breadth-Height Index.—This cranial index has been very little exploited, but I am glad to find that an authority like Turner [6] advocated its use very strongly. In this Micmac skull the index proved to be 90.5, this rendering it platychamaecephalic. This latter title was suggested by Turner[6], who pointed out that in brachycephalic skulls the breadth was usually greater than the height, and that certainly proved to be the condition in this instance. The height according to the index was of course 90.5% of the breadth.

The Nasal Index.—The nasal bones and the septum were markedly deflected to the right, evidently due to some accident during life. However, this apparently did not occur at the time of the accident which caused the death of the individual as the bones showed no recent fracture, nor even signs of osseous thickening that would indicate an injury even more remote. This distortion of the nasal bones did not effect the nasal index in any way. The nasal width was found to be exactly half the nasal height, the index thus being 50, and placing the skull in the mesorrhine group. Compare this with the index of 54.9 recorded by the author in a Melanesian skull [7] which was thus markedly platyrrhine, and indicated a very wide nasal aperture, which is, of course, the condition in all the lower races of modern mankind. The nasal index of the Micmac skull proved to be the same as that of the Mongolian type of skull, which is given by Flower [3] as averaging 50, and it is further of interest to note that this figure is intermediate between the lowest types and the British type of skull where the average index was found by the same observer to be 46 (leptorrhine).

The Alveolar or Gnathic Index.—The basi-nasal and the basi-alveolar lengths proved to be exactly the same, namely 104 mm., so that the alveolar index was obviously 100, thus placing the skull in the middle of the mesognathous class[3] (Flower)[3]. The projection of the jaws proved however, to be almost entirely of the subnasal variety which corresponds to the condition met with in the Andamanese skull[1]. The upper part of the face certainly looked definitely orthognathous. The most significant fact regarding this index was that it practically corresponded to the figure for the average Mongolian type of skull, thus providing one more feature of affinity between the North American Indian and the Mongolian.

The Stephano-Zygomatic Index.—This index was calculated as 83.3, the result being that the zygomatic arches were tolerably well exposed when the skull was viewed from above, thus placing it in the phaenozygous group. It was, however, not nearly as phaenozygous as the two Melanesian skulls recently described by the writer, where the figures were 73 and 71, and represented the lowest ebb for this index. The average stephano-zygomatic index for the European male is just over 90[3], so that this Micmac skull, so far as this index was concerned, occupied a remarkably intermediate position between the highest and the lowest types of modern Hominidae.

The Orbital Index.—This is admittedly a rather variable cranial index, but it exhibits some consistent features. For example, it is persistently high in all the Mongoloid races. It is therefore not surprising to find that this Micmac skull, whose cranial indices have been already shown to possess some close Mongolian affinities, should exhibit an orbital index of 88.04, thus placing it at the highest limit of the mesosemic group. In order to lend further emphasis to this point it is of value to contrast the above figure with 80 and 81 which were the orbital indices recently recorded by the writer in two Melanesian skulls[8]. In the memoir dealing with these and also in another paper[7] I discussed the influence which the degree of development of the frontal and maxillary air sinuses exerts upon the orbital contour, so that it will not be necessary to dilate further upon this topic. It is however, important to point out that the height of the orbital aperture is greater in all the Mongoloid races than in the European, and this fact of course accounts for the high degree of index yielded by these. It is therefore strange that as regards this index the European skull occupies a position intermediate between the Mongoloid and the lowest races of modern Hominidae.

The Maxillo-Facial Index. Broad headed races are also broad faced as a rule, though this is by no means infallible. The index in this skull proved to be 47.03, so that it followed the above rule consistently and was brachyfacial or chamaeprosopic, the index in this case conveying the information that the facial breadth was slightly more than twice the facial height.

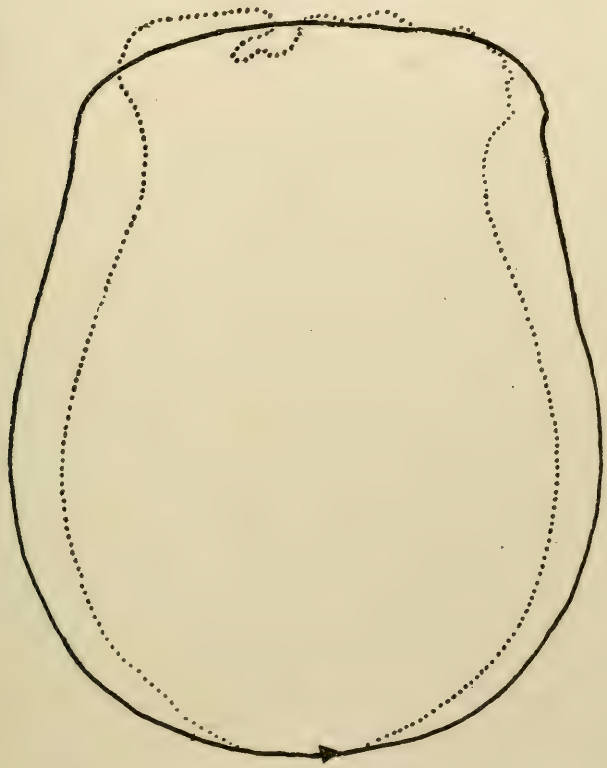

Fig 2. shows the superiority of the Micmac skull when compared with the outline of the Java calvaria (shown in dotted outline). Both crania are drawn to the same scale, which intensifies the marked post-orbital constriction of the Java specimen. Note further how the heavy gorilla-like supraorbital ridges of the Java calvaria project beyond the well modelled frontal contour of the Micmac skull.

The Fronto-Parietal Index.—This cranial index has been much exploited during recent years in relation to the study of the calvaria of fossil man, and has proved itself to be a valuable addition to modern craniometrical methods. In order to introduce the subject of this index it is useful to mention first of all that the minimum post-orbital diameter of the Java calvaria [illegible] (Pithecanthropus erectus) is only 87 mm. The fronto-parietal index for Pithecanthropus was found to be 65.4, which meant of course that the minimum post-orbital

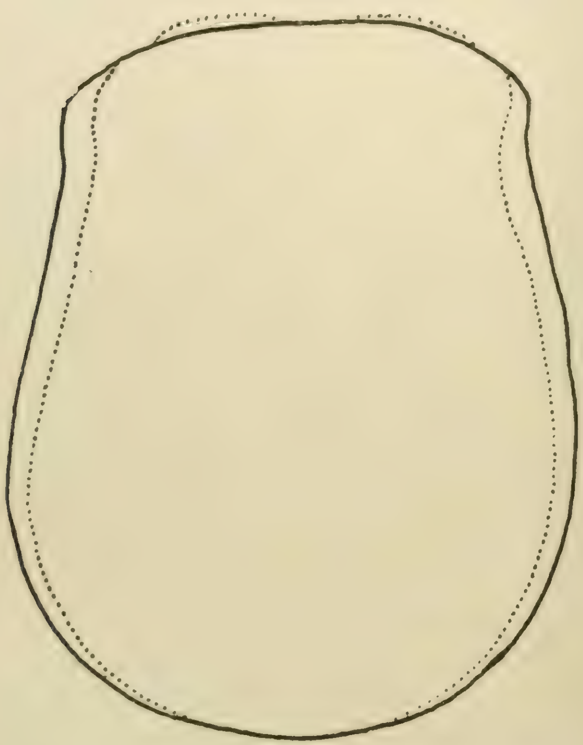

Fig 3 demonstrates the fact that the Micmac skull was better filled than the Neanderthal calvaria, especially in the region of the post-orbital constriction. The Neanderthal specimen is shown in dotted outline and both crania are drawn to the same scale. Note how the prominent Neanderthal supraorbital ridges project beyond the Micmac frontal contour.

diameter was 65.4% of the maximum parietal width. The fronto-parietal index in this Micmac skull was calculated to be 71.5 which compared unfavourably even with that of a Melanesian skull, recently recorded by the author as 72.6.[7] This detrimental comparison was partly explained by the fact that the maximum parietal width of the Melanesian skull was very low, namely 128 mm. This remarkable post-orbital constriction imparts a characteristic outline to the Java calvaria, as well as to the crania of the anthropoid apes, when studied from above. Fig. 2 shows the Java calvaria (in dotted outline) and the outline of the Micmac skull drawn to the same scale and seen from above. The minimum post-orbital diameter was 87 mm., in the Java skull, and 105.5 mm., in this Micmac skull, while the maximum parietal breadths were 133 and 147.5 mm., respectively. This Micmac skull thus exhibited a considerable degree of filling out of the general cranial contour, and more particularly a laudable attempt to obliterate the post-orbital constriction. In Fig. 2 this latter effect is seen to be in marked contrast to the retraction of the Micmac frontal contour on each side of the mesial plane, the evolutionary scheme underlying this, no doubt, being to remove as much trace as possible of the heavy gorilla-like supraorbital arches of the Java calvaria. Fig. 3 which exhibits outlines of this Micmac skull and the Neanderthal calvaria (in dotted outline) drawn to the same scale, will be found to present several points of interest. Note in the first place the superiority of this Micmac frontal contour, as compared with the projecting supraorbital ridges of the Neanderthal specimen. The minimum post-frontal diameter and the maximum parietal breadth of the Neanderthal calvaria [7] were 107 and 147 mm., respectively, which it may be noted were practically the same as those of this Micmac skull, but the Neanderthal calvaria was 199 mm., in maximum length, so that when reduced to the same scale, the relative superiority of this Micmac skull in all its transverse dimensions was at once apparent.

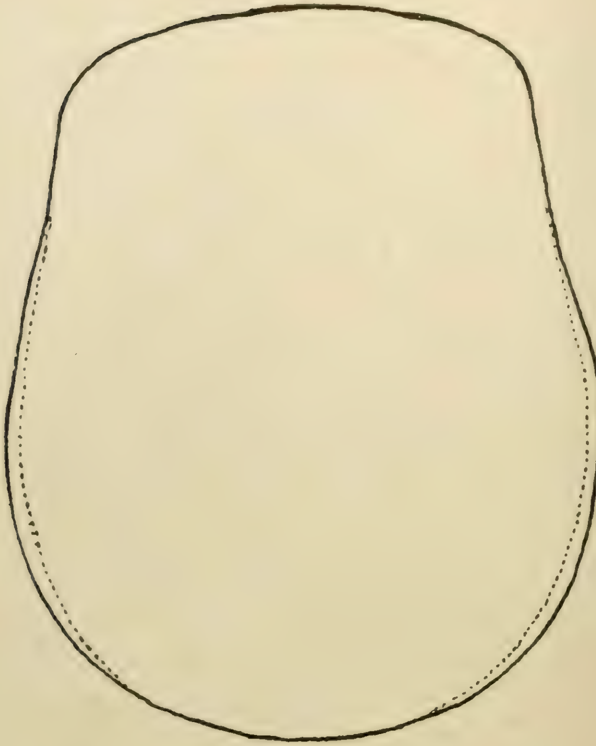

Fig. 4 exhibits outlines of the Micmac and the Piltdown crania (Smith Woodward's first reconstruction), viewed from above and drawn to the same scale. The Piltdown specimen is shown in dotted outline. The superiority of the transverse dimensions of the Micmac skull is only relative, owing to its being shorter than the Piltdown cranium. The frontal contours of both skulls are seen to coincide exactly.

As shown in Fig. 4, the frontal contour of the Micmac skull, when drawn to the same scale, was found to coincide with that of the Piltdown skull [2] (Smith Woodward's first reconstruction).[1] Otherwise the slight relative superiority of this Micmac skull is at once apparent, though the post-orbital

(1) The writer understands that Smith Woodward has prepared a second reconstruction which exhibits a greater cranial capacity than the first. I have so far had no opportunity to examine this second model.

diameter and the maximum parietal breadth were actually slightly greater in the Piltdown specimen (112 m m., and 150 m m., respectively). The maximum Piltdown cranial length was, however, 190 m m., as compared with 182.5 mm., which of course detracted slightly from the breadth when both crania were drawn to the same scale.

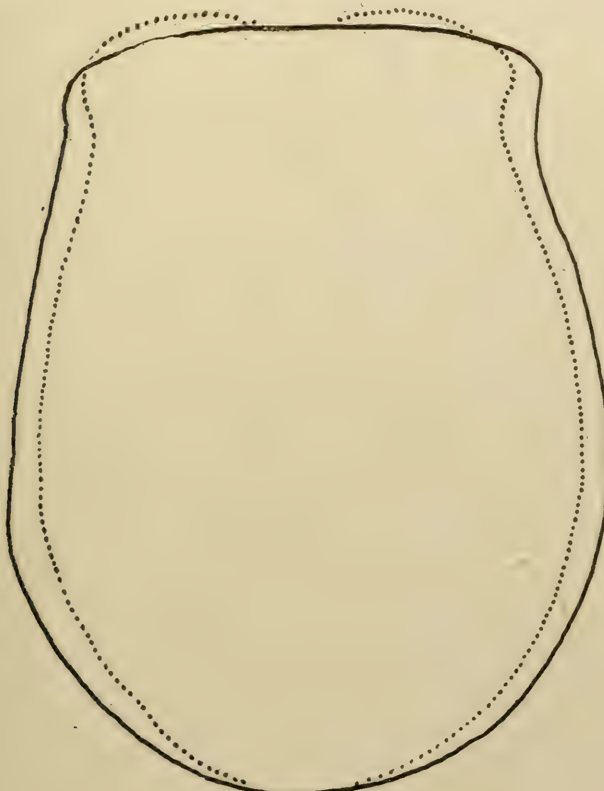

Fig. 5 exhibits outlines of the Micmac skull and a Melanesian skull, drawn to the same scale and viewed from above. The Melanesian cranial contour is represented in dotted outline and is seen to be comparatively deficient in all its transverse dimensions, but particularly so in the region of the post-orbital constriction. Indeed it compares unfavourably to a slight degree even with the Neanderthal calvaria (Fig. 3) and in common with that, exhibits the prominent supraorbital ridges which project well beyond the line of the Micmac frontal contour.

Fig. 5 is an outline of a Melanesian skull (in dotted outline) drawn to the same scale as the Micmac skull which will be observed to exhibit the superiotity of its transverse dimensions in every way. Note for example its smooth rounded frontal contour as compared with the heavy supraorbital projections of the Melanesian skull. Observe again how poorly filled is the Melanesian skull, particularly in the region of the post-orbital constriction. In fact it will be noted on comparing this with Fig. 3 that the contour of the Melanesian skull shows a grade actually inferior to that of the Neanderthal skull, and might indeed almost be regarded as a half way stage back to the Java type. (See Fig. 2).

The Calvarial Height Index.—The calvarial height was 98.5 mm., which yielded a calvarial height index of 56.7. This was practically the same as the average index for two Melansian skulls recently recorded by the writer in Vol. XIV of these Transactions, (7) but is distinctly better than the average of 100 Aboriginal Australian skulls (unsexed) which was recently given by Berry & Robertson (01) as 53, though inferior to the average of 32 European skulls which was given by the same two observers as 59.8.(10) The salient point to be noted, however, was that the figure was well within the range of variation for even the European type of skull (54.4 to 66.2). It may be noted in passing that this index exhibits a marked improvement when compared with those of the Java calvaria (34. 2), the Neanderthal calvaria (40.2), the Piltdown skull (47.3)(1) and the Cro-magnon skull (50).

The Bregmatic Angle.—This angle was ascertained to be 60° (See Figs. 6 and 7) which is certainly within the range of variation for the higher races of modern Hominidae. In fact I find from tables of comparison of this angle, furnished by Berry & Robertson, (10) that it was almost exactly the same as the mean average for forty European skulls, namely

(1) This was calculated by the writer from the list of cranial measurements by Smith Woodward of his first reconstruction of the Piltdown cranium.

59.9°, the minimum of this series being 54° and the maximum

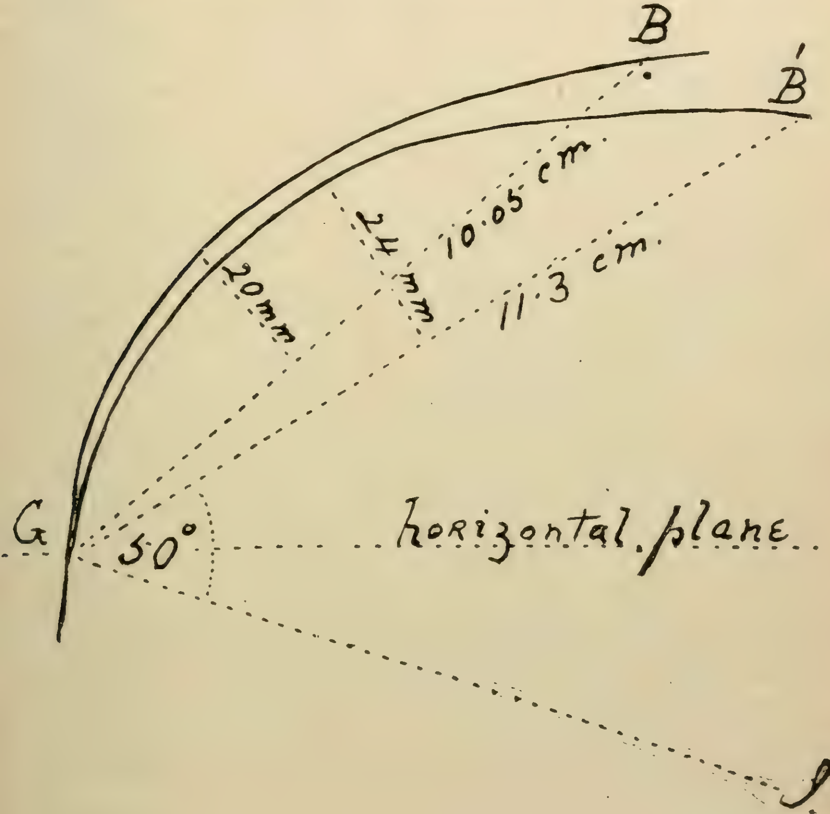

Fig. 6 has been devised for the purpose of comparing the frontal contour, the glabella-bregma chord and the bregmatic angle (BGI) of the Piltdown cranium (Smith Woodward's first reconstruction) with those of the Micmac skull. It will be noted that though the Piltdown bregmatic angle (50°) is smaller, yet its frontal cranial curvature shows a greater superiority and thus does not fall much short of the Micmac cranial outline. GB & GI represent the glabella-bregma and glabella-inion lines respectively.

68°. The angle in this Micmac skull was greater than that recently recorded by the writer [7] in two New Hebrides Melanesian skulls (55° and 59°) and exhibited a pronounced superiority over those of the Java calvaria (37.5°) and the fossil hominidae such as for example Neanderthal man (44°), Piltdown man (50°) and the Cro-magnon man (54°). Fig 6 has been devised for the purpose of comparing the bregmatic angle in the Micmac and the Piltdown crania. This angle it may be noted is included between the glabella-bregma (G. B.) and the glabella-inion (G. I.) lines. The frontal curves of both skulls are exhibited in the mesial plane in the Fig., and it will be noted how effectively an increase in the size of this angle (in this case from 50° to 60°) raises the cranial roof during the evolutionary process, and thereby of course substantially increases its capacity.

The Cranial Chords and Curvatures.

The Glabella-bregma chord which measured 100.5 mm., was comparatively short when compared with that of the average European skull, which was given by Berry & Robertson, [10] as 112.5 mm., (the average of five). This low figure probably was explained partly at least by the fact that this Micmac skull as a whole was comparatively shorter than the average European type, and this would tend to shorten the individual cranial chords and curvatures (Fig. 7). It was even below the minimum range of variation for the European type which was 109 mm. The maximum distance of the frontal cranial arc from the frontal chord was at a point 37.5 mm. from the glabella and measured 20 mm. This was less than the average for the Canadian skull, which I found to be about 24 mm., and was less even than the distance in the Piltdown skull which was supposed to be 24 mm., as Fig. 6 shows. It is thus clear that any slight increase of this distance assists greatly in the "uplifting" of the frontal cranial arc. For example, in Fig. 6 it will be noted that, though the bregmatic angle is much less in the Piltdown skull, the enhanced distance between the chord and arc brings it up very nearly to the outline of the Micmac skull.

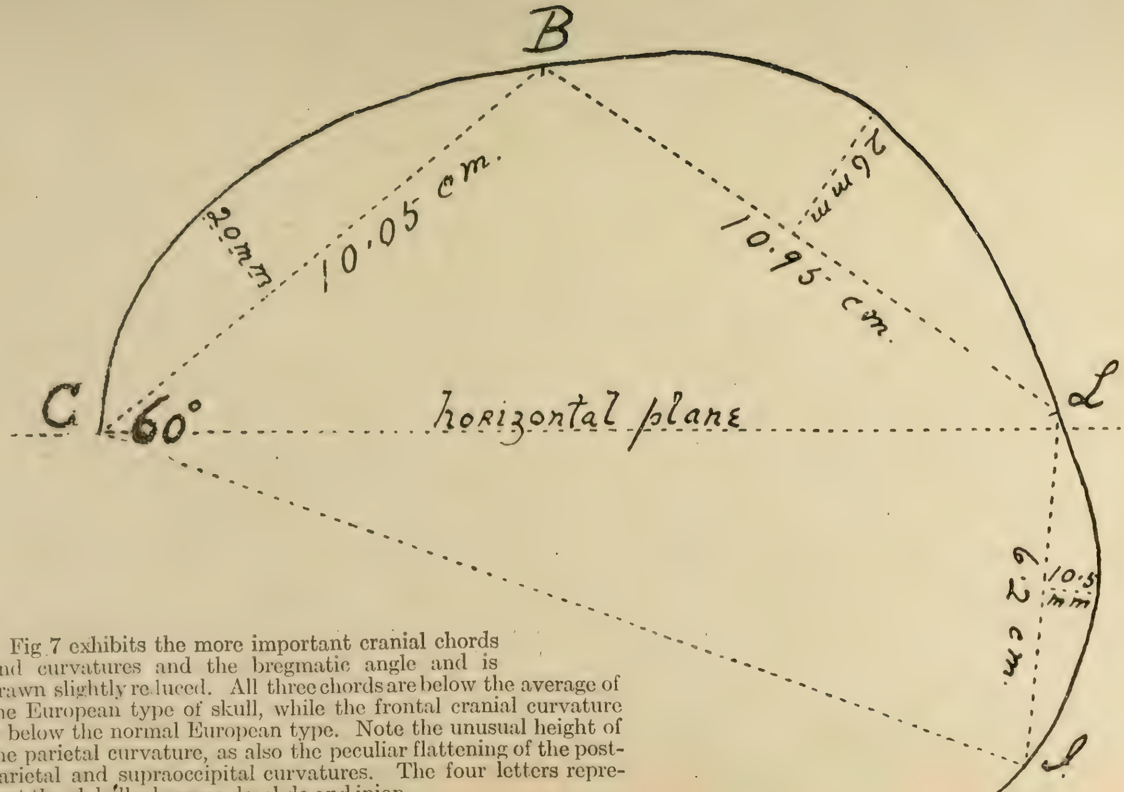

Fig 7 exhibits the more important cranial chords and curvatures and the bregmatic angle and is drawn slightly reduced. All three chords are below the average of the European type of skull, while the frontal cranial curvature is below the normal European type. Note the unusual height of the parietal curvature, as also the peculiar flattening of the post-parietal and supraoccipital curvatures. The four letters represent the glabélla, bregma, lambda and inion.

The Bregma-Lambda Chord measured 109.5 mm., which was likewise below the European average of 112 mm., given by Büchner.[21] The maximum distance of the parietal cranial arc from the chord was at a point 52.5 mm., from the bregma and measured 26 mm., which was slightly above the European average [2] of 24 mm. The post-parietal and supra-occipital areas of the cranial curvature were rather flattened as exhibited in Figs. 7 and 12.

The lambda-Inion Chord was found to be 62 mm., which was just below the European average of 63 mm., as given by Bŭchner.[21] The maximum distance of the lambda-inion cranial arc from the chord was at about its centre and measured 10.5 mm., which was practically the same as the European average of 11 mm.[21]

The Inter-Malar Breadth.—This amounted to 119 mm., and was therefore less than the interzygomatic breadth. This dimension proved to be practically the same as the average intermalar breadth in Turner's [6] extensive series of Scottish skulls.

The Antero-Posterior Diameter of the Foramen magnum was 36 mm. This was practically the same as the average for 7 male Munsee North American Indian Crania which was found by Hrdlicka [4] to be 35 mm., and likewise approximated to the average dimensions of this opening in a series of Scottish skulls,[6] which when calculated from Turner's tables proved to be 35.3 mm. The relative size of the Foramen Magnum in various races does not appear to yield any definite factor of anthropological significance.

The Palato-Maxillary Index.—The palato-maxillary breadth was 64.5 mm. and the length 57.5 mm., so that the palato-maxillary index proved to be 112.1, thus classing the skull as mesuranic. This result may be compared to 115.4 which was obtained in a Melanesian skull,[7] thus placing it in the brachyuranic class. This index does not appear to possess any inter-racial significance for the extreme limits of its fluctuations were found by Turner (6) to be present in his extensive series of Scottish skulls. For example, 19 of these crania showed indices above 120, and 11 possessed indices below 105.

The Dental Index.—All the teeth had dropped out of their sockets, but it is evident that all were present at death for the alveoli were deep and showed a healthy condition of the bone, though the fragile tissue of their front walls had been broken away here and there. The sockets for the molar and premolar series were very clearly defined, so that by measuring from the front edge of the first premolar socket to the posterior edge of the third molar socket an approximate idea of the dental index could be obtained. It worked out at 45.6, thus placing the skull in the megadont class, and rendering the dentition comparable to that of the lowest types of modern Hominidae. However, one meets occasionally with anomalies of this nature in single specimens of skulls. For example I found that the dentition was microdont in two New Hebridian skulls (7) of the Melanesian type, where one would have expected a definite megadont condition. One cannot therefore rely on a small series of skulls, far less on any single specimen owing to the vagaries of the racial range of variation, which vitiates the value of all individual cranial indices and measurements.

The Spheno-Maxillary Angle.—I have usually found this to be a trustworthy cranial angular measurement, and I am bound to say that it provided a surprise in this skull, for it proved to be as much as 95° which was as great as in the two Melanesian skulls recently described by the author.(7) The angle is usually much smaller than this in the orthognathous skull of the higher races of mankind, and generally measures about 75° in Europeans. One would have expected to have found the spheno-maxillary angle in the North American Indian about midway in size between the highest and the lowest races of modern Hominidae, instead of being comparable to that of such a low type as the Melanesian. However, as this Micmac skull is a single specimen, I will not rest satisfied until I have been able to estimate the size of this very important angle in numerous examples of North American Indian skulls. (Fig. 8).

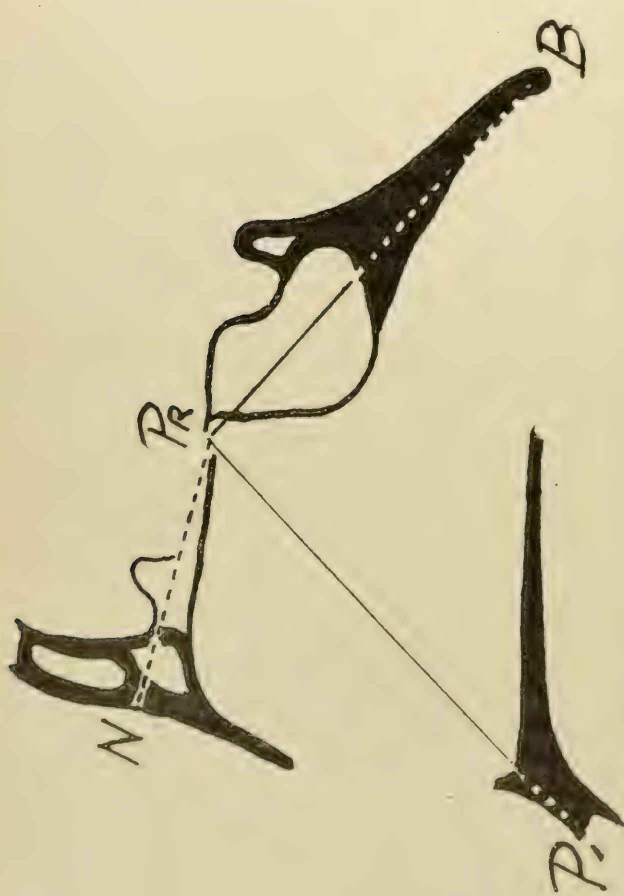

Fig 8 is a tracing of the basal portion of the Micmac skull in order to demonstrate the important spheno-maxillary (P. Pr. B.) and spheno-ethmoidal (N. Pr. B) angles, which in this specimen are both decidedly more Simian than the average in the European type of skull and conform to the size found in the aboriginal Australian and Melanesian types of cranium. The letters P. N. Pr. and B. represent the prosthion, nasion, Prosphenion and basion respectively.

The Spheno-Ethmoidal angle.—This angular measurement provided even a greater surprise than the previous one for it was ascertained to be as high as 157°, which compared unfavourably even with such low cranial types as the Aboriginal Australian ([11]) (153°) and the Melanesian ([7]) (151°). This

Fig. 9 shows the foramino-basal angle of the Micmac cranium which proved to be slightly more Simian than the average European type of angle and like the spheno-maxillary and spheno-ethmoidal angles was practically the same size as in aboriginal Australian and Melansian types of skull.

angle was found to be 138° by Duckworth([1]) as, the average of two European skulls, so that the difference in its size amongst the highest and the lowest races of modern mankind was very considerable. It may be mentioned that this angle approximates to 180 in the anthropoid ape, and gradually diminishes in size as one ascends the evolutionary scale. (Fig. 8).

The Foramino-Basal Angle.—This angular measurement consistently followed the previous two, and was found to be 146° which was exactly the same as in the lowly evolved aboriginal Australian [11] and the Melanesian. [7] This angle gradually increases in size as one ascends the evolutionary stem and measures 149° in the European cranium [11] These three angular measurements clearly place this Micmac skull at a considerable distance from the European type of skull, and indeed, in a rather unfavourable inter-racial position; and I am therefore all the more eager to secure an early opportunity of ascertaining their condition in a whole series of North American Indian skulls. (Fig. 9).

Special Study of the Facial Skeleton.

The author made a special study of the facial portion of the skull in the following way. Horizontal lines were drawn through the nasion, the lower borders of the orbits, the akanthion, and the prosthion respectively. These divided the face into upper, middle and lower horizontal areas. On studying the relative proportions of these it was observed that the middle and lower areas were approximately equal in depth while the uppermost was distinctly more extensive in its vertical dimensions than the lower two. The points through which these lines are drawn are, with the exception of the lower orbital margins, recognized as fairly constant in position, though in the case of this skull the position of the prosthion could be only approximately determined owing to slight deficiency of the alveoli of the incisor teeth. Still it was considered possible that this method of studying the *norma frontalis* of the skull might be utilized as an additional criterion for determining the race of any given skull. I have so far not applied this method to anything like an extensive series of crania, and am therefore unable at present to make any definite pronouncement as to its value or otherwise. How-

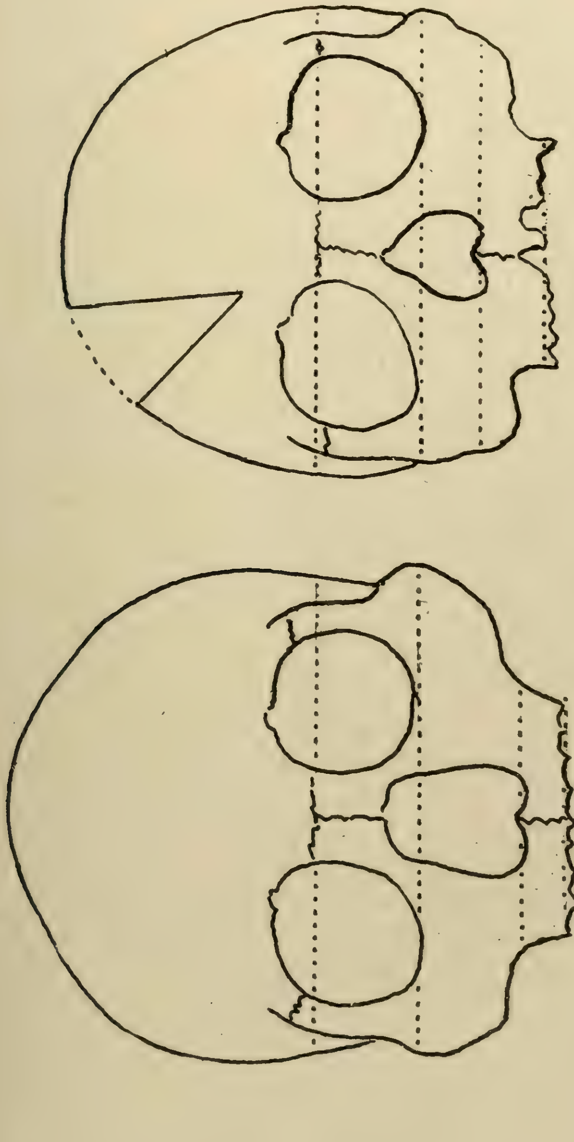

Fig. 10 is a comparative study of the facial portions of the Micmac skull (on the right) and of a Melanesian skull (on the left). These are not drawn to the same scale. Horizontal lines are drawn through the nasion, lower orbital margins, the akanthion and the prosthion. The relative proportions of the three horizontal areas, thus mapped out are shown to be totally different in the two cases. For example in the Micmac skull the two lower areas are almost equal in vertical depth, while the uppermost one is more extensive than either of these. In the Melanesian cranium, on the other hand the two upper areas are approximately equal in vertical depth, while the lowermost possesses only about half the vertical dimensions of either of the upper two. It is suggested that this method may prove to be a useful addition to the craniometric study of the *norma frontalis* of the skull.

ever, I found that the three horizontal areas in the Melanesian skull exhibited a very decided degree of difference from those of this Micmac skull in regard to their relative proportions. Fig. 10 has been designed to demonstrate this comparative difference. The Micmac skull (which is to the right) is an outline sketch of the photograph shown in Fig. 11 and is not drawn to the same scale as the Melanesian skull (exhibited on the left). In the latter, the lower horizontal area shows a marked reduction in depth when compared with the Micmac skull, and is due of course to pronounced foreshortening, the result of an excessive degree of prognathism in this case (an alveolar index of 106.7). On examining the two upper horizontal areas in the Melanesian skull it is at once observed that they are almost exactly equal in depth. (Fig. 10).

It is evident, then, that this method disclosed a very profound inter-racial difference, so far as these two individual skulls were concerned. Indeed, the results look so hopeful and encouraging that I intend to apply this method to an extensive series of skulls, when the opportunity arises, and would cordially invite others who are interested in craniology to do likewise.

The writer cannot conclude this paper without expressing his cordial thanks to Dr. J. W. Fewkes, Chief of the Bureau of American Ethnology, and also to Dr. E. Sapir, Head of the Division of Anthropology, Geological Survey of Canada, for valuable contributions of literature, and also for numerous references to the bibliography relating to the Physical Anthropology of the North American Indian. The completion of this memoir would have been rendered impossible without the valuable help of these two gentlemen, which is hereby gratefully acknowledged by the author.

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Eskar Excavation in Nova Scotia.—By Walter H. Prest, Halifax, N. S.

Read 12 May, 1919.

Among the interesting but much neglected branches of scientific work awaiting investigation in Nova Scotia is the exploration of eskars. I recently had the pleasure of sectioning an eskar at Middlefield, Queens County, Nova Scotia. I herewith give a general description of this section and the conclusions that seemed to me most reasonable and natural.

The Middlefield eskar

This eskar crosses the road from Annapolis to Liverpool, about thirteen miles from the south coast. It is one of those described in a paper read by me at a meeting of the Nova Scotian Institute of Science in March, 1918.* The following description will give an idea of its structure and the conditions under which it was formed.

Its general course is parallel to the south coast and direct across the drainage system of the province. In this peculiarity it is in accord with the great majority of eskars in Nova Scotia. As far as explored by me it begins on a low tableland about five miles west of the Port Medway River, descending the gentle slope for several miles toward that stream. However, as a local peculiarity, it inclines up stream as it approaches the Medway; crossing swamps and crossing successive elevations. It continues on the eastern side of the river with the same variations in height and course. In its approach to a wide meadow it has been spread out as if by the action of the waves of a lake of later age. Here much sand has been spread out in banks and flats. This could not have been so distributed except by the wave action of a shallow and wind-swept sheet of water.

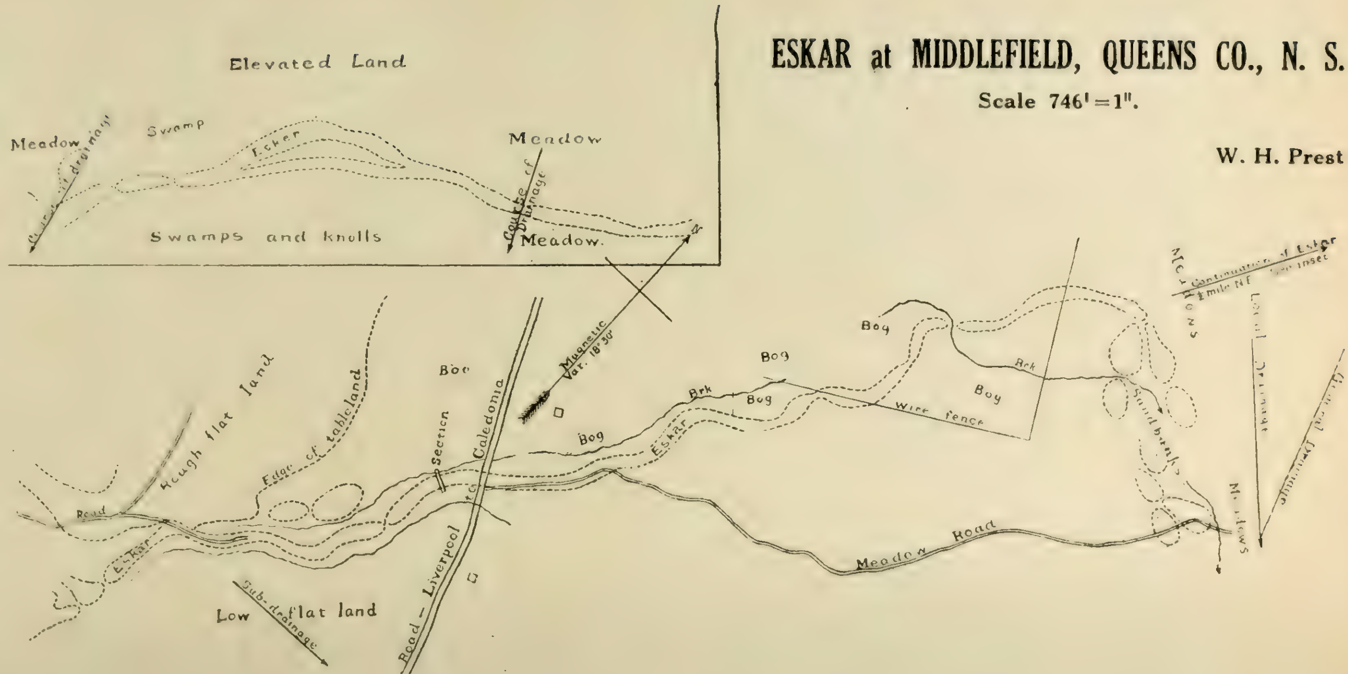
In the neighborhood of the Middlefield road this eskar is from 30 to 80 feet wide and from 5 to 16 feet in height,

* On the nature and origin of the Eskers of Nova Scotia. Trans. N. S. Inst. Sci., Vol. XIV. Pt. 4. The present paper is supplementary to the former and should be read in connection with it.

ESKAR at MIDDLEFIELD, QUEENS CO., N. S.

Scale 746' = 1".

W. H. Prest



being a very noticeable feature in the landscape. The surrounding country, especially to the north, is only moderately covered by glacial debris.

Character of Material

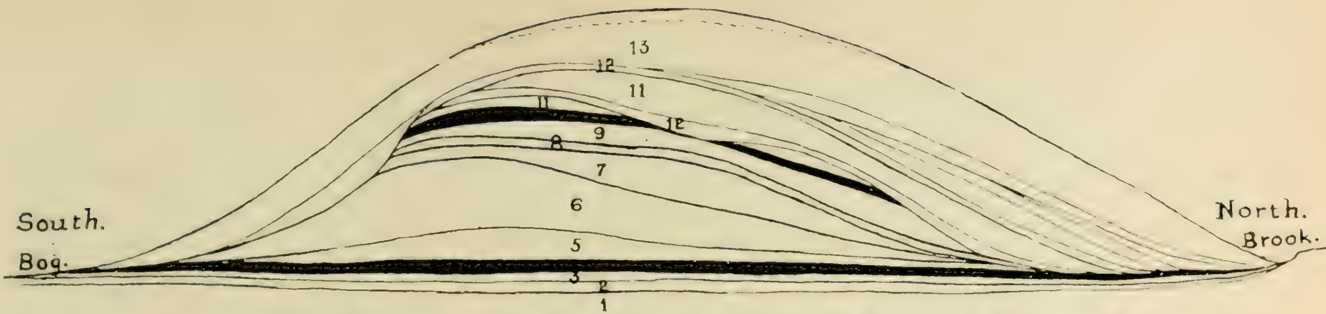
The eskar material is evidently reworked drift. Like other eskars, its varied character and peculiar form are its most striking features. They have been the cause of much speculation as to origin and mode of deposition. This eskar shows evidence of extreme changes in the conditions governing its deposition. Rapid evasion and quiet sedimentation are evident within a few feet or even inches of each other. A glance at the cross section will show the relation of these beds to each other.

Sequence of deposits

Beginning at the bottom of our excavation we find what appears to be a somewhat modified boulder clay. The depth of this could not be determined without a pump, as the soil contained a large amount of water. Above this a layer of fine clay, passing into a red bed of much worn rocks, No. 3, cemented by iron oxide. These indications of a rapid current and mineral precipitation are followed by an intensely black deposit of rocks, gravel and sand, No. 4. This has apparently been blackened by a precipitation of manganese oxide in addition to iron. This passes gradually into another layer of red iron cemented rocks, No. 5. These last three beds seem to have been the product of one period of rapid water transportation. This question of mineral precipitation needs a more thoro and detailed investigation than I had time to carry out; but the modus operandi is probably the same as that which fills our brooks with bog iron and manganese.

Metallic precipitate

On this iron cemented bed of coarse material is laid a thick bed of well-assorted gravel, graded to a wonderful degree of perfection. One would think that human intelligence had been used in the process. It is the thickest bed in the section. Its sides, especially on the south, was eroded before the next bed, No. 7, was laid down, This consists of rounded rocks, gravel and sand, evidently deposited by a very rapid, but at times a variable current. It also suffered erosion, before the next bed, No. 8, was laid down.



Section across an eskar at Middlefield, Queens County, N.S.
Width 80 ft, Height 16 ft, Course S 36° W, Scale 12' = 1".

13.- Disturbed gravel, rocks, and sand.
12.- Stratified rocks and gravel, fine and coarse.
11.- Rounded rocks, with very little gravel.
10.- Fine laminated clay.
9.- Fine sand.
8.- Coarse sand.
7 - Rocks, gravel, and sand.
6 - Fine gravel, well assorted.
5 - Rounded rocks and gravel cemented with bog iron.
4 - Same, with trace of bog manganese.
3 - Same as Bed No 5.
2 - Fragmentary seams of clay with boulders.
1 - Partly modified drift.

W. H Prest.

Variable conditions

Beds No. 8, 9 and 10 were deposited under a variable but gradually lessening turbulence of waterflow. First, gravel and coarse sand, then fine sand. Then came a rather sudden change to extremely quiet conditions when a very finely laminated clay was laid down. This clay could be deposited only when a former outlet was dammed by debris and the resultant current capable of moving only the very finest material. This tranquil condition ended in a period of slight erosion.

Erosion

On the fine clay was laid the fine sands of bed No. 11, followed again by erosion which cut deeply into the southern side of the eskar. The cause of this erosion is referred to later.

Then succeeded alternating conditions, during which were deposited the gravel and sands of bed No. 12 and the coarser material of bed No. 13. Thence, to the top of the eskar, the deposits showed the results of alternating rapid and moderate currents. All these upper beds showed the confusing postglacial effects of frost and the growth of vegetation.

Summary of history

Now let us summarize the possible history of this deposit. At the beginning we have a provincial if not a continental glacier. All large glaciers show crevasses, and our Nova Scotian glacier could hardly have been an exception. The cause of the formation of ice crevasses is evidently a tension or strain which reaches its breaking point where the slope of descent changes to one more or less steep. This is the case both in Greenland and on the Antarctic continent. It must have been so at Middlefield, where we have to the south a gentle tho fairly even slope and to the north a flat lake region. And yet this eskar does not lie exactly on the edge of the lake region, but a short distance to the south. At the edge of the lake region we have a few short ridges, evidently the beginning of another system of crevasses, which in time might have become the seat of a prominent eskar.

The Crevasse theory

We have here support for the belief that crevasses, after their successive formation across a continental ice sheet, were carried forward in the general advance until climatic changes called a halt. The surface water, pouring into the debris gathered each summer, sufficed to keep the crevice open until the melting ice added to the accumulation and formed a permanent eskar. I think all will agree that where the slope is so slight as in Maine and Nova Scotia, no advance was possible after the mass and moving power of the ice had dwindled to a certain point. When this stage was reached its dissolution began. Only then began that re-erosion and redeposition of stratified eskar material that is so noticeable a feature of these deposits.

Objections

Plasticity of ice

It has been objected by some, that hills and other local irregularities would mark the icefields with a system of radiating cracks. I admit this where the ice was thin or the elevations were increased to mountains. But I cannot think that a 300 or 400 foot hill would be noticeable under an ice sheet 5,000 to 10,000 feet thick. And besides, the well-known plasticity of ice enables it to accommodate itself to extreme irregularities of surface. This fact is attested to by the testimony of many explorers and investigators. For this reason small and local cracks not enlarged by running water would certainly close, freeze up and disappear in winter. But the immense cracks formed along the slopes of a continental glacier are too wide and deep to be thus easily disposed of. That they were not thus disposed of is evident to all who have read the account given of them by Arctic and Antarctic explorers. Only in great icefields could such deep and lasting crevasses be formed. Even there the smaller cracks would close or refill with ice before they could gather enough material to keep them open until a higher temperature and a flow of water made them permanent. The size of the larger cracks must have made them permanent from the first.

Permanent crevasses

Erosion ice cracks

I have made the claim that the edges of the cracks thus formed may be used as an eroding tool. But it has been objected that on account of the plasticity of ice all cracks may close before being used in the work of erosion or as a place for the deposition of debris. That all cracks do not do so we have these facts to the contrary, viz.: Shackleton, Nansen, and others, tell us that on sunny days the surface water from the melting ice disappeared in wide deep cracks in the centre of vast icefields. That these crevasses never became full is ample evidence that the water passed away in the depths of these channels. Even the supposed subglacial streams must be fed thru crevasses from the surface, else where would the water come from?—and if not permanently open, where would the water go? This melting of the surface ice is a common summer occurrence, and can be the only possible source of water in the great ice sheets of the glacial age. I doubt if any crevasses could close permanently in a latitude where summer melting was possible. This, added to the eroding power of the debris incorporated in the base of the ice sheet, must in ages prove ample for all the results noted.

Only source of water

We know that frozen or cemented basal drift is and has been ridden over by advancing ice sheets. Such instances have been noted in Dawson's Acadian Geology and numerous other works. We know that frozen or cemented till is often loosened by the percolation of water. Also it must be acknowledged that the impact of surface water, descending as Polar explorers saw it, for perhaps 1,000 feet, must without doubt be a very effective eroding agent. It may also be doubted whether the lower ice edge in a glacial crevasse is capable of eroding the underlying drift. We know that the frontal edge does so. Knowing this, we cannot doubt at least the moderate erosive power of an ice edge many miles to the rear, where the ice sheet is probably many times thicker and the weight immensely greater than at the front.

Erosion by falling water

Thus even before the cessation of glacial movement the churning effects of summer torrents from the glacial surface would wear and polish the debris for the grading and stratification of a later age. It may be reasonably concluded that this torrential action recurred each summer for many ages before all forward movement of the ice sheet stopped. We are also compelled to admit that under these known conditions the debris in these crevasses must be subject to much greater

Churning effects

wear than the compact and frozen till in the inequalities beneath the ice sheet. Its orderly stratification was therefore possible only in the closing stages of the ice age, when moderate tho often interrupted currents transferred the debris along the crevasse from higher to lower grounds. Slight movements along the line of glacial action after stratification had begun would account for the curved and distorted layers noted by some observers.

Age of Stratification

So far, I have been using as working theories only the observations of the most reliable explorers—facts which none of us would have the temerity to doubt. Readers of the works of Arctic and Antarctic explorers will acknowledge the actual operation at the present time in the polar regions of what I propose to call the Crevasse theory of eskar formation. Only this small doubt remains; We cannot see the Polar eskars as we see our own. But doubt in this case would be the same as if we emptied a scuttle of coal into a deep dark hole, and then doubted its presence there because we could not see it.

Evidence for working theory

A feeble doubt

To return to the treatment of more local details we may note some peculiarities of the Middlefield eskar. One is the absence of large boulders; in fact the entire absence of anything but the most well-worn and rounded rocks of any kind. Even river and lacustrine boulders do not show a more intense torrential action. Nothing less than the most violent and long-continued agitation, as under a torrent of water falling from an immense height, could show such results.

Local peculiarities

In regard to the absence of large boulders, those being firmly bedded in the ice sheet could not have been easily overridden and swept into the maelestrom of aqueous action unless in the course of the crevasse. Large boulders would more probably be carried forward in the general ice movement.

Another peculiarity is the abrupt enlargement of the upper end of the Middlefield eskar on the eastern side of a flat tableland. This enlargement is a perfectly natural result of the enlargement of the highest part of the crevasse by the fall of surface water at the first possible point of entrance where the ice was thinnest.

And now let us review as far as possible from the limited local evidence at hand the successive processes that brot about the present form of the Middlefield eskar.

Review of Evidence

At the bottom of the Middlefield crevasse, after the final pause of the ice sheet, began a slight erosion. This depression was afterwards filled in with modified drift. Its then stationary character is shown by the fine sediment that followed this erosion which was deposited among the exposed rocks of the boulder clay.

Insufficiency of old theories

This deposit is shown as No. 2 on the sectional plan. The conditions accompanying the deposition of this fine clay prevents the acceptance of any of the theories of origin usually applied. A glacial lake on the slope of this watershed is an impossibility. A super-glacial stream would have no source of debris supply. A subglacial stream on the top of a watershed could not wear and polish the eskar material at its very beginning as this was polished. None of these theories can explain all the peculiarities of eskars.

The only solution

A crevasse dammed by debris is the only explanation that will account for quiet water on the slope of a watershed, and its retention at such a high level. We find evidence here for the belief that each stage of erosion provided material for the damming of the crevasse and the beginning of a quiet water stage in which was deposited the finer material of the next beds.

A striking feature

Beds No. 3, 4 and 5 show turbulent water conditions in a bed of smoothly worn boulders. The most striking peculiarity of these beds is that they show the precipitation of mineral matter instead of clay. Beds No. 6, 7, 8, 9 and 10 make a series which show an increasing current to No. 7, and then a decreasing tho irregular current which ended in the extremely quiet water deposit at No. 10. The important information conveyed by this clay bed will be referred to later on. Then came a slight change in conditions and a stronger current covered the clay with sand. (Bed No. 11). Then came a period of erosion which cut away both sides of all the beds from No. 6 to No. 10. This was caused either by the removal of a debris dam or by an increase of temperature and a more rapid melting of the ice and a consequent increase in the flow of water.

High level erosion and deposition

One result of this erosion was that the southern side of the eskar is the most steeply eroded, while the northern slope is broader and less steep. These facts tell a tale of great import. Nearly all of us have noticed in ice-filled road drains, how a crack becomes a watercourse which fills with earth as the crack grows larger. If the crack ran north and south nothing worthy of note happened. But if it ran east and west the north side received more sunlight than the south side. And as the north side melted faster, the debris spread out on that side while lying higher and closer to the south or shady wall.

An important evidence

The Middlefield eskar tells us the same tale. A tale of a time when high ice walls enclosed and overhung the debris there and the slanting southern sunlight shone only on the northern wall. The south wall, always in the shadow, could melt but slowly, and the debris lying against it was eroded but little, long retaining its steep face. The north wall of the crevasse receding faster, gave more room for the eroded material, hence the gentle slope. Nature's records here seem to be clear and easily read. The relative slopes of the sides of an east and west eskar are important evidences of origin, and I much desire such information from other investigators.

The only solution

I must say here that while evidences of such erosion are noticeable on the lower layers they are not so prominent as on the beds numbered from 6 to 11.

This erosion was the beginning of new conditions brot on by increasing waterflow. the result probably of increasing temperature. Strong currents covered the lower beds with unconformable layers of generally coarse but variable character. Large rocks alternate with small rocks, gravel and sand. The upper

Agreement with climatic improvement

layers are confused by the growth of vegetation and the effects of frost.

Summary of local evidence

We have in this eskar evidences of two periods of erosion, two periods of deposition, and a period of mineral precipitation. These represent apparently, no sudden changes of climate or increase or decrease of rainfall, but only the conditions seen in the average rapid stream. There the erosion and transport of material forms or removes pools and rapids as a river erodes its bed.

Evidence limited

In drawing conclusions from these observations we must remember that this section was made on but one portion of a long eskar, which differed in height, breadth, and environment in its different parts. It is only by averaging the results from many sections that correct conclusions can be arrived at. I think however that the following may be accepted as a working hypothesis. The eskar material, while being gathered, was thrust forward in the general glacial movement. All this time the enclosed debris, according to evidence of polar expeditions, was subject to the most tumultuous agitation by the streams of water poured into the crevasse by the melting summer sun. This was the first stage of eskar formation.

A working hypothesis

Then came a pause and the process of stratification. The melting ice gave up its enclosed material, adding to that already gathered. And this material was continually worn, rolled, and gradually shifted from higher to lower levels as long as water remained in the crevasse. This condition, of course, ended on the higher sooner than on the lower ground. But all these conditions were localized and probably repeated many times in the same place as the ice sheet proceeded toward its dissolution.

Other Evidence in Nova Scotia

That water transport of heavy material has thus been effective is seen in the immense eskars that traverse river valleys. Such a ridge is seen at Nine Mile River, Hants County, Nova Scotia. Here is seen an enormous eskar 50 feet high and often 300 feet wide. It traverses the valley, usually parallel to the river but sometimes crossing it. There is evidence to show that the river once ran at this high level. To do so it must have occupied a glacial crevasse until the ice melted enough to allow it to occupy its original bed. We may reasonably conclude that during this time all the material that would otherwise have been transported in lower channels filled the crevasse.

Enormous eskars of Labrador

The same enormous valley eskars are seen in the basin of the Ashuanippi and other rivers of Labrador. Details concerning these eskars have been published by the Canadian Geological Survey.

The Frontal theory

A friend has drawn my attention to the frontal theory of eskar formation advanced by W. B. Wright, of the Geological Survey of Iceland. In this the essential condition is the presence of stagnant water along a retreating ice front. In reply I must say that such a condition could not apply on this gradually sloping watershed where the wide river valley offers no obstructions capable of forming anything larger than pools and ponds. These long ridges of variously bedded deposits of varied character means locally confined and swirling currents and changing conditions of very local extent. Only on the low lands where lakes are possible is the debris from the eskar spread out in wide banks of regular stratified material.

Evidence from the West

Trowbridge, writing on the eskars of the west, notes that eskars are more common on rough than on level country. For instance, hundreds are seen in Maine and Sweden, while on the Upper Mississippi they are very rare. This is valuable evidence, and indicates the need of inequalities of surface for the production of the tension needed for the formation of crevasses.

An unsolved problem

Finally, I will put this problem to opposers of the crevasse theory of eskar formation: How could the quiet water necessary for fine clay deposition on the top of an eskar, and on the slope of a watershed, ever have been retained except by enclosing walls that have since disappeared?

Former paper on eskars

In my former paper on Eskars read before this Institute in 1918, I maintained the crevasse theory of the origin of eskars. I still see no reason to alter my conclusions.

Work of Dr. MacKay

Before closing I must note a detailed examination of a road cutting thru an eskar near Pictou town made by Dr. A. H. MacKay, Superintendent of Education for Nova Scotia.* These details were handed to the Canadian Geological Survey by Hugh Fletcher, and if not destroyed must be available yet. I regret not being able to compare them with my own observations.

In concluding this description I must thank those whose generosity has made possible the cutting of the first section thru an eskar in Nova Scotia for purely scientific purposes.

* Dr. MacKay maintains that the Pictou Town eskar is best accounted for on the Crevasse Theory—that none of the other theories can account for all the conditions observed. —*The Editor.*

The Phenology of Nova Scotia, 1918.—By A. H. MacKay, LL.D.

(Read by title, 12 May, 1919.)

These observations were made by the school children of the Province of Nova Scotia as a part of the Nature Study work prescribed. The pupils report by bringing into the school-room the flowering or other specimens when first observed, for authoritative determination by the teacher, who generally credits the first finder by placing the name and the observation on the honor roll section of the blackboard for the day. The teacher, after testing the correctness of the observation, marks it on the schedule with which every teacher is provided—a copy of which is sent in to the Inspector with the school returns at the end of June and January.

The following tables are compiled from 171 of the best schedules out of the 350 sent in. The selections were made and compiled under the direction of Mr. H. R. Shinner, B. A., and Miss Frances Foley, of the Education Department.

The schedules for each year are carefully bound up in a large annual volume, which is placed in the Provincial Museum and Science Library, where they can be used by students of climate, etc. The compilers of the phenochrons of the different belts, slopes or regions, have been rural science teachers who have most distinguished themselves as instructors. They were selected for the purpose on the recommendation of the Director of rural science education. The sheets from which the provincial phenochrons are calculated are also bound in annual folio volumes for ease of consultation and preservation.

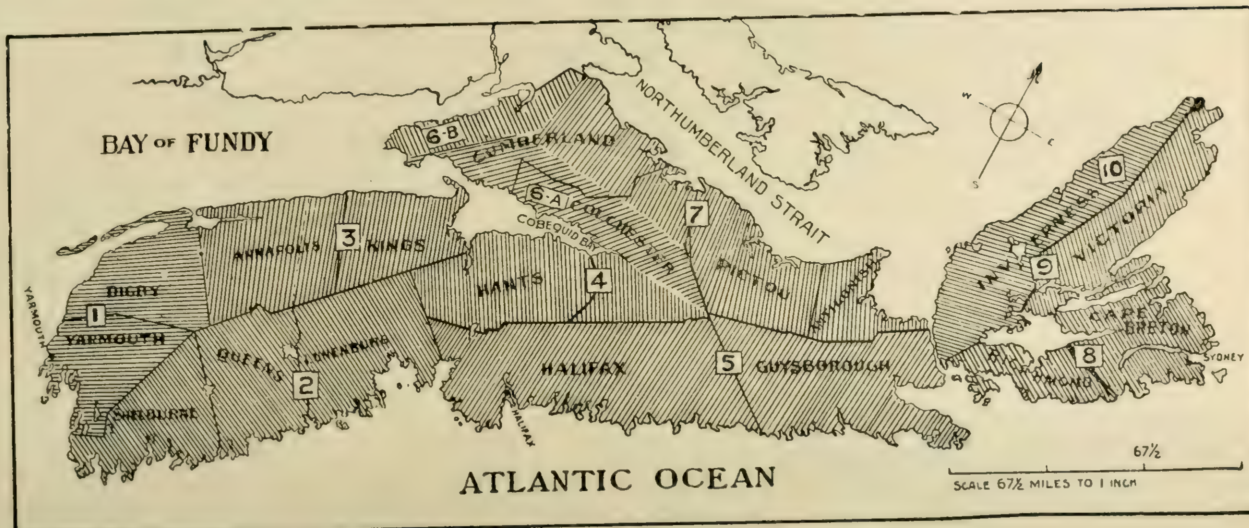
The Province is divided into its main climate slopes or regions not always coterminous with the boundaries of counties. Slopes, especially those to the coast, are subdivided into belts, such as (a) the coast belt, (b) the low inland belt, and (c) the high inland belt, as below:—

No.	Regions or Slopes.	Belts.
I.	Yarmouth and Digby Counties,	(a) Coast, (b) Low Inlands, (c) High Inlands.
II.	Shelburne, Queens & Lunenburg Co's,	" " "
III.	Annapolis and Kings Counties,	(a) South Mts., (b) Annapolis Valley, (c) Cornwallis Valley, (d) North Mts.
IV.	Hants and Colchester Counties,	(a) Coast, (b) Low Inlands, (c) High Inlands.
V.	Halifax and Guysboro Counties,	" " "
VI.A.	Cobequid Slope (to the south),	" " "
VI.B.	Chignecto Slope (to the northwest),	" " "
VII.	Northumberland Straits Slope (to the n'h),	" " "
VIII.	Richmond & Cape Breton Co's,	" " "
IX.	Bras d'Or Slope (to the southeast),	" " "
X.	Inverness Slope (to Gulf, N. W.),	" " "

The ten *regions* are indicated on the outline map on the next page.

THE LOCAL COMPILERS FOR EACH REGION, 1918.

Region No.		Region No.	
I.	Miss Annie Roney, Weymouth.	VI.a	Mr. R. N. Bagnell, Great Village, Col. Co.
II.	Miss Emma Soley, Liverpool.	VI.b	Miss Mary Soley, Springhill.
III.	Miss Marjorie North, Annapolis.	VII.	Miss Flora Zwicker, Pugwash, Cumb. Co.
IV.	Miss Gertrude M. Chase, Three Mile Plains.	VIII.	Miss Grace Horton, Glace Bay.
V.	Miss Jamesina Moore, Musquodoboit.	IX & X.	Mr. J. J. LeBlanc, Belle Cote.



THE TEN PHENOLOGICAL REGIONS OF NOVA SCOTIA.

THE PHENOLOGY OF NOVA SCOTIA, 1918.

[Compiled from the best 171 out of 350 local observation schedules.]

YEAR 1918.

Day of the year corresponding to the last day of each month.

Jan.........	31	July.......	212
Feb.........	59	Aug.......	243
March.......	90	Sept.......	273
April........	120	Oct........	304
May........	151	Nov.......	334
June........	181	Dec........	365

For leap Year add one to each except January.

WHEN FIRST SEEN. OBSERVATION REGIONS.											YEAR 1918.	WHEN BECOMING COMMON.	OBSERVATION REGIONS.									
1. Yarmouth and Digby	2. Shelburne, Queens and Lunenburg	3. Annapolis and Kings	4. Hants and Colchester	5. Halifax and Guysboro	6a. Cobequid Slope (to the South)	6b. Chignecto Slope (to the North)	7. Northumb. Sts Slope (to the North)	8. Richmond and Cape Breton	9. Bras d'Or (to the Sth) 10. Inverness (to N. W)	Average Dates		Average Dates	1. Yarmouth and Digby	2. Shelburne, Queens and Lunenburg	3. Annapolis and Kings	4. Hants and Colchester	5. Halifax and Guysboro	6a. Cobequid Slope (to the South)	6b. Chignecto Slope (to the North)	7. Northumb. Sts Slope (to the North)	8. Richmond and Cape Breton	9. Bras d'Or (to the Sth) 10. Inverness (to N. W)
103	105	105	103	113	115	114	116	118	126	113	1. Alnus incana, Wild...............	119	116	114	113	115	119	117	121	122	126	130
133	103	117	117	111	131	129	120	124	127	121	2. Populus tremuloides...............	127	115	142	122	124	126	125	135	124	129	133
103	103	104	113	111	115	114	118	121	122	112	3. Epigea repens, L.................	119	106	112	112	119	119	120	121	124	127	128
119	125	121	127	128	133	128	121	133	130	127	4. Equisetum arvense................	132	125	131	127	131	130	129	139	132	137	136
....	....	....	138	129	....	....	126	133	132	132	5. Sanguinaria Canadensis...........	138	....	....	150	138	137	....	....	130	138	135
120	120	122	127	128	119	127	126	131	133	125	6. Viola Blanda....................	132	127	127	129	131	134	127	135	132	137	137
123	124	124	127	133	125	129	130	135	136	129	7. Viola palmata, *cucullata*...........	135	130	130	130	134	137	133	138	135	140	140
130	....	127	....	130	....	....	130	137	130	130	8. Hepatica triloba, etc...............	136	142	121	133	....	135	....	....	134	144	143
128	126	127	129	133	140	133	128	131	140	131	9. Acer rubrum.....................	136	132	131	132	134	138	140	137	134	136	142
123	124	124	127	133	126	129	130	133	135	129	10. Fragaria Virginiana...............	136	133	132	132	136	139	135	136	136	139	142
156	151	155	161	164	165	164	161	159	172	161	11. Fragaria Virginiana (fruit ripe)....	172	170	169	166	172	172	174	171	170	179	175
127	126	117	131	133	132	132	132	138	138	131	12. Taraxacum officinale..............	138	135	133	134	136	140	137	139	138	144	143
133	146	135	136	138	130	130	131	152	....	137	13. Erythronium Americanum.........	143	142	156	140	143	147	130	135	138	156	....
130	129	138	132	133	134	135	135	140	137	134	14. Coptis trifolia....................	139	136	135	139	136	138	139	139	139	145	143
....	....	131	124	133	123	132	125	137	134	130	15. Claytonia Caroliniana.............	136	....	....	138	129	136	132	136	131	148	138
157	131	137	135	141	127	129	142	144	142	138	16. Nepeta Glechoma................	143	164	133	140	141	142	133	138	146	148	143
137	133	132	137	142	141	139	137	142	145	138	17. Amelanchier Canadensis...........	143	142	139	137	140	145	146	142	141	147	146
....	....	180	....	....	....	....	215	....	....	197	18. Amelanchier Canadensis (fruit ripe)	200	....	....	180	....	....	....	....	220	....	....

THE PHENOLOGY OF NOVA SCOTIA, 1918.—*Continued.*

Year 1918.

Day of the year corresponding to the last day of each month.

Jan	31	July	212
Feb	59	Aug	243
March	90	Sept	273
April	120	Oct	304
May	151	Nov	334
June	181	Dec	365

For Leap Year add one to each except January.

When First Seen. — Observation Regions.

Year 1918.	1. Yarmouth and Digby	2. Shelburne, Queens and Lunenburg	3. Annapolis and Kings	4. Hants and Colchester	5. Halifax and Guysboro	6a. Cobequid Slope (to the South)	6b. Chignecto Slope (to the North)	7. Northumb. Sts Slope (to the North)	8. Richmond and Cape Breton	9. Bras d'Or (to the S'h) 10. Inverness (to N. W.)	Average Dates
19. Prunus Pennsylvanica	139	137	137	142	146	147	139	138	155	151	143
20. Prunus Pennsylvanica (fruit ripe)	...	...	...	...	...	...	...	230	240	...	235
21. Vaccinium Can. and Penn.	135	134	138	140	147	144	138	141	152	149	142
22. Vaccinium Can. & Penn (fruit ripe)	192	176	178	211	...	...	...	214	211	...	197
23. Ranunculus acris	141	142	145	148	155	142	147	148	154	157	148
24. R. repens	148	...	155	155	163	...	163	15[illegible]	167	164	157
25. Trill. erythrocarpum	139	141	137	140	147	140	139	14[illegible]	156	...	142
26. Rhododendron Rhodora	144	138	141	143	147	150	141	141	158	130	143
27. Cornus Canadensis	143	143	143	147	153	146	149	148	157	154	148
28. Cornus Canadensis (fruit ripe)	...	...	...	190	...	...	...	...	176	168	178
29. Trientalis Americana	139	138	146	145	148	147	145	143	155	150	146
20. Clintonia borealis	144	144	147	150	154	150	151	150	158	...	150
31. Calla palustris	151	...	151	151	160	157	163	157	163	144	155
32. Cypripedium acaule	147	145	146	152	156	156	153	157	179	170	156
33. Sisyrinchium angustifoliŭm	153	149	147	156	161	162	156	157	168	163	157
34. Linnaea borealis	147	158	152	164	165	151	161	163	161	171	159
35. Kalmia glauca	155	145	146	147	155	160	147	171	163	153	154
36. Kalmia angustifolia	154	164	159	151	166	...	153	167	157	154	158
37. Crataegus oxyacantha	161	148	150	159	163	169	163	159	160	147	148
38. Crataegus coccinea, etc	153	151	153	158	147	...	161	155	166	157	157
39. Iris versicolor	167	160	152	165	169	169	164	165	175	173	166
40. Chrysanthemum Leucanthemŭm	159	154	157	158	168	16[illegible]	154	160	169	162	161
41. Nuphar advena	155	164	154	154	166	...	164	161	176	168	162
42. Rubus strigosus	149	159	156	141	163	170	158	151	164	155	157

When Becoming Common. — Observation Regions.

Year 1918.	Average Dates	1. Yarmouth and Digby	2. Shelburne, Queens and Lunenburg	3. Annapolis and Kings	4. Hants and Colchester	5. Halifax and Guysboro	6a. Cobequid Slope (to the South)	6b. Chignecto Slope (to the North)	7. Northumb. Sts Slope (to the North)	8. Richmond and Cape Breton	9. Bras d'Or (to the Sth) 10. Inverness (to N. W.)
19. Prunus Pennsylvanica	148	145	142	142	146	152	154	147	142	158	151
20. Prunus Pennsylvanica (fruit ripe)	240	...	...	...	...	...	...	...	237	244	...
21. Vaccinium Can. and Penn.	148	145	140	143	147	148	148	143	146	167	157
22. Vaccinium Can. & Penn (fruit ripe)	218	...	206	...	220	...	...	...	219	220	...
23. Ranunculus acris	158	152	15[illegible]	152	156	162	153	154	155	166	161
24. R. repens	158	145	153	160	163	166	...	168	128	170	167
25. Trill. erythrocarpum	149	146	146	140	145	152	148	147	147	159	...
26. Rhododendron Rhodora	148	151	143	145	146	152	152	146	144	160	142
27. Cornus Canadensis	154	151	148	149	155	159	151	155	155	163	160
28. Cornus Canadensis (fruit ripe)	196	...	209	...	198	...	...	...	...	181	...
29. Trientalis Americana	152	145	144	150	148	153	154	151	147	161	156
20. Clintonia borealis	157	152	150	155	155	158	160	159	155	168	...
31. Calla palustris	162	157	156	155	157	167	163	169	161	184	160
32. Cypripedium acaule	161	157	151	150	164	150	163	158	161	152	168
33. Sisyrinchium angustifoliŭm	162	160	155	153	161	164	167	163	163	171	167
34. Linnaea borealis	161	155	163	166	117	172	...	170	170	167	170
35. Kalmia glauca	158	156	151	152	153	162	166	150	171	169	157
36. Kalmia angustifolia	161	163	167	166	151	168	...	158	...	162	157
37. Crataegus oxyacantha	164	169	155	155	164	166	...	170	164	168	...
38. Crataegus coccinea, etc	161	166	159	158	162	152	...	160	160	172	161
39. Iris versicolor	171	168	165	162	175	175	...	168	170	178	179
40. Chrysanthemum Leucanthemŭm	167	163	161	162	167	173	172	168	166	174	173
41. Nuphar advena	168	164	168	159	162	172	...	173	167	180	170
42. Rubus strigosus	162	167	156	162	158	167	176	163	157	171	160

...	205	...	193	...	...	...	193	221	...	203	43. Rubus strigosus (Fruit ripe)	212	...	210	...	196	...	...	...	215	228	...
161	163	169	170	171	...	171	...	191	...	171	44. Rhinanthus Crista-galli	177	165	170	172	171	180	...	...	174	208	...
167	157	158	169	165	176	162	157	164	166	164	45. Rubus villosus	171	175	165	165	175	172	183	173	164	171	167
...	236	241	240	...	...	...	...	239	...	239	46. Rubus villosus (Fruit ripe)	246	...	243	245	248	...	...	...	...	248	...
161	163	165	154	160	...	...	169	176	170	165	47. Sarracenia purpurea	170	167	168	169	...	165	...	...	174	181	...
166	166	167	146	175	...	171	155	185	...	166	48. Brunella vulgaris	176	174	172	173	180	175	181	...	166	190	...
172	164	167	177	174	168	164	168	133	...	165	49. Rosa lucida	177	172	177	174	177	177	173	176	174	193	...
158	160	162	163	165	166	169	167	170	176	166	50. Leontodon autumnale	172	167	163	170	172	169	175	177	173	181	...
...	168	176	...	172	175	...	172	167	...	172	51. Linaria vulgaris	176	...	173	180	...	178	...	...	177	170	...
131	131	128	138	135	132	133	130	134	133	132	52. Trees appear green	142	142	140	136	144	144	143	154	138	146	143
141	137	139	139	146	155	144	141	151	151	144	53. Ribes rubrum (Cultivated)	150	143	142	144	142	152	172	150	145	153	136
...	202	...	...	...	...	...	...	219	...	210	54. Ribes rubrum (Fruit ripe)	220	...	...	...	...	...	...	...	...	220	...
144	145	141	141	149	162	143	143	149	153	147	55. R. nigrum (Cultivated)	154	154	149	146	146	154	178	152	146	157	157
...	...	...	...	...	...	...	...	185	...	185	56. R. nigrum (Fruit ripe)	190	...	...	...	...	...	...	...	...	190	...
139	141	135	146	153	...	147	141	160	152	146	57. Prunus Cerasus	154	143	145	139	149	157	180	153	146	165	158
...	...	...	...	...	...	...	214	...	...	214	58. Prunus Cerasus (Fruit ripe)	218	...	...	...	...	...	...	...	218	...	...
147	140	138	145	146	157	146	142	159	155	147	59. Prunus domestica	155	156	144	143	148	156	163	156	147	169	168
146	141	139	146	151	157	147	142	159	152	148	60. Pyrus Malus	157	154	147	146	152	158	162	152	148	167	160
158	149	147	156	160	157	153	150	167	161	156	61. Syringa vulgaris	161	167	155	152	161	162	157	157	156	171	171
151	155	149	152	156	159	156	138	164	163	154	62. Trifolium repens	163	158	159	157	160	163	168	163	160	171	169
142	133	146	156	159	160	157	153	166	158	153	63. Trifolium pratense	162	151	156	154	166	166	162	167	162	172	171
148	156	168	...	171	...	166	163	169	173	164	64. Phleum pratense	168	156	160	170	...	175	...	171	169	174	...
173	176	179	...	...	...	...	...	193	...	180	65. Solanum tuberosum	188	176	...	...	...	...	...	...	...	200	...
108	114	114	124	121	107	120	123	120	121	117	66. Ploughing first of season	125	119	122	125	127	128	116	130	129	129	132
125	123	126	132	129	128	128	133	134	133	129	67. Sowing	137	135	131	135	135	136	131	135	139	141	142
118	123	131	135	127	131	130	132	127	130	128	68. Potato planting	140	129	131	138	167	137	137	143	142	136	140
128	116	127	134	142	137	136	130	125	118	129	69. Sheep-shearing	137	139	124	132	135	151	127	148	137	134	131
197	186	201	205	193	...	...	217	216	214	204	70. Hay-cutting	216	214	200	208	...	216	...	...	223	233	221
243	...	240	246	239	...	...	240	248	239	242	71. Grain-cutting	248	...	239	243	255	245	...	...	247	256	253
270	...	261	268	263	...	...	276	270	275	269	72. Potato-digging	277	300	277	267	270	271	...	...	287	276	282
94	89	100	98	105	107	110	91	106	96	99	73a Opening of rivers	...	...	...	...	...	...	...	...	...	...	...
89	96	112	48	112	118	117	111	113	118	103	73b. Opening of lakes	...	...	...	...	...	...	...	...	...	...	...
103	103	108	112	102	108	107	114	113	115	108	74a. Last snow to whiten ground	...	...	...	...	...	...	...	...	...	...	...
106	109	120	112	103	108	107	115	112	126	122	74b. Last snow to fly in air	...	...	...	...	...	...	...	...	...	...	...
138	150	163	170	145	125	172	148	126	123	146	75a. Last spring frost—hard	...	...	...	...	...	...	...	...	...	...	...
140	162	173	171	165	172	...	171	145	154	161	75b. Last spring frost—hoar	...	...	...	...	...	...	...	...	...	...	...
...	116	93	...	103	113	112	130	114	118	112	76a. Water in streams—high	...	...	...	...	...	...	...	...	...	...	...
284	...	...	...	163	...	...	223	...	...	257	76b. Water in streams—low	...	...	...	...	...	...	...	...	...	...	...
264	315	249	248	243	...	...	275	232	280	263	77a. First autumn frost—hoar	...	...	...	...	...	...	...	...	...	...	...
308	251	282	...	332	...	...	281	293	279	290	77b. First autumn frost—hard	...	...	...	...	...	...	...	...	...	...	...
301	307	296	307	307	...	...	308	297	291	302	78a. First snow to fly in air	...	...	...	...	...	...	...	...	...	...	...
310	309	308	311	312	...	...	322	318	310	312	78b. First snow to whiten ground	...	...	...	...	...	...	...	...	...	...	...
331	350	...	334	343	...	...	331	330	...	336	79a. Closing of lakes	...	...	...	...	...	...	...	...	...	...	...
...	357	...	335	...	...	...	326	352	...	342	79b. Closing of rivers	...	...	...	...	...	...	...	...	...	...	...
95	91	89	96	87	...	97	91	...	103	94	81a. Wild ducks migrating, N	...	...	...	...	...	...	...	...	...	...	...
...	...	...	297	271	...	...	249	...	271	272	81b. Wild ducks migrating, S	...	...	...	...	...	...	...	...	...	...	...
94	84	94	90	86	84	94	85	...	96	90	82a. Wild geese migrating, N	...	...	...	...	...	...	...	...	...	...	...
327	328	...	333	318	...	...	...	...	276	316	82b. Wild geese migrating, S	...	...	...	...	...	...	...	...	...	...	...

THE PHENOLOGY OF NOVA SCOTIA, 1918.—*Continued.*

Year 1918.

Day of the year corresponding to the last day of each month.

Jan.	31	July	212
Feb.	59	Aug.	243
March	90	Sept.	273
April	120	Oct.	304
May	151	Nov.	334
June	181	Dec.	365

For Leap Year add one to each except January.

When First Seen. Observation Regions. 1. Yarmouth and Digby	2. Shelburne, Queens and Lunenburg	3. Annapolis and Kings	4. Hants and Colchester	5. Halifax and Guysboro	6a. Cobequid Slope (to the South)	6b. Chignecto Slope (to the North)	7. Northumb. Sts. Slope (to the North)	8. Richmond and Cape Breton	9. Bras d'Or (to the S'h) 10. Inverness (to N. W)	Average Dates	Year 1918.	When Becoming Common. Observation Regions. Average Dates	1. Yarmouth and Digby	2. Shelburne, Queens and Lunenburg	3. Annapolis and Kings	4. Hants and Colchester	5. Halifax and Guysboro	6a. Cobequid Slope (to the South)	6b. Chignecto Slope (to the North)	7. Northumb. Sts. Slope (to the North)	8. Richmond and Cape Breton	9. Bras d'Or (to the Sth) 10. Inverness (to N. W)
82	86	88	88	90	85	94	88	90	98	89	83. Melospiza fasciata (North)	....	....	....	....	....	....	....	....	....	....	....
87	81	82	76	84	....	83	86	87	95	85	84. Turdus migratorius (North)	....	....	....	....	....	....	....	....	....	....	....
74	90	84	93	89	....	86	90	93	97	88	85. Junco hiemalis (North)	....	....	....	....	....	....	....	....	....	....	....
136	132	126	132	134	....	134	130	129	121	130	86. Actitis macularia (North)	....	....	....	....	....	....	....	....	....	....	....
149	106	126	133	119	....	....	122	118	125	125	87. Sturnella magna (North)	....	....	....	....	....	....	....	....	....	....	....
131	125	123	135	127	117	125	125	127	122	126	88. Ceryle Alcyon (North)	....	....	....	....	....	....	....	....	....	....	....
128	137	126	138	132	129	128	129	134	125	130	89. Dendroeca coronata (North)	....	....	....	....	....	....	....	....	....	....	....
136	141	134	141	149	139	139	139	137	152	141	90. D. aestiva (North)	....	....	....	....	....	....	....	....	....	....	....
121	149	118	128	113	92	126	123	128	137	123	91. Zonotrichia alba (North)	....	....	....	....	....	....	....	....	....	....	....
142	148	142	142	144	156	151	149	150	150	147	92. Trochilus colubris (North)	....	....	....	....	....	....	....	....	....	....	....
134	131	137	140	143	138	144	132	150	132	138	93. Tyrannus Carolinensis (North)	....	....	....	....	....	....	....	....	....	....	....
140	....	140	132	145	129	143	137	161	150	142	94. Dolychonyx oryzivorus (North)	....	....	....	....	....	....	....	....	....	....	....
146	136	141	144	143	149	124	143	141	143	141	95. Spinis tristis (North)	....	....	....	....	....	....	....	....	....	....	....
151	107	126	171	140	....	....	152	142	157	143	96. Setophaga rutilla (North)	....	....	....	....	....	....	....	....	....	....	....
109	149	142	155	....	149	154	145	155	....	145	97. Ampelis cedrorum (North)	....	....	....	....	....	....	....	....	....	....	....
131	139	132	130	135	....	149	133	123	120	132	98. Chordeiles Virginianus	....	....	....	....	....	....	....	....	....	....	....
99	105	100	114	114	117	113	112	115	121	111	99. First piping of frogs	....	....	....	....	....	....	....	....	....	....	....
110	111	110	124	119	118	122	119	122	126	118	100. First appearance of snakes	....	....	....	....	....	....	....	....	....	....	....

THUNDERSTORMS—PHENOLOGICAL OBSERVATIONS, NOVA SCOTIA, 1918.

The indices indicate the number of stations from which the Thunderstorms were reported on the day of the year specified.

OBSERVATION REGIONS.

1. Yarmouth and Digby.	2. Shelburne, Queens and Lunenburg.	3. Annapolis and Kings.	4. Hants and Colchester	5. Halifax and Guysboro.	6a. Cobequid Slope (to the South)	6b. Chignecto Slope (to the north)	7. Northumb. Sts. Slope (to the north).	8. Richmond and Cape Breton.	9. Bras d'Or Slope 10. Inverness Slope	Total 1918
							32			32
							36			36
39										39
						42				42
		43								43
46^{6}	46^{5}	46^{8}	46^{2}	46^{7}	46^{2}	46^{11}	46^{2}			46^{43}
47	47									47^{2}
						50				50
56^{2}						56^{2}				56^{4}
	57			57						57^{2}
			66							66
67										67
							70			70
		74				74				74^{2}
		81^{4}				81^{7}				81^{11}
					83					83
								109		109
		110								110
								112		112
						113				113
	114^{6}		114^{3}	114^{6}	114^{2}	114^{7}	114^{2}	114^{2}	114	114^{29}
	115		115	115			115			115^{4}
			116			116				116^{2}
								119		119
	123									123
126^{3}						126				126^{4}
127						127	127			127^{3}
128^{6}	128^{8}	128^{6}	128^{4}	128^{4}		128^{13}	128	128^{4}	128	128^{47}
		129			129					129^{2}
130		130			130			130^{2}		130^{5}
						131		131^{2}		131^{3}
						135				135
		141^{4}	141^{2}		141	141^{4}				141^{11}
143		143	143^{3}	143	143	143^{4}			143^{2}	143^{13}
					144					144
				147						147
150										150
		151								151

THUNDERSTORMS—PHENOLOGICAL OBSERVATIONS, NOVA SCOTIA, 1918.

The indices indicate the number of stations from which the Thunderstorms were reported on the day of the year specified.

OBSERVATION REGIONS.

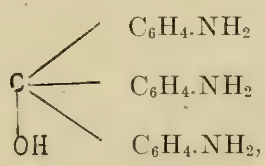
1. Yarmouth and Digby.	2. Shelburne, Queens and Lunenburg.	3. Annapolis and Kings.	4. Hants and Colchester	5. Halifax and Guysboro.	6a. Cobequid Slope (to the South).	6b. Chignecto Slope (to the north).	7. Northumb. Sts. Slope (to the north).	8. Richmond and Cape Breton.	9. Bras d'Or Slope 10. Inverness Slope	Total 1918
152^{5}	152^{3}	152^{3}	152	152^{2}		152^{3}		152		152^{18}
153^{3}		153^{7}	153^{3}	153^{4}		153^{15}	153	153^{2}	153	153^{36}
154	154	154^{5}	154^{2}			154^{3}				154^{12}
						155				155
					157					157
	158									158
								159		159
							161			161
					162					162
163	163^{4}	163^{6}				163^{4}			163	163^{16}
164^{7}	164^{4}	164^{6}	164^{4}	164	164^{2}	164^{12}				164^{36}
			166^{3}							166^{3}
				169						169
170				170						170^{2}
						172				172
	173									173
						174	174^{10}			174^{11}
							194			194
226										226
236										236
							237			237
						238				238
							249			249
						261	261^{2}			261^{3}
						262				262
							263^{3}			263^{3}
						267				267
268										268
278										278
279						279				279^{2}
298										298
							302			302
							304			304
							309			309
311^{2}							311			311^{3}
							344			344
							354			354

A Method for Making Methyl Violet.—By Henry Jermain Maude Creighton, Dr. Sc., Assistant Professor of Chemistry in Swarthmore College, Swarthmore, Pa., U. S. A.

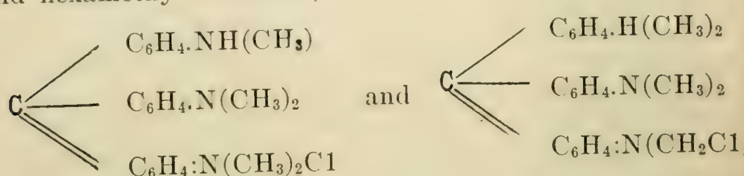
(Read 12 May, 1919)

In the year 1860, C. Lauth began to study the action on mono- and dimethylaniline of those oxidizing agents which produce rosaniline, and as a result of his efforts a beautiful violet dye, now known as methyl violet in contradistinction to Hofmann's violet, was placed on the market in 1866. The discovery and preparation of this dye represent a logical step forward from the manufacture of magenta (homorosaniline chloride), even though the processes by which methyl violet is made at the present time bear no relation to any of those by which the latter is prepared. The popular misnomer "aniline dye" may justly be applied to methyl violet, for it is one of the few synthetic dyestuffs which can be traced back to aniline as a starting point.

The name methyl violet is used to designate a number of triphenylmethane dyestuffs which are derived from the parent substance para-rosaniline,



by partial or complete substitution of the hydrogen atoms of the amino groups by alkyl groups. Since substitution in a compound by batho-chromic groups (methyl, ethyl, hydroxymethyl, etc.) is attended by a displacement of the absorption bands towards the red end of the spectrum, causing the color of the substance to pass successively into the yellow, orange, red, purple and violet, the substitution in para-rosaniline by alkyl groups caused the red color of the former to change to violet, the shade of the violet color of the derived substance approximating more closely to the blue or red according as the number of alkyl groups is greater or less. The red or blue shades of the various alkyl substitution products of para-rosaniline are usually denoted by affixing to the name methyl violet the letters R, 2R, 3R, B, 2B, 3B, etc. Thus Hofmann's violet, which is a mixture of the lowest substitution products of para-rosaniline, gives shades corresponding to the letters R, 2R and 3R. On the other hand methyl violet, as prepared in the manner described below, is essentially a mixture of the hydrochlorides of penta- and hexamethyl-rosaniline,



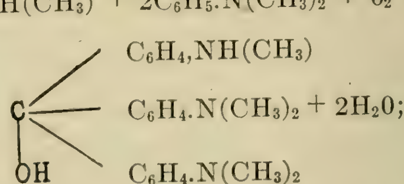
and accordingly gives bluer shades than Hofmann's violet, which correspond to the letters B and 2B. A preponderance of the penta-compound gives a methyl violet B, while an increase in the proportion of the hexa-derivative produces a methyl violet 2B.

Methyl violet B or 2B is formed by the action of a number of oxidizing agents on dimethylaniline. The first step in its formation is the production of formaldehyde and monomethylaniline:

$$2C_6H_5.N(CH_3)_2 + O_2 = 2CH_2O + 2C_6H_5.NH(CH_3).$$

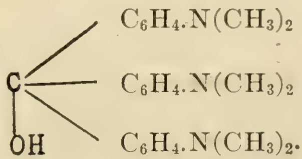
Part of the formaldehyde, which supplies the so-called methane carbon, then combines with one molecule of monomethylaniline, two molecules of dimethylaniline and one molecule of oxygen to form the penta-carbinol base:

$$CH_2O + C_6H_5.NH(CH_3) + 2C_6H_5.N(CH_3)_2 + O_2 =$$



while part of it combines with three molecules of dimethylaniline and one molecule of oxygen to form the hexa-carbinol base:

$$CH_20 + 3C_6H_5.N(CH_3)_2 + 0_2 =$$



Treatment with hydrochloric acid converts these carbinol bases into the corresponding hydrochlorides.

In the manufacture of methyl violet at the present time, copper sulphate is employed as the oxidizing agent. This salt reacts with some of the sodium chloride present in the reaction mass (melt) to form cupric chloride, and this is reduced to cuprous chloride. As this latter compound is easily reoxidized to the cupric salt, *in situ*, by atmospheric oxygen, the melt was formerly rendered porous by the admixture of a large quantity of sand so that the air might have ready access. At the present time the use of sand has been entirely replaced by common salt, as this can be easily removed by dissolution immediately after oxidation, thus considerably decreasing the bulk of the product to be worked with.

The following method for the manufacture of methyl violet has been developed by the writer and gives very good results:

A quantity of finely-ground copper sulphate, corresponding to 12 kilograms of the hydrated salt, is intimately mixed with 190 kilograms of dried sodium chloride. To this mixture, under constant stirring, is added 8 kilograms of phenol dissolved in one liter of water, and this is followed by the gradual addition of 20 kilograms of dimethylaniline. The melt is transferred to a closed iron vessel equipped with a stirring and mixing device, where it is continuously stirred at a temperature of 57-60°C. until a sample when squeezed in the hand forms a ball which does not fall apart. This usually requires about eight hours.

The reaction liberates a considerable amount of heat. This may be increased by dehydrating the copper sulphate prior to mixing with the salt. By employing the dehydrated salt, or suitable proportions of hydrated and dehydrated salt, the amount of external heat required to maintain the melt at the proper temperature may be decreased, thus effecting a saving in fuel.

When oxidation is complete, the melt is gradually added to a large wooden vat containing 1000 liters of boiling water, in which are dissolved 13 kilograms of slaked lime. The liquid is boiled, by blowing in high pressure steam, until all the lumps disappear. The insoluble double salt of the color base and cuprous chloride is allowed to settle and the supernatant liquid runs off. This liquid contains most of the salt and the phenol in the form of calcium phenate. The double salt of the color base and cuprous chloride is now decomposed with sodium sulphide, which converts the latter into copper sulphide. To accomplish this 1000 liters of water are run into the vat, the temperature brought to 70°C., and 3.3 kilograms of sodium sulphide dissolved in a small quantity of water slowly added while the liquid is stirred continuously. At the end of one-half hour the temperature is raised to 100°C. and the liquid boiled for five or six hours. The color base and the copper sulphide are then allowed to settle, the supernatant liquid run off, and the residue washed twice with 1000 liters of water.

In order to separate the color base from the copper sulphide, 1000 liters of water are run into the vat, the mixture brought to boiling, 15 kilograms of sulphuric acid gradually added, and boiling continued for two hours. During this treatment the color base dissolves, forming a deep violet solution, practically all of the copper sulphide remaining undissolved. After the solid material settles, the solution of dye is run off into a second vat, at a lower level, and the residue in the first vat is again extracted with sulphuric acid. The resulting solution of dye is combined with that in the second vat. To the combined liquids sufficient sodium hydroxide is added to almost neutralize the acid. The dye is now salted out by the addition of sodium chloride, and on cooling it solidifies to a lustrous green resinous mass. As this dye contains a small quantity of the insoluble copper compound, it is redissolved in 750 liters of boiling water. The dye solution is passed through a filter into a third vat where, on salting out, a particularly pure methyl violet is obtained. The insoluble residue remaining in the second vat and in the filter is added to the first vat, where it is again treated with sodium sulphate with the next melt.

The method that has been described has been operated under the supervision of the writer's assistants, Messrs. K. R. Brown, C. D. Pratt and J. E. Allen, and has given yields of 75-85 per cent. of methyl violet. The color of the dye produced had a 2B shade.

Swarthmore College,
Swarthmore, Pa.,
April 9th, 1919.

An Abandoned Marine Sand-bar in the Cornwallis Valley, Nova Scotia.— By Frederick C. Churchill, Wolfville, N. S.

(Read 12 May, 1920.)

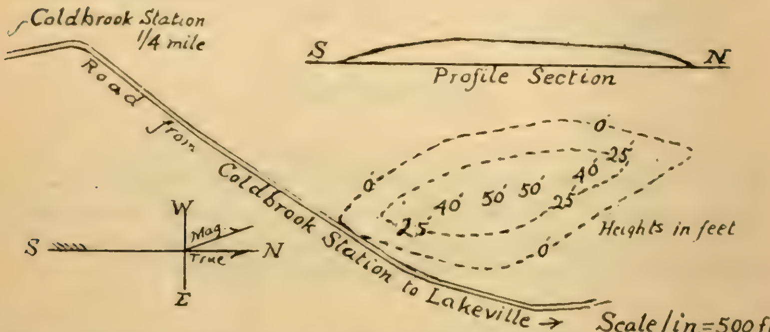
During the summer of 1917, while tracing out the floor of an extinct lake near Coldbrook, Kings County, Nova Scotia, I came across a large mound of sand with some gravel, and judging from its external appearance, my first impression was that I had discovered a drumlin.

This discovery led me to abandon what I first set out to do, and I immediately began to look for evidence to support my theory of a drumlin, but finally I felt uncertain as to its origin.

The following summer (1918), Prof. D. S. McIntosh, of Dalhousie, visited the spot with me, and we spent one day looking over the ground; and he agreed with me that, owing to its shape and the direction of its longer axis, it looked like a drumlin; but, being cautious, he suspended judgment.

Early in the spring of 1919, W. J. Wright, then professor of geology at Acadia University, spent a day with me examining the mound and surrounding country. He said he felt quite sure it was not a drumlin, stating for his reasons the following facts: the absence of boulder-clay in the mound itself, and that in the surrounding country the boulder-clay lies below the sand and gravel. These facts were verified by farmers who live near by. They say in digging wells, after penetrating the sand which is usually 8 to 10 feet deep, clay with loose stones is found. This I believe is the boulder-clay. Mr. Wright then suggested to me that if I wished to know the origin of this bank of sand I was to look for evidence later than the Glacial Period.

Before I continue my paper I should describe my drumlin-shaped sand-bank and the country immediately surrounding it.



Abandoned Marine Sand-bar in Cornwallis Valley, N S.

The Cornwallis Valley is flanked on either side by hills, namely, the North and South Mountains, and consists of numerous banks of sand and gravel. Very few of these rise high enough above the general elevation of the country to become conspicuous objects of topography, the whole country presenting to view a monotonous sandy plain dotted here and there with small groves of pine trees and poplars. The average elevation of the country is about 70 feet above sea level.

About half a mile north of Coldbrook station and a mile and a half from the foot of the South Mountain, lies the sand-bar now under discussion. The road from Coldbrook station to Lakeville passes near it on the east side. The mound is approximately 900 feet long, 300 feet wide, and 50 feet above the surrounding plain. It is so thickly covered with pine trees that a photograph fails to show its contour. It is composed of sand with some gravel, and the direction of its longer axis is N. 10° W.—S. 10° E., true bearings. The north end has a gentle slope, suggesting an ice movement from the north. The south end is much steeper. These facts first led me to think it was a drumlin, but there is stronger evidence against this idea.

I was fortunate enough to find that a quantity of sand had been excavated from the south end, and this afforded me an excellent opportunity to examine these deposits. I found the gravel to lie below the sand. They are both fine, and shew good evidence of being deposited in water. I was unable to find any trace of boulder-clay.

In the first part of this paper I pointed out that boulder-clay was found in this neighborhood by farmers upon digging wells; and I think I can show ample proof that this mound of sand lies above, and, as was suggested by Mr. Wright, is younger than the Glacial Period.

Following up Mr. Wright's suggestion, I examined a much wider field than this immediate vicinity. At Wolfville and Avonport I have found these stratified sands and gravels to overlie marine clay, and boulder-clay still lower. The scanty literature I find upon this subject supports this view in another part of the valley, namely Middleton. In some places I find the stratified marine clay wanting, but, according to Dawson, all these deposits are not necessarily found in any one place.

That the eastern part of North America experienced a submergence following the Glacial Period is an established fact, and there is evidence that the Cornwallis and Annapolis Valleys suffered a like fate. Marine clays containing fossils have been found at Avonport and Middleton. Marine benches are seen at different levels on the South Mountain. A wave-cut platform is also reported near Blomidon, and stratified sands and gravels are very common throughout the valley.

I have searched for fossils in this sand, but without success.

According to the late Prof. Haycock, this valley was submerged by the waters of the Bay of Fundy after the Glacial Period, and the North Mountain was left as a low island in the Bay.

In conclusion, I think that the origin of this bank of sand may be found by examining the effects this submergence would have upon this part of the country. These strong tides, sweeping down and up the valley, over the material of the sea floor, would scour up loose sand and heap it in bars of various shapes.

The material of this bar consists of quartz sand, with small pebbles of bluish slate, quartz, trap, etc., all more or less abraded or semi-rounded. The slate was probably derived from the rocks of the Gold Measures or of the Devonian or Silurian formation, which lie to the south, and the trap from the Triassic igneous rocks of the North Mountain. Very likely the material is glacial drift worked over by the sea.

Upon the re-elevation of the country, the denuding agencies of the atmosphere would probably alter the sand-bar's original form somewhat, and would mould it into its present shape.

This interpretation may be erroneous, but it seems to be in harmony with the few facts that have been given me and with the scanty evidence I have been able to gather.

Supplementary Notes.

In my paper which I submitted to the society on May 10th of this year, I claimed that the mound of sand near Coldbrook was an abandoned marine sand-bar. Since then I have collected stronger evidence to support my claim.

During the early part of the summer of 1920, I spent part of a day in Woodside, Kings Co. The peculiar shape of a number of small hills and hummocks immediately drew my attention, and I investigated them.

Some of these mounds of sand are about 1,000 feet long, and 200 to 300 feet wide, but I do not think that any of them exceed 20 or 25 feet in height. They nearly all stand a little above the level of the surrounding country, which is a gentle undulating plain.

Generally speaking, the direction of their longer axis is east and west. This fact is certainly fatal to the drumlin theory. Moreover, I think it supports the sand-bar theory, because some of them have not an east-and-west axis, but are at angles to this direction.

The material of these bars is chiefly fine water-worn sand, with some fine gravel. I examined the structure of one, where a large quantity of sand had been removed. It was well stratified, and this points to water-laid material, when it is supported by rounded gravel and sand. A slight trace of cross-bedding was also seen, which is characteristic of sandy deposits.

I also learned that the till lies below these sandy hills, which proves that their age is Post-Glacial.

These sand-bars are about ten miles in a northeasterly direction from the sand-bar I described at Coldbrook, and I believe they now stand on what was once the shore-line of the North Mountain, when it stood as a long narrow island on the Bay of Fundy. These bars are now situated about a mile, perhaps a little less, from the base of the North Mountain. They shew that shallow water, as well as strong currents, were the chief agents in their construction.

No doubt these soft deposits have experienced considerable erosion since they have been exposed to the destructive influence of the atmosphere, having both their size and shape altered. Notwithstanding the wear that time has imposed upon them, they still remain as monuments of geological change, and tell the investigator that once the sea dashed against the hills that lie to the north.

APPENDIX I.

LIST OF MEMBERS, 1918-1919.

ORDINARY MEMBERS.

		Date of Admission
Barnes, Albert Johnstone, B. SC., Maritime Teleph. & Telegr. Co., Halifax	May	13, 1912
Bishop, Watson L., Berwick, N. S.	Jan.	6, 1890
Blackadder, Edward, M. D., Halifax	Sept.	27, 1917
*Bronson, Prof. Howard Logan, PH.D., F.R.S.C., Dalhousie University, Halifax	Mar.	9, 1911
Campbell, George Murray, M. D., Halifax. (Died 12 Dec., 1920)	Nov.	10, 1884
Cameron, Prof. John, M. D., D. SC., F. R. S. E., Dalhousie University, Halifax	Nov.	2, 1915
*Colpitt, Parker R., City Electrician, Halifax	Feb.	2, 1903
Coysh, Basil Radcliffe, D.D.S., Halifax	May	1, 1919
Creighton, Prof. Henry Jermain Maude, M. A., M. SC., DR. SC. (Zurich), F. C. S., Swarthmore College, Swarthmore, Penn., U. S. A.	Jan.	7, 1908
*Davis, Charles Henry, C. E., New York City, U. S. A.	Dec.	5, 1900
*Doane, Francis William Whitney, City Engineer, Halifax	Nov.	3, 1886
Donkin, Hiram, M. E., Deputy Com. of Mines, Halifax	Nov.	30, 1892
*Fergusson, Donald M., chemist, Acadia Sugar Ref. Co., Dartmouth, N. S.	Jan.	5, 1909
Forward, Charles C., Dominion Government Analyst, Halifax	Jan.	5, 1917
*Fraser, Sir C. Federick, LL. D., Superintendent School for the Blind, Halifax	Mar.	31, 1890
Freeman, Philip A., Hx. Elec. Tramway Co., Halifax	Nov.	6, 1906
Harris, Prof. David Fraser, M. B., C. M., M. D., B. SC. (Lond.) D. SC., F. R. S. F. R. S. C., L. M. C. C., Dalhousie University, Halifax	Feb.	29, 1912
Hatcher, Prof. Alfred G., Royal Naval College of Canada, Esquimault, B. C.	Dec.	9, 1914
Hattie, William Harrop, M. D., Provincial Health Officer, Dartmouth	Nov.	12, 1892
Irving, G. W. T., Education Dept., Halifax	Jan.	4, 1892
Johnstone, Capt. John Hamilton Lane, C.E., B.A., M.SC., PH.D., M.B.E., Halifax	Dec.	2, 1912
McDougall, John G., M. D., C. M., Lecturer in Clinical Surgery, Dalhousie University, Halifax	Nov.	2, 1915
McInnes, Hector, K. C., M. P. P., Halifax	Nov.	27, 1889
McIntosh, Prof. Donald Sutherland, B. A., M. SC., Dalhousie University, Halifax	Mar.	9, 1911
*MacKay, Alexander Howard, B. A., B. SC., LL. D., F. R. S. C., Hon. Colonel, Superintendent of Education, Halifax	Oct.	11, 1885
Mackay, Prof. Ebenezer, PH. D., Dalhousie College, Halifax. (Died 6 Jan., 1920)	Nov.	27, 1889
*MacKay, George M. Johnstone, M. A., M. S., Schenectady, N. Y., U. S. A.	Dec.	28, 1903
*MacKenzie, President Arthur Stanley, PH. D., F. R. S. C., Dalhousie University Halifax	Nov.	7, 1905
Matheson, Donald J., B. SC., Science Master, Halifax County Academy, Halifax	Nov.	2, 1915
Moore, Prin. Clarence Leander, M.A., F.R.S.C., Pictou Academy, Pictou, N. S.	Jan.	7, 1908
Murray, Prof. Daniel Alexander, PH. D., Montreal	Dec.	18, 1903
*Nicholls, Prof. Albert G., M. D., D. SC., F.R.S.C., Dalhousie University, Halifax	Nov.	2, 1915
Nickerson, Carleton Bell, M. A., Demonstrator in Chemistry, Dalhousie University, Halifax	Mar.	9, 1911
Piers, Harry, Curator Provincial Museum and Librarian Provincial Science Library, Halifax	Nov.	2, 1888

*Life Members.

Date of Admission

Richardson, Prof. Lorne N., Royal Naval College of Canada, Esquimalt, B. C Dec. 9, 1914
*Ritchie, Stephen Galway, B.A., D. M. D., Halifax.......................... Oct. 3, 1919
*Robb, D. W., Amherst, N. S. .... Mar. 4, 1890
Sexton, Prof. Frederick H., D. SC., Director of Technical Education, Halifax... Dec. 18, 1903
*Smith, Prof. H. W., B. SC., Agr. Col., Truro, N. S.; Assoc. Memb. Jan. 6, 1890.. Dec. 1900
*Stewart, Lieut. Col. John, M. B., C. M., Halifax.......................... Jan. 12, 1885
Vickery, Hubert Bradford, M. SC., Halifax................................. Nov. 2, 1915
Westwood, Lt. Ralph V., R.N.V.R., Halifax.................................. Dec. 5, 1919
Winfield, James H., manager Mar. Tel. & Tel. Co., Halifax.................. Dec. 2, 1903
*Woodbury, William W., B. SC., D. D. S., Halifax........................... Nov. 30, 1916
*Yorston, William G., C. E., Assistant Road Commissioner, Halifax........... Nov. 12, 1892

ASSOCIATE MEMBERS.

Allen, E. Chesley, Halifax.. Nov. 28, 1913
Barteaux, James E., M. A., Inspector of Manual Tra.&Tech. Schools, Truro, N.S. Nov. 2, 1915
Brittain, Prof. William H., B. S. A., Provincial Entomologist, Truro, N. S..... Nov. 2, 1915
*Caie, Rovert, Yarmouth, N. S.. Jan. 31, 1890
Churchill, Frederick C., Wolfville, N. S.................................. Apr. 3, 1919
*Connolly, Prof. C. J., PH. D., St. Francis Xavier College, Antigonish, N. S.... Nov. 5, 1911
Cumming, Principal Melville, B. A., B. S. A., N. S. College of Agricultural, Truro. Nov. 2, 1915
DeWolfe, Loran A., M. SC., Director of Rural Science Schools, Truro, N. S...... Nov. 2, 1915
Haley, Prof. Frank R., Acadia College, Wolfville, N. S..................... Nov. 5, 1901
Harlow, L. C., B. SC., PH. D., College of Agriculture, Truro, N. S............. Mar. 23, 1905
*Henderson, Lieut. George Hugh, C. E., B. SC., M. A. .... Nov. 2, 1915
*MacKay, Hector H., M. D., New Glasgow, N. S.............................. Feb. 4, 1902
Payzant, E. N., M. D., Wolfville, N. S..................................... Apr. 8, 1902
Perkins, Prof. P. B., Mt. Allison Univ., Sackville, N. B.................... May 1, 1919
Perry, Prof. Horace Greeley, M. A., Acadia University, Wolfville, N. S......... May 12, 1913
*Reid, A. P., M. D., L. R. S. C., Middleton, Annapolis, N. S. (Died Feb., 1920).. Jan. 31, 1890
Shaw, Prof. Percy J., B. A., N. S. College of Agriculture, Truro, N. S......... Nov. 2, 1915

CORRESPONDING MEMBERS.

Ami, Henry N., D. SC., F. G. S., F. R. S. C., Ottawa, Ont..................... Jan. 2, 1892
Bailey, Prof. L. W., PH. D., LL. D.; F. R. S. C., Fredericton, N. B............ Jan. 6, 1890
Ball, Rev. E. H., Chester, N. S.. Nov. 29, 1871
Barbour, Major J. H., R. A. M. C., F. L. S., St. Omer, France................ Dec. 28, 1911
Bethune, Rev. Charles J. S., M. A., D. C. L., F. R. S. C., Toronto, Ontario...... Dec. 29, 1868
Cox, Prof. Philip, B. SC., PH. D., Fredericton, N. B......................... Dec. 3, 1902
Dobie, W. Henry, M. D., Chester, England................................... Dec. 3, 1897
Faribault, E. Rodolphe, B. A., B. SC., F. R. S. C., Geological Survey of Canada, Ottawa: Assoc. Memb. March 6, 1888.......................... Dec. 3, 1902
Ganong, Prof. W. F., B. A., PH. D., Smith College, Northampton, Mass., U. S. A.. Jan. 6, 1890
Gates, Reginald Ruggles, PH. D., F. L. S., London, Eng...................... Nov. 30, 1916
Matheson, Prof. Robert, PH. D., Cornwall University, Ithaca.................. Nov. 30, 1916
Matthew, G. F., M. A., D. SC., LL. D., F. R. S. C., St. John, N. B............. Jan. 6, 1890
Mowbray, Louis L., curator, Bermuda Natural History Society, Hamilton, Bermuda... May 3, 1907
Peter, Rev. Brother Junian.. Dec. 12, 1898
Prest, Walter Henry, Halifax, N. S.; Assoc. Memb. Nov. 29, 1894. (Died 25 Dec., 1920).. Nov. 2, 1900
Prichard, Arthur H. Cooper, British School of Archaeology, Rome, Italy..... Dec. 4 1901
Prince, Prof. E. E., Commissioner and General Inspector of Fisheries, Ottawa.. Jan. 6, 1897

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*Life Members.

THE attention of members of the Institute is directed to the following recommendations of the British Association Committee on Zoological Bibliography and Publications:

"That authors' separate copies should not be distributed privately before the paper has been published in the regular manner.

"That it is desirable to express the subject of one's paper in its title, while keeping the title as concise as possible..

"That new species should be properly diagnosed and figured when possible.

"That new names should not be proposed in irrelevant footnotes, or anonymous paragraphs.

"That references to previous publications should be made fully and correctly, if possible in accordance with one of the recognized sets of rules of quotations, such as that recently adopted by the French Zoological Society."

THE

PROCEEDINGS AND TRANSACTIONS

OF THE

Nova Scotian Institute of Science

HALIFAX, NOVA SCOTIA

VOLUME XV

PART 2

SESSION OF 1919-1920

HALIFAX

PRINTED FOR THE INSTITUTE BY THE ROYAL PRINT AND LITHO LIMITED

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CONTENTS

PROCEEDINGS

OF THE

Nova Scotian Institute of Science

SESSION OF 1919 - 1920

(Vol. XV, Part 2)

58TH ANNUAL BUSINESS MEETING.

Physiological Lecture Room, Dalhousie College, Carleton St., Halifax, 10th November, 1919.

THE PRESIDENT, DR. H. L. BRONSON, in the chair. Other members present: PROF. C. J. CONNOLLY, DR. E. MACKAY, D. J. MATHESON, DR. A. H. MACKAY, PROF. D. S. MCINTOSH, C. B. NICKERSON, DR. J. CAMERON, DR. D. FRASER HARRIS, DR. J. H. L. JOHNSTONE, P. R. COLPITT, DR. W. W. WOODBURY, E. CHESLEY ALLEN, DR. S. G. RITCHIE, B. R. COYSH, F. C. CHURCHILL and H. PIERS.

THE PRESIDENT in his opening remarks stated that the society's efforts to increase its membership had met with success, the number of members being nearly doubled. The membership list had also been generally revised. The council was considering what might be done by the society to further the cause of science in a more popular and general way, and a committee had been appointed to deal with the subject, but was not ready to report. Reference was made to the loss sustained during the year through the death of MAJOR GENERAL HARDY, who had been the last surviving original member of the Institute, 1862, and who died at Dover, England, on 11th April, 1919; of DR. DONALD A. CAMPBELL, who died at Halifax on 7th January, 1919; and of REV. ROBERT LAING, who died on 19th April, 1919.

By request of the President, Mr. Piers briefly sketched the career of General Hardy and spoke of his interest in all that related to this province and its natural history as well as in the affairs of the Institute which he assisted in founding.

The Treasurer, Mr. Matheson, presented his financial report for the year ended Oct. 1919, shewing that the receipts were \$1,103.93, the expenditures \$185.95, and the balance in hand \$917.98 (in current account), while the balance at credit of the reserve fund was \$361.48, and the permanent endowment fund, invested in Maritime Telephone bonds, was \$1,000.00. The report was received and adopted.

On motion, \$500.00 will be invested in Victory Bonds, and placed to the credit of the permanent endowment fund, as representing life-fees.

The Librarian's report was presented by Mr. Piers, showing that 1,163 books and pamphlets had been received through the exchange-list during the calendar year 1918. The total number of books and pamphlets received by the entire Provincial Science Library (with which that of the Institute is incorporated) for the same year, was 1,432. The total number in the Science Library on 31st Dec. 1918, was 60, 890. Of these, 44,390 belong to the Institute, and 16,500 to the Science Library proper. 128 books were borrowed in 1918, besides the many consulted in the Library. No binding or purchasing had been done by the Library directly, there still being no grant at its disposal. The report was received and adopted.

Dr. A. H. MacKay laid on the table copies of the Transactions, vol. xiv, part 4, which had recently come from the press.

The following were elected officers for the ensuing year (1919-1920):

President—Professor Howard Logan Bronson, Ph.D., F.R. S.C., *ex officio* F.R.M. S.

First Vice-President—Professor C. J. Connolly, Ph.D. (Antigonish.)

Second Vice-President—Professor John Cameron, M.D., D.Sc., F.R,S.E.

Treasurer—Donald J. Matheson, B.Sc.

Corresponding Secretary—Professor Ebenezer Mackay, Ph.D.

Recording Secretary and Librarian—Harry Piers.

Councillors without office—ALEX. HOWARD MACKAY, LL.D., F.R.S.C.; PROFESSOR DONALD SUTHERLAND MCINTOSH, M.SC.; CARLETON BELL NICKERSON, M.A.; PROFESSOR DAVID FRASER HARRIS, M.D., D.SC., F.R.SS. E. C.: E. CHESLEY ALLEN; STEPHEN GALWAY RITCHIE B.A., D.M.D.; and CAPTAIN JOHN H. L. JOHNSTONE, M.SC., M.B.E.

On motion of DR. E. MACKAY, the PRESIDENT, PROF. CONNOLLY and MR. PIERS were appointed a committee to consider means by which the Institute could extend its usefulness.

FIRST ORDINARY MEETING.

Physiological Lecture Room, Dalhousie College, Carleton St. Halifax; 10th November, 1919.

The first ordinary meeting was held on the conclusion of the annual business meeting. The PRESIDENT, DR. BRONSON, in the chair.

PROF. DONALD SUTHERLAND MCINTOSH, M. SC., Dalhousie University, read a paper entitled "Port Hood Harbour: its Past, Present and Probable Future." (See Transactions, p. 71) The subject was discussed by DR. A. H. MACKAY, MR. PIERS and PROF. CONNOLLY.

SECOND ORDINARY MEETING.

Physiological Lecture Room, Dalhousie College, Carleton St., Halifax, 19th January, 1920.

THE PRESIDENT, DR. BRONSON, in the chair.

It was reported that PROF. DONNELL BROOKS YOUNG, B.SC., PROF. ROY AUBREY SPENCER, B.SC., M.SC., EBENEZER W. TODD, B. SC., and DR. FRANK W. RYAN, proposed on 10th Nov., had been elected ordinary members by the Council in December.

The following papers were read by title:

(1) Scattered Notes of a Field Botanist in Brittany, France, during the War.—By MAJOR J. H. BARBOUR, R.A.M.C., F.L.S., St. Omer, Pas de Calais, France.

(2) The Blue Crab (*Callinectes sapidus* Rathbun): Extension of its Range Northward to near Halifax, N. S.—By HARRY PIERS, Curator of the Provincial Museum, Halifax. (See Transactions, page 83).

On motion from the CHAIR, seconded by PROF. McINTOSH, it was unanimously resolved that the Nova Scotian Institute of Science desires to place on record its profound sense of loss in the death from pneumonia on the sixth day of January, 1920, after an illness of eight days, of PROFESSOR EBENEZER MACKAY, PH.D. (J. H. U.), MacLeod Professor of Chemistry in Dalhousie University. He was a member of the Institute from 1889, from 1907 to 1910 its President, from 1899 a member of the Council, and for the last few years the efficient Corresponding Secretary. As he was only in his fifty-sixth year, full of vigor, incessantly active, happy and hopeful; an ideal trainer of students in science; the most tactful and generous of collaborators; his death is a profound loss to the Nova Scotian Institute of Science, as well as to Dalhousie University and the science of Chemistry in Canada. Even in the affairs of the city of Halifax his usefulness in aiding many public improvements has created demonstrations of sorrow for his loss which have rarely fallen to the lot of an educationist.

It was further resolved that an obituary notice and portrait of the late Dr. Mackay be inserted in the proceedings. (See page xxvii.)

PROF. D. S. McINTOSH reported that he had received an interesting specimen of Inyoite from Hillsboro, New Brunswick, a mineral which formerly had only been reported from California, U.S.A.

THIRD ORDINARY MEETING.

Physiological Lecture Room, Dalhousie College, Carleton St., Halifax, 9th February, 1920,

THE PRESIDENT, DR. BRONSON, in the chair.

The election of a Corresponding Secretary to fill the vacancy caused by the death of DR. E. MACKAY, was left to the Council.

C. B. NICKERSON read a paper by PROF. H. JERMAIN M. CREIGHTON, D. Sc., F.C.S., Swarthmore, Penn., U. S. A., on "Variation in the Composition of Compressed Illuminating

Gas with Pressure as it issues from the Compression Cylinder." (See Transactions, page 91) The paper was discussed by DR. BRONSON, DR. A H. MACKAY, C.B NICKERSON, E. W. TODD, and DR. S. G. RITCHIE.

HARRY PIERS, Curator of the Provincial Museum, Halifax, read a paper on the "Accidental Occurrence of the Pygmy Sperm Whale (*Kogia breviceps*) on the Coast of Nova Scotia: an extension of its known range." (See Transactions page 95) The subject was discussed by DR. MACKAY, PROF. D. B. YOUNG, F. C. CHURCHILL, PROF. CAMERON, DR. S. G. RITCHIE, and others.

FOURTH ORDINARY MEETING.

Physiological Lecture Room, Dalhousie College, Carleton St., Halifax, 8th March, 1920.

The SECOND VICE-PRESIDENT, DR. CAMERON, in the chair.

It was announced that WILLIAM G. ROBERTSON, Halifax, proposed on 9th Feb., had been elected an ordinary member by the Council.

PROF. D. FRASER HARRIS, M.D., D.Sc., F.R.SS.E. and C., Dalhousie University, read a paper on "The Descent of Man in Medicine," illustrated with charts and lantern slides. A vote of thanks was presented to the lecturer.

On motion of MR. PIERS and DR. HARRIS, it was resolved that the N. S. Institute of Science convey to the publishers and editors of *Nature*, London, its congratulations on the occasion of the fiftieth aniversary of the establishment of that well-known scientific journal, and wish them continued success in the future.

FIFTH ORDINARY MEETING.

Munro Room, Dalhousie College, Carleton St., Halifax, 12th April, 1920.

THE PRESIDENT, DR. BRONSON, in the chair.

It was announced that RALPH F. HOPKINS, Halifax, proposed on 8th March, had been elected an ordinary member by the Council.

A letter was read from the editor of *Nature*, thanking the Institute for its resolution of 8th March.

PROF. JOHN CAMERON, M.D., D.Sc., F.R.S.E., Dalhousie University, read a paper entitled, "A Contribution to the Ethnology and Craniology of the Eskimos of Southampton Island, Hudson Bay," illustrated by lantern slides. The subject was discussed by DR. A. H. MACKAY, G. W. T. IRVING, H. PIERS, A. B. WISWELL, and others.

SIXTH ORDINARY MEETING.

Physiological Lecture Room, Dalhousie College Carleton St., Halifax, 10th May, 1920.

The PRESIDENT, DR. BRONSON, in the chair.

On motion, PROF. DONALD S. MCINTOSH was elected Corresponding Secretary to fill the unexpired term of office of the late DR. E. MACKAY.

A paper by FREDERICK C. CHURCHILL of Wolfville, N. S., on "An Abandoned Marine Sand-bar in the Cornwallis Valley, N. S." was read by MR. PIERS. (See Transactions page 65.) The subject was discussed by PROF. MCINTOSH, E. W. TODD, DR. BRONSON, MR. PIERS and the author.

A paper by PROF. H. JERMAIN M. CREIGHTON, D. Sc., Swarthmore, Penn., on "A Convenient Form of Burette for Exact Gas Analysis," was read by C. B. Nickerson in the author's absence. (See Transactions, page 115). The paper was discussed by DR. BRONSON, MR. NICKERSON, and MR. TODD.

The following papers were read by title:

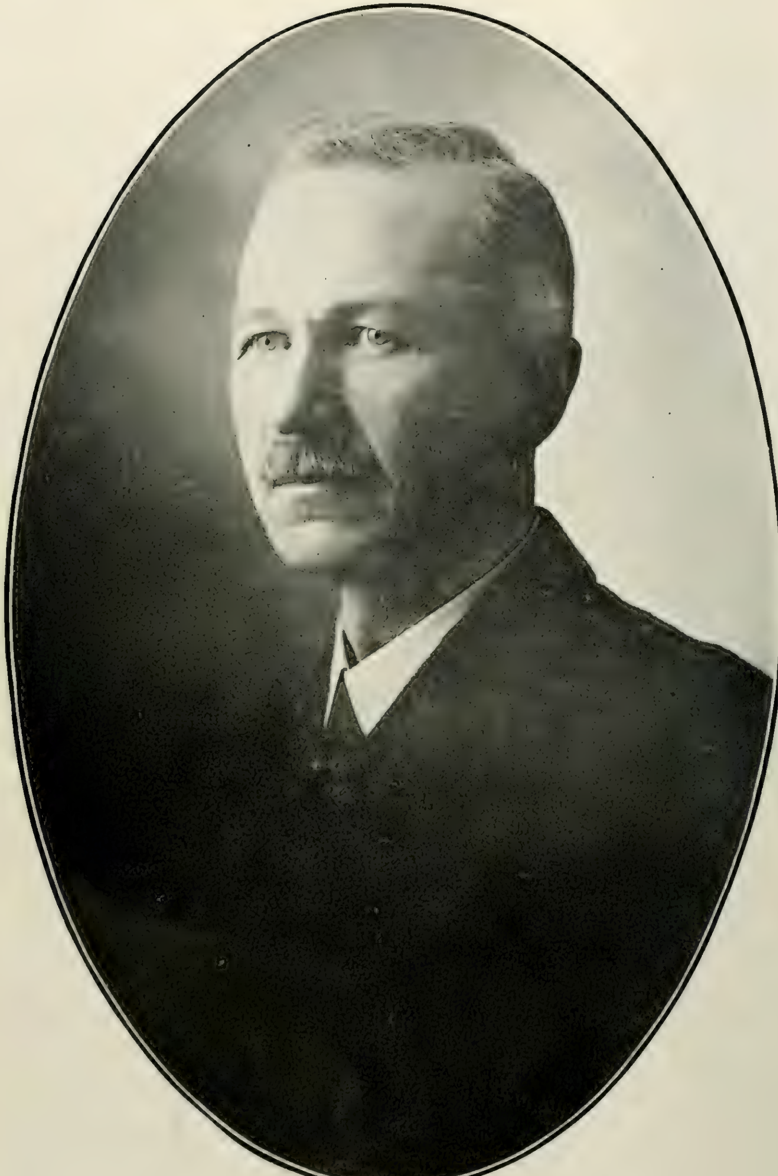
"The Spring Bird Migration of 1914 at Antigonish, N. S." —By HARRISON F. LEWIS, Quebec, P.Q. (See Transactions, page 119.)

"Phenological Observations, Nova Scotia, for 1919". By A. H. MACKAY, LL.D., F. R. S. C. (See Transactions, page 56.)

A discussion took place as to the selection of papers for publication, the cost of printing having very greatly advanced of late, and resulted in matters being left in the hands of the Council.

A vote of thanks was passed to PROFESSORS HARRIS and CAMERON for the use of their lecture-room as a place of meeting.

HARRY PIERS,
Recording Secretary.



PROFESSOR EBENEZER MACKAY,
B. A. (Dal.), Ph. D. (J. H. U.)

Born, 1864; Died, 1920.

President of
N. S. INSTITUTE OF SCIENCE,
1907-1910

Obituary Notice of Ex-President Professor Ebenezer Mackay, B.A. (Dal.), Ph.D. (J.H.U.) 1864-1920.

On the 6th of January, 1920, a great science teacher died in Halifax after about a week of illness from pneumonia, struck down in spite of the best medical skill after one of the most busy sessions of the Chemistry Department of the University of Dalhousie, of which he was the very efficient head.

Ebenezer Mackay was born January 24th. 1864, at Plainfield, at the foot of Mount Dalhousie, Pictou County, Nova Scotia. He was the son of Angus and Elizabeth Mackay, the father coming out from Rogart, Sutherlandshire, Scotland, as the youngest member of a large family, whose descendants have already figured well in the history of Canada.

Ebenezer had a good grounding in the rural school. He carried off honors in the Pictou Academy, and graduated from the University of Dalhousie in 1886 with first-class honors in experimental physics and chemistry, and the Mackenzie Gold Medal.

He was Principal of the High School and the Public Schools of New Glasgow, Pictou County, from 1886 to 1892, where he had great success. He then took a post-graduate course in the Johns Hopkins University, became a Fellow in 1895, and graduated Ph. D. in 1896. He was engaged in a special research course of study at Harvard when appointed to the McLeod Professorship of Chemistry and Mineralogy in Dalhousie, 1896, after which he became a resident of the City of Halifax, and one of the active members of the Nova Scotian Institute of Science.

He was elected a member 27 November, 1889, and became President, 11 November, 1907, and was continued in this office until 12 December, 1910. He was elected President of the "Greater Halifax Conference" in 1911; and later filled many high positions in scientific, educational, social and civic departments.

His urbanity of manner, his unassuming demeanor, his accuracy of language with minimum expenditure of words, as well as his encyclopedic knowledge, his self-reliance, coupled with a most genial and sympathetic disposition, endeared him to all, from the rural school to the great scientific fellowships, and also to the general public which had often commandeered his services. He was the soul of honor and friendship.

The tragedy of his unexpected removal in the prime of his powers, and at the beginning of the fruition of his career, appealed profoundly to the general public as well as to the members of the Institute, as was shewn in the public obsequies on the occasion. His students were becoming important contributors to original research for which the Institute was organized as a stimulus. The torch had been suddenly flung down; but, *Vitai Lampada!* it is being caught up by those who learned to play the game.

A. H. McK.

TRANSACTIONS

OF THE

Nova Scotian Institute of Science

SESSIONS OF 1919-1920

(Vol. XV, Part 2.)

PORT HOOD HARBOUR: ITS PAST, PRESENT AND PROBABLE FUTURE.—By D. S. McINTOSH, B. A., M. Sc., *Professor of Geology*, Dalhousie University, Halifax, N. S.

(Read 10 November, 1919)

INTRODUCTION

To an observant watcher by the seashore, the work of storm waves is readily apparent. The seeming ease with which the sand, pebbles and larger fragments of rock are moved about cannot fail to be noted. When the waves strike so as to make an oblique angle with the shoreline, the undertow is changed into a current which sweeps material along the coast instead of carrying it directly seaward. If the cliffs are reached by the storm, the waves hurl loose portions of rock from the beach against them, gradually wear them back, and sweep the debris along in the direction of advance. The shoreline is thus being worn away in one place and built up in another; the land mass is being reduced, while bars and shoals are forming on and near the strand line. With each succeeding storm this activity is repeated, and it needs but length of time to greatly alter the contour of the coast. Like most of the natural processes, the action of the waves along the shore is slow in making noticeable changes, and what is observed by one generation may be lost to the next. Hence, the necessity of records of change which may be invaluable to the future geographer.

The collection and preservation of data that had been neglected and were in danger of being forgotten was the motive that prompted the writer of this paper. Interest grew with the work, however, and its scope has been enlarged so as to present what, in the writer's opinion, is the probable development of Port Hood Harbour into a safe natural haven, the manner in which it became changed into a less safe refuge, and, likewise, to attract attention to the probable future of the port.

Location of Port Hood[1] Harbour.

The County of Inverness embraces the western side of Cape Breton Island from Cape St. Lawrence to the Strait of Canso. From Cape St. Lawrence, the general trend of the coast line is south-west for about eighty-five miles in a straight line to Cape Linzee near Port Hood, the shiretown of the County. From here it bends south with an easterly component and extends to Point Tupper, about thirty-five miles. Two islands lie off the coast to the south west of Cape Linzee and are a continuation of the north-east trending land to the north, and formed at one time an integral portion of it. The outer or Henry Island is over a mile beyond Smith Island, the larger of the two. The latter island is situated a mile from the mainland and opposite the town of Port Hood. Between Smith Island and the mainland is the harbour which is the subject under consideration. (See Fig. 1.)

Events of the Distant Past.

It is *a far cry* from the Port Hood Harbour of today to the time in which the coal-measures were laid down. The rocks around the harbour are associated with that period of time. They are

1. Just au Corps (Just' au Corps) corrupted by the English to Chestico, was a former name for Port Hood. Mr. Brown in his History of Cape Breton, quoting from a report on the state of the island, says that "the Acadians had built small vessels during the winter of 1764-65 at Just au Corps seven leagues to the northward of the Gut of Canceau, for the French merchants at St. Pierre and Miquelon." There is added as a footnote:

"Mr. Morris states that during the French occupation of the island, fifty men were constantly employed at Just au Corps quarrying freestone for Louisburg and the French forts in the West Indies." Port Hood is the name used by Brown in reference to grants of land made during Macormick's administration, begun in 1787. This name appears also on Desbarres' charts, and was given the place in honour of Admiral Hood of the British Navy.

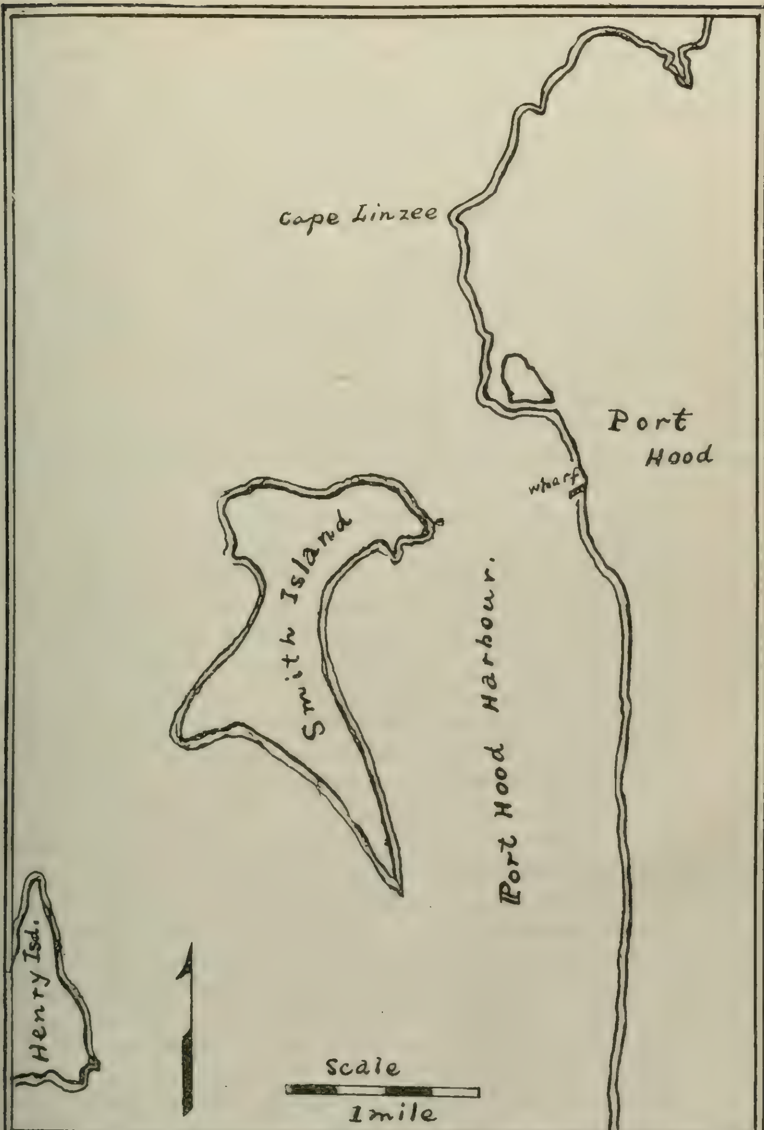


FIG. 2. SKETCH-MAP. PORT HOOD HARBOUR OF TO-DAY.

sedimentary, and one must realize that there was a time in the long, long ago when here was a shallow sea in which sand and mud were being deposited in alternating beds with layers of gypsum and sea-shells, and where at various times great swamps existed in which grew the vegetation from which the coal of today resulted. A glance at a geological map of the Island will show that what is now Cape Breton was then a much smaller land area made up of individual parts into and around which the sea extended. It had, however, topographical features similar to those of the present landscape, as the valleys of today are found to be floored by these same sedimentary rocks that are seen at Port Hood. The plateau of older rock that today occupies the larger part of the north and interior of the Island existed as today, but the sea entered all the old valleys drowning the rivers for a long distance towards their sources. Through succeeding ages, the sediment laid down in the sea was changed. The mud, sand, and gravel became consolidated into hard rock; the shells became limestone; the vegetation, coal; and the gypsum grew firmer. Slowly the land emerged from the sea, and not unlikely the area where is now the Gulf of St. Lawrence became land, and the old St. Lawrence and other streams made their way seaward and emptied far beyond the coast line of today. Onwards through the vast stretches of time the land was undergoing change—now elevation, now subsidence; but always were the sub-aerial forces at work removing material from a higher to a lower level, and the ocean waves beating upon the coast tearing away here and building up there. A general subsidence of the land allowed the sea to flood the lower course of the St. Lawrence and cover a large part of the surrounding area, and thus brought about the St. Lawrence Gulf, the waves of which are now pounding upon the Inverness coast. A period there was also, during which the whole country was covered by ice as Greenland is today, and this event also left its impress upon the land. These long-continued processes, at length, resulted in the physical features of today with a somewhat more extensive land area.

The Less Distant Past and Origin of the Harbour.

In the less distant past, the land stood some scores of feet higher in relation to the sea than it does today. The continuous action of the waves was, however, gradually reducing the extent of the land, and its height was being lessened by weathering and running water. In the course of time a line of weakness was found on the seaward side, and a portion was detached from the land mass and formed Henry Island.

It cannot be stated with certainty how the harbour came into existence, but there is evidence that points strongly to the probable way. Its location was an area of structural weakness. (See Fig. 1.) The rocks on the present landward side and on the greater part of Smith Island form a part of the Coal Measures. Smith Island has a fringe of the Lower Carboniferous on the northern end, showing also on both sides on the shore underneath the rocks of the Coal Measures. Here is the contact of the two formations, and the upper beds of the lower series consist of soft shales, gypsum, marl, etc. which yield easily to eroding forces. The harbour length is along the strike of these rocks. It is not unlikely, also, that this is a broken or faulted area. The soft rock and the attitude and conditions of the beds were, thus, such as to lend themselves readily to rapid wear whether to sub-aerial or wave processes. The slope of the land was in all probability southward, and it may be said with a good deal of certainty that a gentle sloping valley developed about the middle portion of the area largely through stream and general erosion and that it lay open to the south. A slow subsidence of the land bringing it to about the present level allowed the sea to enter this valley depression. The sinking of the land was general along our coast. All our rivers show it. The sea enters their lower courses. Mabou river, some few miles north of Port Hood, has its lower valley drowned. The tidal waters extend inland to Mabou village some five miles. A depth of fifty feet of water in the Mabou river channel would indicate a sinking of that extent at least, probably much more, as the channel bed has silted up largely since the subsidence. The harbour of Port Hood thus began as a submerged valley of erosion. On the northern side of the depression the rocks were more resistant hard sandstone and withstood the wave attacks and the general weathering, so that the harbour lay sheltered from the northern gales by a neck of land perhaps a half-mile wide.

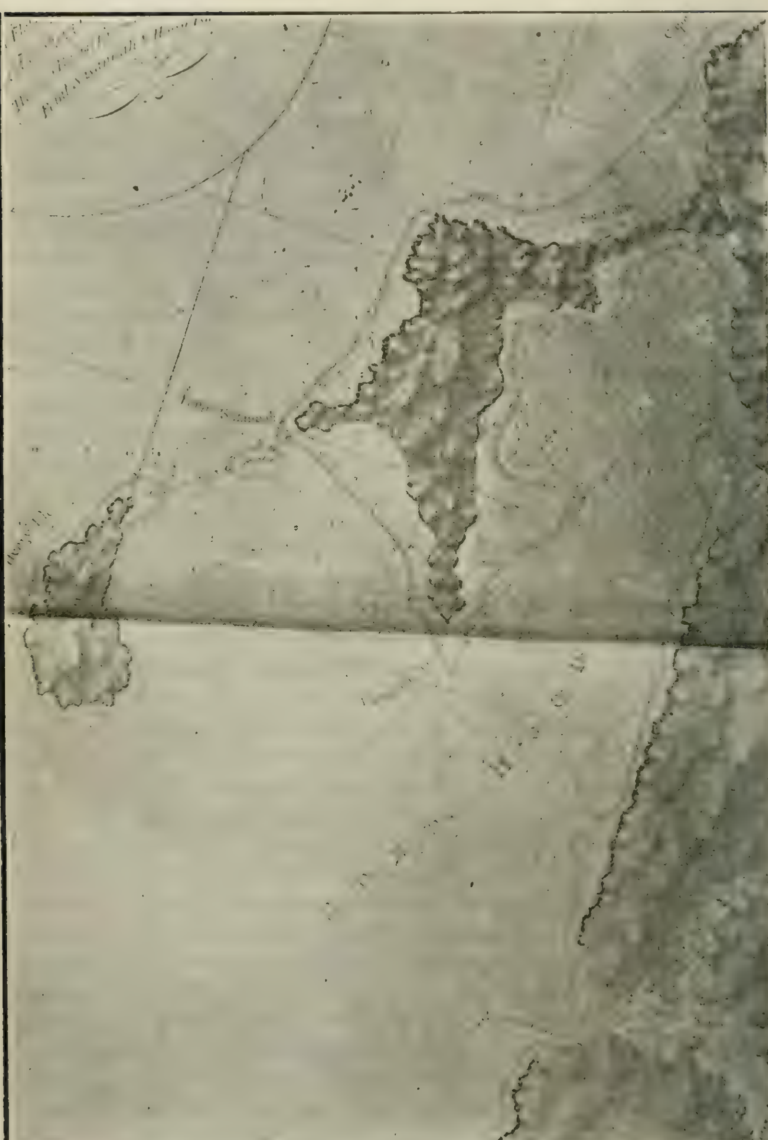


Fig. 2. Port Hood Harbour. (Reduced from Desbarres' Chart, 1781.)

EVIDENCE OF FORMER LAND CONNECTION.

The discussion up to this point has been based upon known geological changes in the earth's history, and the probable results of processes at work under conditions that very likely existed. That they may be questioned, the writer is well aware. No doubt, however, exists as to the presence of a land connection where is now the northern entrance to the harbour.

In the Legislative Library at Halifax are three volumes of unique charts owned and used by Admiral Lord Nelson, and presented to the Library on August 21st, 1885, by Vice-Admiral Sir J. E. Commerell, K. C. B., V. C. They were published for use of the Royal Navy of Great Britain by Joseph F. W. Des-Barres, and bear the date of 1781. Two of these charts, plates 3 and 33, are of the western coast of Cape Breton and show the harbour of Port Hood, with the depths of water in the harbor and around the coast. Henry Isle is separated from the nearest land by shallow water with two narrow channels three fathoms deep. What is now Smith Island is joined to the mainland and the connecting neck is marked "Sand hills," but at four places, two near each end of the neck, is the conventional sign for "Cliffs of red earth." (See Fig. 2.) These red banks must indicate underlying rock above high water mark. It is probable that the original rock extended from each side, and that towards the middle the sea had worn it down, so that at high tide or during heavy gales some water passed to and from the harbour. The customary sand grasses would cover the sand hills.

On the plate, a part of which is shown in Figure 2, is the following in engraved script;—"Port Hood, situated on the north-western extremity of the Island of Cape Breton, bears by eompass North 4° East distance twenty miles from the north entrance of the Gut of Canco, and East 8° South $17\frac{1}{2}$ miles from Cape George, The Flood Tide sets from ye Northward at from Cape George. The Flood Tide sets from ye Northward at the rate of one and half miles an hour and on the days of Full and Change it is High Water at half-past seven. Common Spring Tides rise about five feet. To sail in, keep your course to the Eastward till Point Emersion is on with the Gut of Canso; this direction will lead you into no less than six fathoms water, and close by the end of the Sand Flatt which runs from the South-east part of the Peninsula, here are two small remarkable white beaches at the bottom of the cliffs. When the Southermost bears W. by S. you may haul around by the anchorage in four and five fathoms water and muddy bottom, where ships may lie well sheltered from all winds. The water on the Flatts appears very white, and breaks when ye wind blows strong from the southward.

"There is a passage for small vessels between Point Susannah and Henry Isle."

In the Crown Lands Office in Halifax are old land grants which show that late as 1826 the northern entrance was closed. On one grant the connecting strip of land is divided into cross lots from end to end of the neck, six in all, evidently for fishing purposes. The narrowest part of the neck on this grant, which bears date of 1826, is about six chains. There appears to be some doubt about the accuracy of these plans, as a grant of 1823 on which the land connection is much narrower has written upon it: "A dependance can be placed on this plan.—T. Crawley, Sur-General."

There is also available evidence of personal recollection. The writer is indebted to Mr. N. H. Meagher, until recently a Judge of the Supreme Court in his native province, for the following:"My father came to Nova Scotia about 1820 or 1821 and for a time lived at Port Hood. At that time there were a numberof Smiths living on the inner Port Hood Island. A daughter of one of these married a man named Hayes—a Catholic. The visit of the priest to Port Hood at that time was a very rare event, and when one came, my father was sent over to the island to notify the Hayes family of his presence on the mainland. Sometimes he made the journey to the Island on foot, and at others on horseback. At that time a small stream would cross the sand bar when high tides occurred—and only then."

The Immediate Past.

There is, therefore, accurate knowledge of Port Hood Harbour as it existed somewhat less than a hundred years ago. As a haven for ships it ranked high. It was excellently protected from wind and wave. Lying open to the south-west, it would not be affected much by a storm from that quarter as the reach of outside water in that direction is not great. The approach lay open giving easy accessibility. The channel was sufficiently wide with a depth at the shallowest part of six fathoms. No bars obstructed it, although a sand shoal had built out nearly half the width from the western side about a third of the distance from the mouth. There was, however, sufficient water in a wide channel east of this. The depth of water in the harbour varied from four to six fathoms. The anchorage was safe. There was freedom from strong or high tides and from fog. One drawback it had then as now, ice interfering with navigation for something like three of the winter months.

A False Move and Serious Results.—The abundance of fish around this coast early attracted men to the sea. The homes of the fishermen were around the harbour, but the best fishing grounds lay to the north. To reach the banks it was necessary to make a wide detour south and around the island. A channel for boats could easily be made across the isthmus from the head of the harbour to the open sea. This would be a great convenience. Accordingly at the lowest part of the beach a passage for boats was cut through. This was left unprotected in any way, and soon the waves and currents widened it making great inroads on both sides, until at the present day the channel is about three-quarters of a mile wide with a maximum depth of one and a-half fathoms. In less than a hundred years, therefore, a neck of land three-quarters of a mile in length has been removed by the ceaseless action of the waves.

The Change a Gradual One.—For a time after the opening of the northern entrance, the harbour retained its main former characteristics. Fishermen from other parts frequented the fishing grounds and sought refuge here. Some three-score years ago when the "North Bay" was the favorite mid-summer haunts of the American mackerel hookers and seiners, Port Hood was a noted rendezvous. More than a hundred schooners of the fleet were often at anchor at one time in its capacious harbour. Many interesting accounts of the time are related of the encounters between law-breakers and coastal-guard cutters. Our own countrymen were often to be found among the fishermen, and frequently figured in the escapades. Capt. Patillo of the schooner "Highland Lass" seems to have been one of the ablest and most daring of these mackerel catchers. His ability to locate fish was well known. Should the fleet be around the Magdalen Islands at night-fall, and in the morning the "Highland Lass" be missing, Patillo had surely sailed for Port Hood through the night, and accordingly the whole fleet would follow. His hair-breadth escapes from the cutters were also the common property of the fleet.

The Present Conditions.

The removal of the land protection on the north left the harbor open to the northerly and northeasterly gales which are the most severe along this coast. The seas sweep in and it is difficult to maintain a wharf on the Port Hood side. The land on both sides of the harbour has suffered much from the waves. In this connection, Mr. Meagher says: "In my own recollection when I went to school at Port Hood in the winter of 1863 the land extended out, I am quite sure, as far as, if not further than the head of the present public wharf. There was an old Catholic Church, the first at Port Hood, situate some distance to the southward and eastward of the present pier, and was, I believe, as far out from the present shoreline as the head of the pier. There were some old buildings there too—one of them a store belonging to Peter Smythe. They disappeared years ago. I am under the impression that there was an old meeting house there too. The school boys in the spring of the year were in the habit of going to the shore and having contests to see who threw down the largest area of sod which had been undermined several feet by the action of the sea." The harbour has silted up to some extent at the middle and at the southern end, and many of its fine features as a haven of refuge are gone. It now partakes of the type of harbour determined by a shelter behind an island. In this regard it compares favourably with others of that type. The old anchorage still remains with Smith Island serving as a protection from the north and west winds. The island side serves also as a safe shelter for the fleet of fishing boats, and a site for the wharves and buildings connected with the fisheries which continue to be valuable. On the mainland side towards the southern entrance, a coal shipping pier was built some years ago. It appears not to have been adversely affected by the waves, but the shifting sands have, doubtless, lessened the depth of water around.

The Probable Future.

In the ordinary course of natural events, the harbour must be destroyed, providing the coast remains stationary. The island is wearing away somewhat rapidly. For thousands of years, however, it may exist as an inferior type of natural haven, and serve as a port. The current through the northern entrance is such as to preclude the probability of the island being in time tied to the mainland by a sand bar, and thus renewing the old condition.

What nature may not do, may, however, be done by man. It is possible to close the northern entrance artificially. The attempt was begun in 1903 when the sum of nearly three thousand dollars was spent. Work on the project was continued each succeeding summer up to 1912, the whole expenditure being upwards of one hundred and thirty-five thousand dollars. The plan of operation consisted in building a structure across the channel from a point a short distance above the public wharf to extend to the nearest point on the island. Stout twigs were made into mattresses, these sunk and ballasted. Work was done on both sides of the channel, but has not been resumed since 1912. The project is referred to by the Chief Engineer as the "proposed closing of the northern entrance," and he says "the estimated cost is approximately five hundred thousand dollars at present prices for labour and material."

But a new danger threatens the sheltered portion of the harbour. On the northern end of the island about 250 feet from the shore at the channel, there begins a weak place in the rock, and this extends westward for about 600 feet. This is probably the same kind of rock and structure which led at first to the depression that formed the harbour. The cliff here is about 30 feet high and from it the ground slopes southward for about 650 feet to a pond on a level with the se . This pond is separated from the best sheltered part of the harbour by a narrow sand beach about 60 feet wide over which at very high tides the sea enters the pond. Now this northerly facing cliff of soft rock is rapidly wearing away under the attacks of the northerly storms. Last year, it is stated, the sea advanced about 15 feet. As it is cutting into a southerly sloping area, it is likely to progress more rapidly as the work goes on, unless the increasing length of the cove it forms becomes a deterring factor. It is, at any rate, evident that in fifty years or so, this place may be cut across and a small island be left where is now the headquarters of the fisheries for the Port

Hood Island. This part of the island, therefore, needs to be protected artificially to preserve the present harbour.

Like many other harbours, that of Port Hood has a tragic side to its history. On December 17th, 1876, the schooner *Maggie H*, Capt. McLellan, from Bonne Bay, Newfoundland, was wrecked there. The newspaper report describes her as a vessel of 90 tons register, 10 years old, built at Boston and owned by Capt. Murdoch McLellan of Port Hawkesbury. Besides the crew of nine men, there were on board, as passengers, a man and his wife and three children. Two members of the crew and the three children were lost. The remainder of the crew and passengers were rescued by Mr. H. A. Smith, of Port Hood Island, and his three brothers, each of whom received a silver watch from the Government in recognition of his humane act. The newspaper of the same date contains also the following:—"A despatch to the Marine and Fisheries received yesterday states that the barque *Minerva* of Charlottetown was ashore at Port Hood, full of water, and was breaking up. The second mate was drowned in attempting to land."

In the preparation of this paper the writer has received valuable help from several sources. He wishes to acknowledge his indebtedness to Mr. Harry Piers of the Provincial Museum, who acquainted him with the presence of the charts in the Legislative Library, to Miss Donohoe, the efficient librarian of that institution, to Mr. R. M. Smith, of Port Hood Island, for information and some measurements on the island, to the officials of the Crown Lands Office, and to Dr. A. W. Chisholm, M. P. for Inverness County, for statistics regarding the work of closing the northern entrance to the harbour. Grateful acknowledgements are due also to Mr. N. H. Meagher, who took a keen interest in the work from its inception, and furnished material and helpful suggestions.

THE BLUE CRAB (*Callinectes sapidus* Rathbun): EXTENSION OF ITS RANGE NORTHWARD TO NEAR HALIFAX, NOVA SCOTIA.—BY HARRY PIERS, Curator of the Provincial Museum of Nova Scotia, Halifax,

(Read 19 January, 1920.)

Callinectes sapidus, the Blue or Common Edible Crab of the Atlantic coast of the United States, and the only northern form of the genus, was, until 1895, known as *Lupa* (*Callinectes*) *hastatus* of Say. It is not the *Lupa hastata* of Desmarest, and therefore was assigned its present name by Miss Mary J. Rathbun in a paper on "The Genus Callinectes" (Proc. U. S. Nat. Museum, vol. 18, p. 349, Wash., 1895). It belongs to the family *Portunidae* (the swimming Crabs), which is distinguished by the last pair of periopods (legs) being broad and flattened at the end, thus forming effective paddles for propulsion.

Range.—Up to now the most northern locality from which it has been recorded is Millpond, an inlet of Salem Harbour, Massachusetts, U. S. A., where a single individual was taken as recorded by C. Cooke in the *American Naturalist*, vol. 1, p. 52, 1867. It is occasionally found in Massachussetts Bay (Smith, Rept. U. S. Com. Fish and Fisheries for 1871-2, p. 548, 1874). It is common in bays and at the mouths of rivers from Cape Cod, Mass., to the northern extremity of Texas, and is especially abundant in Chesapeake Bay, where it is the basis of an extensive industry. Specimens have been taken also in the Bermudas, Jamacia, and Brazil; but outside of the region from Cape Cod to Texas it is of rare occurrence. Dr. J. F. Whiteaves makes no reference to it in his Catalogue of Marine Invertebrates of Eastern Canada, Ottawa, 1901, nor do any later writers mention its occurrence north of Salem Harbour. Dr. A. G. Huntsman of the Biological Board of Canada informs me that they have never obtained it in any of their investigations along the Atlantic coast, and he knows of no reference to its occurrence in Canadian waters. Mr. William MacIntosh, curator of the Museum of the Natural History Society of New Brunswick, St. John, tells me that he has no record of its having been taken along the New Brunswick coast.

Habitat.—It occurs on muddy shores and bottoms, down to deep water, and among eelgrass, being particularly abundant in bays and in the brackish waters of estuaries; and has even been taken in fresh water contiguous to the coast. During the summer it is found in relatively shallow water; but retires in winter to greater depths. Adults are more often obtained in deep water; but the young, as well as some adults, come inshore to water only a few inches in depth.

Economics.—Next to the Lobster, this crab is the most important food crustacean of the United States, it being extensively eaten both in the hard- and soft-shelled stage, and is highly esteemed.* Any extension of its range is therefore of considerable general interest.

Occurrence on the Nova Scotian coast.—In the Provincial Museum of Nova Scotia, Halifax, when I took charge of it in 1899, was an old dried specimen of an adult female *Callinectes sapidus*, but without any data. As there were a few foreign crustaceans in the collection, I did not then consider its presence of any significance.

On 8th November, 1902, I purchased from a Miss Iceton, in the Halifax market, two specimens of the species, a male and an immature female, which had been found alive, cast up with kelp on the sand beach at Cow Bay, Halifax County, N. S., on 7th November, and which had been boiled and so turned red. A third one, an adult male, had been taken with the others, and was obtained for the Museum on the following market day. I requested the woman to look for more, and accordingly other specimens from the same place were obtained from her in November and December of that year, and in April and May, 1903; making in all fourteen specimens. One of them was alive when I received it, and the others quite fresh.

Two more specimens, a male and an immature female, were taken on 8th May, 1903, in what is known as the Lily Pond, a brackish lagoon, immediately behind the Cow Bay sand-and-gravel beach. This lagoon is now connected with the sea at high-tide by a narrow channel at the southwestern end of the beach. Up to about 1901 the water of this pond was fresh, being fed by a couple of brooks, and white waterlilies flourished there; but about that year a new outlet was broken through and since then the water has been brackish. The pond is

* "Soft-shelled" crabs are those met with two or three days after moulting, before the shell has become hard. The period between moults is from 15 to 25 days, according to whether the individual is young or approaching maturity. The usual period of life is about three years, and the number of eggs laid about 1,750,000.

shallow, and the bottom mostly sand, overlaid with decaying organic material.

The place where all these specimens were obtained was at the southwestern end of the sand beach, near the present outlet of the Lily Pond, or Cow Bay Pond as it is sometimes called, about four-fifths of a mile southwest of the Mosher house. The two which were collected in brackish water were taken in the adjoining pond, close to the outlet, and therefore in the immediate vicinity of where the others were found in salt water.

Cow Bay itself is on the Atlantic coast, seven miles in a direct line east-southeast from the city of Halifax, in Halifax County, and lies between Hartling Point on the west and Osborne Head on the east. It has a long beach of sand and gravel, exposed to the full inward sweep of the Atlantic Ocean.* The locality is very scantly settled by farmers.

One male Blue Crab was obtained from Beazley and Henrion, fish dealers, of Halifax, who told me it had been taken at Cole Harbour, Halifax County, on 25th November 1902; but as Cole Harbour is about three miles northeast from Cow Bay, and it is the only specimen reported to have come from there, I think it very probable that it also came from the latter place. The dealer had purchased it from someone living in that district, and may have mistaken the name of the exact locality, as such details were of no interest to him.

All of the Cow Bay specimens were obtained in the Halifax market from one woman, who then lived in that district, and they were taken by her brothers. She told me that no one about Cow Bay to whom the crabs had been shown, had seen the species before. Since the spring of 1903, this woman has ceased coming to the market, and I have not since happened to note any of the crabs exposed for sale. I am therefore not in a position to state whether the colony still exists at Cow Bay, but there can be hardly any doubt that it does, as it seemed to be well established.

Besides the Cow Bay occurrence, I am only aware of this species having been once taken elsewhere in Nova Scotian waters. Mr. E. Chesley Allen, formerly of Yarmouth but now of Halifax, informs me that he identified a single adult specimen of *C. sapidus*

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* For an account of Cow Bay beach and its pond, see McIntosh, Prof. D. S., A Study of the Cow Bay Beaches, Trans. N. S. Inst. Sc., vol. 14, pt. 2, p. 109, 1906.

which he obtained in a fish-market in Yarmouth. It had been taken on the shore at Sandford, just outside of the mouth of the Bay of Fundy, Yarmouth Co., six miles north-northwest of the town of Yarmouth, N. S., about the year 1921. No person of the district had met with the species before, and it is the only specimen Mr. Allen has noted in this province, although he has carefully examined the shore about Yarmouth for marine invertebrates. His specimen has since been lost. On the coast at Sandford there is, I believe, a lagoon or cove which is separated from the sea by a roadway.

Summary of specimens.—In all, seventeen specimens and the right cheliped of an eighteenth one, have been received by the Museum from the Cow Bay district, exclusive of the old female, without data, which we suppose must have been also collected here. Of the 18 complete specimens, 12 are males, immature and adult, varying in greatest width from 4.20 inches to 6.03 inches; and 6 are females, varying in width from 4.30 inches to 5.90 inches. Of the females, 2 are adults with the distinguishing broad, rounded abdomen, and 4 are immature specimens with wedge-shaped abdomens.*

Grouped as to months in which they were taken, we get the following result; April, 6 specimens (all male): May, 3, (2 males and 1 immature female); November, 6, (4 males and 2 immature females); and December, 2, (both females, immature and adult). These scant figures indicate that they may be most common in April and November. It is possible that during the more busy summer season they were not searched for. In the winter they no doubt retire, as elsewhere in their range, to the bottom in deeper and warmer water, but they are met with on shore as early as the later part of April and as late as 11th December. In Chesapeake Bay, Va. and Md., U. S. A., they are most abundantly taken in May or June, and in October or November.

Particulars of Nova Scotian specimens.—On the next page are given particulars of the eighteen complete specimens and one cheliped of *Callinectes sapidus* in the Provincial Museum:

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* Unlike the case of the female, we have no criterion by which to distinguish adult males from immature ones, except so far as size and general appearance is indicative of age, unless one can make observations on sexual activity.

Accession Number	Sex	Age	Locality	Date	Carapace	
					Length	Greatest Width
					Ins.	Ins.
Old specimen	Female	Adult	Nova Scotia (?).	Not known.	2.25	4.65
1073	Male	....	Cow Bay, Hfx. Co., N. S.	7 Nov. 1902	2.55	5.26
1073	Female	Immature	" " " "	" " "	2.35	5.09
1077	Male	....	" " " " "	" " "	2.75	6.03
1078†	"	....	" " " " "	14 " "	2.50	5.36
1098	"	....	Cole Har. (?), Hx. Co., N. S.	25 " "	2.36	5.14
1099	Female	Immature	Cow Bay, Hfx. Co.	27 " "	1.96	4.30
1125	"	"	" " " " "	11 Dec. "	2.18	4.82
1126	"	Adult	" " " " "	" " "	2.52	5.90
1811	Male	....	" " " " "	24 Ap. 1903	2.46	5.30
"	"	....	" " " " "	" " "	2.46	5.12
"	"	....	" " " " "	" " "	2.64	5.70
"	"	....	" " " " "	" " "	2.46	5.26
"	"	....	" " " " "	" " "	2.31	4.74
"	"	....	" " " " "	" " "	2.28	4.73
(Right cheliped)	?	....	" " " " "	....	....	....
1815	Male	....	" " " " "	1 May "	2.73	6.00
1820	"	....	Cow Bay Lily Pond, Cow Bay	8 " "	1.98	4.20
"	Female	Immature	" " " " "	" " "	2.00	4.35

All specimens were obtained from one person, except the "old specimen" and No. 1098.

† Alive when received.

12 males: average length, 2.457 ins; average width, 5.237 ins.

6 females: average length, 2.210 ins.; average width, 4.852 ins.

2 adult females: average length, 2.39 ins.; average width, 5. 28 ins.

Males vary in size from the smallest (No. 1820), 1.98 ins. in length, 4.20 ins. width, to the largest (No. 1077), 2.75 ins. length, 6.03 ins. width.

Females vary in size from the smallest (No. 1099), 1. 96 ins. length, 4.30 ins. width, to the largest (No. 1126), 2.52 ins. length, 5.90 ins width.

Largest immature female is No. 1073, 2.35 ins. length, 5.09 ins. width.

All of these specimens agree fully with descriptions and figures of *Callinectes sapidus*. The following notes on the colour were made from Acc. No. 1078 (male), which was alive when received, and No. 1077 (male) which was quite fresh, and represent fairly well the colouration as found here, which agrees generally with that of more southern specimens:

Colour.—Carapace greenish-olive, passing into olive-green on posterior margin. Tips of teeth on anterior margin of carapace and of lateral spines, reddish. Underparts generally white. Legs (periopods) pale olive-green and blue; their callosites and spines red. Upper part of chelae ("pincer-claws") dirty olive-green; inner side of same, a fine cobalt blue.

In Chesapeake Bay, U. S. A., 36 adult females had an average width of 6.117 inches, and they are known to attain a width of 7 inches; and the average width of adult males is there probably about 6.5 inches at least, while they are known to grow to a width of 8.5 inches.* As our two adult females (with rounded abdomens)

* Churchill, E. P., Life History of the Blue Crab, Bull. Bur. of Fisheries, vol. 36, 1917-18, p.101, Wash., 1919.

only measure 4.65 inches and 5.90 inches, and the males are all 6.03 inches or less in breadth, we are lead to the conclusion that our Nova Scotian individuals undergo their final moult and so attain maturity at a smaller size then do those of the more favourable southern coast. This is as might be expected on the extreme northern extension of the geographical range, where suitable food may not be so abundant, and the torpid winter condition may be slightly longer, as this crab becomes sluggish when the temperature of the water falls below 50 degrees.

Conclusion.—We thus see that at this northern locality on the Atlantic coast of Nova Scotia, in latitude 44° 37′, there is a remarkable and apparently well-established and comparatively numerous colony of this important species of crab, which previously had never been recorded from Canadian waters, or even from further north than Salem Harbour, Mass., situated in latitude 42° 30′, nearly four hundred miles to the southwest. It seems truly remarkable that this crab has not been found in the Bay of Fundy, except the single specimen from Sandford, Yarmouth Co., or even on the coast of Maine.* It would be interesting to know if it occurs in suitable localities elsewhere along our Nova Scotian Atlantic coast, or whether at Cow Bay and Sandford, we have isolated colonies whose origin may have been casual individuals, or even a single egg-bearing female, borne northeastward on the Gulf Stream and thence straying to our shore. This current has brought many unexpected marine visitors from the south. Such accidental crustacean wanderers, if cast upon a favourable part of the coast, where suitable food occurred, could multiply and establish themselves. The marked swimming ability of the family to which the Blue Crab belongs, may lend strength to such an explanation of the origin of such colonies here, should subsequent observations indicate that the species does not occur in the intervening area between Nova Scotia and Massachussetts.† Nothing at present indicates that the Cow Bay colony and the Sandford individual are the survivors of an occupation which once extended unbroken up to this latitude.

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* See Rathbun's List of Crustacea of New England, 1905.

† W. P. Hay (Life History of Blue Crab, Rept. U. S. Bur. of Fisheries, 1904, p. 401, Wash., 1905) says the species is one of great activity and considerable power of endurance. It progresses through the water by a sculling motion of the broad hind legs, and under ordinary conditions it moves slowly, its efforts apparently being to keep afloat while it is borne along by the current. In this way it might easily go adrift and be carried northward by the set of the Gulf Stream.

Previous references to these specimens.—It may be mentioned that in notes on interesting accessions published in the Report on the Provincial Museum for 1902 (appended to the Report of the Department of Mines), Halifax, 1903, page 5, I briefly referred to our first specimens as "several Blue Crabs (*Callinectes sapidus*), new to this province, taken at Cow Bay"; and in the report for 1903 (Halifax, 1904, page 6), stated that in that year "a number of Blue Crabs (*Callinectes sapidus*) have been obtained from Cow Bay and Eastern Passage, showing that this species has an established habitat in the province." This reference to the Eastern Passage I cannot now explain, as that locality is not given for any of the specimens recorded in our accession-book or on the labels, and it is without doubt a mistake, although at the time of then writing I must have had some reason for thinking that the species also occurred near the sandy Eastern Passage, an arm of Halifax Harbour, which adjoins Cow Bay to the westward.* As these brief records were buried in the before-mentioned reports, it seems well to draw attention more formally to such an interesting and unexpected extension of the geographic range of an important economic species.

Summary.—1. The Blue Crab (*Callinectes sapidus*) occurs as a fairly numerous colony at Cow Bay, on the Atlantic coast of Nova Scotia, seven miles east-southeast from Halifax, and possibly at immediately adjoining favourable localities. A single specimen has also been taken at Sandford, Yarmouth County, at the mouth of the Bay of Fundy. It occurs in both salt and brackish water, but apparently rarely in the latter.

2. No previous records are known of its occurrence to the north of Salem Harbour, Mass., and the question naturally arises whether in Nova Scotia we have merely isolated colonies established by casual drift individuals borne northward by the Gulf Stream and cast upon our shore; or whether, less likely, they are the survivors of a continuous occupation which once extended this far north. Further search should be made to

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*Since writing the above, I have met the woman from whom I obtained the Cow Bay specimens of this crab which are in the museum. She had been a Miss Iceton of Cow Bay, but is now Mrs. Soward of Purcell's Cove, N. W. Arm. She assures me that all the Blue Crabs I obtained from her were taken at the southwestern end of Cow Bay beach, near the outlet of Cow Bay Pond, about 4/5 mile southwest of the Mosher house. She has never heard of any having been taken in the Eastern Passage or elsewhere discover if the species exists elsewhere on our coast to the south-westward of Halifax, from which region, with the exception of Sandford, it has so far not been reported.

3 Inhabitants of the districts where it was found, had not noted the species before, which, although not evidence of much weight, tends to increase the probability that it had been introduced by natural agencies within comparatively recent years.

4. Individuals from Nova Scotia seem to mature when of a slightly smaller size than do those of more southern regions, but this is not sufficiently pronounced to be at all varietal.

Provincial Museum. Halifax, N. S.,
12th December, 1919.

VARIATION IN THE COMPOSITION OF COMPRESSED ILLUMINATING GAS WITH PRESSURE AS IT ISSUES FROM THE COMPRESSION CYLINDER.—BY HENRY JERMAIN MAUDE CREIGHTON, DR. SC., F. C. S., Assistant Professor of Chemistry, Swarthmore College, Swarthmore, Penna., U. S. A.

(Read 9 February, 1920)

In the course of another investigation it became necessary for the writer to employ an illuminating gas containing 5 to 6 per cent. of carbon dioxide. As the content of carbon dioxide in the gas of the laboratory was about one-half this amount, a cylinder of purified carburetted water-gas under a pressure of approximately 300 pounds per square inch was obtained through the courtesy of a neighboring gas company. An analysis of the gas prior to compression gave the following results:

	Per cent.	
Carbon dioxide	5.5	
Illuminants	13.7	
Oxygen	0.9	
Carbon monoxide	26.9	
Hydrogen	35.0	53.0
Methane	12.4	
Ethane	1.3	
Nitrogen	4.3	
	100.0	

Before employing the gas in the investigation to which reference has been made, the carbon dioxide content in a sample taken from the compression cylinder was determined. To the writer's surprise this amounted to only 3.5 per cent. The same result was obtained with several other samples. On thinking the matter over, the conclusion was reached that the low carbon dioxide content in the samples of gas taken from the compression cylinder must be due to differences in the rates of diffusion of the components of the gas through the very small orifice of the compression cylinder; the heavier carbon dioxide diffusing less rapidly than the lighter hydrogen and methane. In order to substantiate this conclusion, and to ascertain the manner in which the composition of the diffused gas altered with the diffusing pressure, analyses were made of samples of gas taken from the compression cylinder as the pressure therein was gradually decreased.

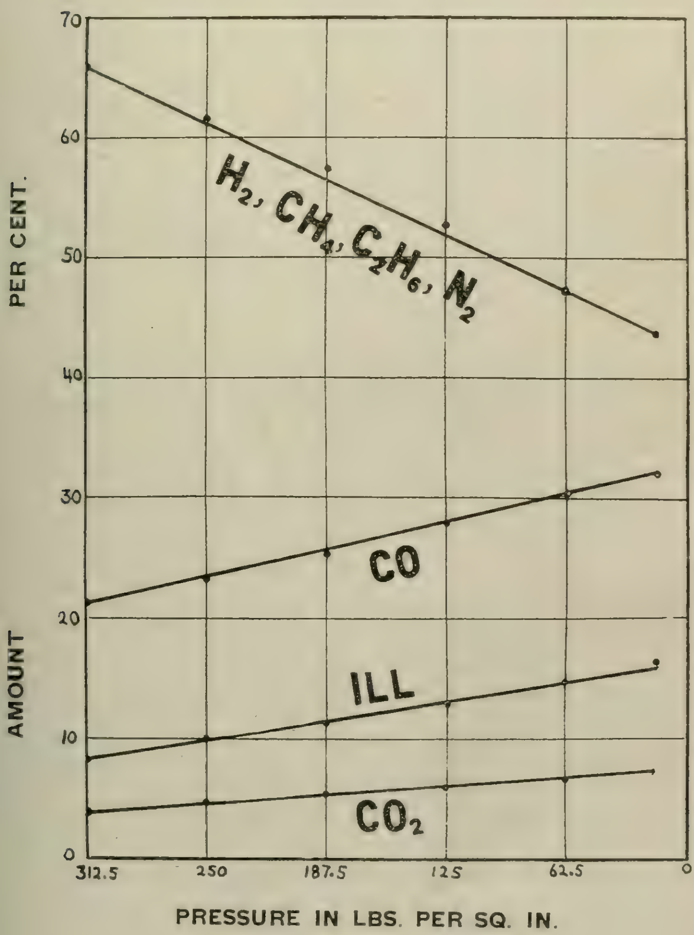
The reducing valve of the compression cylinder was connected with a gas-meter, which in turn was attached to a bunsen burner. Samples of the gas were obtained for analysis from a three-way tube placed between the cylinder and the gas-meter. The gas was allowed to flow from the cylinder at a constant rate of 120 liters per hour. Since each division on the scale of the main pressure gauge of the cylinder corresponded to 62.5 pounds per square inch, samples of gas were taken for analysis after each reduction in pressure of this amount. Determinations of carbon dioxide, illuminants, oxygen and carbon monoxide were made in the usual way. Owing to lack of apparatus for the separation and estimation of hydrogen, methane and ethane, these components could not be separately determined. In Table 1 are recorded the amounts of carbon dioxide, illuminants, oxygen, carbon monoxide and the mixed lighter components $(H_2+CH_4+C_2H_6+N_2)$ found in samples of gas taken at various cylinder pressures. These results are shown graphically in Figure 1.

TABLE 1

Component	Percentage Composition						
	At a pressure (in lbs. per sq. in.) of :						Average
	312.5	250	187.5	125	62.5	15	
CO_2	3.8	4.5	5.2	5.8	6.4	6.9	5.4
Ill.	8.2	9.8	11.2	12.9	14.8	16.6	12.2
O_2	1.0	0.8	0.9	0.7	0.8	0.7	0.8
CO	21.2	23.2	25.3	28.1	30.5	32.0	26.7
$H_6 + CH_4 + C_2H_8 + N_2$	65.8	61.7	57.4	52.5	47.5	43.8	55.0

It will be observed from the results contained in Table 1, that the averages of carbon dioxide, oxygen and carbon monoxide agree closely with the amounts of these components contained in the gas before compression. The low average for illuminants and the consequent high average for the residue of hydrogen, methane, ethane and nitrogen are quite possibly due to condensation of a small portion of the heavy hydrocarbons while the gas was under the higher pressures. From the data contained in the table and from the curves it will be seen that, in accordance with Graham's diffusion law, with decrease in pressure the percentage increase for carbon monoxide is less than that for carbon dioxide, and this in turn is less than that of illuminants.

FIG. 1



Accidental Occurrence of the Pygmy Sperm Whale (*Kogia breviceps*) on the Coast of Nova Scotia: an extension of its known range; with remarks on the probability of the former presence in these waters of the True Sperm Whale (*Physeter macrocephalus*).—By Harry Piers, Curator of the Provincial Museum, Halifax, N. S.

(Read 9 February, 1920.)

Contents.

Any information regarding the rarer Cetaceans of Nova Scotia is of value, as we have little positive data regarding their occurrence here This more particularly applies to the True Whales (*Balaenidae*) and the Sperm Whales (*Physeteridae*). Our Dolphins (*Delphinidae*) are somewhat better known, but they also deserve attention. Whenever possible, advantage should be taken of any opportunity to examine and definitely determine the specific name of specimens stranded or otherwise taken on ou coast.

Pygmy Sperm Whale (*K. breviceps*).

Specimen taken at Herring Cove, Halifax County, N. S.—On 17th January, 1920, when Jeremiah Gray and other men were cutting out ice to prevent it carrying away the wharves, in case of storm, in Herring Cove (west long. 63° 33′, north lat. 44° 34′), a small inlet on the western side of the outer part of Halifax Harbour, Halifax County, Nova Scotia, they chanced to come upon the body of a small-sized whale. The animal was eight and a half feet long, and it was lying dead just beneath the ice. The spot where it was found was about one hundred yards from the head of the narrow cove, and about twenty yards from the western shore, and the depth of water there is ten feet at low tide. The species had never before been seen by any of the many fishermen and other sea-going men of the locality.

The winter of 1919-20 had been a most abnormally cold one, with the temperature about zero (Fah.) for quite long periods, and cold weather had set in very early in the season, about the middle of December. Herring Cove had frozen on 12th January, and the ice, which was five inches thick, extended from the head of the inlet, nearly down to the government wharf which is on the western shore three hundred yards from the head. No doubt the whale on coming into the small inlet, had got under the ice, and not happening to retrace its way, had drowned beneath the strong covering, as it was unable to reach the surface to breathe. The black skin was abraded off the top of the head, doubtless from the frantic efforts of the suffocating animal to force its way through the ice.

A newspaper reference to the capture of the whale caused me to telephone for the head, fins and flukes to be sent to the Provincial Museum, where they arrived on 22nd January. On examination of these essential parts, I was much surprised to find that the species was the Pygmy Sperm Whale (*Kogia breviceps*, Blainville), a nearly adult female, belonging to the family *Physeteridae* and related to the huge Sperm Whale or Cachalot (*Physeter macrocephalus*, Linn.) from which it differs distinctly, apart from the great inequality in size. An adult Pygmy Sperm Whale grows to a length of only fifteen feet or so, while a male true Sperm Whale may be nearly seventy feet in length. After making careful drawings and measurements, the flesh was removed from the head; and the skull, dorsal and left pectoral fins, and the flukes were preserved (Museum Accession No. 4829).

Specimens taken on the United States coast.—The Pygmy Sperm Whale, which is generally a rare species, has never before been reported from Canadian waters, and previous to 1904 there was no reference to its occurrence on the adjoining New England coast from Maine south to Connecticut (*vide* Glover M. Allen's List of Mammalia: Fauna of New England; Occas. Papers Bost. Soc. Nat. Hist., vol. 7, Bost., 1904; and F. B. Sumner's Catalogue of Marine Fauna of Woods Hole and Vicinity, Bull. U. S. Bur. of Fisheries, vol. 31, Wash., 1913). Since 1904 it has been twice taken in Massachussetts waters, and a life-size cast and the skeleton of one of these are in the museum of the Boston Society of Natural History (*vide* letter of G. M. Allen, 30 Jan., 1920.) That is the most northern range on this coast hitherto known. Gerrit S. Miller did not include it in his Preliminary List of New York Mammals (Bull. N. Y. State Mus., 6, no. 29, Albany, 1899), but a large female, containing a foetus, was stranded at Long Beach, Long Island, N. Y., on 28th February 1914, and the skeleton is now in the American Museum of Natural History, New York, (*vide* Bull. Am. Mus. Nat. Hist., 38, pp. 7-72, N. Y., 1918), and a second specimen was taken at South Beach, Staten Island, N. Y., on 1 March 1920 and is now in the same museum (*vide* letter of F. A. Lucas). It has been taken several times on the coast of New Jersey, viz., (a) female, 8½ ft. long, containing a foetus, collected at the Life Saving Station, Spring Lake, lat. 40° 10′, on 27th April, 1883, now in U. S. National Museum, acc. 13060, (type of *Kogia goodei* True)*; (b) adult female, 10ft. 6 in. long, collected at Barnegat City, 24th Oct. 1885, now in U. S. National Museum, acc. 16706; and (c) young male, collected at Loveladies, 25th Oct. 1885, now in U. S. National Museum, acc. 16705. In Virginia, a male was washed up on the beach during a storm at Dam Neck Mills, south of Virginia Beach, in Feb., 1887 (U. S. Nat. Museum, acc. 22559); and in North Carolina, a male, 7 ft. 10 in. long, was taken at Kitty Hawk, 5th Jan. 1885 (U. S. Nat. Museum, acc. 15560).† It is not commonly found about the West Indies.

Range.—Its general range is in tropical regions, and its occurence beyond is more or less accidental. True (1885) gives the geographic habitat as "temperate and tropical seas". Lydekker (Guide to Whales, Porpoises and Dolphins in Brit. Museum, p. 26, Lond., 1909) says it is very widely distributed, having been met with in the Indian and Southern Oceans, and in the North Pacific, but it does not occur in British waters. It is apparently more common in the southern hemisphere; it or very closely related forms having been taken a number of times in the New Zealand seas, and also once on the coast of California. Some of these specimens have been described as different species, but G. M. Allen thinks that probably they should all be included under

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*This specimen is figured by True, Rept. U. S. Fish Com. for 1883, pl. 8, fig. 22, Wash., 1885.

†I am indebted to W. deC. Ravenal and Wm. Palmer, of the U. S. National Museum, Wash., for particulars regarding the specimens taken on the coasts of New Jersey, Virginia, and North Carolina.

breviceps. F. E. Beddard (Mammalia, p. 367, Camb. Nat. History, Lond., 1902) allows two species, if the accounts of their osteology are to be depended upon, namely *Kogia breviceps* and *Kogia* (*Callignathus*) *simus*, the latter from the coast of India. The former is said to have 13 pairs of ribs, no teeth in upper jaw and 14 or 15 in each ramus of lower jaw; and the latter, 14 pairs of ribs, 2 teeth in upper jaw and 9 in each ramus of lower jaw. *K. floweri*, a Californian form, whose teeth are particularly long and recurved, and *K. pottsi* from New Zealand, have been described as distinct forms, but further investigation will probably indicate that they are merely varietal forms of *K. breviceps*.

We thus see that the accidental occurrence of *Kogia breviceps* in north latitude 44° 34′, close to Halifax, Nova Scotia, is remarkable and worthy of note, because it considerably extends the range and also adds another mammal to the casual members of our marine fauna.

How the present individual came on our coast.—To account for its occurrence here, we must surmise that it had come from tropical regions, to the southern coast of the United States or the vicinity of the West Indies, and thence northward in the warm waters of the Gulf Stream, and straying westward out of that current, had come by chance to our cold shore in the middle of an unusually severe winter, there to die, not directly as a result of the low temperature of the water, but because of the ice which gave it no opportunity to come to the surface to breathe. That it coasted up along the shore of the United States, is a less probable hyposthesis. The number of female specimens containing foetuses which have been taken in northern waters, suggests the possibility that their unusual visits are in some way associated with the breeding season.

Description.—As the species is seldom met with, a description of the present specimen will be of some interest. The accompanying plate illustrates the external characters of the entire animal, and also depicts all aspects of the cranium, which latter is complete in all its parts. These drawings have been made with considerable care, so as to be accurate in all particulars, especially as regards the skull. Gray, in his Catalogue of Seals and Whales in the British Museum, second edition, Lond., 1866, p. 216, gives figures of the dorsal and lateral views of a skull and a lateral view of a lower jaw, reproduced from those of M. de Blainville of 1838, and these figures have generally been copied as depicting the cranial characters of this species. De Blainville's drawing, made from a single skull from Cape of Good Hope, in the Paris Museum, was not a perfect one, as the original lacked some rather important parts, particularly about the maxillary notches, and the details of the parts present are not very well represented. The ear-bones (periotic and tympanic bones) were without doubt missing in de Blainville's specimen, as is very often the case with cetacean skulls; and these extremely interesting and important bones have never, I believe, before been figured, and they are difficult to describe without drawings. Both the right and left ear-bones are complete in our specimen and the left one is figured, in opposite side-views, on my plate, on a scale very slightly less then one-third natural size. (See plate, page 101.)

Diagnosis.—The species may be readily recognized by its protruding snout, bluntish head which is not truncate, the toothless upper jaw, and toothed lower jaw having about fourteen sharp teeth on each side, blowhole on the top of the head, and the presence of a dorsal fin. The skull may be known by its unsymmetrical and concave dorsal region, and the dental characters referred to.

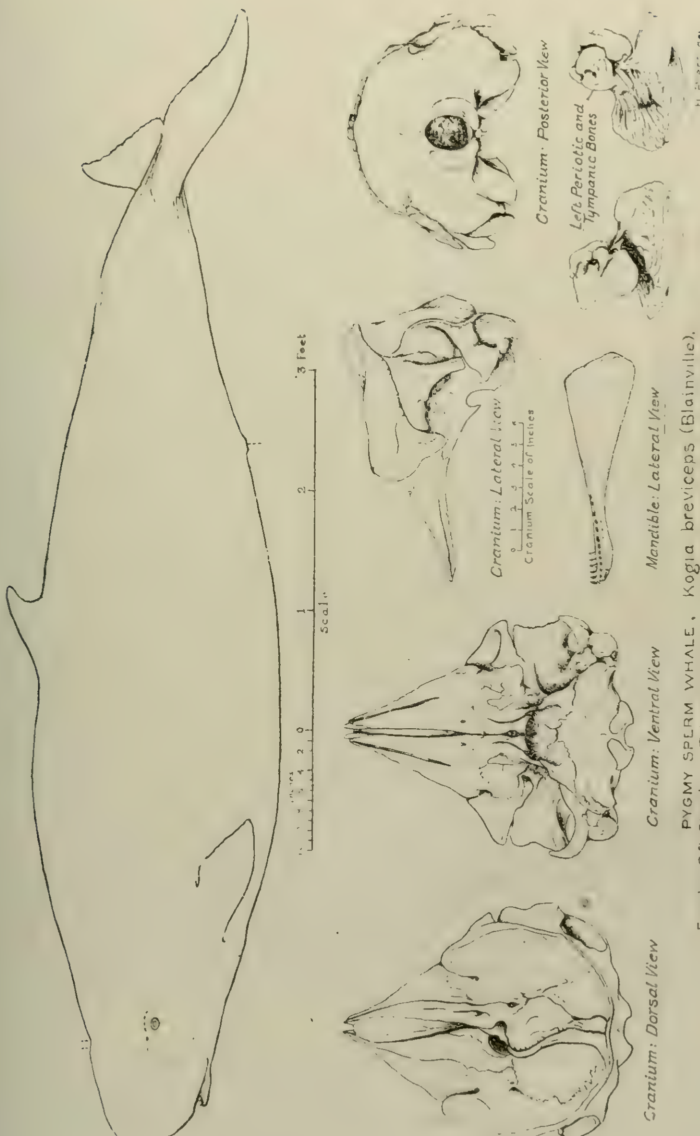
External characters.—Head contained six times in total length. Snout projecting beyond the mouth; the face only very slightly flattened below extremity of snout. Eye much above angle of mouth. Blowhole on top of head and very slightly to left side; shape crescentric. Lower jaws very narrow in front; no teeth in upper jaw; fourteen on each side of lower jaw. Dorsal fin present, small and low, falcate. Pectorals rather small, pointed. Peduncle of tail strongly keeled above and below.

Viewed dorsally, the snout is moderately sharp; viewed laterally, the front of the head is blunt, the mouth projecting 3 inches beyond a vertical line from the anterior end of the mouth. Mouth very narrow, capable of being opened to an angle of about 70°; tongue short, its extremity only coming to 3 ins. of end of mandible; transverse diameter of throat, 2.15 ins. Eye set rather high, about midway between dorsal and ventral lines, and slightly posterior to the posterior end of mouth opening. The single external oriface of the blowhole is on the upper part of the head (not anteriorly as in *Physeter*), and it is somewhat crescentic, with the convexity to the front, and its transverse length is 2.45

ins. It is situated not quite on the medial dorsal line, the centre being .52 inch to the left of that line. It is closed, in a valve-like manner, by the posterior wall coming in contact with the anterior wall, so as to exclude water; and surrounding it is a white, very tough, muscular or cartilaginous fibre. The outer vestibule of the blowhole is of the length of the external opening, and is 1.75 ins. deep It is coloured black within. From the left end of this vestibule is a small tubular passage (spiracle) penetrating nearly perpendicularly into the head, to the left superior naris, which could be explored with a probe to a depth of 5.50 ins. from the surface of the head. A right-hand passage could not be located with the probe, but the man who removed the flesh said he found also a right-hand smaller opening leading into the head, and connecting with the right-hand superior naris. Although I searched for the small external ear-opening, I was not quite sure I had located it, but the position of the well-developed ear-bones (tympano-periotic bones) of the skull, shows that the external orifice must be about 2.50 ins. behind and a little below the level of the eye, where I had detected a minute pore or opening.

Dorsal fin composed of adipose tissue, without any osseous connection with the vertibrae; low, falcate; its basal length contained about 13 times in length of animal, its height about $2^1/_4$ times in its basal length. Pectoral fins short, moderately broad, and somewhat pointed; their anterior margin a little less than $^1/_8$th as long as length of animal, their greatest breadth contained $2^1/_2$ times in their greatest length. Flukes moderately excavated on the hind margin, and with a small acute notch in the centre of that margin; the distance from tip to tip, 1.84 times the greatest length of the pectoral.

The weight of the animal was reported to have been about 400 pounds. The "blubber" or fatty tissue was concentrated on the outside of the animal, immediately beneath the skin, and at the back of the neck it formed a layer 1.40 ins. thick, white in colour and it readily furnished a clear yellowish oil of high quality. The flesh was of a very dark red colour, entirely free from fat; and on being eaten after frying, was exceedingly tender, but in my opinion was somewhat too strong in flavour to be very palatable, although two gentlemen who also tried it considered it excellent. It has no oily or fishy flavour; but does not possess the very fine edible qualities of a steak from the back of the Harbour Porpoise



PYGMY SPERM WHALE, Kogia breviceps (Blainville).
Female, 8 ft. 6 ins. long. Taken at Herring Cove, near Halifax, Hx. Co., Nova Scotia; 17 Jan., 1920.

(*P. communis*), which is particularly savoury, resembling somewhat a very tender moosesteak.

Colour.—Upper parts and sides, including interior of blowhole, outside of pectoral and upper side of flukes, black. Underparts whitish or greyish white. Inside of mouth pink; teeth white.

Skull.—As crania of the Pygmy Sperm Whale are seldom met with in collections, particularly in America, a rather full description of that part of the animal will probably be of interest. The skull of *Kogia* and that of the allied *Physeter* are thought to be perhaps the most modified from the ordinary type of cranium in the whole mammalian class. The skull of the present specimen is short, broad, and with the exception of the mandible, massive; and crests are strongly developed. The rostrum, from in front of the maxillary notches, forms about an equilateral triangle, the lateral margins being somewhat concave anteriorly and slightly convex posteriorly. The length of rostrum to a line drawn between the bases of the deep maxillary notches, is contained in the total length of skull, 1.91 times (52.3 per cent.). The greatest breadth of the skull (post-orbitally) is contained in the total length, 1.23 times (81.6 per cent.).

Viewed dorsally the skull is very strongly asymmetrical along the median posterior region, whereas the lateral outlines are symmetrical. The lack of symmetry is chiefly noticeable in (a) the median crest, (b) the intermaxillae, and (c) the nares. We find the prominent median crest strongly twisted to the left as it proceeds from the vertex anteriorly until it reaches the nares; the left intermaxilla anteriorily is widened, and the right one narrowed, whereas posteriorly the right one is widened and passes back to the vertex and the left one is short. The left naris is very much the larger one, its diameter being about 3⅓rd times that of the right one; and although the septem is mesially situated, the disproportion between the magnitude of the two openings give the nares the appearance of being towards the left side. A prominent horse-shoe shaped crest proceeds from one maxillary notch, around to the vertex, and thence to the other notch.

Examined more minutely, the two intermaxillae show great lack of symmetry, more particularly in the posterior parts. Both widen posteriorly, but in different degrees, and the right one is much the longer. The right one is anteriorly the narrower, but from the small right naris backward it is considerably widened, is twisted, and joins the median crest on its lefthand edge, and extends to within a short distance of the supraoccipital-frontal crest. The left premaxilla is wider than the right one before tho nares, and seemingly terminates at the posterior margin of the large left naris, but the suture is somewhat difficult to discern.

The maxillae are narrow anteriorly, but widen and thicken greatly at the maxillary notch, which latter is narrow but penetrates very deeply (4.3 cm. deep). Transversely the maxillae begin to be strongly concave here. Just posterior to the notches, the maxillae are very greatly thickened, and thence rise in a strongly elevated lateral crest which passes in a curve, as before mentioned, back to where they and the supraoccipital form a sharp, curved tranverse crest near the vertex. This curved crest thus forms a "horse-shoe" enclosing a concave basin, in which formerly was situated the loose connective tissue containing the supply of spermaceti. Another very prominent crest arises at the vertex (where it joins the transverse crest) and passes forward, being twisted to the left, S-wise, and finally is lost at the posterior margin of the large left naris. Whether this crest is formed by the right margin of the left maxilla, or by it in conjunction with the left nasal, I am unable to say with certainty, as only the median suture between the maxillae can be traced. At any rate, the nasals are difficult to precisely locate, unless the sutures should subsequently open up.

The frontal is entirely covered by the maxillae posteriorly; but the supraorbital process of the frontal is massive and well developed. The body of the malar is massive, and has a strong postero-inferior process, just anterior to the orbit. The zygomatic process of the squamosal is prominent, but shows no unusual thickening. The greatest breadth of the skull is in this region. The supraoccipital bone rises almost vertically from the foramen magnum, to meet the posterior margins of the maxillae (and the covered frontals) and then joins in forming the transverse crest.

Viewed ventrally, the skull is symmetrical. The intermaxillae show for a short distance only (3.5 cm.) at tip of rostrum. The maxillae are convex in cross-section, and have two narrow but deep channels towards their lateral margins; these grooves representing the obselete tooth-row. The palatines show, in a rather small area, just anterior to the pterygoids. The pterygoids meet mesially for about half their length anteriorly, then are separated by an elongate-ovate space, and again approximate posteriorly at their crests. Their posterior free margins or crests are straight and set somewhat obliquely to a transverse line. From the sides of the inferior nares, two sharp, much elevated crests proceed backward, divergingly, to the region of the auditory meatus, as is usual in allied animals.

The interesting periotic and tympanic bones, or "ear-bones," are dark coloured in the exterior member, which measures 5.8 cm. in vertical length, 3.4 cm. in antero-posterior breadth, and 2.1 cm. in greatest thickness at the superior end; while the interior inflated, shell-like member (the tympanic) is ivory-coloured, rather thin, and beautifully and rather intricately convuluted in a manner which cannot be easily described. Both of the ear-bones have been preserved and are complete. The accompanying plate contains opposite sideviews of the left ear-bone, on a scale slightly less than one-third the natural size. As before mentioned, I believe the ear-bone of this species has never before been figured.

The mandibles (lower jaws) are very thin and delicate, and have little depth at the anterior half where the tooth-row is situated, but are moderately deep at the posterior ends. The symphysis is long (6.5 cm.); and posterior to it the rami gradually, and then strongly, separate from each other. The tooth-rows are thus approximately parallel, and only 1.5 cm. apart, for about half the length of the rows. The length of the tooth-row is contained in the mandibular length, $2^1/_2$ times; the distance between the condyles is about $^5/_6$ths of the same length; and the depth from the coronoid process to the angle, is contained 2 $^2/_3$rd times in that length, while the depth at the tooth-row is only $^1/_6$th of the length of the tooth-row.

Teeth.—Upper jaw toothless; teeth in lower jaw, 14 on each side; dental formula, $\frac{0-0}{14-14}$. The teeth are not very firmly attached in the alveolae, and therefore may be slightly moved about. They are rather small, slender, conical, decidedly sharp, very slightly curved inward at the tip and also toward the embedded basal part. Their total length, midway in the row, is .73 inch; the diameter at the basal part is .12 in., and the crown projects out of the gum .35 in. They are separated, from centre to centre, .36 in.

External measurements.—The following general measurements, with the exception of those of the fins and flukes, were made by Mr. Gray, and without doubt follow the contour of the body in some of the dimensions. They also have been reduced to percentages of the total length of the animal.

	Inches	Cm.	Percent.
Total length, snout to notch in posterior margin of tail	102.00	259.3	100.0
Circumference of body	70.00	178.0	68.6
Snout to anterior end of dorsal fin	48.00	122.0	47.1
Snout to anterior insertion of pectoral fin	24.00	61.0	23.5
Dorsal fin, basal length	7.50	19.0	7.4
Dorsal fin, vertical height	3.40	8.6	3.3
Pectoral fin, greatest length, (anterior margin)	12.50	31.8	12.3
Pectoral fin, greatest breadth	5.10	13.0	5.0
Pectoral fin, basal length	5.75	14.6	5.6
Flukes, from tip to tip	23.00	58.5	22.5

The following measurments (chords) were very carefully made by myself frcm the head. They have also been reduced to percentages of the total length of the head.

	Inches	Cm	Percent
Length of head, snout to basal condyle	17.25	43.8	100.0
Diameter of head, from eye to eye	13.75	35.0	79.7
Snout to anterior margin of eye	13.80	35.1	80.0
Snout to anterior margin of blowhole	10.40	26.5	60.3
Snout to anterior end of mouth (above)	7.50	19.1	43.5
Snout to posterior end of mouth	13.00	33.1	75.3
Mouth opening, length measured on upper jaw	6.25	15.9	36.2
Mouth opening, length measured on lower jaw	6.00	15.2	34.8
Upper jaw, breadth near anterior end	1.50	3.8	8.7
Lower jaw, breadth near anterior end	1.00	2.5	5.8
Lower jaw, width midway in length	2.50	6.3	14.8
Lower jaw, width at posterior end of mouth opening	4.25	10.8	24.6
Blowhole, transverse length	2.45	6.2	14.2
Blowhole, antero-posterior width	.85	2.2	5.0
Centre of blowhole to centre of right eye	10.38	26.3	60.2
Centre of blowhole to centre of left eye	9.35	23.7	54.2
Right hand extremity of blowhole to centre of right eye	9.16	23.2	53.1
Right hand extremity of blowhole to centre of left eye	8.12	20.6	47.1
That is, the blowhole is situated *to left* of medial dorsal line	.52	1.3	3.0
Eye, length	1.00	2.5	5.8
Eye is 7.20 ins. (18 3 cm.) above, and about 2 ins. (5 cm.) posterior to the posterior angle of mouth			
Blubber, thickness at back of head	1.40	3.6	
Skin, thickness	.02	.05	

Cranial Measurements.—The following are the measurements of the skull, with the same reduced to percentages of the total length of the skull:

	Cm.	Percent.
Total length, from centre of line joining surface of occipital condles to extremity of rostrum	34.8	100.0
Length of rostrum to line joining bases of maxillary notches	18.2	52.3
Length of rostrum to outer end of maxillary notches	15.2	43.7
Breadth of rostrum at base of maxillary notches	12.8	36.9
Greatest breadth of rostrum in front of maxillary notches	16.5	47.4
Depth of maxillary notches	4.3	12.4
Breadth of rostrum midway in its length	10.6	30.5
Breadth of right intermaxilla at middle of rostrum	1.7	4.9
Breadth of left intermaxilla at middle of rostrum	2.0	5.8
Breadth of both intermaxillae between their exterior edges, at middle of rostrum	6.5	18.7
Greatest breadth between intermaxillae posteriorly	8.2	23.6
Length of right tooth-groove	12.0	34.5
Length of left tooth-groove	10.9	31.3
Posterior end of right tooth-groove to base of maxillary notch	6.1	17.5
Posterior end of left tooth-groove to base of maxillary notch	7.3	21.0
Extremity of rostrum to anterior margin of right superior naris	20.2	58.0
Extremity of rostrum to anterior margin of left superior naris	18.6	53.4
Extremity of rostrum to end of pterygoid crest, mesially	21.5	61.8
Extremity of rostrum to end of pterygoid crest, laterally	22.1	63.5
Anteorbital breadth (between processes of malar)	27.4	78.7
Breadth between orbits	28.0	80.5
Breadth between squamosals (postorbital breadth):- greatest breadth of skull	28.4	81.6
Breadth between hinder margins of temporal fossae	18.0	51.7
Greatest breadth of occipital bone	23.9	68.7
Temporal fossa, greatest length	8.1	23.2
Temporal fossa, greatest breadth	5.2	14.9
Length of mandible	30.6	88.0
Length of symphysis of mandible	6.5	18.7
Length of tooth-row of mandible, right	11.8	34.0
Length of tooth-row of mandible, left	12.0	34.5
Depth between angle and coronoid process	8.3	24.0
Distance apart of upper edges of mandible, halfway in length	6.7	19.2
Diameter of right naris, antero-posteriorly	1.3	3.7
Diameter of right naris, laterally	1.1	3.2
Diameter of left naris, antero-posteriorly	4.0	11.5
Diameter of left naris, laterally	3.2	9.2
Diameter of largest tooth	.24	.7

Micmac Indian tradition of a blunt-headed whale.—On showing the head of this whale to a very well-informed Micmac Indian, Jeremiah Lone-cloud (*alias* Bartlett), he examined it carefully and stated that he had never seen the species before, but from descriptions given him by two very old Indians, Noel Jeddore, who is now dead, and Soolian (William) Bill, he felt sure it must be what was known by the Indian name *Ded'-men-ak-paj'-jet*, a name which means "blunt-head" fish. Noel Jeddore had been born at Melrose, St. Mary's, N. S., and died about 25 years ago, aged 84 years; and old Soolian Bill had formerly belonged to Cape Breton Island and now lives on the Truro reservation, aged about 97 years.*

Noel Jeddore told Lone-cloud that about fifty years ago, say about 1870, he and other Indians were encamped on a small island called by the Indians *Up-quaw'-we-kunk* or "Bark-camp Island", off West Medford, on the south side of the entrance to Pereau Creek, in Minas Basin, Kings Co., N. S., when a school of about a dozen cetaceans became stranded on a mudflat there. The Indians examined them and got some of the flesh for food, and he said that the cooked back-fin was much relished by them. The animals were about 12 or 15 feet long, coloured black, and had a small dorsel-fin. Such cetaceans had never before or afterwards been seen by Jeddore and his companions, but he had heard from other older Indians that such animals had occurred years previously, and that they had been called by the Micmacs *Ded-men-ak-paj-jet*, from the blunt apparancee of their head. This word resembles an old Micmac name applied to another rare cetacean which once occurred here, *Ded-men-ak-part*, which means "head cut off squarely," not merely "blunt-head." Further reference will be made to this latter animal when I come to write of the true Sperm Whale. (See page 112).

Old Soolian Bill very recently told Lone-cloud that he also had seen the cetacean which they call *Ded-men-ak-paj-jet*, and said it occurred in the same season when the others were taken off West Medford. About fifty years or more ago, he states, a number of sea animals of the kind seen at West Medford came ashore in a "gut" of water near the Indian reservation at Whycocomagh, St. Patrick's Channel, Bras d'Or Lakes, Cape Breton Island.† Bill and other Indians examin-

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*The well-known and respected Micmac Indian, William Prosper, usually known as "Soolian Bill," died at the Truro Reservation on 3rd April, 1923, and it was claimed that he was one hundred and one years of age. The name Soolian is evidently a corruption of the French name Guillaume (William). He was born at Bay of Islands, Newfoundland, and came to Whycocomagh, Cape Breton, about 1848, removing to Dartmouth, opposite Halifax, in 1860, the year the Prince of Wales was in Nova Scotia. About 1888 he finally went to Truro. If he came to Halifax in 1860, as stated, the date of the occurrence of the above-mentioned cetacean at Whycocomagh must nhave been prior to that year.

†It may be mentioned that at the same time that these cetaceans came ashore at Whycocomagh, two very large whales (Micmac *Boot-up*, name for any large whale) came in at the same place and one ran ashore and was killed by the Indians with a scythe-blade on the end of a pole. Soolian Bill saw it, and he said it made a great commotion with its very long fins, so that one had to be careful in approaching it. It was towed to Arichat, Rich. Co., and there the blubber was removed. It is not reported whether it had a back-fin or not. Probably it was the Humpback Whale (*Megaptera nodosa*).

ed and cut up the animals and obtained much oil from the blubber; and one which they opened contained a foetus. They also called the animal *Ded-men-ak-paj-jet*, agreed that it was the same species as that taken in Minas Basin, and that it was extremely rare, but that old Indians told them it had been taken years before. It also had a dorsal-fin.

The rare animals described by Jeddore and Soolian Bill were not Black-fish (*Globicephala melas*) which is the only other distinctly "blunt-headed" cetacean it might be confused with, and which is a common species, well known to the Indians as *Sarb'-a-dee'-meekw*, which means "John Fish," but why so-called is not known. The Bottlenose Dolphin (*Tursiops truncatus*) has too much beak to be particularly designated as the "blunt-head." We are therefore led to conclude that these very rare cetaceans referred to by our Micmacs, must have been the Pygmy Sperm Whale (*K. breviceps*), which answers the Indians' rough description in having a blunt head, a dorsal-fin, and being about twelve or fifteen feet long, black in colour, and very rare in these waters. The presence of the dorsal-fin shows it was not the true Sperm Whale, for which apparently our Indians also have a descriptive name. This is a related subject to which we will now refer.

SPERM WHALE (*P. macrocephalus*).

Did the True Sperm Whale formerly occur on the Nova Scotian coast?—Whether the huge Sperm Whale or Cachalot (*Physeter macrocephalus* Linn.) ever occurred on our Nova Scotian coast, accidentally or otherwise, in the early years when its range was very much less restricted than now, is a point which is not definitely settled in my mind, although from evid ence at hand I am very decidedly of the opinion that it must have. In a paper like this, dealing with a related species, it may not be altogether out of place to give a little attention to the subject.

Many years ago the true Sperm Whale was reported all along the New England coast as far north as Casco Bay, Maine, where it is recorded that one was stranded in 1668.* Casco

*G. M. Allen, List of Mammalia of N. E., Occ. Papers Bost. Soc. Nat. Hist. 7, pt. 3, Bost. 1904; and G. Brown Goode, Fisheries and Fishing Industries of U. S., sec. 1, page 9, Wash., 1884.

Bay is in the same latitude as southern Nova Scotia. In August 1761, one was killed in lat. 45° 54′, long. 53° 57′, which is off the southern Newfoundland coast and 275 miles due east of Scaterie, Cape Breton; and in 1766 another was seen near George's Bank, which is to the south of Nova Scotia and a little beyond its limits.* These are merely recorded occurrences, but of course there are many others which did not happen to be noted. The most northern grounds which they regularly frequented some thirty-five years ago, were off Cape Hatteras. Glover M. Allen, in a recent letter to me, writes that "the Sperm Whale (*P. macrocephalus*) must occasionally reach Nova Scotian waters, although I do not recall at this moment a definite record. It is taken once in a while off the Newfoundland coast at the whaling stations." The manager of a Newfoundland whaling station told Prof. E. E. Prince that their whaling vessels had twice taken Sperm Whales off the Cape Breton coast and towards Newfoundland.

While this paper is in type, I find a thrilling account of the capture of thirty Sperm Whales in the harbor of Keels (lat. 48° 32′) in Bonavista Bay, almost eighty miles north-northwest of St. John's, Newfoundland, in the early part of August, 1922. The account, by Thomas Kelly, appeared in the "Canadian Fishermen," Gardenville, P.Q., Oct. 1922, vol. 9, p. 221, and it describes a remarkable instance of daring among the Newfoundland fishermen. A motor-boat from Keels, when a few miles off land, encountered about seventy large whales, which the fishermen mistook for Blackfish or "Pot-heads" (*G. melas*) and which they accordingly undertook to drive to the shore. Some seven motorboats took part in this operation, three boats on either side, and one behind making much noise with its exhaust. The large animals went shorewards like a flock of sheep, and made no commotion even when a boat happened to run upon one of their backs.

When, however, the whales found that they were entrapped in the cliff-surrounded harbour of Keels, they began to fight terrifically, and the men, in some twenty or thirty boats, commenced to kill them. Hatchets, axes, knives, and guns were used in efforts to subdue the monsters. Forty-eight bullets are said to have been fired into the head of one of them. Men were to be seen on the backs of the animals, chopping with axes. No

*G. B. Goode, loc. cit., page 8.

men were killed, although a small boat was smashed to pieces. Hawsers and steel cables were made fast to some of the whales but were snapped with great ease. Some of the infuriated animals dashed themselves against the cliffs and so died. In all thirty were killed.

The services of a man who for ten years had been foreman of a "whale factory" were secured, and he identified them as Sperm Whales. Wells were made in the heads of the monsters, and a great quantity of pure oil was dipped therefrom; from one to four puncheons of fluid being taken from each head.

Additional particulars of this very remarkable occurrence were forwarded to me on 19th January, 1923, by the Department of Mines and Fisheries of Newfoundland, which had obtained the information from a most reliable source, Mr. J. F. Murphy of St. John's, who had visited Keels and examined the dead animals. Mr. Murphy says that they were undoubtedly Sperm Whales, the most valuable of the cetaceans, and he enclosed a carefully prepared drawing with measurements made by himself, which proves conclusively that their specific identity had been correctly determined. They were all young males, and varied in length from 45 to 48 feet, whereas an adult male sometimes measures as much as 80 feet. The one he measured particularly was 47 feet in greatest length from the anterior end of the truncated snout to the tip of the flukes or tail. From the snout to the posterior angle of the mouth it measured 12 feet; and from the angle of the mouth to the extremity of the flukes, 35 feet. The vertical depth of the head, from the dorsal region to the mouth, was 7 feet; and the distance between the two ends of the flukes was from 9 to 11 feet. It had 22 teeth in each side of the lower jaw. Three of the teeth, forwarded by Mr. Murphy to the Provincial Museum, are definitely the teeth of the true Sperm Whale.

He says that about forty-four of the whales were driven ashore at Keels, the harbour of which is of circular form, everywhere surrounded by vertical cliffs except at the entrance. The fishermen killed thirty of them, using guns, axes, mowing-scythes, and sharpened sticks employed as lances. In some cases stout pieces of timber with pointed ends were driven into the blow-hole of the animals, which maddened them, and so furious did they become (probably because of the difficulty experienced in their efforts to breathe) that they dashed themselves against the cliffs, thus driving home the stakes which had protruded from the front of their heads like a vessel's jib-boom. These animals died suddenly. Later the others, which were wounded, went into a "flurry" and thrashed themselves to death against the cliffs and isolated rocks.

Knowing that the valuable substance called ambergris is obtained from the alimentary canal of this species of whale, Mr. Murphy went to Keels and had the stomach of one of the carcasses opened. In it was found about a bushel of the beaks of small and large species of squid, the favourite food of this whale, the beaks being of all sizes from a quarter up to one-and-a-half inch in length, each with a curious growth on the larger end, somewhat like a cock's comb. No ambergris was found. It is known that beaks of the cuttle-fish or squid are frequently found embedded in ambergris sent to market, and Mr. Murphy believes that the irritating action of these pointed beaks on the animal's stomach causes the formation of that material. Other carcasses were then opened, but also without finding real ambergris. One, however, contained a growth about six or eight inches long and about six inches in diameter, having holes in it like those of a sponge, and varying in color from pale green to dark brown. This was examined by the government analyst, Mr. Davis, who reported that it was not ambergris. It is possible that it may have been an early stage in the formation of that substance, and that the animals were too young to have developed it perfectly.

The fishermen were unfortunately entirely unprepared for such an unexpected and unprecedented occurrence, and had no knowledge of the great value of such whales, and they destroyed them, with but little if any profit to themselves. Two or three groups of men dipped from four to five hundred gallons of pure, clear sperm-oil from the head of each whale. Very little of it, however, was saved, as they had no facilities for properly handling it owing to the huge carcasses and the workers being exposed to the wash of the surf.

Sperm whales usually swim in herds or schools, or else singly. The schools consist of (a) females and their young, with one or two adult males, and (b) young and half-grown males. Full-grown males go singly in search of food. The Keels school was one of the herds of half-grown males, which had no doubt come northeastward in the Gulf Stream, and then by chance had wandered westward to the Newfoundland coast, in pursuit of the great multitude of squid which are its principal food.

When we consider the northern range of the Sperm Whale in early years, before the persistent industry of whalers had nearly exterminated it in the northernmost waters of the Atlantic, it cannot be possible that that species did not also occur in our intervening waters, at least casually if not somewhat regularly, a couple of hundred years ago and probably much later.

In the absence of definite records, we naturally turn for some light on the subject to our Micmac Indians who are keen observers of natural objects which come to their attention, and whose ability for handing down information traditionally, in the absence of written records, is trully remarkable.

Our Indians inform me that very old men of their tribe have an ancient tradition, handed down by their fathers, of a very rare cetacean which the later men have never seen. To this animal they gave the very characteristic descriptive name of *Ded'-men-ak'-part*, which signifies "head cut off sharply or squarely," or as my informant, Lone-cloud, further explained it, "Just the same as if you cut the head off squarely in front." Such a name could surely only have been applied to the Sperm Whale, whose large and remarkably blunt head is so characteristic a feature that it would instantly have attracted the sharp eyes of our natives on viewing a casually stranded individual, and who, in their well-known fashion, would have included this character in framing a descriptive name which has been handed down to later generations. It must be noted that this name is to be distinguished from the related one, *Ded-men-ak-paj-jet*, to which reference has previously been made, which means an animal with merely a blunt head, and which I believe designated the Pygmy Sperm Whale, as a dorsal-fin is specifically referred to as being present. The same Indian knew the two names and applied them to different animals. The name *Ded-men-ak-part* was known through tradition to both old Soolian Bill, formerly of Cape Breton Island, and to Nole Jeddore, before mentioned, so that the animal probably occurred both about that island as well as off the mainland of Nova Scotia. Unfortunately the tradition does not seem to mention whether the dorsal fin was absent in this very blunt-headed cetacean; for if it did, the identification would be as about complete as could be desired.

Conclusion.—Taking into consideration all the evidence, I think we may quite safely conclude that *Ded-men-ak-part* of the Micmacs was the true Sperm Whale and that it formerly occurred to some extent at least in our Nova Scotian waters.

Teeth of this cetacean should be searched for in some of the Indian shell-heaps or kitchen-middens in Nova Scotia, as the natives would no doubt preserve such relics of an unusual marine animal if one had been stranded on our coast.

In the DesBrisay collection of Indian remains collected in Lunenburg County, N. S., now in the Provincial Museum, is a small tooth, a good deal corroded, which has a general resemblance to one from an exceedingly young Sperm Whale.* But it may even prove on further examination to be merely a young Bear's canine tooth, which somewhat closely resembles the former. I do not believe it belonged to a Black-fish (*Globicephala melas*) or any other cetacean I happen to be familiar with, and it is decidedly not a tooth of a Pygmy Sperm Whale. It measures 1.87 in. (47.5 mm.) in greatest length; its diameter, midway in length, is .48 in. (12.5 mm.); it projected out of the gum .57 in. (14.5 mm.), and the conical free end (crown) is very strongly incurved;

The Provincial Museum possesses several Sperm Whale teeth, but theyhave all been brought by whalers from the southern whaling rounds.

Provincial Museum, Halifax, N. S.,
9th February, 1920.

*The smallest Sperm Whale on record, taken on the New England coast, was one 16 feet long, taken near New Bedford in 1842.

A Convenient Form of Burette for Exact Gas Analysis.

By Henry Jermain Maude Creighton, D. Sc., Assistant Professor of Chemistry, Swarthmore College, Swarthmore, Penn., U. S. A.

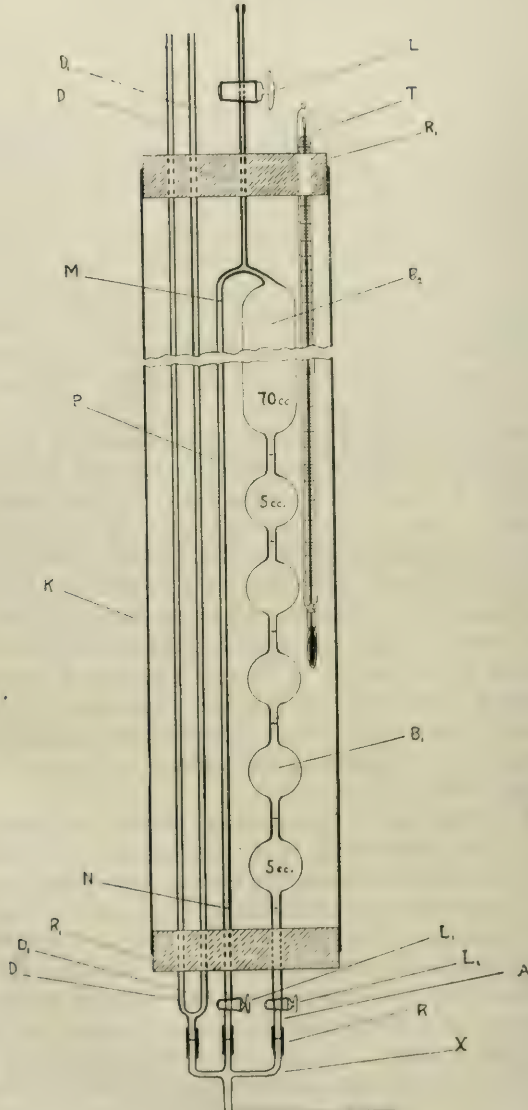
(Read 10 May, 1920)

A large number of gas burettes for various kinds of analysis is described in the chemical literature and in the catalogues of chemical apparatus. With most of these burettes, which have a volume of 100 or 150 cc. and are graduated to read to 0.1 or 0.2 cc., it is not possible to measure differences in volume with an accuracy of more than 0.1 or 0.2 per cent., an accuracy sufficient for many purposes. Since in some kinds of work a greater accuracy is highly desirable, the writer proposes to describe a type of burette which has he designed and had specially made for determining differences in gaseous volumes with a accuracy of about 0.02 per cent.

This burette (Figure I) consists of a measuring tube, P, and a reservoir-tube, A, joined together at the top by a capillary tube to which is connected a stop-cock, L, and closed at the bottom ends by the stop-cocks, L1 and L2. The tube A is made up of five small bulbs, B1, each holding 5.00 cc. between the marks on the constricted portions on either side of the bulb, and a large bulb, B2. The volume of the bulb B2 and the capillary tube between the stop-cock L amd the mark M on the upper portion of the tube P is 70 cc. The arm P, consisting of a thick-walled tube with an internal diameter of three millimeters, has a volume of 5.00 cc. getween the marks M and N. This portion of P is graduated throughout its entire length and each division reads 0.01 cc.

As small variations in temperature during analysis produce changes in the volume of gas amounting to several hundredths of a cubic centimeters, the burette is enclosed in a water-jacket, K, along with a thermometer, T, reading to tenths of a tenth of a degree. The water-jacket has a diameter of 85, cm., and is closed at the ends by the rubber stoppers R1. There are also enclosed in the water-jacket two leveling tubes, D1 and D2, which have approximately the same diameter as the small arm, P, of the burette. These two tubes are joined together at the bottom outside the water-jacket. Each of the rubber stoppers, R1, has a small opening (not shown in the Figure)

FIG. 1.



through which the water-jacket be filled or emptied, or through which water at a constant temperature can be circulated.

The lower end of D1, and D2, and the lower ends of thr small and large arms of the burette are joind by heavy rubbee tubing to the three-arm tube X, the horizontal portion of which is joined by two meters of rubber pressure tubing to a reservoir containing mercury.

The absorption pipettes are connected to the upper end of the burette in the usual way. The rubber connections are, however, enclosed in mercury to prevent leaks. It is also advisable to employ for L a stop-cock with a mercury seal.

In order to measure a given volume of gas enclosed in the burette, the stop-cock L1 is closed, the stop-cock L2 opened and the reservoir containing the confining liquid raised or lowered, until the level of mercury the in the larger arm of the burette is brought to one of the marks between two of the bulbs B1. If the volume of gas is between 95 and 100cc., the first small bulb is filled with mercury; if the volume is between 90 and 95 cc. the first two small bulbs are filled with mercury and so on. The stop-cock L2 is then closed and the stop-cock L1 opened, and the fraction of 5cc contained in P measured by bringing the mercury in P, D1 and D2 to the same level. This is readily accomplished by getting the mercury meniscus in each of the three tubes in a line, one behind the other When this is done, the stop cock L1 is closed and the volume of gas read. It is necessary, of course, to make corrections for changes temperature and pressure which occur during analysis.

With this particular burette it is only possible to measure gas. volumes which are more than 70 cc. and not more than 100 cc.

The writer has used this burette to determine the carbon-dioxide, oxygen and carbonmonoxide in more than one hundred samples of air, in laboratories and large industrial plants. In a number of instances where small quantities (0.02 to 0.04 per cent.) of carbonmonoxide were found present in the air, subsequent investigation showed its presence to be due to small leaks in the illuminating gas lines and connections.

The Chemical Laboratory,
March 2nd, 1920.

NOTES ON THE SPRING BIRD MIGRATION OF 1914 AT ANTIGONISH, NOVA SCOTIA.—BY HARRISON F. LEW S, Quebec, P. Q.

(Read 10 May, 1920)

The County of Antigonish lies in the eastern part of the Nova Scotian peninsula on the south shore of St. George's Bay, an arm of the Gulf of St. Lawrence. With the exception of two weeks in late December and early January, the period from August 25, 1913, to June 27, 1914, was spent by me in the county, my residence being in the small town of Antigonish, the county town.

In the spring of 1914, a record of the migration was made for the Biological Survey of the United States Department of Agriculture. The time spent in making observations for this record consisted chiefly of the early morning hours every day with additional time later in the day on Saturdays and Sundays. There was then no thought of publishing the results of these observations, but, in view of the scarcity of published records of the birds of Antigonish County, to which my attention has since been called, and of the improbability of additional similar work on my part in the county, it may be advisable to make readily accessible such data as were obtained. As far as I know, or have been able to find out, the only previous publications relating directly to the birds of this county are the four brief ones hereinafter quoted in their respective appropriate connections.

The coming of spring is normally later in Antigonish County than it is in western and central Nova Scotia. This is due to the large fields of heavy ice which form in winter in the Gulf of St. Lawrence, and which, in melting, cool the winds which blow from them across the land to the southward. The spring of 1914 was said by the inhabitants of the county to be somewhat later than the average. Snow in the woods was knee-deep on April 25. About two inches of snow fell on the night of May 1-2. On May 15 the shore of St. George's Bay was found to be strewn with great blocks of ice, some of them three or four feet thick, while large fields of ice could be seen floating in the bay. Heavy frosts, accompanied by the formation of thin ice on dishes of water left out-of-doors, occurred once or twice in early June. These conditions are the cause of the lateness of the arrival of many species of birds. Where I have any especial reason to think that the date of arrival as observed for a particular species is, or may be, inaccurate, this fact has been indicated in this paper.

Of the species herein recorded from Antigonish County, the following are stated by Chapman ('Handbook of Birds of Eastern North America' revised edition, 1912, p. 30) to be characteristic of the Alleghanian fauna: Black-billed Cuckoo, Kingbird, Bobolink, Chipping Sparrow, Blue-headed Vireo, Catbird, and White-breasted Nuthatch.

Taking one species, such as the Fox Sparrow, for instance, the following items are recorded concerning it in this paper in the order here stated: serial number, scientific name, vernacular name, date first seen, number of individuals observed on the date first seen, date next seen, date of becoming common, estimated degree of abundance, date last seen, remarks. So far as they are applicable or were noted, similar items are recorded in similar order for each of the other species in the list of migrants. The nomenclature used is that of the 1910 edition of the 'A. O. U. Check-List'. Terms indicating degrees of abundance are used in the following relative order: rare, uncommon, not common, tolerably common, common, very common, abundant, very abundant. A species is not recorded as breeding unless its nest was seen by me in the county; other species were observed as summer residents, presumably breeding, unless otherwise stated.

1. *Sterna hirundo*. Common Tern.—First seen, May 21 (13); next seen, May 23; common, May 21; a very common summer resident; breeds. On June 13th I visited Mahoney's Beach, at the western side of the entrance to Antigonish Harbor, and there found about 50 pairs of this species nesting. The beach on which the nests were placed is a long, narrow ridge of sand, forming part of the mainland, and separating the waters of Antigonish Harbor from those of St. George's Bay. Much of it is covered with the usual low herbage of our sand beaches; other parts are bare white sand. I counted 49 nests containing eggs; of which 23 were hollowed in the sand, while the 26 others were hollowed in dry bunches or windrows of seaweed which had been thrown above ordinary high-tide mark by the storms of winter. On June 21 I again visited this colony, when I found but one nest containing eggs. As a search revealed no trace of the other eggs or of any young Terns, it seems probable that

the colony, so easily accessible, had been raided by human enemies in the interval between my two visits.

2. *Anas rubripes.*—Black Duck.—First seen, March 28 (2); next seen, April 10; apparently uncommon.

3. *Branta canadenis canadensis.*—Canada Goose.—First seen, March 19 (10); next seen, March 29 common, March 19; common; last seen, May 7; a transient only. Apparently these birds pause in their migration for some time at this point, until conditions farther north are favorable for a resumption of their movement to their breeding grounds. During April the great shallow areas in Antigonish Harbor form the feeding-ground of large flocks of Canada Geese, containing several thousand individuals.

4. *Botaurus lentiginosus.*—American Bittern.—First seen, May 10 (1); next seen, May 13; common, May 21; common.

5. *Ardea herodias herodias.*—Great Blue Heron.—First seen, April 27 (1); next seen, April 30; not common.

6. *Gallinago delicata.*—Wilson's Snipe.—First seen, April 20 (2); next seen, April 22; not common. When passing through Antigonish County in 1917, I saw a single bird of this species on the upper South River on April 10.

7. *Actitis macularia.*—Spotted Sandpiper.—First seen, May 13 (2); next seen, May 15; common, May 17; common.

8. *Aegialitis semipalmata.*—Semipalmated Plover.—First seen, May 15 (5); next seen, May 23; not common. Probably not an accurate record of first arrival. The only place where I observed this species was Mahoney's Beach.

9. *Aegialitis meloda.*—Piping Plover.—First seen, May 23 2); next seen, June 13; rare. Perhaps not an accurate record of first arrival. The only place where I observed this species was Mahoney's Beach, at the mouth of Antigonish Harbor. When I visited the Beach on May 15, none were seen, but 2 were there at the time of my next visit, on May 23. The greatest number of individuals seen in one day was 4, seen June 13.

10. *Pandion haliaetus carolinensis.*—Osprey.—First seen May 9 (1); next seen, May 17; uncommon.

11. *Ceryle alcyon.*—Belted Kingfisher.—First seen, April 30 (1); next seen, May 2; common, May 5; tolerably common.

12. *Colaptes auratus luteus.*—Northern Flicker. First seen April 20 (1); next seen April 26; common, April 28; common'

13. *Chordeiles virginianus virginianus.*—Nighthawk.—First seen, May 29 (1); next seen, May 30; uncommon.

14. *Chaetura pelagica.*—Chimney Swift.—First seen, May 22 (2); next seen, May 23; common, May 25; common. (This record published in "A Cooperative Study of Bird Migration" by Charles H. Rogers, 'Bird-Lore', Vol. XVI, No. 4, p. 272, July-August, 1914.)

15. *Archilochus colubris.*—Ruby-throated Hummingbird.—First seen, May 31 (1); next seen, June 1; common, June 1; very common.

16. *Tyrannus tyrannus.*—Kingbird.—First seen, May 21 (2); next seen, May 22; common, May 22; common.

17. *Nuttalornis borealis.*—Olive-sided Flycatcher.— First seen, May 25 (1); next seen, May 27; uncommon.

19. *Myiochanes virens.*—Wood Pewee.—First seen, May 30 (1); next seen, May 31; uncommon.

19. *Empidonax flaviventris.* —Yellow-bellied Flycatcher.—First seen, May 25 (3); next seen, May 30; common, May 30; common.

20. *Empidonax trailli alnorum.*—Alder Flycatcher.—First seen, May 28 (1); next seen, May 30; common, June 3; common.

21. *Empidonax minimus.*—Least Flycatcher.—First seen May 19 (1); next seen, May 20; common, May 21; common,

22. *Otocoris alpestris* subsp.?— Prairie (?) Horned Lark.—First seen, March 24 (1); next seen, March 25; common, March 27; tolerably common; last seen, April 18. Although Horned Larks were observed as transients only, all my observations of them in the field led me to believe them to be Prairie Horned Larks, *O. a. praticola.* It is possible that their breeding-grounds were in some of the great pasture areas in Antigonish County, some miles from Antigonish town.

23. *Dolichonyx oryzivorus.*—Bobolink.—First seen, May 16 (1); next seen, May 18; common, May 21; common.

24. *Agelaius phoeniceus phoeniceus.*— Red-winged Blackbird.—First seen, May 2 (1); next seen, May 23; rare summer resident; breeds. Probably not an accurate record of first arrival. An account of my discovery of a nest and eggs of this species in a swamp near the mouth of Antigonish Harbor has been published in 'The Auk', Vol. XXXI, No. 4, pp. 537-538, October, 1914.

25. *Euphagus carolinus*.—Rusty Blackbird.—First seen. April 8 (5); next seen, April 9; common, April 11; tolerably common transient rare in summer.

26. *Quiscalus quiscula aeneus*.—Bronzed Grackle.—First seen, April 7 (1); next seen, April 8; common, April 12; common.

27. *Carpodacus purpureus purpureus*.—Purple Finch.—First seen, May (1); next seen, May 10; common, May 11; common. Although individuals of this species not infrequently pass the winter in Nova Scotia, my notes lead me to believe that migrants usually do not arrive until late April or early May.

28. *Astragalinus tristis tristis*.—Goldfinch.—First seen, May 26 (1); next seen, May 27; common, May 28; very common. Individuals of this species also are known to winter in Nova Scotia, but it would appear from my notes that the migrants generally arrive in the latter half of May.

29. *Pooecetes gramineus gramineus*.—Vesper Sparrow.—First seen April 28 (3); next seen, April 29; common, April 28; tolerably common.

30. *Passerculus sandwichensis savanna*.—Savannah Sparrow.—First seen, April 26 (2); next seen, April 27; common, April 30; common.

31. *Passerherbulus nelsoni subvirgatus*.—Acadian Sharp-tailed Sparrow.—First seen, June, 3 (1); next seen, June 4; uncommon.

32. *Zonotrichia albicollis*.—White-throated Sparrow.—First seen, May 8 (1); next seen, May 9; common, May 9; abundant summer resident; breeds. It will be observed that this speces arrived on the night of May 7-8, and that the Fox Sparrow departed on the same night. At Halifax, N. S., in 1918, the Fox Sparrow departed and the White-throated Sparrow arrived on the night of April 28-29. In both of these instances the Fox Sparrow had been a very common transient. The feeding habits of these two species appear to be essentially similar, as they both feed largely on the ground among bushes, and it is possible that this fact, in combination with the comparative scarcity of food in early spring, when much of the ground is still snow-covered, may have aided in causing these species to be thus complementary in Nova Scotia at that season.

33. *Spizella passerina passerina*.—Chipping Sparrow.—First seen, May 9 (2); next seen, May 10; common, May 15; very common summer resident; breeds.

34. *Junco hyemalis hyemalis.*—Slate-colored Junco.—First seen, March 24 (1); next seen, April 4; common, April 7; abundant summer resident; breeds.

35. *Melospiza melodia melodia*—Song Sparrow.—First seen, April 4 (1); next seen, April 5; common, April 7; very common. First song heard April 5, when, of 4 birds seen, one only was heard to sing.

36. *Melospiza lincolni lincolni.*—Lincoln's Sparrow.—First seen, May 19 (1); next seen, May 20; common, May 20; tolereably common.

37. *Melospiza georgiana.*—Swamp Sparrow.—First seen, April 30 (1); next seen, May 5; common, May 9; tolerably common.

38. *Passerella iliaca iliaca.*—Fox Sparrow.—First seen, April 13 (4); next seen, April 14; common, April 14; very common; last seen, May 7; a transient migrant only. Antigonish appears to lie on an important highway of migration for this species. Probably most of these birds were on their way to Newfoundland.

39. *Zamelodia ludoviciana.*—Rose-breasted Grosbeak.—First seen, May 25 (3); next seen, May 27; common, May 27; common. Nowhere else has it been my good fortune to find this species as common as I found it about Antigonish.

40. *Petrochelidon lunifrons lunifrons.*—Cliff Swallow.—First seen, May 22 (25); next seen, May 23; common, May 22; common. The accuracy of this date of arrival seems questionable, although I watched carefully for this species.

41. *Hirundo erythrogaster.*—Barn Swallow.—First seen, May 15 (9); next seen, May 16; common, May 15; common summer resident; breeds.

42. *Iridoprocne bicolor.*—Tree Swallow.—First seen, April 26 (1); next seen, April 28; common, May 15; common.

43. *Riparia riparia.*—Bank Swallow.—First seen, May 23 (5); next seen, May 30; common, May 30; locally common summer resident; breeds. Found only about earthen banks along the shore of St. George's Bay. As I did not visit that shore between May 15 and May 23, the above date of arrival may not be accurate.

44. *Bombycilla cedrorum.*—Cedar Waxwing.—First seen, May 27 (9); next seen, June 5; irregular in occurrence.

45 *Vireosylva olivacea.*—Red-eyed Vireo. First seen, May 25 (4); next seen, May 27; common, May 27; common.

46. *Lanivireo solitarius.*—Blue-headed Vireo.—First seen, May 20 (1); next seen, May 21; common, May 23; tolerably common.

47. *Mniotilta varia.*—Black-and-White Warbler.—First seen, May 16 (1); next seen, May 18; common, May 20; common.

48. *Vermivora ruficapilla ruficapilla.*—Nashville Warbler. --First seen, May 25 (1); next seen, May 30; rare.

49. *Compsothlypis americana usneae.*—Northern Parula, Warbler.—First seen, May 16 (1); next seen, May 18; common, May 20; 21 very common.

50. *Dendroica aestiva aestiva.*—Yellow Warbler.—First seen May 19 (1); next seen, May 20; common, May 20; very common

51. *Dendroica caerulescens caerulescens.*—Black-throated Blue Warbler.—First seen, May 23 (1); next seen, May 24; uncommon.

52. *Dendroica coronata.*—Myrtle Warbler.—First seen, April 21 (2); next seen, April 22; common, May 5; common.

53. *Dendroica magnolia.*—Magnolia Warbler.—First seen, May 14 (1); next seen, May 16; common, May 21; very abundant. I consider this to be the most abundant summer resident bird about Antigonish If my experience in a number of other localities in Nova Scotia is typical, I should judge this to be the most abundant Warbler, perhaps the most abundant summer resident bird, in the province as a whole.

54. *Dendroica pensylvanica.*—Chestnut-sided Warbler.—First seen, May 24 (1); next seen, May 25; rare.

55. *Dendroica striata.*—Black-poll Warbler.—First seen, May 25 (3); next seen May 27; common, May 28; common. Although I have no reason to suppose that this species is a summer resident in Antigonish County, I can now find no record of the date of its departure for the summer.

56. *Dendroica fusca.*—Blackburnian Warbler.—First seen, May 27 (1); next seen, May 30; not common.

57. *Dendroica virens.*—Black-throated Green Warbler.—First seen, May 9 (1); next seen, May 10; common, May 17; abundant The second Warbler in point of abundance.

58. *Dendroicapalmarum hypochrysea.*—Yellow Palm Warbler.—First seen, April 24 (1); next seen, May 9; common, May 9; very common transient; probably not generally common as a summer resident. I have no similar migration record for this or any like species. In comparison with records of arrival in

other parts of Nova Scotia in other years, April 24 appears to be a normal date of arrival for this bird. The individual seen on that date at Antigonish was clearly observed in the bare branches of an apple tree. On the days immediately following I sought faithfully for this Warbler, for I always tried to obtain dates of second observations as close to arrival dates as possible, and, as day after day went by without my seeing anything more of the species, I hunted for it the more persistently. Yet it was not observed again until fifteen days after the first individual was seen; then, on May 9, it suddenly became common.

59. *Seiurus aurocapillus.*—Oven-bird.—First seen, May 18 (1); next seen, May 20; common, May 20; very common.

60. *Seiurus noveboracensis.*—Water-Thrush.—First seen, May 17 (2); next seen, May 19; common, May 20; common transient; not common summer resident. In most of western Nova Scotia this bird appears to be uncommon or rare. About Antigonish I found it, by comparison, rather more common as a summer resident and very much more common as a transient visitor in spring. In summer it is confined to deep, swampy woods, where there is stagnant water, but in the migration its cheerful song sounds not only in such places, but along every brook and river and body of fresh water, large or small. Apparently Antigonish is on the main highway followed by individuals of this species which breed in Cape Breton and Newfoundland, and, perhaps, eastern Labrador. The comparative rarity of the species in western Nova Scotia would seem to indicate that these eastern migrants enter the province by way of the Isthmus of Chignecto.

61. *Oporornis philadelphia.*—Mourning Warbler.—First seen May 30 (1); next seen, May 31; not common. More common than I have found it elsewhere in Nova Scotia.

62. *Geothlypis trichas trichas.*—Maryland Yellow-throat.—First seen, May 21 (4); next seen, May 22; common, May 22; common.

63. *Wilsonia pusilla pusilla.*—Wilson's Warbler.—First seen, May 25 (3); next seen, May 28; uncommon; last seen, May 28; observed as a transient only.

64. *Wilsonia canadensis.*—Canadian Warbler.—First seen, May 25 (1), next seen, May 27; common, May 29; common.

65. *Setophaga ruticilla.*—Redstart.—First seen, May 21 (2); next seen, May 22; common, May 22; very common.

66. *Anthus rubescens*.—American Pipit.—My only observation of this species at Antigonish was of one bird seen in a plowed field on May 20.

67. *Dumetella carolinensis*.—Catbird.—First seen, May 28 (6); next seen, May 30; common, May 28; common.

68. *Nannus hiemalis hiemalis*.—Winter Wren.—First seen, May 8 (1); next seen, May 9; not common.

69. *Regulus calendula calendula*.—Ruby-crowned Kinglet.—First seen, April 27 (1); next seen, April 30; common, May 2; common.

70. *Hylocichala guttata pallasi*.—Hermit Thrush.—First seen May 1 (1); next seen, May 8, common.

71. *Planesticus migratorius migratorius*.—Robin.—First seen. March 26 (1); next seen, March 28, common; April 9, very common. (This record published in "A Cooperative Study of Bird Migration," by Charles H. Rogers, 'Bird Lore', Vol. XVI, No. 3, p. 182, May-June, 1914).

Unfortunately regular notes on birds not observed as spring migrants were not made. From occasional notes on rare or unusual occurrences, or events of particular interest, however, the following additional data concerning the birds of Antigonnish County may be supplied. Certain familiar species, which were presumably common or abundant, must, from lack of record, here be conspicuous by their absence.

72. *Harelda hyemalis*.—Old Squaw.—One male observed on St George's Bay, not far from the entrance to Antigonish Harbor, January 31, 1914.

73. *Bonasa umbellus togata*.—Canada Ruffed Grouse.—A not common permanent resident.

74. *Coccyzus erythrophthalmia*.—Black-billed Cuckoo.—The familiar, characteristic notes of a Cuckoo distinctly heard June 20, 1914, doubtless emanated from one of this species.

75. *Sphyrapicus varius varius*.—Yellow-bellied Sapsucker.—A pair observed September 27, 1913.

76. *Cyanocitta cristata cristata*.—Blue Jay.—My only records are of several observations of the species during January and February, 1914.

77. *Perisoreus canadensis canadensis*.—Canada Jay.—Recorded in September and October, 1913, and January, 1914.

78. *Corvus brachyrhynchos brachyrhynchos*.—Crow.—Common permanent resident.

79. *Pinicola enucleator leucura.*—Pine Grosbeak.—My only observation was of a flock of 8 or 9, containing no adult males seen near Maryvale, April 18, 1914

80. *Passer domesticus domesticus.*—English Sparrow.—A common permanent resident in Antigonish town

81. *Loxia curvirostra minor.*—American Crossbill.—A small flock, containing several adult male , was observed at close range, May 2, 1914, near Mahoney's Beach. The birds were feeding in low spruce trees and on the ground. A few Crossbills were seen during the winter, but the species was not determined.

82. *Acanthis linaria linaria.*—Redpoll.—Seen in small flocks during the winter and early spring.

83. *Plectrophenax nivalis nivalis.*—Snow Bunting.—Recorded as seen occasionally in small flocks from January 11 to March 7.

84. *Spizella monticola monticola.*—Tree Sparrow.—My only observation was of a single individual, March 7, 1914.

85. *Lanius borealis.*—Northern Shrike.—Single individuals observed several times in winter and early spring. Heard singing in January and February.

86. *Certhia familiaris americana.*—Brown Creeper.—Several observed in song in heavy deciduous woods in late April.

87. *Sitta carolinensis carolinensis.*—White-breasted Nuthatch. Observed several times in autumn and winter, principally on shade trees in Antigonish town.

88. *Sitta canadensis.*—Red-breasted Nuthatch.—My only observation of this species was of a pair seen January 24, 1914. (See "A Problem in Food-Supply and Distribution," 'Bird-Lore,' Vol. XVI, No. 2, p. 113, March-April, 1914.)

89. *Penthestes atricapillus.*—Chickadee.—Common; particularly noticeable in winter.

90. *Penthestes hudsonicus littoralis.*—Acadian Chickadee. Common permanent resident in coniferous woods.

91. *Regulus satrapa satrapa.*—Golden-crowned Kinglet. Noted in February, 1914. Doubtless observed, but not recorded, in other seasons also.

THE PHENOLOGY OF NOVA SCOTIA, 1919.—BY A. H. MACKAY, LL.D., Halifax.

These observations were made by the school children of the Province of Nova Scotia as a part of the Nature Study work prescribed. The pupils report by bringing into the schoolroom the flowering or other specimens when first observed, for authoritative determination by the teacher, who generally credits the first finder by placing the name and the observation on the honor roll section of the blackboard for the day. The teacher, after testing the correctness of the observation, marks it on the schedule with which every teacher is provided—a copy of which is sent in to the Inspector with the school returns at the end of June and January.

The following tables are compiled from 140 of the best schedules out of the 400 sent in. The selections were made and compiled under the direction of Mr. H. R. Shinner, B. A., and Miss Gladys MacLeod, of the Education Department.

The schedules for each year are carefully bound up in a large annual volume, which is placed in the Provincial Museum and Science Library, where they can be used by students of climate, etc. The compilers of the phenochrons of the different belts, slopes or regions, have been rural science teachers who have most distinguished themselves as instructors. They were selected for the purpose on the recommendation of the Director of rural science education. The sheets from which the provincial phenochrons are calculated are also bound in annual folio volumes for ease of consultation and preservation.

The Province is divided into its main climate slopes or regions not always coterminous with the boundaries of counties. Slopes, especially those to the coast, are subdivided into belts, such as (a) the coast belt, (b) the low inland belt, and (c) the high inland belt, as below:

No.	Regions or Slopes.	Belts.
I.	Yarmouth and Digby Counties,	(a) Coast, (b) Low Inlands, (c) High Inlands.
II.	Shelburne, Queens & Lunenburg Co's,	" "
III.	Annapolis and Kings Counties,	(a) South Mts., (b) Annapolis Valley, (c) Cornwallis Valley, (d) North Mts.
IV.	Hants and Colchester Counties,	(a) Coast, (b) Low Inlands, (c) High Inlands.
V.	Halifax and Guysboro Counties,	" " " "
VI.a.	Cobequid Slope (to the south),	" " " "
VI b.	Chignecto Slope (to the northwest),	
VII.	Northumberland Straits Slope (to the n'h),	
VIII.	Richmond & Cape Breton Co's.	" " " "
IX.	Bras d'Or Slope (to the southeast),	" " " "
X.	Inverness Slope (to Gulf, N. W.),	" " " "

The ten *regions* are indicated on the outline map on page 134.

THE PHENOLOGY OF NOVA SCOTIA, 1919.

(Complied from the best out of 350 local observation schedules.)

YEAR 1919.

Day of the year corresponding to the last day of each month.

Jan.	31	July	212
Feb.	59	August	243
March	90	Sept	273
April	120	Oct.	304
May	151	Nov.	334
June	181	Dec.	365

For Leap Year add one to each except January.

When First Seen. Observation Stations: 1. Yarmouth and Digby	2. Shelburne, Lunenburg and Queens	3. Annapolis and Kings	4. Hants and Colchester	5. Halifax and Guysboro	6a. Cobequid Slope 6b. Chignecto Slope	7. Northumb. Sts Slope	8. Richmond and Cape Breton	9 & 10. Inverness and Bras d'Or Slope	Average Dates	Year 1919.	Average dates.	When Becoming Common. Observation Regions: 1. Yarmouth and Digby	2. Shelburne, Lunenburg and Queens	3. Annapolis and Kings	4. Hants and Colchester	5. Halifax and Guysboro	6a. Cobequid Slope 6b. Chignecto Slope	7. Northum. Sts Slope	8. Richmond and Cape Breton	9 & 10. Inverness and Bras d'Or Slope
90	90	98	100	101	107	102	109	117	101	1. Alnus incana, Wild	110	104	102	109	106	107	115	108	114	127
101	124	106	110	106	115	111	118	115	111	2. Populus tremuloides	117	119	132	114	115	113	119	117	123	119
85	93	96	101	109	103	115	113	114	103	3. Epigea repens, L.	115	98	104	108	109	115	138	119	120	122
119	119	120	122	118	121	121	144	134	127	4. Equisetum arvense	128	121	128	126	130	126	122	130	135	138
....	....	....	127	128	130	118	130	....	127	5. Sanguinaria Canadiensis	133	....	....	....	132	136	135	129	135	....
116	117	122	120	127	121	126	128	125	122	6. Viola Blanda	134	129	125	128	127	134	129	132	133	173
121	125	125	125	133	124	130	133	126	127	7. Viola palmata, cucullata	133	130	131	133	131	139	131	136	138	134
124	123	124	134	126	....	....	....	123	125	8. Hepatica triloba, etc	138	....	154	128	137	134	138	....	....	....
113	125	127	127	123	126	129	132	133	126	9. Acer rubrum	133	126	131	133	132	127	134	133	144	130
120	123	121	123	128	127	127	128	129	125	10. Fragaria Virginiana	133	130	130	131	131	134	132	135	135	137
154	162	162	161	165	160	162	167	166	162	11. " " fruit ripe	168	168	170	170	171	172	176	172	177	141
122	124	126	125	131	130	131	134	131	128	12. Taraxacum officinale	133	125	130	134	131	137	137	137	139	125
118	130	138	126	127	129	126	134	137	129	13. Erythronium Americanum	137	....	133	143	136	135	135	136	138	140
129	130	135	133	136	133	137	135	137	134	14. Coptis trifolia	139	136	136	142	135	141	135	141	140	141
....	....	156	123	131	122	122	136	166	136	15. Claytonia Caroliniana	140	....	146	160	129	138	132	128	142	152
142	137	138	132	137	133	145	141	131	137	16. Nepeta Glechoma	145	153	145	143	139	144	138	147	151	143
139	136	136	135	138	142	139	146	143	139	17. Amelanchier Canadiensis	144	144	140	141	141	143	143	143	150	149
....	....	....	....	210	....	....	....	....	210	18. " " fruit ripe	215	....	....	....	....	215	....	....	....	....

....	....	....	203	205	....	....	200	....	203	43. " " fruit ripe	212	....	....	....	211	216	....	....	210	....
158	167	164	170	170	....	160	174	....	166	44. Rhinanthus Crista-galli	171	162	167	168	174	176	179	167	....	....
159	162	166	165	171	168	162	169	156	164	45. Rubus villosus	169	164	170	171	171	175	170	168	173	167
....	....	....	210	233	245	241	247	....	235	46. " " fruit ripe	240	....	....	....	211	246	245	246	254	....
163	163	160	163	166	155	171	....	128	158	47. Sarracenia purpurea	162	168	168	163	167	173	157	171	....	132
164	169	165	157	171	139	178	170	166	164	48. Brunella vulgaris	171	172	173	164	160	177	....	178	176	170
175	172	172	170	174	169	170	....	....	171	49. Rosa lucida	174	....	173	176	177	179	170	173	....	....
163	164	165	171	167	166	166	168	171	166	50. Leontodon autumnale	172	169	169	170	177	174	174	171	172	176
122	169	175	155	175	173	167	168	....	163	51. Linaria vulgaris	170	....	169	179	155	179	170	170	172	....
136	134	133	132	133	140	135	139	138	135	52. Trees appear green	147	144	144	142	142	144	159	163	146	145
135	140	143	137	150	152	148	140	144	143	53. Ribes rubrum (cultivated)	150	142	145	149	145	152	153	150	154	150
....	....	....	199	....	....	196	201	....	198	54. " " (fruit ripe)	206	....	....	....	207	....	....	196	215	....
137	146	138	143	145	148	147	149	144	144	55. R. nigrum (cultivated)	150	147	153	143	148	152	153	151	158	152
....	....	....	207	....	....	200	205	....	204	56. " fruit ripe	209	....	....	....	210	....	....	200	219	....
137	148	143	146	156	152	146	154	151	148	57. Prunus Cerasus	153	143	152	148	152	161	157	150	159	158
....	....	....	....	....	....	....	213	....	213	58. " " fruit ripe	213	....	....	....	....	....	....	....	213	....
143	149	145	146	150	155	150	156	157	150	59. Prunus domestica	156	149	156	149	153	158	161	154	163	164
144	149	145	147	151	151	149	157	158	151	60. Pyrus Malus	156	152	155	152	153	156	158	154	161	163
154	158	155	156	158	160	158	165	159	158	61. Syringa vulgaris	163	161	164	159	161	164	158	162	168	170
157	161	160	159	162	162	161	166	164	161	62. Trifolium repens	167	164	168	165	165	168	169	167	169	171
150	153	156	156	156	159	161	162	160	157	63. Trifolium pratense	166	162	....	162	163	163	168	167	171	169
178	152	153	169	....	163	167	168	164	164	64. Phleum pratense	167	....	160	161	170	173	167	171	168	168
....	177	....	174	....	....	....	....	....	170	65. Solanum tuberosum	179	....	....	....	178	....	....	....	181	....
109	110	117	119	123	120	126	118	116	115	66. Ploughing first of season	128	114	134	130	129	130	126	134	126	130
133	120	133	138	132	132	135	137	134	132	67. Sowing	139	139	127	141	145	138	139	146	135	142
123	127	135	137	141	137	138	129	131	133	68. Potato-planting	142	130	133	146	148	146	146	149	142	142
129	125	131	135	135	128	136	122	134	131	69. Sheep-shearing	137	139	132	139	142	143	131	148	137	126
....	....	....	....	214	....	213	217	....	214	70. Hay-cutting	219	....	....	....	....	216	....	218	225	....
....	....	....	246	252	246	246	246	....	246	71. Grain-cutting	253	....	....	....	251	256	252	251	257	....
....	....	....	260	256	265	271	269	....	264	72. Potato-digging	271	....	....	....	271	257	273	275	281	....
....	79	86	78	....	109	86	86	99	89	73a Opening of rivers	....	....	....	....	....	....	....	....	....	....
69	....	99	88	....	119	93	104	109	97	73b Opening of lakes	....	....	....	....	....	....	....	....	....	....
109	120	116	120	114	121	120	116	113	116	74a Last snow to whiten ground	....	....	....	....	....	....	....	....	....	....
111	123	119	121	120	120	122	123	125	120	74b " to fly in air	....	....	....	....	....	....	....	....	....	....
123	137	146	126	....	127	131	130	121	130	75a Last Spring frost—hard	....	....	....	....	....	....	....	....	....	....
140	129	142	157	....	....	164	152	129	145	75b " " —hoar	....	....	....	....	....	....	....	....	....	....
101	....	108	92	....	102	119	113	113	106	76a Water in streams—high	....	....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....	....	....	76b " " —low	....	....	....	....	....	....	....	....	....	....
....	....	....	258	255	270	268	264	....	263	77a First autumn frost, hoar	....	....	....	....	....	....	....	....	....	....
....	....	....	304	276	295	287	288	....	290	77b " " hard	....	....	....	....	....	....	....	....	....	....
....	....	....	302	281	291	289	281	....	290	78a First snow to fly in air	....	....	....	....	....	....	....	....	....	....
....	....	....	304	324	318	318	316	....	316	78b " whiten ground	....	....	....	....	....	....	....	....	....	....
....	....	....	336	339	....	330	335	....	335	79a Closing of lakes	....	....	....	....	....	....	....	....	....	....
....	....	....	345	335	....	349	358	....	346	79b " rivers	....	....	....	....	....	....	....	....	....	....
94	92	99	87	70	85	75	93	93	87	81a Wild ducks migrating, N	....	....	....	....	....	....	....	....	....	....
....	....	....	300	272	....	307	....	....	259	81b " " S	....	....	....	....	....	....	....	....	....	....
86	81	99	79	77	79	80	90	85	84	82a " geese " N	....	....	....	....	....	....	....	....	....	....
....	....	....	313	272	....	312	228	....	303	82b " " S	....	....	....	....	....	....	....	....	....	....

THE PHENOLOGY OF NOVA SCOTIA, 1919.—*Continued.*

YEAR 1919.

Day of the year corresponding to the last day of each month.

Jan.	31	July	212
Feb.	59	Aug.	243
March	90	Sept.	273
April	120	Oct.	304
May	151	Nov	334
June	181	Dec.	365

For Leap Year add one to each except January.

WHEN FIRST SEEN. — OBSERVATION REGIONS.

	1. Yarmouth and Digby	2. Shelburne, Lunenburg and Queens	3. Annapolis and Kings	4. Hants and Colchester	5. Halifax and Guysboro	6c. Cobequid Slope 6b. Chignecto Slope	7. Northum. Sts Slope	8. Richmond and Cape Breton	9 & 10. Inverness and Bras d'Or Slope	Average Dates
19. Prunus Pennsylvanica	139	142	142	141	142	143	142	149	148	143
20 " " fruit ripe	....	....	....	207	218	237	....	....	....	220
21. Vaccinium Can. and Penn.	136	140	141	141	152	143	143	147	155	144
22. " " fruit ripe	....	....	....	....	234	....	199	....	....	216
23. Ranunculus acris	142	144	149	148	154	151	150	153	144	148
24. R. repens	150	144	153	156	163	150	157	164	164	155
25. Trill. erythrocarpum	142	145	141	144	145	143	147	152	152	143
26. Rhododendron Rhodora	142	144	146	145	149	144	148	156	....	147
27. Cornus Canadiensis	143	147	145	149	157	146	149	150	151	148
28. " " fruit ripe	142	....	140	161	....	159	240	....	....	150
29. Trientalis Americana	143	145	148	146	141	145	151	153	147	146
30. Clintonia borealis	145	161	148	153	158	152	155	156	....	153
31. Calla palustris	....	157	155	158	....	156	168	161	152	158
32. Cypripedium acaule	148	147	153	158	156	161	161	157	161	157
33. Sisyrinchium angustifol	153	149	154	154	159	154	159	164	162	157
34. Linnaea borealis	153	163	168	163	158	161	166	171	152	161
35. Kalmia glauca	149	161	162	155	166	149	158	154	155	156
36. Kalmia augustifolia	153	162	169	158	178	153	159	....	151	160
37. Crataegus oxyacantha	159	159	156	153	158	158	159	160	....	158
38. Crataegus coccinea, etc	156	158	154	157	159	161	159	163	164	159
39. Iris versicolor	158	159	159	163	164	163	164	169	162	162
40. Chrysanthemum Leucanth.	156	158	160	160	167	160	160	168	163	161
41. Nuphar advena	157	163	167	157	167	165	162	165	168	163
42. Rubus strigosus	156	159	162	155	164	157	156	163	149	158

WHEN BECOMING COMMON. — OBSERVATION REGIONS

	Average dates.	1. Yarmouth and Digby	2. Shelburne, Lunenburg and Queens	3. Annapolis and Kings	4. Hants and Colchesier	Halifax and Guysboro	6a. Cobequid Slope 6b. Chignecto Slope	7. Northum Sts. Slope	8. Richmond and Cape Breton	9, & 10. Inverness and Bras d'Or Slope
19. Prunus Pennsylvanica	146	145	136	148	146	148	147	137	152	154
20 " " fruit ripe	223	....	....	....	209	223	237	....	....	....
21. Vaccinium Can. and Penn.	149	146	151	146	147	156	147	147	155	140
22. " " fruit ripe	221	....	....	....	....	240	....	203	....	....
23. Ranunculus acris	156	152	149	154	157	162	149	158	161	157
24. R. repens	161	161	153	158	162	168	159	160	....	171
25. Trill. erythrocarpum	150	142	150	146	150	150	151	153	167	15.
26. Rhododendron Rhodora	151	147	147	151	152	155	151	152	159	....
27. Cornus Canadiensis	154	150	156	142	155	162	150	156	156	156
28. " " fruit ripe	158	160	....	151	165	....	....	240	....	....
29. Trientalis Americana	153	153	155	154	152	147	151	156	156	157
30. Clintonia borealis	158	151	155	153	159	161	156	162	162	161
31. Calla palustris	162	....	161	159	166	....	158	169	165	156
32. Cypripedium acaule	161	153	157	159	165	162	163	165	162	163
33. Sisyrinchium angustifol	161	157	159	155	159	164	160	164	169	167
34. Linnaea borealis	167	163	163	171	168	164	167	170	175	163
35. Kalmia glauca	161	148	167	166	160	171	162	163	156	160
36. Kalmia augustifolia	164	163	167	171	167	...	158	164	....	161
37. Crataegus oxyacantha	162	167	162	159	156	163	162	162	169	...
38. Crataegus coccinea, etc	163	158	163	158	162	165	170	162	168	167
39. Iris versicolor	167	165	162	164	169	169	169	166	173	164
40. Chrysanthemum Leucanth.	168	164	167	165	167	172	168	169	173	170
41. Nuphar advena	169	168	167	171	165	173	171	163	169	171
42. Rubus strigosus	164	165	167	167	158	171	163	160	169	167

THE PHENOLOGY OF NOVA SCOTIA, 1919.—*Continued.*

Year 1919.

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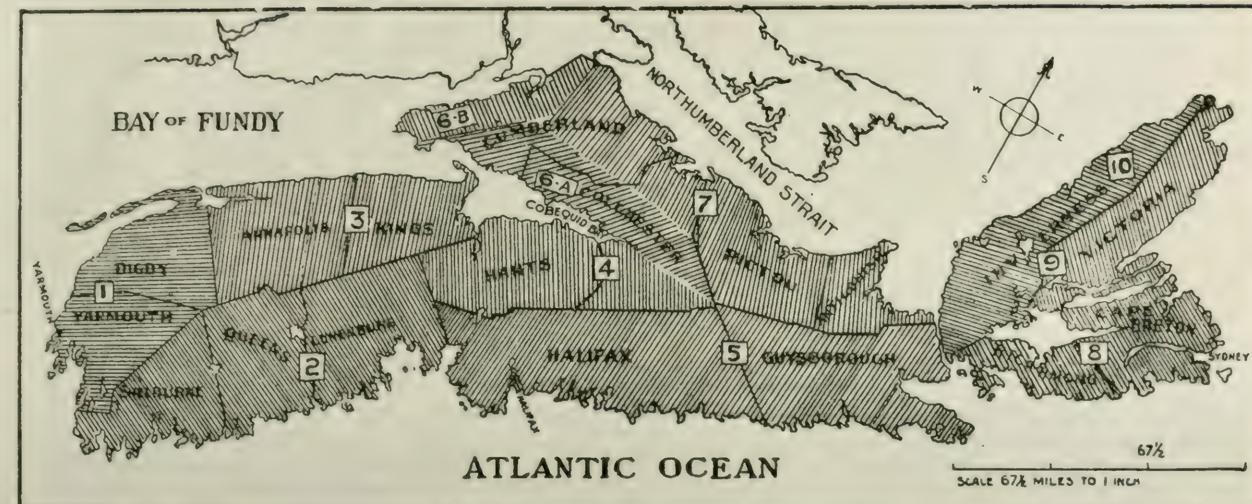
When First Seen. Observation Stations: 1. Yarmouth and Digby	2. Shelburne, Lunenburg and Queens	1. Annapolis and Kings	4. Hants and Colchester	5. Halifax and Guysboro	6a. Cobequid Slope 6b. Chignecto Slope	7. Northumb. Sts. Slap	8. Richmond and Cape Breton	9 & 10 Inverness and Bras d'Or Slope	Average dates	Year 1919	When Becoming Common: Average dates	Observation Reigons: 1. Yarmouth and Digby	2. Shelburne, Lunenburg and Queens	3. Annapolis and Kings	4. Hants and Colchester	5. Halifax and Guysboro	6a. Cobequid Slope 6b. Chignecto Slope	7. Northumb, Sts Slope	8. Richmond and Cape Breton	9 & 10. Inverness and Bras d'Or Slope
79	104	96	88	85	92	91	93	98	92	83 Melospiza fascata, "	....	....	....	....	....	....	....	....	....	....
86	79	75	76	100	76	85	95	82	84	84 Turdus migratorius "	....	....	....	....	....	....	....	....	....	....
83	83	92	90	....	106	90	92	....	90	85 Junco hiemalis "	....	....	....	....	....	....	....	....	....	....
127	128	118	121	125	122	134	137	74	120	86 Actitis macularia "	....	....	....	....	....	....	....	....	....	....
....	104	132	125	....	....	135	....	99	119	87 Sturnella magna "	....	....	....	....	....	....	....	....	....	....
131	128	118	121	125	122	134	137	74	122	88 Ceryle Alcyon "	....	....	....	....	....	....	....	....	....	....
123	....	124	126	123	132	131	132	....	127	89 Dendroeca coronata "	....	....	....	....	....	....	....	....	....	....
126	131	138	135	136	142	141	143	152	138	90 D. aestiva "	....	....	....	....	....	....	....	....	....	....
119	....	108	120	130	145	118	135	147	128	91 Zonotrichia alba "	....	....	....	....	....	....	....	....	....	....
141	145	147	147	144	144	147	142	155	145	92 Trochilus colubris "	....	....	....	....	....	....	....	....	....	....
129	150	134	136	138	152	138	151	158	143	93 Tyrannus Carolinensis "	....	....	....	....	....	....	....	....	....	....
139	....	139	123	143	136	139	147	....	138	94 Dolychonyx oryzivorus "	....	....	....	....	....	....	....	....	....	....
143	....	144	139	147	....	141	143	....	142	95 Spinis tristis "	....	....	....	....	....	....	....	....	....	....
102	....	155	149	145	....	152	145	....	141	96 Setophaga ruticilla "	....	....	....	....	....	....	....	....	....	....
127	100	....	150	149	166	153	134	103	135	97 Ampelis cedrorum "	....	....	....	....	....	....	....	....	....	....
91	129	136	141	129	139	134	136	130	129	98 Chordeiles Virginianus	....	....	....	....	....	....	....	....	....	....
86	89	100	98	101	101	101	109	104	98	99 First piping of frogs	....	....	....	....	....	....	....	....	....	....
90	102	110	112	114	122	121	116	108	110	100 First appearance, snakes	....	....	....	....	....	....	....	....	....	....

THE LOCAL COMPILERS FOR EACH REGION, 1919.

Region No.		Region No.	
I.	Miss Jennie C. Allan	VIa	Miss Vera M. Allen
II.	Miss C.A. Zinck	VIb	" " " "
III.	Miss Zaidee Horsfall	VII.	Miss Fannie M. Layton
IV.	Miss Gertrude M.ᶜChase	VIII.	Mr. Wilbert Spencer
V.	Miss J. D. Stoddard	IX & X.	Miss Gladys MacLeod



THE TEN PHENOLOGICAL REGIONS OF NOVA SCOTIA.

THUNDERSTORMS—PHENOLOGICAL OBSERVATIONS, NOVA SCOTIA, 1918-1919.

The indices indicate the number of stations from which the Thunderstorms were reported on the day of the year specified.

OBSERVATION REGIONS.

1. Yarmouth and Digby.	2. Shelburne, Queens and Lunenburg.	3. Annapolis and Kings.	4. Hants and Colchester	5. Halifax and Guysboro.	6a. Cobequid Slope. (to the South)	6b. Chignecto Slope (to the north)	7. Northumb. Sts. Slope (to the north)	8. Richmond and Cape Breton.	9. Bras d'Or Slope 10. Inverness Slope	Total 1919
								64		64
							91			91
							99			99
		107								107
			108				108			108^{2}
			109^{7}	109^{2}			109^{2}			109^{11}
			111							111
								112		112
115							115			115
								120		120
									121	121
					122					122
125^{2}	125^{3}	125	125^{3}		125^{2}		125^{13}	125^{3}	125^{6}	125^{33}
126										126
							127			127
				134			134^{2}	134	134^{4}	134^{8}
				135			135			135^{2}
									137	137
	138		138							138^{2}
							141			141
145			145							145^{2}
				146	146^{2}					146^{3}
147					147					147^{2}
	149	149^{2}			149			149		149^{5}
		152								152
155										155
	156^{3}		156^{6}				156^{4}	156	156	156^{15}
					157		157^{5}	157	157	157^{8}
		158^{2}	158^{6}	158	158^{5}		158^{6}		158	158^{21}
					161		161			161^{2}
168	168^{2}	168^{2}		168			168			168^{7}
		170	170	170	170		170^{2}	170		170^{7}
		171^{3}	171^{3}		171		171	171		171^{13}
172		172	172^{13}	172^{5}	172^{2}		172^{10}		172	172^{32}
										173
			173							..

THUNDERSTORMS—PHENOLOGICAL OBSERVATIONS, NOVA SCOTIA, 1919.

The indices indicate the number of stations from which the Thunderstorms were repor'ed on the day of the year specified.

OBSERVATION REGIONS.

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			174							174
	198^3									198^3
	201^3									201^3
	202^2									202^2
	203									203
								215		215
									220	220
								226		226
								227		227
		238						238		238^2
		251								251
							261			261
								268		268
							275			275
		278								278
		279^3								279^3
							280			280
							302^2	302		302^3

Fig. 11. Front view of the Micmac Skull. *Norma frontalis.*

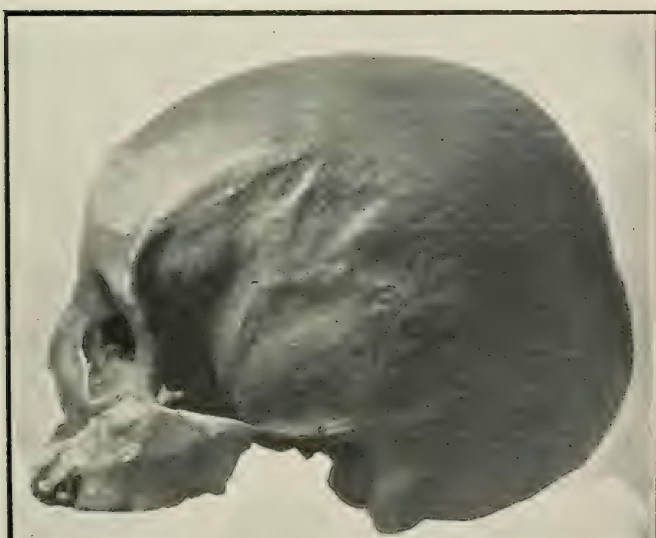

Fig. 12. Lateral view of the Micmac Skull. *Norma lateralis.*

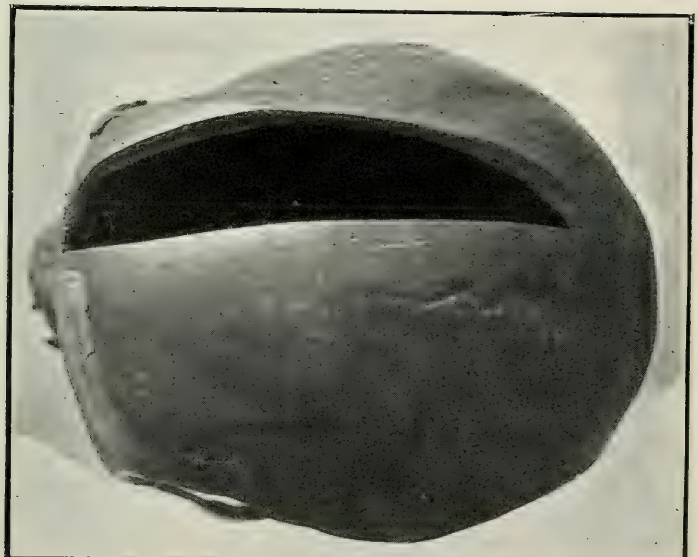

Fig. 13. The Micmac Skull viewed from above. *Norma verticalis.*

THE attention of members of the Institute is directed to the following recommendations of the British Association Committee on Zoological Bibliography and Publications:—

"That authors' separate copies should not be distributed privately before the paper has been published in the regular manner.

"That it is desirable to express the subject of one's paper in its title, while keeping the title as concise as possible.

"That new species should be properly diagnosed and figured when possible.

"That new names should not be proposed in irrelevant footnotes, or anonymous paragraphs.

"That references to previous publications should be made fully and correctly, if possible in accordance with one of the recognized sets of rules of quotations, such as that recently adopted by the French Zoological Society."

THE

PROCEEDINGS AND TRANSACTIONS

OF THE

Nova Scotian Institute of Science

HALIFAX, NOVA SCOTIA

PART 3—SESSION OF 1920-1921
PART 4—SESSION OF 1921-1922

HALIFAX

PRINTED FOR THE INSTITUTE BY THE ROYAL PRINT AND LITHO LIMITED

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CONTENTS

VOL. XV. PART 3

PROCEEDINGS

OF THE

Nova Scotian Institute of Science

SESSION OF 1920-1921

(Vol. XV, Part 3)

59TH ANNUAL BUSINESS MEETING.

Physiological Lecture Room, Dalhousie College, Carleton St., Halifax, 8th November, 1920.

THE PRESIDENT, DR. H. L. BRONSON, in the chair. Other members present: DR. J. CAMERON, D. J. MATHESON, PROF. D. S. MCINTOSH, DR. A. H. MACKAY, PROF. C. B. NICKERSON, DR. D. FRASER HARRIS, DR. S. G. RITCHIE, DR. J. H. L. JOHNSTONE, E. W. TODD, DR. F. W. RYAN, DR. B. R. COYSH, F. C. CHURCHILL (Wolfville), P. R. COLPITT and H. PIERS.

THE PRESIDENT opened the session with remarks on the progress of the Society during the past year. He referred to the greatly increased cost of printing the Transactions and to the decision arrived at by the Council at its meeting of 13th October, that first right to publication would be given to papers dealing with local natural science, and second place would be given to other classes of scientific work by active members residing in Nova Scotia. The Council had also decided to exercise its right to have abstracts made of papers, if necessary. He also referred to the loss the Society had sustained through the death of its past-president, DR. EBENEZER MACKAY, on 6th January, 1920, and of DR. A. P. REID, on 26th February, 1920.

The Treasurer, MR. MATHESON, presented his financial report for the year ended October 1920, showing that the receipts were $1,939.48, the expenditures $1,225.15, and the bal-

He was also an enthusiastic student of Anthropology, as well as interested in scientific subjects in general. He joined the Institute in November 1894, and in November 1900 was elected a corresponding member in recognition of his services.

THE PRESIDENT delivered a popular lecture on "The Civilization and Culture of Ancient Egypt," illustrated by lantern-slides. On motion of HIS HONOR, THE LIEUT.-GOVERNOR, the thanks of the meeting were conveyed to the lecturer.

THE PRESIDENT then invited the audience to partake of refreshments in an adjoining room.

THIRD ORDINARY MEETING.

Physiological Lecture Room, Dalhousie College, Carleton St., Halifax, 14th February, 1921.

THE PRESIDENT, DR. CAMERON, in the chair.

DR. BRONSON reported for the committee on popular lectures that DRS. NICHOLLS and DAWSON had consented to give lectures.

FREDERICK C. CHURCHILL, Wolfville, read a paper on "Probable Changes in the Drainage of the Black and Gaspereaux Rivers, Kings Co., N. S." (See Transactions p. 141). The subject was discussed by DR. MACKAY, PROF. MCINTOSH, and MR. PIERS.

MR. PIERS then read chapters on the Micmac Indians, their habits, folklore, and anecdotes regarding them, from an unpublished lecture, entitled "In Evangeline's Land: Reminiscences of the Country and of the Indians," written by the late MAJOR-GENERAL CAMPBELL HARDY, of Dover, England, author of "Forest Life in Acadia," and an original member of the Institute.

FOURTH ORDINARY MEETING.

Physiological Lecture Room, Dalhousie College, Carleton St., Halifax, 14th March, 1921.

THE PRESIDENT, DR. CAMERON, in the chair.

It was announced that HUGH W SCHWARTZ, M D., Halifax, had been elected a member on 3rd March.

PROF. ALBERT G. NICHOLLS, M.D., D.Sc., Dalhousie University, delivered a popular lecture on "Insects as Vectors of Disease," illustrated by lantern-slides and microscopical demonstration.

FIFTH ORDINARY MEETING.

Physiological Lecture Room, Dalhousie College, Carleton St., Halifax, 18th April, 1921.

THE PRESIDENT, DR. CAMERON, in the chair.

A paper by CHARLES ALEX. VICKERY, B.A., Dalhousie University, entitled "The Effect of Thermoluminescence on Electrical Conductivity," was read by title.

PROF. JAMES A. DAWSON, Ph.D., Dalhousie University, delivered a popular lecture on "Some Problems in Protozoology," illustrated by lantern-slides. The subject was discussed by the PRESIDENT, DR. JOHNSTONE, E. C. ALLEN, DR. FRASER HARRIS, PROF. BELL and PROF. NICHOLLS.

SIXTH ORDINARY MEETING.

Physiological Lecture Room, Dalhousie College, Carleton St., Halifax, 9th May, 1921.

THE PRESIDENT, DR. CAMERON, in the chair.

It was reported that PROF. WALTER PERCY COPP, B.Sc., Dalhousie University, had been elected a member on 28th April.

EARLE F. WHYTE, B.A., Dalhousie University, read a paper entitled "A Study of the Extraction of Potash from Orthoclase Feldspar, by Carbon Dioxide and Sulphur Dioxide." (See Transactions, p. 145). The subject was discussed by the PRESIDENT, PROF. NICKERSON, DR. JOHNSTONE, MR. TODD, PROF. McINTOSH and MR. PIERS.

A paper by DR. A. H. MACKAY, "Phenological Observations, Nova Scotia, for 1920," was read by title. (See Transactions, p. 153.)

Bed-rock (Triassic) sandstone outcrops in this brook, but throughout the valley the stream has never deepened its bed to any great extent. The drift lies scattered everywhere and a number of boulders are well ice-scratched.

The delta that lies a little way up the valley's mouth, has experienced a large amount of sub-aerial erosion as well as that done by the stream, although the characteristic flat top of the delta is still to be seen, its surface is uneven in places, and as the brook has cut longitudinally through, one can see that its top-set and bottom-set beds are nearly horizontal. In other places, owing to the growth of grass, I could not make out much of its structure. Where the delta unites to the side of its valley, its top is quite level or has a gentle down-stream slope.

The other brook is about a mile to the west and flows almost due north. Near the head of this gorge there appears more drift and larger boulders are found. A little west of this valley is a splendid example of glacial drift, probably the lobe of a moraine.

The delta in this brook is in a somewhat better state of preservation than the other. Although time has marked it by erosion, it still shows a flat top, and where the present stream has cut its path through, one can see the bedding and imagine its former shape.

The material of these deltas is a fine calcareous, sandy loam, and I think there is some evidence to show that it has been in part derived from the boulder-clay over which these brooks have run.

As the beds of these brooks are above the marsh land, till evidently lies below them, as it has been found below the marsh in several places in this locality.

Although the present streams are quite small, these valleys seem too large to have been cut by the streams that now occupy them. These valleys are about forty feet deep and several hundred feet wide between the tops of their sides. However, I think they are of recent origin and have been cut quickly by swiftly flowing streams.

I believe the history of these brooks and their deltas may be found by piecing together the Post-glacial changes that have taken place in this part of the country. The evidence seems to show that these brooks began their flow after the final retreat of the ice. It is admitted that at the close of the Glacial Period the land stood a little higher relative to sea-level than it does at the present day. This would give these streams a high grade and they could cut a gorge, both large and deep, through or into the loose drift and even into the soft bed-rock that lies below; but bed-rock has been reached by one stream only and that in one place.

That these brooks have cut into but not through the drift, seems quite evident. The absence of boulder-clay in these valleys I think can be accounted for by the fact that it is easily washed away from the surface. The larger material, such as boulders, remained as the stream was unable to remove them.

The melting of the ice must have supplied vast quantities of water, and the streams, as I before have stated, must have been larger than they are today.

Immediately after the retreat of the ice, the land stood high relatively to sea-level; but subsidence had already begun, and as the waters of the sea advanced upon the land these streams had their grades lessened until finally deposition began and the lower end of their valleys were drowned. Probably deposition continued until the tops of these deltas stood a little above the level of the receiving body of water which was the sea or rather the craters of Minas Basin.

The strong tides forcing their way up these small valleys seem even to have aided rather than hindered deposition, as we witness today in the growing deltas of the Gaspereau and Cornwallis rivers.

Following this submergence, a period of uplift in the land set in. This continued until these small deltas now stand well above sea-level.

As the railroad between Wolfville and Grand Pré stations is level and crosses the mouth of these brooks, I have chosen it as a datum place to show the difference in relative level between land and sea, since these deltas were laid down.

Where the railroad passes these brooks, it is 28 feet above sea level, and the base of both of these deltas is about six feet above it. The height of one delta above its valley floor is 22 feet, the other 26 feet. This makes the top of one delta 28 feet and the other 32 feet above the railroad, and 56 feet and 60 feet respectively above sea-level. As they both have experienced sub-aerial denudation, 65 feet would be a more correct estimate; and we must also remember that they may have stood a little above water-level.

As the streams have cut quite through these deposits, they have eroded their channels about 26 feet; besides they have cut their way quite deep in other parts of their course, and even in some places aggraded their bed.

While preparing this paper, I have observed several other fossil deltas in brooks near here; in one brook south of Wolfville the top of one delta now stands between 75 and 80 feet above sea-level.

Probable Change in Drainage of the Black and Gaspereau Rivers, Kings Co., N. S.—By F. C. Churchill, Wolfville, N. S.

(Read 14 Feb., 1921)

Although I fully realize the difficulty, also the rashness, on my part in attempting a question of this nature, nevertheless I feel that a beginning should be made to decipher many of these problems in our local geology; and unless one begins I am afraid very little will ever be accomplished.

I have spent much time in examining the region in Kings Co. drained by these rivers, and also have speculated much concerning their probable history; but I wish the reader to understand that very much of this is speculation on my part, and it will have to be in the future that one may know the full history of these changes.

The Deep Hollow is intimately connected with the history of these rivers and demands a description. It lies to the north of the Black and Gaspereau Rivers, and is nearly opposite where the Black River joins the Gaspereau, lying nearly 150 feet above.

This whole region slopes in a northerly direction and may be considered part of the South Mountain; the Deep Hollow and Black River running nearly at right angles to the Gaspereau and flowing northward. The small brook now occupying the Hollow is fed by springs, and is entirely too small to have cut a gorge of this size; and the question is, From whence came the sources of this river?

The road that runs through the valley from Whiterock, north to New Minas, follows the ancient channel of the river; and as one passes over it, he is impressed that it once must have been a river, as it winds to and fro like a river over its flood-plain. The valley shows many signs of being stream-cut, having overlapping rock spurs, the height of which reaches 75 feet or more cut into the hard slate and quartzite.

I am indebted to Mr. E. R. Faribault of Ottawa for an excellent map of this region, which has enabled me to understand its complicated geological structure. The slates and quartzites underlying this section are folded into a series of parallel anticlines and synclines having their axes in a north-east and south-west direction, and are disturbed by numerous faults.

In viewing this region I have considered it as the inner margin of an elevated ancient coastal plain, the outer or seaward margin being near the Bay of Fundy where the underlying rocks dip north-westerly towards the shore. If my supposition be well founded the earliest lines of drainage to be established on this surface, would follow the surface of the ground and run as a consequent stream, taking the shortest course to the sea, across the strike of the strata parallel to the dip. This is the law of coastal plain drainage, and I think there is reason to believe that the Black River took this course through the Deep Hollow.

I have located a large meandering gorge in the North Mountain nearly opposite the Deep Hollow, and this may be its old outlet into the Bay of Fundy. Be this as it may, the fact is well established that when anticlines and synclines are eroded their remaining portions form a series of ridges like the cuestas of a coastal plain, and that the earliest drainage over those eroded structures is parallel to the dip, and the later rivers and tributaries develop by running at right angles to these, that is, parallel to the strike.

Judging from the structure and position, I have assumed that the Deep Hollow was once the northerly extension of the Black River. This river shows many signs of great age. By this expression I mean stage of development. Its meanderings are well incised into the hard slates and quartzites, its only signs of youth being its falls which are situated near its junction with the Gaspereau. I think however these falls do not necessarily show youth, but are the result of the uplift in this region which brought near the surface the dyke of hard diorite that crosses this stream. But the river has cut deeply into this dyke, thus showing this uplift to be greatly remote in time.

The Gaspereau River on the other hand has no incised meanderings and its appearance is far more youthful.

The probable history of these rivers may be stated as follows: When the Black River began its flow the whole region was well elevated above sea level, and as time elapsed it cut its valley and its drainage area to a very low grade. In this stage of development it meandered lazily over its flood plain, thus outlining the present Deep Hollow. Then a period of uplift began, giving the river a high grade and enabling it to cut its course into the bed rock below. Probably the Gaspereau was just beginning its journey to the sea during this uplift, having begun its flow a short distance east of the Deep Hollow.

Probably during this process the Gaspereau was steadily working its way headward until it finally tapped the Black River at the Deep Hollow, and diverted its waters eastward, although that part of the Gaspereau which now lies west of the Deep Hollow may have been a tributary to the Black River.

My reasons for supposing that the Gaspereau began its flow to the east of the Deep Hollow are based upon the law of coastal plain drainage, that the later rivers grow chiefly by headwater erosion; that is, they cut their valley headward, and the Gaspereau appears to have followed this rule. A short distance east of the Deep Hollow, near the present Electric Power dam, the river flows into a syncline of quartzite and slate. This structure, in my mind, helps one to understand the drainage of this region. If the Gaspereau cut headward into this syncline it took it a long time to cut such a deep gorge, and during the time this gorge was being cut, the Black River had ample time to engrave its meanderings into the hard rocks of the Deep Hollow before it was tapped by the Gaspereau.

The Gaspereau has still the appearance of a youthful river where it crosses the mentioned syncline. Here the valley is steep and gorge like and time has not yet elapsed for it to obey the law of stream development, that rivers seek the lines of least resistance and forsake synclines and move over on the adjacent anticline which is the weaker structure.

Moreover, before the Black River was tapped by the Gaspereau it was a weak sluggish stream with a course of about 12 miles to the sea from Whiterock. On the other hand the Gaspereau, a young and vigorous stream with a short course of about 6 or 7 miles to the sea from Whiterock, had the advantage over the Black River and captured its drainage area.

What has happened to this drainage area during the Glacial Period I would not care to venture more than a guess. We can safely say, however, that portions of these rivers were dammed by the ice, its debris producing the lakes in this district; and when the country finally was submerged, the marine waters were admitted well up into the valley. Evidence of this may be seen in the gravel deposits that now stand about 200 feet above sea level.

After re-elevation of the country, owing to the increased grade of the rivers, vast quantities of glacial material must have been swept into the sea, thus helping to build up our modern marine marshes.

The topography of this region, I believe, is all pre-glacial, the small mounds of gravel and the gentle slopes of the hills to the north, have been more or less shaped by the ice sheet that has now vanished.

A STUDY OF THE EXTRACTION OF POTASH FROM ORTHOCLASE FELDSPAR BY CARBON DIOXIDE AND SULPHUR DIOXIDE. THESIS submitted by EARLE FORRESTER WHYTE, B. A., to the Faculty of Dalhousie College for the Degree of Master of Arts, March 19, 1921.

(Read 9 May, 1921)

Introduction.—The term potash usually includes any simple compound of potassium from which the metal or any particular salt can be easily obtained. Such deposits of potash are of remarkably rare occurrence, insomuch that the world has been dependent on one or two sources for almost its entire supply of this indispensable substance.

The largest deposit, and the one which has supplied practically all demands since 1860, is that in Northern Germany known as the Stassfurt Deposit. The next largest bed of potassium salts is in Alsace, and the fact that this country has recently changed ownership will introduce an element of competition in the potash trade. Another large deposit has been found in Spain, and smaller deposits in Galicia and California, while a certain percentage of these salts is obtained from the nitre beds of Chili, and a further small quantity is recovered from a few industries, as cement mills, molasses distillery slop, and beet-sugar refineries.

But while potassium in suitable form occurs only in a few places, yet it is widely distributed as a component of rocks and soil, and is also found in vegetable and animal substances. In 1914 the supply of potassium salts from Germany was cut off, and it became necessary to discover some other source from which to obtain the potash required by the industries. As orthoclase is a mineral of very common occurrence, and in unlimited quantity, and contains from 9% to 14% K_2O, a great deal of research work has been done on it in the endeavor to extract its potash content.

Historical.—Though it was during the period of the Great War that attention was more particularly focussed on felspar as a possible source of potash, yet attempts have been made to extract it from orthoclase since the middle of the 19th century. Patents for the recovery of the potash content of felspars have been issued in the United States, Canada, and Great Britain from 1854 to the present time. Quite a variety of methods are indicated. The greatest number of these involve the fusion process with a basic compound, usually one of the alkalis or alkaline earths. Others follow a process of digestion of the finely ground mineral with the same basic compounds, the time factor extending from a day to a month. Electrolysis of the moistened powder has also been tried but complete extraction is only arrived at after many repetitions of the treatment. Others have endeavored to solve the problem by heating the mineral in a finely ground state to a high temperature and suddenly cooling to destroy its crystalline nature, and then treating with an alkali under pressure. Another method is to treat the pulverized mineral with hydrofluoric acid and treat the residue with gypsum.

A few abstracts of patents issued will give a more definite idea of what has been done:

Cushman, U. S. Pat. No. 851922, 1907, mixed powdered felspar with water to form a thin sludge. This sludge was then placed in a wooden container which was set inside another larger vessel in which water was then placed. Electrodes are introduced, the positive pole being in the inner vessel and the negative in the outer. On the passage of a current, the potash, soda, and other soluble bases are partially liberated and pass into the water of the outer vessel. By agitating the sludge, or adding thereto a small amount of hydrofluoric acid, an almost complete recovery of potash is effected.

Messerschmitt, U. S. Pat. No. 1,076,508, 1913, extracts the potash from potash-bearing minerals, such as felspar, by powdering the mineral and forming a mixture of 1000 pounds of spar, 600 lbs. of basic calcium nitrate, 120 gallons of water, and 200 lbs. of lime. This mixture is introduced into a digester and heated under pressure of 50-125 pounds for 10-24 hours. The sludge obtained is leached with water and a solution of potassium nitrate is obtained. Any calcium nitrate present is thrown down by the addition of an alkali carbonate to the solution and filtered out. The final solution is then evaporated.

Coolbaugh and Quinney, U. S. Pat. No. 1,125,007, 1915, mix felspar with gypsum or limestone, heat to fusion point, cool rapidly and crush to fine powder. This powder is then leached with water containing a small percentage of sulphuric acid, and the potassium aluminum sulphates obtained in solution are separated by crystallization. A recovery of 90-92 per cent. of the potash contained in the felspar is claimed.

It is claimed that most of these methods give satisfactory results, but the cost of extraction is too great to permit of competition with the industries of Europe.

The future then of the potash industry on the American Continent, depends on the discovery and development of an economical process of separation.

Method.—In a foregoing paragraph several methods for decomposing felspar are outlined, but the decisive objection to these is their cost of operation. A cheap method is still being sought. Rocks are being decomposed continuously in nature in the general process of change and denudation. Statements of geologists on this matter will be of interest. The Encyclopedia Britannica says "It has been supposed that the alteration of the granite or felspar has been effected mainly by meteoric agencies, the carbonic acid having decomposed the alkaline silicate of the felspar, whilst the aluminous silicate assumes a hydrated condition and forms kaolin." It may be mentioned that the formation of kaolin and of potash is brought about by the same operation.

With regard to kaolinization A. W. Graham says:—"The ordinary effect of the atmospheric moisture on the rocks is the attack upon the felspars producing kaolin or clay. This commonly takes place in the presence of CO_2. The formula for the alteration of orthoclase felspar into kaolin, quartz, and potash being

$$2K\,Al\,Si_3O_8 + 2H_2O + CO_2 \rightarrow H_4Al_2Si_2O_9 + 4SiO_2 + K_3CO_3$$

Bulletin 695, U. S. Geological Survey states, in effect, that felspathic decay is not formed by ordinary weathering but by the operation of thermal waters and gaseous emanations, and carbonated waters. While all these processes and others are operative yet the chief chemical activity is due to carbonic acid.

The most important gaseous emanation referred to is probably SO_2. There is a deposit of potash in Hungary supposed to have been derived from orthoclase by the action of sulphurous emanations of a neighboring volcano.

Though nature works by means of these simple agents yet progress is very slow. Many chemical reactions can be hastened by catalytic agents, and this is what has been attempted in the present case. (It will be remembered that the function of a catalyst is to increase the speed of a chemical reaction). Heat and pressure were employed. Platinum sponge was also given a trial.

Apparatus.—The first experiments were made with an ordinary Kipp carbon dioxide generator. A continuous stream of gas was passed through a water mixture of the finely ground felspar, heat and agitation being furnished by boiling. These experiments were, of course, carried out under atmospheric pressure only.

In order to conduct the work at higher pressures a special piece of apparatus was obtained. It was essentially a heavy iron retort consisting of a body of 3½" steel piping of ¼" thickness. A piece of pipe 13½" long was taken and the ends closed by screwing on two heavy caps. A head 3" in diameter was cut out of one cap and into this removable head were screwed a pet-cock and an inlet pipe, both ½". The head was held in place by a heavy clamp, and the inlet which extended to within an inch of the bottom of the retort was connected with the gas supply by means of a ¾" junction. A hole was tapped in the side of the retort for the pressure gauge.

The gas and pressure were supplied by a cylinder of liquid carbon dioxide, the pressure was also furnished by superheated steam by the simple expedient of boiling with all valves closed.

The only other piece of apparatus used was a hand spectroscope with which qualitative tests were made for potassium.

Analysis.—A quantity of orthoclase sufficient for the work in hand was procured from the geological laboratory and an analysis made of it. The following results were obtained.

Silica,	SiO_2	65.520%
Alumina,	$Al\ O_3$	21.520 "
Potash,	K_2O	11.860 "
Soda,	Na_2O	1.675 "
Lime,	CaO	.151 "
Magnesia,	MgO	.004 "
		100.730%

In making a determination of potassium both the chlorplatinate and the newer perchlorate methods were followed. All things considered the results showed fair agreement. The only reagent it was necessary to prepare was the chlorplatinic acid. This was made by dissolving some scrap platinum in aqua regia. From time to time small amounts of concentrated hydrochloric acid were added but the platinum went into solution very slowly. The digestion required two or three days.

Experimental Results.—Two series of experiments were carried on, one with carbon dioxide, the other with sulphur dioxide. Considerable difficulty was met with from the presence of iron. Efforts were made to meet this nuisance by lining the retort with smoke-stack varnish, which helped in some degree but introduced more or less organic matter. In working out the determination the iron was removed by ammonia, which made it necessary to determine the potash as a chloride after removing the ammonium salts by ignition, while the organic matter was removed partly by filtering and partly by ignition. This made the process of determination rather long. The following is a table of results. The amount of K_2O shown is the percentage of the orthoclase, not of its potash content. The latter figure may be obtained, approximately, by removing the decimal point one place to the right.

Weight of Sample (grams)	Treatment	Time	Result	Remarks
8.3908	Heat & agitation (boiling)	2½ hrs.	Unchanged	
1.5212	" " "	4 "	"	Traces of iron
16.1080	CO_2 & steam, atmos. press.	6 "	.158% K_2O	
13.2200	CO_2 & intermittent boiling, "	4 "	.196% "	Little Iron
12.5794	CO_2 no heat, pressure advanced	2 "	.161% "	Little Iron
15.4311	CO_2 Interm't boiling, " "	2½ "	.458% "	Little Iron
60.5300	" no heat, Pressure 50 lbs.	2 "	.090% K_2O	
52.3200	" " " " " "	5 "	none	
28.6770	" intermittent heating by steam, pressure 100 lbs.	10 "	.145% K_2O	More iron
19.7476	CO_2 sintered feldspar for ¾ hrs superheated steam, 100 lbs.	5 "	.224% K_2O	
2.3964	SO_2 and boiling	1 hr.	.376% K_2O	residue dark
2.6800	" " "	2 hrs.	.396 "	
3.2020	" " "	4 "	.385	" "
15.0214	" " "	4 "	.334 "	" "
21.0526	SO_2 sintered feldspar superheated steam, 100 lbs. press.	2 "	.300 "	" "

Successive Treatment with CO_2

Treatment	Time	Potash
CO_2 and Boiling, Atmos. Press.,	2 hrs.	.132%
" " " " "	"	.100%
" " " " "	"	.115%

Certain deductions from these results are quite clear, while others remain problematical.

It seems that heat and agitation alone do not cause a measurable amount of decomposition, at least during a period of a few hours.

Considering the action of carbon dioxide it would appear at first that the time factor, heat, and agitation make practically no difference, the percentage of potash obtained being the same with a variation of these agents.

But when the preliminary experiment was made with a higher pressure and intermittent boiling an increase of decomposition was obtained, which suggested heat and pressure as being of some importance. Accordingly the special piece of apparatus previously described was procured, but the results were disappointing. It is obvious that the pressure used had no effect, and it was only when heat and agitation were employed that the degree of disintegration was brought up to what might be termed the normal amount.

It was thought that if the felspar were sintered the crystalline character of the mineral would be sufficiently destroyed to permit of more decomposition. This was accordingly done, but practically no change in the result was obtained.

The idea was gradually being acquired that the sample of orthoclase had previously undergone a certain degree of weathering or alteration of some kind in consequence of which a small percentage of the sample was subject to the action of carbon dioxide while the rest was unaffected. To test this idea a series of successive treatments was carried out. The sample was treated for two hours at atmospheric pressure with heat and agitation (boiling) and a continuous stream of carbon dioxide. The residue was reground and the treatment repeated. Practically the same amount of decomposition was obtained each time. This dispels the idea of prealteration and points to the conclusion that the breaking down of the felspar is of a progressive nature. It may be mentioned here that on filtering the reaction product a very fine clay light brown in color was always left on the filter. The reason for its color is not apparent, but its presence confirms the fact of decomposition. After arriving at this conclusion of progressive decomposition it is interesting to recall Grünwald's experiments on the decomposition of feldspar by electrolysis. After fourteen repetitions he obtained about one-third the total potash content, and claimed to obtain complete decomposition by continuing the process.

With regard to the action of sulphur dioxide the same conclusion may be drawn, with this difference—that the percentage decomposition by this agent is much greater.

When platinum sponge was added to the reaction mixture no additional change was observed.

In summary, then, it is concluded: First, SO_2 is more effective than CO_2 in decomposing feldspar.

Second, Heat and agitation have a small value in combination with an active chemical agent.

Third, Platinum as a catalyst is of no value in this reaction.

Fourth, the value of the time factor beyond two or three hours is nil.

Fifth, The decomposition of feldspar is of the nature of an incomplete chemical reaction, the point of equilibrium being definite and appreciably different in the cases of SO_2 and CO_2.

This is readily explained by the ionic hypothesis. Sulphurous acid is a weak acid and carbonic acid is very weak; consequently the degree of ionization is very small. The formation of a very small amount of the largely ionized salts of these acids is sufficient to repress the ionization of the acids, thus bringing about a state of equilibrium at a very early stage. This also explains why the time and pressure factors are of practically no value while the products of the reaction remain in the reaction mixture.

Sixth, As a process for extracting potash from orthoclase feldspar, this method is valueless.

THE PHENOLOGY OF NOVA SCOTIA, 1920.—BY A. H. MACKAY, LL.D., Halifax.

These observations were made by the school children of the Province of Nova Scotia as a part of the Nature Study work prescribed. The pupils report by bringing into the schoolroom the flowering or other specimens when first observed, for authoritative determination by the teacher, who generally credits the first finder by placing the name and the observation on the honor roll section of the blackboard for the day. The teacher, after testing the correctness of the observation, marks it on the schedule with which every teacher is provided—a copy of which is sent in to the Inspector with the school returns at the end of June and January.

The following tables are compiled from 150 of the best schedules out of the 450 sent in. The selections were made and compiled under the direction of Mr. H. R. Shinner, B. A., and Miss Gladys MacLeod, of the Education Department.

The schedules for each year are carefully bound up in large annual volumes which are placed in the Provincial Museum and Science Library, where they can be used by students of climate, etc. The compilers of the phenochrons of the different belts, slopes or regions, have been rural science teachers who have most distinguished themselves as instructors. They were selected for the purpose on the recommendation of the Director of rural science education. The sheets from which the provincial phenochrons are calculated are also bound in annual folio volumes for ease of consultation and preservation.

The Province is divided into its main climate slopes or regions not always coterminous with the boundaries of counties. Slopes, especially those to the coast, are subdivided into belts, such as (a) the coast belt, (b) the low inland belt, and (c) the high inland belt, as below:

No.	Regions or Slopes	Belts
I.	Yarmouth and Digby Counties,	(a) Coast, (b) Low Inlands, (c) High Inlands.
II.	Shelburne, Queens & Lunenburg Co's,	
III.	Annapolis and Kings Counties,	(a) South Mts., (b) Annapolis Valley, (c) Cornwallis Valley, (d) North Mts.
IV.	Hants and Colchester Counties,	(a) Coast, (b) Low Inlands, (c) High Inlands.
V.	Halifax and Guysboro Counties,	" "
VI.a.	Cobequid Slope (to the south),	" "
VI.b.	Chignecto Slope (to the northwest),	
VII.	Northumberland Straits Slope (to the n'h),	
VIII.	Richmond & Cape Breton Co.'s	" "
IX.	Bras d'Or Slope (to the southeast),	" "
X.	Inverness Slope (to Gulf, N. W.),	" "

The ten *regions* are indicated on the outline map on page 157.

THE PHENOLOGY OF NOVA SCOTIA, 1920.

(Complied from the best 150 out of 450 local observation schedules.

Day of the year corresponding to the last day of each month.

Jan.	31	July	212
Feb	59	Aug	243
March	90	Sept	273
April	120	Oct	304
May	151	Nov.	334
June	181	Dec.	365

For Leap Year add one to each except January.

When First Seen. Observation Stations. 1. Yarmouth and Digby	2. Shel. Queen & Lunenburg.	3. Annapolis and Kings	4. Hants and Colchester	5. Halifax & Guysboro	6a. Cobequid Slope	6b. Chignecto Slope	7. Northum. Sts. Slope	8. Richmond and Cape Breton	9. & 10. Inverness and Bras d'Or Slope	Average dates.	Year 1920	When Becoming Common. Average dates.	Observation Regions. 1. Yarmouth and Digby	2. Shel. Queen & Lunenburg.	3. Annapolis and Kings	4. Hants and Colchester	5. Halifax & Guysboro	6a. Cobequid Slope	6b. Chignecto Slope	7. Northum. Sts. Slope	8. Richmond and Cape Breton	9. & 10. Inverness and Bras d'Or Slope
101	102	96	89	92	112	108	95	109	110	101	1. Alnus incana, Wild	107	109	111	104	95	100	119	98	103	114	116
	117	123	109	97	114	117	123	126	127	117	2. Populus tremuloides	124	....	124	127	115	110	120	120	131	131	137
99	98	99	101	99	113	110	106	114	120	106	3. Epigea repens, L.	116	107	110	109	111	111	126	123	116	120	128
115	126	123	121	123	131		127	135	128	125	4. Equisetum arvense	133	126	131	129	134	129	136	....	133	141	136
		132	125	120	121		130	137		128	5. Sanguinaria Canadensis	135	....	....	135	130	132	....	....	136	144	....
122	123	125	126	129	128	127	129	133	127	127	6. Viola Blanda	132	127	130	132	132	134	135	129	134	138	133
122	127	127	129	133	130	129	132	137	133	129	7. Viola palmata, *cucullata*	135	130	133	135	135	137	133	131	136	140	140
	132	98	121	122			134		177	131	8. Hepatica triloba, etc	136	....	135	111	....	129	....	....	136	....	171
123	133	130	134	136	141	130	133	136	137	133	9. Acer rubrum	139	130	140	137	139	139	146	....	138	141	142
124	126	125	127	130	134	131	131	134	136	129	10. Fragaria Virginiana	138	131	133	134	134	138	155	136	138	141	144
153	161	158	159	164	161	160	163	167	166	161	11. " " fruit ripe	170	169	169	172	170	169	169	167	171	173	174
127	129	130	132	135	138	134	136	137	133	133	12. Taraxacum officinale	139	134	136	137	138	140	143	143	140	142	139
144	....	132	141	133	132	134	134	141	138	138	13. Erythronium Americanum	141	....	....	138	150	138	140	137	139	147	140
133	135	136	142	136	140	138	138	142	140	138	14. Coptis trifolia	143	139	140	142	146	142	144	143	143	146	145
.	....	130	135	136	131	126	133	136	134	133	15. Claytonia Caroliniana	138	....	....	136	140	137	133	139	137	140	139
137	132	135	138	139	146	143	144	150	144	141	16. Nepeta Glechoma	149	145	139	142	14.	143	150	136	149	155	144
141	140	138	139	141	148	139	141	147	147	142	17. Amelanchier Canadensis	147	148	145	142	143	146	159	146	144	150	152
...		...	.	.	139	...	212	.	.	212	18. " " fruit ripe	215	....	....	....	....	....	141	....	215	....	..

141	144	143	143	141	144	142	144	153	151	145	19.	Prunus Pennsylvanica	152	149	150	147	148	162	148	148	149	159	156
					145		221	230		225	20	" " fruit ripe	227						147		224	230	
142	140	137	142	141	151	143	145	151	159	145	21.	Vaccinium Can. and Penn.	151	149	146	146	149	148	153	152	150	159	163
					148		217	238		228	22.	" " fruit ripe	229						152		223	235	
144	145	158	148	157	156	153	151	157	157	153	23.	Ranunculus acris	157	153	156	152	155	160	157	159	157	164	161
146	153	161	157	163	163	150	160	169	153	157	24.	R. Repens	163	156	158	164	162	170	166	154	165	173	158
141	147	141	147	146	145	140	146	159		146	25.	Trill. erythrocarpum	161	143	151	146	148	150	151	149	152	163	
143	146	145	143	150	151	150	149	156	167	150	26.	Rhododendron Rhodora	155	153	154	148	152	154	156	150	154	164	159
145	151	150	148	150	152	149	150	156	158	151	27.	Cornus Canadensis	157	153	157	159	154	155	161	156	156	160	160
		148					238			238	28.	" " fruit ripe	238			151			161		241	235	
144	148	147	147	149	154	144	149	156	15	149	29.	Trientalis Americana	155	150	153	153	152	156	158	155	154	162	162
146	150	145	139	155	160	146	156	160	150	150	30.	Clintonia borealis	156	151	156	151	160	159	160	154	160	163	154
157	148		159				159	158	151	155	31.	Calla palustris	165				164		170			168	160
156	152	157	156	155	165	166	154	156	160	157	32.	Cypripedium acaule	161	162	160	151	162	161	167		163	162	162
151	156	148	155	158	160	165	159	164	164	158	33.	Sisyrinchium angustifol.	163	157	162	157	160	163	168	167	164	168	170
161	162	162	160	167	158	175	157	160	158	162	34.	Linnaea borealis	167	160	167	163	167	172	169	175	168	166	169
149	158	135	159	162	156	146	153	156	165	154	35.	Kalmia glauca	162	15	16	150	166	168	167		156	161	171
155	162	157	153		159	181	156	181	163	163	36.	Kalmia augustifolia	164	160	168	164	161		164		162		170
160	160	156	172	156	157	166	156	169	175	162	37.	Crataegus oxyacantha	167	165	165	161	175	169	160	163	164	173	176
163	159	160	151	160	158		157		154	158	38.	Crataegus coccinea, etc	166	170	163	165	157	166	171		165		168
161	162	161	165	168	166	161	164	172	170	165	39.	Iris versicolor	170	165	166	167	170	171	177	167	169	176	175
158	162	159	163	165	165	174	164	172	167	165	40	Chrysanthemum Leucanth.	171	165	163	169	168	171	174	177	169	176	175
158	154	167	159	161	169	169	165	165	164	163	41.	Nuphar advena	169	166	167	173	171	165	170	172	169		170
159	160	156	154	168	157	167	158	159		160	42.	Rubus strigosus	165			162	157	170	162	176	165	165	168
	213	220					204	195		208	43	" " fruit ripe	218	167	170	225	168				215	215	
165	169	167	159	169		180	168	170	159	167	44.	Rhinanthus Crista-galli	171	169	172	174		173		184		175	175
161	168	160	164	170	160	172	166		172	166	45	Rubus villosus	171		228	171	170	175	166	180	157		176
							232	236		234	46	" " fruit ripe	242	165	169						240	243	
163	165	168	165	159	163		165	171		165	47	Sarracenia purpurea	170	174	164	173	169	164			170	176	
164	162	160	150	166	165		164			162	48	Brunella vulgaris	169		173	167	157		171	179	170		
171	169	167	169	175		151	168	205		167	49.	Rosa lucida	170	167	171	173	175	180		153	172	210	
163	165	168	169	170	168	166	170	175		168	50.	Leontodon autumnale	174		177	176	175	175	173	171	171	177	
178	167		145	174	143		168		170	164	51.	Linaria vulgaris	168	145	148			169	148		173		180
136	138	136	135	139	143	134	137	146	128	136	52.	Trees appear green	147	149	149	144	142	148	147	145	156	151	140
140	144	144	143	146	149		146	154	153	146	53.	Ribes rubrum (cultivated)	153			148	150	152	155		150	160	158
144							205	210		205	54.	" " (fruit ripe	211								208	221	
139	145	147	149	146	152	168	147	156	154	150	55.	R. nigrum (cultivated)	156	154	157	152	153	153	159		152	160	159
							206	194		200	56.	" fruit ripe	205								209	201	
144	151	144	149	154	154	149	148	156	154	150	57.	Prunus Cerasus	155	149	156	149	153	160	157	150	152	161	159
							210	209		209	58.	" " fruit ripe	211								211	217	
153	152	145	143	154	160	151	149	163	155	153	59	Prunus domestica	158	152	159	150	156	158	166		154	168	161
148	150	146	148	153	155	154	154	162	157	153	60.	Pyrus Malus	156	155	157	153	164	160	159	152	154	167	134
157	161	153	164	162	165	162	156	170	159	161	61.	Syringa vulgaris	166	162	165	162	164	169	166	168	164	172	166
155	159	158	164	159	165	162	161	161	164	160	62.	Trifolium repens	166	161	165	168	162	167	167	170	167	165	171
147	154	153	156	160	163	158	160	165	168	158	63.	Trifolium pratense	166	156	161	163	168	164	166	173	167	167	173
167	147	152	159	173	168		165		165	162	64.	Phleum pratense	168	175	170	135		180	175		172		167
	187						175	194		185	65	Solanum tuberosum	190				138				180	200	

THE PHENOLOGY OF NOVA SCOTIA, 1920.—*Continued.*

When First Seen.											Year 1920.	When Becoming Common.										
Observation Stations.													Observation Regions.									
1. Yarmouth and Digby	2. Shel. Queen & Lunenburg.	3. Annapolis and Kings	4. Hants and Colchester	5. Halifax & Guysboro	6a. Cobequid Slope	6b. Chignecto Slope	7. Northum. Sts. Slope	8. Richmond and Cape Breton	9. & 10. Inverness and Bras d'Or Slope	Average dates.	Day of the year corresponding to the last day of each month. Jan. .... 31 July ....212 Feb. .... 59 Aug. ....243 March .... 90 Sept. ....273 April ....120 Oct. ....304 May ....151 Nov. ....334 June ....181 Dec. ....365 For Leap Year add one to each except January.	Average dates.	1. Yarmouth and Digby	2. Shel. Queen & Lunenburg.	3. Annapolis and Kings	4. Hants and Colchester	5. Halifax & Guysboro	6a. Cobequid Slope	6b. Chignecto Slope	7. Northum. Sts. Slope	8. Richmond and Cape Breton	9. & 10. Inverness and Bras d'Or Slope
109	113	108	125	128	126	122	130	123	119	120	66. Ploughing first of season	131	125	125	126	139	136	134	137	137	128	126
129	123	132	139	133	138	137	138	136	133	133	67. Sowing	141	136	133	142	141	142	146	144	145	142	141
122	120	129	142	137	140	133	139	132	136	133	68. Potato-planting	140	130	131	140	132	142	144	157	147	137	143
124	116	132	137	144	140	151	137	130	123	133	69. Sheep-shearing	144	142	123	141	....	155	152	167	146	137	132
176	191	215	....	....	....	....	216	216	....	209	70. Hay-cutting	243	....	196	234	....	....	....	....	223	221	....
...	230	236	....	....	....	....	237	249	....	238	71. Grain-cutting	245	....	237	247	....	....	....	....	244	252	....
256	270	260	....	....	....	....	267	269	....	264	72. Potato-digging	274	....	279	267	....	....	....	....	271	276	....
58	85	77	83	88	73	90	101	85	98	84	73a Opening of rivers	....	....	....	....	....	....	....	....	....	....	....
97	89	79	108	112	....	107	....	94	134	103	73b Opening of lakes											
114	111	119	113	118	118	119	118	114	123	116	74a Last snow to whiten ground	....	....	....	....	....	....	....	....	....	....	....
121	120	123	124	121	126	123	123	124	121	122	74b " " to fly in air	....	....	....	....	....	....	....	....	....	....	....
98	142	100	124	168	137	....	127	150	124	130	75a Last spring frost —hard	....	....	....	....	....	....	....	....	....	....	....
151	142	153	151	165	....	....	165	171	146	155	75b " " " —hoar	....	....	....	....	....	....	....	....	....	....	....
....	81	77	83	71	74	....	110	120	115	93	76a Water in streams—high	....	....	....	....	....	....	....	....	....	....	....
....	286	293	62	156	....	....	155	280	....	286	76b " " —low	....	....	....	....	....	....	....	....	....	....	....
....	310	261	....	....	....	....	254	296	....	280	77a First autumn frost—hoar	....	....	....	....	....	....	....	....	....	....	....
265	283	301	263	....	....	....	299	306	....	286	77b " —hard											
312	315	306	310	....	....	....	301	304		308	78a First snow to fly in air	....	....	....	....	....	....	....	....	....	....	....
326	331	315	317	....	....	....	309	314	....	319	78b " whiten ground	....	....	....	....	....	....	....	....	....	....	....
....	....	355	....	....	....	....	307	326	....	329	79a Closing of lakes	....	....	....	....	....	....	....	....	....	....	....
....	....	356	....	....	....	....	343	358	....	352	79b " rivers	....	....	....	....	....	....	....	....	....	....	....
88	84	88	76	82	109	81	91	88	89	87	81a Wild ducks migrating, N.	....	....	....	....	....	....	....	....	....	....	....
....	291	294	....	....	....	....	317	281	....	296	81b " " " S.	....	....	....	....	....	....	....	....	....	....	....

THE LOCAL COMPILERS FOR EACH REGION, 1920.

Region No.		Region No.	
I.	Miss Jennie C Allen	VIa.	Miss Evangeline B. Morrison
II.	Miss Sadie Miller	VIb.	Miss Janet M. Carlisle
III.	Miss Mary Drysdale	VII.	Mr. R. Byrus Curry
IV.	Miss Sadie I. McLellan	VIII.	Mr. D. K. Finlayson, B. A.
V.	Mr. Wilbert Spencer	IX & X.	Miss Armenia H. Rice

THE TEN PHENOLOGICAL REGIONS OF NOVA SCOTIA.

THE PHENOLOGY OF NOVA SCOTIA, 1920.—*Continued*

YEAR 1920

Day of the year corresponding to the last day of each month.

Jan.	31	July	212
Feb	59	Aug.	243
March	90	Sept.	273
April	120	Oct.	304
May	151	Nov.	334
June	181	Dec.	365

For Leap Year add one to each except January.

WHEN FIRST SEEN. — OBSERVATION STATIONS.

1. Yarmouth and Digby	2. Shel. Queen & Lunenburg.	3. Annapolis and Kings	4. Hants and Colchester	5. Halifax & Guysboro	6a. Cobequid Slope	6b. Chignecto Slope	7. Northum. Sts. Slope	8. Richmond and Cape Breton.	9. & 10. Inverness and Brais d'Or Slope	Average dates	Year 1920
87	83	87	71	80	101	81	86	85	86	185	82a Wild geese migrating N.
...	333	295	...	...	84	...	279	279	...	296	82b " " " S.
87	85	85	90	85	94	84	90	90	96	88	83. Melospiza fasciata North
91	82	82	83	82	97	84	83	89	89	86	84. Turdus migratorius "
91	86	119	93	80	100	89	89	88	102	84	85. Junco hiemalis "
127	126	122	128	132	132	...	129	131	126	128	86. Actitis macularia "
144	106	113	109	...	...	...	125	132	105	119	87. Sturnella magna "
118	125	126	129	131	136	124	129	126	130	126	88. Ceryle Alcyon "
134	131	137	133	130	154	140	131	131	...	136	89. Dendroeca coronata "
135	134	140	141	147	129	133	144	140	137	138	90. D. aestiva "
127	160	126	127	122	126		117	127	129	129	91. Zonotrichia alba "
141	148	141	149	152	147	147	151	146	148	147	92. Trochilus colubris "
144	136	138	138	144	144	149	142	144	154	143	93. Tyrannus Carolinensis "
150	136	134	138	144	132	110	149	135	156	138	94. Dolychonyx oryzivorus "
145	141	147	147	147	149	150	142	...	...	146	95. Spinis tristis "
140	137	143	146	154	...	116	152	...	171	145	96. Setophaga ruticilla "
148	125	156	143	169	...	...	145	...	...	148	97. Ampelis cedrorum "
123	130	130	135	127	121	156	131	154	150	136	98. Chordeiles Virginianus
88	96	93	96	98	115	115	102	94	118	102	99. First piping of frogs
104	111	114	118	118	126	136	122	121	117	118	100. First appearance snakes

WHEN BECOMING COMMON. — OBSERVATION REGIONS.

Year 1920	Average dates	1. Yarmouth and Digby	2. Shel. Queen & Lunenburg.	3. Annapolis and Kings	4. Hants and Colchester	5. Halifax & Guysboro	6a. Cobequid Slope	6b. Chignecto Slope	7. Northum. Sts. Slope	8. Richmond a d Cape Breton.	9. & 10. Inverness and Bras d'Or Slope
82a	...	...	...	...	...	...	...	...	...	...	...
82b	...	...	...	...	...	...	...	...	...	...	...
83.	...	...	...	...	...	...	...	...	...	...	...
84.	...	...	...	...	...	...	...	...	...	...	...
85.	...	...	...	...	...	...	...	...	...	...	...
86.	...	...	...	...	...	...	...	...	...	...	...
87.	...	...	...	...	...	...	...	...	...	...	...
88.	...	...	...	...	...	...	...	...	...	...	...
89.	...	...	...	...	...	...	...	...	...	...	...
90.	...	...	...	...	...	...	...	...	...	...	...
91.	...	...	...	...	...	...	...	...	...	...	...
92.	...	...	...	...	...	...	...	...	...	...	...
93.	...	...	...	...	...	...	...	...	...	...	...
94.	...	...	...	...	...	...	...	...	...	...	...
95.	...	...	...	...	...	...	...	...	...	...	...
96.	...	...	...	...	...	...	...	...	...	...	...
97.	...	...	...	...	...	...	...	...	...	...	...
98.	...	...	...	...	...	...	...	...	...	...	...
99.	...	...	...	...	...	...	...	...	...	...	...
100.	...	...	...	...	...	...	...	...	...	...	...

THUNDERSTORMS—PHENOLOGICAL OBSERVATIONS, NOVA SCOTIA, 1920

The indices indicate the number of stations from which the Thunderstorms were reported on the day of the year specified.

OBSERVATION REGIONS.

1. Yarmouth & Digby	2. Shelburne, Queens & Lunenburg.	3. Annapolis & Kings.	4. Hants & Colchester.	5. Halifax & Guysboro.	6a. Cobequid Slope.	6b. Chignecto Slope.	7. Northum. Sts. Slope.	8. Richmond & Cape Breton.	9 & 10. Inverness & Bras d'Or Slope.	Total 1920
			45							45
		72^3	72							72^4
73^3										73^3
		84								84
	90^4									90^4
	91									91
96^2										96^2
97										97
		114^2		114^2						114^4
115^6	115^{10}									115^{10}
116										116
									120	120
				122						122
124										124
				125						125
130										130
		135	135^2							135^3
136^2	136^2	136								136^5
									151	151
					152^2	152			152	152^4
		153	153		153	153^2				153^5
		154								154
	155	155^2								155^3
				156						156
160										160
								161		161
164								164^2	164^2	164^5
								165^8	165^{11}	165^{19}
		166								166
167										167
				170				170		170^2
					171					171
				172						172
	173^5								173	173^6
174	174									174^2
			175^4	175						175^5
176^2		176		176^2	176					176^6

Thunderstorms—Phenological Observations, Nova Scotia, 1920

The indices indicate the number of stations from which the Thunderstorms were reported on the day of the year specified

Observation Regions

1. Yarmouth & Digby	2. Shelburne, Queens & Lunenburg.	3. Annapolis & Kings.	4. Hants & Colchester.	5. Halifax & Guysboro.	6a. Cobequid Slope.	6b. Chignecto Slope.	7. Northum. Sts. Slope.	8. Richmond & Cape Breton.	9 & 10. Inverness & Bras d'Or Slope.	Total 1920
			185							185
			189							189
	227									227
								235^4		235^4
								236		236
		243^2						243^4		243^6
	244^2	244^3	244					244		244^7
		245								245
		256								256
	257^2		257					257		257
	258									258
								259^2		259^2
								268		268
								270^2		270^2
		272								272
		274								274
	280^2									280^2
		285								285
		286								286
	295									295
		309						309		309^2
								311		311
								321		321
		333								333
		339								339
	340									340

CONTENTS

VOL. XV. PART 4

PROCEEDINGS

OF THE

Nova Scotian Institute of Science

SESSION OF 1921-1922

(Vol. XV. Part 4)

60th Annual Business Meeting.

Physiological Lecture Room, Dalhousie College, Carleton St., Halifax, 14th November, 1921.

The President, Dr. John Cameron, in the chair. Other members present: Prof. C. B. Nickerson, D. J. Matheson, Prof. D. S. McIntosh, Dr. A. H. MacKay, Dr. D. Fraser Harris, Dr. S. G. Ritchie, Dr. H. L. Bronson, Dr. J. H. L. Johnstone, P. R. Colpitt, Dr. F. W. Ryan, E. W. Todd, Dr. A. G. Nicholls, Dr. J. A. Dawson, H. Piers, and others. The meeting was honoured by the presence of His Honour Lieut.-Governor Grant and a number of ladies.

The President, Dr. Cameron, delivered a presidential address entitled "Our Present Knowledge regarding the Ancestry of Man." On motion of the Lieut.-Governor, a vote of thanks was presented to Dr. Cameron.

The general public then withdrew, and the members proceeded with the current business.

The President referred to the loss the society had sustained during the past year, in the death of Dr. George Murray Campbell, on 12th December, 1920, and of Walter Henry Prest, on Christmas Day, 1920.

It was announced that Robie Wilfred Tufts, of Wolfville, had been elected an associate member on 3rd October, and H. R. Chipman, B. A., Dalhousie University, Halifax, an ordinary member on the same date.

The Treasurer, D. J. Matheson, presented his financial report, dated 12th November, 1921, showing that the receipts were $1,363.63, the expenditures $54.99, and the balance in hand (in current account) $1,308.64, while the balance at credit of the reserve fund was $134.39, and the permanent endowment fund was $1,500. It was pointed out that there was chargeable against the balance, the cost of printing the Transactions, vol. 15, pt. 1.—The report was received and adopted.

The Librarian's report was presented by Mr. Piers, showing that 1,199 books and pamphlets had been received through the exchange-list during the calendar year 1920. The total number of books and pamphlets received by the entire Provincial Science Library (with which that of the Institute is incorporated) for the same year was 1,507. The total number in the Science Library on 31st December, 1920, was 64,050. Of these, 47,048 belong to the Institute and 17,002 to the Science Library proper. 138 books were borrowed in 1920, besides many consulted in the Library. No binding or purchasing had been done by the Library directly, there being no money grant for that purpose for a number of years past.—The report was received and adopted.

It was resolved that Dr. MacKay and Mr. Piers be a committee, with power to add to their number, to interview the Government with the object of having a grant of money voted for the purchase of books and for the binding of parts of Transactions in the Provincial Science Library, which institution has been without a regular grant since 1907.

The following were elected officers for the ensuing year (1921-22):

President—Prof. John Cameron, M.D., D.Sc., F.R.S.E., *ex-officio* F.R.M.S.

First Vice-President—Prof. Carleton Bell Nickerson, M.A.

Second Vice-President—Frederick C. Churchill (Wolfville).

Treasurer—Donald J. Matheson, B.Sc.

Corresponding Secretary—Prof. Donald S. McIntosh, M.Sc.

Recording Secretary and Librarian—Harry Piers.

Councillors without office—A. H. MacKay, LL.D., F.R.S.C.; Prof. D. Fraser Harris, M.D., D.Sc., F.R.SS.E.&C.;

E. Chesley Allen; Stephen G. Ritchie, B.A., D.M.D.; William W. Woodbury, B.Sc., D.D.S.; Prof. Howard L. Bronson, Ph.D., F.R.S.C.; Prof. J. A. Dawson, Ph.D.

Auditors—Parker R. Colpitt; John H. L. Johnstone. Ph.D., M.B.E.

First Ordinary Meeting.

Physiological Lecture Room, Dalhousie College, Carleton St., Halifax, 9th January, 1922.

The President, Dr. Cameron, in the chair.

It was reported that the following had been elected members on 1st December: H. Hope Blois, principal of Bloomfield School, Prof. W. A. Peck, Prof. Geo. F. Sleggs, Dr. J. Stanley Bagnall, all of Dalhousie University; Dr. Frank Woodbury, Dr. Alden W. Faulkner and Dr. Allan R. Cunningham, all of Halifax.

Dr. Stephen G. Ritchie delivered a lecture on "Diffusion Experiments in Gelatine; with an introduction on Colloids," illustrated by lantern-slides. The subject was discussed by Dr. Bronson, Prof. Nickerson, Dr. Harris and Dr. Dawson.

Popular Lecture.

Physiological Lecture Room, Dalhousie College, Carleton St., Halifax, 23rd January, 1922.

The President, Dr. Cameron, in the chair. There were also present a large number of members and their friends.

Prof. A. G. Nicholls, M.D., D.Sc., F.R.S.C., delivered a popular lecture on "The Struggle for Life," illustrated by lantern-slides.

Second Ordinary Meeting.

Physiological Lecture Room, Dalhousie College, Carleton St., Halifax, 13th February, 1922.

The President, Dr. Cameron, in the chair.

It was reported that the following had been elected ordinary members on 9th January: E. R. HAMILTON, of N. S. Tramways and Power Company, and HAROLD LARNDER, W. J. JACKSON, H. W. McCURDY and PROF. HAROLD R. THEAKSTON, of Dalhousie University.

On motion it was resolved that the Institute learns with deep regret of the death of its member, DR. FRANK WOODBURY.

THE PRESIDENT, DR. CAMERON, delivered a lecture on "The Physical Characters of the Eskimo Skull," which was followed by one by DR. STEPHEN G. RITCHIE on "The Dentition of the Eskimo," illustrated by some twenty-four skulls obtained from the Mackenzie River and westward by the Arctic Expedition of 1913-18. The subject was discussed by DR. BAGNALL, DR. RYAN, DR. MACKAY, MR. PIERS, PROF. COPP and DR. FRASER HARRIS.

POPULAR LECTURE.

Room 19, Science Building, Dalhousie College, Studley, Halifax, 27th February, 1922.

THE PRESIDENT, DR. CAMERON, in the chair, and a large number of members and their friends present.

It was reported that HORACE E. READ, B.A., Halifax, had been elected an ordinary member on 13th February.

PROF. JOHN H. L. JOHNSTONE, Ph.D., M.B.E., delivered a popular lecture on "The Smallest Things in Nature (the Atom, Electron and Proton)."

THIRD ORDINARY MEETING.

Physiological Lecture Room, Dalhousie College, Carleton St., Halifax, 13th March, 1922.

THE PRESIDENT, DR. CAMERON, in the chair.

FREDERICK W. CHURCHILL read a paper on "The Effects of Glaciation in the Vicinity of Wolfville, N. S." (See Transactions, p. 161.)

A paper by PROF. H. J. M. CREIGHTON, D.Sc., Swarthmore, Penn., U. S. A., on "A Relation Between the Fluidity and the Temperature of Liquids" was read by PROF. NICKERSON. (See Transactions, p. 165.)

Popular Lecture.

Physiological Lecture Room, Dalhousie College, Carleton Street, Halifax, 27th March, 1922.

The President, Dr. Cameron, in the chair. A large number of members and their friends were present.

It was reported that the following had been elected ordinary members on 13th March: G. N. Stultz, D.D.S., John K. Redden, George A. Chudleigh, D.D.S., Gordon R. Hennigar, D.D.S., F. W. Dobson, D.D.S., Arabella Mackenzie, D.D.S., and F. Hubert Dentith.

Prof. J. A. Dawson, Ph.D., Dalhousie University, delivered a popular lecture on "Modern Aspects of Heredity," illustrated by lantern slides.

Fourth Ordinary Meeting.

Physiological Lecture Room, Dalhousie College, Carleton St., Halifax, 10th April, 1922.

The President, Dr. Cameron, in the chair.

The President read a paper on "The Skull of Fossil Man recently unearthed in South Africa, and its Bearing upon the Ancestry of Man." The subject was discussed by Prof. McIntosh, Dr. Fraser Harris, Mr. Todd, Mr. Piers, and Dr. Arabella Mackenzie.

Popular Lecture.

Room 2, Science Building, Dalhousie College, Studley, Halifax, 28th April, 1922.

The President, Dr. Cameron, in the chair, and a large number of others also in attendance.

Prof. Carleton Bell Nickerson delivered a popular lecture on "Colour Photography," illustrated by lantern slides.

Fifth Ordinary Meeting.

Physics Lecture Room, Science Building, Dalhousie College, Studley, Halifax, 26th May, 1922.

The President, Dr. Cameron, in the chair.

The following papers were read by title:

1. Phenological Observations, Nova Scotia, for 1921. By A. H. MacKay, LL.D., F.R.S.C. (See Transactions, p. 189.)
2. Diatoms of Nova Scotia collected about thirty years ago by Dr. A. H. MacKay, and named and distributed in slides by Tempere and Peragallo of Paris, 1907 to 1915. By A. H. Mackay, LL.D., etc. (See Transactions, p. 175.)
3. List of a Small Collection of Ants obtained in Queen's County, N. S., by the late Walter H. Prest. By Harry Piers. (See Transactions, p. 169.)

Popular Lectures.

Physics Lecture Room, Science Building, Dalhousie College Studley, Halifax, 26th May, 1922.

The President, Dr. Cameron, in the chair, and a large number of others also present.

R. Letts, of the Marconi Wireless Telegraph Company of Canada, delivered a popular lecture on "The Mechanism of the Wireless Telephone," followed by a practical demonstration of the transmission of music by wireless.

Harry Piers,
Recording Secretary.

OBITUARY NOTICE OF WALTER HENRY PREST, GEOLOGIST, 1856-1920.—BY H. PIERS.

By the death of Walter Henry Prest, which occurred at Halifax on Christmas Day, 1920, Nova Scotia lost an unassuming man who possessed native ability of the highest degree, and science a geologist of marked attainments.

Mr. Prest was born at Mooseland, Halifax County, N. S., about 1856. His opportunities for attending school were very slight. He did not receive regular instruction for more than a year or two, so that his learning was self-acquired. He possessed, however, an insatiable thirst for knowledge, which overcame all obstacles, so that by hard application he taught himself, while earning a living, and soon became a persistent and discriminating reader and a deep thinker—characteristics which he retained till the last.

When but a mere lad he worked in the Mooseland gold mines, and acquired an interest in geology which rapidly developed, and which became of service when he engaged in mining operations on his own account. At the age of about twelve years he made a compass survey of the district about his home, and mapped it. At that time he had no books on geology, and had to think out causes and effects for himself. A juvenile geological essay which he sent to the "Nova Scotian" newspaper, brought a highly appreciative note from the editor, and his regret that he could not publish it, as it was not in accord with theological beliefs.

As a youth he came to Halifax, and frequented the poorly-equipped Citizens' Free Library, which to him contained undreamed-of treasures. Then for some years, after about 1875, he engaged in prospecting and gold-mining, while adding to his knowledge at every opportunity.

During the summers of 1892 and 1893 he ably assisted Dr. L. W. Bailey in his survey of southwestern Nova Scotia, for the Geological Survey of Canada, and that gentleman gives the highest credit to Prest's knowledge of geology, prospecting and mining, and his enthusiasm and powers of endurance. His great zeal in this work for his country caused his health to break down. In 1901 he explored parts of the Labrador coast and collected plants there. In 1904 he was assistant to Mr. Faribault on the geological survey of Lunenburg County, and that geologist also refers to the especially valuable and useful nature of his services. During the intervening and later years he was engaged in land surveying and mining, and would make a survey in weather which would keep other men indoors. In 1914 he was employed in the Mines Office, Halifax, and prepared an excellent report on our metalliferous mines for the annual report of that department. For a time he was connected with the Crown Lands Office. During the Great War he volunteered for service, but not being suitable for overseas work, he served with the home-defence forces till the end of the war.

In 1892 he published his first paper on a geological subject in the Transactions of the N. S. Institute of Science, and his notable paper of 1894 on "Deep Mining in Nova Scotia" was very widely read and quoted. Since then that journal has had numerous valuable contributions from his pen, mostly relating to our gold measures and glacial geology, but some dealing with anthropological subjects. He also contributed many articles to the mining pages of the late "Industrial Advocate" of Halifax. In 1915 he published a bound volume on the "Gold Fields of Nova Scotia: a Prospector's Handbook," a useful work which contains a very great amount of original information and which has been much praised. He always possessed great stores of systematic notes on his observations in the field, from which he could always draw.

In 1919 and 1920 he devoted some time to collecting ants, with the view of eventually publishing a paper on the subject; but this he did not live to accomplish. (See Trans. N. S. Inst. Sc., vol. 15, pt. 4, p. 169.)

In the year of his death he spent some months in the libraries of Boston, studying daily from early morning till late at night; and as a result left a voluminous manuscript nearly ready for the printer, dealing with the origin of religions, etc., which evidences much research into all literature bearing on the subject.*

Probably next to Dr. Faribault, of the Geological Survey, he had become recognized as a high authority on problems relative to the Gold Measures of this province, and also an authority on local glacial geology; and his name and writings are known to most of the foremost geologists of America, with many of whom he corresponded.

In November, 1894, he was elected a member of the N. S. Institute of Science, and he became a constant reader of the technical journals in that society's library, and his reading embraced most of the very latest and best monographs on geological and anthropological subjects. He had acquired a knowledge of some foreign languages, such as French and German, and was not daunted in extracting information from a paper in those languages.

Although unable to secure a college education himself, he was an advocate of the great advantage of such a training, and deeply regretted his own inability to take a collegiate course. His self-education was a form of laboratory training, in which he had to find out things for himself, and his laboratory was the realm of nature. He never failed to take advantage of all the best that scientific men made public, and therefore was thoroughly modern in technical ideas Of late years he lamented that he was denied the leisure to keep up his reading of the latest contributions to knowledge. In his demeanour he was modest and unassuming to a fault; but when he used his pen he compelled attention.

That his country did not show its appreciation of his merits in a monetary way, is a matter we may have to reproach ourselves with. Among students of Nova Scotian geology, he will not be forgotten, for his writings will always have to be reckoned with. His life was a long, brave struggle with adverse circumstances, against which he nobly bore up; and his achievements show what can be done by persistence and intense application.

*This manuscript, closely written in two volumes, is at present in the custody of Mr. Fred P. Ronnan, of Halifax.

Published Writings of W. H. Prest

1892. Evidence of the post-glacial extension of the southern coast of Nova Scotia. Trans. N. S. Inst. Sc., vol. 8, pp. 143-147.

1893. *See extracts from his notes in* Bailey's Preliminary report on geological investigations in southwestern Nova Scotia. Rept. Geol. Survey Canada, vol. 6, for 1892-3, Ottawa, 1895, report Q.

1894. Deep mining in Nova Scotia. Trans. N.S.I.S., vol. 8, pp. 420-434.

1896. Glacial succession in central Lunenburg. Trans. N.S.I.S., vol. 9, pp. 158-170.

1896. *See extracts from his notes in* Bailey's Report on geology of southwest Nova Scotia. Rept. Geol. Survey Canada, vol. 9, for 1896, Ottawa 1898, report M.

1897. Measurements of two Beothuk skulls. Proc. N.S.I.S., vol. 9, pp. pp. lxxxviii-xc.

1901. On drift ice as an eroding and transporting agency. Trans. N.S.I.S., vol. 10, pp. 333-344.

1902. Supplementary note on drift ice as an eroding and transporting agent. Trans. N.S.I.S., vol. 10, pp. 455-457.

1905. Edible wild plants of Nova Scotia. Trans. N.S.I.S., vol. 11, pp. 387-416.

1911. A suggestion for anthropological work in Nova Scotia. Trans. N.S.I.S., vol. 13, pp. 35-39.

1911. Prospecting in Nova Scotia. Journal Mining Soc. of N. S., vol. 16, pp. 73-91, with ills.

1912. Report on cave examination in Hants County, N. S. Trans. N.S.I.S. vol. 13, pp. 87-94, with ills.

1914. Report of the metalliferous mines of Nova Scotia for year ended September 30, 1914. In Annual Report of the Mines, Dept. Pub. Works and Mines, 1914, Halifax, 1915, pp. 86-112, with ills.

1915. The gold fields of Nova Scotia: a prospector's handbook. Halifax, Industrial Publishing Co., 1915, 158 pp., with original illus., also map.

1918. On the nature and origin of the eskers of Nova Scotia. Trans. N.S. I.S., vol. 14, pp. 371-393.

1919. Eskar excavation in Nova Scotia. Trans. N.S.I.S., vol. 15, pp. 33-45, with ills.

Also many articles in the mining section of "The Industrial Advocate," Halifax, up to the time it ceased publication about August, 1916.

TRANSACTIONS

OF THE

Nova Scotian Institute of Science

SESSIONS OF 1921-1922

(Vol. XV, Part 4)

The Effects of Glaciation in the Vicinity of Wolfville, N. S.—By Frederick C. Churchill, Wolfville, N. S.

(Read 13 March, 1922)

About a mile east of Wolfville post office there lies a gorge occupied by a small brook, the waters of which flow northward into the Minas Basin and thus drain part of the Wolfville ridge.

This valley, called Evan's Gorge, runs at right angles to the Gaspereau River. The tiny brook begins its flow at the summit of the ridge, and as one looks to the south towards the Gaspereau he will see only a slight depression without any stream. Down this slope a little surface or sheet wash finds its way to the river below, and the hillside is more or less swampy, being kept moist by springs.

Looking northward from the water-shed, the head of the gorge is surrounded by a basin-shaped depression, cut in the arkosic sandstone of the Horton Series which underlies this region. An escarpment of sandstone crosses the head of the gorge, at the crest of the ridge. Here the perpendicular drop to the bottom of the valley is about fifty feet, and it seems reasonable to suppose that this escarpment was at one time the location of a waterfall when the valley was occupied by a larger stream than the present one.

This basin-shaped depression is now the site of a stagnant pool, almost entirely fed by springs and well filled by vegetation adapted to such places. Continuing north and along the valley, we see overlapping rock spurs for several hundred feet, and throughout this distance it has a zigzag course, both facts pointing to a stream-cut valley. As we advance northward towards its mouth, it gradually grows wider and finally ceases, the brooks flowing over a gently sloping surface. The length of the gorge is about 3,500 feet and its width averages about 350 feet.

Throughout its entire course, it is free from drift, which is so common in this locality. Near its mouth a well-defined moraine may be seen, which will be described later.

During my many examinations of this gorge I noted the following evidences which seem to support the theory that this valley was cut by a rapidly-flowing stream, and that the time was not sufficient to allow it to become adjusted to the underlying rock structure. Here rocks dip about twenty degrees in a northeasterly direction, and as the stream runs nearly parallel to the strike it may thus be considered a strike valley. When strike valleys develop normally and are adjusted to the geological structure, one side is steep and the other side has a gentle slope; but here we find that both sides slope alike, and this seems to show that the gorge was cut out rapidly and, therefore, not adjusted. Here the sandstone is very soft and easily eroded.

Judging from the direction of the valley, the location of the moraine, and the fact that the head of the gorge is the lowest point on the Wolfville ridge with the exception of a place south of Grand Pré, where a similar gorge exists, it appears that this valley may have been a spill-way of the Gaspereau River. If the Gaspereau was ever dammed by glaciation, this gorge would naturally carry off the overflow, and after the retreat of the ice would dwindle to its present size

It seems hard to believe that the present watershed of the Wolfville ridge could supply enough water to cut a valley of this size; and moreover if this were true, the valley would have been cut more slowly and would show a normal development.

The moraine that lies to the northwest of the mouth of the gorge is about sixty or seventy feet above sea level, and contains a little boulder-clay and many huge boulders weighing several tons down to the smallest rock fragments. Here may be seen trap from the North Mountain, sandstone, shale, and other rocks, lying in a confused heap. None of these rocks have been transported from any great distance; the trap had the longest journey, about twelve miles. These boulders are characteristic of glaciation, having a flat smooth side with rough edges, and many are well striated.

Boulder-clay is not very abundant and was probably washed to lower levels. This confused mass of rock rubbish was well washed over by the waters of the Basin when the land stood relatively lower after the final retreat of the ice sheet.

The glacial striæ in this locality are quite numerous on the slates that lie to the south, and show that the ice movement was south ten degrees east. About a half-mile south of Wolfville the hills are terraced, and these have frequently been mistaken for raised beaches. Upon examining these, one will find gravel and loose pebbles, but they lie in confused heaps and are not stratified. Here the boulder-clay is very deep, and these terraces mark the places where the ice dropped its load as it smoothed out the clay during its journey. These terraces are conspicuous bits of topography and are found 200 to 300 feet above sea-level.

South of Grand Pré the hills are frequently drumlin shaped, having a gentle slope to the north and steeper on their south side. These prettily-rounded hills are carved out of till, and are true monuments of glaciation.

A RELATION BETWEEN THE FLUIDITY AND THE TEMPERATURE OF LIQUIDS.—BY HENRY JERMAIN MAUDE CREIGHTON, Assistant Professor of Chemistry in Swarthmore College, Swathmore, Pennsylvania.

(Read 13 March, 1922)

Some years ago it was shown by Ramsay and Young[1] that for any pair of closely related substances—such as methyl acetate and ethyl acetate, or propyl propionate and propyl butyrate—the ratio of the absolute temperatures (T) corresponding to equal vapour pressures is constant, *i. e.*, $\frac{T'_A}{T'_B} = \frac{T_A}{T_B} =$ constant. For substances not closely related it was found that the relation was less simple, but that it might be expressed by the equation, $R' = R + c(t' - t)$, where R' is the ratio of the absolute temperatures of the two substances corresponding to any vapor pressure, the same for both; R is the ratio of the absolute temperatures at any other vapor pressure, again the same for both; c is a constant; and t' and t are the temperatures of one of the substances corresponding to the two vapour pressures. This relationship was tested by Ramsay and Young for 23 pairs of substances, and has also been found to hold up to the critical point. The method has been employed by Ramsay and Travers[2] to calculate the vapor pressure of the inert gases argon, krypton and xenon.

At the suggestion of Ramsay, Findlay[3] showed that a precisely similar equation to that of Ramsay and Young connects the absolute temperatures at which two substances have equal solubilities, and also the two absolute temperatures at which two chemical equilibria have equal equilibrium constants.

The writer has recently found that the two absolute temperatures at which two substances have the same value for other of their physical constants are related by an equation having this same form. In this paper the relation between the fluidity (reciprocal of viscosity) and the absolute temperature of liquids is presented briefly.

The constant c in the equation $R' = R + c(t' - t)$, where R' and R are the ratios of the absolute temperatures of two

1. Phil. Mag., (5), *20*, 515 (1885); *21*, 33 (1886).
2. Phil. Trans., A., *197*, 47 (1901).
3. Proc. Roy. Soc., *69*, 471 (1902).

liquids A and B corresponding to two values of the fluidity ($\varnothing$) and t' and t are the temperatures of liquid B corresponding to the two fluidities, is determined as follows: The ratios $\frac{T_A}{T_B}$ corresponding to a number of different fluidities are plotted as abscissae against the absolute temperatures, T_B, of one of the liquids as ordinates. A straight line is then drawn through the series of points obtained and "smoothed ratios" read off, corresponding to the temperatures T_B. The values of the smoothed ratios are substituted in the equation $R' = R + c(t' - t)$, and the equation solved for the constant *c*.

The success with which fluidities can be calculated by means of the equation $R' = R + c(t' - t)$ is shown by the examples contained in Tables I and II. In these tables, the asterisk indicates the temperature ratio R from which the other temperature ratios (R') and the corresponding temperatures (T_A) have been calculated.

TABLE I.

Calculation of the Fluidity of Methyl Alcohol (A) from the Fluidities of Water (B).

$c = 0.000568.$

Observed Fluidity $\varnothing$	Observed absolute Temperature: Methyl Alcohol[4] T_A	Observed absolute Temperature: Water[5] T_B	Ratio of observed Temperature $T_A \div T_B$	Calculated absolute Temperature T_A	Calculated Fluidity $\varnothing$	Difference $\varnothing$calc. *minus* $\varnothing$ obs.
170.5	293.1	319.0	0.9189	293.7	170.8	+0.3
182.4	298.1	323.0	0.9221*	298.1	182.4	0.0
195.1	303.1	327.6	0.9252	302.9	194.9	−0.2
209.9	308.1	332.5	0.9266	308.3	210.2	+0.3
223.7	313.1	336.6	0.9302	313.0	223.5	−0.2
238.0	318.1	341.0	0.9328	317.9	237.6	−0.4
253.7	323.1	345.6	0.9349	323.1	253.7	0.0
269.5	328.1	350.0	0.9374	328.1	269.5	0.0
286.5	333.1	354.4	0.9399	333.2	286.7	+0.2

4. Bingham, E. C. and J. L. Cadwell, *Zeitschr. physik. Chem.*, *83*, 649-50 (1913).
5. Bingham, E. C. and G. F. White, *ibid.*, *83*, 646 (1913).

TABLE II.

Calculation of the Fluidity of Octane (A) from the Fluidities of Benzene (B).

c = 0.000354.

Observed Fluidity	Observed absolute Temperature		Ratio of observed Temperatures	Calculated absolute Temperature	Calculated Fluidity	Difference
	Octane[6]	Benzene[7]				Ø calc. *minus* Ø obs.
Ø	T_A	T_B	$T_A \div T_B$	T_A	Ø	
142.2	273.1	287.6	0949.7	273.4	142.6	+0.4
163.2	283.1	296.8	0954.0*	283.1	163.2	0.0
174.8	288.1	301.5	0955.7	288.1	174.8	0.0
185.9	293.1	306.1	0957.6	293.0	185.7	−0.2
197.4	298.1	310.8	0959.1	298.0	197.2	−0.2
209.0	303.1	315.5	0960.5	303.2	209.2	+0.2
233.7	313.1	324.9	0963.7	313.1	233.7	0.0
259.4	323.1	334.1	9967.3	322.8	258.8	−0.6
286.1	333.1	343.3	0970.1	333.2	286.3	+0.2

6. Landolt-Börnstein, "Physikalisch-Chemische Tabellen," S. 78, Berlin 1912.
7. Ibid., S. 80

The preceding examples are only a few of those that have been studied. In most cases the agreement between the calculated fluidity values and those determined by experiment is closer than the fluidity values determined by two different investigators. This agreement indicates that this method can be applied to the calculation of the fluidity or viscosity of liquids with a close approximation of the truth.

In order to calculate the fluidity of a liquid A from the known values of another liquid B, the fluidity of the former is determined at any two temperatures T'_A and T_A. The ratios $\frac{T'_A}{T'_B} = R'$ and $\frac{T_A}{T_B} = R$ are then obtained, the values plotted as abscissae against the absolute temperatures T'_B and T_B as ordinates, and a straight line drawn through the two points.

By multiplying a particular temperature T_B by the corresponding temperature ratio (read off from the curve), the absolute temperature T_A is obtained at which the fluidity of liquid A is equal to that of liquid B at the absolute temperature T_B. In this way the fluidity of liquid A over the whole range of known fluidities of liquid B may be calculated.

Department of Chemistry,
Swarthmore College,
Swarthmore, Pennsylvania.

January 25th, 1922.

LIST OF A SMALL COLLECTION OF ANTS (*Formicidae*) OBTAINED IN QUEEN'S COUNTY, NOVA SCOTIA, BY THE LATE WALTER H. PREST.—BY HARRY PIERS, Curator of the Provincial Museum, Halifax, N. S.

(Presented 26 May, 1922)

The names, distribution and relative abundance of even the commoner species of Ants occurring in Nova Scotia, are, I believe, practically unknown. It is therefore advisable to publish a short list of a few forms which the late Walter Henry Prest, of Halifax, was able to gather during a single month's field work shortly before his death. Everything pertaining to the Ant fauna of the province is of interest in connection with the general geographical distribution of these insects.

Mr. Prest, when a lad living at Moose River, Halifax County, became much interested in the Ants which he found in his home district, and he made extensive notes on their habits as he observed them. Having no descriptive works with which he might identify the various forms he met with, in fact possessing no books at all on the subject, he gave the various kinds tentative designations of his own, under which he classified his records.

In later years he specialized in the study of geology, and became widely known as a particularly well-informed student of and writer on the Gold Measures and pleistocene geology of Nova Scotia, in which subjects he was recognized as quite an authority. During these years his youthful studies of Ants were laid aside but not forgotten. The subject was taken up with revived interest in the summer and autumn of 1919, when he did some collecting at Pleasantfield, Queen's County, and about Halifax. Hearing from him of his interest in this neglected subject, I strongly urged him to collect and study all the forms he might meet with; and as books were not available to assist in questions of identification, I suggested that he send what he collected to Prof. William Morton Wheeler, of the Bussey Institution, Forest Hills, Boston, Mass., who is now the foremost authority on this family of insects in North America, and that he himself should make notes on his observations on all the specimens obtained, with the view of publishing something on the subject when sufficient material had accumulated.

Accordingly in September, 1920, while again engaged in prospecting and geological work at Pleasantfield, near Fifteen-mile Brook, three miles north-northwest of Middlefield, on the road from Liverpool to Brookfield, Queen's County, he collected, in vials, duplicate sets of some 31 lots of specimens, together with 6 lots from North Brookfield, eleven and a quarter miles further inland and to the north-northwest, in the same county.

One set was deposited in the Provincial Museum of Nova Scotia on 28th October, 1920 (Acc. No. 4944), and the other set, numbered to agree with the Museum's set, was forwarded on the same day to Prof. Wheeler, who had very kindly con-consented to identify the specimens. There being only one specimen of No. 32 (*Myrmica brevinodis*), it was sent to Prof. Wheeler, but the species is also represented in No. 27.

Not long afterward Mr. Prest was taken ill and died at Halifax on 25th December, 1920. Prof. Wheeler on 4th January, 1921, identified the specimens and sent to me the list of his determinations according to the numerical designations.

It is deeply to be regretted that Mr. Prest did not live to further carry on his investigations in this line, as it was his habit to devote his whole energy to anything he undertook. In that case the publication of a list would have awaited until much more material had been gathered, and his own full notes as to habits, abundance, etc., had been incorporated. After his death I was unable to ascertain where those notes were, and we have now only his very brief memoranda, usually as to habitat, which are written on the labels of the specimens.

In order that the results of his interruped work may be of some use to future students, I have arranged the list of forms in systematic order, and appended the very brief notes which the collector actually attached to each vial of specimens. The names are according to the determinations of Prof. Wheeler, while the numbers refer to the original numbering of the collection, and indicate the order in which they were obtained.

It will be seen that fourteen forms, representing twelve species, are represented in the thirty-seven lots collected; and probably among them will be found a large proportion of the commoner Ants occurring here. A recent list of the Ants of Connecticut, U. S. A., contains sixty-four forms, representing about forty-five species, so that possibly about thirty forms should be found in our more northern region, where fewer kinds are liable to occur.

This short list will serve as a slight contribution to our local knowledge of these insects, and it is to be hoped that some other student will take up and make reasonably complete the work which Prest began. I do not happen to know of the publication of any other list of Ants of this province.*

Nos. 1 to 29, and 36 and 37 were collected at Pleasantfield, Queen's County; and Nos. 30 to 35 at North Brookfield in the same county; and all in the same month, September, 1920, except No. 37, which was obtained about July, 1919.

The following five lots of specimens were not determined by Prof. Wheeler, and therefore do not appear in the list: No. 10, "nests under rocks in low lands"; Pleasantfield. No. 17, "nests under stone; may be same as No. 18" (i. e. *B. heeri* subsp. *depilis*); Pleasantfield; received in fragments by Prof. Wheeler. No. 23, "nests beneath rocks; with Aphids on spruce root"; Pleasantfield; also received in fragments. No. 26, "nests in moss of meadows, a few inches above water; with Aphids"; [possibly the same as No. 27, *Myrmica brevinodis*]; Pleasantfield. No. 35, "duplicate or variety of a Pleasantfield species"; North Brookfield. The above quoted notes are Mr. Prest's.

Order HYMENOPTERA (Bees, Wasps, Ants, etc.)

Superfamily FORMICINA.

Family FORMICIDAE (Typical Ants).

Subfamily MYRMICINAE.

Crematogaster lineolata Say.—No. 6, nests in old wood; No. 14, nests in old stump, may be variety of No. 15; No. 15, nests under rock; No. 24, nests beneath rocks; No. 36, nests in old log; Pleasantfield.

Myrmica brevinodis Emery, variety.—No. 11; Pleasantfield. No. 32, North Brookfield.

Myrmica brevinodis Emery, variety with smooth postpetiole. —No. 27, nests in moss of meadows, a few inches above water, with Aphids; Pleasantfield.

Myrmica scabrinodis Nylander, variety.—No. 33; North Brookfield. Also in No. 31, two species living in the same nest, but in different passages, beneath rocks; North Brookfield. (The other species in No. 31 is *Lasius niger* var. *sitkaensis*.)

*H. S. Poole in 1900 published a very brief note on the periodical appearance of Ants in a chimney at Stellarton, N S., but he did not name or describe the species. See Proc. N. S. Inst. Sc., vol. 10, p. xlix.

Subfamily Dolichoderinae.

Dolichoderus (*Hypoclinea*) *taschenbergi* Mayr variety *aterrimus* Wheeler.—No. 4, honey ants; No. 13, honey ants, with Aphids; Pleasantfield.

Tapinoma sessile Say.—No. 19, nests beneath rocks on dry land; No. 20, nest under stone; Pleasantfield.

Subfamily Formicinae.

Brachymyrmex heeri Forel subspecies *depilis* Emery,—No. 17(?), nest under stone, may be same as No. 18; No. 18, nest under stone; Pleasantfield.

Lasius (*Formicina*) *brevicornis* Emery.—No. 34; North Brookfield.

Lasius niger Linn. subspecies *alienus* Förster variety *americanus* Emery.—No. 9, nest under rocks in dry land; No. 21, nest under stone; Pleasantfield.

[Large swarms of *Lasius niger alienus* var. *americanus* are observed about Halifax during the nuptial flight on fine, warm, more or less calm days during the first week of September. This small, black, winged ant was observed in swarms about Halifax and Northwest Arm on 1st Sept., 1919. On 3rd Sept., 1921, a very hot day, numerous swarms were also noted about Halifax and Bedford. On the evening of 4th Sept., 1922, it occurred in countless small swarms, one swarm very closely following its predecessor and appearing like never-ending whisps of smoke or mist against the sky, all flying in a northwesterly direction, over Armdale at the head of the Northwest Arm, Halifax. The insects were also very pleantiful in the air generally. They were noted from 6 to 7.30 p. m. daylight-saving time (5 to 6.30 standard time). It had been a dull, cloudy day, with a northwest breeze during the earlier part of the afternoon, and a temprature of 68°. Rain and lightning occurred at 10.40 p. m. Specimens sent to Prof. Wheeler were males of this variety (see Museum Acc. No. 5145). On 9th September, 1923, a warm, calm day, very many of these winged ants were observed about Armdale, Northwest Arm, and MacNab's Island. Less numerous swarms of large, winged, black ants of another species, not determined, occur on hot days from about 29th May to 4th June.—H. Piers.]

Lasius niger Linn. variety *sitkaensis* Pergande.—No. 12, beneath rocks on hills of No. 5 (*Formica ulkei*); No. 22, nests beneath rocks; Pleasantfield. No. 30, nest in well-formed hill;

also in No. 31, two species living in the same nest, but in different passages, beneath rock; North Brookfield. (The other species in No. 31 is *Myrmica scabrinodis*.)

Formica exsectoides Forel.—No. 1, without slaves; No. 3, slave owners; No. 28, nests in hills,—may be a lighter variety of Nos. 1 and 3; Pleasantfield.

Formica fusca Linn.—No. 2, slaves; No. 8, black wood-ants; No. 16, nest in rotten log; No. 25, nests beneath rocks, may be same as No. 2; No. 29, nests beneath rocks; Pleasantfield.

Formica ulkei Emery.—No. 5, slave-making ants, with well-formed hills; No. 37, stones carried by No. 5 to top of ant-hill, 1½ ft. high,—"carried by one ant, it shows strength; by two, intelligence"; Pleasantfield.

Camponotus herculeanus Linn. subspecies *ligniperda* Latreille variety *noveboracensis* Fitch.—No. 7, wood ants, keep Aphids; Pleasantfield.

DIATOMS OF NOVA SCOTIA: Collected by Alexander Howard MacKay, and determined, distributed and lists published by J. Tempère and H. and M. Peragallo, Paris, France, 1907-1915.—By A. H. MACKAY, LL.D., F.R.S.C.

(Read by title, 26 May, 1922)

These diatomaceous deposits were collected about thirty-five years ago by me, when Principal of the Pictou Academy. The species were named and distributed in PREPARED MICROSCOPIC SLIDES by Tempère and Peragallo, and the lists were published in the second edition of "Diatomées du Monde Entier" published from 1907 to 1915 in 30 "Fascicules" of 16 pages each, descriptive of 1000 microscopic slides of diatomaceous deposits from all parts of the world. The genera and species are arranged alphabetically for the convenience of future reference to the nomenclature.

(The number in brackets indicates the Serial No. of the slide of the set of 1000 containing a sample of material from the locality named.)

LIST OF SPECIES.

Achnanthidium flexellum Bréb. Grant Lake, Pictou Co. (374).

Amphora libyca Ehr. var. ? Grant Lake (374); Maclean Pond, Pictou Co. (394) and Earltown Lake, Colchester Co. (605).

lineata, var. *euglypta*. Earltown Lake, Colchester Co., (605).

ovalis Ktz. Maclean Pond, Pictou Co. (394).

ovalis Ktz. forma *minor*. High Pond (372); Swamp Pond (373), Pictou.

Cocconeis lineata Ehr. Maclean Pond, Pictou Co. (394); Drakesville (679).

placentula Ehr. Swamp Pond (373); Grant Lake (374); Drakesville (679).

Cyclotella Charetoni H. & M. P. Musquodoboit Lake, Halifax Co. (879).

comta Ktz. High Pond, Pictou Co. (372).

Cyclotella

Temperii F. Heri. var. ? High Pond, Pictou Co. (372); Maclean Pond, Pictou Co. (394).

Terryana Temp. & Per. Mill's Pond, Morris River (395).

var. *major.* Mill's Pond, Morris River (395).

var. *minor.* Mill's Pond, Morris River (395).

Cymatopleura apiculata W. Sm. Mill's Pond, Morris River (395).

solea W. Sm. Mill's Pond, Morris River (395).

Cymbella arcus Ehr. Drakesville (679).

acutiuscula Cl. Grant Lake, Pictou Co. (374).

amphicephala Naeg. Besancon's Lake, Pictou Co. (733).

aspera Ehr. Cornwallis (992).

capitata M. Per. & F. H. Heribaud. Grant Lake (374) and Maclean Pond, Pictou Co. (394).

cistula Kirch. Swamp Pond (373); Grant Lake (374); Maclean Pond, Pictou Co. (394); Mill's Pond, Morris River (395).

cistula Hemp. Earltown, Colchester Co. (605); Drakesville (679).

var. *crassa.* Grant Lake, Pictou Co. (374).

cuspidata Ktz. Mackintosh Lake, Pictou Co. (14), (15).

forma *major* (120 mu long). Grant Lake, Pictou Co. (374).

cymbiformis Bréb. Grant Lake, Pictou Co. (374); Drakesville (679).

Ehrenbergii Ktz. Grant Lake, Pictou Co. (374); Maclean Pond, Pictou Co. (394); Earltown Lake, Col. Co. (605); Cornwallis, N. S. (992).

var. *crassa* (New var.). Shorter and at the extremities more rostrate-truncate than that figure in A. S. Atlas 9:7. Grant Lake, Pictou Co. (374).

heteropleura Ralfs. Grant Lake, Pictou Co. (374); Maclean Pond, Pictou Co. (394); Earltown Lake, Col. Co. (605).

var. (?) Mackintosh Lake (14), (15).

lanceolata Ehr. Mackintosh Lake (14 & 15); Earltown Lake (605).

Cymbella

maculata Ktz. Maclean Lake (394).

naviculaeformis Auers. Grant Lake (374).

Diploneis elliptica Ktz. Grant Lake (374); Maclean Pond (394).

Smithii Bréb. Swamp Pond, Pictou Co. (373); Grant Lake (374); Maclean Pond (394).

Encyonema gracile Rab. High Pond, Pictou Co. (372); Earltown Lake (605); Besancon's Lake, Pictou Co. (733); Musqudoboit Lake (879).

lunula Grun. High Pond, Pictou Co. (372); Earltown Lake (605).

Mackayiana Temp. & Peragallo. New species. Similar to the form in Atlas A. S. pl. 10, fig. 49, 50, but at the center much more developed, with striae less radiant and strongly granulated to the number of 7 on the back and 8 on the belly in 10 mu. Length 60 mu., breadth 20 mu. Mill's Pond, Morris River (395).

turgidum Greg. Drakesville (679).

ventricosum Grun. Grant Lake (374); Besancon's Lake (733); Cornwallis (992).

Epithemia amphicephala Grun. Maclean Pond (394).

gibba Ktz. Maclean Pond (394); Earltown Lake (605); Drakesville (679).

turgida Ktz. Grant Lake (374); Maclean Pond (394); Earlton Lake (605); Drakesville (679).

turgida Ktz. var. *granulata.* Grant Lake (374); Maclean Pond (394); Earltown Lake (605).

turgida Ktz. var. *porcellus,* forma *excavata.* Grant Lake (374).

Westermanii Ktz. Drakesville (679).

Epithemia zebra Ktz. Grant Lake (374); Maclean Pond (394); Earltown Lake (605); Drakesville (879).

zebra Ktz. forma *minor.* Grant Lake (374).

forma *proboscidea.* Drakesville (679).

Eunotia arcus Ehr. Mackintosh Lake (14, 15); High Pond (372); Grant Lake (374); Besancon's Lake (733); Cornwallis (992).

Eunotia

var. *hybrida.* High Pond (372).

var. *uncinata.* Earltown Lake (605); Cornwallis (992).

var. *bidentula* W. Sm. High Pond (372); Besancon's Lake (733); Musqudoboit Lake (879).

diodon Ehr. Grant Lake (374).

flexuosa Bréb. var. (?) High Pond (372).

formica Ehr. Mackintosh Lake (14, 15).

gracilis Ehr. Mackintosh Lake (14, 15); Swamp Pond (373).

Rab. Mill's Pond, Morris River (395).

W. Sm. Besancon's Lake (733).

Bréb. Musquodoboit Lake (879).

impressa Ehr. Grant Lake (374).

incisa Greg. High Pond (372); Swamp Pond (373); Grant Lake (374); Besancon's Lake (733).

lunaris Grun. High Pond (372); Maclean Pond (394); Musquodoboit Lake (879).

var. *bilunaris.* High Pond (372).

major Rab. Mackintosh Lake (14, 15); High Pond (372); Swamp Pond (372); Grant Lake (374); Maclean Pond (394).

minor V. H. Grant Lake (374); Besancon's Lake (733).

monodon Ehr. Swamp Pond (373); Grant Lake (374); Maclean Pond (394); Besancon's Lake (733).

forma *curta.* Grant Lake (374).

obtusiuscula Grun. var. *incisa* Grun. Besancon's Lake (733).

pectinalis Rab. High Pond (372); Besancon's Lake (733).

var. *undulata.* High Pond (372); Bezancon's (733).

venter (?) Grant Lake (374); Bezancon's (733)

ventricosa. High Pond (372).

pentaglyphis Ehr. Swamp Pond (373).

praerupta Ehr. Cornwallis (992).

bidens. Cornwallis (992).

robusta (Ehr). Ralfs. Mackintosh Lake (14,15) High Pond (372).

Eunotia

var. (?) Musquodoboit Lake (879).

var. *diadema.* Mackintosh Lake (14, 15).

var. *hexadon.* High Pond (372); Besancon's (733).

var. *octagon.* Swamp Pond, Pictou Co. (373).

var. *polydon.* Mackintosh Lake (14, 15); Swamp Pond (373); Grant Lake (374); Besancon's Lake (733).

Fragilaria capucina Desmaz. var. *mesoleia.* Drakesville (679).

construens Grun. var. *binodis.* Drakesville (679).

var. *genuina.* Drakesville (679).

virescens Ralfs. Besancon's Lake (733).

undata W. Sm. Besancon's Lake (733).

Gomphonema acuminatum Ehr. Grant Lake (374); Maclean Pond (394); Earltown Lake (605); Drakesville (679).

var. *coronatum.* Earltown Lake (605).

var. *intermedia.* Grant Lake (374).

var. *pusilla.* Grant Lake (374); MacLean Pond (394).

var. *trigonocephala.* Maclean Pond (394).

var. *Augur.* Maclean Pond (394).

Brebissonii Ktz. Cornwallis (992).

capitatum Ehr. High Pond (372); Maclean Pond (394); Drakesville (679).

constrictum Ehr. Grant Lake (374); Maclean Pond (394); Mill's Pond (395); Earltown Lake (605); Drakesville (679).

gracile Ehr. Cornwallis (992).

var. *Atlas.* A. S. 236:31. High Pond (372).

intricatum Ktz. Grant Lake (374); Drakesville (679); Cornwallis (992).

montanum Schum. Cornwallis (992).

var. *succisa.* Grant Lake (374); Maclean (394).

parvulum Ktz. High Pond (372).

Gomphonema turris Ehr. Drakesville (679).

Hantzschia amphioxys Grun. var. *elongata.* Earltown Lake (605).

Melosira arenaria Moore. Earltown Lake (605).
crenulata Ktz. Grant Lake (374); Besancon's (733); Cornwallis (992).
var. *Jonensis*. Earltown Lake (605).
granulata Ralfs. Swamp Pond (373); Grant Lake (374).
lineolata Grun. Cornwallis (992).
tenuis Ktz. Maclean Pond (394); Besancon's Lake (733).

Navicula acrospheria Breb. Mill's Pond (395).
var. *dilatata*. Maclean Pond (394).
affinis Ehr. High Pond (372); Grant Lake (374); Besancon's (733).
var. *amphirhynchus*. Grant Lake (374); Besancon's (733).
Americana Ehr. var. *bacillaris*. Grant Lake (374); Maclean (394).
amphigomphus Ehr. Mackintosh Lake (14, 15); High Pond (372); Swamp Pond (373); Drakesville (679); Besancon's Lake (733); Musquodoboit Lake (879).
amphirhynchus Ehr. Grant Lake (374); Maclean Pond (394); Earltown Lake (605).
forma *curta*. Grant Lake (374).
amphisbaena Borz. MacLean Pond (394).
ampliata Ehr. Earltown Lake (605).
bacilliformis Grun. Grant Lake (374); Maclean Pond (394).
biceps Greg. var. *stauronciformis*. Besancon's Lake (733).
bisulcata Lag. Swamp Pond (373); Besancon's Lake (733).
Bogotensis Grun. Besancon's Lake (733).
borealis Ehr. Cornwallis (992).
Braunii Grun. Grant Lake (374); Maclean (394); Mill's Pond (395).
Brebissonii Ktz. Mackintosh (14, 15); High Pond (372); Besancon's Lake (733); Musquodoboit Lake (879).
var. *diminuta* Musquodoboit Lake (879)

Navicula

cardinalis Cl. Grant Lake (374); Maclean Pond (394).

var. (?) B. Kitt. Earltown Lake (605).

columnaris Ehr. Swamp Pond (373); Maclean Pond (394).

commutata Grun. Grant Lake (374); Musquodoboit Lake (879); Cornwallis (992).

costata Ehr. Grant Lake (374).

conspicua A. S. Swamp Pond (373).

cuspidata Ktz. High Pond (372); Grant Lake (374); Maclean (394); Mill's Pond (395); Earltown (605); Drakesville (679).

var. *gracilis* M. Per. (With all the characters of *N. cuspidata* but more slender or delicate, with striae stronger—13 in 10 mu. Found also with the craticular form which confirms this determination—1911). In Earltown Lake (605).

Dactylis Ehr. Mackintosh Lake (14, 15).

Ktz. Swamp Pond (373); Grant Lake (374); Maclean (373); Musquodoboit Lake (879).

Dariana A. S. (Adolph Schmidt). Mill's Pond (395).

decurrens Ktz. Besancon's Lake (733).

dicephala Ehr. var. (?) Maclean Pond (394).

dilatata Ehr. Mackintosh Lake (14, 15); High Pond (372); Swamp Pond (373); Maclean Pond (394); Cornwallis (992).

divergens W. Sm. High Pond (372); Grant Lake (374); Maclean Pond (394); Cornwallis (992).

dubia Greg. High Pond (372).

elliptica Ehr. Mackintosh Lake (14, 15); Earltown Lake (605).

esox Ehr. Grant Lake (374).

Ktz. Mill's Pond (395).

eximia Cl. Swamp Pond (373).

firma Ktz. High Pond (372); Grant Lake (374); Maclean Pond (394); Earltown (605); Besancon's (733); Cornwallis (992).

var. *subampliata*. Maclean Pond (394); Mill's Pond (395).

Navicula, firma

var. *subundulata*. High Pond (372).

flexuosa Cl. Grant Lake (374); Maclean Pond (394).

follis Ehr. Grant Lake (374).

fusca Pritch. Earltown Lake (605).

gentilis Donk. Maclean Pond (394); Cornwallis (992).

gibba Ehr. High Pond, Pictou Co. (372).
Ktz. Swamp Pond, Pictou Co. (373).
" Grant Lake, Pictou Co. (374).
" Maclean Pond, Pictou Co. (394).
" Earltown Lake, Col. Co. (605).
" Besancon's Lake, Pictou (733).
" Cornwallis (992).

gigas Ehr. Mackintosh Lake (14 & 15).
" High Pond (372).
Ktz. Swamp Pond (373).
" Grant Lake (374).
Ehr. Earltown Lake (605).
Ktz. Bezancon's Lake (733).
" Musquodoboit Lake (879).
Ehr. Cornwallis (992).

hemiptera Ktz. Grant Lake (374); Maclean Pond (394); Besancon's Lake (733); Cornwallis (992).

heroina A. S. Musquodoboit Lake (879).

Hitchcockii Ehr. Grant Lake (374); Maclean Pond (394); Earltown Lake (605).

interrupta W. Sm. Mill's Pond, Morris River (395).

iridis Ehr. High Pond (372); Grant Lake (374); Besancon's Lake (733); Musquodoboit Lake (879).

var. *ampliata*. Swamp Pond (373); Grant Lake (374); MacLean Pond (394); Besancon's (733).

Legendrei F.H. & M. Per. Grant Lake, Pictou Co. (374).

legumen Ehr. Swamp Pond (373); Grant Lake (374); Maclean Pond (394).
Ktz. Mill's Pond, Morris River (395).

Navicula

limosa Ktz. Grant Lake (374); Maclean Pond (394); Mill's Pond (395); Earltown Lake (605); Drakesville (679).

var. *gibberula*. Swamp Pond (373); Earltown (605).

lineolata Ehr. Besancon's Lake, Pictou County (733).

macilenta Ehr. High Pond (372); Swamp Pond (373); Maclean (394); Mill's Pond (395); Musquodoboit Lake (879).

Grun Besancon's Lake, Pictou Co (733).

major Ehr. Mackintosh (14, 15); Swamp (373); Musquodoboit (879); Cornwallis (992).

Ktz. Grant Lake (374); Maclean Pond (394); Mill's Pond (395); Besancon's Lake, Pictou Co. (733).

var. *asymetrica*. Swamp (373); Grant (374); Maclean (394); Mill's Pond, Morris River (395).

var. *subacuta*. Swamp Pond (373).

Ktz. Earltown Lake, col. Co. (605).

mesolepta Ehr. High (372); Grant (374); Maclean (394); Cornwallis (992).

mesolepta Ehr. var. *stauroneiformis*. High Pond (372); Grant Lake (374); Maclean (394); Besancon's Lake (733).

Ktz. var. *stauroneiformis*. Earltown Lake (605).

mesotyla Ehr. var. (?) Grant Lake (374); Maclean Pond (394).

microstauron O'Meara. Grant (374); Maclean (394); Cornwallis (992).

nobilis Ktz. Swamp (373); Grant (374); Maclean (394); Besancon (733); Cornwallis (992).

occidentalis Cl. Grant Lake, Pictou Co. (374).

pachyptera Ehr. Grant Lake (374).

parva Ehr. Grant Lake (374).

Paulensis Grun. High (372); Swamp (373); Grant (374); Mill's (395); Musquodoboit Lake (879).

peregrina Ktz. Grant (374); Earltown (605); Drakesville (679).

polyonca Bréb. Mill's Pond (395).

Navicula

popula Ktz. Maclean Pond, Pictou Co. (394).

pupula Ktz. var. (?) Earltown Lake (605).

producta W. Sm. var. (?) Maclean Pond, Pictou Co. (394).

pseudobacillum Grun. Grant Lake (374); Earltown Lake (605).

radiosa Ktz. Grant (374); Maclean (394); Earltown (605); Drakesville (679).

rupestris Grun. Besancon's Lake, Pictou Co. (733).

Hantz. Musquodoboit (879); Cornwallis (992).

semen Ehr. Cornwallis (992).

serians Ktz. High (372); Swamp (373); Musquodoboit (879); Besancon (773).

var. *minor* High Pond (372).

stauroptera Grun. Maclean Pond (394).

streptoraphe Cl. Grant Lake (374); Maclean Pond (394).

subacuta Ehr. forma *minor*. Swamp Pond (373).

subsolaris Grun. High Pond, Pictou Co. (372).

tabellaria Ktz. Maclean Pond (394); Besancon's Lake (733).

var. *acrospheriaeformis*. (New variety). "Extremities as large (wide) as the middle. Axial area wide unto the ends which are like those of *N. acrospheria*. Mill's Pond (395).

tabellaria Ktz. var. *stauroneifornis*. Grant Lake, Pictou (374).

transversa A. S. Mackintosh (14, 15); Swamp (373); Grant (374); Maclean (394); Mill's (395); Earltown (605); Besancon (733).

trigonocephala Cl. Mill's Pond (395).

ventricosa Ktz. Grant (374); Maclean (394); Earltown (605).

viridis Ktz. Mackintosh (14, 15); Grant (374); Maclean (394); Mill's Pond (395); Besancon's Lake (733).

var. *commutata*. Earltown (605); Musquodoboit (879); Cornwallis (992).

var. *fallax*. High Pond (372); Maclean (394).

viridula Ktz. Earltown Lake (605).

Navicula viridula Ktz.
var. *major*. Earltown Lake (605).
(?) Adolf Schmidt's Atlas 44:22. Musquodoboit Lake (879).

Nitzschia scalaris W. Sm. Grant Lake (374).
sigmoidea W. Sm. Grant Lake (374); Mill's Pond (395).
spectabilis W. Sm. Mill's Pond (395).

Pleurostauron acuta W. Sm. Maclean Pond, Pictou Co. (394).
var. *maxima*. Swamp (373); Grant Lake (374).
sagitta Grun. Besancon's Lake, Pictou Co. (733).

Pseudo-Eunotia hemicyclus Grun. High Pond (372); Besancon's Lake (733).

Stauroneis amphilepta Ehr. Grant Lake (374); Maclean Pond (394).
acuta W. Sm. Earltown Lake, Colchester Co. (605).
anceps Ehr. High (372); Grant (374); Maclean (394); Besancon's (733); Musquodoboit (879).
var. (?) Earltown Lake, Col. Co. (605).
var. *amphicephala*. High (372); Grant (374); Maclean (394); Besancon (733).
var. *elongata* (new variety). (Much longer and more lanceolate than var. birostris, less finely striated. 145 mu. long, 15 mu. broad, with 18 striae in 10 mu.) Mill's Pond, Morris River (395).
var. *fossilis*. Besancon's Lake (733).
Baileyi Ehr. High (372); Swamp (373); Grant (374); Maclean (394); Mill's Pond (395); Besancon (733); Musquodoboit (879); Cornwallis (992).
gracilis Sm. Mackintosh (14, 15); High (372); Swamp (373); Grant (374); Maclean (394); Mill's (395); Earltown (605); Besancon (733).
lanceolata Ktz. Musquodoboit Lake (879).
Phoenicenteron Ehr. Mackintosh (14, 15); High (372); Swamp (373); Grant (374); Maclean (394); Mill's (395); Earltown (605); Besancon's (733); Cornwallis (992).

Stauroneis

var. *maxima*. Maclean Pond (394).

var. *lanceolata*. Mill's Pond (395).

var. *elegans* (new variety). (Larger than the type, carries sometimes a central granule in the middle of the median nodule. 150 mu. long by 30 wide. 3 to 15 striae in 10 mu.). Mill's (395).

producta Grun. Earltown Lake, Col. Co. (605).

Stodderi Greenl. var. *superba*. (new variety). (Area stauroneiform, large and recurved towards the borders on which are seen longitudinal ribs. 90 to 125 mu. long. 9 longitudinal ribs in 10 mu., 15 transverse striae.) High Pond, Pictou Co. (372).

Stenopterobia anceps Breb. High (372); Besancon (733); Musquodoboit (879).

Surirella Baileyi Laevis. High Pond, Pictou Co. (372).

bifrons Ktz. Mackintosh (14, 15); Swamp (373);

Ehr. Besancon Lake (733); Musquodoboit Lake (879).

var. Adolf Schmidt, Atlas 23:2. High Pond (372).

biseriata Breb. Mackintosh Lake (14, 15).

elegans Ehr. Grant (374); Maclean (394); Mill's Pond (395).

cardinalis Kitt. Grant Lake (374); Mill's Pond (395).

cruciata A. S. var. (?) Swamp Pond (373).

Kittonii A. S. var. (?) Mill's Pond (395).

linearis W. Sm. Besancon Lake (733); Musquodoboit Lake (879).

var. *commutata*. Earltown Lake (605).

Surirella linearis W. Sm. var. *constricta*. High (372); Besancon (733); Musquodoboit (879).

var. *elliptica*. Musquodoboit Lake (879).

oblonga Ehr. High Pond, Pictou Co. (372).

Rattrayi A. S. Musquodoboit Lake (879).

robusta Ehr. Grant (374); Maclean (394); Earltown (605); Besancon (733).

Saxonica Auers. High (372); Swamp (373); Mill's (395); Besancon (733).

Surirella

splendida Ehr. Besancon's Lake, Pictou Co. (733).

forma *minor*. Mackintosh Lake (14, 15).

striatula Turp. Musquodoboit Lake (879).

tenera Greg. High (372); Maclean (394); Mill's (395); Besancon (733).

var. *nervosa*. Maclean Pond (394).

Thuringiaca Hantz. High Pond, Pictou Co. (372).

Synedra biceps Ktz. Mill's Pond, Morris River (395).

capitata Ehr. Drakesville (679).

ulna Ehr. Drakesville (679).

Tabellaria fenestrata Ktz. High (372); Grant (374); Maclean (394); Besancon (733).

floculosa Ktz. Besancon's Lake (733).

Vanheurckia rhomboides Bréb. High (372); Besancon (733); Musquodoboit (879).

forma *major*. High Pond (372).

NOTE

The location of "Drakesville" cannot yet be identified in Nova Scotia, altho given with the other Nova Scotian localities simply as "in Canada." Morris Lake, near Dartmouth, Nova Scotia, empties as a small stream into the Atlantic in Halifax County.

Mackintosh Lake is on the boundary of Pictou and Colchester Co.

The Phenology of Nova Scotia, 1921.—By A. H. MacKay, LL.D., Halifax.

These observations were made by the school children of the Province of Nova Scotia as a part of the Nature Study work prescribed. The pupils report by bringing into the school-room the flowering or other specimens when first observed, for authoritative determination by the teacher, who generally credits the first finder by placing the name and the observation on the honor roll section of the blackboard for the day. The teacher, after testing the correctness of the observation, marks it on the schedule with which every teacher is provided—a copy of which is sent in to the Inspector with the school returns at the end of June and January.

The following tables are compiled from 140 of the best schedules out of the 350 sent in. The selections were made and compiled under the direction of Mr. H. R. Shinner, B. A., and Miss Annimae Bill, of the Education Department.

The schedules for each year are carefully bound up in large annual volumes which are placed in the Provincial Museum and Science Library, where they can be used by students of climate, etc. The compilers of the phenochrons of the different belts, slopes or regions, have been rural science teachers who have most distinguished themselves as instructors. They were selected for the purpose on the recommendation of the Director of rural science education. The sheets from which the provincial phenochrons are calculated are also bound in annual folio volumes for ease of consultation and preservation.

The Province is divided into its main climate slopes or regions not always coterminous with the boundaries of counties. Slopes, especially those to the coast, are subdivided into belts, such as (a) the coast belt, (b) the low inland belt, and (c) the high inland belt, as below:

No.	Regions or Slopes	Belts
I.	Yarmouth and Digby Counties,	(a) Coast, (b) Low Inlands, (c) High Inlands.
II.	Shelburne, Queens & Lunenburg Co's,	
III.	Annapolis and Kings Counties,	(a) South Mts., (b) Annapolis Valley, (c) Cornwallis Valley, (d) North Mts.
IV.	Hants and Colchester Counties,	(a) Coast, (b) Low Inlands, (c) High Inlands.
V.	Halifax and Guysboro Counties,	" "
VI.a.	Cobequid Slope (to the south),	" "
VI.b.	Chignecto Slope (to the northwest),	
VII.	Northumberland Straits Slope (to the n'h),	
VIII.	Richmond & Cape Breton Co.'s	" "
IX.	Bras d'Or Slope (to the southeast),	" "
X.	Inverness Slope (to Gulf, N. W.),	" "

The ten *regions* are indicated on the outline map on page 157.

THE PHENOLOGY OF NOVA SCOTIA, 1921.

(Complied from the best 140 out of 350 local observation schedules.

YEAR 1921.

Day of the year corresponding to the last day of each month.

Jan.	31	July	212
Feb.	59	Aug.	243
March	90	Sept.	273
April	120	Oct.	304
May	151	Nov.	334
June	181	Dec.	365

For Leap Year add one to each except January.

WHEN FIRST SEEN.

Year 1921	Observation Stations: 1. Yarmouth and Digby	2. Shel. Queen & Lunenburg.	3. Annapolis and Kings	4. Hants and Colchester	5. Halifax & Guysboro	6a. Cobequid Slope	6b. Chignecto Slope	7. Northum. Sts. Slope	8. Richmond and Cape Breton	9. & 10. Inverness and Bras d'Or Slope	Average dates.
1. Alnus incana, Wild	90	89	101	106	105	110	130	107	106	113	106
2. Populus tremuloides	105	124	107	118	97	....	123	123	117	118	115
3. Epigea repens, L.	88	94	93	101	103	105	103	105	111	117	102
4. Equisetum arvense	99	121	117	121	122	111	120	122	128	120	118
5. Sanguinaria Canadensis	112	148	....	123	125	....	125	120	127	127	126
6. Viola Blanda	111	114	116	119	118	117	117	119	122	123	118
7. Viola palmata, *cucullata*	115	121	119	122	125	119	123	124	129	125	123
8. Hepatica triloba, etc	130	123	120	122	124	....	....	126	....	115	123
9. Acer rubrum	113	118	115	123	129	....	....	123	131	120	122
10. Fragaria Virginiana	112	120	116	121	123	120	122	121	124	124	120
11. " " fruit ripe	132	150	156	154	161	157	158	156	164	151	153
12. Taraxacum officinale	117	124	122	124	127	123	127	128	131	126	125
13. Erythronium Americanum	118	124	131	131	141	129	123	119	....	....	127
14. Coptis trifolia	120	121	129	129	131	128	133	131	133	132	129
15. Claytonia Caroliniana	....	....	120	121	128	122	124	123	123	117	122
16. Nepeta Glechoma	132	133	129	132	135	129	122	140	141	140	133
17. Amelanchier Canadensis	120	132	125	133	137	134	134	134	143	139	133
18. " " fruit ripe	....	....	....	159	....	....	....	178	201	....	179

WHEN BECOMING COMMON.

Year 1921	Average dates.	Observation Regions: 1. Yarmouth and Digby	2. Shel. Queen & Lunenburg.	3. Annapolis and Kings	4. Hants and Colchester	5. Halifax & Guysboro	6a. Cobequid Slope	6b. Chignecto Slope	7. Northum. Sts. Slope	8. Richmond and Cape Breton	9. & 10. Inverness and Bras d'Or Slope
1. Alnus incana, Wild	110	102	98	112	113	112	115	....	111	110	119
2. Populus tremuloides	121	112	127	116	127	105	....	127	130	122	122
3. Epigea repens, L.	102	103	105	105	115	111	114	112	114	117	119
4. Equisetum arvense	124	109	127	120	126	126	117	127	126	133	128
5. Sanguinaria Canadensis	131	115	151	....	128	128	....	131	125	133	140
6. Viola Blanda	123	118	123	121	126	124	122	120	123	127	128
7. Viola palmata, *cucullata*	128	122	126	125	128	130	126	127	129	133	130
8. Hepatica triloba, etc	137	181	130	130	130	128	....	....	129	....	134
9. Acer rubrum	127	128	124	122	128	134	120	....	128	135	127
10. Fragaria Virginiana	128	121	128	124	131	132	126	131	128	130	132
11. " " fruit ripe	167	168	167	165	164	170	162	168	164	173	169
12. Taraxacum officinale	132	127	130	128	132	131	130	133	133	135	140
13. Erythronium Americanum	137	136	133	153	134	145	135	132	124	....	....
14. Coptis trifolia	132	123	132	133	126	133	122	138	136	138	138
15. Claytonia Caroliniana	130	....	....	125	126	138	126	148	128	126	125
16. Nepeta Glechoma	139	133	138	136	140	142	140	128	144	146	144
17. Amelanchier Canadensis	138	128	136	130	138	141	135	139	138	147	147
18. " " fruit ripe	210	....	....	....	....	....	....	....	....	210	....

121	137	134	138	145	139	134	138	151	140	138	19. Prunus Pennsylvanica	144	135	142	139	148	147	143	140	141	155	145
....	178	....	....	....	....	....	....	220	....	199	20. " " fruit ripe	203	....	178	....	....	....	....	....	....	228	....
119	133	134	136	136	142	136	139	150	151	138	21. Vaccinium Can. and Penn.	145	132	141	140	141	144	150	142	144	154	158
....	....	....	235	....	....	....	222	209	....	222	22. " " fruit ripe	227	....	....	....	235	....	....	....	....	219	....
123	141	142	146	151	144	148	147	155	154	145	23. Ranunculus acris	154	148	149	148	155	156	153	154	153	161	158
147	146	147	151	154	152	155	155	161	161	153	24. R. Repens	159	152	153	152	158	169	157	158	161	165	166
136	138	135	145	144	139	137	141	148	146	141	25. Trill. erythrocarpum	148	144	150	142	149	150	142	147	147	151	154
128	138	137	143	143	142	143	148	151	153	143	26. Rhododendron Rhodora	148	137	145	143	148	148	145	147	153	155	160
133	146	142	146	151	147	153	146	151	153	147	27. Cornus Canadensis	152	144	152	146	153	156	150	156	150	156	157
....	170	....	....	....	....	....	....	221	....	195	28. " " fruit ripe	205	....	178	....	....	....	....	....	....	233	....
135	143	137	143	147	147	143	141	150	148	143	29. Trientalis Americana	150	145	150	145	148	152	148	152	146	155	155
141	147	146	152	155	150	159	153	160	145	151	30. Clintonia borealis	166	145	152	151	156	156	153	....	156	165	152
....	142	150	154	164	162	....	150	164	158	156	31. Calla palustris	159	....	148	152	158	170	....	....	152	168	162
143	149	148	154	153	150	147	157	162	157	152	32. Cypripedium acaule	158	150	155	153	158	159	162	154	161	167	163
145	149	145	149	156	151	153	153	161	158	152	33. Sisyrinchium angustifol	156	151	155	148	155	160	152	159	153	166	163
156	157	148	159	160	165	167	163	167	160	160	34. Linnaea borealis	164	163	163	157	156	165	163	171	168	173	157
143	153	147	146	144	147	139	155	157	150	148	35. Kalmia glauca	152	148	158	151	151	153	153	140	156	161	150
147	159	154	154	160	163	142	152	174	154	156	36. Kalmia augustifolia	163	154	166	159	163	169	168	148	158	178	163
149	146	149	152	160	160	153	157	160	....	154	37. Crataegus oxyacantha	159	154	153	151	158	167	165	....	159	165	157
164	152	147	149	157	....	....	152	161	152	154	38. Crataegus coccinea, etc	161	170	158	152	154	161	....	....	157	167	168
154	165	155	159	165	162	157	162	168	168	162	39. Iris versicolor	167	162	169	164	164	170	165	162	165	172	163
151	156	153	158	164	161	159	157	163	157	158	40. Chrysanthemum Leucanth	165	161	162	160	168	167	166	166	163	169	165
156	160	155	157	163	160	159	160	165	159	159	41. Nuphar advena	164	161	165	163	164	167	168	164	165	171	156
144	153	150	154	160	162	160	149	162	149	154	42. Rubus strigosus	162	157	162	156	162	165	168	166	162	168	162
....	....	134	....	164	....	....	....	204	176	169	43. " " fruit ripe	184	....	....	....	....	165	....	....	197	213	160
152	163	164	165	171	171	....	170	171	160	165	44. Rhinanthus Crista-galli	170	161	169	173	170	176	174	....	173	175	165
149	160	158	161	163	172	163	160	170	169	163	45. Rubus villosus	168	165	168	164	167	169	172	170	165	174	....
....	....	....	....	....	....	....	....	239	....	239	46. " " fruit ripe	247	....	....	....	243	....	....	....	....	251	....
162	167	166	161	170	....	161	168	....	165	165	47. Sarracenia purpurea	170	167	171	170	165	174	....	164	174	....	173
162	170	159	170	172	165	....	165	170	172	167	48. Brunella vulgaris	172	169	175	163	175	176	170	....	170	174	174
169	171	161	168	165	169	....	171	....	172	168	49. Rosa lucida	174	177	176	171	178	171	173	....	174	....	172
155	157	162	166	167	159	164	163	170	163	163	50. Leontodon autumnale	169	161	165	168	174	171	166	172	166	174	168
....	164	156	159	176	178	130	157	167	158	160	51. Linaria vulgaris	160	....	169	165	170	....	....	146	130	173	162
119	130	123	125	131	123	123	128	137	132	127	52. Trees appear green	140	134	141	133	137	147	137	150	137	146	142
128	134	132	140	147	145	146	138	147	150	141	53. Ribes rubrum (cultivated)	144	132	142	137	146	150	151	137	144	152	150
....	....	181	168	....	....	....	....	....	....	175	54. " " (fruit ripe	178	....	....	181	171	....	....	....	....	....	....
127	136	138	142	145	147	149	133	149	150	143	55. R. nigrum (cultivated)	148	131	141	141	147	149	152	160	145	155	154
....	177	....	....	....	....	....	....	....	....	177	56. " fruit ripe	177	....	177	....	....	....	....	....	....	....	....
129	140	133	142	148	147	145	140	153	147	142	57. Prunus Cerasus	148	139	145	137	144	157	151	152	145	159	150
....	178	176	176	....	....	....	....	....	....	177	58. " " fruit ripe	182	....	178	189	178	....	....	....	....	....	159
130	140	134	139	149	152	145	139	155	147	143	59. Prunus domestica	149	140	147	139	144	152	157	155	146	160	149
132	141	135	143	147	142	141	142	153	149	142	60. Pyrus Malus	148	142	147	141	148	153	146	147	147	159	153
141	149	146	148	154	151	152	149	162	151	150	61. Syringa vulgaris	156	149	156	151	157	160	156	155	154	166	155
150	153	153	156	158	154	159	156	160	157	156	62. Trifolium repens	161	156	161	159	162	164	160	163	162	166	160
139	147	149	154	158	158	159	156	160	159	154	63. Trifolium pratense	160	146	156	153	161	161	163	165	162	166	165
155	148	160	168	163	152	168	171	....	166	161	64. Phleum pratense	168	162	155	170	170	167	....	175	172	....	169
172	172	171	169	164	....	....	....	....	....	120	65. Solanum tuberosum	173	181	163	172	....	169	....	....	....	....	178

THE PHENOLOGY OF NOVA SCOTIA, 1921.—*Continued.*

Day of the year corresponding to the last day of each month.

Jan.	31	July	212
Feb.	59	Aug.	243
March	90	Sept.	273
April	120	Oct.	304
May	151	Nov.	334
June	181	Dec.	365

For Leap Year add one to each except January.

When First Seen. — Observation Stations.

Year 1921.	1. Yarmouth and Digby	2. Shel. Queen & Lunenburg.	3. Annapolis and Kings	4. Hants and Colchester	5. Halifax & Guysboro	6a. Cobequid Slope	6b. Chignecto Slope	7. Northum. Sts. Slope	8. Richmond and Cape Breton	9. & 10. Inverness and Bras d'Or Slope	Average dates.
66. Ploughing first of season	91	106	110	124	117	115	115	121	114	111	171
67. Sowing	103	122	125	133	122	129	124	131	130	127	125
68. Potato-planting	107	116	128	138	125	129	140	134	125	128	127
69. Sheep-shearing	120	119	123	142	132	124	138	140	118	123	128
70. Hay-cutting	175	191	....	....	....	....	....	....	204	....	190
71. Grain-cutting	....	204	....	246	....	....	....	235	227	....	228
72. Potato-digging	....	264	262	253	....	....	....	265	267	....	262
73a Opening of rivers	68	81	79	89	80	69	60	74	85	124	81
73b Opening of lakes	70	87	92	92	107	....	....	78	109	101	92
74a Last snow to whiten ground	95	116	118	105	120	119	110	116	100	120	112
74b " " to fly in air	108	132	125	125	131	137	116	130	130	131	127
75a Last spring frost —hard	121	121	125	127	170	130	....	140	119	122	131
75b " " " —hoar	103	....	134	142	130	....	....	154	168	....	138
76a Water in streams—high	....	77	85	197	72	....	99	....	102	69	89
76b " " —low	....	....	....	....	....	....	....	....	249	....	249
77a First autumn frost—hoar	263	253	233	....	....	....	....	290	237	....	255
77b " —hard	313	297	263	299	....	....	....	290	307	....	295
78a First snow to fly in air	298	299	286	....	....	....	....	298	297	....	296
78b " whiten ground	311	312	311	....	....	....	....	303	315	....	310
79a Closing of lakes	329	322	331	....	....	....	....	355	329	....	333
79b " rivers	343	311	334	....	....	....	....	....	355	....	336
81a Wild ducks migrating, N.	79	79	82	81	71	....	79	77	81	84	79
81b " " " S.	....	293	287	332	....	....	....	....	296	....	302

When Becoming Common. — Observation Regions.

Year 1921.	Average dates.	1. Yarmouth and Digby	2. Shel. Queen & Lunenburg.	3. Annapolis and Kings	4. Hants and Colchester	5. Halifax & Guysboro	6a. Cobequid Slope	6b. Chignecto Slope	7. Northum. Sts. Slope	8. Richmond and Cape Breton	9. & 10. Inverness and Bras d'Or Slope
66. Ploughing first of season	127	109	118	122	130	123	122	166	131	121	125
67. Sowing	132	117	127	132	141	131	128	135	139	138	130
68. Potato-planting	136	122	127	139	148	136	136	115	143	132	135
69. Sheep-shearing	139	142	135	129	147	141	135	141	150	130	135
70. Hay-cutting	196	181	....	....	....	....	....	....	....	211	119
71. Grain-cutting	236	....	....	....	....	....	....	....	....	236	....
72. Potato-digging	278	....	....	....	....	....	....	....	....	278	....
73a Opening of rivers	....	....	....	....	....	....	....	....	....	....	....
73b Opening of lakes	....	....	....	....	....	....	....	....	....	....	....
74a Last snow to whiten ground	....	....	....	....	....	....	....	....	....	....	....
74b " " to fly in air	....	....	....	....	....	....	....	....	....	....	....
75a Last spring frost —hard	....	....	....	....	....	....	....	....	....	....	....
75b " " " —hoar	....	....	....	....	....	....	....	....	....	....	....
76a Water in streams—high	....	....	....	....	....	....	....	....	....	....	....
76b " " —low	....	....	....	....	....	....	....	....	....	....	....
77a First autumn frost—hoar	....	....	....	....	....	....	....	....	....	....	....
77b " —hard	....	....	....	....	....	....	....	....	....	....	....
78a First snow to fly in air	....	....	....	....	....	....	....	....	....	....	....
78b " whiten ground	....	....	....	....	....	....	....	....	....	....	....
79a Closing of lakes	....	....	....	....	....	....	....	....	....	....	....
79b " rivers	....	....	....	....	....	....	....	....	....	....	....
81a Wild ducks migrating, N.	....	....	....	....	....	....	....	....	....	....	....
81b " " " S.	....	....	....	....	....	....	....	....	....	....	....

THE PHENOLOGY OF NOVA SCOTIA, 1921.—*Continued*

When First Seen.											Year 1921	When Becoming Common.										
Observation Stations.													Observation Regions.									
1. Yarmouth and Digby	2. Shel. Queen & Lunenburg.	3. Annapolis and Kings	4. Hants and Colchester	5. Halifax & Guysboro	6a. Cobequid Slope	6b. Chignecto Slope	7. Northum. Sts. Slope	8. Richmond and Cape Breton.	9. & 10. Inverness and Brais d'Or Slope	Average dates	Day of the year corresponding to the last day of eoch month. Jan. .... 31 July. ....212 Feb. .... 59 Aug. ....243 March .... 90 Sept. ....273 April. ....120 Oct. ....304 May. ....151 Nov. ....334 June ....181 Dec. ....365 For Leap Year add one to each except January.	Average dates	1. Yarmouth and Digby	2. Shel. Queen & Lunenburg.	3. Annapolis and Kings	4. Hants and Colchester	5. Halifax & Guysboro	6a. Cobequid Slope	6b. Chignecto Slope	7. Northum. Sts. Slope	8. Richmond and Cape Breton.	9. & 10. Inverness and Bras d'Or Slope
84	77	77	76	75	74	75	77	77	90	78	82a Wild geese migrating N.	....	....	....	....	....	....	....	....	....	....	....
....	309	286	322	....	....	....	305	298	....	302	82b " " " S.	....	....	....	....	....	....	....	....	....	....	....
81	74	83	87	88	88	109	81	84	81	86	83. Melospiza fasciata North	....	....	....	....	....	....	....	....	....	....	....
69	77	70	73	72	72	78	73	71	76	73	84. Turdus migratorius "	....	....	....	....	....	....	....	....	....	....	....
70	83	76	84	71	80	89	88	87	118	85	85. Junco hiemalis "	....	....	....	....	....	....	....	....	....	....	....
94	111	97	118	129	106	....	130	120	122	114	86. Actitis macularia "	....	....	....	....	....	....	....	....	....	....	....
138	112	98	122	130	....	....	136	....	99	133	87. Sturnella magna "	....	....	....	....	....	....	....	....	....	....	....
100	130	128	126	121	106	....	131	123	139	134	88. Ceryle Alcyon "	....	....	....	....	....	....	....	....	....	....	....
107	107	120	134	130	109	....	130	122	136	121	89. Dendroeca coronata "	....	....	....	....	....	....	....	....	....	....	....
123	135	135	138	130	....	151	141	141	160	139	90. D. aestiva "	....	....	....	....	....	....	....	....	....	....	....
79	105	127	127	128	....	128	116	124	106	116	91. Zonotrichia alba "	....	....	....	....	....	....	....	....	....	....	....
144	150	143	142	144	145	147	139	151	161	147	92. Trochilus colubris " ..	....	....	....	....	....	....	....	....	....	....	....
....	136	123	137	140	145	140	137	146	....	138	93. Tyrannus Carolinensis "	....	....	....	....	....	....	....	....	....	....	....
..	147	133	137	141	161	....	136	137	140	142	94. Dolychonyx oryzivorus "	....	....	....	....	....	....	....	....	....	....	....
137	146	139	135	130	165	....	131	145	142	141	95. Spinis tristis "	....	....	....	....	....	....	....	....	....	....	....
142	161	124	143	....	....	....	138	143	150	143	96. Setophaga ruticilla "	....	....	....	....	....	....	....	....	....	....	....
136	140	151	151	135	125	....	129	....	....	138	97. Ampelis cedrorum "	....	....	....	....	....	....	....	....	....	....	....
88	115	128	129	129	108	158	114	152	126	125	98. Chordeiles Virginianus.	....	....	....	....	....	....	....	....	....	....	....
82	93	90	94	100	104	105	100	103	103	97	99. First piping of frogs.	....	....	....	....	....	....	....	....	....	....	....
94	103	111	113	106	114	102	114	111	115	108	100. First appearance snakes.	....	....	....	....	....	....	....	....	....	....	....

THUNDERSTORMS—PHENOLOGICAL OBSERVATIONS, NOVA SCOTIA, 1921

The indices indicate the number of stations from which the Thunderstorms were reported on the day of the year specified.

OBSERVATION REGIONS.

1. Yarmouth & Digby	2. Shelburne, Queens & Lunenburg.	3. Annapolis & Kings.	4. Hants & Colchester.	5. Halifax & Guysboro.	6a. Cobequid Slope.	6b. Chignecto Slope.	7. Northum. Sts. Slope.	8. Richmond & Cape Breton.	9 & 10. Inverness & Bras d'Or Slope.	Total 1921
		59		59						59^{2}
	62									62
			66							66
		67				67	67^{3}	67^{3}	67^{6}	67^{14}
		68^{2}		68				68^{2}		68
				70						70
			71	71						71^{2}
		75								75
			80							80
			81							81^{7}
	85	85								85^{2}
						87				87
			91	91						91^{2}
						96				96
				106						106
			107							107
			111	111						111^{2}
				112						112
	114									114
		128								128
	135									135
	136			136^{2}						136^{3}
		140		140^{2}						140^{3}
141	141^{6}	141^{20}	141^{15}	141^{6}	141^{7}	141^{7}	141^{4}			141^{64}
142^{1}	142^{3}	142^{16}	142^{15}	142^{3}	142^{7}	142^{7}	142^{7}	142^{2}	142	142^{65}
		143^{3}	143^{2}	143			143		143^{2}	143^{9}
144										144
				145						145
				147			147			147^{2}
	152			152^{2}						152^{3}
		155								155
							156			156
			158	158		158				158^{6}
	159^{6}		159^{4}	159^{9}		159	159^{2}	159^{2}	159	159^{25}
	160^{9}	160	160^{6}	160^{5}			160			160^{22}
	161									161
162		162								162
163^{1}		163^{2}	163^{2}	163						163^{9}

THUNDERSTORMS—PHENOLOGICAL OBSERVATIONS, NOVA SCOTIA, 1921

The indices indicate the number of stations from which the Thunderstorms were reported on the day of the year specified

OBSERVATION REGIONS

1. Yarmouth & Digby	2. Shelburne, Queens & Lunenburg.	3. Annapolis & Kings.	4. Hants & Colchester.	5. Halifax & Guysboro.	6a. Cobequid Slope.	6b. Chignecto Slope.	7. Northum. Sts. Slope.	8. Richmond & Cape Breton.	9 & 10. Inverness & Bras d'Or Slope.	Total 1921
164^{4}	164^{4}	146^{3}	164^{4}	164	......	......	......	......	......	164^{21}
165	165^{3}	......	......	165^{2}	......	......	165	......	......	165^{7}
166^{2}	166^{3}	166	166^{6}	166^{6}	......	......	......	......	......	166^{18}
......	167	167	167	167	......	......	......	......	......	167^{4}
......	......	......	......	168	......	......	......	......	......	168
......	170	......	......	......	......	......	......	......	......	170
......	......	......	......	......	......	171	......	......	......	171
172	172	......	172	172	......	172	172^{3}	......	......	172^{8}
......	173	......	......	173	......	......	......	......	......	173^{2}
174	174^{2}	174^{5}	174^{5}	174^{2}	......	174^{5}	174^{5}	......	174	174^{24}
......	175^{4}	......	175	......	......	......	......	175	......	175^{6}
......	176	176	176^{2}	......	......	......	......	......	......	176^{4}
177	......	177^{8}	177^{3}	......	......	......	......	......	......	177^{12}
......	178	......	178^{3}	......	......	......	......	......	......	178^{4}
......	191	......	......	......	......	......	......	......	......	191
......	......	......	......	......	......	......	......	199	......	199
......	......	......	......	......	......	......	......	225	......	225
......	226	......	......	......	......	......	......	......	......	226
230	......	......	......	......	......	......	......	......	......	230
......	......	......	......	......	......	......	......	239	......	239
......	......	......	......	......	......	......	242	......	......	242
......	......	......	......	......	......	......	......	258	......	258
......	......	......	......	......	......	......	266	......	......	266
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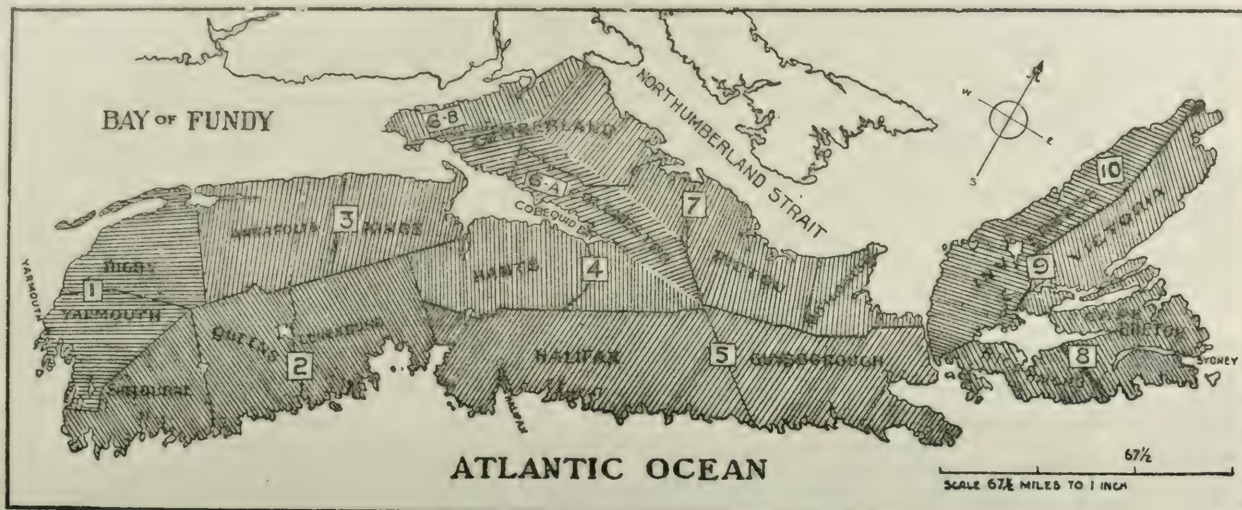
THE LOCAL COMPILERS FOR EACH REGION, 1920.

Region No.		Region No.	
I.	Miss Mary B. Marshall	VIa.	Miss Laura I. Davison
II.	Miss Violet Mailman	VIb.	Miss Georgina Landry
III.	Miss Olive I. Banks	VII.	Miss Dorothy Cameron
IV.	Miss Dorothy C. Black	VIII.	Mr. D. K. Finlayson, B. A.
V.	Miss Alice C. Archibald	IX & X.	Miss C. M. Warren



THE TEN PHEONOGICAL REGIONS OF NOVA SCOTIA.

APPENDIX

LIST ON MEMBERS, 1921-22

ORDINARY MEMBERS

	Date of Election
Allen, E. Chesley, School for the Blind, Halifax	Nov. 28, 1913
Bagnall, John Stanley, D.D.S., Halifax	Dec. 1, 1921
Barnes, Albert Johnstone, B.SC., Mar. Tel. & Tel. Co., Halifax	May 13, 1912
Bell, Prof. Hugh Philip, M.SC., PH.D., Dalhousie University, Halifax	Dec. 1, 1920
Blois, H. Hope, Principal of Bloomfield School, Halifax	Dec. 1, 1921
*Bronson, Prof. Howard Logan, PH.D., F.R.S.C., Dalhousie University, Halifax	Mar. 9, 1911
Cameron, Prof. John, M.D., D.SC., F.R.SS.E. & C., Dalhousie University, Halifax	Nov. 2, 1915
Chipman, H. R., B.A., Dalhousie University, Halifax	Oct. 3, 1921
Chudleigh, George Aubrey, D.D.S., Halifax	Mar. 13, 1922
*Colpitt, Parker R., Coburg Road, Halifax	Feb. 2, 1903
Copp, Prof. Walter Percy, B.SC., Dalhousie University, Halifax	Apr. 28, 1921
Coysh, Basil Radcliffe, D.D.S., Chester, N. S.	May 1, 1919
Creighton, Prof. Henry Jermain Maude, D.SC., F.C.S., Swarthmore, Penn.	Jan. 7, 1908
Cunningham, Allan Rupert, M.D., Halifax	Dec. 1, 1921
*Davis, Charles Henry, C.E., New York City, U.S.A.	Dec. 5, 1900
Dawson, Prof. James Arthur, PH.D. Dalhousie University, Halifax	Dec. 1, 1920
Dentith, Francis Wm. Hubert, Armdale, Halifax	Mar. 13, 1922
*Doane, Francis William Whitney, City Engineer, Halifax	Nov. 3, 1886
Dobson, F. W., D.D.S. Halifax	Mar. 13, 1922
Donkin, Hiram, M.E., Dep. Minister of Mines, Halifax	Nov. 30, 1892
Easson, Prof. R. C., Dalhousie University, Halifax	Dec. 1, 1920
Faulkner, Alden West, D.D.S., Halifax	Dec. 1, 1921
*Fergusson, Donald M., Vancouver, B. C.	Jan. 5, 1909
Forward, Charles C., Dom. Govt. Analyst, Halifax	Jan. 5, 1917
*Fraser, Sir C. Frederick, LL.D., Halifax	Mar. 31, 1890
Freeman, Philip A., N. S. Tramway & Power Co., Halifax	Nov. 6, 1906
Hamilton, E. R., N. S. Tramway & Power Co., Halifax	Jan. 9, 1922
Harris, Prof. David Fraser, M.B., C.M., M.D., B.SC. (Lond.), D.SC., F.R.SS.E. &C., L.M.C.C., Dalhousie University, Halifax	Feb. 29, 1912
Hattie, William Harrop, M.D., Dalhousie University, Halifax	Nov. 12, 1892
*Henderson, Geo. Hugh, C.E., B.SC., M.A.	Nov. 2, 1915
Hennigar, Gordon R., D.D.S., Halifax	Mar. 13, 1922
Hopkins, Ralph H., Post Office Dept., Halifax	Mar. 31, 1920
Jackson, Wilfred James, M.A., Dalhousie University, Halifax	Jan. 9, 1922
Johnstone, Prof. John Hamilton Lane, M.SC., PH.D., Dalhousie University, Halifax	Dec. 2, 1912
Larnder Harold, Dalhousie University, Halifax	Jan. 9, 1922
McCurdy, H. W., Dalhousie University, Halifax	Jan. 9, 1922
McDougall, John G., M.D., C.M. Dalhousie University, Halifax	Nov. 2, 1915
McInnes, Hector, K.C., Halifax	Nov. 27, 1889
McIntosh, Prof. Donald Sutherland, M.SC., Dalhousie University, Halifax	Mar. 9, 1911
*MacKay, Alexander Howard, B.A., B.SC., LLD., F.R.S.C., Hon. Colonel, Superintendent of Education, Halifax	Oct. 11, 1885
MacKay, Charles Alexander, M.A., Dalhousie University, Halifax	Dec. 1, 1920
*MacKay, George M. Johnstone, M.A., M.SC., Schenectady, N. Y., U. S. A.	Dec. 28, 1903
MacKenzie, Arabella C., D.D.S., Halifax	Mar. 13, 1922
*Mackenzie, President Arthur Stanley, PH.D., F.R.S.C., Dalhousie University, Halifax	Nov. 7, 1905
Matheson, Donald J., B.SC., Science Master, Halifax County Academy, Halifax	Nov. 2, 1915
*Nicholls, Prof. Albert G., M.D., D.SC., F.R.S.C., Dalhousie University, Halifax	Nov. 2, 1915
Nickerson, Prof. Carleton Bell, Dalhousie University, Halifax	Mar. 9, 1911
Peck, Prof. W. A., Dalhousie University, Halifax	Dec. 1, 1921
Piers, Harry, Curator Provincial Museum and Librarian Provincial Science Library, Halifax	Nov. 2, 1888
Read, Horace Emmerson, B.A., Dalhousie University, Halifax	Feb. 13, 1922
Redden, John Keith, Halifax	Mar. 13, 1922
*Ritchie, Stephen Galway, B.A., D.M.D., Halifax	Oct. 3, 1918
*Robb, D. W., Amherst, N. S.	Mar. 4, 1890
Robertson, William G., Halifax	Feb. 26, 1920
Ryan, Frank W., D.D.S., Halifax	Nov. 27, 1919
Schwartz, Hugh W., M.D., Halifax	Mar. 3, 1920
Sexton, Prof. Frederic H., D.SC., Director of Technical Education, Halifax	Dec. 18, 1903
Sleggs, Prof. George F., B.SC., Dalhousie University, Halifax	Dec. 1, 1921
*Smith, Prof. H. W., B.SC., Agric. College, Truro, N. S. (Ord. Member, Dec. 1900)	Jan. 6, 1890

*Life Member

	Date of Election
*Stewart, Lt. Col. John, M.B., C.M., Halifax (Senior Ordinary Member)	Jan. 12, 1885
Stultz, Guy N., D.D.S., Halifax	Mar. 13, 1922
Theakston, Prof. Harold Raymond, B.SC., Dalhousie University, Halifax	Jan. 9, 1922
Todd, Ebenezer Walter, B.A., Dalhousie University, Halifax	Nov. 27, 1919
Vickery, Hubert Bradford, D.SC., New Haven, Conn., U.S.A.	Nov. 2, 1915
Whyte, Earle Forrester, M.A., Clark University, Worcester, Mass., U.S.A.	Dec. 1, 1920
Winfield, James H., Mar. Tel. & Tel. Co., Halifax	Dec. 2, 1903
Woodbury, Frank, D.D.S, Halifax. (Died Feb. 5, 1922)	Dec. 1, 1921
*Woodbury, William Weatherspoon, B.SC., D.D.S., Halifax	Nov. 30, 1916
*Yorston, William G., C.E., Halifax	Nov. 12, 1892
Young, Prof. Donnell Brooks, late of Dalhousie University, Halifax	Nov. 27, 1919

ASSOCIATE MEMBERS

	Date of Election
Barteaux, James E., M.A., Insp. of Manual Tra. & Tech. Schools, Truro	Nov. 2, 1915
Bishop, Watson Lenley, Berwick, N. S.	Jan. 6, 1890
Brittain, Prof. William H., B.S.A., Provincial Entomologist, Truro	Nov. 2, 1915
Churchill, Frederick C., Wolfville, N. S.	Apr. 3, 1919
Connolly, Prof. C. J., PH.D., St. Francis Xavier University, Antigonish, N. S.	Nov. 5, 1911
Cumming, Principal Melville, B.S.A., LL.D., Agricultural College, Truro	Nov. 2, 1915
DeWolfe, Loran A., M.SC., Director of Rural Science Schools, Truro, N. S.	Nov. 2, 1915
Haley, Prof. Francis Raymond, Acadian University, Wolfville, N. S.	Nov. 5, 1901
Harlow, Prof. L. C., B.SC., PH.D., Agricultural College, Truro, N. S.	Mar. 23, 1905
Hatcher, Prof. Alfred G., Royal Naval College, Esquimalt, B. C.	Dec. 9, 1914
*Johns, Thomas W.	Nov. 27, 1889
*MacKay, Hector H., M.D., New Glasgow, N. S.	Feb. 4, 1902
Moore, Clarence Leander, M.A., F.R.S.C., Principal of Pictou Academy, Pictou.	Jan. 7, 1908
Murphy, Martin, D.SC., I.S.O., Moncton, N. B.. (Senior Associate Member)	Jan. 15, 1870
Murray, Prof. Daniel Alexander, PH.D., McGill University, Montreal	Dec. 18, 1903
Payzant, E. N., M.D., Wolfville, N. S.	Apr. 8, 1902
Perry, Prof. Horace Greeley, M.A., Acadia University, Wolfville, N. S.	May 12, 1913
Richardson, Prof. Lorne N., Royal Naval College, Esquimalt, B. C.	Dec. 9, 1914
Scott, Prof. J. M., M.A., M.SC., Prov. Normal College, Truro, N. S.	Nov. 2, 1915
Shaw, Prof. Percy J., B.A., Agricultural College, Truro, N. S.	Nov. 2, 1915
Tufts, Robie Wilfred, Wolfville, N. S.	Oct. 3, 1921
Westwood, Lieut. Ralph V., Stratford-on-Avon, England	Dec. 5, 1918

CORRESPONDING MEMBERS

	Date of Election
Ami, Henry M., D.SC., F.G.S., F.R.S.C., Laurier Ave., Ottawa	Jan. 2, 1892
Bailey, Loring W., PH.D., LL.D., F.R.S.C., Fredericton, N. B.	Jan. 6, 1890
Ball, Rev. Edward Henry, D.C.L., Chester, N. S. (Died Apr. 11, 1922)	Nov. 29, 1871
Barbour, Major J. H., R.A.M.C., F.L.S., London, Eng	Dec. 28, 1911
Bethune, Rev. Charles J. S., D.C.L., F.R.S.C., Toronto, Ont (Senior Corresponding Member.)	Dec. 29, 1868
Cox, Prof. Philip, PH.D., University of N. B., Fredericton, N. B	Dec. 3, 1902
Dobie, W. Henry, M.D., Chester, England	Dec. 3, 1897
Faribault, E. Rudolphe, D.SC., F.R.S.C., Geol. Survey, Ottawa (Assoc. Member, Mar. 6, 1888)	Dec. 3, 1902
Ganong, Prof. William F., PH.D., Northampton, Mass., U.S.A.	Jan. 6, 1890
Gates, Reginald Ruggles, PH.D., F.L.S., London, Eng.	Nov. 30, 1916
Matheson, Prof. Robert, PH.D., Cornell University, Ithica, U.S.A	Nov. 30, 1916
Mowbray, Louis L., Director of Miami Aquarium, Miami, Fla	May 3, 1907
Peter, Rev. Brother Junian	Dec. 12,, 1898
Prest, Walter Henry, Halifax (Died Dec. 25, 1920). (Assoc. Member, Nov. 29, 1894)	Nov. 2, 1900
Prichard, Arthur H. Cooper	Dec. 4, 1901
Prince, Edward E., LL.D., D.SC., Commissioner of Fisheries, Ottawa	Jan. 5, 1897

*Life Member.

LIST OF PRESIDENTS

OF THE NOVA SCOTIAN INSTITUTE OF NATURAL SCIENCE, AFTERWARDS THE NOVA SCOTIAN INSTITUTE OF SCIENCE, SINCE ITS FOUNDATION IN 1862.

Hon. Philip Carteret Hill, D.C.L.	31 Dec.	1862	to	26 Oct. 1863
John Matthew Jones, F.L.S., F.R.S.C.	26 Oct.	1863	"	8 Oct. 1873
John Bernard Gilpin, M.A., M.D., M.R.C.S.	8 Oct.	1873	"	9 Oct. 1878
William Gossip	9 Oct.	1878	"	13 Oct. 1880
John Somers, M.D.	13 Oct.	1880	"	26 Oct. 1883
Robert Morrow	26 Oct.	1883	"	21 Oct. 1885
John Somers, M.D.	21 Oct.	1885	"	10 Oct. 1888
Prof. James Gordon MacGregor, M.A., D.SC., F.R.S., F.R.S.C.	10 Oct.	1888	"	9 Nov. 1891
Martin Murphy, C.E., D.SC., I.S.O.	9 Nov.	1891	"	8 Nov. 1893
Prof. George Lawson, PH.D., LL.D., F.I.C., F.R.S.C.	8 Nov.	1893	"	10 Nov. 1895
Edwin Gilpin, Jr., M.A., LL.D., D.SC., F.G.S., F.R.S.C., I.S.O.	18 Nov.	1895	"	8 Nov. 1899
Alexander McKay, M.A.	8 Nov.	1897	"	20 Nov. 1899
Alexander Howard MacKay, B.A., B.SC., LL.D., F.R.S.C.	20 Nov.	1899	"	24 Nov. 1902
Henry Skeffington Poole, M.A., D.SC., A.R.S.M., F.G.S., F.R.S.C.	24 Nov.	1902	"	18 Oct. 1905
Francis William Whitney Doane, C.E.	18 Oct.	1905	"	11 Nov. 1907
Prof. Ebenezer Mackay, PH.D.	11 Nov.	1907	"	12 Dec. 1910
Watson Lenley Bishop	12 Dec.	1910	"	11 Nov. 1912
Donald MacEachern Fergusson, F.C.S.	11 Nov.,	1912	"	13 Oct. 1915
Prof. David Fraser Harris, M.B., C.M., M.D., B.SC., D.SC., (London) F.R.SS. E. & C.	13 Oct.	1915	"	18 Nov. 1918
Prof. Howard Logan Bronson, PH.D., F.R.S.C.	18 Nov.	1918	"	8 Nov. 1920
Prof. John Cameron, M.D., D.SC., F.R.SS.E. & C.	8 Nov.	1920	"	20 Nov. 1922
Prof. Carleton Bell Nickerson, M.A.	20 Nov.	1922		

NOTE—Since 1879 the Presidents of the Institute have been *ex-officio* Fellows of the Royal Microscopical Society.

The first general meeting of the Nova Scotian Institute of Natural Science was held at Halifax, on 31st December, 1862. On 24th March, 1890, the name of the society was changed to the Nova Scotian Institute of Science, and it was incorporated by an act of the legislature in the same year.

The foundation of the Halifax Mechanics' Institute on 27th December, 1831, and of the Nova Scotian Literary and Scientific Society about 1859 (the latter published its transactions from 4th January to 3rd December, 1859) had led up to the establishment of the Nova Scotian Institute of Natural Science in December, 1862.

INDEX VOL. XV.

(Roman numerals refer to the Proceedings, Arabic numerals to the pages of Transactions.)

THE attention of members of the Institute is directed to the following recommendations of the British Association Committee on Zoological Bibliography and Publications:

"That authors' separate copies should not be distributed privately before the paper has been published in the regular manner.

"That it is desirable to express the subject of one's paper in its title, while keeping the title as concise as possible.

"That new species should be properly diagnosed and figured when possible.

"That new names should not be proposed in irrelevant footnotes, or anonymous paragraphs.

"That references to previous publications should be made full and correctly, if possible in accordance with one of the recognized sets of rules of quotations, such as that recently adopted by the French Zoological Society.

THE

PROCEEDINGS AND TRANSACTIONS

OF THE

Nova Scotian Institute of Science

HALIFAX, NOVA SCOTIA

VOLUME XVI PARTS 1-2-3-4

SESSIONS 1922-1926

HALIFAX

PRINTED FOR THE INSTITUTE BY THE ROSS PRINT LIMITED

Date of Publication 21st Nov., 1927.

PRICE TO NON-MEMBERS: ONE HALF-DOLLAR

THE

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To The Writer:

THE attention of the members of the Institute presenting communications for publication is directed to the follow-lowing notes:

1. Fifty "separates" of each communication accepted by the Council for publication are provided for the author;

2. Drawings which have to be reduced in size should have the lines and letters sufficiently large to be distinctly visible in the print; the drawings should be about double the size of the desired print; and the copy should be carefully typed or in distinct manuscript;

3. The nomenclature of species, etc., should be given in good form, as recommended by the authorities directing the abstracting of scientific literature;

4. References to previous or other papers should be made clearly and neatly in the forms approved by the said abstracting authorities;

5. The title of a "paper" communicated should be made as brief as possible while expressing its subjet as definitely as desirable.

6. Footnotes pertaining to the text of the "paper" should be numbered consecutively (from 1 onwards) by *superscript* numerals placed (above) after the word or sentence to which the note refers. As these footnotes will be in smaller type and therefore set up on a different machine, they should be all written in consecutive order as an appendix to the "paper". The printer will place each at the base of its proper page when making up the page.

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PROCEEDINGS

OF THE

Nova Scotian Institute of Science

SESSION OF 1922-1923

VOL. XVI. PART 1.

61ST ANNUAL SESSION

ANNUAL BUSINESS MEETING

Physiological Lecture Room, Dalhousie College, Halifax
20th November, 1922.

THE PRESIDENT, DR. JOHN CAMERON, in the chair.

Other members present: Prof. C. B. Nickerson, D. J. Matheson, Prof. D. S. McIntosh, Dr. A. H. MacKay, Prof. D. Fraser Harris, Dr. S. G. Ritchie, Prof. J. A. Dawson, E. W. Todd, Prof. W. P. Copp, Prof. H. P. Bell, Dr. A. R. Cunningham, H. E. Read, and H. Piers.

The President made some remarks on the papers which had been presented during the last session. A noteworthy feature had been the course of popular lectures; while there had been but few original papers, the preparation of which is the chief aim of the Society.

The Recording Secretary referred to the death of two members during the year: Dr. Frank Woodbury had passed away on 3rd February, and a minute of regret at his decease was passed on 13th February. The Rev. Edward Henry Ball, D.C.L., a member of the Institute since 1871, had died at Chester, N. S., on 11th April, 1922, and the Secretary gave a brief sketch of his life and of his study of our provincial flora a number of years ago.

The Treasurer, D. J. Matheson, presented his annual report, dated 17th November, showing that the receipts were $1,974.16; the expenditures, $875.70; balance on hand (in current account), $1,098.46; and the balance at credit of reserve fund, $138.41; while the permanent endowment fund is $1,500. It was pointed out that there is chargeable against the balance, the cost of printing the Transactions, vol. 15, part 2; and subsequent parts 3 and 4. The report was received and adopted.

The Librarian's report was presented by Mr. Piers, showing that 1,077 books and pamphlets had ben received during the year 1921. The total number of books and pamphlets received by the Provincial Science Library, with which that of this Institute is incorporated, during 1921, was 1,407. The total number in the Science Library on 31st December, 1921, was 65,457 Of these, 48,125 belong to the Institute, and 17,332 to the Science Library proper. 117 books were borrowed in 1921, besides those consulted in the library. No binding or purchasing has been done by the library directly, there being no money grant at its disposal since 1907. The report was received and adopted.

Officers for the ensuing year (1922-23), were elected as follows:

President,—Prof. Carleton Bell Nickerson, M. A., *ex officio* F. R. M. S.

First Vice-President,—Prof. John Hamilton Lane Johnstone, M.Sc., Ph.D., M.B.E.

Second Vice-President,—Stephen Galway Ritchie, B. A., D. M. D.

Treasurer,—Donald J. Matheson, B. Sc.

Corresponding Secretary,—Prof. Donald Sutherland McIntosh, M. Sc.

Recording Secretary and Librarian,—Harry Piers.

Councillors without office.—Alexander Howard MacKay, LL. D., F. R. S. C.; Prof. David Fraser Harris,

M. D., D. Sc., F. R. SS. E. and C.; E. Chesley Allen; Prof. James Arthur Dawson, Ph. D.; Prof. Albert G. Nicholls, M. D., D. Sc., F. R. S. C.; Prof. Hugh Philip Bell, M. Sc.; and John Stanley Bagnall, D. D. S.

A committee on popular lectures was appointed as follows: Dr. Harris, Dr. Cameron, and Dr. Ritchie.

The chair was taken by the new President, who thanked the Institute for the honour done him.

A vote of thanks was presented to the retiring president for the able manner in which he had filled the chair during his term of office.

First Ordinary Meeting.

Physiological Lecture Room, Dalhousie College, Halifax; 8th January, 1923.

The President, Prof. Nickerson, in the chair.

It was reported that at the council meeting of 1st November, Charles E. W. Dodwell, C. E., of Halifax, had been elected an ordinary member, and Lloyd A. Munro, M. A., of Montreal, an associate member; and at the council meeting of 30th November, the following were elected ordinary members: Prof. W. G. Hardy, B. Sc., Prof. H. S. King, Mrs. H. S. King, and H. L. Scammell, all of Halifax.

Prof. Hugh P. Bell, M. Sc., Dalhousie University, read a paper on "The Rusts of the Balsam Fir," illustrated by lantern slides. The subject was discussed by the President, Dr. A. H. MacKay, and others.

The President read a paper by Lloyd A. Munro, M. A., of Montreal, on "A Study of Molybdenum Blue." The paper was discussed by Dr. MacKay, and others.

Harry Piers read a paper on the "Accidental Occurrence in Nova Scotia of the Rock Ptarmigan (*Lagopus rupestris* *welchi* or *L. ruspestris rupestris*); with remarks on the status of *L. welchi* as a specific name." The subject was discussed by Dr. MacKay, Dr. Cameron, and Dr. Dawson.

The President announced that arrangements had been made for a course of popular lectures during the session.

First Popular Lecture

Chemistry Lecture Room, Dalhousie College, Halifax, 29th January, 1923.

The President, Prof. Nickerson, in the chair, and many members and their friends in attendance.

Prof. Walter P. Copp, B. Sc., Dalhousie University, delivered an interesting popular lecture on "The Quebec Bridge," illustrated by lantern slides.

Second Popular Lecture

Physiological Lecture Room, Dalhousie College, Halifax, 26th February, 1923.

The President, Prof. Nickerson, in the chair, and about fifty persons present.

It was announced that A. C. McLatchy, Halifax, had been elected an ordinary member on 2nd February.

Prof. John Cameron, M. D., D. Sc., F. R. SS. E. & C., Dalhousie University, delivered an interesting popular lecture on "Races that Dwell above the Clouds," with lantern illustrations. He dealt with the inhabitants of Tibet, Bhutan, and ancient Peru.

Third Popular Lecture

Chemical Lecture Room, Dalhousie College, Halifax, 28th March, 1923.

The President, Prof. Nickerson, in the chair.

Prof. Donald S. McIntosh, M. Sc., of Dalhousie University, delivered an instructive popular lecture on "Weather in the Belt of Cyclonic Storms," illustrated by lantern slides.

Second Ordinary Meeting

Physiological Lecture Room, Dalhousie College, Halifax, 16th April, 1923.

The President, Prof. Nickerson, in the chair.

The President read a paper on "A Modification of the Procedure for the Qualitative Separation of the Metals of the Alkaline Earth Group."

A paper by Prof. T. L. Walker, Ph. D., Director of the Royal Ontario Museum of Mineralogy, Toronto, on "The Nature of Louisite," was read by Mr. Piers, in the absence of the author. The subject was discussed by Prof. D. S. McIntosh, Prof. H. S. King, E. W. Todd, H. Piers, Prof. Nickerson, Dr. Johnstone, and D. J. Matheson.

Fourth Popular Lecture

Physiological Lecture Room, Dalhousie College, Halifax, 30th April, 1923.

The President, Prof. Nickerson, in the chair, and about thirty persons present.

Prof. J. A. Dawson, Ph. D., Dalhousie University, delivered an interesting popular lecture on "In-Breeding and Out-Breeding," illustrated by lantern slides. The subject was discussed by the President, Dr. MacKay, Dr. Bronson, Dr. Cameron, Dr. Cunningham, Dr. Johnstone, and H. H Blois.

Fifth Popular Lecture

Physiological Lecture Room, Dalhousie College, Halifax, 16th May, 1923.

The President, Prof. Nickerson, in the chair, and about fifty persons present.

Dr. J. Cameron, was appointed delegate to represent the Institute at the Meeting of the Royal Society of Canada.

It was reported that Prof. W. F. McKnight, N. S. Technical College, Halifax, had been elected an ordinary member on 4th May.

Prof. D. Fraser Harris, M. D., D. Sc., F. R. SS. E. & C., delivered an interesting and instructive popular lecture on "What Seeing Means," illustrated by lantern slides. The audience then adjourned to the physiological laboratory where preparations of parts of the eye were shown under the microscope.

Third Ordinary Meeting

Physiological Lecture Room, Dalhousie College, Halifax, 21st May, 1923.

The President, Prof. Nickerson, in the chair.

The Following papers were then read:

(I.) A Procedure for the Qualitative Analysis of the group Magnesium, Potassium, and Sodium, by Prof. Harold S. King, Dalhousie University. Discussed by the President, Dr. Johnstone, Mr. Todd, and Mr. Piers.

(2.) The Electrical Conductivity of Calcite. By W. J. Jackson, M. A., Dalhousie University. Discussed by Dr. Johnstone, the President, and Mr. Todd.

(3.) A Scheelite (Tungsten-bearing) Deposit recently discovered at Lower Sackville, Halifax County. By Harry Piers. Discussed by Dr. Johnstone, Mr. Todd, and F. W. Dixon.

(4.) Phenological Observations, Nova Scotia, 1922. By A. H. MacKay, LL. D., F. R. S. C., Superintendent of Education.

Harry Piers,
Recording Secretary.

PROCEEDINGS

OF THE

Nova Scotian Institute of Science

SESSION OF 1923-1924

(Vol. XVI., Part 2).

Sixty-second Annual Business Meeting

Physiological Lecture Room, Dalhousie College, Carleton Street,

Halifax, 14*th November*, 1923.

The President, Prof. Carleton Bell Nickerson, in the chair. Other members present: D. J. Matheson, Prof. D. S. McIntosh, Dr. A. H. MacKay, Dr. A. G. Nicholls, Dr. John Cameron, E. W. Todd, Prof. H. S. King, Prof. W. P. Copp, Prof. W. F. McKnight and H. Piers.

The President delivered a short opening address, in which he dealt with the welfare of the society and the increasing difficulty of obtaining original papers.

The Treasurer's report was presented by Mr. Matheson, showing that the receipts of the year ended 14th November, were $1,748.10; the expenditures, $109.02; and the balance on hand, in current account, $1,639.08; while the reserve fund balance was $156.55.—The report was received and adopted.

The Librarians report was presented by Mr. Piers, showing that 1,466 books and pamphlets had been received through the exchange list during 1922. The total number of books and pamphlets received by the Provincial Science Library (with which that of the Institute is incorporated) during 1922, was 1,707. The total number in the Science Library on 31st December, 1922, was 67,164. Of these, 49,591 (about 74 per cent.) belong to the Institute, and 17,573 to the Science Library proper. 138 books were borrowed, besides those consulted in the Library. No binding or purchasing has been done, there having been no money grant available for the library since 1907.—The report was received and adopted.

It was reported that J. B. Fielding, Halifax, had been elected a member on 2nd October.

It was resolved that a course of popular lectures be again given during this session.

Officers for the ensuing year (1923-24) were elected as follows:

President,—PROF. CARLETON BELL NICKERSON, M. A., *ex-officio* F. R. M. S.

First Vice-President,—PROF. JOHN HAMILTON LANE JOHNSTONE, M.Sc., Ph.D., M.B.E.

Second Vice-President,—PROF. ALBERT G. NICHOLLS, M. D., D.Sc., F.R.S.C.

Treasurer,—DONALD J. MATHESON, B.Sc.

Corresponding Secretary,—PROF. DONALD S. MCINTOSH, M.Sc.

Recording Secretary and Librarian,—HARRY PIERS.

Councillors without office,—A. H. MACKAY, LL.D., F. R. S. C.; PROF. D. FRASER HARRIS, M.D., D.Sc., F.R. SS. E. and C.; PROF. HUGH P. BELL, M.Sc.; STEPHEN G. RITCHIE, D.M.D.; PROF. HOWARD L. BRONSON, Ph.D., F.R.S.C.; PROF. HAROLD S. KING, B.A., and FRANK W. RYAN, D.D.S.

Auditors,—P. R. COLPITT and E. C. ALLEN.

First Oridnary Meeting

Physiological Lecture Room, Medical Science Building, Dalhousie College, Halifax, 14th January, 1924

The President, Prof. Nickerson, in the chair.

A paper, entitled "A Nova Scotian Life Table," was read by Dr. Arthur C. Jost, Provincial Health Officer, Halifax.

First Popular Lecture

Physiological Lecture Room, Medical Science Building, Halifax, 28th January, 1924

The President, Prof. Nickerson, in the chair, and about thirty persons present.

E. Chesley Allen, Superintendent of the School for the Blind, delivered a popular lecture, entitled "The Lure of Nature Hiking."—The subject was discussed by the President, Dr. Ritchie, Prof. King, Dr. Johnstone, Mr. Piers, Mr. Feilding, Miss Mary Fletcher, Mrs. W. L. Pazyant, and Mr. Todd.

Second Popular Lecture

Physiological Lecture Room, Medical Science Building, Halifax, 25th February, 1924.

The President, Prof. Nickerson, in the chair.

Prof. Douglas McIntosh, D.Sc., Dalhousie University, delivered a popular lecture on "The Age of the Earth."

Third Popular Lecture

Physiological Lecture Room, Medical Science Building, Halifax, 31st March, 1924.

The President, Prof. Nickerson, in the chair.

Dr. Stephen G. Ritchie, delivered a popular lecture on "Musical Sounds, their Nature and Quality," illustrated by lantern slides.

SECOND ORDINARY MEETING

Physiological Lecture Room, Medical Science Building, Halifax, 21st April, 1924.

THE PRESIDENT, PROF. NICKERSON, in the chair.

In the absence of the author, MR. PIERS read a paper by FREDERICK C. CHURCHILL, Los Angeles, Cal., on "RECENT CHANGES IN THE COAST LINE IN THE COUNTY OF KING'S, N. S." The subject was discussed by PROF. D. S. MCINTOSH, MR. PIERS, DR. D. MCINTOSH, THE PRESIDENT, and DR. CAMERON.

PROF. HAROLD S. KING, B.A., Dalhousie University, read a paper on a "MODIFICATION OF THE ADAMS METHOD OF PREPARING ALKYL IODIDES."—The subject was discussed by the PRESIDENT, DR. D. MCINTOSH, DR. BRONSON, and DR. RITCHIE.

FOURTH POPULAR LECTURE

Assembly Hall, N. S. Technical College, Halifax, 28th April, 1924.

THE PRESIDENT, PROF. NICKERSON, in the chair, and about eighty persons present.

PROF. M. F. BANCROFT, Acadia University, delivered a popular lecture on "SIGHT-SEEING AT BANFF AND LAKE LOUISE," illustrated by coloured lantern slides and motion-pictures. A vote of thanks was presented to Prof. Bancroft.

THIRD ORIDNARY MEETING

Physiological Lecture Room, Medical Science Building, Halifax, 14th May, 1924

THE PRESIDENT, PROF. NICKERSON, in the chair.

In relation to MR. CHURCHILL'S paper of 21st April, DR. D. MCINTOSH made some additional remarks on the progress of erosion on the coast of Yorkshire, England, and at Heligoland.

PROF. DOUGLAS MCINTOSH, D.Sc., read a paper on "OXONIUM COMPOUNDS."—The subject was discussed by the PRESIDENT, DR. JOHNSTONE, and MR. TODD.

DR. A. H. MACKAY presented a paper on "PHENOLOGICAL OBSERVATIONS, NOVA SCOTIA, FOR 1923."—The subject was discussed by the PRESIDENT, DR. JOHNSTONE, and MR. TODD.

HARRY PIERS, curator of the Provincial Museum, presented a paper on "*Coregonus labradoricus*, an interesting addition to the Freshwater Fish Faŭna of Nova Scotia."—The subject was discussed by the PRESIDENT, DR. MCINTOSH, and DR. JOHNSTONE.

A committee on popular lectures was appointed as follows: DR. NICHOLLS, DR. RITCHIE, DR. JOHNSTONE, and PROF. BELL, with power to add to their number.

FIFTH POPULAR LECTURE

Physiological Lecture Room, Medical Science Building, Halifax, 27th May, 1924

THE PRESIDENT, PROF. NICKERSON, in the chair, and fourteen members present.

J. B. FEILDING, Halifax, delivered a popular lecture on "The Biology of the Pearly Mussel and its Ultimate use in the Button Trade," illustrated by lantern slides.

A vote of thanks was presented to MR. FEILDING.

HARRY PIERS,
Recording Secretary.

PROCEEDINGS

OF THE

Nova Scotian Institute of Science

SESSION OF 1924-1925

(VOL. XVI. PART 3)

63RD ANNUAL BUSINESS MEETING

Physiological Lecture Room, Dalhousie College, Halifax, 12th November, 1924

THE PRESIDENT, PROF. C. B. NICKERSON, in the chair.

Other members present: Dr. J. H. L. Johnstone, D. J. Matheson, Prof. D. S. McIntosh, Dr. A. H. MacKay, Dr. S. G. Ritchie, Dr. H. L. Bronson, Prof. H. S. King, P. R. Colpitt, E. W. Todd, Prof. W. P. Copp, Dr. D. McIntosh, Prof. J. N. Gowanloch and H. Piers.

The President, in his opening remarks, gave brief sketches of the lives of three members who had died during the year, namely, Donald M. Fergusson, a former president of the Institute, Dr. F. W. Dobson, and Dr. Frank W. Ryan, the last of whom had been a member of council. He also reviewed the activities of the society during the past session. The full address is appended to the Proceedings at page XVIII.

The Treasurer's report was presented by D. J. MATHESON, showing the receipts for the year were $2,274.58; the expenditures, $1,596.93; balance in hand (in current account), $677.65; and the balance at credit of reserve fund, $151.09; while the permanent endowment fund is $1,500.00. The report was received and adopted.

The Librarian's report was presented by MR. PIERS, showing that 1,253 books and pamphlets had been received through the exchange-list in 1923; and 1,087 have been received during the nine months, Jan. to Sept., 1924. The total number of books and pamphlets received by the entire Provincial Science Library (with which that of the Institute is incorporated) during 1923, was 1,428. The total number in the Science Library on 31st Dec., 1923, was 68,592. Of these, 50,844 (about 74%) belong to the Institute, and 17,748 to the Science Library proper. 101 books were borrowed in 1923, besides those consulted in the library. No binding or purchasing has been done, there being no money grant available for that purpose since 1907. The report was received and adopted.

The Corresponding Secretary, PROF. McINTOSH, reported on his work during the year; as well as did DR. MACKAY on progress in publishing the Transactions.

It was decided that the popular lectures be continued during the present session.

It was reported that DR. A. C. JOST, Halifax, had been elected an ordinary member on 30th June.

On motion of MR. PIERS and DR. BRONSON, the Council was recommended to elect as a corresponding member, DR. DAVID FRASER HARRIS, The Aggons, Dane Hill, Sussex, Eng., a former president of the society.

The Recording Secretary was directed to send letters of condolence to the families of deceased members, D. M. FERGUSSON, DR. F. W. DOBSON and DR. F. W. RYAN, of whose deaths this Institute learns with deep regret.

Officers for the ensuing year (1924-25) were elected as follows:—

President—STEPHEN GALWAY RITCHIE, B. A., D. M. D., *ex officio* F. R. M. S.

First Vice-President—PROF. J. H. L. JOHNSTONE, PH. D., M. B. E.

Second Vice-President—PROF. A. G. NICHOLLS, M. D., D. Sc., F. R. S. C.

Treasurer—D. J. MATHESON, B. Sc.

Corresponding Secretary—PROF. D. S. McINTOSH, M. Sc.
Recording Secretary and Librarian—HARRY PIERS.
Councillors without Office— A. H. MACKAY, LL. D., F. R. S. C.; PROF. H. P. BELL, M. Sc.; PROF. H. S. KING; PROF. J. CAMERON, M. D., D. Sc., F. R. S. C. & E. C. C. FORWARD; PROF. D. McINTOSH, PH.D., and PROF. C. B. NICKERSON, M. A.
Auditors—P. R. COLPITT and PROF. W. P. COPP.

On motion a vote of thanks was presented to the retiring President, PROF. NICKERSON, for the able manner in which he had filled the chair during his term of office.

FIRST ORDINARY MEETING

Physiological Lecture Room, Dalhousie College, Halifax, 8th December, 1924.

The President, DR. RITCHIE in the chair.

It was reported that DR. DAVID FRASER HARRIS had been elected a corresponding member on 2nd December.

PROF. HAROLD S. KING, Dalhousie University, read a paper on "The Action of Aqueous Ammonia on Mercurous Chloride." The subject was discussed by PROF. NICKERSON, MR. TODD, DR. D. McINTOSH, DR. RITCHIE and DR. BRONSON.

FIRST POPULAR LECTURE

Physics Lecture Room, Dalhousie College, Studley, Halifax, 26th January, 1925.

The President, DR. RITCHIE, in the chair.

PROF. H. L. BRONSON, PH. D., delivered a lecture, illustrated by experimental demonstrations, entitled "Elementary Discussion of Waves and Radiant Energy," it being the first of a series of four popular addresses on Radio Telephony arranged for the session. The subject was discussed by DR. MACKAY, P. R. COLPITT, PROF. COPP and the PRESIDENT.

SECOND ORDINARY MEETING

Physiological Lecture Room, Dalhousie College, Halifax, 16th February, 1925.

The President, DR. RITCHIE, in the chair.

On motion of MR. PIERS and PROF. McINTOSH, it was resolved that the Institute learns with very deep regret of the death of its corresponding member, PROF. LORING W. BAILEY, PH. D., LL. D., F. R. S. C., which took place at Fredericton, N. B., on 10th January; and of its associate member, DR. ELIAS NICHOLAS PAYZANT, M. D., at Wolfville, N. S., on 22nd of the same month; and desires to express to the members of their families its sympathy in their bereavement.

No paper was read.

SECOND POPULAR LECTURE

Physics Lecture Room, Dalhousie College, Studley, Halifax, 23rd February, 1925.

The President, DR. RITCHIE, in the chair.

PROF. J. H. L. JOHNSTONE, PH. D., of Dalhousie University, delivered the second of the series of lectures on Radio Telephony, the subject being "The Production, Transmission and Detection of Wireless Waves." The lecture was illustrated by experiments and lantern slides.

THIRD POPULAR LECTURE

Physics Lecture Room, Dalhousie College, Studley, Halifax, 30th March, 1925.

The President, DR. RITCHIE, in the chair.

ARTHUR WILLARD GREIG, A. R. R. L., delivered the third lecture on Radio Telephony, his subject being "Short Wave Transmission." The lecture was illustrated by experiments, including a demonstration of the method of measuring short radio waves.

Fourth Popular Lecture

Physics Lecture Room, Dalhousie College, Studley, Halifax, 27th April, 1925

The President, Dr. Ritchie, in the chair.

T. W. Murray, A. R. R. L., superintendent of the Halifax Radio Station, delivered the concluding lecture of the series on Radio Telephony, the subject being "Transatlantic Reception and Dispersal of News Traffic."

Third Ordinary Meeting

Physiological Lecture Room, Dalhousie College, Halifax, 11th May, 1925.

The President, Dr. Ritchie, in the chair.

It was reported that the following gentlemen had been elected ordinary members on 26th February: Prof. O. S. Gibbs, Prof. E. Gordon Young, Prof. Boris Babkin and N. B. Dreyer, all of Dalhousie College; Major William Coates Borrett, of Dartmouth, and Arthur Williard Greig and George A. Sandoz, of Halifax.

A committee on popular lectures was appointed, consisting of Dr. Nicholls, Prof. Young and Prof. Bell, with power to add to the number, in order that it might arrange and carry out a series of popular lectures on biological subjects for next year's session.

The following papers were read by title:—

"On the Action of Potassium Hydroxide on Aromatic Aldehydes," by Keith Huestis Butler.

"Observations on the Physiology of *Gyrodactylus*, a parasite of fish," by Prof. J. N. Gowanloch.

"Intertidal Behaviour of *Buccinum undatum*," by Prof. Gowanloch.

Harry Piers,
Recording secretary.

ANNUAL PRESIDENTIAL ADDRESS

PROF. C. B. NICKERSON, M. A.

(12 Nov., 1924)

Fellow Members of the Institute, Ladies and Gentlemen:—

The item of business on the agenda card which calls for "Opening Remarks by the President," should properly mark, I think, the close of the Institute year for 1923-24. Before entering upon our new session, with its new officers, new plans, etc., I can perhaps best utilize the very few minutes which I have allotted to myself in briefly reviewing the work of the past year.

That review must unfortunately, include the mention of the loss by death of three of our members.

MR. DONALD MACEACHERN FERGUSSON, F. C. S., was born in the island of Colonsay, Scotland, in 1869, but spent the greater part of his childhood and youth in Greenock, receiving his training as a chemist in the laboratory of Messrs. MacGowan & Biggart, public analysts. He came to Halifax, Nova Scotia, in March, 1890, as chief chemist for the Acadia Sugar Refining Co., which position he held until October, 1920. He resigned then as he was not in good health and took the easier position as assistant in the Government laboratory in Halifax, where he stayed for five months, after which he and his family went to Vancouver, British Columbia. He was elected a member of the Nova Scotian Institute of Science on the 5th of January, 1909. Later he became a life member and was president from November, 1912 to October, 1915. During 1903 and 1904 he was a special student in biology at Dalhousie and was for some years an enthusiastic member of the Journal Club formed by the late Professor Eben. MacKay among chemists in Halifax and Dartmouth. He was well known in musical circles in Halifax and Dartmouth, where he played the double-bass in the Philharmonic Orchestra and was for about fifteen years choirmaster of St. James's Presbyterian Church, Dartmouth. It was hoped the change to Vancouver would improve his health, but he gradually failed and died, April 15, 1924.

Mr. Fergusson although for many years engaged in the routine work of an industrial laboratory, never allowed himself to fall into the rut to which work of that kind is so apt to lead. On the contrary, by every means within his power, he kept his scientific interests sharpened and whenever recent advances in chemistry and physics were discussed at our meetings here or in the Journal Club at Dalhousie, we could always depend on Mr. Fergusson to take an active part.

A pleasing personality combined with a bright sense of humor made him a delightful friend, and I am sure that the members of the Institute who knew him, must feel in his death a keen sense of personal loss.

During the late summer, the Institute again suffered a loss in the death of F. W. Dobson, D. D. S., who joined as an ordinary member in March 1922. Dr. Dobson being a recent member, had not entered into any of the activities of the society, but his expressed interest in scientific work, and in the welfare of Nova Scotia, would undoubtedly have led him to do so had he lived. I had only a slight acquaintance with Dr. Dobson and I am therefore unable to speak more intimately of his life and work outside of the Institute.

In the sudden and unexpected death of Frank W. Ryan, D. D. S., on the 17th of October, the Institute also lost a valued friend and member. Dr. Ryan was born in New Brunswick in 1860, and since 1900 he had been a well-known dentist in this city. He became interested in the Nova Scotian Institute of Science and joined as an ordinary member in Nov. 1919. and at our last annual meeting was elected a member of the Council. Dr. Ryan at the time of his death was Dean of the Dental Faculty of Dalhousie University, and also Professor of Operative and Dental Surgery. No sketch of Dr. Ryan's life and work could be adequate which did not recall his personality. Always genial and sympathetic, his work both as an educator and a member of the Institute's council, will make his name to be long remembered by the members of this society.

During the past year, 6 original papers were read before the Institute. These papers are all now, I believe, in the process of being published. For a number of years, the society has been much behind-hand in this matter of publication and I happen to know that this delay has prevented us from getting several important papers. This is unfortunate, but we cannot blame those who wish the account of an original work to appear at the earliest possible date, since credit for priority in such matters is reckoned from the actual date of publication. We understand of course, that increased costs during the war and after, have necessarily made the publication problem a difficult one for us. I am glad to say, however, that at present our printing is much more nearly up to date than it has been for seven or eight years.

For several winters past as you know, the Institute has been conducting a series of so-called Popular Lectures. The original intention in holding these lectures was, I believe, first, to attempt to attract those people to our meetings who have a general interest in scientific subjects, but who are not sufficiently familiar with the details of any one subject to benefit by attending our regular meetings. Another reason was, and I should perhaps say this in confidence, to advertise the Institute of Science. I think that most of us will admit that these lectures have done something, at least, toward the accomplishment of both purposes. The results have been rather discouraging at times but I am quite certain that the general interest in these lectures is on the increase. There is, of course, much to be done in the matter of working out a more satisfactory scheme for advertising the lectures , arrangements of a program, etc., and these are problems which should be discussed and disposed of at this meeting.

In closing, I wish to thank the members of this society and in particular, the members of the Institute's council for their help and co-operation in carrying on my work as President for the past two years.

PROCEEDINGS

OF THE

Nova Scotian Institute of Science

SESSIONS OF 1925-1926

VOL. XVI, PART 4

64TH ANNUAL BUSINESS MEETING

Physiological Lecture Room, Dalhousie University, Halifax, 14th October, 1925

THE PRESIDENT, DR. STEPHEN G. RITCHIE, in the chair.

Other members present: Dr. J. H. L. Johnstone, Dr. A. G. Nicholls, D. J. Matheson, Prof. D. .S McIntosh, Dr. A. H. MacKay, Prof. H. S. King, Prof. D. McIntosh, Prof. C. B. Nickerson, Dr. G. H. Henderson, Prof. W. P. Copp, Mr. Scammell, Prof. E. G. Young, Prof. O. S. Gibbs, and H. Piers.

The Presidential Address was delivered by DR. STEPHEN G. RITCHIE, which will be found in full at the end of the Proceedings, page XXVII

The Treasurer's report was presented by D. J. MATHESON, showing that the receipts for the year ended 14th Oct., 1925, were $1,328.40; the expenditures $25.50; balance in hand (in current amount), $1302.90; and balance at credit of reserve fund, $165.92. The report was received and adopted. It was pointed out that there was chargeable against the balance, the cost of three parts of the Transactions which are in the printer's hands.

The Librarian's report was presented by MR. PIERS, showing that 1,485 books and pamphlets had been received through the exchange list during the year 1924; and 1,142 have been received during the nine months, January to September, 1925. The total number of books and pamphlets received by the entire Provincial Science Library (with which that of the Institute is incorporated) during the year 1924, was 1,642. The total number in the Science Library on 31st December, 1924, was 70,234. Of these, 52,329 (about 75 per cent.) belong to the Institute and 17,905 to the Science Library proper. 108 books were borrowed in 1924, besides those consulted in the library. No binding or purchasing has been done, there being no grant at its disposal since 1907. The report was received and adopted.

Dr. Nicholls reported from the Popular Lectures Committee. It suggested two alternatives: (1) a series of four lectures, or (2) an exhibit which would interest the public in the development of science. The committee was instructed to ascertain if it would be possible to have two or three popular lectures on biological subjects, with the addition of the exhibition referred to.

Reference was made to the loss the society had sustained through the death, during the past year, of three members, Prof. L. W. Bailey, Ph. D., of Fredericton; Dr. E. N. Payzant, of Wolfville, and Sir Charles Frederick Fraser, of Halifax.

It was announced that Rev. Brother William B. Cornelia, of St. Mary's College, Halifax, had been elected an ordinary member on 1st October.

Officers for the ensuing year (1925-6) were elected as follows:

President—Stephen Galway Ritchie, B. A., D. M. D., *ex officio* F. R. M. S.

First Vice-President—Prof. John Hamilton Lane Johnstone, Ph.D., M. B. E.

Second Vice-President Prof. Albert G. Nicholls, M. D., D. Sc., F. R. S. C.

Treasurer—Donald J. Matheson, B. Sc.

Corresponding Secretary—Prof. Donald S. McIntosh, M. Sc.

Recording Secretary and Librarian—Harry Piers.

Councillors without office—Alexander H. MacKay, LL. D., F. R. S. C.; Prof. Harold S. King; Prof. Douglas McIntosh, Ph. D.; Prof. Carleton B. Nickerson, M. A.; Prof. George H. Henderson, Ph. D.; Prof. O. S. Gibbs, and Prof. E. Gordon Young.

Auditors—Parker R. Colpitt and Prof. W. P. Copp.

First Ordinary Meeting

Physiological Lecture Room, Dalhousie University, Halifax, 16*th November*, 1925

The President, Dr. S. G. Ritchie, in the chair.

Prof. Donald S. McIntosh presented a paper entitled "Notes on an Esker in the Interior of Digby County, N. S."

Second Ordinary Meeting

Dental Lecture Room, Dalhousie University, Halifax, 14*th December*, 1925

The President, Dr. S. G. Ritchie, in the chair.

It was reported that the following had been elected members on 3rd December: E. A. Smith, E. E. , Ph. D., F. P. S., Secaucus, New Jersey, U. S. A. (Associate); William W. Page, Halifax (Ordinary), and George C. Lawrence, B. Sc., Dalhousie College, Halifax (Ordinary).

A paper was read by Miss Margaret F. McCurdy, M. Sc., entitled "Notes on the Reduction of Potassium Platinic Chloride." The subject was discussed by Dr. D. McIntosh, Dr. H. R. Chipman, Prof. King, Dr. Johnstone and Mr. Todd.

H. Ritchie Chipman, Ph. D., read a paper entitled "Notes on the Devitrification of an Old Glass." The subject was discussed by Dr. Young, Dr. E. Whyte, Prof. D. S. McIntosh, Prof. Nickerson, Dr. D. McIntosh, Dr. Henderson, Prof. King, Dr. Johnstone and the President.

E. W. Todd, B. A., Dalhousie University, read a paper on "Some Qualitative Tests for Methyl Alcohol." The subject was discussed by Dr. D. McIntosh, Prof. Nickerson, Dr. MacKay, Dr. Chipman, Prof. King and Dr. Young.

Third Ordinary Meeting

Dental Lecture Room, Dalhousie University, Halifax,
18*th January*, 1926

The President, Dr. S. G. Ritchie, in the chair.

It was announced that Dr. J. D. Forbes, Atlantic Experiment Station for Fisheries, Halifax, had been elected an ordinary member on the 12th inst.

The President stated that the members of the Institute had on the 7th inst., presented a piece of plate to Mr. and Mrs. Harry Piers on the occasion of the twenty-fifth anniversary of their marriage, and he read a letter from Mrs. Piers expressing, on the part of herself and Mr. Piers, their very deep appreciation of the kindness of the society in making the presentation and of the accompanying good wishes. Mr. Piers also personally expressed his thanks to the meeting.

On motion of Mr. Piers and Dr. MacKay, it was resolved that the Institute learns with deep regret of the death at Montreal on the 9th of January, 1926, of its former President, Martin Murphy, C. E., D. Sc., D. S. O., and desires to express its sympathy to the bereaved family.

A discussion took place regarding a new policy for the Institute; and it was resolved that the matter be left to the council, in order that it might draft a notice to the members, requesting them to bring before the society the results of all scientific work they might be engaged upon, to be published in abstract or in some cases in full.

The following papers were read:

(1) Hydrogen in Cathode Zinc.—By W. Roy Elliot, B. A., Dalhousie Univ. The subject was discussed by Dr. Johnstone.

(2) Negative Geotropy of the Periwinkle.—By F. Ronald Hayes, Dalhousie Univ. The subject was discussed by Dr. MacKay, Mr. Piers and Prof. Gowanloch.

(3) On the Radium Content of Some Nova Scotian Minerals.—By Carl C. Kenty, M. Sc., Dalhousie Univ. The paper was discussed by Mr. Piers and Dr. Henderson.

Fourth Ordinary Meeting

Dental Lecture Room, Dalhousie University, Halifax,
25th February, 1926

The President, Dr. Ritchie, in the chair.

The committee on popular lectures reported that it was trying to arrange for an exhibition of interesting scientific material to be held, if possible, in April.

Prof. Harold S. King presented a paper entitled "Note on a Simple Still for the Preparation of Pure Water." The subject was discussed by Dr. Bronson, Dr. MacKay amd Mr. Piers.

K. L. Dawson, A. M. E. I. C., of the N. S. Tramways and Power Co., Halifax, read a paper on "The Removal of Carbon Disulphide from Coal Gas in Halifax: a Study in Vapour Pressure." The paper was discussed by Dr. MacKay, Prof. Gowanloch, Prof. D. S. McIntosh and Mr. Piers. A vote of thanks was presented to Mr. Dawson for his communication.

Fifth Ordinary Meeting

Dental Lecture Room, Dalhousie University, Halifax,
29th March, 1926

The First Vice-President, Dr. Johnstone, in the chair.

Robert C. Robb, Dalhousie University, read a paper entitled "A Study of Huntington's Chorea as a Mendelian Character." It was discussed by Dr. Babkin, Prof. Dreyer, Dr. Young and Prof. Nickerson.

Prof. N. B. Dreyer, M. A., M. R. C. S., Dalhousie University, read a paper on "An Experimental Study of Saline Cathartics." Among those who took part in the discussion were Dr. Johnstone, Dr. Young, Dr. Babkin, Dr. D. McIntosh, Prof. King and Prof. Nickerson.

Sixth Ordinary Meeting

Dental Lecture Room, Dalhousie University, Halifax,
19th April, 1926

The President, Dr. Ritchie, in the chair.

The following papers were presented:—

(1) The Ratio of the Electric Units of Charge.—By George C. Laurence, B. Sc., Dalhousie University. The subject was discussed by Dr. Johnstone, Dr. Bronson, Dr. Ritchie and Dr. Henderson.

(2) Liquid Hydrogen Sulphide as an Ionizing Solven.—By H. Ritchie Chipman, Ph. D. The subject was discussed by Dr. E. Whyte, Dr. Johnstone and Dr. D. McIntosh.

(3) The Augmented Secretion of the Salivary Glands.—By Prof. B. Babkin, D. Sc. and P. D. McLarren, M. D. Discussed by Prof. E. G. Young.

(4) The Digestibility of the White of Egg.—By I. G. Macdonald and Prof. E. G. Young, Ph. D. Discussed by Prof. Nickerson and Dr. Babkin.

SEVENTH ORDINARY MEETING

Dental Lecture Room, Dalhousie University, Halifax,
17*th May*, 1926

THE PRESIDENT, DR. RITCHIE, in the chair.

The following papers were presented:—

(1) Boundary Problems for a Self-Adjoint System of Partial Differential Equations.—By PROF. F. H. MURRAY, Ph. D., King's College.

(2) Solubilities and Molecular Weight Determinations in Liquid Chlorine.—By KEITH H. BUTLER, B. A., Dalhousie University.

(3) A Study of Early Development in *Cumingia*, with special reference to Cytology.—By MISS MARGARET E. MACKAY, M. A., Dalhousie University. Discussed by DR. RITCHIE and DR. BEAN.

(4) Effects of Various Treatments on the Tensile Strength of Fish Muscle.—By J. C. FORBES, Ph. D., Atlantic Experimental Station for Fisheries.

HARRY PIERS,
Recording Secretary.

Presidential Address 1924-5

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(*Read* 14 *Oct.* 1925)

The 63rd year of existence of the Nova Scotian Institute of Science has passed into history and it may be of interest to the present members to give a brief historical sketch of the Institution so that by comparison with the past we may the better realize what progress is being made in the present. In making this retrospect I find I have been anticipated by Mr. Harry Piers who at the 50th anniversary of the Institute in 1912 presented a very interesting and complete history of its membership and activities up to that year. It is to this monograph that I am indebted for most of the information herein.

Mr. Piers tells us that the study of Natural Science in Nova Scotia was well under way by individual workers as early as the year 1800, when Titus Smith, known as the Dutch Village Philosopher, was a botanist and naturalist of note. Other early workers were the Rev. Thomas MacCullouch, D. D., ornithologist, first principal of Pictou Academy 1816-1837 and principal of Dalhousie College, 1837. Abraham Gesner, M. D., F. G. S. geologist and mineralogist, author of "Remarks on the Geology and Mineralogy of Nova Scotia," a rather rare book at this time. There were others, too, William Bennett Webster, M. D., M. P. P. mineralogist; Richard Brown, geologist and mining engineer, and Sir William Dawson whose fame is international.

In 1813 a Mechanics' Institute was formed in Halifax. This was a literary and scientific organization meeting once a week during the sessions. It became very popular, but in the 50's interest began to wane, and about 1860 it became more or less dormant, and then defunct. In 1868 the collection of specimens belonging to the Institute was handed over to the Provincial Museum by the trustees which action finally closed the history of the society.

In 1859 the Nova Scotia Literary and Scientific Society was in evidence; but due, apparently, to conflicting interests the scientific men shortly afterwards proposed the formation of a separate organization. They held several preliminary meetings and, after a roster of prospective members had been made out, on the 31 Dec., 1862, in the hall of the Medical Society at Halifax, there was organized the Nova Scotian Institute of Natural Science. There were twenty-four charter members. Bylaws were passed and adopted, meetings being scheduled for the first Monday of every month during the session. The first ordinary meeting was held at Dalhousie College, 19th, Jan., 1863. Dr. J. B. Gilpin had the honor of reading the first paper on "The Common Herring of Nova Scotia," which was followed by one from Capt. Hardy, R. A., on the "Nocturnal Life of Animals in the Forest." At the February meeting the patron, the Earl of Mulgrave, was present and spoke at length.

In April 1864, the place of meeting was changed to the Province Building Institute Room. This was used until May 1871, after which for sixteen years meetings were held in the Provincial Museum and thereafter in the Legislature Council Chamber and Assembly Room. Later a shift was made in 1909 to the Technical College and finally another back again to Dalhousie College.

During its early years the Institute held nine field-days; but owing to lack of interest these were discontinued.

The first volume of the Transactions representing four years of work was published in 1867. The earlier volumes were edited by the Secretary and President Wm. Gossip;

from 1887-89—by Dr. Honeyman;

from 189-1901—by Dr. MacGregor;

from 1901-1908—by Mr. Harry Piers;

from 1908—for several years—by Dr. Creighton and

Dr. Alex. H. MacKay. After Dr. Creighton's retirement, by Dr. MacKay who still performs that duty in a very able manner.

In 1868, through the strenuous efforts of some of the porminent members of the Institute, the Provincial Museum was founded, and all specimens collected by the Institute were deposited there.

About 1867 the Institute received its first grant of $200.00 from the Legislature. In 1890 the grant was raised from $400.00 to $500.00 to meet the cost of printing 1300 copies of the Transactions. The grant has been continued at this figure up to the present time.

On the 1st March, 1878, through the efforts of the Institute of Science, a Technological Institute for instruction in technical subjects was established. After three sessions it passed out of existence, May 1880, for lack of funds. It was the unsuccessful forerunner of the present Technical College; "and yet," Mr. Piers states, "I never heard its name mentioned during all the agitation leading up to the foundation of the latter institution."

Much to my surprise I find that on the 2nd April the Institute of Science was honoured by having its then and subsequent presidents made ex-office Fellows of the Royal Microscopical Society, a distinction which our presiding officer still enjoys.

The session of '88-89 was an epoch, making one in the annals of the Institute. Dr. James Gordon MacGregor was elected president and held office until Nov. 1891. It was a period of awakening and regeneration. His resistless energy placed the organization on a higher plane. One result of his activities was the phenomenal growth of the library. In 1890 he increased the edition of the Transactions to 1300 copies, which were sent in exchange to learned institutions and libraries throughout the whole world. This resulted in two things—an increased notoriety for our research workers whose papers were printed therein, and in the building up of the library through the larger number of exchanges. Another result of his ideas was the broadening of scope through the dropping in

1890 of the word Natural from the title of the organization. Many papers in physics and chemistry were thus admitted although the change met with considerable opposition. The Institute was incorporated the same year.

In 1901 Dr. MacGregor accepted the chair of Natural Philosophy in Edinburgh University, the Institute uniting with others in extending a farewell dinner to the man who had done so much for the organization. He died in 1913.

The later years of the Institute have been uneventful.

Interest in science on the whole has been maintained and valuable work put on record. A concerted effort has been made during the past five years to create a wider public interest in science through the medium of free popular lectures during each session.

The results are very promising. From the research standpoint our output is disappointing. MacGregor thought an average of twelve papers a year far too small. At present we do not begin to approach that number. The Institute should give this matter serious consideration. Many papers of interest are being published elsewhere which should undoubtedly be first presented before this Institute.

Now a word or two about our library. It began in 1864 with one book. Additions thereafter were rapid so that eventually it reached such proportions that the Institute could no longer comfortably handle it. In 1899 by letter to the Provincial Secretary, the Institute stated its willingness to intrust its library to the custody of the Government (the right of property remaining with the society) on condition that it should be made the nucleus of a public library to be maintained by the Government in connection with the Provincial Museum, and to be open to all who may wish to use it under such restrictions only as might be necessary for the safe keeping of the books, and also that the Government appoint a competent ibrarian to take the library in charge. The Government saw the wisdom of this step and in the summer of 1900 it became the Provincial Science Library of Nova Scotia under the control of the Department of Public Works and Mines, the scientific works of the Legislative Library being added thereto. In 1913 the records show that it contained about 45,000 books and pamplets. At the present time it contains over 70,000 of which 75 per cent belong to the Institute of Science.

The Provincial Museum which Dr. MacKay has called "the ward of the Government but the child of the Institute" now contains 30,000 specimens two thirds of which are Nova Scotian.

This sketch would be incomplete without the mention of at least a few of those who have been prominent in the Institute and in the advancement of science in the Province in the past, all of whom have gone to their reward.

The Hon. Philip Cartaret Hill, D. C., D. C. L., first president and at the time mayor of Halifax.

John Matthew Jones, F. L. S., F. R. C. C., zoologist.

John Somers, M. D., botanist.

John Bernard Gilpin, M. D., M. R. S. C., F. R. S. C., zoologist.

Robert Morrow, comparative anatomist and zoologist.

Prof. George Lawson, botanist and chemist.

Edwin Gilpin, Jr., LL. D., D. S. C., F. R. S. C., economic geologist.

Rev. John Ambrose, M. D., D. C. L., zoologist.

Robert Grant Haliburton, M. A., D. C. L., F. R. C. S., ethnologist (son of Sam Slick).

Col. William. James Myers, meteorologist.

Thomas Belt, geologist and naturalist.

John Robert Willis, conchologist.

Andrew Downs, ornithologist.

Rev. David Honeyman, D. C. L., F. G. S., F. R. G. S., geologist.

Henry Youle Hind, D. C. L., F. R. G. S., geologist and explorer.

Rev. Dr. Geo. Patterson, archeologist.

Hugh Fletcher, B. A., geologist.

Maj. Gen. Campbell Hardy, naturalist.

Dr. L. W. Bailey, geologist and scientist.

An account such as the foregoing must of necessity be brief and sketchy. But brief as it is it is sufficient to show that this Institute of ours through its members must have been a tremendous factor in the scientific, industrial and economic development of this province; and I believe there is every reason to think that it will continue as such.

In conclusion may I be permitted to say, that I have deemed it a great honor to be the executive head of this fine old organization during the past year. It is a source of gratification to me to have this opportunity of extending my sincere thanks to those who contributed papers, to the lecturers whose able efforts were greatly appreciated by the large audiences which attended during the series on radio telephony; and lastly to the members of the Council and the Secretary for their cheerful and able assistance without which the session just closed could not have been a success.

TRANSACTIONS

OF THE

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(Vol. xvi Part 1)

Accidental Occurence in Nova Scotia of the Rock Ptarmigan (*Lagopus rupestris welchi* or *L. rupestris rupestris*); with Remarks on the Status of *L. welchi* as a Specific Name.—By Harry Piers, Curator of the Provincial Museum of Nova Scotia, Halifax.

(Read 8 January, 1923)

Hitherto none of the Ptarmigans has ever been taken in Nova Scotia, that province being far to the south of their normal range. William Brewster found the stout-billed Willow Ptarmigan (*Lagopus lagopus lagopus*, Linn.), with a chick about ten days old, on the 10th July, 1881, near Fox Bay (lat. 49° 12′), Anticosti Island, where it is reported to be plentiful,* that island being the most southerly extension of its normal range in easternmost Canada. It has occurred accidentally at Bangor, Maine, in Essex County, Massachusetts, and in northern New York, and once in New Brunswick. This Ptarmigan is more southern in its range and less elevated in its habitat than the Rock Ptarmigan (*L. rupestris rupestris*, Gmelin) and therefore more likely to occur here, with the exception perhaps of the insular races of each of these two species, Allen's Ptarmigan (*L. lagopus alleni*, Stejneger) and Welch's Ptarmigan (*L. welchi*, Brewster), both of which are confined to Newfoundland.

Specimen taken at Elmsdale, Nova Scotia, 1922.—On 20th April, 1922, Malcolm Lucas, a twelve-year-old lad, who lives on his father's, C. A. Lucas, farm on the northwest side of the

* Brewster, W., Birds observed during a Summer Cruise on Gulf of St. Lawrence, Proc. Bost. Soc. Nat. Hist., 22, p. 383, 1883.

post-road between Elmsdale and Enfield, ⅓ mile southwest of Elmsdale, Hants County, in the interior of Nova Scotia, while playing in a field at the back of their house, saw a strange white bird alight in the field which adjoins woodland. The bird began to feed on the remains of the preceding year's buckwheat. He ran into the house and got a .22 rifle, with a bullet from which he wounded the bird and then caught it, but it died soon afterwards. The railway trackmen of the locality also reported having seen the strange bird the same day, but they thought it was a white dove or pigeon.

Description.—Such a bird had never been seen before, and the specimen was brought to the Provincial Museum on May 1st, and was then in excellent condition (Museum Accession No. 5090). It was an adult male Ptarmigan in full winter plumage. The general colour was snowy white; tail very dark fuscous (very nearly black), very narrowly tipped with white, the broadest part of the white tips, .08 inch, being on the two middle feathers; middle line of shafts of primaries dark fuscous (except toward tip); transocular or loral stripe and bill, black; bare skin above eye, red; feet soiled white.

The measurements, very carefully made, were: length, 15.00 inches; wing, 7.40; tail, 4.45; tarsus, 1.29; bill from nostril, .38; depth of bill at nostril, .32; weight, 15 1-2 ozs. The feet and plumage did not show the slightest evidence that the bird had ever been in captivity; and the bird was not at all in a starved or emaciated condition, thereby showing that it had fared well for food.

Determination.—The dimensions of the bill show conclusively that it is not one of the varieties of the stout-billed Willow Ptarmigan *(L. lagopus lagopus)*, but that it is one of the races of the Rock Ptarmigan *(L. rupestris rupestris, L. rupestris reinhardi*, or what is known as *L. welchi*).

In measurements, these three last-mentioned geographic races agree, and they are structurally the same, and it is also impossible to distinguish them apart by colour when in the white winter plumage. It is claimed, however, that they may be separated by certain colour differences when in the summer plumage, if we agree that the published descriptions have been founded upon sufficiently abundant material, for in a bird which shows so much variation in individual specimens, the difference in all cases may not be quite as great as it appears on paper. Regarding the winter plumage, however, it is quite clear that even specialists such as Dr. Jonathan Dwight, are unable to separate the members of the Rock Ptarmigan group when in that dress.

It being, therefore, granted that these three races when in white plumage cannot be separated by any known structural or colour criterion, we are necessarily forced to attempt to approximately identify this specimen by considering the geographic range of the three races and their proneness to migrate, and thus arrive at some idea as to what one was most likely to have found its way by chance so far south of its normal range.

Ranges of the Rock Ptarmigans.—The typical Rock Ptarmigan, *L. rupestris rupestris* (Gmelin, 1788), A.O.U. 302, occurs in Arctic America, breeding from Melville Island in the west to Melville Peninsula in the east and south on the Barren Grounds from Alaska in the west to Ungava in the east, and also on alpine summits south to central Yukon. It winters south in the mountains of British Columbia, and even it is said as far as Vancouver Island, as well as to southern Mackenzie (about lat. 63°) in the west; and to southern Ungava and Hamilton Inlet (lat. 54°), Labrador, in the east. In normal seasons it comes south on Hudson Bay to lat. 58°, and in some seasons down to 55° at the entrance of James Bay. It thus has a southward movement in winter of perhaps about four hundred miles. It is therefore distinctly a migratory race, and hence perhaps liable to occasionally get out of its normal range at the times of the vernal and autumnal movements.. The nearest point that it normally approaches Nova Scotia is Hamilton Inlet, Labrador, which is about 700 miles northward of Elmsdale, Nova Scotia.

Reinhardt's Ptarmigan, *L. rupestris reinhardi* (Brehm, 1823), A.O.U. 302a, the second member of the group, is the most northeasterly geographic race. It occurs in Greenland (the only form there), and on the western side of Baffin Bay and Davis Strait, viz. on Ellismere Land, western shores of Cumberland Sound, Melville Peninsula (*vide* Arctic Manual, 1875), northern Ungava, and northern extremity of Labrador, probably nearly as far southeastward as about Okkak in Labrador. This race, therefore, replaces the preceding from about Melville Peninsula or Baffin Land. It does not occur nearer to Nova Scotia than the district somewhat to the north of Okkak, Labrador, which is about 940 miles north of this province.

Welch's Ptarmigan, *L. welchi*, Brewster, 1885, A.O.U. 303, is an insular geographic race which is only found on the interior (?) elevated parts of the island of Newfoundland, where it occurs with a race of the Willow Ptarmigan, known as Allen's Ptarmigan (*L. lagopus alleni*). Welch's bird may be generally considered as non-migratory. Cape Ray, the nearest point of Newfoundland, is only about 275 miles northeast of Elmsdale, Nova Scotia.

Our specimen must be either Welch's or the Rock Ptarmigan. —The northern range of Reinhardt's Ptarmigan should dismiss it from mind in relation with the Elmsdale specimen, as it would have had to cover at least 940 miles in coming here. Therefore I think the latter must be referred either to Welch's (*L. welchi*) or to the typical Rock Ptarmigan (*L. rupestris rupestris*).

The question of identity as affected by distance from normal southern range.—We will see if the matter may be still further narrowed down. As we have found that the nearest southern winter range of the typical Rock Ptarmigan is Hamilton Inlet, lat. 54°, about 700 miles to the north of us, it is far more probable, when the traversed distance is considered, that our specimen is Welch's Ptarmigan of Newfoundland, which island is only about 275 miles northeast of the place where the bird was taken, and it would only have had to come one-third the distance the Rock Ptarmigan would have to come from Hamilton Inlet. Cabot Strait, which separates Newfoundland from Cape North, Cape Breton Island, is only about 64 miles wide.

Even a non-migratory bird like Welch's Ptarmigan might easily be caught in a northeasterly gale and so blown across that narrow strait to Cape Breton, from whence it could have wandred southwestward, overland, to Elmsdale, a further land journey of 210 miles. It is also probable that it could have been borne in this direction by the drift-ice of spring setting southward; in fact this is a very likely explanation of its transport hither. Judged by the criterion of distance alone, one would readily decide that our specimen must be Welch's Ptarmigan of Newfoundland.

The question of identity as affected by migratory and non-migratory habits of the two races.—Welch's Ptarmigan is practically a non-migratory bird, confined to a large island, and one would not expect it to have any natural tendency to proceed beyond its normal limits; unless, as we have said, it happened to be blown off land by a heavy gale, or was carried south on an ice-berg. The true Rock Ptarmigan, on the other hand, is a migratory bird, which from its breeding grounds on Melville Peninsula regularly migrates southward in Eastern Canada, in autumn, as far as lat. 58°, or even 55° on Hudson Bay, and to Hamilton Inlet. From thence, in the spring, it returns northward to the Barren Grounds in the far north. The southern migration, consisting of thousands of birds, passes Chesterfield Inlet, northwestern part of Hudson Bay, early in October, and passes northward again in May (*vide* A. P. Low).

This migratory characteristic, might tend to cause an individual, at the time of the northward spring movement, to take some erratic course of flight, perhaps assisted at first by a northerly gale which would drive it far out of its normal course; and thus separated from its companions, it might proceed overland some 750 miles, via Quebec and New Brunswick, into Nova Scotia, in the latter part of April. Taking migratory instinct as the basis of probability in the case, it would seem more likely that our specimen would be the true Rock Ptarmigan (*L. rupestris rupestris*), which is endowed with instinct and power for extensive migratory movements, which Welch's Ptarmigan is not.

Conclusion.—We thus find that Welch's Ptarmigan would have had only one-third the distance to cover that the Rock Ptarmigan would have had; but the former lacks the strong migratory instinct of the latter. Personally, I feel strongly inclined to believe that our Elmsdale specimen came the much shorter distance, from Newfoundland, having first been blown out to sea or else transported on ice as before suggested, and that therefore it should be recognized as Welch's Ptarmigan, the so-called *Lagopus welchi* or *Lagopus rupestris welchi* as no doubt it should be properly called. It is to be regretted that the question of identity will probably never be more closely ascertained.

Welch's Ptarmigan probably a geographical race of the Rock Ptarmigan.—As there is no known difference in form, structure or measurements between Welch's and the Rock Ptarmigan, the only difference being the subsidiary one of the colour in the summer plumage, the winter plumages being indistinguishable apart, it is extremely probable that *L. welchi* is not a valid separate species, but is merely a non-migratory, insular geographical race of *L. rupestris*, differing only in seasonal colour.

Brewster, when first describing *welchi* in the "Auk," vol. 2, April, 1885, pp. 193-195, says: "as there is good evidence that their habitat is strictly isolated, intergradation with any of their allies is so improbable that I have thought it best to describe the bird as a full species, which I name after the collector of my type." It is confined to the rocky hills and mountains of parts of Newfoundland, while the stouter-billed Allen's Ptarmigan (*L. lagopus alleni*, Stejn.) occupies the rocky barrens.

The variation of colouring in the Ptarmigan generally, is great, even among individuals; and until a more extensive series of *L. welchi* has been collected and compared with a large number of other related forms, one naturally feels cautious in fully accepting it as a separate species, even if it has been so generally considered in America since 1885.

W. R. Ogilvie-Grant, in his Catalogue of Game Birds in the British Museum (Catalogue of Birds in British Museum, vol. 22), Lond., 1893, p. 50, after referring to *reinhardi*, *welchi*, and other related forms, under the head of *L. rupestris*, says: "of the greater number of these supposed different species, we have seen a dozen examples, and of the rest there are excellent figures and descriptions. After going over all the facts very carefully and allowing for very slight individual differences and climatic variations, we cannot see the slightest object to be gained in cataloguing under endless names what are clearly only forms of one species, especially as *L. rupestris*, taken as a whole, appears to be barely specifically distinct from *L. mutus* [of Europe]."

The scholarly Dr. Coues, who chafed under much of the "hair-splitting" tendencies of American ornithologists of his time, says of *Lagopus* in his Key to North American Birds, 5th ed., 1903, vol. 2, p. 743: "Specific characters founded upon colour alone are peculiarly fallacious in this genus. We have three well known good species, one of them with several alleged sub-species; I record all these, also the three other North American forms, without vouching for any, excepting *L. lagopus*, *L. rupestris*, and *L. leucurus*."

I understand that P. A. Taverner, naturalist of the Geological Survey of Canada, is inclined to somewhat agree with Ogilvie-Grant and Coues, being skeptical as to whether *welchi* should be specifically separated from *rupestris*.

It seems to me time that *welchi* should be considered untenable as a separate species, and that its very close relationship with *rupestris*, from which it cannot be separated in winter plumage, should at least relegate it to sub-specific rank as at present a mere geographical, non-migratory, insular race, with a more southern habitat, of that species, under the varietal name *Lagopus rupestris welchi*, as has already been done by Blasius in 1862 with Brehm's *Tetrao reinhardi* of 1823. This seems to be the more necessary, when we have seen that some systematists even go so far as to think that *L. rupestris*, taken as a group, is barely specifically distinct from the European *L. mutus*.

On the other hand it may be said that as long as we know so little about the fundamentals of specifity, the difference between species must be the present conventional and necessarily somewhat arbitary one of non-intergradation; and until intergradation has been actually demonstrated, we have to give the two forms full specific distinction no matter how slight the difference may be, and even if it leads us into what seems to be an obvious error.

We can only hope that someone will soon undertake to collect a sufficient number of specimens of the so-called *L. welchi* and of *L. rupestris*, to be in a position to definitely settle the specific or sub-specific status of the former. Careful comparison of many specimens would doubtless demonstrate that it intergrades with the mainland phase through individual variation at least.

Provincial Museum, Halifax, N. S.,
5th January, 1923.

A Study of Molybdenum Blue, its Properties and Composition.—By Lloyd Alexander Munro, B. A., Dalhousie University, Nova Scotia.

(Read 8 January, 1923)

Introduction.—Centuries before Molybdenum was recognized as an element, the name Molybdos, "heavy" had been given by the Greeks to ores of lead. Until the middle of the eighteenth century, Graphite or "Plumbago", as it was then called, and Molybdenite, were thought to be identical. Scheele, in 1778, proved that these were different minerals. In his "Treatise on Molybdena," he pointed out that one of these, Molybdenite, formed a "pecular white earth," when treated with nitric acid. "Black Lead" did not give a similar reaction. The white precipitate from Molybdenite was found to be acidic in character. Scheele named it "Acid of Molybdena" or "Molybdic Acid." The metal was isolated several years later (1790) by Hjelm. He reduced Molybdic acid by heating it with charcoal.

Molybdenum Blue is the name given to the blue coloration obtained when Molybdic Acid is reduced in acid solution. This reaction is one of the most characteristic tests for Molybdenum. In addition to this there are several other tests for the element. A common one is the precipitation of curdy mass in solution of Molybdate when not too dilute. This also gives a yellow-green color to the blow-pipe flame. It imparts a green color to the Borax bead.

Later work has brought to light other tests. The Chemical Abstracts (1913) give a paper on "Sensitive Reaction for the Detection of Molybdenum," (A.C.S. 3726). The presence of Molybdenum was shown by a blood red color obtained by KCNS in a solution of molybdate reduced by calcium chloride, or zinc and sulphuric acid. The test was not dependable when stannous chloride was used.

In 1912, Melikov published a paper (Ber. 31. 2448) on "Reaction for Detectionof Molybdic Acid." The test was for formation of a red ammonium per-molybdate similar to K_2O_2 $Mo\ O_4\ H_2\ O_2$.

Although the above reactions are sensitive, the standard test for Molybdenum is the formation of Molybdenum Blue. Nearly all text books on Inorganic Chemistry *mention* the blue as a test for Molybdenum or Tin, but few tell anything about its properties. A still smaller number assign any formula to the compound which causes coloration. Formulae suggested by these writers show little agreement.

A few extracts from well known volumes will show this clearly. The "Encylopedia Brittanica," says: "ammonium molybdate $(NH_4)_{10}Mo_{24}O_{15}$ with hydrochloric acid or nitric acid gives a white precipitate; with reducing agents, such as sulphurated hydrogen, sulphuric acid and zinc, stannous chloride, etc., it gives a *blue coloration*, which turns green and finally brown."

Holleman, (translated by Cooper, 1911), states:

"A very characteristic test for molybdic acid is the following: the substance is mixed with zinc and sulphuric acid. At first a *blue coloration* (a Molybdate of Molybdic Oxide) appears."

Kolbe also merely mentions the blue as a test. "If zinc is added to a solution of molbydic acid a blue color is first produced which becomes green and finally dark brown in color, due to reduction."

Mellor, in his very readable book on "Inorganic Chemistry," does not give any definite formula. "The molybdates," he writes, "are reduced by zinc in acid solution to one of the lower oxides, *approximately* $Mo_2\ O_3$ and at the same time the color of the solution changes through various shades of violet, blue and black."

Browning of Yale, in his book "The Rarer Elements," does not suggest the formula for Molybdenum Blue.

Finally, Roscoe and Schorlemmer in their "Treatise on Chemistry," Vol. II. 1044 (1917), give the following:

"When molybdic acid is reduced in solution by sulphuretted hydrogen, sulphur dioxide, stannous chloride, nascent hydrogen, etc., a blue color is obtained, due to the formation of an oxide or oxides between the di- and the tri-oxide. The solution deposits a blue precipitate of this oxide which contains (?) water. It is termed "Molybdenum Blue."

It will be seen from the above extracts that very little is definitely known concerning the properties or composition of Molybdenum Blue. Attempts were made by various investigators to find it's formula. A number of different formulae have been brought forth. These will be briefly noted, without giving any details of the methods by which they were obtained.

The formula of lowest molecular weight is that given by Rammelsberg. He assigns to the Blue the formula $Mo_2\ O_5, = MoO_2MoO_3$. Others regard it as $Mo_3\ O_8 = MoO_2.2MoO_3$.

Guichard suggests $Mo_5O_{14}\ 6H_2\ O = MoO_2\ 4\ MoO_3.\ 6H_2O$. Zsigmondy says "The formula *is supposed to be* $Mo_3\ O_8,\ 5H_2O$. According to Klassen, it consist of complex derivatives of an oxide Mo_2O_5 and Molybdic acid, analogous to phosphomolybdic acid.

Since 1917, no further work has been published on the question of its composition. This research was undertaken with the object of determining the correct formula for Molybdenum Blue and to make a study of its properties.

Demonstration

A solution of ammonium molybdate was the first requisite. This was made according to the method given by Noyes. A solution of stannous chloride was also made. This was obtained by dissolving pure tin shot in concentrated hydrochloric acid and diluting it to required strength. Some metalic tin was kept in the bottom of the flask.

On attempting to obtain Molybdenum Blue by adding a portion of the $SnCl_2$ solution to some of the solution of ammonium molybdate, a blue coloration was first obtained, but it soon changed to green and finally pale yellow. It was thought that this bleaching action might be due to the nitric acid in the molybdate solution. This was found to be the case. Hence neutral solutions of molybdate were used. These were made by dissolving 5 grams of the salt in 500 c c of distilled water.

Molybdenum Blue was obtained by the action of $SnCl_2$ in the presence of HCl, by Hydrogen sulphide from hot acid solution, nascent hydrogen, sulphur dioxide, and oxalic aicd. Quantities of the blue were obtained by stannous chloride and Dumanski's method. These were by far the most satisfactory. Dumanski dissolved 15 g of ammonium molybdate in 400 c c water. To this solution 100 c c of 3 N or 4 N. H_2SO_4 was added. The boiling solution was reduced with H_2S. Samples of the blue obtained by these two methods were dried at 40° for some hours, put in a sealed bottle and labelled according to their mode of preparation.

In the preparation of the Blue it was found that, if the amount of stannous chloride added to a constant amount of the molybdate solution, were varied, the precipitated Blue and the filtrate varied in color. It was noted that as the amount of stannous chloride was increased, the precipitated Blue became darker in color while the filtrate, instead of being blue, was green or almost colorless. By adding molybdate solution to this filtrate the blue color and further precipitate was obtained. This suggested that green was further reduction product as $SnCl_2$ was evidently in excess.

To prove this a few drops of hydrogen peroxide were added. A blue color was obtained. Same result was obtained with $FeCl_3$ as oxidizing agent. When more $SnCl_2$ instead of H_2O_2 was added to the green solution, a brown color appeared. When the green solution obtained with sulphur dioxide was allowed to stand exposed to the air, it became blue. This property was shown by the colorless solution obtained by reduction with Oxalic acid.

FIG. 1

A test tube containing a brown solution obtained by reduction by zinc and H_2SO_4 was treated with three drops of H_2O_2. A green color appeared in two thirds of the tube. Another drop of peroxide was then added. This gave a blue solution in the upper part of the tube. These experiments show conclusively that the green and browns are successive reduction products.

The colloidal nature of the blue was confirmed by adding an electrolyte (NaCl) to the clear filtrate. The mixture was shaken. A precipitate formed. After allowing the solution to stand for a few hours, the precipitate was removed by filtration. The filtrate was still blue. More electrolyte was added but no further precipitate was obtained. The fact that the filtrate was blue would suggest that Molybdenum Blue exists in the crystalloidal form also.

A simple dialyzer was made by covering the mouth of a funnel tube 2″ in diameter, with a membrane of sheepskin. Solutions of the Blue, the filtrates from the preparation by $SnCl_2$ and H_2S, were placed in the dialyzer and the latter kept immersed in distilled water for five days. The water was changed every twelve hours. After twelve hours dialysis, some of the water was evaporated over microscopic slides. Examination under the microscope revealed large amount of stannous chloride crystals. Slides prepared after thirty hours dialysis showed stannous chloride needles, and a little Blue. At the end of four days continuous dialysis, the water in which the dialyzer had been immersed for twelve hours, gave almost no deposit on the slide. This slight deposit consisted of tint patches of Blue with a mere trace of stannous chloride. That some Blue passes through the membrance would suggest that it might be crystalloidal as well as colloidal. The blue patches might well be aggregations of ultramicroscopic crystals.

The bleaching action of animal charcoal on solution of Molybdenum Blue was tried. The blue solution was soon bleached by the charcoal. Concerning this phonomenon Zsigmondy says: "Colloids can be completely removed from a liquid by porous bodies. As a lecture experiment the author has used the absorption of Molybdenum Blue by animal charcoal. As in other cases the absorption was quantitative and irreversible."

It was found however, that if the solution was filtered as soon as it became colorless and the filtrate treated with $SnCl_2$, a slight blue coloration was obtained. This shows that it is incorrect to assume, as Zsigmondy evidently does, that the bleaching action is wholly due to absorption. The action is also one of oxidation, although to a much smaller extent.

The oxidizing power of charcoal was shown by treating the brown solution obtained from the extreme reduction of Blue by Zinc. The supernatant liquid gradually changed to blue.

Vectoriality.—Some liquids are vectorial in character. They form "crystals" while still in the liquid, i. e., they assume definite shapes. Extensive research has been done on this property of liquids. The question as to whether, or not, colloided phases exhibit vectorial properties, has apparently not been settled to the satisfaction of all, as yet. However, men who have worked upon this problem usually support the affirmative. To quote Lincoln ("Physical Chemistry," 1920):

"Von Weimarn even believes vectoriality is manifested by gaseous substances and in addition, has presented evidence which he considers to be direct proof of the vectorality of the colloid phases. In the case of colloid iodine and certain colloid dyes, L. Pelet and Wild claim to have observed the fusion of ultra-microscopic particles which assumed definite crystalline shapes."

An attempt was made to obtain crystalline Molybdenum Blue and thus confirm the work of Von Weimarn and Pelet and Wild.

Microscopic slides were placed in shallow evaporating basin containing filtrate from Blue prepared with $SnCl_2$. The solution was allowed to evaporate at room temperature. When slide became exposed it was removed and allowed to dry. It was examined under the microscope.

Fig. 2

The first slide showed a blue gel with little colorless crosses here and there. These little crosses were found to be incipient crystals, for, on the second slide examined, cross and square crystals, derived from these, were found side by side. The third slide (Fig. 2) showed these crystals in large numbers. In many cases the cross could be seen, forming the diagonals of the square. This cross pattern reminded one of similar pattern found in a variety of the minerals, Andalusite, Chiastolite. The crosses in the mineral are supposed to be caused by "impurities on crystalization" (Butler). It seems more reasonable in the case of a Molybdenum compound that they are the edges of an octahedron. If this be so, they are molybdic oxide. A few colorless hexagonal crystals were also noticed. These were recognized as ammonium molybdate. The photograph shows these crystals, some hexagonal ones, as well as gel and amicrons.

Fig. 3

A portion of dialyzed hydrosol was evaporated. at 18°. The deposit on slide was examined under microscope. A beautiful back ground of blue gel was seen. This gel contained a few dark blue opaque particles of regular outline. They were almost cubic in shape. Fig. 3 shows the slide under low power. The hydrosol was treated with NH_4Cl. Precipitate was separated from solution by filtration. The blue filtrate was allowed to evaporate over slides. Crystals were found as shown in Fig. 5 and 6. As can be readily seen, they belong to the cubic system. It will also be noticed that the corners are truncated. These little faces do not appear on crystals on slide No. 2. These crystals (No. 4) are pale blue in color. They are certainly not ammonium chloride crystals.

Fig. 4

They are different from either molybdic oxide or ammonium Molybdate. It is therefore probable that they are crystals of crystalloidal Blue.

Fig. 5 shows a crystal under high power. The truncated corners can be seen quite distinctly. The cross in centre appears quite plainly.

As will be noted more fully later, the hydrogel was found to be soluble in absolute alcohol.

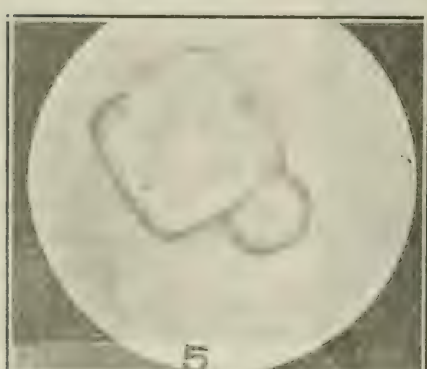


Fig. 5

A concentrated solution of the Alcosol was made. It was concentrated further by slow evaporation. Fig. 3 shows a section of the slide obtained. The particles are cubes varying in color from lightblue to very dark blue, according to their thickness. The light blue ones were examined under crossed nicols. They are isotropic. A basal section of a cubic crystal would give this effect.

Fig. 6

The writer can see no valid reason for considering these crystals other than crystal of colloidal Molybdenum Blue. This fact would lend strength to Wiemarn's and Pelet's supposition that colloids have the property of vectorality.

Pure crystals of Stannous chloride were dissolved in absolute alcohol. A saturated solution of Ammonium Molybdate in alcohol was also prepared. Portions of the stannous chloride solution were diluted by adding more alcohol. A few drops of this solution were added to the molybdate. A brownish precipitate was obtained. The same experiment was tried with HC1 added to the molybdate solution. The same result was obtained.

The alcohol solution was treated with zinc and sulphuric acid with no apparent reaction. Sulphuretted hydrogen was passed into the solution. A colloidal solution resulted. This solution was fluorescent, giving blueish grey and red by reflected and transmitted light, respectively. After standing for some hours the solution became a fawn color and a flocculent brownish precipitate similar in color to that obtained by adding

$SnCl_2$, separated out. Three weeks later the solution was filtered. The precipitate formed a gel on the filter. It turned a darker brown. Lack of time prohibited further investigation. The experiments showed that Blue could not be obtained except in water solution.

The Gel.—Solubility in solvents: The hydrogel prepared by action of stannous chloride and sulphuretted hydrogen was dried. The solubility of the dried gel in various solvents was ascertained. It was found that the gel dissolved in water, absolute alcohol and methyl alcohol. No apparent solution took place when gel was shaken in ether, benzene, carbon bisulpide, acetone and chloroform. The fact that Molybdenum blue is soluble in absolute alcohol is of more importance than would, perhaps, be recognized at first glance. This will be dealt with later.

The negative character of the colloidal Blue was shown by a modification of Cohen's apparatus. It consisted of a U-tube partly filled with agar, in which sodium chloride had been dissolved. The dialyzed hydrosol was poured into each arm, the levels in each being the same. Platinum electrodes were immersed in the hydrosol. A current of 1-2 mil amperes and pressure 4 volts was passed through tube for 16 hours. At the end of that time it was found that blue solution had become colorless. The level of water in the cathode arm had risen. Solutions in each arm were tested for oxidation or reduction. The cathode arm gave negative tests. The solution from the anode tube showed oxidation, due to chlorine liberated from the electrolyte ($NaCl$).

A solution of the hydrosol in agar was now placed in a U-tube. Electrodes were immersed in gel. Potential was raised to 10 volts. A current of 3 milamperes was passed through tube for 16 hours. The blue migrated towards the anode. This proved that hydrosol carried a negative charge.

An experiment was undertaken to find whether the hydrosol and alcosol had the same rate of migration. Solutions of

Blue were made by dissolving equal quantities in equal volumes of water and of alcohol. These solutions were placed in tubes over agar. The tubes were connected in parallel. It was found that the migration of hydrosol was greater than that of the alcosol. Results were of little value, however, on account of the unequal diameter of the tubes. Since resistance, and therefore amount current varies with the area of cross section, and rate of migration depends on amount of current, the difference might have been partly due to difference in tubes. The resistance of the solutions was so great that the current could not be measured with mil-ammeter.

Analysis of Blue.—Samples of "hydrogel" were pulverised and dried at temperature of 105°-110°C until three weighings, taken at intervals of one hour, gave the same weight.

Apparatus.—Apparatus for reduction of an oxide was set up. It consisted of a hydrogen generator; wash bottle containing C. P. sulphuric acid; short length of hard glass tubing, small platinum boat and a U-tube containing sulphuric acid over glass beads. The platinum boat, which had been ignited, cooled in a desiccator and weighed, was partially filled with the prepared Blue. The amount of Blue taken for analysis was recorded. The boat and Blue were placed in the hard glass tube, the apparatus connected. When a stream of hydrogen had been passing through the apparatus for ten minutes, heat was applied to the boat. It was heated at red heat for eight hours. The boat was weighed as quickly as possible and

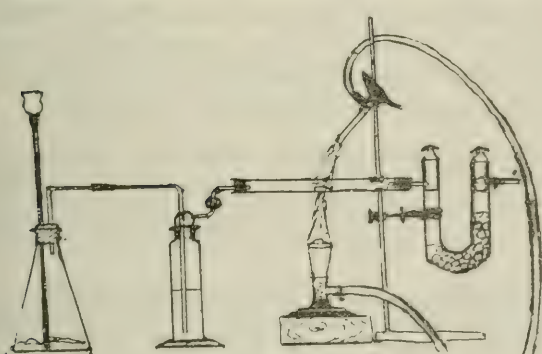


Fig. 7

reduction and heating continued for four hours more. At the end of that time the boat containing the residue was again weighed. The boat was allowed to cool in a stream of hydrogen. Weighing was done as rapidly as possible. It was found that the Blue lost very little or no weight during the final four hours heating. The gain in weight of the U tube served as a check.

Three determinations were made. The results agreed very well considering the possible experimental error, due to sublimination of Molybdenum, moisture absorbed by blue during first weighing, and also variation in amount of water in hydrogel. In discussing the various formulae that have been suggested the average results obtained will be considered.

Average time of reduction	Average Wt. of hydrogel	Wt. of residue	Average Loss in Wt.
12.2 hrs.	.2669 g	.1785 g	.0884 g

The residue was blueish grey. It was taken to be Molybdenum with a trace of oxide. As no further loss in weight resulted between weights at the end of eight and twelfth hours of treatment the residue could not be Mo_2O_3MoO, MoO_2, MoO_3, for these oxides are broken down below bright red heat. When the heat was increased, a metallic mirror was deposited in the tube. This would show that the residue was Molybdenum. In the following calculations it will be treated as such:

Let us consider the first formula suggested, Mo_2O_5. If this were the formula residue would weigh $\frac{Mo_2\ O_5}{Mo_2\ O_5} \times 2669 = \frac{192}{272} \times 2669 = 1884$ g.

This is more than $5\frac{1}{2}\%$ greater than actual weight of residue.

According to this formula the loss in weight would be:

$$\frac{O_5}{Mo_2\ O_5} \times .2669 = \frac{80}{272} \times .2669 = .08045.$$

This is 10% smaller than experimental result. The formula Mo_2O_5 must therefore be considered incorrect.

Considering Guichard's formula—

Mo_5O_{14}, $6H_2$ O it is calculated that residue should weigh

$$\frac{Mo_5}{Mo_5\ O_{14}\ 6\ H_2\ O} \times .2669\ g = .1980\ g.$$ This 10% too great.

The "loss in weight" as calculated by the formula, would be correspondingly small.

The formula given in Zsigmondy's "Colloids" is Mo_3O_8, $5H_2$ O. This would give a residue weighing .1517 g, as calculated by

$$\frac{Mo_3}{Mo_3O_8\ \ 5\ H_2O} = \frac{288}{506} \times .2669 = .1517\ g.$$ or 85.1% of experimental value.

According to this formula the weight of gas and water-vapor given off would be $\frac{O_8\ 5\ H_2\ O}{Mo_3\ O_8\ 5H_2\ O} \times .2669 = \frac{218}{506} \times .2669 =$ .1150 g, which is over 10% greater than experimental value.

The formula most generally given is Mo_3O_8. According to this the residue would be $\frac{Mo_3}{Mo_3\ O_8} \times .2669 = \frac{288}{416} \times .2669 = 1848g$

This is 3.5% greater than actual weight of residue.

Calculating the weight of oxygen given off; weight of oxygen equals $\frac{O_8}{Mo_3\ O_8} \times .2669 = \frac{128}{416} \times .2669 = .0831$ g.

which is $6\frac{1}{2}\%$ less than the "loss in weight" of sample.

From the relation of weight of residue and weight of gas given off, it was thought that the formula would be Mo_3O_8 H_2 O.

Calculations were made.

Weights of residue equals—

$$\frac{Mo_3}{Mo_3\ O_8\ H_2\ O} \times .2669 = \frac{288}{434} \times .2669 = .1771\ g.$$

This agrees with experimental values within 4-5%.

The wt. of gas given off $\frac{O_8 H_2 O}{Mo_3 O_8 H_2 O} \times .2669 = .0898$ g.

This agrees within 1-1/3% of epxerimental result.

The formula $Mo_3O_8 2H_2 O$ was tried, but gave poor agreement.

From these calculations, it has been shown that the formula $Mo_3 O_8 H_2 O$ agrees most closely with actual weights of analysis. It should be noted also, that this formula comes the nearest to the molecular weight as determined by Dumanski. He found it to be 440. This formula $Mo_3 O_8 H_2 O$ gives molecular weight of 434; $Mo_3 O_8$ 416 and $Mo_3 O_8 5H_2 O = 506$.

It has been found, as noted above, that the dried hydrogel is soluble in absolute alcohol. Now Zsigmondy, in his "Chemistry of Colloids," "(T. Spear, 1917)" discussing Silicic Acid Organogels, states: "The fact that water may be replaced by other substances as solvents, without any marked change in the character of the gel, points clearly, as Van Bemmelen has noted, to the assumption, *that water is not there as a hydrate* chemically combined, but is absorbed water that fills the spaces between the ultramicrons." He gives G. Tschermak; (Zeit. f. phys. Chemie. 53, 349-367), (1905); G. Tammann; (Zeit f. Anorg Chemie. 71, 375), (1911); as references.

It is obvious, then, that the formula for Molybdenum Blue given, in the same volume, is incorrect. If we accept the work of Bemmelen, any formula which shows one or more molecules of water of hydration must be discarded. This leaves just Mo_2O_5, or $Mo_3 O_8$. Of these $Mo_3 O_8$ is the better.

Ostwald in his "Inorganic Chemistry," says: "Between this ($Mo O_2$) and trioxide are the readily formed Blue compounds, the composition of which *varies*, and cannot be characterized with sufficient sharpness." This variation may be due to the different formula-weights of water enclosed by the ultramicrons. Certainly the formula $Mo_3O_8 H_2O$ best expresses the composition of the sample of Blue analyzed, but for the anhydrous gel, the formula is, no doubt, Mo_3O_8.

It would be interesting to note whether the variation in composition of the precipitated ammonium phosphomolybdates, which "seem to violate the constancy of composition test for distinguishing compounds from mixtures," could not be explained in a similar manner. Possibly the variation is due to the adsorption of water or an oxide by the ultramicrons, the amount of which varies with conditions.

The formation of Molybdenum Blue by the action of ammonium molybdate and a stannous salt is a sensitive test for tin. An attempt was made to determine the sensitiveness of the test for tin.

Stannous chloride was obtained by dissolving .2138 g of pure tin in C.P. HC1. The solution was diluted to 500 cc and 50.01 cc of this solution diluted to 500 cc. A tin bead was dropped into the resulting solution and the solution immediately titrated against an approximately 1/5% solution of Ammonium molybdate.

$$\text{Average ratio } \frac{1 \text{ cc tin}}{60.1 \text{ cc sol. AM}}$$

$$\text{Sensitivity} = \frac{.2138}{5000} \times \frac{1}{600} = \frac{1}{1.423.000},$$

(Some error due to $SnCl_2 \rightarrow SnCl_4$.)

Sensitivity of test for Molybdenum was also tried. It could not be determined with any degree of accuracy, owing to the formation of the green solution, when $SnCl_2$ was in excess. This faint green color was very hard to detect.

Summary of Findings or Confirmations

1. Blue is most readily prepared by action of $SnCl_2$ and H_2S.

2. Green and brown colors are due to further reduction com-

pound. Action is reversible.

3. Blue only obtained in acid solution.
4. Negative colloid.
5. Exists as crystalloid also.
6. Forms cubic crystals from alcohol, and transparent cubes bearing face of octahedron from blue filtrate after gel has been precipated by NH_4Cl.
7. Insoluble in ether, chlorform, benzene, carbon bi-sulphide and acetone.
8. Soluble in water, absolute alcohol and methyl alcohol.
9. Formula of hydrogel as obtained from analysis $= Mo_3O_8, H_2O$. Formula of Blue $= Mo_3O_8$.
10. Sensitivity of test for tin is 1 part in 1,423,000.

A Modification of the Procedure for the Qualitative Separation of the Metals of the Alkaline-Earth Group.—By C. B. Nickerson, M. A., Professor of Chemistry, Dalhousie University.

(Read 16 April, 1923)

The separation of the ions, Barium-Strontium-Calcium, has always furnished something of a problem to teachers of Qualitative Analysis. Although several very excellent methods of analysis are available, the writer has found them to be somewhat tedious of manipulation, and requiring more time for a successful separation than is usually convenient for the ordinary college class in Qualitative Analysis. It is not the purpose of this paper to go into the various reasons why the separation of these ions is a difficult one, but rather to describe a method which has been used successfully by the writer in his classes for a number of years.

This method depends upon the separation of calcium from strontium by taking advantage of the solubility of calcium sulphate in a boiling solution containing a considerable quantity of ammonium acetate. The solubility of calcium sulphate, and the insolubility of strontium sulphate in solutions of ammonium sulphate and ammonium chloride have been known for a long time and several procedures for the qualitative separation of these ions are based on this principle. The substitution of ammonium acetate for the chloride or sulphate however, has been found to be generally more suitable and also, in the hands of students, capable of greater accuracy. The separation of barium ion from calcium and strontium ions by the well known acetic acid-chromate method has also been studied quantitatively, and a modification of the usual method of separation proposed.

Procedure.

Treatment of the Filtrate from the Sulphides of the Fe.-Zn. etc. group.

Boil the solution until free from H_2S. Filter if necessary and add NH_4Cl, (if it has not already been added). Make ammoniacal and add 10-20 cc of ammonium carbonate solution. (The temperature of the solution at the time of the addition of ammonium carbonate should not exceed 70° C.)* Filter and test for completeness of precipitation. The precipitate may now contain the carbonates of barium, strontium and calcium; the filtrate will contain the ions of the alkali group with magnesium ion.

Treatment of the Precipitate.

Dissolve the precipitate by pouring over it 10 cc of 3 N. acetic acid. Continue this treatment, using the same 10 cc of acid, until all action is over. Carefully neutralize the acetic acid solution with ammonium hydroxide and then add 3 cc of acetic acid in excess. Next add about 10-15 cc of potassium chromate solution: a yellow precipitate is barium chromate and confirms the presence of barium. Heat to boiling, let stand 10 minutes, and filter. To the clear filtrate, which should be orange yellow in color with the excess of di-chromate ions, add 10 cc of acetic acid, a strong excess of ammonium hydroxide, and 10 cc of ammonium sulphate solution. (The solution should have a volume of approximately 100 cc at this point.) Boil for about two minutes; a white precipitate is strontium sulphate and confirms the presence of strontium. Let stand for about ten minutes and filter.

To the clear filtrate add 10 cc of ammonium oxalate solution. If no precipitation occurs at once, boil for a few moments; a white precipitate is calcium oxalate and confirms the presence of calcium.

The usual and most satisfactory method of studying problems of this kind is to determine the analytical limits involved. That is, to find the minimum quantity of one ion which can be detected in presence of a maximum quantity of the other. With this idea in view solutions were prepared of the following

*H. B. Vickery: these Transactions, Vol. XIV, page 31.

concentrations. The ordinary C. P. chemicals were used in all cases.

Acetic Acid	3 N. solution
Ammonium Hydroxide	3 N. solution.
Ammonium Carbonate	3 N. solution.
Ammonium Sulphate,	10% solution.
Ammonium Oxalate	Saturated solution at 15° C.
Potassium Chromate	10% solution.

Test solutions of the chlorides of barium, strontium and calcium were prepared of such concentration that 1 cc of solution contained 5 mgs. of the metal.

Separation of Ba and Sr.

The method given in the procedure above for the separation of these ions involves nothing new. It was necessary however to study the separation quantitatively to determine its practical limits of accuracy so far as this particular procedure was concerned. Assuming that the detection of about 2 mgs. of barium in 100 cc's of solution represents reasonable accuracy in a separation of this kind, it was only necessary to determine the amount of acetic acid which would allow the precipitation of that quantity of barium as barium chromate, and also to determine the maximum amount of strontium chromate which could be held in solution by the same concentration of acetic acid.

Separation of Barium and Strontium.

Separations of barium and strontium were carried out according to the method given, using varying concentrations of acetic acid. The solubility of the barium chromate was found to increase rapidly as the excess of acetic acid was increased. With an excess of 3 cc's of 3 N. acetic acid, it was found that 1.5 mgs. of barium gave a noticeable precipitate of barium chromate, while under similar conditions, as much as 500 mgs. of strontium gave no trace of precipitate.

The usual source of error at this point is of course, that when barium is present alone and in considerable quantity, there may not be sufficient quantity of acetic acid present to hold all of it in solution as the chromate, and as a result, some of the barium may be precipitated in place of strontium as the sulphate. Tests were made, therefore, to determine the maximum amounts of barium which could be present under the conditions of the procedure. It was found that a solution containing 400 mgs. of barium and no strontium, failed to give the slighest precipitate as the sulphate after having been removed as the chromate in presence of 3 cc's of acid.

Separation of Strontium and Calcium

The problem to be studied in this separation was the extent to which calcium sulphate is dissolved by ammonium acetate under the conditions of experiment, and also to find the minimum quantity of strontium that could be detected by precipitation as the sulphate. In an investigation of this separation using ammonium sulphate and ammonium chloride, Vickery* has found that 80 cc's of a 10% solution of ammonium chloride were necessary to prevent all precipitation of calcium sulphate in a solution containing 200 mgs. of calcium, and that under similar conditions, 3 mgs. of strontium gave a faint turbidity.

Solutions were prepared containing varying quantities of strontium and calcium, and separations were carried out according to the procedure given. It was found that 3 mgs. of strontium could readily be detected in the presence of 400 mgs. of calcium. Also it was found that a solution containing only 400 mgs. of strontium gave not the slightest test for calcium.

It is apparent therefore, that the substitution of ammonium acetate for the chloride or sulphate offers a wider limit for the delicacy of the strontium-calcium separation. The final detection of calcium in the filtrate from strontium sulphate depends upon the well known oxalate precipitation, and of course,

*These Transactions, Vol. XIV, page 30.

needs no further verification. No confirmatory tests for the three ions have been included in the procedure given. It is assumed however that the usual ones are to be applied whenever it is thought necessary.

No claims are made for exceptional accuracy in the above mentioned procedure. It is not intended to replace the various methods which are in general use by experienced analysts. In the writer's opinion, it does, within reasonable limits, offer an accurate method of analysis for a rather troublesome group of metals.

A Procedure for the Qualitative Analysis of the Group: Magnesium, Potassium, Sodium.—By Harold S. King, Assistant Professor of Chemistry, Dalhousie University, Halifax, N. S.

(Read 21 May, 1923)

The course of qualitative analysis as given at Dalhousie University is so arranged that magnesium is not precipitated with the alkaline earth group but is found associated with the alkali metal group. In this paper a procedure is outlined for the analysis of the last group in the basic analysis, i.e. magnesium, potassium and sodium.

The classical method of analyzing for these constituents is to test for magnesium by the phosphate method in a side sample and, if present, to evaporate the solution to dryness and ignite to remove ammonium salts. Then the magnesium is precipitated as hydroxide by means of barium hydroxide, the excess barium is removed as carbonate by the addition of ammonium hydroxide and ammonium carbonate. The solution is evaporated and ignited a second time to remove ammonium salts, and the residue is analyzed for potassium and sodium. The difficulties with this standard procedure are that the barium hydroxide solution absorbs carbon dioxide readily, the filtering and washing of the precipitates are slow, and particularly, two separate evaporations and ignitions are necessary.

The procedure about to be described is found to be somewhat simpler in operation. Its main features are made plain in the accompanying outline, while the detailed description and discussion of the precedure are as follows:

Procedure 1. Detection of Magnesium.

Evaporate the filtrate from the alkaline earth group precipitation until crystals appear. Add 15 c.c. of 15n.NH_4OH and 5-20 c.c. of 4n. H_3PO_4. A white granular precipitate may be $MgNH_4PO_4$ and indicates the presence of magnesium. Filter and wash once. Treat the precipitate by P.2 and the filtrate by P.3.

NOTES.—1. Because of the reaction $MgNH_4PO_4 + H_2O = NH_4OH + Mg HPO_4$, a large excess of NH_4OH is used.

2. Only the minimum quantity of H_3PO_4 necessary should be added. Too large an excess causes the solution used in P.7 to be too acid. The excess of phosphate may be removed before carrying out P.4 by adding hydrated ferric oxide and filtering.

3. If, at the beginning of the analysis of the iron and aluminium groups, phosphates were found to be present in the sample under investigation, it might be well at that point to add sufficient phosphoric acid to insure the complete precipitation of the alkaline earth group and magnesium as phosphates, and then to follow the procedure as given by C. B. Nickerson in his paper "Arrangement of Procedure for the Removal of Phosphate Ions from the Iron and Alkaline Earth Groups" published in the Transactions of the Nova Scotian Institute of Science, Vol. XIII, Part 2, pp. 95-98.

Procedure 2. Removal of Alkaline Earths.

Extract the precipitate from P.1 with 5 c.c. of 3n. H_2SO_4. To the extract add 10 c.c. of methylated spirits and shake for a few minutes. Filter, if necessary.

NOTES.—1. Traces of the alkaline earth group may have escaped precipitation as carbonates. If so, they would be precipitated in P.1 by the phosphate in the form of a flocculent, NOT GRANULAR, precipitate. Therefore, the confirmatory test for magnesium should be carried out if the precipitate formed in P.1 is scanty or flocculent.

2. The sulphates of the alkaline earth group are insoluble in an alcoholic solution, though calcium sulphate is appreciably soluble in aqueous solution. Methylated spirits are used rather than ethyl alcohol because of the regulations concerning the use of the latter.

Procedure 3. Confirmatory Test for Magnesium.

Add to the filtrate from P.2 5 c.c. of 15n. NH_4OH and 5 c.c. of 4n. H_3PO_4. Let stand at least half an hour with frequent shaking. A white granular precipitate is $MgNH_4PO_4$ and confirms the presence of magnesium.

NOTES.—1. H_3PO_4 is used rather than Na_2HPO_4 because the precipitate formed in the former case is more distinctly crystalline.

Procedure 4. Removal of Ammonium Salts.

Evaporate the filtrate from P.3 in a beaker until crystals appear. Then transfer to an evaporating dish and evaporate to dryness. Ignite the residue carefully with a free flame until no more white fumes come off. (Hood.) Do not heat to red heat. Be sure to heat the sides of the dish as well as the bottom. Cool and add 10 c.c. of water. Heat just to boiling and filter through a very small filter paper into a test-tube. Bubble through this solution a fine stream of the oxides of nitrogen made by warming 1 gram of starch with 4 c.c. of nitric acid (Sp. Gr. 1.33) in a 100 c.c. flask. Then boil the solution in the test tube. Divide the solution into one-fourth and three-fourth portions. Treat the one-fourth portion by P.5 and the three-fourth portion by P.7.

Notes.—1. The bulk of the ammonium salts is removed by volatilization. Care must be taken, however, not to heat to incipient redness because at this temperature NaCl and especially KCl are volatile.

2. A residue so small as to be almost invisible may contain sufficient potassium or sodium to give tests. Therefore, the procedures 5 and 7 should not be omitted.

3. The reagents used throughout the analysis may have dissolved enough silicic acid from the glass to give a white residue of silica at this point. A brown residue may be due to organic matter derived from the filter paper or to impurities in the ammonia used. The excess of phosphoric acid gives a residue also.

4. The oxides of nitrogen formed by the action of starch on nitric acid of Sp. Gr. 1.33 are approximately a one to one mixture of NO and NO_2. They form nitrous acid in solution which reacts with the last traces of the ammonium salts to give nitrogen. It is important to remove ammonium salts completely because they interfere with the potassium test.

5. The ammonia free solution is divided into two portions and the potassium and sodium are tested for without separating them. For extreme accuracy they may be separated by the perchlorate method as given in the "Exact method of analysis of the alkali group," by A. A. Noyes, in his "Qualitative Chemical Analysis."

Procedure 5. Detection of Potassium.

Dilute the one-fourth portion from P.4 to 5 c.c. and add 5 c.c. of $Na_3Co(NO_2)$ reagent. Let stand for at least 10 minutes if no immediate precipitate forms. A yellow precipitate may be $K_2NaCo(NO_2)_6$ and indicates the presence of potassium. Treat by P.6 without filtering.

NOTES.—1. The sodium cobaltinitrite reagent is made up 0.1 formal in $Na_3Co(NO_2)_6$, 3n. in $NaNO_2$ and 1n. in CH_3COOH.

2. As little as 0.1 mg. of potassium can be detected in the above portion after long standing even in the presence of a large excess of sodium.

3. Incomplete precipitation of magnesium does not interfere with this test. For example, as much as 100 mgs. of magnesium give no precipitate and do not interfere with the precipitation of the potassium.

4. Ammonium gives a precipitate of $(NH_4)_2NaCo(NO_2)_6$ which is almost as insoluble as the potassium precipitate and very similar to it. Therefore every precaution is taken to remove ammonium previous to this test. Moreover, if the precipitate formed is scanty, the confirmatory test should be made.

Procedure 6. Confirmatory Test for Potassium.

Boil the solution from P.5 for a minute. Then cool and add 3 c.c. of the $Na_3Co(NO_2)_6$ reagent. Let stand for ten minutes. A yellow precipitate is $K_2NaCo(NO_2)_6$ and confirms the presence of potassium.

NOTES.—1. The cobaltinitrite reagent contains an excess of sodium nitrite and acetic acid. On boiling, any ammonium present is decomposed by the nitrous acid. The cobaltinitrite is decomposed also, so that after cooling more of the reagent is added.

2. This confirmatory test is more satisfactory than the flame test because the presence of sodium does not interfere.

Procedure 7. Detection of Sodium.

To the three-fourth portion from P.4 add 5 c.c. of the $K_2H_2Sb_2O_7$ reagent. Let stand at least one hour or better overnight. A white, crystalline precipitate adhering to the walls of the test-tube is $Na_2H_2Sb_2O_7$ and shows the presence of sodium.

NOTES.—1. The dipotassium dihydrogen pyroantimonate reagent is 0.05 formal in $K_2H_2Sb_2O_7$, 0. 1n. in KOH and saturated with $Na_2H_2Sb_2O_7$. It must be freshly made because of its instability.

2. When the portion analyzed is free from other substances, as little as 0.5 mg. of sodium can be detected with this reagent. With large amounts of potassium present, 8 mgs. of sodium may escape detection. Therefore, for more delicate work, potassium should be removed. Usually, however, this accuracy is sufficient.

3. Magnesium and the alkaline earths give a flocculent precipitate which, in small quantities, does not interfere with the test. The sodium precipitate adheres in part to the walls of the test-tube while the flocculent precipitate can be removed easily by decanting.

4. The sodium precipitate has a great tendency to form a supersaturated solution. Rubbing the inside of the test tube with a stirring rod aids the precipitation. Sodium should not be considered absent until the solution has stood at least an hour or better overnight. Very often the compound comes down in the form of a few crystals rather than as a precipitate.

5. The flame test is not to be depended upon for the detection of sodium because of its extreme delicacy. The amounts of sodium introduced from the utensils, filter paper and dust give enough sodium to color the flame but not sufficient to detect by the pyroantimonate test.

Outline for the Analysis of Magnesium, Potassium and Sodium.

<table>
<tr><td colspan="4">Filtrate from the Alkaline Earth Group Precipitation.
(P.1) Evaporate. Add NH_4OH and H_3PO_4. Filter.</td></tr>
<tr><td colspan="2">White granular ppte.
$MgNH_4PO_4$
(P.2) Extract with H_2SO_4. Add alcohol. Filter.</td><td colspan="2">Filtrate: (P.4)
Evaporate to dryness. Ignite. Dissolve in H_2O. Bubble in NO and NO_2. Boil.</td></tr>
<tr><td rowspan="2">Ppte.
Alkaline
Earth
Sulphates
Reject.</td><td rowspan="2">Filtrate:
(P.3)
Add NH_4OH and H_3PO_4 White gran. ppte.
$MgNH_4PO_4$.
∴ Mg^{++}</td><td>1/4 Solution.
(P.5) Add
$Na_3Co(NO_2)_6$
Yellow ppte.
$K_2NaCo(NO_2)_6$.</td><td rowspan="2">3/4 Solution.
(P.7)
Add $K_2H_2Sb_2O_7$
White cryst. ppte.
$Na_2H_2Sb_2O_7$.

∴ Na^+</td></tr>
<tr><td>(P.6)
Boil. Add
$Na_3Co(NO_2)_6$
Yellow ppte.
$K_2NaCo(NO_2)_6$.
∴ K^+</td></tr>
</table>

ON THE NATURE OF LOUISITE.—BY PROF. T. L. WALKER, PH. D., Director of the Royal Ontario Museum of Mineralogy, Toronto, Ontario.

(Read 16 April, 1923)

In 1878, Honeyman, *Nova Scotian Institute of Natural Science*, Vol. V, *p. 15*, gave this name to a zeolite which formed part of a boulder picked up on the Blomidon shore, King's County, Nova Scotia, by Mr. Robert W. Starr, who accompanied Dr. D. Honeyman while he was engaged in July, 1877, in the study of the geology of that region. It was analyzed by Henry Louis, then of Londonderry Mines, N. S., after whom it was named by Dr. Honeyman. The mineral was closely related to apophyllite in composition except that it was much higher in silica.

The type specimen is the property of the Provincial Museum in Halifax, and when Mr. Harry Piers, curator of that institution, suggested that it should be re-examined, I gladly accepted in order to find the true place of louisite among the zeolites.

The specimen, which is waterworn, weighed less than one pound. It is white on the outer surface, and when examined by a strong lens is seen to contain innumerable tiny roundish masses somewhat glassy in lustre. The white crust extends to a depth of about an eighth of an inch and surrounds the leek-green glassy mineral which has been known as louisite. Louisite is quite cleavable in one direction, possesses a vitreous lustre, and as it can be readily scratched with a knife, appears to be about 5 in the scale of hardness. Its streak is white, and according to Louis it has a density of 2.41.

A thin section prepared for microscopic study showed when examined between crossed nicols that louisite is an aggregate of radiating spherules of quartz in cleavable apophyllite. (Figure 1). A portion from the centre of the mass was crushed and treated with a heavy liquid consisting of bromoform and carbon tetrachloride of such a density that about half of the powdered mineral floated, while the rest sank to the bottom.

When these two portions were examined with the microscope, it was found that the lighter was almost entirely free from quartz spherules and had a density of 2.369 which agrees with the known values for apophyllite. In the heavier portion nearly all the grains were complex, consisting of radiating masses of quartz usually attached to fragments of apophyllite. The density of the heavier portion was found to be 2.542 which would correspond to a mixture of quartz and apophyllite in the ratio of 2 : 1.

Fig. 1. Microphotograph of louisite spherules of quarts in apophyllite; crossed nicols x 40 diameters.

The apophyllite was analysed by E. W. Todd with the following result:

	%	Molecu. ratio	Apophyllite	Bal.
SiO_2	53.64	.893	.864	.029
Al_2O_3	.12	.001	....	.001
Fe_2O_3	.18	.001	....	.001
CaO	24.19	.432	.432	....
Na_2O	.64	.010	.007	.003
K_2O	4.42	.047	.047	....
H_2O	16.61	.923	.905	.018
F	.48	.026	.026	....
Less oxygen equivalent	(– .20)			
	100.08			

The molecular ratios of the different constituents are indicated in the second column. In the third the constituents which go to form the apophyllite, using the formula of Rammelsberg, $4CaO$, $8SiO_2$. $8H_2O$. $K(F.OH)$, are indicated. In the last column the balance is very small, consisting of 1.74% SiO_2, .12 Al_2O_3, .18 Fe_2O_3, .18 Na_2O, and .32 H_2O. Chemically considered, the lighter portion is very nearly pure apohyllite with a little quartz and very slight mixture probably of some zeolite.

The optical properties of the two minerals which make up the aggregate known as louisite, were examined by the immersion method and found to possess indices of refraction in accord with the suggestion that the individual minerals are quartz and apophyllite.

I wish to acknowledge the kindness of Mr. Piers in permitting me to examine the only known specimen of louisite.

On a New Tungsten (Scheelite) Deposit at Lower Sackville, Halifax County, N. S.—By Harry Piers, Curator of the Provincial Museum of Nova Scotia, Halifax.

Read 21st May, 1923.

Previous discoveries of Tungsten ores in Nova Scotia.— Before describing the Tungsten prospect at Lower Sackville, Halifax County, it will be well to very briefly refer to the occurrences of similar and related ores which had previously been found in Nova Scotia since about 1893, the data regarding which are much scattered. The ores so far found here are Scheelite or Calcium Tungstate, Hübnerite or Manganese Tungstate, Wolframite or Iron-and Manganese Tungstate, and the decomposition product, Tungstite or Oxide of Tungsten.

Tungsten ore in the form of Scheelite was apparently first discovered in Nova Scotia about 1893 or '94, associated with a little arsenopyrite and pyrite in a quartz vein intersecting the main auriferous vein of the Quartzite Division of the Gold Measures at the Ballou or Old American Mine, Malaga Gold District, Queen's Co. (See Rept. Geol. Surv. Canada for 1894, n. s., vol. 7, p. 14 R.)

It was next found as brownish Hübnerite in quartz in a gneissic or granitic rock of Pre-Cambrian age at Tom Murphy's Brook, Emerald, near Northeast Margaree, Inverness Co., about 1897-98. (See Rept. Geol. Surv. Canada for 1898, vol. 11, p. 10 R. For specimen of this mineral, see Prov. Museum acc. no. 1737.)

In November, 1907, Tungstite, the yellow oxide of Tungsten, was discovered in drift boulders 1½ mile west of the crusher of the Consolidated Mines Company, Moose River Gold District, in the eastern section of Halifax Co., by John A. Reynolds and W. S. Currie, of Moose River, and was determined by A. L. McCallum and Dr. T. L. Walker, in May 1908, (see sample, Museum acc. no. 3237); and about June of that year Scheelite in quartz was found by Mr. Reynolds in drift boulders near Stillwater Brook, about 2¼ miles southwest of Moose River Gold Mines, (see sample, acc. no. 3246); and finally in the latter part of the same month, the Scheelite, of a buff colour, was located *in situ* on the footwall of a quartz vein, interbedded in a slate belt, between quartzite walls, dipping northwest at an angle of 75°, at Stillwater Brook, about three-quarters of a mile north of the place where the last-mentioned boulders had been discovered,—that is, about 2½ miles west-southwest of Moose River Gold Mines. (See sample of this ore, acc. no. 3527.) Other scheelite-bearing veins were also found alongside this ore. This deposit was very extensively developed by an incline shaft which was some three hundred feet long by March, 1911. It became a well-known and much-talked-of mine, and the place itself received the name of Scheelite. The deposit first belonged to W. S. Currie, J. A. Reynolds and A. L. McCallum; afterwards passed to A. A. Hayward; and then to various companies. It had produced a large amount of ore for several years, but finally after the Great War, the mine was closed, said to have been because the pay-streaks were too restricted, and too much dead-work had therefore to be done. It was the most important deposit of Tungsten ore yet located here.

Owing to the important nature of this extensive deposit, search for the mineral was greatly stimulated throughout the province, and in December, 1908, brownish buff-coloured Scheelite was also discovered in a rather narrow interbedded quartz vein in a slate belt, in the Quartzite Division of the Gold Measures, just northeast of Perry Lake, about a mile northwest of the Waverley Gold District, Halifax Co., by Louis Newell McDonald, who had prospected the vein for gold about ten years before. This deposit has never been developed. (See samples of this ore, acc. nos. 3331-2.)

The discovery of small quantities of tin ore (cassitirite) in pegmatitic granite at Lake Ramsay in the northwest section Lunenburg Co., in October, 1906, and at Wallabach Stream, between Camp and Harris Lakes, 4½ miles to the north-northeast, late in 1907, led to extensive prospecting in the whole of the interesting New Ross district. Tungstite and Wolframite were found in quartz at Ernest Turner's tin prospect on the northwest side of Wallabach Stream, in pegmatite in irruptive granite of probable Devonian age, about 11th June, 1909, by Dr. T. L. Walker, (see museum acc. nos. 3374 and 3688). The Geological Survey of Canada also reported Hübnerite as having been found near Lake Ramsay (Sum. Rept. for 1907, p. 82), and Scheelite with cassiterite, copper pyrite, and zinc blende in quartz-porphyry on the Wallabach Stream. (Sum. Rept. for 1911, p. 339).

About the 16th of May, 1911, Scheelite, with a little arsenopyrite and oxides of iron and manganese, was found by Orlando Harlow in a quartz vein, said to be six inches wide, in slate, in the Gold Measures, a half mile west-northwest of Huey Lake, about 2½ miles west of Baker Settlement and about 11 miles westward of Bridgewater, Lunenburg Co. Several veins were located there. (See Geol. Surv. Canada Sum. Rept. for 1911, p. 339; and for sample of ore, see museum acc. no. 3757).

In Queen's County, the well-known prospector and local geologist, Walter H. Prest, discovered white Scheelite in drift at Fifteen-mile Brook, between Middlesfield and Greenfield, about or shortly before May, 1911, (see museum acc. no. 3689, and Geol. Surv. Can. Sum. Rept. for 1911, p. 334); and in October of the same year, E. R. Faribault of the Geological Survey discovered that ore *in situ* in a quartz vein prospected for gold by Mr. Ells at Fifteen-mile Brook, near Middlefield, a short distance to the northeast of where Mr. Prest had previously found numerous loose pieces of the same mineral. This is in the Quartzite Division of the Gold Measures.

In 1911, the Provincial Museum received a specimen of Scheelite with arsenopyrite in quartz from near Tangier, Guysborough Co., (see acc. no. 3698). About 1914, Mr. Brennan discovered brownish-buff Scheelite in a vein cutting the Dunbrack Vein, Oldham Gold District, Halifax Co., (see acc. no. 5042). And in 1919, George A. Cameron found buff-coloured Scheelite with arsenopyrite in a sharp fold of an east-and-west quartz vein of the Gold Measures, at a depth of 155 feet, in a cross-cut south from the Kaulback shaft, on the old Torquoy property, Moose River, Halifax County, about 2½ miles due east of the Scheelite mine at Scheelite. (See museum acc. no. 4796.) It was apparently in a well-defined ore-shoot confined to the sharp fold referred to.

Apparently all of these eleven deposits of Tungsten ore in Nova Scotia, are associated with quartz veins (mostly interbedded ones) in the Quartzite Division of this Gold Measures, (Lower Cambrian or possibly Pre-Cambrian age), of Halifax, Lunenburg and Queen's Counties, with the exception of the ores about Lake Ramsay and New Ross, Lunenburg Co., which are in pegmatite in Devonian granite, and the Hübnerite at Emerald, Inverness Co., which is in Pre-Cambrian rocks. Tungstite is liable to occur as an alteration product at any of the known deposits. Scheelite is the most common ore here, and it is usually associated with more or less arsenopyrite. The only deposit which so far has been commercially worked, is that at Scheelite near Moose River.

Discovery of the Sackville deposit.—In September, 1921, Frederick W. Dixon, while prospecting a 2¾ inch quartz vein in an outcrop of quartzite on his property at Lower Sackville, Halifax County, N. S., discovered arsenopyrite in the vein, and brought samples to the Provincial Museum for determination on the 23rd of that month. (See museum acc. no. 5026.)

On continuing to prospect the vein, he found that it widened to six inches or more; and on 3rd of October, he discovered therein another mineral. Not knowing what it was, he brought a sample to the Museum on the next day, (see acc. no. 5038). This was identified as a brownish-pinkish-buff coloured Scheelite in white quartz, the Scheelite having tabular-shaped cavities which had been left unfilled at the time of deposition, and which give it a sort of semi-cubical appearance when broken. Thus it very greatly resembled in colour and general appearance the Scheelite from Perry Lake about a mile northwest of Waverley, which had been discovered in 1908. A little yellow Tungstite (oxide) also showed on one of these specimens (acc. no. 5039). I told Mr. Dixon he had better immediately take up the mineral rights to the property, which he did; and on 10th

October he informed me where the specimens had been discovered, as the location of the vein had been unknown to me. As it was on the southwestward range of the Waverley anticline, and about on the strike of the very similar ore at Perry Lake, 3¾ miles to the northeast, I thought that the vein, on being further prospected to the northeast, might possibly be correlated with the latter.

Prospecting work.—Mr. Dixon accordingly examined the rock outcrops in that direction, but failed to locate an extension of his vein. With the aid of a few men, work was begun in sinking on the vein where it cropped, and this was continued till winter put an end to the season's operations. He extracted a considerable amount of fine-looking ore, very promising large samples of which were brought to the Museum on 22nd October and in January, (acc. nos. 5045 and 5060).

In the spring of 1922, he resumed the work of prospecting the vein, and followed it downward on its dip, extracting more ore of excellent quality.

Examination of the deposit.—As the relative attitude of this vein to the country-rock could not be ascertained by Mr. Dixon, nor its relationship, if any, to the Perry Lake deposit, and without such information it was difficult to judge how intelligently the work of prospecting was being conducted, I visited the deposit on 3rd May, 1922, accompanied by Dr. F. H. Sexton, Mr. J. L. Hetherington, and the owner. I then made the following notes on the occurrence:

Location.—The despoit is situated on Fred. W. Dixon's property, formerly Robert Ward's, a very short distance to the north-northeast of the site of Fultz's old Twelve-mile House, at the forks of the Old Cobequid Road and what is known as the "New" Windsor Road, nearly two miles north of Bedford railway station on tide-water at the head of Bedford Basin, and about 12 miles by road from Halifax, Halifax Co.

Geological horizon.—It occurs in a vein of white quartz in heavily-bedded blue-gray quartzite or "whin" of the lower or Quartzite Division of the Gold Measures which are believed to be of Lower Cambrian or possibly even Pre-Cambrian age.

Description of the deposit.—Considerable difficulty was experienced in determining the true dip of the heavily-bedded quartzite, which outcrops in succeeding ridges to the east-northeast. However, I ascertained that it dipped 25° south-southeastward, and that its strike was N.70°E. (true bearings). This showed that the desposit was located a short distance on the southern side of the Waverley anticline, and not on the northern side as in the case of the Perry Lake interbedded deposit.

There had been sunk a small pit, of irregular shape, measuring about 32 feet in length along the direction of the strike of the rocks, and about 15 feet in greatest width, with a maximum depth of about 9 feet at the northeast end.

The vein-matter (ore-bearing quartz), had mostly been blasted out, and removed to a neighboring barn, but some of it remained on the northeastern part of the floor of the pit. Owing to this unfortunate removal of the greater part of the vein, it was difficult to ascertain its true attitude to the country-rock. The vein had cropped on the southern side of the pit, that being the spot where it had first been discovered on the surface; and there a small remnant of it, still in place, was 9 inches wide, while part of it there, now removed, is said to have been as thin as 3 or 4 inches. It then dipped northward at a steep angle of perhaps 50°, but soon flattened out on the floor of the small pit, and where last seen in the quartzite, on the northeast side, was apparently steepening again. Good ore had been obtained on the northern part of the floor of the pit, and Mr. Dixon says that the vein in one part had become as wide as 18 inches, which I could well believe from the size of some of the largest samples received at the Museum.

From this examination it is clear that the deposit is on the southern side of the axis of the Waverley anticline, the course of which is here about N. 47° E. (true bearings). The anticlinal axis is without doubt located in the low-lying ground, covered with deep soil, a very short distance to the northwest of the deposit. The swinging of the strike somewhat around towards the axis of the anticline, suggests that the rock at the pit may be near the place where it noses around the axis. About a hundred feet south-southeast of the pit is an exposure of blebby (nodular) quartzite in slate, dipping southward about 60°, showing that the beds steepen just there. The quartzite ledge in which the deposit occurs, can be traced for some distance east-northeastward and diagonally across the Old Cobequid Road; but the vein could not be located in the many exposures I examined in that direction.

A fissure vein.—From the opposing dips of the quartzite country-rock and of the quartz vein which carries the ore—the former dipping about 25° to the south-southeastward, and the latter at varying angles to the northward,—it is also clear that the vein is not interbedded as I hoped it was, but that it is a fissure one penetrating northward, at varying pitches, into the heavily-bedded quartzite which itself dips, as stated, S. 20° E. at an angle of 25°. The Perry Lake Scheelite deposit, on the contrary, is an interbedded vein on the northern side of the anticlinal axis, as it dips to the northwestward in harmony with the strata.

It seems quite possible that if the Sackville vein is followed further into the country-rock, it will be found ultimately to be an off-shoot from an interbedded vein somewhat to the northward at a moderate distance. This I believe will prove to be the case. As has been said, no indication of the extension of the vein could be located in the exposures on the strike to the east-northeastward; and to the westward soil covers the rock-surface.

Suggestion as to future exploration.—It seems that the best that can at present be done, is to follow the fissure-vein wherever it may lead into the measures, to ascertain what it is connected with and thus possibly locate a main interbedded vein which would be more regular and extensive, and it is to be hoped as well mineralized. This is what I recommended to be done, should the work be continued, unless new evidence of the existence of the vein could be found near by. The amount of ore present in the fissure-vein, judging by what had recently been taken out, should at least pay for this exploratory work. A number of barrels of good ore were shown, all of which had been taken out of the small pit described.

Judged as a prospect only, which so far it only is, it seems to me to be one of the very best Scheelite discoveries that has yet been made in this province, and the deposit decidedly deserves to be further investigated.

THE ELECTRICAL CONDUCTIVITY OF CALCITE.—BY W. J. JACKSON, M.A., McGregor Fellow in Physics, Dalhousie University, Halifax, N. S.

(Read May 21, 1923)

It has been found that in crystals of calcite there is a polarisation effect due possibly to a space charge near the electrodes or throughout the crystal; the amount varying with different crystals. There is a displacement current as well as a conduction current. The relation between the current and the temperature is approximately exponential. The conductivity is directional. When the crystals are exposed to X-Rays the change in conductivity does not last for more than one or two hours.

Introduction

Experimental work on the thermo-luminescent properties of calcite and similar crystals has been carried out by Mackay* in which he found that when the crystals became luminescent the electrical conducitvity increased. The photo-electric conductivity of diamond crystals has been recently investigated by Miss Levi,† who found that the electrical resistance of diamond crystals varied with the wave-length of the exciting light. In a paper on the change in the electrical resistance which certain crystals undergo on exposure to radiation, Gudden and Pohl‡ offer an hypothesis that conduction takes place by means of negative carriers, which on becoming separated from neutral atoms leave them positively charged; the positive ions then create a space charge within the crystal.

Apparatus and Method of Measurement

Crystals of calcite were selected from a larger block of calcite which was thermo-luminescent.

Electrodes were fastened to the parallel faces by drilling the calcite and fastening in copper wires with an amalgam cement (dental). The approximate size of No. 1 crystal was (2 cm. × 5 cm. × .75 cm.) and No. 2 (2.5 cm. × 2.5 cm. × 1 cm.)

After the crystals had been carefully cleaned with alcohol and dried they were mounted as shown in the diagram.

* Proc. Roy. Soc. Canada. Vol. XV. Page No. 241; 1921.

† Proc. Roy. Soc. Canada. Vol. XVI., Page No. 95; 1922.

‡ Zeitschr. Für Physik No. 6. Page 249. No. 7. Page 65; 1921.

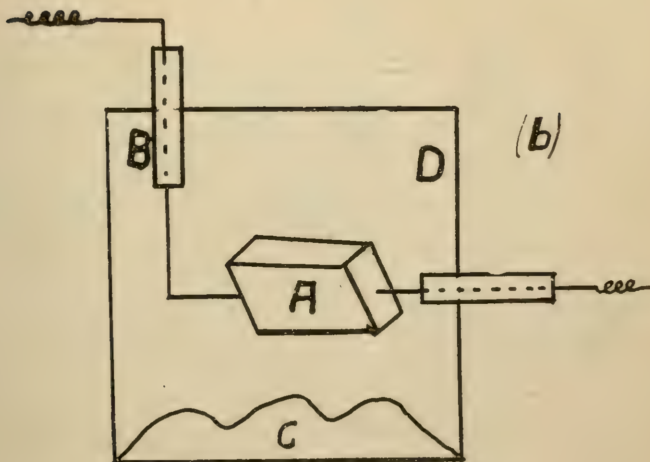


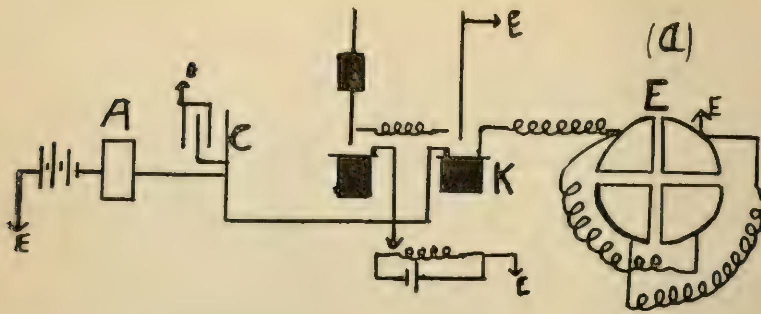
FIG. 1.

A—Cyrstal. B—Quartz Tubing. C—Cal. Chloride. D—Tin Container.

Diagram Showing Mounting of Calcite Crystal

A guard ring was used to eliminate effects due to surface conductivity. Later it was found that this precaution was not necessary. The current through the crystals, which varied from 10^{-13} amperes to 10^{-11} amperes, was measured by means of a Dolazalek electrometer. The whole apparatus was carefully screened electrostatically and precautions were taken to keep the crystals and insulation dry. Calcium chloride was used as a drying agent.

The temperature was kept constant at any desired value by placing the crystal in a DeKhotinsky thermo-constant electrical oven. It was found that the temperature of this oven when regulated did not vary more than .5 °C. The diagram, Fig. No. 1 (A), shows the appratus assembled.



A—Crystal K—Insulated Keys
C—Mica Condenser P—Potentiometer
E—Dolazalek Electrometer.

FIG 2

I. Effect of Time and Temperature on the Conductivity.

A constant E. M. F. of 300 Volts obtained from storage cells, was applied to the crystal and the current was measured by the electrometer at definite intervals. Table No. 1 gives a typical set of readings, showing the decrease of current through the crystal with time, and Curve "A," Fig. No. 3, shows the data graphically.

Table No. 1

Time (Hrs.)	No. of Secs. per 100 Scale div.	Current
0	10.6 Sec.	56.9 K
2	26.7 "	22.5 K
6	32.8 "	18.2 K
10	43.7 "	15.1 K
18	52.6 "	11.4 K

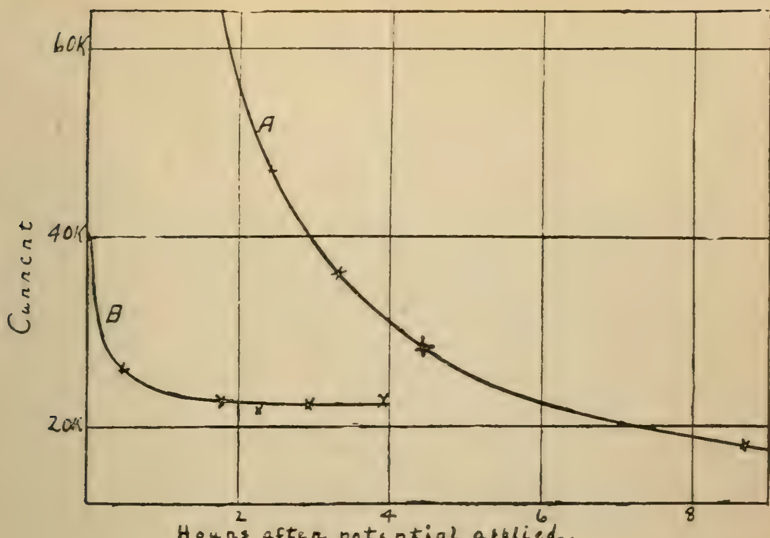


FIG. 3.

Curve "B" Fig. No. 3, is the time-current curve for crystal No. 2. The current in this case being multiplied by a factor 10 to accentuate it on the scale.

The electrical conductivity of the calcite was then measured at different temperatures at a definite time after the potential had been applied, so that the polarization effect was practically eliminated. Table No. 2 shows the effect of temperature on the conductivity and the curve in Fig. No. 4, shows that the logarithm of the current is approximately proportional to the absolute temperature.

Table No. 2

Temperature	Current
27.5°C.	8.05 K
31.0°C.	10.5 K
41.3°C.	15.3 K
45.0°C.	24.0 K
59.0°C.	65.0 K
68.5°C.	125. K

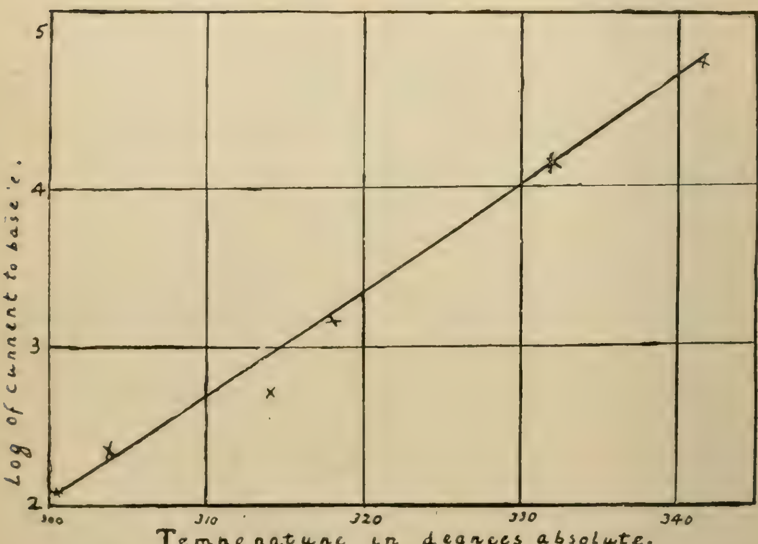


FIG. 4.

II. Polarisation and Depolarisation

The potential was applied to the crystal for 8 hours. After disconnecting the battery the crystal was earthed and the depolarization current measured by the electrometer. This current plotted against time gives what is designated here as the deplolarization curve.

Considerable light is thrown on the conduction of electricity through the calcite crystal by a study of these curves.

From the data obtained it can be said that probably a space charge exists near the elctrodes or possibly throughout the crystal. The experimental facts also give evidence of a displacement current and also a conduction current through the crystal.

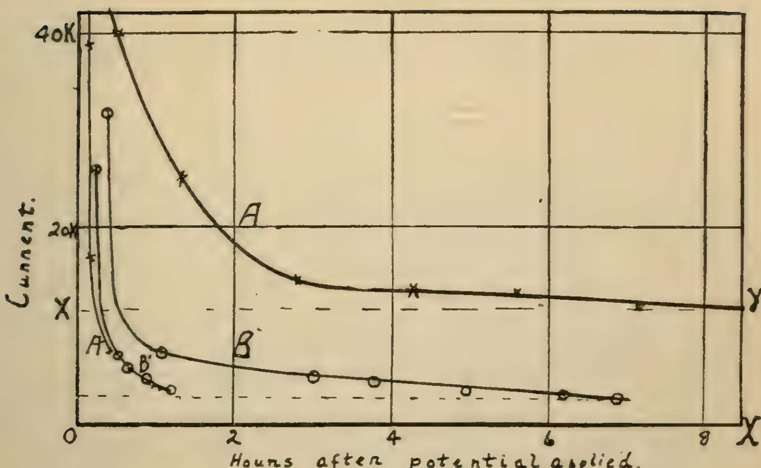


FIG. 5.

Fig. No. 5 shows a typical Current-time curve and also the corresponding depolarization curve. If a line XY is drawn as shown in the figure and the area under the curve "A" down to that line measured it is seen to be approximately equal to the area under the curve A′ (down to OX) which is the corresponding depolarization curve. Curves B and B′ also show the same phenomena. Other curves obtained, of which those in Fig. No. 5 are typical go to show that there is a displacement as well as a conduction current.

III. Directional Conductivity

In crystals No. 1 and No. 2 the conductivity in opposite directions was found to be different. Miss Levi* found similar results for diamond crystals. Curves "A" and "B," Fig. No. 5 show the relative values of the current through the crystal in opposite directions. Positive and Negative potentials were applied to both sides of the crystals alternately; the electrometer was also connected to the opposite side of the crystal.

* Proc. Roy. Soc. Canada. XVI. Page 95; 1922.

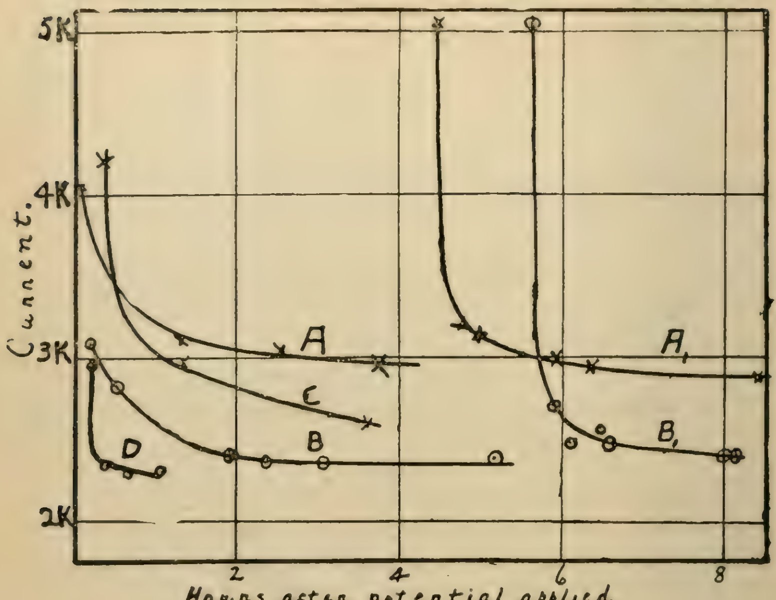


FIG. 6.

Curves A and B, Fig. 6, indicate the variation of current with time for crystal No. 2, while C and B are the corresponding curves for a direction at right angles to the first case.†

Effects of X-Rays on Polarization.

A potential of 200 volts was applied to the crystal for three or four hours before exposure to X-Rays. The results are graphically shown in Fig. 6, curves A and A′, B and B′.

† In some later work done at Princeton University using crystals sputtered with silver, the writer was unable to find any difference in conductivity in opposite directions through the crystal. It is quite possible that the earlier results on directional conductivity may have been an effect due entirely to contact.

It is noted that the current through the crystal is increased but that the X-Ray exposure has not a permanent effect on the conductivity.

Summary

1. In calcite crystals there is a polarization effect due possibly to a space charge near the electrodes or throughout the crystal.

2. There is a displacement current as well as a conduction current.

3. The relation between the current and the temperature is approximately exponential.

4. The conductivity is directional.

5. Exposure of the crystals to X-Rays increases the conductivity; returning to a normal value in one or two hours.

The writer wishes to thank Dr. J. H. L. Johnstone who suggested this problem and under whose direction the work was carried out, and also Dr. H. L. Bronson who offered many suggestions.

The Phenology of Nova Scotia, 1922.—By A. H. MacKay, LL.D., Halifax.

These observations were made by the school children of the Province of Nova Scotia as a part of the Nature Study work prescribed. The pupils report by bringing into the schoolroom the flowering or other specimens when first observed, for authoritative determination by the teacher, who generally credits the first finder by placing the name and the observation on the honor roll section of the blackboard for the day. The teacher, after testing the correctness of the observation, marks it on the schedule with which every teacher is provided—a copy of which is sent in to the Inspector with the school returns at the end of June and January.

The following tables are complied from 130 of the best schedules out of the 300 sent in. The selections were made and compiled under the direction of Mr. H. R. Shinner, B.A. and Miss Annimae Bill, of the Education Department.

The schedules for each year are carefully bound up in large annual volumes which are placed in the Provincial Museum and Science Library, where they can be used by students of climate, etc. The compilers of the phenochrons of the different belts, slopes or regions, have been rural science teachers who have most distinguished themselves as instructors. They were selected for the purpose on the recommendation of the Director of rural science education. The sheets from which the provincial phenochrons are calculated are also bound in annual folio volumes for ease of consultation and preservation.

The province is divided into its main climate slopes or regions not always coterminous with the boundaries of counties. Slopes, especially those to the coast, are subdivided into belts such as (a) the coast belt, (b) the low inland belt, and (c) the high inland belt, as follows:

No.	Regions or Slopes	Belts
I.	Yarmouth and Digby Counties,	(a) Coast, (b) Low Inlands, (c) High Inlands.
II.	Shelburne, Queens & Lunenburg Co's.	
III.	Annapolis and Kings Counties,	(a) South Mts., (b) Annapolis Valley, (c) Cornwallis Valley, (d) North Mts.
IV.	Hants and Colchester Counties,	(a) Coast, (b) Low Inlands, (c) High Inlands
V.	Halifax and Guysboro Counties,	" "
VI.a.	Cobequid Slope (to the south),	" "
VI.b.	Chignecto Slope (to the northwest),	" "
VII.	Northumberland Straits Slope (to the north),	" "
VIII.	Richmond & Cape Breton Co.'s	" "
IX.	Bras d'Or Slope (to the southeast),	" "
X.	Inverness Slope (to Gulf, N. W.),	" "

The ten regions are indicated on the outline map

Compilation Instructions—Averaging Local Phenochrons For "Reign" or "Belt" Phenochrons.

If ten or fewer good phenological observations schedules can be selected from those belonging to any given belt, they may be averaged as indicated in the columns within. If there are not ten from each belt, then it may be better to combine two belts, or if necessary, three belts on the form within. In the latter case the average will be the "region" phenochron. When a full sheet can be made out for each belt, the average of the phenochrons for the three "belts" will give the phenochrons for the "region." Finally, the phenochrons of each of the ten regions will be averaged to find the provincial phenochron for each phenomenon on the list. This will be done by the compiler-in-chief.

There is a convenience in averaging the dates of ten stations, which accounts for the ten columns for stations in the form within. When a few dates are not given it may be fair to enter in the blanks the dates from a similar and neighboring station which is not otherwise utilized for the sheet. Great care should be taken that such observations taken from a schedule not summarized, should be what might have been observed at the station indicated in the heading, and to indicate such a transference the date should be surrounded by a circle with the pen, which would always mean that the observation was not made in the station heading the column, but in a neighboring one, and was taken from a supernumerary schedule.

THUNDER-STORMS.—These dates will be entered in their respective columns and opposite the month indicated. They will not be averaged, of course. The number of observation schedules represented in any "region" or general sheet under this head should be noted somewhere on the top margin of the page.

ACCURACY.—Care must be exercised in selecting schedules, the observations of which appear to have been carefully made, neglecting any which give reason for doubt, when selecting for summation on the form within. Great care must also be exercised in copying the figures and entering them, so that no slip may occur. Every entry should be checked. One slip may spoil the effect of all the accurate numbers entering into the summation. In like manner great care has to be taken in adding and averaging the figures, and for this purpose every sum should be done twice (once in reverse order,) so as to give absolute confidence in the accuracy of the work.

REMARKS.—The compiler filling one of these blanks should keep one copy for himself while sending the other to the compiler-in-chief.

The set of stations on the right under "when becoming common," must be EXACTLY the same as on the left, under "when first seen." The compiler can enter explanatory remarks in the blank below, and should sign each sheet as a guarantee of its correctness. These sheets will be bound into a volume for each year.

THE PHENOLOGY OF NOVA SCOTIA 1922

(Compiled from the best 130 out of 300 local observation schedules.)

Year 1922

Day of the year corresponding to the last day of each month.

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93	98	109	118	113	117	117	113	116	118	111	1. Alnus incana, Wild	118	113	105	114	124	118	123	123	121	121	122
....	105	116	121	115	112	112	121	121	118	116	2. Populus tremuloides	121	....	110	121	131	117	116	116	127	128	123
95	132	96	108	103	105	105	110	116	116	109	3. Epigea repens, L.	114	107	130	109	116	112	116	116	113	124	122
116	127	126	132	134	133	133	127	135	130	129	4. Equisetum arvense	136	120	130	135	135	140	136	136	132	142	157
....	....	128	128	132	....	....	127	135	135	131	5. Sanguinaria Canadensis	135	....	....	130	133	135	....	....	132	140	139
117	123	122	128	128	124	124	128	132	134	126	6. Viola Blanda	132	126	128	130	136	134	128	128	135	138	138
127	125	127	131	131	129	129	130	121	137	129	7. Viola palmata, CUCULLATA.	135	132	131	134	138	138	131	131	137	141	141
....	107	....	....	....	....	....	124	140	....	124	8. Hepatica triloba, etc.	131	....	120	....	....	....	....	....	127	147	....
123	124	128	134	133	142	142	130	136	131	132	9. Acer rubrum	137	129	131	133	138	139	146	146	135	143	132
123	123	119	126	124	124	124	123	132	131	113	10. Fragaria Virginiana	133	130	130	131	134	132	130	130	133	142	141
153	157	151	159	165	163	163	161	171	170	161	11. Fragaria Virginiana, fruit ripe	170	166	166	161	167	173	172	172	170	178	174
128	125	130	131	127	133	133	129	138	151	133	12. Taraxacum officinale	139	135	132	136	138	134	139	139	136	143	162
....	138	138	139	141	....	....	128	147	165	142	13. Erythronium Americanum	146	....	142	143	140	144	....	....	135	151	167
128	129	134	139	135	137	137	138	142	138	136	14. Coptis trifolia	141	134	135	141	144	139	141	141	143	147	142
....	122	124	127	127	124	124	122	143	138	128	15. Claytonia Caroliniana	135	....	140	130	134	139	127	127	127	150	139
117	130	135	140	139	....	....	144	176	152	129	16. Nepeta Glechoma	145	133	139	139	142	144	....	....	149	161	157
129	135	140	141	142	140	140	142	142	147	140	17. Amelanchier Canadensis	145	141	140	144	148	147	142	142	146	151	149
....	....	....	....	....	....	....	171	....	180	176	18. Amelanchier Canadensis, fruit ripe.	....	....	....	....	....	....	....	....	....	....	....
140	139	142	152	148	143	143	143	152	148	145	19. Prunus Pennsylvanica	150	146	144	146	155	152	....	148	148	158	154
....	....	....	....	....	....	....	175	....	....	175	20. Prunus Pennsylvanica, fruit ripe	....	....	....	....	....	....	....	....	....	....	....
129	134	143	147	146	145	145	146	154	149	144	21. Vaccinium Can. and Penn.	150	143	138	148	154	151	....	150	151	159	155
....	....	....	....	....	....	....	....	223	....	223	22. Vaccinium Can. fruit ripe	228	....	....	....	....	....	....	....	....	228	....

THE PHENOLOGY OF NOVA SCOTIA 1922 (CONTINUED)

Year 1922

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When First Seen — Observation Stations

Year 1922	1. Yarmouth & Digby Counties, N. S.	2. Shelb., Queens & Lunenburg Co., N. S.	3. Annapolis & Kings Counties, N. S.	4. Hants & Col. South of Cobequid Bay.	5. Halifax & Guysboro Counties, N. S.	6a. Cobequid Slope to South.	6b. Chignecto slope to North West	7. Northumberland Straits Slope	8. Richmond & Cape Breton Counties, N. S.	9. & 10. Bras D'Or & Inverness Slopes, N. S.	Average Dates
23. Ranunculus acris	148	144	151	152	151	148	148	151	153	157	150
24. R. Repens	153	146	153	158	160	152	152	156	163	163	156
25. Trill. erythrocarpum	141	141	140	143	145	144	144	144	153	143	144
26. Rhododendron Rhodora	142	141	144	150	148	147	147	151	154	179	150
27. Cornus Canadensis	144	142	145	149	153	149	149	151	153	157	149
28. Cornus Canadensis, fruit ripe	....	144	....	160	....	....	....	....	180	196	170
29. Trientalis Americana	146	145	142	149	152	133	133	147	146	150	144
30. Clintonia borealis	148	147	147	153	152	....	....	150	155	155	151
31. Calla palustris	....	160	148	155	164	....	....	159	166	156	158
32. Cypripedium acaule	153	127	153	157	154	160	160	157	158	155	138
33. Sisyrinchium angustifoliun	152	150	152	156	162	154	154	157	163	167	157
34. Linnaea borealis	157	158	158	167	169	....	....	163	163	167	162
35. Kalmia glauca	155	150	154	151	154	153	153	158	159	153	154
36. Kalmia augustifolian	158	158	152	162	159	145	145	167	160	157	156
37. Crataegus oxyacantha	155	149	158	153	158	154	154	158	163	169	157
38. Crataegus coccinea, etc.	154	153	155	161	156	154	154	155	169	164	158
39. Iris versicolor	157	155	157	167	167	155	155	161	166	168	161
40. Chrysanthemum Leucanthemum	157	154	155	159	163	159	159	158	162	168	159
41. Nuphar advena	155	159	163	163	160	....	....	162	165	159	161
42. Rubus strigosus	154	152	154	162	164	169	169	154	160	160	160
43. Rubus strigosus, fruit ripe	....	178	178	....	239	....	....	178	....	....	193
44. Rhinanthus Crista-galli	154	165	165	168	171	....	....	172	170	163	166

When Becoming Common — Observation Stations

Year 1922	Average Dates	1. Yarmouth & Digby Counties, N. S.	2. Shelb., Queens & Lunenburg Co., N. S.	3. Annapolis & Kings Counties, N. S.	4. Hants & Col. South of Cobequid Bay	5. Halifax & Guysboro Counties, N. S.	6a. Cobequid Slope to South.	6b. Chignecto Slope to North West.	7. Northumberland Straits Slope	8. Richmond & Cape Breton Counties, N. S.	9. & 10. Bras D'or & Inverness Slopes, N. S.
23. Ranunculus acris	155	152	151	154	161	155	....	151	163	157	146
24. R. Repens	160	158	153	156	166	162	....	154	162	170	164
25. Trill. erythrocarpum	149	145	149	145	153	151	....	148	148	163	144
26. Rhododendron Rhodora	151	148	144	149	155	154	....	149	155	159	....
27. Cornus Canadensis	156	154	150	154	158	158	....	154	155	157	161
28. Cornus Canadensis, fruit ripe	156	....	147	....	165	....	....	....	....	....	....
29. Trientalis Americana	150	151	151	148	157	156	....	140	150	151	154
30. Clintonia borealis	156	154	153	153	155	158	....	....	155	160	164
31. Calla palustris	163	....	164	156	158	167	....	....	166	172	160
32. Cypripedium acaule	163	159	156	155	162	161	....	175	162	162	161
33. Sisyrinchium angustifoliun	160	158	154	156	161	165	....	157	160	168	168
34. Linnaea borealis	168	162	162	165	177	172	....	....	168	169	172
35. Kalmia glauca	159	161	154	158	155	159	....	157	162	163	156
36. Kalmia augustifolian	161	164	159	157	172	164	....	149	172	166	160
37. Crataegus oxyacantha	163	160	163	162	157	161	....	....	163	166	172
38. Crataegus coccinea, etc.	164	160	157	161	168	161	....	....	162	174	169
39. Iris versicolor	165	164	154	162	173	169	....	161	166	171	172
40. Chrysanthemum Leucanthemum	164	165	160	162	167	169	....	165	165	169	148
41. Nuphar advena	166	161	157	168	168	169	....	....	166	175	165
42. Rubus strigosus	167	162	....	160	171	167	....	180	160	167	160
43. Rubus strigosus, fruit ripe	239	....	....	....	....	239	....	....	....	....	....
44. Rhinanthus Crista-galli	169	166	170	172	144	177	....	....	176	175	168

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WHEN FIRST SEEN — Observation Stations

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45. Rubus villosus	158	157	159	167	169	170	170	166	173	154	164
46. Rubus villosus, fruit ripe	....	....	....	....	242	..	..		236	..	239
47. Sarracenia purpurea	163	159	153	...	172	..	.	169	169	160	163
48. Brunella vulgaris	166	166	170	178	172			167	173	171	171
49. Rosa lucida	165	165	166	173	178	171	171	166	171	169	170
50. Leontodon autumnale	159	156	161	163	169	167	167	164	170	171	165
51. Linaria vulgaris	153	163	172	174	170	172	172	165	169	159	166
52. Trees appear green	131	129	136	140	139	142	142	134	140	145	138
53. Ribes rubrum (cultivated)	138	137	142	147	153	154	154	147	146	148	147
54. Ribes rubrum (fruit ripe)	....	....	....	....	..	....	..		...	.	...
55. R. nigrum (cultivated)	136	139	146	148	152	153	153	147	155	150	148
56. R. nigrum, fruit ripe	....	...	...	....	.	.	.	.	...	...	.
57. Prunus Cerasus	141	141	143	151	151	150	150	149	153	155	148
58. Prunus Cerasus, fruit ripe	....	....	....	....	224	....	..	174	...	178	192
59. Prunus domestica	143	145	151	153	153	150	150	150	157	156	151
60. Pyrus Malus	145	144	147	151	153	155	155	151	157	157	152
61. Syringa vulgaris	147	152	156	156	156	159	159	155	161	163	156
62 Trifolium repens	154	152	158	156	160	161	161	157	156	162	158
63. Trifolium pratense	149	149	155	161	158	168	168	158	160	166	159
64. Phleum pratense	160	151	163	163	162	151	151	163	165	162	159
65. Solanum tuberosum	172	177	174	....	165	....	....	180	165	171	172
66. Ploughing first of season	106	107	119	120	134	122	122	123	118	120	119

WHEN BECOMING COMMON — Observation Stations

Year 1922	Average Dates	1. Yarmouth & Digby Counties, N. S.	2. Shelb., Queens & Lunenburg Co., N. S.	3. Annapolis & Kings Counties, N. S.	4. Hants & Col. South of Cobequid Bay	5. Halifax & Guysboro Counties, N. S.	6a. Cobequid Slope to South.	6b. Chignecto Slope to North West.	7. Northumberland Straits Slope	8. Richmond & Cape Breton Counties, N. S.	9. & 10. Bras D'or & Inverness Slopes, N. S.
45. Rubus villosus	169	165	165	164	170	171	....	178	173	176	161
46. Rubus villosus, fruit ripe	242	....	....	....	....	242	....	....	...	242	....
47. Sarracenia purpurea	171	168	165	170	....	177	....	....	170	174	171
48. Brunella vulgaris	175	171	173	176	179	173	....	...	174	175	176
49. Rosa lucida	174	172	173	169	178	178	....	176	173	170	173
50. Leontodon autumnale	172	165	166	171	176	174	...	173	169	175	177
51. Linaria vulgaris	169	163	165	177	.	174	....	178	154	163	172
52. Trees appear green	146	145	140	143	148	151	....	146	145	148	152
53. Ribes rubrum (cultivated)	153	144	148	151	153	156	....	159	150	150	155
54. Ribes rubrum (fruit ripe)	....	....	....	....	....	....	....	....	....	....	....
55. R. nigrum (cultivated)	153	142	145	151	160	156	154	154	152	160	156
56. R. nigrum, fruit ripe	....	....	....	....	....	....	....	....	....	....	....
57. Prunus Cerasus	153	147	146	148	155	153	156	156	153	158	155
58. Prunus Cerasus, fruit ripe	224	....	....	....	....	224	....	....	....	....	....
59. Prunus domestica	154	147	151	151	158	155	153	153	154	161	160
60. Pyrus Malus	157	151	151	153	156	157	161	161	155	161	161
61. Syringa vulgaris	162	158	156	157	161	161	165	165	158	166	168
62 Trifolium repens	164	160	158	163	166	167	168	168	161	162	165
63. Trifolium pratense	165	155	155	160	166	165	173	173	165	169	171
64. Phleum pratense	166	166	156	172	176	166	157	157	171	.169	169
65. Solanum tuberosum	174	180	179	....	....	174	....	....	....	171	166
66. Ploughing first of season	126	118	117	125	135	119	130	130	132	130	128

THE PHENOLOGY OF NOVA SCOTIA 1922 (CONTINUED)

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67. Sowing	124	129	126	136	135	136	136	138	135	136	133
68. Potato-planting	116	121	129	136	134	135	135	140	128	133	131
69. Sheep-shearing	143	111	126	146	140	137	137	138	131	120	133
70. Hay-cutting	....	....	....	208	....	....	....	216	235	....	220
71. Grain-cutting	....	251	....	237	....	....	....	240	263	....	248
72. Potato-digging	....	275	....	265	....	....	....	268	267	....	269
73a Opening of rivers	68	83	74	81	102	72	72	84	92	95	82
73b Opening of lakes	87	96	104	110	114	....	....	108	116	131	108
74a Last snow to whiten ground	100	120	111	116	92	87	87	116	116	111	106
74b Last snow to fly in air	118	116	126	126	116	100	100	137	127	135	120
75a Last spring frost—hard	129	117	131	141	141	110	110	126	130	127	126
75b Last spring frost—hoar	154	86	157	151	149	....	....	138	150	176	146
76a Water in streams—high	84	127	68	114	124	....	....	110	126	127	110
76b Water in streams—low	....	....	....	....	....	....	....	....	143	180	162
77a First autumn frost, hoar	....	286	....	....	277	....	....	257	287	....	277
77b First autumn frost, hard	....	310	....	....	305	....	....	264	302	....	295
78a First snow to fly in air	....	291	....	291	311	....	....	300	297	....	298
78b First snow to whiten ground	....	293	....	291	312	....	....	305	315	....	303
79a Closing of lakes	....	338	....	....	348	....	....	....	337	....	341
79b Closing of rivers	....	....	....	....	350	....	....	....	....	....	350
81a Wild ducks migrating, N.	81	101	89	80	80	88	88	81	89	104	88
81b Wild ducks migrating, S.	....	....	....	....	....	....	....	330	....	....	330

When Becoming Common — Observation Stations

Year 1922	Average Dates	1. Yarmouth & Digby Counties, N. S.	2. Shelb., Queens & Lunenburg Co., N. S.	3. Annapolis & Kings Counties, N. S.	4. Hants & Col. South of Cobequid Bay	5. Halifax & Guysboro Counties, N. S.	6a. Cobequid Slope to South.	6b. Chignecto Slope to North West.	7. Northumberland Straits Slope	8. Richmond & Cape Breton Counties, N. S.	9. & 10. Bras D'or & Inverness Slopes, N. S.
67. Sowing	139	134	131	136	143	139	141	141	145	142	134
68. Potato-planting	139	131	131	138	143	138	143	143	148	137	140
69. Sheep-shearing	144	149	120	134	153	149	158	158	149	140	127
70. Hay-cutting	230	....	....	....	215	....	....	....	230	246	....
71. Grain-cutting	258	....	261	....	242	....	....	....	....	270	....
72. Potato-digging	275	....	285	....	275	....	....	....	265	274	....
73a Opening of rivers	....	....	....	....	....	....	....	....	....	....	....
73b Opening of lakes	....	....	....	....	....	....	....	....	....	....	....
74a Last snow to whiten ground	....	....	....	....	....	....	....	....	....	....	....
74b Last snow to fly in air	....	....	....	....	....	....	....	....	....	....	....
75a Last spring frost—hard	....	....	....	....	....	....	....	....	....	....	....
75b Last spring frost—hoar	....	....	....	....	....	....	....	....	....	....	....
76a Water in streams—high	....	....	....	....	....	....	....	....	....	....	....
76b Water in streams—low	....	....	....	....	....	....	....	....	....	....	....
77a First autumn frost, hoar	....	....	....	....	....	....	....	....	....	....	....
77b First autumn frost, hard	....	....	....	....	....	....	....	....	....	....	....
78a First snow to fly in air	....	....	....	....	....	....	....	....	....	....	....
78b First snow to whiten ground	....	....	....	....	....	....	....	....	....	....	....
79a Closing of lakes	....	....	....	....	....	....	....	....	....	....	....
79b Closing of rivers	....	....	....	....	....	....	....	....	....	....	....
81a Wild ducks migrating, N.	....	....	....	....	....	....	....	....	....	....	....
81b Wild ducks migrating, S.	....	....	....	....	....	....	....	....	....	....	....

Year 1922

Day of the year corresponding to the last day of each month.

Jan.	31	July	212
Feb.	59	Aug.	243
March	90	Sept.	273
April	120	Oct.	304
May	151	Nov.	334
June	181	Dec.	365

For Leap Year add one to each, except January

When First Seen — Observation Stations

Year 1922	Average Dates	1. Yarmouth & Digby Counties, N. S.	2. Shelb., Queens & Lunenburg Co., N. S.	3. Annapolis & Kings Counties, N. S.	4. Hants & Col. South of Cobequid Bay.	5. Halifax & Guysboro Counties, N. S.	6a. Cobequid Slope to South.	6b. Chignecto slope to North West	7. Northumberland Straits Slope	8. Richmond & Cape Breton Counties, N. S.	9. & 10. Bras D'Or & Inverness Slopes, N. S.
82a Wild geese migrating, N.	80	83	72	77	75	84	84	76	87	67	79
82b Wild geese migrating, S.	....	....	....	333	....	....	....	....	....	....	333
83. Melospiza fasciata, North	79	86	83	103	88	...	....	92	102	105	92
84. Turdus migratorius, North	81	77	73	82	76	76	76	84	89	93	81
85. Junco hiemalis, North	83	78	83	94	85	83	83	92	93	61	84
86. Actitis macularia, North	120	98	118	139	132	124	124	133	126	140	125
87. Sturnella magna, North	....	114	103	....	156	....	....	127	121	....	124
88. Ceryle Alcyon, North	114	105	127	138	129	...	....	124	126	127	124
89. Dendroeca coronata, North	121	136	125	136	131	....	....	135	137	143	133
90. D. aestiva, North	134	133	125	152	135	138	138	145	142	145	139
91. Zonotrichia alba, North	117	99	127	123	134	....	....	125	128	126	122
92. Trochilus colubris, North	146	144	146	148	154	144	141	146	161	160	149
93. Tyrannus Carolinensis, North	147	135	137	137	146	139	139	139	126	....	138
94. Dolychonyx oryzivorus, North	138	135	124	133	143	139	139	142	141	145	138
95. Spinis tristis, North	113	140	142	155	131	124	124	144	130	152	139
96. Setophaga ruticilla, North	....	137	122	128	145	....	....	156	163	121	140
97. Ampelis cedrorum, North	135	152	137	153	119	167	167	148	134	151	146
98. Chordeiles Virginianus	133	114	117	121	131	132	132	122	131	144	128
99. First piping of frogs	90	97	94	107	105	105	105	99	110	111	102
100. First appearance, snakes	106	102	107	122	116	132	132	119	123	135	120
....	....	....	....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....	....	....	....	....

When Becoming Common — Observation Stations

Year 1922	Average Dates	1. Yarmouth & Digby Counties, N. S.	2. Shelb., Queens & Lunenburg Co., N. S.	3. Annapolis & Kings Counties, N. S.	4. Hants & Col. South of Cobequid Bay	5. Halifax & Guysboro Counties, N. S.	6a. Cobequid Slope to South.	6b. Chignecto Slope to North West.	7. Northumberland Straits Slope	8. Richmond & Cape Breton Counties, N. S.	9. & 10. Bras D'or & Inverness Slopes, N. S.
82a Wild geese migrating, N.	....	....	....	....	....	....	....	....	....	....	....
82b Wild geese migrating, S.	....	....	....	....	....	....	....	....	....	....	....
83. Melospiza fasciata, North	....	....	....	....	....	....	....	....	....	....	....
84. Turdus migratorius, North	....	....	....	....	....	....	....	....	....	....	....
85. Junco hiemalis, North	....	....	....	....	....	....	....	....	....	....	....
86. Actitis macularia, North	....	....	....	....	....	....	....	....	....	....	....
87. Sturnella magna, North	....	....	....	....	....	....	....	....	....	....	....
88. Ceryle Alcyon, North	....	....	....	....	....	....	....	....	....	....	....
89. Dendroeca coronata, North	....	....	....	....	....	....	....	....	....	....	....
90. D. aestiva, North	....	....	....	....	....	....	....	....	....	....	....
91. Zonotrichia alba, North	....	....	....	....	....	....	....	....	....	....	....
92. Trochilus colubris, North	....	....	....	....	....	....	....	....	....	....	....
93. Tyrannus Carolinensis, North	....	....	....	....	....	....	....	....	....	....	....
94. Dolychonyx oryzivorus, North	....	....	....	....	....	....	....	....	....	....	....
95. Spinis tristis, North	....	....	....	....	....	....	....	....	....	....	....
96. Setophaga ruticilla, North	....	....	....	....	....	....	....	....	....	....	....
97. Ampelis cedrorum, North	....	....	....	....	....	....	....	....	....	....	....
98. Chordeiles Virginianus	....	....	....	....	....	....	....	....	....	....	....
99. First piping of frogs	....	....	....	....	....	....	....	....	....	....	....
100. First appearance, snakes	....	....	....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....	....	....	....	....

THE LOCAL COMPILERS FOR EACH REGION, 1922.

Region No.		Region No.	
I.	Miss Helena Hicks.	VI.	Miss Alice Soley.
II.	Miss E. Constance Andrews.	VII.	Miss Christine Gilchrist.
III.	Miss Aunimae Bill.	VIII.	Miss Blanche Boutilier.
IV.	Miss Una E. Jenkyns.	IX., X.	Miss Rebecca M. Dunn.
V.	Miss M. Martin.		

THE TEN PHEONOGICAL REGIONS OF NOVA SCOTIA

Thunderstorms—Phenological Observations, Nova Scotia, 1922

The indices indicate the number of stations from which the Thunderstorms were reported on the day of the year specified.

Observation Regions

1. Yarmouth and Digby Counties, N. S.	2. Shelburne, Queens & Lunenburg Co., N. S.	3. Annapolis & Kings Counties, N. S.	4. Hants & Colchester So. of Cobequid Bay	5. Halifax & Guysboro Counties, N. S.	6a. Cobequid Slope to South	6b. Chignecto Slope to North West	7. Northumberland Straits Slope	8. Richmond & Cape Breton Co., N. S.	9. & 10. Bras D'Or & Inverness Slopes, N.S.	Year 1922
							45			45
				67			67			67^{2}
							72			72
			73^{4}				73^{9}			73^{13}
							75			75
88	88^{3}						88			88^{5}
94										94
96										96
	98									98
								99		99
100^{4}	100^{2}									100^{6}
101^{3}	101^{2}			101						101^{6}
102	102			102			102			102^{4}
									103	103
							107^{8}			107^{8}
							108			108
			109	109						109^{2}
				110						110
							118			118
				121			121			121^{2}
			122^{5}		122^{2}	122^{2}	122^{12}			122^{21}
			123^{2}							123^{2}
	125									125
127		127					127			127^{3}
			128^{9}				128	128^{4}	128	128^{15}
							129			129
		130								130
								131		131
								132		132
							135^{2}			135^{2}
				136						136
								137		137
								138		138
139		139								139^{2}
140^{2}							140			140^{3}
			141^{2}				141^{3}			141^{5}
				144						144

THUNDERSTORMS—PHENOLOGICAL OBSERVATIONS, NOVA SCOTIA, 1922

The indices indicate the number of stations from which the Thunderstorms were reported on the day of the year specified.

OBSERVATIONS REGIONS

1. Yarmouth and Digby Counties, N. S.	2. Shelburne, Queens & Lunenburg Co., N. S.	3. Annapolis & Kings Counties, N. S.	4. Hants & Colchester So. of Cobequid Bay	5. Halifax & Guysboro Counties, N. S.	6a. Cobequid Slope to South	6b. Chignecto Slope to North West	7. Northumberland Straits Slope	8. Richmond & Cape Breton Co., N. S.	9. & 10. Bras D'Or & Inverness Slopes, N.S.	Year 1922
......	......	145	145^{2}	......	145	145	145^{16}	......	......	145^{21}
146^{2}	146^{3}	146	146	......	......	......	146^{2}	......	......	146^{9}
......	......	......	......	......	......	......	151	......	......	151
......	......	......	......	152^{2}	......	......	......	......	......	152^{2}
......	......	......	......	153^{2}	......	......	153^{2}	......	......	153^{4}
......	......	154	......	......	154	154	154	......	......	154^{4}
......	......	......	......	......	......	......	155	......	......	155
......	......	......	......	......	......	......	156	......	......	156
157	......	......	......	157	......	......	......	......	......	157^{2}
158^{2}	158^{5}	158^{2}	158^{2}	158^{2}	158	158	158^{7}	......	......	158^{22}
159	......	......	......	......	......	......	......	......	......	159
160	160^{3}	......	160^{4}	160	......	......	160^{18}	160^{5}	160^{3}	160^{35}
......	......	......	......	......	161	161	161^{2}	161^{2}	161	161^{7}
......	......	......	......	......	......	......	......	162	......	162
......	163^{6}	163^{2}	163^{12}	......	......	......	163^{16}	......	163^{3}	163^{39}
......	164	......	......	......	......	......	......	......	164^{2}	164^{3}
......	......	......	......	......	......	......	166	......	......	166
......	......	......	......	168	......	......	......	......	......	168
......	......	......	......	......	......	......	169	......	......	169
......	......	171^{3}	171	171	......	......	171^{3}	......	......	171^{8}
......	......	......	......	......	......	......	173	......	......	173
......	......	......	......	175	......	......	......	......	......	175
......	......	176	176	......	......	......	176	......	......	176^{3}
......	......	177	......	......	......	......	177	......	......	177^{3}
......	......	......	......	......	......	......	179	......	......	179
......	......	......	......	......	......	......	......	180	......	180
......	......	......	......	......	......	......	203	......	......	203
......	......	......	......	......	......	......	......	228	......	228
......	......	......	......	......	......	......	229	......	......	229
......	......	......	......	230	......	......	......	230	......	230^{2}
......	......	......	......	......	......	......	231	......	......	231
......	......	......	......	......	......	......	259	259	......	259^{2}
......	......	......	......	......	......	......	266	......	......	266
......	......	......	......	......	......	......	......	278	......	278
......	......	......	......	......	......	......	281	......	......	281
......	......	......	......	......	......	......	......	358	......	358

TRANSACTIONS

OF THE

Nova Scotian Institute of Science

SESSIONS OF 1923-1924

(Vol. xvi Part 2)

A Nova Scotia Life Table. — By A. C. Jost, M. D., C. M., Provincial Medical Officer, Halifax, N. S.

(Read 14 January, 1924)

For the preparation of the Life Table presented herewith there were available the following data.—

1. Population Statistics of the Province by sexes, in single years of age, (age 0-4), in five year periods, (ages 5-89), and in one eleven year period (90-100). These had been obtained from the census figures of the censuses of 1911 and 1921. The geometrical method of computing the populations of the various age groups during the intercensal years was followed. Both censuses were taken as at June first of the census year. Since April first was the central point of the years for which mortality statistics were available, some correction of the population figures was necessary and was carried out. Correction was also made for the persons of the population whose ages were not given in the census returns, these persons being placed pro rata in the various age groups. During the three years there were all told 793837 male lives and 766282 female lives at risk divided into the age groups hereafter given.

II. Mortality Statistics showing deaths by sexes and for various age groups for the three years ending Sept. 30th, 1918-19, 1919-20 and 1920-21. This information gave the number of deaths by years, (ages 0-4), in five year age groups, (5-19), in ten year groups, (20-89), and one eleven year group, (90-100). As before, these figures were corrected for those whose ages were not given in the returns. The total number of deaths which occured in the three years was 12152 males and 11060 females.

The lack of data respecting deaths in quinquennial periods, and the occurrence of one eleven year group, made impossible the wholly mathematical method of life table construction advised by George King. The method used was that recommended by Sir Arthur Newsholme, and might be called a graphical rather than a mathematical method. Curves showing the population and the deaths for the individual years from 0 to 106 were laid off. From these, there was computed the death rates of the individual years and from these death rates the "Probability of living" (px) was computed by using the usual formula.

By selecting the three years 1918-19, 1919-20 and 1920-21, the high provincial mortality, due to the Halifax disaster and the influenza epidemic, was avoided, and figures were obtained, which, it was thought, represented with a fair degree of accuracy the average mortality prevailing in the Province.

The numerical data from which the table was constructed is here given according to age groups.

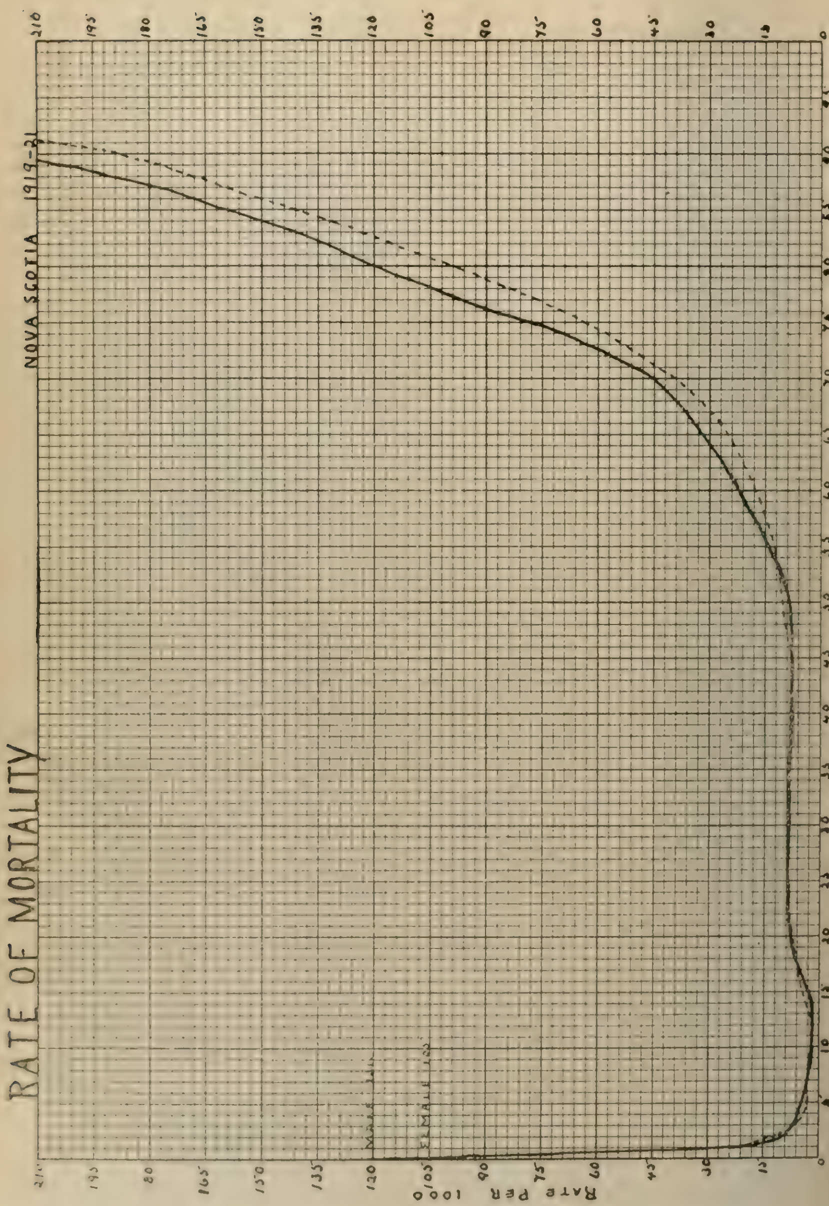
	MALE		FEMALE	
AGE GROUPS	LIVES AT RISK	DEATHS	LIVES AT RISK	DEATHS
0–4..........	91228	3199	89472	2571
5–9..........	90689	315	87565	244
10–14.........	86857	161	83082	214
15–19.........	77740	412	77365	442
20–29.........	122718	1057	122906	984
30–39.........	98304	862	91866	800
40–49.........	84218	672	75555	649
50–59.........	61073	848	57430	738
60–69.........	45936	1236	42444	1043
70–79.........	25633	1823	26411	1589
80–89.........	8604	1305	10608	1354
90–100........	801	251	1514	416
Over 100.......	36	11	64	16
Totals.........	793837	12152	766282	11060

The calculated death rates of the individual ages for both males and females, from which the "probability of living" was obtained, are shown on the accompanying chart. It will be seen that a fair degree of "smoothness" was secured. In the table itself will be found, not only the expectation of life (the curtate expectation) for the period given, but for the purpose of comparison the corresponding expectation obtained from a life table of the Province based upon figures of the two years 1910 and 1911.

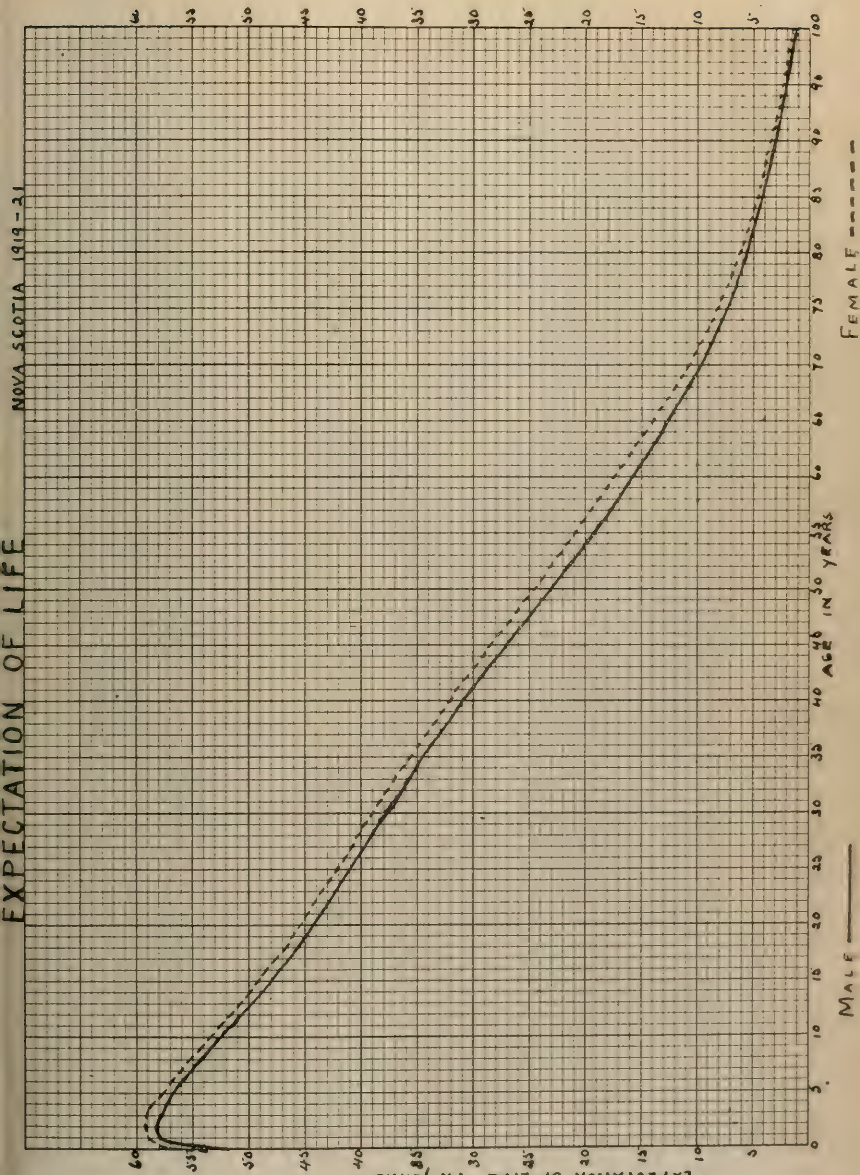
The difference between the "curtate" and the "complete" expectations of life should be noted. These for practically all ages except those of the extremes of life, differ from each other by one half year exactly—the curtate being the shorter.

Many published tables give "complete" not "curtate" expectations, and, if comparisons are being made, this fact, and a possible difference in nomenclature, must be kept in mind.

In addition, reference should be made to another term, frequently used, namely the "Probable duration of Life." This is to the age at which half the life table population shall have ceased to exist, or in this case, when the 100,000 persons with whom life table started have become 50,000. This point will be found to be between the ages of 62 and 63 in the case of the males—and of 64 and 65 in the case of the females of the Provincial population. Its position has changed relatively little in the period between the two censuses.


RATE OF MORTALITY
NOVA SCOTIA 1919-21
AGE IN YEARS
RATE PER 1000
MALE
FEMALE

No. 1


EXPECTATION OF LIFE
NOVA SCOTIA 1919-21
FEMALE
MALE
AGE IN YEARS
EXPECTATION OF LIFE IN YEARS

No. 2

LIFE TABLE FEMALES

NOVA SCOTIA

Based on the Population Statistics of 1911 and 1921, and the Mortality Statistics of 1918-19, 1919-20, and 1920-21

AGE	Rate of Mortality per thousand	Probability of living	Number Alive at beginning of age interval	Population or years of life lived.	Curtate Expectation of Life 1921	Curtate Expectation of Life 1911
0	105.98	......	100000	5362013	53.62	53.15
1	21.85	.97839	89402	5272611	58.97	58.75
2	14.32	.98578	87470	5185141	59.27	59.07
3	5.80	.99421	86226	5098915	59.13	58.70
4	4.35	.99566	85728	5013187	58.47	58.17
5	3.71	.99630	85357	4927830	57.73	57.51
6	3.02	.99698	85041	4842789	56.94	56.74
7	2.57	.99744	84785	4758004	56.11	55.96
8	2.40	.99760	84568	4673436	55.26	55.15
9	2.23	.99778	84365	4589071	54.39	54.33

LIFE TABLE — FEMALES (Continued)

AGE	Rate of Mortality per thousand	Probability of living	Number Alive at beginning of age interval	Population or years of life lived.	Curtate Expectation of Life 1921	Curtate Expectation of Life 1911
10	2.03	.99798	84178	4504893	53.51	53.50
11	2.01	.99800	84009	4420884	52.62	52.65
12	2.04	.99796	83841	4337043	51.72	51.79
13	2.76	.99724	83670	4253373	50.83	50.93
14	4.12	.99588	83439	4169934	49.97	50.10
15	4.73	.99529	83096	4086838	49.18	49.33
16	5.23	.99479	82705	4004133	48.41	48.59
17	5.81	.99421	82274	3921859	47.66	47.65
18	6.21	.99381	81798	3840061	46.94	47.12
19	6.49	.99352	81293	3758768	46.23	46.40
20	6.82	.99320	80766	3678002	45.53	45.80
21	7.17	.99286	80217	3597785	44.85	44.96
22	7.53	.99250	79645	3518140	44.17	44.26
23	7.83	.99221	79048	3439092	43.50	43.57
24	8.12	.99191	78432	3360660	42.84	42.90

LIFE TABLE — FEMALES (Continued)

AGE	Rate of Mortality per thousand	Probability of living	Number Alive at beginning of age interval	Population or years of life lived.	Curtate Expectation of Life 1921	Curtate Expectation of Life 1911
25	8.32	.99171	77798	3282862	42.19	42.24
26	8.55	.99149	77154	3205708	41.54	41.59
27	8.70	.99133	76497	3129211	40.90	40.95
28	8.88	.99115	75835	3053376	40.26	40.31
29	8.97	.99108	75164	2978212	39.62	39.65
30	8.98	.99106	74494	2903718	38.97	38.98
31	9.03	.99102	73828	2829890	38.33	38.28
32	9.08	.99096	73165	2756725	37.67	37.57
33	9.03	.99102	72504	2684221	37.02	36.84
34	9.00	.99105	71853	2612368	36.35	36.10
35	8.76	.99127	71209	2541159	35.68	35.37
36	8.54	.99149	70588	2470571	34.99	34.63
37	8.31	.99173	69988	2400583	34.29	33.89
38	8.19	.99185	69409	2331174	33.58	33.14
39	8.06	.99197	68844	2262330	32.86	32.40

LIFE TABLE — FEMALES (Continued)

AGE	Rzte of Mortality per thousand	Probability of living	Number Alive at beginning of age interval	Population or years of life lived.	Curtate Expectation of Life 1921	Curtate Expectation of Life 1911
40	7.94	.99209	68291	2194039	32.12	31.66
41	8.03	.99201	67751	2126288	31.38	30.91
42	8.13	.99191	67210	2059078	30.63	30.16
43	8.23	.99181	66666	1992412	29.88	29.41
44	8.34	.99169	66120	1926292	29.13	28.66
65	8.46	.99157	65571	1860721	28.37	27.92
46	8.72	.99131	65019	1795702	27.61	27.17
47	9.00	.99104	64454	1731248	26.86	26.43
48	9.45	.99060	63877	1667371	26.10	25.70
49	10.08	.98997	63277	1604094	25.35	24.97
50	10.51	.98955	62642	1541452	24.60	24.25
51	10.91	.98915	61988	1479464	23.86	23.32
52	11.32	.98874	61316	1418148	23.12	22.80
53	11.76	.98830	60626	1357522	22.39	22.09
54	12.38	.98769	59917	1297605	21.65	21.37

LIFE TABLE — FEMALES (Continued)

AGE	Rate of Mortality per thousand	Probability of living	Number Alive at beginning of age interval	Population or years of life lived.	Curtate Expectation of Life 1921	Curtate Expectation of Life 1911
55	13.04	.98704	59180	1238425	20.92	20.66
56	13.73	.98637	58413	1180012	20.20	19.94
57	14.46	.98564	57617	1122395	19.48	19.23
58	15.23	.98489	56790	1065605	18.76	18.51
59	16.43	.98371	55932	1009673	18.05	17.79
60	17.66	.98249	55021	954652	17.35	17.07
61	19.09	.98110	54058	900594	16.66	16.36
62	20.62	.97959	53036	847558	15.98	15.64
63	21.82	.97841	51954	795604	15.31	14.95
64	23.11	.97716	50823	744772	14.65	14.26
65	24.99	.97532	49672	695100	13.99	13.59
66	27.01	.97335	48446	646654	13.34	12.95
67	29.21	.97122	47155	599499	12.71	12.32
68	32.42	.96809	45798	553701	12.09	11.71
69	35.94	.96469	44337	509364	11.48	11.11

LIFE TABLE — FEMALES (Continued)

AGE	Rate of Mortality per thousand	Probability of living	Number Alive at beginning of age interval	Population or years of life lived.	Curtate Expectation of Life 1921	Curtate Expectation of Life 1911
70	39.36	.96139	42772	466592	10.90	10.52
71	43.52	.95741	41121	425471	10.34	9.95
72	48.09	.95304	39369	386102	9.80	9.40
73	53.16	.94821	37521	348581	9.29	8.88
74	58.45	.94321	35578	313003	8.79	8.40
75	64.40	.93760	33558	279445	8.32	7.94
76	70.30	.93208	31464	247981	7.88	7.54
77	77.02	.92583	29327	218654	7.45	7.14
78	84.30	.91910	27152	191502	7.05	6.75
79	91.70	.91232	24956	166546	6.67	6.36
80	99.82	.90492	22768	143778	6.31	5.97
81	108.27	.89729	20603	123175	5.97	5.56
82	116.47	.88994	18487	104688	5.66	5.15
83	124.32	.88295	16452	88236	5.36	4.74
84	133.45	.87490	14527	73709	5.07	4.31

LIFE TABLE — FEMALES (Concluded)

AGE	Rate of Mortality per thousand	Probability of living	Number Alive at beginning of age interval	Population or years of life lived.	Curtate Expectation of Life 1921	Curtate Expectation of Life 1911
85	142.42	.86704	12709	61000	4.79	3.87
86	151.14	.85947	11020	49980	4.53	3.46
87	160.20	.85159	9471	40509	4.27	3.10
88	167.31	.84561	8065	32444	4.02	2.76
89	177.37	.83708	6821	25623	3.75	2.47
90	190.28	.82625	5710	19913	3.49	2.26
91	207.96	.81162	4717	15196	3.22	2.10
92	229.26	.79431	3829	11367	2.96	1.99
93	244.56	.78208	3040	8327	2.73	1.88
94	269.93	.76217	2378	5949	2.50	1.82
95	295.77	.74234	1813	4136	2.28	1.75
96	330.57	.71632	1345	2791	2.07	1.66
97	363.63	.69231	964	1827	1.89	1.54
98	384.61	.67743	667	1160	1.73	1.42
99	410.71	.65926	452	708	1.56	1.26
100	441.17	.63856	298	410	1.37	1.03

LIFE TABLE MALES

Nova Scotia

Based on the Population Statistics of 1911 and 1921, and the Mortality Statistics of 1918-19, 1919-20, and 1920-21.

AGE	Rate of Mortality per thousand	Probability of living	Number alive at beginning of age interval	Population or years of life lived.	Curtate Expectation of Life 1921	Curtate Expectation of life 1911
0	121.35	......	100000	5180823	51.80	51.36
1	22.12	.97812	87865	5092958	57.96	57.81
2	9.76	.99028	85941	5007017	58.26	58.31
3	6.49	.99308	85107	4921910	57.83	57.97
4	5.62	.99439	84519	4837391	57.23	57.39
5	4.67	.99533	84045	4753346	56.55	56.73
6	3.90	.99610	83653	4669693	55.82	56.04
7	3.26	.99664	83327	4586366	55.04	55.30
8	2.87	.99712	83048	4503318	54.22	54.52
9	2.54	.99746	82809	4420509	53.38	53.73

LIFE TABLE — MALES (Continued)

AGE	Rate of Mortality per thousand	Probability of living	Number Alive at beginning of age interval	Population or years of life lived.	Curtate Expectation of Life 1921	Curtate Expectation of Life 1911
10	2.14	.99786	82599	4337910	52.51	52.93
11	1.88	.99812	82422	4255488	51.62	52.10
12	1.68	.99832	82267	4173221	50.72	51.25
13	1.74	.99825	82129	4091092	49.81	50.37
14	1.82	.99818	81986	4009106	48.90	49.52
15	2.58	.99742	81837	3927269	47.99	48.68
16	4.14	.99586	81626	3845643	47.11	47.86
17	5.53	.99447	81289	3764354	46.30	47.07
18	6.82	.99320	80840	3683514	45.56	46.30
19	7.55	.99246	80290	3603224	44.87	45.56
20	8.11	.99191	79685	3523539	44.21	44.84
21	8.44	.99159	79041	3444498	43.57	44.13
22	5.85	.99145	78377	3366121	42.94	43.42
23	8.65	.99137	77707	3288414	42.31	42.72
24	8.72	.99131	77037	3211377	41.68	42.02

LIFE TABLE — MALES (Continued)

AGE	Rate of Mortality per thousand	Probability of living	Number Alive at beginning of age interval	Population or years of life lived.	Curtate Expectation of Life 1921	Curtate Expectation of Life 1911
25	8.75	.99127	76368	3135009	41.05	41.32
26	8.78	.99125	75702	3059307	40.41	40.65
27	8.81	.99122	75040	2984267	39.76	39.96
28	8.83	.99119	74382	2909885	39.11	39.28
29	8.82	.99121	73728	2836157	38.46	38.60
30	8.81	.99122	73080	2763077	37.80	37.91
31	8.80	.99123	72439	2690638	37.14	37.21
32	8.79	.99124	71805	2618833	36.47	36.51
33	8.78	.99125	71176	2547657	35.79	35.79
34	8.77	.99126	70554	2477103	35.10	35.06
35	8.76	.99127	69938	2407165	34.41	34.32
36	8.74	.99129	69328	2337837	33.72	33.57
37	8.71	.99131	68725	2269112	33.01	32.81
38	8.68	.99135	68128	2200984	32.30	32.05
39	8.65	.99137	67539	2133445	31.58	31.29

LIFE TABE — MALES (Continued)

AGE	Rate of Mortality per thousand	Probability of living	Number Alive at beginning of age interval	Population or years of life lived.	Curtate Expectation of Life 1921	Curtate Expectation of Life 1911
40	8.62	.99141	66957	2066488	30.86	30.53
41	8.41	.99163	66382	2000106	30.13	29.76
42	8.20	.99182	65827	1934279	29.38	28.98
43	7.96	.99207	65289	1868990	28.62	28.21
44	7.84	.99219	64771	1804219	27.85	27.44
45	7.71	.99232	64265	1739954	27.07	26.67
46	7.63	.99240	64772	1676182	26.28	25.92
47	7.55	.99248	63288	1612894	25.48	25.17
48	7.66	.99236	62813	1550081	24.67	24.42
49	7.91	.99213	62334	1487747	23.86	23.68
50	8.28	.99175	61843	1425904	23.05	22.94
51	9.25	.99080	61333	1364571	22.24	22.19
52	10.26	.98979	60769	1303802	21.45	21.40
53	11.55	.98852	60149	1243653	20.67	20.70
54	12.92	.98716	59459	1184194	19.91	19.96

LIFE TABLE — MALES (Continued)

AGE	Rzte of Mortality per thousand	Probability of living	Number Alive at beginning of age interval	Population or years of life lived.	Curtate Expectation of Life 1921	Curtate Expectation of Life 1911
55	14.48	.98562	58695	1125499	19.17	19.22
56	16.08	.98404	57851	1067648	18.45	18.48
57	17.68	.98247	56929	1010719	17.75	17.75
58	19.27	.98092	55931	954788	17.07	17.05
59	20.98	.97923	54864	899924	16.40	16.37
60	22.68	.97757	53725	846199	15.75	15.74
61	24.38	.97591	52520	793679	15.11	15.12
62	26.08	.97425	51255	742424	14.48	14.52
63	27.78	.97260	49936	692488	13.86	13.91
64	29.58	.97085	48567	643921	13.25	13.31
65	31.38	.96910	47152	596769	12.65	12.71
66	33.18	.96736	45695	551074	12.06	12.11
67	35.08	.96552	44203	506871	11.46	11.51
68	36.98	.96369	42680	464191	10.87	10.92
69	39.98	.96080	41130	423061	10.28	10.32

LIFE TABLE — MALES Continued)

AGE	Rzte of Mortality per thousand	Probability of living	Number Alive at beginning of age interval	Population or years of life lived.	Curtate Expectation of Life 1921	Curtate Expectation of Life 1911
70	45.44	.95556	39518	383543	9.70	9.74
71	51.90	.94941	37762	345781	9.15	9.16
72	58.87	.94282	35852	309929	8.64	8.59
73	65.84	.93625	33802	276127	8.16	8.05
74	73.14	.92944	31647	244480	7.72	7.52
75	80.90	.92215	29415	215065	7.31	7.03
76	89.03	.91477	27124	187941	6.92	6.57
77	97.44	.90707	24812	163129	6.57	6.14
78	105.63	.89967	22507	140622	6.24	5.73
79	113.54	.89255	20249	120373	5.94	5.34
80	120.26	.88656	18073	102300	5.66	4.96
81	127.39	.88024	16023	86277	5.38	4.59
82	134.35	.87411	14104	72173	5.11	4.23
83	142.44	.86703	12329	59844	4.85	3.86
84	151.73	.85897	10689	49155	4.59	3.50

LIFE TABLE — MALES (Continued)

AGE	Rate of Mortality per thousand	Probability of living	Number Alive at beginning of age interval	Population or years of life lived.	Curtate Expectation of Life 1921	Curtate Expectation of Life 1911
85	160.40	.85150	9182	39973	4.35	3.16
86	169.89	.84342	7818	32155	4.11	2.92
87	179.46	.83531	6594	25561	3.87	2.69
88	191.73	.82505	5508	20053	3.64	2.50
89	204.88	.81415	4544	15509	3.41	2.36
90	219.29	.80238	3700	11809	3.19	2.20
91	233.64	.79079	2968	8841	2.97	2.09
92	250.00	.77777	2347	6494	2.76	1.99
93	269.66	.76237	1826	4668	2.55	1.88
94	289.15	.74672	1392	3276	2.35	1.79
95	310.81	.73100	1039	2237	2.15	1.72
96	333.33	.71429	759	1478	1.94	1.64
97	362.06	.69343	542	936	1.72	1.52
98	403.86	.66399	376	560	1.48	1.39
99	477.27	.61468	249	311	1.24	1.23
100	555.55	.56522	153	158	1.03	1.00

Recent Changes in the Coast Line in the County of Kings, Nova Scotia.— By Frederick J. Churchill, Los Angeles, Calif., U. S. A.

Few places are more fascinating than the sea shore for those who are interested in observing the forces of nature at work.

Having spent the greater part of my life near the shore, the writer has frequently watched the meeting-place between land and sea, a location continually changing and with greater rapidity than most of us are aware. There is no place upon the surface of the earth where changes take place more rapidly; and during the span of one brief human existence, the careful observer notices many changes that escape the inexperienced eye.

These forces being destructive and constructive are very interesting. They alter the landscape that delights the eye and inspires the imagination. The north-western portion of Kings County is bounded on the north by the Bay of Fundy. There the great tides, forcing their way up a narrow bay, carry their waters far inland up the still narrower estuaries where they carry on their work. On the bay shore, destruction seems to be the rule, and the sea is surely working its way inland.

Here the hard trap sheet overlying the soft sandstone, at first appears to be an impenetrable barrier; but it is slowly yielding to the attack of the waves and chemical changes. The jointing in the trap is a good lodging-place for water, and as it freezes the rock fragments soon roll down the cliff, and the soft underlying sandstone, being exposed, soon yields itself to the elements. In the spring of the year one may see several tons of rock debris fall at one time to the beach below the over hanging cliff. The probable rate of erosion along this coast is from six inches to a foot each year. After this rock mass is broken up, it is distributed by the tides in various parts of the bay. As we move easterly along the coast and pass Blomidon, we leave the trap rock on its south side, and find the friable sandstone as the bed-rock of the country. It is here that the greatest changes are taking place. Destruction goes on everywhere and at a rapid pace.

These rocks are broken by numerous small faults with a displacement of only a few inches, and this makes them fall an easy prey to the destructive forces.

My personal observations at Kingsport, Starr's Point, consist of several careful measurements during a period of five and six years; and I find the rate of erosion is from five to six feet per year. I placed in the ground iron pipes, and measured the distance to some conspicious object, such as the corner of a foundation of a house or a large tree.

In July, 1917, at Kingsport, an iron pipe was placed in the ground, one hundred feet from the edge of the cliff and near a large oak tree; and on August, 1923, it was only 44 feet from the edge of the bank, an erosion rate of 56 feet in six years. This gives a rate of 9 feet, 4 inches, per year, which is too great to be an average, as at this particular locality the underlying rocks are very soft. At other places than Kingsport, measurements will average nearly six feet per year. Near the mouth of the Pereau River, six feet a year seems to be a fair average.

At Starr's Point and Evangeline Beach careful measurements show six to seven feet per year. Bathing houses at Evangeline Beach that were six feet or more from the edge of the Cliff in 1912, fell to the beach the following spring of 1913. At Starr's Point the writer well remembers when a party consisting of about a dozen persons climbed a stack on the beach and there ate their lunch; today it has almost entirely disappeared. The same can be said of a number of these stacks along the coast.

A well-known Kings County land surveyor told me that in 1884, he surveyed lands then belonging to one Hueston, now owned by Major Henshaw, at Pereau. The orchard of this property which was resurveyed by the same person in 1920, had lost 210 feet, six rows of apple trees had disappeared and each row was 35 feet apart, making a loss of nearly six feet per year.

About thirty years ago there appeared in the Wolfville "Acadian," an advertisement of a lot of marsh land for sale, near the mouth of the Cornwallis River. That lot does not exist today. The owner is well known to the writer and told him the facts. It consisted of several acres. As it was not dyked off from the tides, and it was nearly all loose soil, it cannot be considered as an average rate of erosion.

On the banks of the Avon River, at Horton Bluff, near Avonport, erosion is the rule; and a few miles north of Hantsport the Dominion Atlantic Railway had to move its track inland owing to the river cutting into its bank.

At Hantsport old deeds show that erosion is taking place rapidly; and during my brief experience, buildings have had to be moved inland in order to save them.

Fortunately there is a compensating force replacing in other localities the destruction that takes place in the parts that have been referred to. All of the rivers flowing into the bay, carry into it their load of sediment, and one can readily see these constructive changes as well as the destructive ones. The Cornwallis River has built up a large delta at its mouth; and the early Acadians, by dyking this marsh, reclaimed much of this valuable farm land. This River is still extending its delta, and at low tide, with the exception of a swim of about 100 yards, one can walk between Kingsport and Evangeline Beach. Twenty years ago this was impossible according to several old observors.

Old charts show that the Avon River is fast building up its Delta; and at Hantsport, places where vessels could once anchor at low tide are now mud flats. The fact that the river is cutting into its bank, proves that it is building up its flood-plain, as rivers so doing begin to meander.

At the mouth of Gaspereau River old deeds prove that the river is increasing its delta and more marsh-land is appearing above the low-tide line than thirty years ago.

The changes taking place in this area makes a fertile field for the speculation of the theory of isostasy. Many well-known geologists, such as Sir Archibald Geikie, believe that, as a land area receives heavy accumulation of sediments, it begins to sink under its load, and the partly submerged forest at Bont Island, north of Grand Pre, appears to testify to the correctness of this theory.

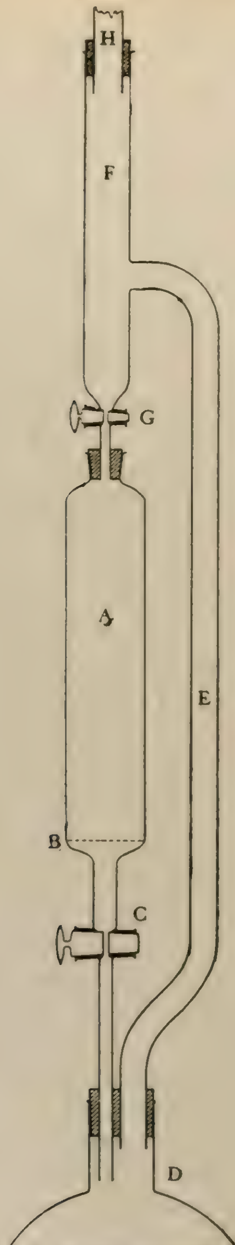
A Modification of the Adams' Method of Preparing Alkyl Iodides.—By Harold S. King, A.B. (Harv.), Assistant Professor of Chemistry, Dalhousie University, Halifax, Nova Scotia.

(Read 21 April, 1924)

INTRODUCTION

The alkyl iodides are among the most important of organic reagents. Usually their cost ready prepared is high in comparison with the price of the raw materials. In most laboratories these reagents, especially methyl and ethyl iodides, are prepared as needed. Consequently any simplification in the procedure for their production is desirable. Adams and Voorhees have published a very satisfactory method in The Journal of the American Chemical Society, Vol. XLI. pp. 789-798, (May, 1919). This method is based on the reaction between an alcohol, phosphorus, and iodine. A mixture of red and yellow phosphorus, together with the alcohol corresponding to the iodide which is to be prepared, is boiled in a flask fitted with a special apparatus for dissolving iodine in the condensed vapors from the distillation and introducing the iodine gradually as as olution into the reaction flask. With this apparatus the preparation of alkyl iodides is smoothly and almost automatically accomplished.

The special apparatus, however, is rather too complicated to be made in the laboratory and somewhat expensive to have constructed by a professional glassblower. The purpose of this paper is to suggest a form which, it has been found, is simple enough for the average student to build, yet which works as efficiently. The accompanying cut illustrates the special apparatus in its simplified form. The iodine holder is a separatory funnel A, which is fitted to the reaction flask D by a rubber stopper. Through this stopper also extends a glass tube E, in which the vapors pass upward and the excess of the distillate flows down. This tube leads into a larger tube F, the lower end of which is constricted to join a stopcock which leads into the top of the separatory funnel. To the upper end of tube F is attached an efficient reflux condenser H.


H
F
G
A
E
B
C
D

DETAILED DESCRIPTION OF APPARATUS

The cylindrical separatory funnel A is 1200 c.c. in volume and holds 2 kg. of loose iodine crystals. A funnel of a different volume may be used if such a one is not available. A piece of perforated platinum foil B, or a mat of coarse glass wool is put in the bottom to prevent clogging of the stopcock by iodine crystals or solid impurities. The stopcock C should be as large as 5 mm. in bore as a further precaution.

For the production of up to 4 kg. of alkyl iodide, a 5 liter, round bottom, short ring neck, pyrex flask D is used. For larger quantities a flask up to 12 liters in capacity may be substituted. The reaction flask is heated by an oil bath.

The tube E should be 2.5 cm. in diameter. This has been found sufficiently large to allow the vapors to rise without interrupting the return of the distillate. It is the same diameter as that recommended by Adams and Voorhees for the lower part of their special apparatus.

The tube F should be 4 cm. in diameter to allow for preliminary condensation. A space is left below the point where tube E enters to act as a reservoir for the distillate.

The stopcock G should be 2 or 3 mm. in bore. It was found convenient to use for this purpose the stopcock from a small, broken, separatory funnel. Funnels in this condition are usually all too common about the laboratory. The tube from this stopcock is connected to the top of the iodine container by a rubber stopper. The bottom of the tube is flush with the bottom of the stopper so that the liquid will flow down the sides of the container instead of forming a channel through the middle of the iodine. Not as much difficulty from this source is encountered when a cylindrical rather than a globular separatory funnel is used.

A condenser H is attached through a rubber stopper. It should be 2.5 cm. in diameter and, when making methyl iodide, at least 210 cm. long. The condenser should be well cooled with a strong stream of water. In hot weather especially there will be some loss of methyl iodide through the condenser. If to the top of the condenser is attached a tube leading under a slush of ice and water, this methyl iodide can be recovered. Of course the tube must have in it a trap—preferably a Bunsen valve—to prevent water from being drawn back into the apparatus.

THE PREPARATION OF METHYL IODIDE

Methyl iodide is the only one of the series prepared with this apparatus by the writer. The details of the method used are given here for the sake of completeness, though they are largely adapted from the directions given by Adams and Voorhees.

In the reaction flask put 1600 g. of absolute methyl alcohol, 200 g. of yellow phosphorus and 240 g. of red phosphorus. The absolute methyl alcohol can be conveniently prepared by adding magnesium turnings and a few crystals of mercuric chloride to the technical alcohol. After refluxing, distill using a good fractionating column. Any acetone present is reduced during the formation of magnesium alcoholate, and the alcoholate reacts with the water present. Fill the separatory funnel A with 2 kg. of iodine, being careful not to let crystals fall below the perforated platinum foil. Set up the rest of the apparatus and open both stopcocks C and G. Heat the oil bath to 100° C. At first alcohol distills, is condensed and flows back into the reaction flask through the iodine container. When the iodine solution begins to enter the flask, partly close stopcock G so that the reaction proceeds not too violently. After some methyl iodide is formed, it, being more volatile than the alcohol, acts as the solvent for the iodine. The temperature of the bath is then lowered to about 70-75° C. The flow through stopcock G at this point has to be further cut down because iodine is more soluble in methyl iodide than in methyl alcohol.

When all the iodine has been dissolved, close both stopcocks, with a rotary motion lower the separatory funnel and fill with a second charge of 2 kg. of iodine. Raise the separatory funnel to its former position. Open stopcock C wide, then stopcock G part way as before.

When all the iodine has reacted, allow the flask to cool. Then, instead of the special apparatus, attach a condenser arranged for downward distillation. The condenser previously used for refluxing is suitable for this purpose. The lower end is attached to an adapter dipping under a slush of ice and water. After the methyl iodide has all distilled over, wash once with water containing a little sodium hydroxide and separate. Care should be taken in disposing of the residues left in the flask after this distillation because they contain yellow phosphorus. Dry the crude product with anhydrous calcium chloride, separate and distill a second time. Unless special precautions are taken a loss of yield will result in this second distillation because of the high vapor pressure of methyl iodide. Very little material will escape if the following device is used. One end of a coil of glass tubing 2 mm. in diameter is attached to the end of the condenser. The coil is cooled in a freezing mixture. The other end of the coil is connected with a tube leading through a stopper into the collecting vessel also cooled in a freezing mixture. A Bunsen valve is inserted into the stopper of the collecting vessel to prevent the entrance of moisture from the air. One should obtain over 90 per cent of the theoretical yield based on the iodine used. In one run using all precaution against volatilization the yield was found to be 95 per cent.

Coregonus labradoricus, the Sault Whitefish, an Interesting Addition to the Freshwater Fish Fauna of Nova Scotia.—By Harry Piers, Curator of the Provincial Museum, Halifax, N. S.

(Read 14 May, 1924)

Up till now, no indigenous form of the genus *Coregonus*, or Whitefishes, of the family Salmonidae, has been reported from the waters of Nova Scotia.

Economic importance of the Whitefish.—The genus is of much economic value elsewhere in the northern part of North America, so that the occurrence here of any form of the genus is a matter of much interest, and would suggest that any such form might be successfully transplanted to other suitable localities in the province, where it might thrive, increase, and become a food-fish of considerable value.

About 1877, an effort was first made by the Fishery Department of the Dominion, to introduce into Nova Scotia the Common Whitefish, *Coregonuss clupeiformis* (Mitchell), of the Great Lakes, which has also been found as far east as New Brunswick. After several such attempts on the part of the Department, to introduce that species here, the effort utterly failed to be successful and probably not an example of the fish is now to be found in our waters.

Coregonus labradoricus of Richardson, the Sault Whitefish, occurs from Lake Winnipeg and the Great Lakes region, to the lakes of the Adirondacks and White Mountains, and northeastward to Quebec Province, Labrador, and New Brunswick. Dr. Philips Cox has found it in some of the lakes of the upper St. John River, New Brunswick. It is generally abundant, particularly at Sault Ste. Marie, between Lakes Superior and Huron, in cold, clear lakes and large streams. It is of good flavour and is valued as food, and reaches a length of 21 inches. It is a variable form, as most of the Whitefishes are, and possibly embraces several recognizable, but trival, varieties, dependent probably on the conditions as to food, water, etc.

The group to which it belongs is an extremly difficult one to diagnose, as there seems to be much intergradation, so-called species seeming to blend with other so-called species. Even *Coregonus labradoricus* is by some regarded as a mere variety of *C. clupeiformis*.

Specimens from Lunenburg Co., N. S.—On 9th May, 1923, S. Edgar March, C. E., of Bridgewater, N. S., took with hook and worm some fish in the swift water from the spillway of the dam at the outlet or eastern end of Millipsigate Lake, not far from the Micmac Gold Mines, near the headwaters of the Petite Riviere, $4\frac{3}{4}$ miles southwest of Bridgewater, in Lunenburg, County, N. S. The lake, which is situated 11 miles from the sea-coast, is about $1\frac{1}{2}$ mile long, and its waters pass into Hebb Lake which is of about the same size. Mr. March only knows of this one place where this species of fish is found, although he has been an angler for forty years and is familiar with the waters of the district. It is possible for it to reach the waters above, and as very small fry it might make its way below.

In order to give a clear idea of the location, it may be said that Manamki, Millipsigate, and Hebb Lakes form a chain, in the order named, connected by streams. They are controlled by the town of Bridgewater and are the source of its water-supply and electric-light system. At the foot of the lowermost or eastern lake, Hebb's, where the power-house is located, is now an 18 to 20 ft. concrete dam, with no fishway, which replaced an old wooden dam which was about 14 feet high. No fish can pass this point upward, and possibly only a very few may be able to go down during great freshets. Fish in this lake should, however, be able to pass up the stream and so into Millipsigate Lake by way of the gates in the dam at the foot of the latter lake, which open up from the bottom. One or two of these particular fish have also been taken in the stream below Minamki Lake.

Mr. March sent a specimen of the fish to the Provincial Museum (acc. no. 5225), which was readily identified as one of the Whitefishes, but owing to certain variations which it presented, it was considered unwise to attempt to determine the species to which it belonged, from a single example. Dr. Philip Cox, of Fredericton, N. B., to whom I also submitted the specimen for examination, was likewise not quite sure as to what form it was. A reference was made to it in the Report of the Museum for 1923, page 16.

On 5th May, 1924, Mr. March obtained two more specimens at the same place, which be forwarded to the Museum (acc. nos. 5454 and 5455). With these three specimens before us, it is now possible to determine the form as a variant of *Coregonus labradoricus* of Richardson, from which it differs mostly in possessing a high scale-formula for the lateral-line, and in seemingly lacking the teeth on the tongue. The supplemented bone of the superior maxillary is well defined, and is of the *Coregonus* type.

The colour of the back is bluish-black, with blue reflections; sides, silvery with blue reflections; belly, silvery with slight bluish reflections; gill covers, yellowish; sides punctated with black; dorsal fin, blackish with black punctations; lower fins, white with black punctations, the other two-thirds blackish; caudal blackish; iris yellow.

Comparative table of size, proportions, and formulae of fin-rays, scales, and gill-rakers:—

	Typical (Jordan and Evermann)	Millipsigate Lake, Lun. Co., N. S.		
		Acc. No. 5225	Acc. No. 5454	Acc. No. 5455
Total length	21ins.	10.30 ins.	11.25 ins.	10.60 ins.
Length to base of caudal	....	9.15 ins.	9.90 ins.	9.22 ins.
Weight	....	5 ozs.	$6\frac{1}{2}$ ozs.	$5\frac{1}{4}$ ozs.
Head in length	5	4.94	4.87	4.63
Depth in length	3 1-5 to 4	4.81	4.71	4.73
Maxillary in head	....	3.36	3.22	3.58
Eye in head	$4\frac{1}{4}$ to 5	4.60	4.95	4.93
Gill rakers in eye	2 to $2\frac{1}{2}$	2.35	2.00	2.00
1st Dorsal, number of rays	11 or 12	$11\frac{1}{3}$	$10\frac{1}{3}$	$10\frac{1}{3}$
Anal, number of rays	11 or 12	$12\frac{1}{3}$	11	11
Ventral, number of rays	....	12	11	12
Scales:				
Lateral line to 1st dorsal	10	9 or 10	11	11
Lateral line	71 to 76	Right, 100 Left, 101	Right, 100 Left, 103	Right, 97 Left, 98
Lateral line to vent	9	9	9	9
Gill rakers above angle	10	11(?)	10	10
Gill rakers below angle	15 or 16	16(?)	14 or 15	15
Back	Not elevated	Not elevated	Not elevated	Not elevated

We thus see that the only points of difference from the typical *C. labradoricus*, seem to be in the apparent lack of teeth on the tongue, and in having from 21 to 24 more scales in the lateral line than that species normally has—which is relatively a large increase in the number. It is, however, a species which is quite variable.

Habits.—Nothing is known of their habits here, except that it is said that they occur in schools.

Size and weight.—From Mr. March's personal knowledge, 18 inches is the greatest length they attain at Millipsigate. As usually caught, they vary from 7 to 16 inches. Of specimens measuring 10 or 11 inches, he has not seen more than half a dozen; and smaller than that, only one. In 1921 he weighed several taken from a more than usually successful catch and they ran from $1\frac{1}{4}$ to $1\frac{1}{2}$ pounds, but they have been taken as light as half a pound. The general proportions and form of the larger fish, are practically the same as those sent to the Museum—that is, the back is not elevated.

Flesh.—They are an excellent table fish. The flesh when cooked is about the same colour as that of a herring, but the bones are small and seem to be no more evident than those of a trout.

Mode of capture.—The three specimens which have been described were taken with a hook baited with a worm, but Mr. Marsh has taken them also with a small minnow, small artificial fly, and with tiny natural flies upon very small bait-hooks. The small artificial fly used was dull yellow and grey, with black body. The natural flies used had black or grey wings. The fish usually take bait a short way below the surface, in swift running water. The fly is taken from two to six inches above the water and occasionally on the surface. They are gamey fighters, and when hooked almost always leap from the water as a salmon does, and pursue the same tactics till exhausted. No great catches have been made.

(Provincial Museum, Halifax, N. S.)

Oxonium Compounds.—By D. McIntosh, M. A., D. Sc.,

Dalhousie University, Halifax, N. S.

(Read by title 14 May, 1924)

Two contributions to theoretical chemistry have stimulated greatly the interest taken in molecular [1] compounds. First, the views of Werner, expressed at length in his "Neuere Anschaungen auf den Gebiete der anorganischen Chemie," and the electron theory of valence (Thomson, Lewis and Langmuir). Amongst the compounds formed by the union of two well defined molecules, the oxonium group has undergone numerous investigations. Friedel, Collie and Tickle, and Baeyer and Williger have contributed to our knowledge of these complexes, and have shown that the ordinary view of the valency of oxygen as two must be modified, and that this number must be increased on occasions to four or even to six. This conception of quadrivalent oxygen, common to chemistry for the last twenty years, has been amplified by the electron theory of valency, so that many compounds whose constitutions were previously obscure, can now be represented graphically with, at least, some small degree of probability.

It appears that a little light is thrown on the mechanism of solution, catalysis, substitution and ionization by a study of these intermediate compounds. We stressed twenty years ago the view that in many instances ionization is preceded by chemical combination[2], a view which now has many adherents. Combination in solution is often indicated by the failure of Raoult's law, and is not infrequently a partial explanation for an apparent anomaly. For instance, water is insoluble in ether and in hydrobromic acid at low temperature, but is easily soluble in a mixture of the two, and from this solution a compound[3] of the three components can be isolated. Acetic acid forms no compound with alcohol, and the production of an ester takes place very slowly. But a compound is formed from alcohol, acetic and hydrobromic

1. See Pfeiffer. Organische Moleklüverbindungen. The only serious omission noticed in this book is that of the excellent and comprehensive work of G. Baume.

acid, the molecules are probably brought nearer together, and the chemical reaction takes place more rapidly. Acetic acid forms no compound with acetaldehyde and polymerization does not take place. Hydrochloric acid forms a compound, probably quite complex, and paraldehyde is rapidly produced. Hydriodic acid forms the complex

$$\begin{array}{ccc} & + & \\ CH_3 & :\underset{\cdot\cdot}{\overset{\cdot\cdot}{O}}:H & \bar{I} \\ & CH_3 & \end{array}$$

with ether, and alcohol and methyl iodide are produced on standing. Then the alcohol unites with the acid forming

$$\begin{array}{ccc} & + & \\ CH_3 & :\underset{\cdot\cdot}{\overset{\cdot\cdot}{O}}:H & \bar{I} \\ & H & \end{array}$$

and methyl iodide and water are the final product. The importance of these intermediate compounds has been recognized from the time Van't Hoff published his "Ansichten ueber organische Chemie," and has been emphasized by no one more forcefully than by Armstrong in his numerous articles. My interest in these oxonium compounds is largely with two simple classes, one containing the halogen hydrides, and the other the halogens, in combination with organic substances containing oxygen. I shall describe a few of these compounds isolated recently, and shall suggest possible formulae for typical members of both these groups.

These two classes differ in many respects. The halogen compounds show only a very small heat of formation, while the others evolve from fourteen to twenty thousand calories for each gram molecule. The halogen hydride complexes conduct the electric current in solution and are therefore dissociated; the halogen compounds are not ionized. The molecular conductivity increases with concentration[4], and this has formed

2. Walker, McIntosh and Archibald, Jour. Chem. Soc. 85, 1098 (1904).
3. Maass and Russel. Trans. Roy. Soc. (Canada) 13,259 (1919).

the starting point for a theory of complexes in solution. Finally, on electrolysis the organic molecule moves to the cathode, thus showing direct combination between it and the hydrogen of the acid.

On the electron theory of valence these compounds, can for the most part, be easily represented. For instance: C_4H_{10} O. HBr and C_4H_{10} O. 2 HBr can be written:

$$\begin{array}{lccccclc} & + & - & & & ++\,H & - & - \\ C_2H_5 & :\ddot{\underset{..}{O}}:H & Br & \text{and} & C_2H_5 & :\ddot{\underset{..}{O}}:H & Br & Br \\ & C_2H_5 & & & & C_2H_5 & & \end{array}$$

The hydrogen atoms share the electrons with the oxygen and give to the group a single or a double charge; the electrons from the hydrogen complete the bromine octets, which are, consequently, negatively charged. The bromine ion and the positively charged groups are held together by the electrostatic force. These two compounds were isolated many years ago.

It is well, I think, to emphasize the similarity between earlier formulae postulating quadrivalent or sexivalent oxygen and newer views. These compounds were previously written:

$$\begin{array}{c} C_2H_5 \\ C_2H_5 \end{array}\!\!>\!O\!<\!\!\begin{array}{c} H \\ Br \end{array} \quad \text{and} \quad \begin{array}{c} C_2H_5 \\ C_2H_5 \end{array}\!\!>\!\begin{array}{c} H \\ O \\ Br \end{array}\!\!<\!\!\begin{array}{c} Br \\ H \end{array}$$

and in solution:

$$\begin{array}{c} C_2H_5 \\ C_2H_5 \end{array}\!\!\overset{+}{>}O-H \quad \overset{-}{Br} \quad \& \quad \begin{array}{ccccc} & ++ & & & \\ C_2H_5 & H & & - & - \\ & O- & & Br & Br \\ C_2H_5 & H & & & \end{array}$$

In an analogous manner the graphical formulae of the alcohol, ketone, and ester complexes may be written without any extension of the octet theory. Even the electrons in the rather involved compounds $(CH_3\ COO\ C_2H_5)_2$ 5 H Br can be satisfactorily grouped. The compounds[5] mentioned by Lowry as

4. Steele, McIntosh and Archibald, Phil. Trans. (A) 205,99, (1905).
5. Jour. Chem. Soc. Industry, 43.218. (1924).

"disturbing" must differ from those just described since liquefied hydrogen chloride has a low Eotvos constant[6], and is presumably, associated. If Lewis' views on the sharing of two electron pairs by hydrogen be accepted this difficulty disappears.

$$\begin{array}{cccccccc} & \mathrm{H} & + & + & & & - & - \\ \mathrm{CH_3} & :\ddot{\underset{\cdot\cdot}{\mathrm{O}}}: & \mathrm{H:} & \mathrm{Cl} & : & \mathrm{H} & \mathrm{Cl} & \mathrm{Cl} \\ & \mathrm{CH_3} & & & & & & \end{array}$$

Compounds with the Halogens

Comparatively few of these compounds have been made, but our investigations[7] have shown no exceptions to the following rules for saturated[8], aliphatic molecules:

1. A mono-acid alcohol unites with one halogen atom.
2. A ketone or an ether unites with two[9].
3. An ethereal salt (an acetate) unites with three halogen atoms.

The ketone complex can have the constitution

$$\begin{array}{cccc} & \mathrm{CH_3} & & \\ \mathrm{CH_3} & :\ddot{\underset{\cdot\cdot}{\mathrm{C}}} & :\ddot{\underset{\cdot\cdot}{\mathrm{O}}}: & \mathrm{Br} \\ & & \mathrm{Br} & \end{array}$$

and calls for no further comment.

The oxides present more difficulty. Lewis suggests the formula

$$\begin{array}{cccc} & + & - & \\ \mathrm{C_2\ H_5} & :\ddot{\underset{\cdot\cdot}{\mathrm{O}}}: & \mathrm{Br} & \mathrm{Br} \\ & \mathrm{C_2H_5} & & \end{array}$$

since Plotnikof has shown that a solution of ether in bromine conducts the electric current.

6. Steele, McIntosh and Archibald, loc. cit.
7. McIntosh, Jour. Chem. Soc., 85.919. (1905).
8. I except Schutzenburger's compound, $C_4H_{10}O\ Br_3$ which always contains a large amount of acid.
9. With ethylene oxide. See Maass and Boomer, Jour. Am. Chem. Soc. 44.1709 (1922).

We have shown[10] that an ether-bromine mixture even when made at a comparatively low temperature and with the greatest care always contains hydrobromic acid, and we ascribed the conduction to the acid. Plotnikof replied to this with perhaps more heat than the question merited. However, the analogous compound with chlorine shows no conduction[11], and for this reason I look on Lewis' formula as incorrect.

Substances such as hydrogen flouride, the alcohols, water, acetic acid, etc., which show association in the liquid or gaseous state have, according to Lewis, a di-valent hydrogen atom. Water can be represented as:

$$\begin{array}{l} \;\;\mathrm{H} \\ :\underset{\cdot\cdot}{\overset{\cdot\cdot}{\mathrm{O}}}:\mathrm{H}:\underset{\cdot\cdot}{\overset{\cdot\cdot}{\mathrm{O}}}: - - - - \\ \;\;\mathrm{H} \quad \mathrm{H} \end{array}$$

If we accept this view—and of its convenience there can be no doubt—we may write for the ether-bromine and the alchol-bromine compounds the formula:

$$\begin{array}{c} C_2H_5\ :\underset{\cdot\cdot}{\overset{\cdot\cdot}{\mathrm{O}}}:\ \mathrm{Br} \\ \mathrm{H{-}C{-}H}:\ \mathrm{Br} \\ CH_3 \end{array} \quad \text{and} \quad \begin{array}{l} C_2H_5\ :\underset{\cdot\cdot}{\overset{\cdot\cdot}{\mathrm{O}}}: \\ \qquad\;\; \mathrm{H} \\ C_2H_5\ :\underset{\cdot\cdot}{\overset{\cdot\cdot}{\mathrm{O}}}:\ \mathrm{Br} \\ \qquad\;\; \mathrm{H}:\ \mathrm{Br} \end{array}$$

and perhaps a better view of the substitution of bromine in ether is indicated in this representation than in any other.

Further the unstable compounds containing a halogen or hydrobromic acid and toluene may be easily represented if we admit the possibility of a halogen atom being shared, but the pairing of the inactive hydrogen atom of a methyl group seems too great an assumption to make. It must be remembered that these very unstable addition compounds are formed only in the neighborhood of —90°C. Possibly the determination of the moleculer surface energy at low temperature might decide this point. Such a formula has the merit

10. Johnson and McIntosh ,Jour. Am. Chem. Soc., 31,1138 (1909).
11. Mennie and McIntosh, Trans. Roy. Soc. (Canada), 16,303. (1922).

that it indicates the easy substitution of chlorine or bromine; benezene gives no compounds with hydrobromic acid.[12]

Experimental

A few typical compounds have been made and analysed with the object of testing somewhat further the rules given for the combination of the halogens and organic substances. These complexes do not differ from those previously made. They melt at low temperatures, are formed with a slight heat evolution, and when substitution is prevented do not conduct. The methods employed have been given in previous papers.

Normal propyl alcohol. This hydroxide gives compounds with both the halogens. With bromine the solution is so viscid that it is impossible to trace the freezing point curve or to obtain the compound pure enough for even an approximate analysis. Chlorine gives a white, crystalline compound, melting below —80°C. The analysis show 35.3, 38.1 per cent. chlorine; propyl alcohol with one atom of chlorine contains 37.2 per cent. No compound could be made with iso-propyl alcohol.

Normal and isobutyl alcohols. No compounds were obtained, due perhaps, to the syrupy solutions. The halogens appear to act more quickly on the iso-alcohols at low temperatures than on the normals.

Methyl ethyl ketone. The chlorine compound contained 43.6, 45.9 per cent. halogen. Required for two halogen atoms, 49.7 per cent. The bromine complex melted at —32°. Found 65.4, 64.4 bromine. For two bromine atoms 69.0 per cent. is necessary.

Methyl acetate. The chlorine compound melts at —70°. It contained 58.0, 57.4 per cent. chlorine. CH_3 $COOCH_3$ 3Cl

Note.—I have said nothing of a new view—the group molecule. This conception seems to be of doubtful value as far as the oxonium compounds are concerned, but convenient and useful in a discussion of the combinations of the hydrocarbons.

12. Maass and Russel. loc. cit.

has 59.0 per cent. *Methyl acetate-bromine.* This substance was found to contain 77.3, 78.7 per cent. bromine; one with three bromine atoms requires 76.4 per cent.

Normal propyl acetate. The compound melted at —38°, and contained 67.7, 66.4 per cent. halogen. The tribrom acetate requires 70.2 per cent.

The chlorine addition product was made, but its melting point was so low that it was not analysed.

Isoamyl acetate. The chlorine compound contained 45.2, 43.1 per cent. For three atoms of chlorine 45.0 is required. The corresponding bromine substance could not be made.

It will be noticed that the difficulty in making the oxonium compound increases with the complexity of the organic component. Perhaps the mobility of the hydrogen atom is largely responsible for the existence of compounds such as HBr $4H_2O$, etc.

Substitution takes place quickly in acetoacetic ether even at a very low temperature. Knorr[13] has shown that in this ester the enol and keto forms are in equilibrium. Possibly compounds could be made from the keto isomeride.

Acetic anhydride. The 94 per cent. material was separated from acetic acid by cooling to a low temperature, and then fractionated repeatedly, the part distilling between 139° and 140° being retained. This had a density of 1.0753 at 20°/4° and froze at -72°. Walten and Withrow[14] give a freezing-point of −86° to this anhydride.

Apparently compounds were formed with both halogens. They were analysed, and the complete freezing point curves determined. But neither method fixed their exact compositions; for the maxima on the curves showed compounds containing three halogen atoms, while the analyses indicated only two. This point will be examined later.

13. B. B. 44,1138 (1911).
14. Jour. Am. Chem. Soc. 45,2690. (1923).

While some doubt exists of compound formation with the halogens, acetic anhydride readily unites with hydrobromic acid. Considerable heat is evolved when the anhydride is added to the liquefied acid, and the mixture is an excellent conductor of electricity. A white crystalline compound. (M.P.—5°) separates out, and shows on analysis 52.1 per cent. acid. It is probably:

$$\left\{\left.\begin{matrix} CH_3\ CO \\ CH_3\ Co \end{matrix}\right\rangle O\right\}_2 \quad 3\ H\ Br$$

which contains 54.3 per cent. This rather complex combination[15] is of the same type as certain compounds of the halogen hydrides with acetic acid.

DALHOUSIE UNIVERSITY,
MAY, 1924.

15. Jour. Am. Chem. Soc. 45, 28,538. (1906).

The Phenology of Nova Scotia, 1923.—By A. H. MacKay, LL.D., Halifax.

These observations were made by the school children of the Province of Nova Scotia as a part of the Nature Study work prescribed. The pupils report by bringing into the schoolroom the flowering or other specimens when first observed, for authoritative determination by the teacher, who generally credits the first finder by placing the name and the observation on the honor roll section of the blackboard for the day. The teacher, after testing the correctness of the observation, marks it on the schedule with which every teacher is provided—a copy of which is sent in to the Inspector with the school returns at the end of June and January.

The following tables are complied from 149 of the best schedules out of the 275 sent in. The selections were made and compiled under the direction of Miss M. G. McLeod and Miss Annimae Bill, of the Education Department.

The schedules for each year are carefully bound up in large annual volumes which are placed in the Provincial Museum and Science Library, where they can be used by students of climate, etc. The compilers of the phenochrons of the different belts, slopes or regions, have been rural science teachers who have most distinguished themselves as instructors. They were selected for the purpose on the recommendation of the Director of rural science education. The sheets from which the provincial phenochrons are calculated are also bound in annual folio volumes for ease of consultation and preservation.

The province is divided into its main climate slopes or regions not always coterminous with the boundaries of counties. Slopes, especially those to the coast, are subdivided into belts such as (a) the coast belt, (b) the low inland belt, and (c) the high inland belt, as follows:

No.	Regions or Slopes	Belts	
I.	Yarmouth and Digby Counties,	(a) Coast, (b) Low Inlands, (c) High Inlands.	
II.	Shelburne, Queens & Lunenburg Co's.		
III.	Annapolis and Kings Counties,	(a) South Mts., (b) Annapolis Valley, (c) Cornwallis Valley, (d) North Mts.	
IV.	Hants and Colchester Counties,	(a) Coast, (b) Low Inlands, (c) High Inlands	
V.	Halifax and Guysboro Counties,	"	"
VI.a.	Cobequid Slope (to the south),	"	"
VI.b.	Chignecto Slope (to the northwest),	"	"
VII.	Northumberland Straits Slope (to the north),	"	"
VIII.	Richmond & Cape Breton Co.'s	"	"
IX.	Bras d'Or Slope (to the southeast),	"	"
X.	Inverness Slope (to Gulf, N. W.),	"	"

The ten regions are indicated on the outline map

Compilation Instructions—Averaging Local Phenochrons For "Region" or "Belt" Phenochrons.

If ten or fewer good phenological observations schedules can be selected from those belonging to any given belt, they may be averaged as indicated in the columns within. If there are not ten from each belt, then it may be better to combine two belts, or if necessary, three belts on the form within. In the latter case the average will be the "region" phenochron. When a full sheet can be made out for each belt, the average of the phenochrons for the three "belts" will give the phenochrons for the "region." Finally, the phenochrons of each of the ten regions will be averaged to find the provincial phenochron for each phenomenon on the list. This will be done by the compiler-in-chief.

There is a convenience in averaging the dates of ten stations, which accounts for the ten columns for stations in the form within. When a few dates are not given it may be fair to enter in the blanks the dates from a similar and neighboring station which is not otherwise utilized for the sheet. Great care should be taken that such observations taken from a schedule not summarized, should be what might have been observed at the station indicated in the heading, and to indicate such a transference the date should be surrounded by a circle with the pen, which would always mean that the observation was not made in the station heading the column, but in a neighboring one, and was taken from a supernumerary schedule.

Thunder-Storms.—These dates will be entered in their respective columns and opposite the month indicated. They will not be averaged, of course. The number of observation schedules represented in any "region" or general sheet under this head should be noted somewhere on the top margin of the page.

Accuracy.—Care must be exercised in selecting schedules, the observations of which appear to have been carefully made, neglecting any which give reason for doubt, when selecting for summation on the form within. Great care must also be exercised in copying the figures and entering them, so that no slip may occur. Every entry should be checked. One slip may spoil the effect of all the accurate numbers entering into the summation. In like manner great care has to be taken in adding and averaging the figures, and for this purpose every sum should be done twice (once in reverse order,) so as to give absolute confidence in the accuracy of the work.

Remarks.—The compiler filling one of these blanks should keep one copy for himself while sending the other to the compiler-in-chief.

The set of stations on the right under "when becoming common," must be EXACTLY the same as on the left, under "when first seen." The compiler can enter explanatory remarks in the blank below, and should sign each sheet as a guarantee of its correctness. These sheets will be bound into a volume for each year.

THE PHENOLOGY OF NOVA SCOTIA 1923

(Compiled from the best 149 out of 275 local observation schedules.)

Year 1923

Day of the year corresponding to the last day of each month.

Jan.	31	July	212
Feb.	59	Aug.	243
March	90	Sept.	273
April	120	Oct.	304
May	151	Nov.	334
June	181	Dec.	365

For Leap Year add one to each, except January

When First Seen (Observation Stations)

1. Yarmouth & Digby Counties, N. S.	2. Shelb., Queens & Lunenburg Co., N. S.	3. Annapolis & Kings Counties, N. S.	4. Hants & Col. South of Cobequid Bay.	5. Halifax & Guysboro Counties, N. S.	6a. Cobequid Slope to South.	6b. Chignecto slope to North West	7. Northumberland Straits Slope	8. Richmond & Cape Breton Counties, N. S.	9. & 10. Bras D'Or & Inverness Slopes, N. S.	Average Dates	Year 1923
129	116	116	113	125	122	122	118	135	127	123	1. Alnus incana, Wild
	110	131	132	140	126	123	140	137	138	130	2. Populus tremuloides
106	109	111	111	129	125	118	119	125	131	118	3. Epigea repens, L.
125	122	128	125	142	128	131	130	133	139	130	4. Equisetum arvense
122	136	134	129	....	128	132	129	....		130	5. Sanguinaria Canadensis
127	127	132	130	136	129	131	133	137	138	132	6. Viola Blanda
128	132	134	135	141	132	134	136	142	146	136	7. Viola palmata, CUCULLATA.
130	....	134	137	....	....	....	....	....	....	133	8. Hepatica triloba, etc.
132	130	129	131	144	140	136	136	143	144	136	9. Acer rubrum
126	127	128	130	136	131	130	133	138	142	131	10. Fragaria Virginiana
165	163	164	170	175	165	168	171	173	181	167	11. Fragaria Virginiana, fruit ripe
135	133	137	136	142	138	136	139	144	145	139	12. Taraxacum officinale
121	145	151	137	169	131	141	134		176	145	13. Erythronium Americanum
126	134	142	140	143	114	138	137	141	143	136	14. Coptis trifolia
122			137	135	136	136	135	175	135	139	15. Claytonia Caroliniana
136	139	135	141	144	148	142	152	155	166	146	16. Nepeta Glechoma
139	140	140	141	158	150	141	144	152	157	146	17. Amelanchier Canadensis
148	....	....	....	....	....	....	....	183	....	165	18. Amelanchier Canadensis, fruit ripe.
146	145	145	150	167	152	148	150	156	159	152	19. Prunus Pennsylvanica
..		.		.		..		210	182	196	20. Prunus Pennsylvanica, fruit ripe
138	142	142	146	160	150	146	149	155	160	149	21. Vaccinium Can. and Penn.
....	....	....	....	232	....	....	....	230	220	227	22. Vaccinium Can. fruit ripe

When Becoming Common (Observation Stations)

Year 1923	Average Dates	1. Yarmouth & Digby Counties, N. S.	2. Shelb., Queens & Lunenburg Co., N. S.	3. Annapolis & Kings Counties, N. S.	4. Hants & Col. South of Cobequid Bay	5. Halifax & Guysboro Counties, N. S.	6a. Cobequid Slope to South.	6b. Chignecto Slope to North West.	7. Northumberland Straits Slope	8. Richmond & Cape Breton Counties, N. S.	9. & 10. Bras D'or & Inverness Slopes, N. S.
1. Alnus incana, Wild	126	124	118	122	119	129	128	129	122	132	132
2. Populus tremuloides	135		115	134	137	...	127	129	147	145	145
3. Epigea repens, L.	126	116	116	122	120	132	131	126	126	132	136
4. Equisetum arvense	135	130	129	131	129	144	132	134	134	140	144
5. Sanguinaria Canadensis	139		115	146	135	..	.	135	132	...	...
6. Viola Blanda	137	132	131	138	138	139	135	137	137	142	142
7. Viola palmata, CUCULLATA.	141	131	139	140	140	145	139	140	141	146	151
8. Hepatica triloba, etc.	141	....	.	141	141	....	.	....			
9. Acer rubrum	141	137	136	134	134	147	143	141	142	147	149
10. Fragaria Virginiana	139	133	134	135	139	138	141	138	140	146	148
11. Fragaria Virginiana, fruit ripe	175	170	174	172	178	178	175	177	176	180	..
12. Taraxacum officinale	142	140	140	142	143	145	126	146	143	148	149
13. Erythronium Americanum	152	....	149		141	175	136		138	....	176
14. Coptis trifolia	147	131	140	145	145	146	142	141	141	148	148
15. Claytonia Caroliniana	147	....			141	139	139	144	139	186	140
16. Nepeta Glechoma	150	137	145	140	147	153	146	148	159	159	166
17. Amelanchier Canadensis	150	142	146	143	146	159	156	150	149	149	164
18. Amelanchier Canadensis, fruit ripe.	202	...	....	....	.	....	....	...	...	202	....
19. Prunus Pennsylvanica	157	149	160	150	154	167	158	144	153	162	168
20. Prunus Pennsylvanica, fruit ripe	202	....	..	..	.	....	.		.	219	185
21. Vaccinium Can. and Penn.	154	140	149	147	152	161	155	155	154	158	165
22. Vaccinium Can. fruit ripe	235	..	...	...	.	243		...	..	237	224

THE PHENOLOGY OF NOVA SCOTIA 1923 (CONTINUED)

Year 1923

Day of the year corresponding to the last day of each month.

Jan.	31	July	212
Feb.	59	Aug.	243
March	90	Sept.	273
April	120	Oct.	304
May	151	Nov.	334
June	181	Dec.	365

For Leap Year add one to each, except January

When First Seen — Observation Stations

Year 1923	Average Dates	1. Yarmouth & Digby Counties, N. S.	2. Shelb., Queens & Lunenburg Co., N. S.	3. Annapolis & Kings Counties, N. S.	4. Hants & Col. South of Cobequid Bay.	5. Halifax & Guysboro Counties, N. S.	6a. Cobequid Slope to South.	6b. Chignecto slope to North West	7. Northumberland Straits Slope	8. Richmond & Cape Breton Counties, N. S.	9. & 10. Bras D'Or & Inverness Slopes, N. S.
23. Ranunculus acris	147	149	153	153	161	156	153	153	166	162	155
24. R. Repens	146	151	159	165	....	163	157	161	156	....	157
25. Trill. erythrocarpum	142	144	143	144	157	142	141	152	158	...	147
26. Rhododendron Rhodora	143	143	143	151	162	149	148	149	156	....	149
27. Cornus Canadensis	144	147	148	151	163	156	152	155	158	163	154
28. Cornus Canadensis, fruit ripe	142	147	150	....	....	....	153	....	....	....	148
29. Trientalis Americana	142	148	145	144	156	149	148	154	156	158	150
30. Clintonia borealis	155	150	144	159	160	157	150	159	166	....	156
31. Calla palustris	....	154	....	151	....	....	149	160	167	....	156
32. Cypripedium acaule	160	154	154	162	177	149	158	163	160	127	156
33. Sisyrinchium angustifolivm	163	158	158	167	176	162	157	165	173	179	166
34. Linnaea borealis	166	162	161	165	168	160	163	173	162	170	166
35. Kalmia glauca	154	154	155	156	161	148	147	150	162	159	155
36. Kalmia angustifolium	151	162	159	164	163	148	132	154	159	173	156
37. Crataegus oxyacantha	....	164	156	157	176	174	....	166	170	...	166
38. Crataegus coccinea, etc	167	161	162	158	175	160	160	158	178		164
39. Iris versicolor	164	166	167	169	176	159	162	172	165	172	167
40. Chrysanthemum Leucanthemum	169	166	164	169	175	164	160	166	164	167	166
41. Nuphar advena	161	167	165	165	178	143	....	167	169	....	164
42. Rubus strigosus	163	162	165	164	164	155	156	160	159	140	159
43. Rubus strigosus, fruit ripe	....	169	166	....	214	....	....	....	191	197	187
44. Rhinanthus Crista-galli.	162	166	173	....	178	....	162	....	....	....	168

When Becoming Common — Observation Stations

Year 1923	Average Dates	1. Yarmouth & Digby Counties, N. S.	2. Shelb., Queens & Lunenburg Co., N. S.	3. Annapolis & Kings Counties, N. S.	4. Hants & Col. South of Cobequid Bay	5. Halifax & Guysboro Counties, N. S.	6a. Cobequid Slope to South.	6b. Chignecto Slope to North West.	7. Northumberland Straits Slope	8. Richmond & Cape Breton Counties, N. S.	9. & 10. Bras D'or & Inverness Slopes, N. S.
23. Ranunculus acris	162	156	154	158	161	165	164	160	159	170	171
24. R. Repens	162	157	156	163	171	.	167	158	166	160	...
25. Trill. erythrocarpum	150	147	149	148	147	153	144	146	155	162	....
26. Rhododendron Rhodora	153	146	149	149	156	162	157	152	155	156	....
27. Cornus Canadensis	159	149	155	151	156	164	158	157	161	164	170
28. Cornus Canadensis, fruit ripe	151	148	155	....	....	....	....	....	....	....	....
29. Trientalis Americana	156	147	155	152	151	160	155	153	156	162	167
30. Clintonia borealis	161	162	155	151	162	167	161	155	164	169	....
31. Calla palustris	159	....	158	....	153	....	.	....	169	163	.
32. Cypripedium acaule	160	166	159	161	167	....	154	160	168	166	133
33. Sisyrinchium angustifolivm	171	166	162	163	171	180	174	165	171	178	179
34. Linnaea borealis	170	...	166	164	169	173	165	161	177	172	176
35. Kalmia glauca	162	164	160	167	161	166	160	157	157	169	159
36. Kalmia angustifolium	162	155	165	164	167	167	157	143	160	164	178
37. Crataegus oxyacantha	169	....	·170	161	161	. .	180	...	169	173	....
38. Crataegus coccinea, etc	168	165	164	163	163	178	....	168	175	...	....
39. Iris versicolor	174	170	171	171	175	178	180	165	178	171	178
40. Chrysanthemum Leucanthemum	173	174	166	171	173	180	180	163	174	170	177
41. Nuphar advena	172	172	172	169	170	172	....	....	170	173	....
42. Rubus strigosus	163	170	167	174	169	160	166	151	164	166	144
43. Rubus strigosus, fruit ripe	196	....	178	170	....	232	....	....	....	200	204
44. Rhinanthus Crista-galli.	171	165	171	176	....	....	....	....	....	....	....

THE PHENOLOGY OF NOVA SCOTIA 1923 (CONTINUED)

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Jan.	31	July	212
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June	181	Dec.	365

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When First Seen — Observation Stations

Year 1923	1. Yarmouth & Digby Counties, N. S.	2. Shelb., Queens & Lunenburg Co., N. S.	3. Annapolis & Kings Counties, N. S.	4. Hants & Col. South of Cobequid Bay.	5. Halifax & Guysboro Counties, N. S.	6a. Cobequid Slope to South.	6b. Chignecto slope to North West	7. Northumberland Straits Slope	8. Richmond & Cape Breton Counties, N. S.	9. & 10. Bras D'Or & Inverness Slopes, N. S.	Average Dates
45. Rubus villosus	171	162	167	167	....	147	140	159	167	162	160
46. Rubus villosus, fruit ripe	....	178	....	....	246	...	...	...	243	...	223
47. Sarracenia purpurea	161	168	169	....	....	169	150	160	175	...	164
48. Brunella vulgaris	....	167	169	...	....	...	156	165	180	...	137
49. Rosa lucida	172	167	172	173	....	159	...	177	..	..	170
50. Leontodon autumnale	170	167	169	172	176	176	176	171	173	..	172
51. Linaria vulgaris	158	180	172	....	167	145	161	....	172	..	165
52. Trees appear green	135	134	142	137	150	141	134	139	142	151	140
53. Ribes rubrum (cultivated)	141	144	144	148	155	152	156	151	[illegible]	166	151
54. Ribes rubrum (fruit ripe)	145	....	....	...	199	...	...	.	183	..	172
55. R. nigrum (cultivated)	....	144	144	150	150	151	156	152	159	160	151
56. R. nigrum, fruit ripe	154	...	....	....	206	....	....	....	183	..	181
57. Prunus Cerasus	141	150	143	155	165	156	155	155	162	161	154
58. Prunus Cerasus, fruit ripe	....	....	....	....	....	....	...	....	185	...	185
59. Prunus domestica	146	151	149	156	176	163	158	155	168	171	159
60. Pyrus Malus	150	147	146	153	171	161	156	158	167	172	158
61. Syringa vulgaris	164	160	155	164	177	[illegible]	164	165	176	167	166
62 Trifolium repens	157	152	159	163	168	174	162	[illegible]	165	165	163
63. Trifolium pratense	153	152	154	161	173	166	164	....	167	164	162
64. Phleum pratensé	153	155	170	170	174	154	166	....	166	...	163
65. Solanum tuberosum	176	167	....	208	....	....	....	....	..	183	183
66. Ploughing first of season	117	118	125	130	129	131	130	133	127	131	127

When Becoming Common — Observation Stations

Year 1923	Average Dates	1. Yarmouth & Digby Counties, N. S.	2. Shelb., Queens & Lunenburg Co., N. S.	3. Annapolis & Kings Counties, N. S.	4. Hants & Col. South of Cobequid Bay	5. Halifax & Guysboro Counties, N. S.	6a. Cobequid Slope to South.	6b. Chignecto Slope to North West.	7. Northumberland Straits Slope	8. Richmond & Cape Breton Counties, N. S.	9. & 10. Bras D'or & Inverness Slopes, N. S.
45. Rubus villosus	169	177	167	174	171	.	....	150	164	179	169
46. Rubus villosus, fruit ripe	255	..		....	...	260	.	....	...	250	....
47. Sarracenia purpurea	172	167	174	174	....	....	171	....	..	178	....
48. Brunella vulgaris	17[illegible]		171	175	...	..	...	160	169	184	....
49. Rosa lucida	171	174	175	178	179		.	....	179	..	....
50. Leontodon autumnale	176	176	173	174	176	179	180	..	175	178	....
51. Linaria vulgaris	164	....	..	176	...	140	.	...	.	176	.
52. Trees appear green	150	145	142	151	147	161	150	152	144	152	157
53. Ribes rubrum (cultivated)	156	149	151	151	153	154	156	160	156	163	170
54. Ribes rubrum (fruit ripe)	184	149	..	..	..	216	...	....	..	189	...
55. R. nigrum (cultivated)	156	...	149	148	156	150	156	160	156	162	166
56. R. nigrum, fruit ripe	190	156	....	...	.	224	...	....	...	....	...
57. Prunus Cerasus	160	146	156	147	159	168	169	162	159	167	170
58. Prunus Cerasus, fruit ripe	222	...	....	....	....	....	....	....	....	222	...
59. Prunus domestica	163	152	156	152	160	174	164	....	161	173	178
60. Pyrus Malus	164	156	155	154	158	174	166	165	163	172	181
61. Syringa vulgaris	173	169	166	162	169	176	173	171	161	181	175
62 Trifolium repens	169	168	162	166	171	173	171	171	170	169	165
63. Trifolium pratense	168	158	160	166	167	175	171	172	175	171	169
64. Phleum pratensé	176	154	164	179	173	179	....	....	....	172	....
65. Solanum tuberosum	199	....	....	....	212	....	....	....	....	....	186
66. Ploughing first of season	135	122	128	134	139	139	139	139	142	137	1

THE PHENOLOGY OF NOVA SCOTIA 1923 (CONTINUED)

Year 1923

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When First Seen — Observation Stations

Year 1923	1. Yarmouth Digby & Counties, N. S.	2. Shelb., Queens & Lunenburg Co., N. S.	3. Annapolis & Kings Counties, N. S.	4. Hants & Col. South of Cobequid Bay.	5. Halifax & Guysboro Counties, N. S.	6a. Cobequid Slope to South.	6b. Chignecto slope to North West	7. Northumberland Straits Slope	8. Richmond & Cape Breton Counties, N. S.	9. & 10. Bras D'Or & Inverness Slopes, N. S.	Average Dates
67. Sowing	128	125	139	139	143	135	142	147	141	142	138
68. Potato-planting	127	132	141	141	136	143	143	146	135	134	137
69. Sheep-shearing	149	123	135	150	147	161	153	139	126	129	141
70. Hay-cutting	....	....	201	210	201	....	....	204	235	223	212
71. Grain-cutting	....	263	253	241	253	....	....	[illegible]	253	264	256
72. Potato-digging	263	285	244	258	281	....	....	295	265	289	272
73a Opening of rivers	72	108	97	101	117	151	96	100	116	116	107
73b Opening of lakes	107	124	....	105	123	121	....	113	123	123	117
74a Last snow to whiten ground	116	114	111	....	123	164	127	114	116	117	122
74b Last snow to fly in air	116	117	120	119	143	143	123	126	123	147	128
75a Last spring frost—hard	....	164	143	115	103	147	140	127	159	....	137
75b Last spring frost—hoar.	....	153	142	171	169	....	....	156	158	....	168
76a Water in streams—high	122	99	108	110	127	121	110	111	124	137	127
76b Water in streams—low	172	....	....	....	172	137	....	....	236	176	175
77a First autumn frost, hoar	....	305	279	....	264	....	....	275	272	272	278
77b First autumn frost, hard	331	296	....	....	....	....	....	....	311	....	312
78a First snow to fly in air	305	297	....	....	....	345	....	300	298	300	309
78b First snow to whiten ground	345	319	345	....	346	....	....	305	327	....	331
79a Closing of lakes	....	338	367	....	350	156	....	....	357	360	321
79b Closing of rivers	....	....	....	....	....	....	....	....	359	....	359
81a Wild ducks migrating, N.	96	84	113	98	117	103	95	102	99	97	99
81b Wild ducks migrating, S.	283	....	258	329	....	....	....	300	290	320	297

When Becoming Common — Observation Stations

Year 1923	Average Dates	1. Yarmouth & Digby Counties, N. S.	2. Shelb., Queens & Lunenburg Co., N. S.	3. Annapolis & Kings Counties, N. S.	4. Hants & Col. South of Cobequid Bay	5. Halifax & Guysboro Counties, N. S.	6a. Cobequid Slope to South.	6b. Chignecto Slope to North West.	7. Northumberland Straits Slope	8. Richmond & Cape Breton Counties, N. S.	9. & 10. Bras D'or & Inverness Slopes, N. S.
67. Sowing	146	144	134	147	144	147	146	153	153	147	....
68. Potato-planting	145	129	136	148	145	146	156	153	153	143	....
69. Sheep-shearing	147	149	135	139	154	156	140	168	155	131	....
70. Hay-cutting	224	....	....	....	219	211	....	....	....	240	226
71. Grain-cutting	259	....	....	....	241	265	....	....	....	263	267
72. Potato-digging	279	274	....	....	263	290	....	....	....	274	293
73a Opening of rivers	....	....	....	....	....	....	....	....	....	....	....
73b Opening of lakes	....	....	....	....	....	....	....	....	....	....	....
74a Last snow to whiten ground	....	....	....	....	....	....	....	....	....	....	....
74b Last snow to fly in air	....	....	....	....	....	....	....	....	....	....	....
75a Last spring frost—hard	....	....	....	....	....	....	....	....	....	....	....
75b Last spring frost—hoar.	....	....	....	....	....	....	....	....	....	....	....
76a Water in streams—high	....	....	....	....	....	....	....	....	....	....	....
76b Water in streams—low	....	....	....	....	....	....	....	....	....	....	....
77a First autumn frost, hoar	....	....	....	....	....	....	....	....	....	....	....
77b First autumn frost, hard	....	....	....	....	....	....	....	....	....	....	....
78a First snow to fly in air	....	....	....	....	....	....	....	....	....	....	....
78b First snow to whiten ground	....	....	....	....	....	....	....	....	....	....	....
79a Closing of lakes	....	....	....	....	....	....	....	....	....	....	....
79b Closing of rivers	....	....	....	....	....	....	....	....	....	....	....
81a Wild ducks migrating, N.	....	....	....	....	....	....	....	....	....	....	....
81b Wild ducks migrating, S.	....	....	....	....	....	....	....	....	....	....	....

THE PHENOLOGY OF NOVA SCOTIA 1922 (CONTINUED)

Yeav 1923

Day of the year corresponding to the last day of each month.

Jan.	31	July	212
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For Leap Year add one to each, except January.

When First Seen: 1. Yarmouth & Digby Counties, N. S.	2. Shelb., Queens & Lunenburg Co., N. S.	3. Annapolis & Kings Counties, N. S.	4. Hants & Col. South of Cobequid Bay.	5. Halifax & Guysboro Counties, N. S.	6a. Cobequid Slope to South.	6b. Chignecto slope to North West.	7. Northumberland Straits Slope.	8. Richmond & Cape Breton Counties, N. S.	9 & 10. Bras D'Or & Inverness Slopes, N. S.	Average Dates.	Species	When Becoming Common: Average Dates.	1. Yarmouth & Digby Counties, N. S.	2. Shelb., Queens & Lunenburg Co., N. S.	3. Annapolis & Kings Counties, N. S.	4. Hants & Col. South of Cobequid Bay.	5. Halifax & Guysboro Counties, N. S.	6a. Cobequid Slope to South.	6b. Chignecto Slope to North West.	7. Northumberland Straits Slope.	8. Richmond & Cape Breton Counties, N. S.	9 & 10. Bras D'Or & Inverness Slopes, N. S.
107	96	90	92	101	148	....	96	96	96	102	82a Wild geese migrating, N.	....	....	....	....	....	....	....	....	....	....	....
280	....	356	331	364	....	....	....	306	316	325	82b Wild geese migrating, S.	....	....	....	....	....	....	....	....	....	....	....
96	94	100	98	106	114	98	99	123	111	994	83. Melospiza fasciata, North	....	....	....	....	....	....	....	....	....	....	....
81	85	79	90	97	88	101	90	100	95	91	84. Turdus migratorius, North	....	....	....	....	....	....	....	....	....	....	....
113	72	92	98	93	95	100	101	102	100	97	85. Junco hiemalis, North	....	....	....	....	....	....	....	....	....	....	....
144	110	135	136	134	139	118	136	134	155	134	86. Actitis macularia, North	....	....	....	....	....	....	....	....	....	....	....
112	91	145	131	119	131	120	126	137	128	134	87. Sturnella magna, North	....	....	....	....	....	....	....	....	....	....	....
131	112	127	117	129	127	122	122	133	128	125	88. Ceryle Alcyon, North	....	....	....	....	....	....	....	....	....	....	....
...	116	134			120	130	128	162	128	131	89. Dendroeca coronata, North	....	....	....	....	....	....	....	....	....	....	....
132	137	135	145	143	130	131	147	148	....	138	90. D. aestiva, North	....	....	....	....	....	....	....	....	....	....	....
120	119	142	124	138	144	134	122	139	126	131	91. Zonotrichia alba, North	....	....	....	....	....	....	....	....	....	....	....
149	152	149	150	166	157	139	154	159	....	153	92. Trochilus colubris, North	....	....	....	....	....	....	....	....	....	....	....
..	136	138	138	141	146	136	141	136	..	139	93. Tyrannus Carolinensis, North	....	....	....	....	....	....	....	....	....	....	....
147	145	144	138	115	150	141	148	142	....	141	94. Dolychonyx oryzivorus, North	....	....	....	....	....	....	....	....	....	....	....
...	124	143	160	137	162	140	138	152	....	145	95. Spinis tristis, North	....	....	....	....	....	....	....	....	....	....	....
..	161	....	155	....	142	....	146	147	....	150	96. Setophaga ruticilla, North	....	....	....	....	....	....	....	....	....	....	....
142	96	164	141	....	154	147	136	....	....	140	97. Ampelis cedrorum, North	....	....	....	....	....	....	....	....	....	....	....
107	148	139	154	129	123	137	127	128	143	135	98. Chordeiles Virginianus	....	....	....	....	....	....	....	....	....	....	....
106	111	111	116	132	118	111	119	123	129	118	99. First piping of frogs	....	....	....	....	....	....	....	....	....	....	....
107	115	116	124	127	131	128	126	134	134	124	100. First appearance, snakes	....	....	....	....	....	....	....	....	....	....	....

THE LOCAL COMPILERS FOR EACH REGION, 1923.

Region No.		Region No.	
I.	Mrs. Russell Yeaton	VIa.	Miss Ruth K. Chisholm
II.	Miss A. M. Bill	VIb.	Mrs. D. B. Wright
III.	Miss Bertha H. Currie	VII.	Mrs. I. M. Fraser
IV.	Miss Ethel F. Pugh	VIII.	Miss Margaret O'Toole
V.	Miss Pearl Archibald	IX & X.	Mrs. J. J. LeBlanc

THE TEN PHEONOGICAL REGIONS OF NOVA SCOTIA.

THUNDERSTORMS—PHENOLOGICAL OBSERVATIONS, NOVA SCOTIA, 1923

The indices indicate the number of stations from which the Thunderstorms were reported on the day of the year specified.

OBSERVATION REGIONS

1. Yarmouth and Digby Counties, N. S.	2. Shelburne, Queens & Lunenburg Co., N. S.	3. Annapolis & Kings Counties, N. S.	4. Hants & Colchester So. of Cobequid Bay	5. Halifax & Guysboro Counties, N. S.	6a. Cobequid Slope to South	6b. Chignecto Slope to North West	7. Northumberland Straits Slope	8. Richmond & Cape Breton Co., N. S.	9. & 10. Bras D'Or & Inverness Slopes, N.S.	Year 1923
	63									63^{2}
		99^{2}								99^{2}
		100								100
				110						110
111^{2}					111		111^{2}			111^{5}
	112^{2}			112^{2}						112^{4}
				117						117
									123	123
136							136			136^{2}
		137^{4}	137				137			137^{6}
	141^{3}									141^{3}
	142									142
								143		143
					144					144
146	146		146		146		146^{2}			146^{6}
							152			152
					154					154
155			155							155^{2}
		156	156^{2}	156^{3}	156^{4}		156^{16}	156^{14}	156	156^{41}
									158	158
160	160^{2}			160^{2}						160^{5}
									165	165
								167		167
								169		169
								170^{4}	170	170^{5}
								171^{9}	171	171^{10}
	172			172^{2}				172^{4}	172	172^{8}
	176							176		176^{2}
177	177	177	177^{4}		177	177^{4}				177^{12}
178	178		178^{3}	178			178	178		178^{8}
	179			179^{2}			179	179		179^{5}
		180^{3}		180			180^{3}		180	180^{8}
256										256
271										271
328										328
340										340

TRANSACTIONS

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The Action of Aqueous Ammonia on Mercurous Chloride.—

By Harold S. King, Assistant Professor of Chemistry, Dalhousie University, Halifax, Nova Scotia.

(Read 8 December, 1924)

Mercurous chloride is turned grayish black by the action of aqueous ammonia. This is the standard method used in the qualitative analysis of mercury in the mercurous state. Though the test is extremely easy to carry out in the laboratory, theoretically it presents many intricate and scientifically interesting problems.

Before we can assign an equation to the reaction, we must consider the empirical formula for mercurous chloride. The structural formula is necessary for a more thorough consideration of the mechanism of the reaction.

It has long been known that mercurous chloride contains one atom of chlorine for each atom of mercury. The molecular weight of the compound, however, is a point of dispute. Many chemists support the view that the molecule is HgCl, analogous to cuprous chloride; while others consider that there are substantial data in favor of the formula Hg_2Cl_2.

Since mercurous chloride passes into the vapor phase below 400°C., it is natural to suppose that vapor density determinations would give a definite answer to support one view or the other[1]. At 518° the vapor density is 235.5 ($O_2=32$). This seems to indicate that the formula HgCl is correct. But it has been suggested that, if the dimolecular form were to dissociate in the gaseous state into metallic mercury and mercuric chloride, $Hg_2Cl_2 = Hg + HgCl_2$, then the vapor density of the resulting mixture should be $\frac{1}{2}(200+270.9)=235.5$, or the same as found by experiment. This possibility led to many experiments designed to prove the presence of free mercury in the vapor[2]. Though these experiments indicated that some dissociation took place, for the most part they failed to give any idea of the extent. A. Smith and A. W. C. Menzies[3], however, concluded from their work on the vapor pressure of calomel that neither HgCl nor Hg_2Cl_2 was present in the vapor. The case seems to be analogous to that of ammonium chloride. Ordinarily, ammonium chloride dissociates on volatilization to give a gaseous mixture of ammonia and hydrogen chloride. But if the ammonium chloride be dried with extreme care before heating, then the dissociation does not take place. H. B. Baker[4] has obtained results with very dry mercurous chloride indicating that the molecules in this condition exist in the gaseous form chiefly as Hg_2Cl_2 but dissociate in the presence of a trace of moisture to Hg and $HgCl_2$.

A. Smith and A. W. C. Menzies[3] found that mercurous chloride, dissolved in mercury, lowered the vapor pressure of the mercury to an extent equal to the lowering calculated on the assumption that the molecule of calomel is HgCl. On the other hand, E. Beckmann[5] obtained the molecular weight corresponding to Hg_2Cl_2 by the freezing point method, using either mercuric chloride or anthraquinone as the solvent. Similarly, he obtained the formulae Hg_2Br_2 and Hg_2I_2 by noting the effect of these halides on the freezing points of the corresponding mercuric halides.

From the point of view of the modern theories of atomic structure, it is hard to conceive of the molecule HgCl existing to any extent at ordinary temperatures. According to C. R. Bury[6], the electron structure for mercury is 2.8.18.32.18.2. It is easy to see that an atom of such a structure would lose two electrons readily to chlorine for instance. But to lose only one electron ought to leave a very unstable and extremely reactive substance. The case is in no wise analogous to that of copper. Here, according to the same hypothesis, the two forms have different electron structures;—2.8.18 for the cuprous ion and 2.8.17 for the cupric. From the above electron structure for mercury, one would predict, *a priori*, that if mercury could exist with any valence other than two, the trivalent would be more stable than the monovalent form.

The evidence is so much in favor of the formula Hg_2Cl_2 for mercurous chloride, that in this paper it will be used in preference to the simpler form.

The next point to consider is how these four atoms may be combined in the molecule. The structural formula for Hg_2Cl_2 is universally represented as Cl–Hg–Hg-Cl. This might be written according to the Lewis-Langmuir hypothesis as :Cl:Hg:Hg:Cl: where each chlorine has completed its octet leaving the two mercury atoms held together by a single electron pair. However a radically different structure explains the properties of mercurous chloride more satisfactorily It is well known that mercuric compounds easily form complex ions such as $HgCl_4^{=}$, $HgI_4^{=}$, etc. It seems that the mercuric ion is capable of attracting to itself four groups. By sharing an electron pair with each of these groups, it completes an additional octet about the mercury kernel. When chlorine acts on an excess of metallic mercury, the primary reaction is probably $Hg+Cl_2=HgCl_2$[7]. Then the mercuric chloride reacts with metallic mercury to give mercurous chloride: $HgCl_2+Hg=Hg_2Cl_2$. It is quite possible that the atom of metallic mercury first loses its two valence electrons to the mercuric chloride molecule and then shares an additional pair of electrons from the outer shell of its kernel to give a compound containing a mercury ion surrounded by an additional octet as in

$$\begin{array}{l} \mathrm{Hg{:}\overset{\cdot\cdot}{\underset{\cdot\cdot}{Hg}}{:}Cl} \\ \qquad\mathrm{Cl} \end{array}$$

which can be represented by the non-electronic formula $Hg=HgCl_2$. This structure is substantiated by the fact that calomel dissociates so easily. If mercurous chloride be exposed to light, it soon turns dark due to the formation of free mercury. It is a common phenomenon for light to loosen electrons in compounds. Kinetic vibration also tends to break down the molecule. But heat alone is not sufficient; at least a trace of water must be present to catalyze the dissociation. The action of water is possibly that of making the unshared electron pair in the additional octet about one of the mercury atoms more mobile so that it can migrate to the other mercury with the formation of the metal.

This type of structure may be applied to other mercurous compounds than the halides. Mercurous nitrate is $Hg_2(NO_3)_2 .2H_2O$, which might be represented as mercuro diaquo mercuric nitrate or $[Hg=Hg(H_2O)_2] (NO_3)_2$. According to this structure, the nitrate ions are not held in the complex, but are free to ionize in solution. The great solubility of mercurous nitrate in contrast to the insolubility of the halides is thus accounted for.

From the isotopic point of view mercurous chloride is very complex. F. W. Aston[8] has shown that mercury is a mixture of isotopes. By the mass spectrograph method, he obtained a band from mass number 197 to 200 probably including isotopes for each unit within this range, in addition to lines at mass numbers 202 and 204. That is, mercury may consist of a mixture of six isotopes of mass numbers 197, 198, 199, 200, 202 and 204. He also found chlorine to be a mixture of two isotopes with mass numbers 35 and 37. If the structure of mercurous chloride is $Hg=HgCl_2$, then 108 isotopic isomers are possible.

We are now in a position to consider the reaction between mercurous chloride and aqueous ammonia. This is best expressed by the equation

$$Hg_2Cl_2+2NH_3=Hg+HgNH_2Cl+NH_4Cl.$$

The formation of metallic mercury as one of the products of the reaction has not been universally accepted. R. J. Kane[9] believed that Hg_2NH_2Cl was formed instead of mercury and infusible white precipitate. This view has persisted in many text books to the present day. Therefore the most important question to settle concerning the reaction is whether or not metallic mercury is formed. C. Barfoed[10] exposed the dry precipitate to the air and found that about half of the mercury volatilized on standing, leaving a residue much lighter in color than the original precipitate. This residue was identical with the infusible white precipitate formed by the reaction between mercuric chloride and aqueous ammonia. H. Saha and K. N. Choudhuri[11] found that infusible white precipitate was soluble in concentrated aqueous ammonia. When the precipitate obtained by the action of ammonia on calomel was extracted with this solvent, infusible white precipitate was found to go into solution leaving a residue of metallic mercury. J. G. F. Druce[12] found that the precipitate would not amalgamate metallic copper, and at first announced that this was proof that metallic mercury could not be present, but later he reversed his opinion.

It seemed to me that these proofs, especially the second, were not rigid, because of the possibility of secondary reactions. Therefore a purely physical proof was devised, which depended on the difference in density between mercury and infusible white precipitate. The freshly prepared precipitate was thoroughly mixed with cold glycerine. The mixture was floated on a layer of glycerine in a test tube and whizzed in a centrifuge. The mercury settled out faster than the infusible white precipitate so that the part that was thrown out last was very perceptibly lighter in color, being nearly white. The part that settled out first gave a residue of free mercury on treatment with hydrochloric acid, while the white precipitate was dissolved without residue by the same reagent. The use of cold glycerine as a suspending medium was necessary to prevent too rapid deposition. There does not seem to be any possibility for secondary reactions in this method, so it can be taken as proved that the precipitate formed by the action of aqueous ammonia on mercurous chloride is not a simple substance but a mixture with metallic mercury as one of the components.

The next point for examination is the mechanism for the formation of the mercury. It has already been pointed out that there is an equilibrium between mercurous chloride on the one hand and metallic mercury plus mercuric chloride on the other. $Hg = HgCl_2 \rightleftarrows Hg + HgCl_2$. This equilibrium may be expressed according to the law of mass action as

$$\frac{[Hg]\quad[HgCl_2]}{[Hg = Hg\,Cl_2]} = K.$$

Any secondary reaction that will lower the concentration of mercuric chloride will cause further dissociation of the mercurous chloride until a new point of equilibrium will have been reached. The addition of soluble chlorides such as NH_4Cl or NaCl with the formation of $M_2[HgCl_4]$ has this effect to some extent[13]. Ammonia reacts very completely with mercuric chloride to form infusible white precipitate, which is very insoluble. Therefore when aqua ammonia is added to calomel, it reacts with the small concentration of mercuric chloride in equilibrium with the calomel. More of the calomel then dissociates, and, if there is sufficient ammonia present, the reaction proceeds to completion. When the materials are thoroughly dried, the reaction with ammonia is slowed down very considerably if not prevented entirely[14]. This is probably due to the fact that the presence of water is necessary for the formation of mercuric chloride which, evidently, must be present before the reaction with ammonia takes place.

Another fact pointing to the dissociation of mercurous chloride preliminary to the reaction with ammonia is that one product formed, namely infusible white precipitate, is identical with that produced by the action of ammonia on mercuric chloride. This last reaction may be expressed by the equation $HgCl_2 + 2NH_3 = HgNH_2Cl + NH_4Cl$, but it probably takes place with a number of intermediate steps.

An attempt to determine the structural formula of infusible white precipitate is rather futile so long as its molecular weight is not known. Nevertheless, many such attempts have been made. A provisional formula is often an aid to further work and, for this purpose, that of R. J. Kane[15] and E. C. Franklin[16] is most suitable. Franklin has been able to assign structures in agreement with the empirical formulae to a very large number of ammonia mercury compounds by assuming that they are more or less complex derivatives of the hypothetical HO–Hg–NH_2. In this system, infusible white precipitate is the chloride of the above base, i. e., Cl–Hg–NH_2. This formula has the advantage of fitting into a scheme consistent with a large group otherwise difficult to account for.

Franklin's formula expresses the chemical properties of the compound sufficiently well. For instance it is readily acted upon by hydrochloric acid with the formation of mercuric and ammonium chlorides. Moreover all its nitrogen is liberated as ammonia when treated with potassium hydroxide. Amido-mercuric chloride, as we may now call it, reacts with ammonium chloride to give fusible white precipitate. This substance is generally considered as being $HgCl_2.2NH_3$, that is, mercuric chloride with two molecules of ammonia of crystallization. It would be better to represent the two ammonia molecules as sharing their free electron pairs with the mercury to give

$$\begin{array}{c} Cl \\ H_3N{:}\ddot{Hg}{:}NH_3. \\ Cl \end{array}$$

Here we have an additional octet formed about the mercury as in $HgCl_4^{=}$ or Hg = $HgCl_2$. The reaction is reversible because in the presence of aqua ammonia, fusible white precipitate or dichloro diammine mercury, loses ammonium chloride with the formation of amido-mercuric chloride:

$$Cl—Hg—NH_2 + NH_4^+ + Cl^- \rightleftarrows Cl_2 = Hg = (NH_3)_2.$$

This reaction therefore supports the view that the mercury in amido-mercuric chloride is not surrounded by an additional octet, at least not by a stable one. Actually the molecule may be some polymerization product, because the simple formula does not account for the infusibility of the compound.

It has been suggested that the formation of infusible white precipitate proceeds through the intermediate formation of dichloro diammine mercury

$$HgCl_2 + 2NH_3 = Cl_2Hg(NH_3)_2$$

$$Cl_2Hg(NH_3)_2 \rightleftarrows Cl{-}Hg{-}NH_2 + NH_4Cl$$

J. G. F. Druce[12] has proved that one molecule of ammonium chloride is formed in the reaction, but he gives the intermediate steps as follows:—

$$HgCl_2 + NH_4OH = Cl{-}Hg{-}NH_2 + HCl + H_2O$$

$$HCl + NH_4OH = NH_4Cl + H_2O.$$

The best mechanism probably is that the reaction proceeds as with organic chlorine derivatives:

$$Cl{-}Hg{-}Cl + NH_3 = Cl{-}Hg{-}NH_3^+ + Cl^-$$

$$Cl{-}Hg{-}NH_3^+ + NH_3 = Cl{-}Hg{-}NH_2 + NH^+$$

according to the analogy

$$R{-}Cl + NH_3 = R{-}NH_3^+ + Cl^-$$

$$R{-}NH_3^+ + NH_3 = R{-}NH_2 + NH_4^+$$

In both these reactions, before substitution takes place, there may be some feeble addition compound formed between the chlorine and the ammonia.

The action of aqueous ammonia on mercurous chloride may be summarized by the following series of equations which represent what seem to be the most probable steps in the reaction.

$$Hg = HgCl_2 \rightleftarrows Hg + HgCl_2$$

$$HgCl_2 + NH_3 = Cl{-}Hg{-}NH_3^+ + Cl^-$$

$$Cl{-}Hg{-}NH_3^+ + NH_3 = Cl{-}Hg{-}NH_2 + NH_4^+$$

$$XCl{-}Hg{-}NH_2 = (Cl{-}Hg{-}NH_2)_x$$

This analysis of the reaction between aqueous ammonia and mercurous chloride was carried out as a part of a general investigation into the possibility of separating isotopes chemically. The point of interest was that mercurous chloride gave two different mercury derivatives in the reaction, namely metallic mercury and infusible white precipitate. If the old formula Cl—Hg—Hg—Cl for mercurous chloride were the true one, then on dissociation one of the mercury atoms would drop out of the molecule, presumably by thermal agitation, carrying the electron pair with it. On the assumption that the two mercury atoms differed in mass, one having the mass number 197 and the other 204, to take an extreme instance, a separation of isotopes would be accomplished, if there were any selective action. It was thought that by gravitational attraction the electron pair between the two mercury atoms would be somewhat more firmly held by the heavier mercury atom. In this case it would necessarily be the heavier mercury that formed the metal found as a product of the reaction. The effect of mass on the position or orbit of an outer electron has been proved by L. Aronberg, T. R. Merton and others[17] in the case of lead. Though it is very small, it is conceivable that it might exert a deciding factor in the dissociation, provided all other effects were equally balanced.

However we have arrived at the conclusion that mercurous chloride is not symmetrical in structure. If mercurous chloride is formed when chlorine acts on an excess of mercury to give as the primary product mercuric chloride which then adds an atom of mercury to form the compound $Hg=HgCl_2$, there seems to be no possibility of separating isotopes by this method. Such a separation would imply that the mercury had been added selectively, which is inconceivable. Moreover there is very little possibility of separating isotopes by this reaction even if the old form of structure for calomel be true. G. Hevesy and L. Zechmeister[18] have proved that in the case of lead there is a dynamic equilibrium existing between ions and electrons when the acetates of divalent and tetravalent lead are mixed. They dissolved the tetraacetate of radioactive lead in a solution of the diacetate of ordinary lead. After separating the two forms of lead, they found that the divalent had become radioactive while the tetravalent form had lost an equivalent part of its activity. In other words there must exist an equilibrium in which electrons migrate freely from one kind of lead ion to the other.

$$Pba^{++++} + PBb^{++} \rightleftarrows Pba^{++} + PbBb^{++++} .$$

If this is a typical example of a general principle, we should expect an analogous freedom of movement of electrons between metallic mercury and mercuric compounds. Therefore in the equilibrium $Hg_2Cl_2 \rightleftarrows Hg + HgCl_2$, no separation of isotopic forms would be expected.

In conclusion I wish to acknowledge my indebtedness to P. D. McLarren, M. D., C. M., for the loan of the centrifuge used in this investigation.

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Notes on the Occurrence and Control of the Trematode. *Gyrodactylus*, Ectoparasitic on *Fundulus*.—By James Nelson Gowanloch, B. A., B. Sc., Head of the Department of Zoology, Dalhousie University, Halifax, N. S.

(Read by Title 11 May, 1925)

It is the purpose of the present paper to record certain observations on the occurrence and control of the aberrant trematode *Gyrodactylus*.

Gyrodactylus is an eyeless, monogenetic trematode belonging to the family Gyrodactylidae (of which family it is the type genus) occurring as an ectoparasite on the gills, fins and body integument of fish. The animal is extraordinary in that the uterus usually contains sexually mature young which in turn contain another generation and this yet another generation so that as many as four successive generations may be distinguished at one time, one inside another, a situation that might well have been eagerly cited, had it been known at that time, by Charles Bonnet in support of the theory of "*emboitment.*"

During the progress of other work at the Atlantic Biological Station, St. Andrews, N. B., the writer noted the presence of *Gyrodactylus* as a parasite on *Fundulus heteroclitus L*, and subsequently certain studies of the form were carried out with especial reference to the effect it produced on the host fish, the susceptibilities of the parasite to control measures available in the treatment of the host and choice of host exhibited when various species of fish were made available. It should, perhaps, be pointed out that *Gyrodactylus* constitutes at times a very serious hatchery problem and measures for its control are therefore of considerable practical interest.

When first noted *Gyrodactylus* was observed to occur frequently on the fins of *Fundulus heteroclitus*. It was found that when these fish were held in aquaria supplied with abundant running sea-water and well fed with *Venus mercenaria* the trematodes multiplied with such rapidity that they most seriously affected the hosts and indeed frequently caused death. When an example of these heavily infected hosts is studied it is found to exhibit whitish areas on the fins, around the mouth and around the eyes which areas, on microscopical examination, resolve themselves into masses of closely adjacent, extremely active *Gyrodactylus*. From two hundred and fifty to six hundred of the parasites may be present on a single host. Fish suffering from infection to this extent can be recognized easily even on a hasty macroscopic examination since they present a characteristic picture of anaemia.

The *Gyrodactylus* studied does not accord with any of the available specific descriptions and the determination or morphological description of the species will therefore be left to form the subject of a subsequent account. On the writer's return to Halifax *Fundulus* collected from various marshes within thirty miles of Halifax were searched and were found to be frequently and sometimes heavily infected with a *Gyrodactylus* evidently identical with the species noted in the Bay of Fundy.

Although not noted on any specimens of Sticklebacks (*Gasterosteus*) collected, *Gyrodactylus* was found to thrive on this host whenever *Gasterosteus* was placed in aquaria with infected *Fundulus*. Such parasitized *Gasterosteus* showed even more markedly than *Fundulus* the severe effects produced by the trematodes and almost without exception died. The flounder *Pseudopleuronectes americanus* proved to be immune to infection even when optimal conditions for the migration of the parasites to this host were provided. Careful examination of *Pseudopleuronectes* that had been confined with *Fundulus* carrying thousands of the parasites failed to show any infection and, furthermore, isolation of the flounders with numerous detached and hungry *Gyrodactylus* did not bring about parasitization of this fish.

An attempt was made to apply standard blood-counting methods to the more severely affected *Fundulus* in order to gain some exact measure of their abnormality but this was without success since the blood invariably coagulated before it could be diluted for spreading in the cell. The changes in blood were so evident and so profound that some measurement of the effects was desirable and a haemoglobin estimation of a series of heavily infected fish together with normal controls was made by means of a Dare haemoglobinometer. For the use of this instrument the writer is gratefully indebted to Professor J. J. R. Macleod. The results appear in the following table.

RESULTS OF HAEMOGLOBIN ESTIMATION OF BLOOD OF FUNDULUS HETEROCLITUS HEAVILY INFECTED WITH GYRODACTYLUS WITH A COMPARISON SERIES OF NORMAL FISH.

Serial Number	Sex	Length in cms. to base caudal fin	Condition	Haemoglobin Reading
No. 1	Female	4.7	Heavily infected	20%
No. 2	Male	4.2	Unusually heavy infection	15%
No. 3	Female	4.8	Very heavy infection. Fish seemed almost bloodless	5%
No. 4	Male	4.9	Unusually heavy infection	18%
No. 5	Female	4.5	Heavy infection	38%
No. 6	Male	4.2	Heavy infection	39%
No. 7	Male	4.1	Heavy infection	21%
No. 8	Male	Less than 4.	Heavy infection	51%
No. 9	Female	3.7	Heavy infection	32%
No. 10	Male	4.7	Normal	71%
No. 11	Male	5.1	Normal	62%
No. 12	Male	5.0	Normal	60%
No. 13	Female	5.2	Normal	71%
No. 14	Female	6.1	Normal	68%
No. 15	Female	6.5	Normal	54%
No. 16	Female	6.1	Normal	56%
No. 17	Female	3.2	Normal	82%
No. 18	Male	6.2	Normal	51%
No. 19	Male	4.7	Heavily infected	20%
No. 20	Female	4.8	Heavily infected	15%
No. 21	Male	4.8	Heavily infected	35%

AVERAGE OF HAEMOGLOBIN ESTIMATION FOR NINE NORMAL FISH 63.89%

AVERAGE FOR TWELVE HEAVILY INFECTED FISH 25.75%

The effect of lowered salinities in causing the migration or death of the parasites was observed by exposing heavily infected, adult *Fundulus* to a series of different media constituted as follows: (1) Normal sea water with a salinity of approximately 30 parts per mille; (2) Sea-water diluted to a salinity of 20; (3) Sea-water diluted to a salinity of 15; (4) Sea-water diluted to a salinity of 10; (5) Fresh water; (6) Distilled water. In each case the water was thoroughly aerated before use and *Fundulus* each bearing from 250 to 500 parasites were subjected to these conditions. It was found that within a half an hour all of the trematodes in distilled water and the majority in fresh water had either left their hosts or were dead but in the salinity of as low as ten parts per mille the Gyrodactylus remained attached to the host after seventy-two hours exposure. In higher salinities they appeared to carry on their normal activities. The host fish, usually hardy and unaffected by wide variations in salinity, appeared to suffer from diffuse haemorrhages over the surface of the fins when exposed to distilled or to tap water. However the trematodes were affected long before such results appeared in the hosts and as indicated an exposure of less than an hour in distilled water or of less than two hours in fresh water served to completely clear the host fish of trematodes.

Further observations of the effect of lowered salinities upon the activities and viability of *Gyrodactylus* were then carried out by the isolation of quantities of the trematodes in watch glasses containing either fresh water or distilled water, the accompanying controls of corresponding numbers being placed in normal sea-water. Without exception these control animals exhibited a normal behaviour throughout the entire course of the experiment. The results may be stated briefly. The trematodes subjected to the action of fresh water showed immediate and extreme distress. Within seven minutes many of the parasites had ceased movement and within fifteen minutes many were dead. In two and a quarter hours two-thirds were dead while at five hours all except two individuals had succumbed. These two exhibited feeble movements and survived only a short time. A repetition of the experiment afforded closely similar results. Distilled water killed many of the animals in six minutes and all were dead in twenty three minutes. Here also repetitions gave little deviation from these results. The control animals in normal sea-water were held for twenty-four hours and showed no effects of their detachment from the host other than an increase in motor activity undoubtedly due to hunger. The introduction of a little *Fundulus* blood into the watch-glasses after this period of starvation invariably caused them to become tremendously active in the most agitated and entertaining manner, as they would fling themselves end over end along the surfaces of the glass as if in deliberate search of a new host.

For the purpose of ascertaining the exact cause of death, whether due to the loss of blood or to introduced secondary infections of other organisms, a close examination was made of hosts which had succumbed to the effects of the parasites. The histological picture clearly showed that other organisms were not involved but that death was undoubtedly due to the direct loss of blood caused by the collective feeding activities of the great numbers of these minute trematodes, each of which, individually, could alone cause but trifling damage. The fins, lips and borders of the eye orbits were the regions on which the parasites were most numerous but when infection became heavy the *Gyrodactylus* occured over the whole external surface of the host including the scales and even the cornea of the eye. Their activity is most remarkable. The animals constantly shift from place to place and attach themselves by means of their two retractile cephalic lobes and their caudal disk which is powerfully armed with hooks. The host suffers the loss not merely of the blood upon which they feed but also the diffuse haemorrhages which drain from the innumerable, minute perforations that the parasites inflict. This is the direct cause of death.

Summary

1. Observations on the occurrence and activity of *Gyrodactylus*, a monogenetic trematode occurring as an ectoparasite on *Fundulus heteroclitus* in the Bay of Fundy and in the neighborhood of Halifax, N. S., are here reported.

2. *Gasterosteus* also serves as host but *Pseudopleuronectes americanus* proved not to be susceptible.

3. The trematodes remained apparently unaffected by a series of lowered salinities ranging down to ten parts in a thousand but exposure to the action of either fresh water or distilled water causes the rapid migration of the parasites from the hosts and their death.

4. The toxic action of tap water was found to be lethal in about five hours, that of distilled water lethal in about twenty minutes.

5. The haemoglobin of the parasitized fish was found to be reduced in some instances to less than one twelfth of the normal value, the average for the series examined giving a reading of only forty per cent of the value shown by normal fish.

6. The direct cause of death was found to be the loss of blood from the innumerable minute perforations which the parasites make during their feeding activities.

7. Treatment of affected fish with fresh-water is an evidently available means of destroying the parasites.

A Study of some of the reactions of the Whelk, *Buccinum undatum.*—By James Nelson Gowanloch, B. A., B. Sc., Head of the Department of Zoology, Dalhousie University, Halifax, N. S.

(Read by Title 11 May, 1925)

The study of the reactions of animals to stimuli affords an instructive method of analyzing the mechanism of those organism-environment relations by means of which the living animal apparently free to wander through a wide and varying range of conditions is nevertheless normally restricted to those parts of its environment affording it appropriate conditions of moisture or of aridity, of sunlight or of darkness and of food. Properly controlled experiments on the response to gradients of light, of hydrogen ion concentration or some such chosen factor, provide a means of roughly measuring the directive value of these environmental elements whose aggregate effects may constitute, in the absence of such analyses, a complex and puzzling behaviouristic picture.

There exist however in addition to these directive responses on the part of the animal removed from its normal habitat a set of what may be termed "protective responses" which operating in an animal that has been displaced into a dangerous environment serve to reduce these dangers of its abnormal situation and thus aid in tiding the organism over this hazardous period of exposure. Such for example is the "clumping reaction" of the land isopods *Porcellio rathkei* when removed to abnormally dry surroundings, and such is the sealing up of the operculum that is performed by gasteropods when they are exposed to excessive loss of moisture.

It is the purpose of this paper to set forth briefly the facts of a case remarkable for the entire absence of these usual protective responses; an instance where in their stead a behaviour occurs that not only increases greatly the physiological dangers of the animal's situation but also actually causes the early death of the exposed individual. The case is that of the Common Whelk *Buccinum undatum L* under conditions of inter-tidal exposure.

Buccinum undatum is a marine gastropod, attaining a length of about six centimetres and with a shell grayish in colour exhibiting six whorls. The species is distributed from low water mark to a depth of at least 100 fathoms over the Atlantic, Arctic and Pacific coasts from the Atlantic coasts of North America to the coasts of Siberia. In Europe where the species appears to attain a larger size than in our waters, it is extensively used both as food and as cod-bait. Omnivorous in diet, the Common Whelk crawls about on the substratum by means of its muscular foot and when confined to an aquarium it will sometimes climb a few centimetres up the glass sides. Along coasts with average tidal changes *Buccinum* approaches exposure only during the dead low water of the spring tides. Thus the individuals of the species are never exposed under normal conditions to the danger of death from loss of moisture during inter-tidal desiccation.

Such, however, is not the case in the Bay of Fundy where the remarkable differences in tidal level of from eight to ten metres lay bare at one period of the month an area of the littoral zone that at other periods of the month is completely and even deeply submerged. Under these conditions species that rarely if ever become completely exposed by tidal change will through normal dispersal spread during one period of the month into an area of the submerged sea-bottom that in the course of the tide-cycle will at the spring phase become exposed for hours to the sunlight while the tide is out. While carrying out work at the Atlantic Biological Station situated at St. Andrews, New Brunswick, the writer became interested in the responses of *Buccinum* to these unusual conditions imposed upon it by the Bay of Fundy tides. The results of a few preliminary experiments proved to be so unexpected and stood so apart from the usual behaviour of inter-tidal forms that a brief investigation was undertaken of the normal dispersal behaviour of the species and the behaviour of individuals during normal and experimental exposure to desiccation. Data secured by these diverse methods supported the view that we are here dealing with the interesting case of an organism compelled by unusual tidal conditions to meet with new and severe dangers and inasmuch as its phylogenetic history has not included exposure to such dangers, the species, responding with a set of reactions that are definitely deleterious and even fatal, perishes helplessly within a meter or two of conditions that would serve to shelter it until the tide again returns and the danger passes.

During other than the spring phases of tide *Buccinum undatum*, being a gastropod of more than ordinary motor activity becomes dispersed more and more in the shoreward direction together with such forms as the sea urchin, *Strongylocentrotus drobachiensis* and the starfish, *Asterias vulgaris*. When the tides pass into the spring phase and the amplitude of tidal change rapidly increases these shoreward migrants are suddenly thrust from conditions of continuous immersion in sea water at a temperature of eight degrees centigrade to conditions of daily exposure for hours to the summer sun.

To study the normal activity of *Buccinum* in this situation four series of animals aggregating 152 individuals were marked and released some at low tide level immediately following a spring tide, others at the upper limit of intertidal zone reached by *Buccinum* immediately after a spring tide. The methods of marking used were such that, as controls amply demonstrated, the animals were in every way physiologically normal. Subsequent careful searches were made for and records kept of these individuals. The results may be briefly summarized as follows. The released animals wandered in all directions there being no evidence of any shoreward or seaward directive influence. The rate of what may be termed "walking dispersal" varied greatly for individuals some of which remained near where they were liberated for as long as five weeks. There was an entire absence of any protective migration toward nearby areas offering optimal conditions of shelter. The most significant and unexpected result however occurred in the instance of the animals set free during spring tides at the upper level reached by *Buccinum*. Forty-eight hours later eighteen of the animals were recovered, eleven of which were dead. Since it was evident that their death was in no way due to experimental treatment, an examination of the normal, unmarked *Buccinum* present at this level was immediately made with the surprising result that it was found that nine-tenths of these animals were also dead. The explanation of this heavy mortality must lie, it was thought, in some unusual failure of *Buccinum* to conserve its water-content during exsiccation and an experimental examination of the animal's behaviour during intertidal exposure was undertaken accordingly.

Ten *Buccinum* ranging in weight from 8.25 grams to 41.17 grams were weighed and exposed in a dry paraffined tray suspended over a water table which was covered with flowing sea-water. These conditions thus reproduced very accurately those under which the animals would be exposed in nature during low water of a spring tide on a cloudy day. The animals were then weighed at intervals during the twenty-one hours and forty-five minutes that elapsed from the beginning of the period of exposure until the time when all the animals had died, there being seven successive weighings for each individual. The animals were then desiccated for three days in a drying oven and weighed again and subsequently a chosen group were macerated, the tissues other than the shell removed, the shells being again desiccated and weighed. From these data there was then calculated the rate of loss of water per hour in percentages of the initial total water content providing thus in exact terms the record of each individual's approach to the point where loss of water caused death. During the experiment the activities of the animals were constantly observed. The results may be concisely summarized as follows. When *Buccinum* is subjected to exsiccation it responds in a manner precisely the opposite from that exhibited by a gastropod such as *Littorina litorea*, a form occurring regularly far up into the zone of inter-tidal exposure. Instead of withdrawing into its shell and sealing up its operculum as does *Littorina*, *Buccinum* promptly extrudes its foot and head, exposes almost the maximum possible surface to the action of evaporation and, most disastrous of all, violently expels all fluids that it can with the obvious end result that the organism's water-reserve is speedily lost, its water content sinks swiftly to the danger point and, if desiccation continues, the animal dies.

Since this series provides a representative range in size of the normal *Buccinum* population the average of these figures should give a reliable picture of the water-loss of the animals. When this average is calculated it is found that the average rate of loss of water per hour expressed in terms of percentage of initial total water content is as follows: for the first hour and a third, 4.19 per cent per hour; from the end of the first hour and a third to the end of two and a half hours, 3.55 per cent per hour; from the end of two and a half hours to the end of four hours 1.48 per cent per hour; from the end of four hours to the end of six hours, 0.77 per cent per hour; from the end of six hours to the end of eight hours and forty-five minutes, 0.51 per cent per hour; from the end of eight hours and forty-five minutes to the end of twelve and a half hours, 0.23 per cent per hour; from the end of twelve and a half hours to the end of twenty-one hours and forty-five minutes, 0.24 per cent per hour. Thus it is easily seen that the animals begin the dessication period with a relatively enormous rate of water loss that brings their reserve sharply downward to the danger point. Thus on the average during the twenty-one hours and forty-five minutes of desiccation the animals lost 18.07 per cent of their initial total water content but when considered hour by hour this loss shows an extraordinary and significant crowding of that loss into the early period of exposure. Thus, considered in terms of percentages of the entire water loss sustained, the animals lost 29 per cent during the first hour and a third of desiccation, 55 per cent during the first three hours and no less than 65 per cent during the first four hours of the twenty-one hour period over which water loss was taking place. During the last sixteen hours of the twenty-one hours the loss is, in sharp contrast, being only 16 per cent of the total loss that intervenes between the beginning of the exposure and the death of the organism.

Calculations of the total water content of the animals in per cent of total weight exclusive of shell gave remarkably uniform results, the percentages for five individuals with total weights of 38.35, 8.25, 13.97, 16 5 and 36.07 grams each being 79 per cent, 81 per cent, 79 per cent, 82 per cent and 81 per cent respectively.

The interpretation of this curious piece of ecology is apparently quite simple. In its normal habitat *Buccinum* does not become an inter-tidal animal since its upper limit of distribution brings it only to the edge of the lowest low tides. In the Bay of Fundy the exceptional tidal conditions created by the converging coasts produce a tidal change so great that during the spring phase those individuals of Buccinum that have wandered shoreward find themselves suddenly transformed from animals continuously submerged deeply under the waters of an unusually cold bay into animals exposed for hours to the desiccating action of the sun. The reactions that this exposure evokes from them are the reactions fitted for their normal submerged existence. In the new dangers of the inter-tidal zone exposure this behaviouristic response is the most disastrous one possible and leads to the early death of the individuals unless they are soon covered again by the incoming tide. This elimination of the upper, shoreward fringe of the *Buccinum* population exerts no permanent modifying selective action upon the species as a whole for the quite sufficient reason that it affects only some of the animals of one sharply local region.

TRANSACTIONS

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Notes on An Esker in the Interior of Digby County, Nova Scotia.—By D. S. McIntosh, B. A., M. Sc., Professor of Geology, Dalhousie University, Halifax, N. S.

(Read 16 November, 1825)

The guides to the interior of Digby and Annapolis Counties are familiar with a peculiar surface feature—to them, a landmark. It is well known also to the hunters and trappers, and is termed "The turnpike." The description of it—like to a railway embankment or a turnpike road—seemed to the writer to suit well that of the glacial deposit known as an *esker*.

In the autumn of 1924, a visit was made to the locality. Mr. W. Spurr, of the "Colonial Arms" hotel served as efficient guide and companion. The short motor-ride along the Bear River hillside, amid scenery of wonderful beauty, to Bear River town, made a fitting beginning to the trip that promised much of interest and pleasure. A rough road was negotiated up the Bear River valley passing by Indian Path Hill, 625 feet above sea-level. Fourteen miles from "Colonial Arms" at the end of the car road, Lake Jolly lies spread before the observer at an altitude of 510 feet—*aneroid*. On the shore of the lake is the charred remains of what, a few years ago, was a clothes pin factory; and on the opposite side of the lake was later seen an old road *with wooden rails* by which timber had been conveyed through the woods. The water of the lake has been raised several feet by the dam built by the Bear River Light and Power Company, and the lower courses of streams entering the lake have been drowned. Here our luggage was transferred from the car to a canoe, and here began the "pleasure in the pathless woods" and the "rapture by the lonely shore;" and the additional pleasure of the stealthy movement of the canoe over the waters. A mile over the lake, then about the same distance along *stillwater* up a stream course, followed by a portage of about a quarter of a mile, and the canoe floats in Ninth Lake. The divide has been crossed, and the drainage basin of the Sissiboo River is around and before. The lakes that lie ahead on the route are small and the connecting streams have usually too little water to float even a canoe. A short paddle across Ninth Lake, a portage to Eighth Lake, the glide across the lake and along a rivulet of a hundred yards or so, and Seventh Lake is reached. Over Seventh Lake, followed by a portage of about a quarter of a mile to Sixth Lake, across this lake about a mile and a portage of about the same distance as last one and the canoe is placed in the Sixth Lake stream. Down this stream about a mile, the "turnpike," the object of the trip, lay extending to the east and to the west, broken where the stream has forced a passage through it.

The country around is level with knobs projecting out of the general flatness. The elevation is about 400 feet above sea level. Much of the immediate vicinity is a fire-barren with stunted second growth and bare patches where there is little or no soil. The underlying rock is granite—a portion of the granite belt of the southwestern part of the Province. Much glacial drift is spread over the area—huge granite boulders grading into finer material. The "turnpike" is undoubtedly *an esker.* It follows in a general way the direction of east, 10 degrees south, *Magnetic.* Where the stream has trenched it, the height is 25 feet the base about forty feet through and the top rounded, looking very much indeed like a railway embankment. The material is gravel. It forms a pronounced ridge across the landscape. It was followed eastward for more than two miles. It becomes low and narrow in places, and where the country is wet or swampy it may be absent, but is found again further to the east. Wild animals have made a path along the summit. To the west at the furthest point explored, it is lost in an enormous mass of angular granite boulders. Mr. Spurr states that the esker extends for twenty miles or so across the country, and that to the south there are two similar ridges that appear to join the main esker at an angle from about southwest.

The time spent in exploration and examination was not sufficient to arrive at anything of scientific interest except the location of the esker. It is hoped that an opportunity may be had to again visit the locality and find out something about the ice movement at this point and the cause of the presence here of this glacial deposit, and to visit the similar deposit that runs east from Hectanooga station towards Blue Mountains.

It was rather an unusual occurrence while in a wilderness country, to have an aeroplane pass and re-pass directly overhead. The return trip was uneventful, other than that the writer came within an ace of upsetting the canoe, and that the canoe ran upon a submerged boulder in the middle of a lake and remained fast for some minutes.

Notes on the Estimation of Potassium as Potassium Platinic Chloride. (Abstract). — By Margaret McCurdy B. Sc., Dalhousie University, Halifax, N. S.

(Read 14 December, 1925)

The separation of potassium from sodium and the subsequent estimation of the former by precipitation as the platinic chloride has ranked as a standard analytical process for many years.

According to the method in common use, sodium and potassium are first separated from all other constituents as chlorides. They are then converted into chlorplatinates by the addition of hydrochlorplatinic acid in presence of an excess of hydrochloric acid. The resulting solution is evaporated to dryness on a water bath and the residue treated with absolute alcohol. By these means, sodium platinic chloride is dissolved; the corresponding potassium salt being insoluble. The potassium chlorplatinate is then separated by filtration and finally dried to constant weight at a temperature not exceeding 100° C.

In any determination, drying to constant weight at a low temperature is to be avoided if possible, as it not only may introduce a considerable error, but undoubtedly increases the difficulty of manipulation.

It would be much simpler if it were possible to ignite the precipitate of potassium platinic chloride at a high temperature and from the weight of platinum obtained, calculate the amount of potassium present.

After a number of preliminary qualitative experiments, the following quantitative determinations were carried out.

Purified crystals of potassium platinic chloride were carefully dried and weighed and transferred to a weighed platinum crucible. The crucible and its contents were then ignited to the full heat of a Fisher-Meker burner until constant weight was obtained. The results were as follows:—

Wt. of K_2PtCl_6	0.6848	0.7890	0.3824	0.3758	0.3258	0.2584
Wt. of Platinum	0.2696	0.3180	0.1560	0.1496	0.1302	0.1034
Wt. Potassium from wt. of Platinum, (A)	0.1080	0.1274	0.0625	0.0599	0.0522	0.0414
Original Wt. of Potassium, (B)	0.1101	0.1269	0.0631	0.0604	0.0524	0.0416
Ratio: B/A	1.018	0.996	1.010	1.009	1.005	1.004

These results indicate that there is no loss in accuracy in the method which has been outlined. On the other hand, an appreciable saving of time and a greater ease of manipulation may be obtained by its use.

The reaction which takes place on ignition of the potassium chlorplatinate is best represented by the equation:—

$$K_2PtCl_6 \rightarrow 2\ KCl + 2\ Cl_2 + Pt.$$

NOTES ON THE DEVITRIFICATION OF OLD GLASS.—BY H. RITCHIE CHIPMAN, M. A., Ph. D., F. C. I. C., and DOUGLAS MCINTOSH, M. A., D. Sc., Dalhousie University, Halifax, N. S.

(Read 14 December, 1925)

It has been generally supposed that the devitrification of glass is a phenomenon similar to that studied by Tammann (Zeitm. Electrochem. 10: 532, 1904), Guertler, (Zeit. Anorg. Chem. 40268, 1904) and others, which depends on the form ation of crystal nuclei from which crystallization proceeds.

The devitrification of glass as a surface phenomenon has been explained by Albert Germann (J. A. C. S. 43:11, 1921) as follows. There is always a film of moisture on glass in equilibrium with the atmosphere. The silicates of the glass are in equilibrium with this film and must be more or less hydrolyzed depending on the condition of the glass, so that we may assume the presence of silicic acid, calcium hydroxide, and sodium hydroxide. The bases, however, absorb carbon dioxide and are converted to the acid carbonates. When the glass is heated the absorbed moisture is driven off, the silicic acid becomes dehydrated and roughens the surface. The separated silica forms an infusible coating over the surface of the glass which may under certain conditions dissolve in the underlying silica and the surface clear up, or under other conditions yield difficultly fusible calcium silicate in which case well defined crystal surfaces appear.

Germann took some old glass which showed a tendency to devitrify when heated and removed the surface layer by washing with hydrofluoric acid. If the devitrification was entirely due to the conditions of the surface its removal should destroy the tendency towards devitrification. Germann found this to be the case and suggests that old glass may be easily worked in the blast lamp flame if it is previously washed with hydrofluoric acid.

All of this work had been done with old glass which had been worked in the blast lamp flame and no mention has been made of glass devitrifying at lower temperatures. One of the students at Dalhousie University had occasion to carry out a vapour density determination with a Dumas bulb, and was amazed to find that the bulb became heavily frosted at the temperature of boiling water. It was decided to test Germann's explanation to see if it applied to this case.

The Dumas bulbs in question were believed to be from twenty to thirty years old. They had not changed in appearance except that some of them had small crystals on their inner surface. Germann mentioned that old glass will show efflorescences of sodium carbonate, and it was found that a bulb with crystals gave an alkaline reaction when washed out with water.

One of the bulbs was fastened to a Toepler pump, surrounded by an electric furnace, and, having been exhausted, was heated to about 200°C. Shortly after heating the pressure rose from less than 0.01 mm to 0.2 mm. This was due to water vapour which was pumped off. The temperature was raised to about 450°C. and more gas was given off. The pressure finally reached an apparent maximum when the gas was pumped off and analysed. There was about 0.3 cc. and it proved to be practically all carbon dioxide.

A new bulb was kept in boiling sodium hydroxide solution and then placed in an oven at 120°C. It was thought that this treatment might remove the surface layer and prevent devitrification, but frosting occurred.

Following the suggestion given by Germann, another bulb was washed with hydrofluric acid and then placed in an oven at 120°C. No devitrification occurred. The inside of the bulb was perfectly clear. According to Germann's theory the devitrification requires previous exposure to water vapour. As all the bulbs were sealed when made the inner surface was not exposed to the atmosphere, and hence no devitrification occurred on the inside.

A fresh bulb was partially washed with hydrofluoric acid and placed in the oven. It was found that only the parts of the surface which were not washed with the acid were devitrified.

A bulb was carefully broken into small pieces which were placed in a pyrex bulb and fastened to the pump. The system was exhausted and the bulb heated to 450°C, the pressure rising considerably. The gases were pumped off and were found to be about 50% carbon dioxide. On examination of the pieces after heating it was found that they were frosted on their outside surfaces only.

Some substances when heated will allow the passage of certain gases. It was observed that the devitrified bulbs did not permit the diffusion of any of the gases of the atmosphere when heated to 450°C. The fact that no diffusion took place when the glass was devitrified may be offered as additional evidence that the devitrification had only taken place on the surface, as it would have been expected to occur had the glass been crystalline throughout.

Germann states that the absorption of water from the atmosphere causes a tendency towards devitrification and that certain gases in the air of the laboratory may act catalytically. Apparently something like this has occurred in the case of the bulbs which has caused them to be so "weathered" that they will devitrify at 100°C. The results of these experiments are evidence that the devitrification of these bulbs is a surface phenomenon.

Examination of Some Tests for Methyl Alcohol (Abstract of Paper).—By E. W. Todd, B. A., Instructor in Chemistry, Dalhousie University, Halifax, N. S.

(Read 14 Dec., 1925)

In making recently some tests for methyl alcohol in presence of ethyl alcohol, it was found that unreliable results were obtained with some of the methods tried; and it was thought that a short examination of some of the simpler tests might be useful, with a view to deciding on one that seemed at once satisfactory and of easy application.

Of the methods examined, the most reliable appeared to be the one depending on the development of a violet colour in a solution of fuchsine which had been decolorized by sulphur dioxide, this colour being produced in presence of formaldehyde. The oxidation of the alcohol was accomplished with potassium permanganate in acid solution.

This method is given in the U. S. Pharmacopoeia, 10th Edition, 1926, and is as follows:

TEST FOR METHYL ALCOHOL WITH ETHYL ALCOHOL

"Dilute the alcohol with water to contain about 5 per cent. "by volume of ethyl alcohol. To 5 c. c. of this dilute alcohol "contained in a test-tube of 20 c. c. capacity, add 0.5 c. c. of "phosphoric acid and 2 c. c. of a 3 per cent. aqueous solution of "potassium permanganate, and allow the mixture to stand for "ten minutes. Add 1 c. c. of a ten per cent. aqueous solution "of oxalic acid and allow to stand till the mixture is a transparent "brown. Now, add 5 c. c. of a diluted and cooled sulphuric "acid, prepared by mixing 3 columes of distilled water and 1 "volume of sulphuric acid, add 5 c. c. of freshly prepared fuch-"sin-sulphurous acid T. S., mix well and allow to stand for 10 "minutes.

"At the end of that time, the solution, when observed "against a white background, may have a reddish or pale green "tint, but not a distinct blue or violet color (methanol)."

Tests were made with methyl alcohol alone, with ethyl alcohol alone and with various mixtures of the two alcohols—the amounts are approximate.

Some of the tests made are given below, the alcohol being mixed with distilled water in the proportions indicated. The colour, with only small amounts of methyl alcohol in the mixture, develops slowly.

(1) 2% methyl alcohol. Result:

in 10 minutes, a distinct, though faint violet colour (on looking down the tube).

in 20 minutes, the colour very distinct.

(2) 5% ethyl alcohol. Result:

in 10m. no trace of colour.

in 20m. no trace of colour.

(3) 5% ethyl alcohol and 2% methyl alcohol.

Result:

in 10m. distinct violet colour on looking down the tube (about the same as in (1)).

in 20m. the colour very distinct

(4) 2½% ethyl alcohol and 1% methyl alcohol.

Result:

in 10m. a very faint trace of violet, on looking down the tube.

in 15m. slightly more distinct.

in 25m. quite distinct colour, on looking down the tube.

The test was then applied to methylated spirits and to rum, as set forth in Table I.

TABLE I

Methylated spirits 10% soln.	Methylated spirits with a few drops of methyl alcohol	Rum say 10%
in 10m. practically, no colour.	in 10m. very distinct violet colour on looking down the tube.	in 20m. no violet colour.
in 30m. distinct though faint violet.	in 20m. darker colour.	in 3 hrs. no violet colour.

Some further results are given in Table II.

TABLE II

Methyl alcohol 2%	Ethyl alcohol 5%	Ethyl alcohol 5% and Methyl alcohol 2%	Methylated spirits 10%	Ethyl alcohol with a few drops of formaldehyde added before Schiff's reagent
after 10m. violet-pink colour.	after 10m. no colour	after 10m. violet-pink colour.	after 10m. violet-pink colour.	immediate violet colour

The older U. S. P. Pharmacopeia method was now tried, but was found to be unsatisfactory for the strengths used.

(1) Methylated spirits 10%—Oxidized by copper spiral in beaker of cold water, the liquid then boiled to drive off the acetaldehyde formed.

Result: A yellowish coloration obtained.

(2) 10% methylated spirits to which a drop of formaldehyde was added after oxidation by the copper spiral.
Result: Fine pink colour changing to brownish.

(3) Repeated (1). Result: Yellowish colour, slight turbidity.

MORPHINE TEST—

Preliminary Experiment.

To a solution of morphine in conc. sulphuric acid was added a little dilute formaldehyde solution.
Result: Distinct violet colour.

(1) To a solution of morphine in concentrated sulphuric acid was added a 2% methyl alcohol solution oxidized three times by a copper spiral.
Result: Violet colour not so distinct as above.

(2) Same as (1), only ethyl alcohol about 10% used.
Result: No colour.

(3) Same, only 10% solution of methylated spirits used.
Result: No good colour obtained.

(4) Same, only full strength methylated spirits used.
Result: A violet coloured ring.

In each case, the spirit was oxidized by a copper spiral.

TEST USING MILK AND RESORCINOL.

The results were not found to be consistent—in some cases, the milk apparently contained a preservative that interfered with the test.

The milk, of course, should be tested for formaldehyde before using in these experiments.

Preliminary Experiment.

To some dilute formaldehyde solution a few drops of dilute resorcinol solution were added. This mixture was poured down the side of a test-tube on top of a few cubic centimetres of concentrated sulphuric acid.

Result: A fine rose-pink ring obtained at the junction of the solution and acid.

(1) To some milk a few drops of resorcinol solution were added. This was poured on top of acid as before.

Result: A brownish red ring obtained.

(2) To some milk a few drops of formaldehyde solution were added, and then a few drops of resorcinol solution. The mixture was poured on top of acid as before.

Result: A brownish ring obtained—not pink.

(3) Methyl alcohol (2% solution) oxidized by copper spiral was mixed with milk and a few drops of resorcinol solution added.

Concentrated acid containing a trace of ferrie chloride was poured carefully down the side of the tube.

Result: A rose-red ring obtained.

(4) Ethyl alcohol, oxidized by copper spiral and then mixed with milk, was poured on top of concentrated sulphuric acid containing a trace of ferric chloride.

Result: A brownish red ring changing after some time to nearly black in parts.

(5) Same as (4) only 2% methyl alcohol was used.

Result: Very distinct violet ring.

(6) Same as (4) only a mixture of 5% ethyl alcohol and 2% methyl alcohol was used.

Result: Very distinct violet ring.

Summary

Various tests have been tried and some of the results obtained are given above.

The most satisfactory method was considered to be that given in the U. S. Pharmacopoeia 10th Edition, 1926.

Hydrogen in Electrolytic Zinc.—By W. Roy Elliot, B. Sc., Dalhousie University, Halifax, N. S.

(Read 18 Jan., 1926)

Ralston, in a paper published recently in the Transactions of the American Electrochemical Society[1], called attention to the work of Schwarz on the hydrogen occluded by cathode zinc. This amounts to 5-11 c. c. per gram, and is doubtless the cause of the low specific gravity of electrolytic zinc. At the time the advanced copy of Ralston's paper appeared I was engaged on the study of the properties of zinc deposited under various conditions. I have used some of my depostits to determine the amount of hydrogen occluded as it seemed unlikely that Schwarz' results, obtained by dissolving weighed amounts of zinc in acid, could be exact. The quantities of hydrogen found are about one-tenth those found by Schwarz. In other respects my observations agree with Ralston's.

The zinc was deposited on small aluminium cathodes between lead anodes. The amount of zinc sulphate was kept approximately constant by the addition of small amounts of zinc oxide. The solutions were acid except at the beginning of the experiment and no glue was used. The deposits, except in the two cases mentioned in the table, were of good quality. They were from 0.3-0.4 mm. thick.

The volumes of the occluded gases were determined by placing a weighed amount of the zinc in a pyrex tube, connected to a Toepler pump by a mercury seal. The apparatus was exhausted to 0.01 mm., and allowed to stand for some time to see that no leak developed. The zinc was then melted by a resistance furnace, and the gases were pumped off and measured. No quantitative analysis of the gas was made, but qualitative tests showed it to be hydrogen.

1.—47.193,(1925)

The results are given in Table 1.

Deposited from 8 per cent. Zinc Sulphate

Current Density (Amperes per sq. ft.)	Current Efficiency (Per cent.)	Apparent S. G.	C. C. Hydrogen per gram Zinc
10	93	7.2	1.3
20	68	6.1	1.3
30	45[2]	6.6	1.1
60	17[3]	6.2	2.2
	15 per cent. Zinc Sulphate		
20	89	6.5	0.7
30	84	6.8	0.4
60	87	6.5	0.7
100	84	6.2	0.8
	35 per cent. Zinc Sulphate		
20	95	6.5	0.6
30	94	5.9	0.8
60	98	6.5	0.4
100	95	5.7	0.9

In order to see whether any of the hydrogen was pumped off during the preliminary exhaustion, the volume of the pyrex tube was carefully determined, and the volume of the air displaced by the zinc calculated. The following are the results per gram of zinc.

Gas pumped off during exhaustion............0.07 c. c.—13%
After standing for 24 hours at low pressure.....0.05 c. c.— 9%
On heating to 200° C........................0.06 c. c.—11%
On melting...............................0.35 c. c.—67%

Total 0.52 c. c.; S. G. of Zinc 6.7

2. Poor Deposit
3. Poor Deposit: black surface.

As the thin sheets used in my experiments may have contained a different amount of hydrogen from that present in commercial zinc, I have made some experiments on freshly precipitated cathodes about 2.7 mm. thick from Trail, B. C., obtained through the courtesy of Messrs. Murray and Willis. Determinations were made on strips of the cathodes and on portions carefully planed free from oxide. The results are a little less than those obtained from the thinner strips.

Apparent S. G.	C. C. in a gram of zinc
7.03	0.31
7.08	0.38
7.08	0.40
....	0.54

Strips of commercial electrolytic zinc were heated to various temperatures for a short time, cooled, and the specific gravities determined. The "warts" mentioned by Ralston appeared on the inside surface at about 165° C., and there was marked bending with the inside surface convex.

Temperature	Apparent Specific Gravity	
	A.	B
20°	6.93	6.99
103°	6.90	6.93
165°	6.96	6.93
200°	6.86	6.89
254°	6.77	6.78
305°	6.50	6.58
400°	6.05	5.98

The effect of heating on the apparent specific gravity of the zinc is quite marked.

It appears then, that the hydrogen present in cathode zinc is less than that found previously by Schwarz, and consequently the pressures developed inside the zinc are small.

THE NEGATIVE GEOTROPISM OF THE PERIWINKLE: A STUDY IN LITTORAL ECOLOGY.—BY F. RONALD HAYES, B. Sc., Assistant in Histology and Embryology, Dalhousie University, Halifax, N. S.

(Presented 18 January, 1926)

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I. INTRODUCTION

Various investigators have interested themselves from time to time in an investigation of the anatomical and physiological features associated with the negative geotropism of snails (Parker 1911; Kanda 1916-1), and various theories have been set forth in an attempt to account for this phenomenon.

As early as 1897 Davenport and Perkins experimenting on *Limax maximus*, came to the conclusion that "the precision of orientation in the slug varies directly with the active component of gravity" and "this tendency (to go either up or down) must be ascribed to some internal condition of the individuals, for it varies in different individuals and in the same individuals at different times." It was early suspected moreover, that response to gravity might be associated with the center of gravity of the body of the individual, and Frandsen (1901), also speaking of *Limax*, makes the assertion that the essential factor is "the relative proportions of the anterior and posterior regions of the animal's body. All the conditions being the same it is this factor which determines whether the head end will be directed up or down."

These facts were demonstrated in more critical terms for *Littorina littorea* (*L*) the common periwinkle, by Kanda (1916-2), who, noticing how a periwinkle sank in water, observed that the centre ofgravity for living animals and also for shells is located in the posterior region of the shell. He determined in quantitative terms the direct correspondence between the proportion of animals exhibiting negative geotropism and the active component of gravity.

It is true also that there are pronounced anatomical modifications associated with negative geotropism. Pelseneer (1895) has shown that in the periwinkle, morphological modification and specialization in the respiratory organs has been associated with this activity. Part of the wall of the pallial cavity for example, has become vascular like that of the pulmonary chamber of the true *Pulmonata*. Thus the climbing habit would appear to be normal and characteristic of the species.

Tattersall (1920) records an attempt made in Ireland to turn the climbing habits of the common periwinkle, *Littorina littorea*, to practical use by the erection of stakes along the appropriate part of the littoral zone, on which the periwinkles might ascend and so be collected more easily for marketing. While the observations are deficient in certain respects, they demonstrate several points of interest. The number of periwinkles climbing the stakes varied from 15 to 35 per cent of the total number on the area investigated. Calm water appeared to be a necessity if any periwinkles were to climb, slight agitation of the water around a stake being detrimental to a successful ascent, loosening the slight purchase a periwinkle is able to obtain on a comparatively rough climbing surface.

Tattersall summarizes his results as follows: "From measurements made on the climbing winkles and those found on the ground at the same time, there appears to be no evidence that the former were in any way larger than the latter. In other words the climbing habit is just as strongly developed in young winkles as in older ones."

This assertion is not in agreement with that of Kanda (1916-2), who states that in his experiments on the negative geotropism of L. *littorea*, he used animals about 1.5 by 1.1 centimetres because the larger ones were noticed to be more sluggish in commencing locomotion after being handled. "The younger animals are more active and quicker to respond to stimuli." Results from a series of preliminary experiments conducted with the object of determining if possible, a relationship between size and activity, support the view of Tattersall.

A "physiological agreement" has been shown to exist in many animal groupings in nature (Shelford 1913). By this agreement species may be said to be automatically directed toward their appropriate habitat. Studies have indicated that a directive mechanism exists, consisting of a remarkable assemblage of delicate adjustments of organism to environment. This mechanism results in cases where choice is possible, in a return of the animal to its optimum habitat.

The investigations here described were designed in an attempt to analyze in quantative terms, the influence of a separate environmental factor namely gravity, in determining the natural distribution of *Littorina littorea*.

Experiments were conducted in an effort to determine in quantative terms, whether there existed in specimens of *L. littorea* collected at different levels of the littoral zone, a variation in the negative geotropism which could be directly correlated with vertical habitat. The results indicated that such a variation does exist and an analysis was then made of the effects of desiccation and immersion on negative geotropism.

Desiccation and immersion serve as clues to the study of littoral ecology since, in *Littorina* for example, the essential difference in habitat of individuals in upper and lower littoral zones is a difference in the length of time they are successively submitted to the influence of these two conditions.

Situated on an estuary of the Bay of Fundy, the Atlantic Biological Station where the greater part of the work here recorded was carried out, presents ideal conditions for a study of the littoral zone. A tidal change of over 8 metres exposes at low tide, an area of considerable width, exhibiting very clearly all the features associated with an inter-tidal graduation of fauna and flora.

The littoral zone, in the area where the greater number of collections were made, was comprised of a series of rocky ledges forming an ideal habitat for the periwinkle. *L. littorea* exists in considerable numbers from a short distance above the lowest tidal level to slightly above the mid tide level. It exists below low tide level in smaller numbers to depths of at least 20 fathoms (Huntsman, 1918), and above mid tide level in tide pools and under permanently damp conditions.

Sincere thanks must be given to Prof. J. Nelson Gowanloch of Dalhousie University, for his interest and counsel and for personal direction of a great part of the investigation. I am also indebted to Dr. A. G. Huntsman, Director of the Atlantic Biological Station for advice and assistance at every stage of the work. Certain lines of the investigation were continued throughout the winter at the Zoological Laboratories of Dalhousie University, Halifax, N. S.

II. Experimental Technique

For the experiments in negative geotropism cylindrical glass jars were used, 45 centimeters high and possessing an inside diameter of 6 centimeters. These jars were so graduated that the distance that an animal had travelled from the bottom at the time a reading was taken, could be accurately determined. In most experiments four such jars were used, two of them filled to within 5 centimeters of the top with oxygenated sea water, and two freshly rinsed out with sea water in order to dampen the inside and reduce the temperature.

Five individuals were placed in each jar and their progress upwards on the inside wall of the jar recorded every ten minutes. Thus the experimental result for each "immersed" and "dry" jar experiment is usually computed from the average performance of 10 individuals, never from less than five. As soon as any animals reached the surface of the water further readings were considered invalid and have been disregarded as far as possible in calculating results.

All calculations have been made with reference to a single periodical reading which has been carefully selected as the most typical of the series. In general the procedure has been to use the first reading recorded after any individual had reached the top of the jar. This usually has been the 20 minute reading. The height to which each "immersed" and each "dry" animal had climbed, was noted, and the total distance that all the animals of each group had ascended was found. This was divided so that a figure was obtained which represented the average performance per individual per 10 minutes in centimeters, and this is the experimental result quoted.

It will be observed that no opportunity was offered by this experimental technique for the animals to exhibit positive geotropism. In view of preliminary experiments which were in complete harmony with the results of Kanda (1916-2), who showed that on a vertical surface 100 per cent of *L. littorea* exhibit negative geotropism, this precaution was not deemed necessary.

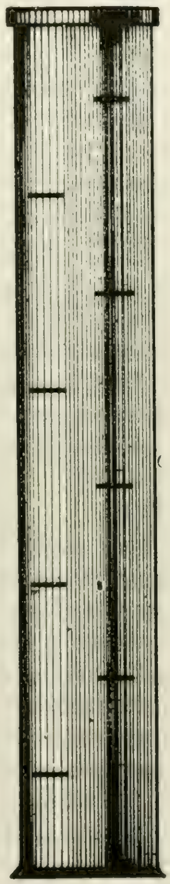

FIG. 1

A Negative Geotropism Jar. Five animals were placed in each of four such jars.

III. Correlation of Negative Geotropism with Vertical Habitat

In Table 1 will be found the figures representing the average responses of animals collected at low, mid and high tide levels.

The results for both "immersed" and "dry" groups are given. All the animals used were collected immediately before the commencement of the experiment.

Table I

Tidal Level	"Immersed" Group Response per Animal per Ten Minutes Centimeters	"Dry" Group Response per Animal per Ten Minutes Centimeters
Low	14.6	3.6
Mid	21.0	19.0
High	26.7	12.6

This table indicates that a physiological gradient exists in *L. littorea* correlated with its position in the littoral zone, and that the negative geotropic response may serve as an index to this gradient. A further discussion of these results will be found at the close of this paper.

IV. Variation in Negative Geotropism due to the Effects of Desiccation

The technique of desiccation was very simple. A number of periwinkles were placed in an open dish and exposed to the air under conditions approximating those of normal intertidal exposure.

Groups were periodically removed and subjected to a negative geotropism experiment similar to that recorded above.

For several days after the desiccation commenced the animals moved about in the dish; then the opercula became sealed with mucus and all activity ceased. Each individual used was subjected to a vital test before any experiment was performed.

It is important to note a difference in the method of calculation of results in the desiccation experiments from that used for the other experiments. Only the animals actually exhibiting a response to gravity were considered. If an individual remained motionless or active on the bottom of the jar it was disregarded from the calculations of averages; hence the twofold character of the tables showing both the percentage of animals responding and the average amount of response for those that did show any activity.

Table 2 shows the effect of a short period of desiccation on negative geotropism. This experiment was conducted in the hot sunshine of an August afternoon, the desiccation taking place in the open; thus there was an approximation of the most severe conditions under which periwinkles would find themselves during intertidal exposure.

Table 2.

Desiccation Time Hours	"Immersed" Group		"Dry" Group	
	Percentage responding	Amount of response per animal per ten minutes Centimeters	Percentage responding	Amount of response per animal per ten minutes Centimeters
0.0	70	7.2	10	5.0
1.0	70	11.2	0	. . .
1.5	100	14.0	20	5.0
2.0	100	6.5	0	. . .
2.5	70	5.4	20	7.5
3.0	100	9.2	0	. . .

It will be seen from the "immersed" group figures of this table that the result of desiccation for a short time is at first to increase both the percentage of individuals exhibiting negative geotropism and the amount of response.

This correlates with what might have been expected from a consideration of the face that animals living at higher tidal levels, and therefore subjected to longer periods of intertidal desiccation than individuals lower down in the littoral zone, exhibit a higher figure for their negative geotropism. Thus the effects of short periods of desiccation entirely confirm the results recorded in Table 1.

The figures in the "dry" group column are seemingly irregular and a suggested explanation is that they are in accord with the observed facts of the life of this form, where there exists a decided lack of activity when the tide is out.

Periwinkles do not move about in search of food after the substratum has thoroughly dried. They are under the necessity of conserving their supply of moisture till they are once more immersed by the incoming tide. A general consideration of all the "dry" group experiments here recorded will be found elsewhere in this paper.

In Table 3 figures are found showing the effect of a longer period of desiccation on negative geotropism. It will be observed that there are no "dry" group results given. The reason is that after a relatively short period of desiccation there was a total absence of activity of the periwinkles except under the stimulus of water. The animals whose performance is recorded in Table 3, were desiccated in a laboratory on a shelf over a large aquarium through which salt water was flowing. They were thus in an atmosphere containing a considerable quantity of moisture and at no time exposed to excessive heat.

TABLE 3

DESICCATION TIME HOURS	"IMMERSED" GROUP	
	PERCENTAGE RESPONDING	AMOUNT OF RESPONSE PER ANIMAL PER TEN MINUTES IN CENTIMETERS
0	90	16.8
7	30	15.8
27	30	9.3
45	50	6.0
91	50	0.7
118	50	0.8
141	40	0.7
172	20	2.8
262	30	0.6
335	10	1.6

From these figures it can be clearly seen that longer periods of desiccation result in a well defined decrease in amount of response and percentage of animals showing activity. No other results could be in accordance with the facts observable through a study of the natural history of the species. If, in nature the animals continued to walk uphill after they had been subjected to intertidal exposure for a few hours, they would clearly soon migrate out of the littoral zone and become subject to conditions which must finally prove to be lethal.

The figures for several of the latter readings are based on the performance of so few individuals that they do not form as exact a mathematical gradient as might have been desired, but the general trend of the results is very clearly definable.

In order to test whether the results of this series of experiments might not be due to starvation rather than to desiccation, animals which had been desiccated for varying periods of time were subjected to a simple test.

They were first regularly tested and then placed in a jar having the mouth covered by wire gauze, which permitted the passage of sea water but not of the algae which serves as food, and suspended in the sea for twenty-four hours; they were then tested again. The results showed conclusively that the effects were from desiccation and not starvation.

Apparently metabolic activity decreases greatly when the animals seal themselves up during periods of drought.

Table 4 furnishes two examples which will suffice as illustration.

TABLE 4

DESICCATION TIME HOURS		"IMMERSED" GROUP		"DRY" GROUP	
		PERCENTAGE RESPONDING	AMOUNT OF RESPONSE PER ANIMAL PER TEN MINUTES CMS.	PERCENTAGE RESPONDING	AMOUNT OF RESPONSE PER ANIMAL PER TEN MINUTES CENTIMETERS
91	Before immersion	50	0.8	0	...
	After immersion	60	6.7	40	2.9
335	Before immersion	10	1.6	0	...
	After immersion	70	4.6	0	...

The results are clear cut. It would seem a fair assumption that if a longer period of recovery had been permitted, the performance would have completely returned to normal.

V. The Effect Continued of Immersion on Negative Geotropism

For the experiments on immersion some 2000 adult specimens of *L. littorea* were collected at low tide level and placed in quart jars, 75 individuals to each jar, and there was added a supply of the fronds of *Fucus* with fruiting buds attached sufficient to serve as food for a long time.

The mouths of the jars were covered with carefully paraffined copper wire gauze. The jars were then suspended from the breakwater at the Biological Station, thus undergoing total immersion. No jar was closer than one meter from the surface and from this depth they ranged to three metres. It was not thought that light could have been a factor in any results.

Controls were used as follows, there being two jars of each control type:

(I) 10 animals per quart jar; no *Fucus*.

(II) 10 animals per quart jar; full supply of *Fucus* for 75 animals.

(III) 75 animals per quart jar; no *Fucus*.

The controls proved effective; no animals died in any control jar nor did any die in any experimental jar.

A geotropism experiment was conducted on a group of the animals periodically, in an attempt to find a variation due to the physiological change of the periwinkles resulting from their continued immersion.

Owing to storms which carried away a number of jars and made it necessary to replace several, the experimental results do not form as perfectly graded a series as might have been desired. Several long gaps toward the latter part indicate a time when it was impossible to obtain experimental data owing to the factor mentioned.

Table 5 records the responses showing in this series of te sts
Insert 8 point here heading—

Table 5

TIME OF IMMERSION HOURS	"IMMERSED" GROUP	"DRY" GROUP
	RESPONSE PER ANIMAL PER TEN MINUTES CENTIMETERS	RESPONSE PER ANIMAL PER TEN MINUTES CENTIMETERS
0 (Normal)	14.6	5.3
104	10.6	2.9
263	15.4	2.1
329	8.8	4.4
521	13.2	2.5
618	16.1	5.1
759	15.7	1.2
927	17.7	4.8
1344	13.1	1.8
1380	3.4	3.1

It seems at least a probability on the basis of these results, that there is an increase in negative geotropism resulting from continued immersion. The 1380 hour result may be discarded as totally out of harmony with the remainder. Starvation and overcrowding for 57 days had doubtless begun to show an effect, this hypothesis being sustained by the 1344 hour result, which gives a slight indication of a lowering of activity.

With the exception of the 329 hour group which varies radically, there is a clear gradient upwards to the 927 hour reading in the "immersed" group.

The "dry" group varies erratically as it does in the other experiments, a result which will be treated of elsewhere.

VI. The Effect of Temperature on Negative Geotropism

A series of field observations was initiated at Point Pleasant Park, Halifax, N. S., on November 28, 1924, with the object of determining the behaviour of *Littorina littorea* in winter, and of ascertaining if possible, whether a reversal of geotropism occurs during that season.

To this end a number of one square metre areas were marked out on the shore at typical parts of the intertidal zone and periodical observations made of the changes in their fauna. The varying numbers of *L. littorea* present on certain of these areas offers a picture of their winter habitat variations.

Periwinkles virtually disappeared from the upper areas and appeared in constantly increasing numbers just at the lowest tidal level. A table showing the variations in numbers of *L. littorea* in five areas at low tide level, each of one square metre, is instructive.

An area is pictured 5 meters long and 1 metre wide, with its greatest length parallel to the shore line, and divided into five one square metre areas. These areas were awash at low tide during neap tides but exposed by the lowest spring tides. Insert 8 point Heading—

Table 6

DATE	AREA				
	A	B	C	D	E
Nov. 28	155	170	135	215	180
Dec. 12	150	200	100	50	50
Dec. 27	415	260	125	205	240
Mar. 11	170	130	170	105	160

The wide variation in numbers over these areas at any given reading is capable of explanation by the prevailing weather conditions, coupled with the nature of the substratum of the areas. The first reading, that of November 28, reveals a reasonable uniformity of distribution over all the areas, a condition which agrees with the expectations, as there is no marked difference in the substratum of the areas such as mud flats, extensive growths of rockweed, etc. Up to the time of the start of the observations there had been no marked change to cold weather. The Dec. 12 records show a marked diminution of numbers of animals on areas "D" and "E" and a decrease also, though not so marked, in area "C". An explanation may be sought in the surface characters of the areas. Areas "A" and "B" provided sheltered crannies, while large flat rocks and gravel covered the other areas. The periwinkles were found in the most sheltered places. The season at this time was one of neap tides so that these areas were immersed almost constantly. Thus the animals in damp crannies and tiny tide pools would be less subject to the effects of cold than those in exposed places. The readings on December 27, taken at a period of spring tides following a period of severe cold, show a marked increase in the number of periwinkles which have come from the upper littoral zone.

The areas were at this time supporting a maximum of *Littorina*, every cranny being filled to capacity. The March 11 figure shows that an upward migration has begun.

The problem involved by these observations was whether it was a reversal of negative geotropism or loss of activity that caused the periwinkles to travel from the upper to the lower zones. It seemed a reasonable hypothesis that they might have been washed down, and such indeed proved to be the case. Observations showed an almost total lack of activity in cold water and there was no evidence of any measurable negative geotropism in individuals tested, nor of any power to cling to the substratum. Tested in water of a temperature near the freezing point the only evidence of activity in the partly extended animal was a feeble waving of tentacles, even the stimulus of a sharp instrument pricking the foot bringing no marked response.

VII. Summary and Conclusions

There exists in *Littorina* a clearly definable, specific, physiological gradient corresponding to the position in the littoral zone, and the variation in negative geotropism may be taken as an index of this gradient. Thus the average figure representing the negative geotropism of an individual collected in the upper littoral zone, will be higher than that for an animal collected at a lower level.

Confirmatory evidence of the existence of this gradient was found in an analysis of the effects of desiccation and immersion on negative geotropism. Desiccation for periods of a few hours might be likened to ordinary intertidal exposure of individuals from the upper zones, resulting in increased negative geotropism following subsequent immersion.

It was found that the greatest negative geotropism value was obtained after desiccation for 1.5 hours. Desiccation for longer periods resulted in a condition which may be compared to that of an animal left above high tide level by neap tides. The result was a profound diminution of geotropic response serving therefore in nature as an effective, automatic check upon the activity of animals already at the upper danger line of their habitat.

Subjection to constant immersion will produce a change in the physiological life history, and a variation can be demonstrated in the negative geotropism which acts as an index to this change. The evidence from immersion experiments is in entire harmony with the other experimental results correlating negative geotropism with tidal level, as it might be expected that constant immersion of an intertidal animal would produce a reaction designed to restore it to its original intertidal position.

Throughout all the experiments, the extreme variability of the factors under which the "dry" group was tested is, I think, quite sufficient explanation for its less consistent results than those for the "immersed" group. The "dry" jars were rinsed out and then the experiment was started. The temperature would be changing and the damp conditions would make a specimen alternately dry and wet. It has been shown (Mitsukuri—1901), that when a periwinkle, crawling over a dry or moist surface, comes to a pool of water, it almost always pauses and may change direction or cease motion.

In a general consideration of these results it should be remembered that the conditions to which *L. littorea* was subjected in an effort to modify its physiological life history, were conditions which would be very often met with in nature without the necessity of radical response. Between spring tides for example, the animals in the low tide level might remain immersed for weeks at a time without serious result. The animals used in the immersion experiments were moreover, collected at low tide level.

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ON THE RADIUM CONTENT OF SOME NOVA SCOTIAN MINERALS.—
BY CARL KENTY, M. Sc., formerly MacGregor Fellow in Physics, Dalhousie University, Halifax, N. S.

(Read 18 January, 1926)

An attempt was made to develop a more sensitive method for measuring the radium content of minerals and in the process the occasion arose to make some measurements on a few Nova Scotian minerals, the results of which seem worth recording.

METHOD

Only a resume of the method used need be given in this note. The radium emanation was boiled off from a solution of the mineral as usual. Instead of a gold leaf electroscope, the measuring instrument was a quadrant electrometer used ballistically. The emanation was introduced into an ionization chamber having a quartz insulated electrode. This electrode was made to charge up from earth potential, for a known time, by a suitably applied electric field, and then connected to a previously earthed quadrant of the electrometer. The magnitude of the resulting ballistic kick was then observed.

The ballistic method possessed several advantages over the ordinary rate of deflection method. In the first place, the natural leak was considerably decreased. This was very important in the present work, which was done in the summer when the leak over the amber supports of the quadrants was very large. Secondly, all shift of the zero during the charging period was eliminated.

The minerals were obtained in solution by grinding in a mortar and boiling with aqua regia. The solutions thus obtained were sealed up and left for the emanation to accumulate for a period of four or more days.

RESULTS

The apparatus was calibrated with standard carnotite solutions. Blank tests made it possible to correct for natural ionization in the chamber. The sensitivity of the electrometer used was about 450 divisions per volt, while that of the apparatus as a whole was 58 electrometer scale divisions per 11^{-10} gram of radium per minute of time of charge. Thus by taking 10 grs. of the mineral, a measurement could be made on a specimen containing 10^{-13} gram Ra. per gram. The following results were obtained:—

Specimen	Location in Nova Scotia	Ra. content in grs.: per gram of mineral.
Common salt	Malagash, Cum. Co.	Less than 5×10^{-14}
Potash salt	Malagash, Cum. Co.	Less than 5×10^{-14}
Felspar (light)	Governor's Lake, Hfx. Co.	8.7×10^{-12}
Felspar (dark)	Governor's Lake, Hfx. Co.	14.0×10^{-12}
Siliceous slate	Upper Musquodoboit, Hfx. Co.	2.6×10^{-13}

Remarks

The dark felspar contained a number of dark coloured impurities of which mica was one. The tests on the Malagash deposit were suggested by Dr. Ellsworth, of the Geological Survey of Canada, as possibly capable of throwing light on the origin of that deposit. The measurements were made on both the soluble and insoluble parts of the salt and no trace of radium was found in either. Further measurements were cut short, owing to the lack of time and to some difficulty in getting samples.

In conclusion, I wish to thank Dr. G. H. Henderson for his kindly interest and guidance throughout the work.

A Note on a Still for the Preparation of Pure Water.—By Harold S. King, A. B., Assistant Professor of Chemistry, University of Dalhousie, Halifax, N. S.

(Presented 19 February, 1926)

It is well known that glass is somewhat soluble in hot water. Consequently the condensers used in the preparation of extremely pure water by distillation must be of some other material. Quartz and platinum are satisfactory in regard to insolubility, but the former is fragile and the latter too expensive. Condensers of pure tin are perhaps the most practical and are in general use both commercially and in the laboratory.

This note is concerned with the connection between the tin condenser tube and the distillation flask. T. W. Richards* has pointed out that cork or rubber connections should not be used, and has suggested that the tin pipe be bent so as to fit into the constricted neck of the distillation flask, water effectively sealing the union to prevent the loss of steam.

The construction in the neck makes the filling and the cleaning out of the flask difficult. If the distillation is too rapid, there is a chance that water that has been in contact with the glass, and consequently contaminated with dissolved material, may be swept by the current of steam up into and through the condenser. Moreover, in case of breakage, a new flask with a special neck has to be made.

It has been found that if, instead of constricting the neck of the flask, the end of the condenser tube be made large enough to fit snugly into a flask of stock size, these difficulties are obviated. To accomplish this end, a block of tin, slightly larger than the neck of the flask, was cast and machined down to fit. A hole the size of the condenser was bored through one end of the cylindrical casting and the other end was drilled out leaving a mere shell. Finally the adapter, so made, was fused to the curved end of the tin condenser tube with pure tin. A trap to catch any spray that is formed in the boiling may be in-

* Richards, Proc. Amer. Acad., 30, 380 (1894); Also see Richards and Crail, J. Amer. Chem. Soc., 45, 1163 (1923)

serted into the distillation flask, if the inner diameter of the top of this device be made equal to that of the tin adapter so that the same condenser may be used whether the trap be inserted or not. This apparatus has been in use for several years in the Chemical Laboratory of Dalhousie University and has been found very convenient and satisfactory. Thanks are due to the mechanician, Mr. George Sandoz, for his aid in the construction of the apparatus.

THE REMOVAL OF CARBON-SULPHUR COMPOUNDS FROM COAL GAS BY WASHING THE GAS WITH OIL (Abstract).— BY K. L. DAWSON, B. SC. (N. S. Tech.), A. M. E. I. C., Superintendent, Gas Department, Nova Scotia Tramways & Power Company, Limited, Halifax, Nova Scotia.

(Presented 25 February, 1926)

This address was built around so many lantern slides, graphs and blackboard demonstrations that it is beyond the scope of these proceedings to publish it in full.

The speaker discussed the development of the equipment now in use at Halifax for removing carbon sulphur compounds from the city gas supply. Through the use of this equipment it is possible to utilize about 6000 tons of Nova Scotian coal per annum which could not be used otherwise for gas-making because of its high sulphur content, 1.5 to 2.5 per cent. In addition he described the methods which were used to obtain an explanation of the physical and chemical aspects of the process.

Essentially the equipment exists in two parts, one to bring the gas and the wash-oil into intimate contact over a large surface for the purpose of permitting the transfer of sulphur compounds from the gas to the oil, the other, to bring the used oil into intimate contact with steam heating coils for the purpose of preparing it for further use by distilling off the absorbed sulphur compounds.

Attempts to establish, by means of chemical analyses of the gas and the oil at various points in the apparatus, the relationship between the temperature surrounding the transfer of the sulphur compounds from the gas to the oil and the quantity of sulphur transferred, failed probably because of the extreme smallness of the quantities to be determined. For instance, in the case of the sulphur in the oil no method was located by which the determination of one part in 60,000 could be made.

By blackboard demonstration and graphs Mr. Dawson showed how he developed a mathematical theory for establishing this relationship. This method involves the use of three fundamental laws of physical chemistry, linked together by the procedure of simple algebra, and the method of attacking problems of this kind advocated by Prof. W. K. Lewis. The laws are Raoult's law of vapor pressure lowering, Dalton's law of partial pressures and the distribution law for dilute solutions.

Using graphs of operating results and lantern slides he indicated that this mathematical theory with formulae built on it, explains all the physical-chemical details encountered and enables the prediction of the results to be expected under given conditions.

From the standpoint of the chemist the absolute accuracy of this mathematical theory has not been proven owing to the fact that he did not have at his disposal a method for determining the minute quantities of carbon-sulphur compounds in the oil. From the standpoint of the operating engineer the theory is alright, because it explains the process and provides a vehicle for studying it; also, the theory has not yet been found wrong in any application of it.

THE ACTION OF SALINE CATHARTICS.—BY N. B. DREYER, B. A. (Cape et Oxon.), M. A. (Oxon.), Assistant Professor, Department of Physiology, Dalhousie University, Halifax, N. S.

(Presented 29 March, 1926)

Compounds, like sodium sulphate, magnesium sulphate and sodium phosphate (Na_2 HPO_4), are used extensively for mild purging. They are given in hypertonic solutions, so that on their entry into the gut, water is withdrawn from the tissues into the lumen of the gut. This increases the volume of the intestinal contents, and results in strong peristaltic movements. The increased activity of the alimentary canal, combined with non-absorption of the salts and water, gives rise to a fluid stool.

In the experiments described below, observations were made not only on peristaltic, but also on segmental movements. At the same time the amount of fluid injected into the gut lumen was compared with that recovered at the end of any given period. This was done to determine if any increase in intestinal content occurred under the action of these salines.

The method adopted was described by Babkin[1] some years ago. It has the advantage over others commonly in use that the muscle of the intestinal wall is only slightly injured locally when inserting the cannulae, and further it does not interfere with the blood supply.

In all cases decerebrate cats were used, the vagi and splanchnic nerves were cut, and the bile and pancreatic ducts were ligated. These ducts were tied so that no secretion from liver or pancreas could enter the duodenum, as this was the portion of gut selected for the experiment. When all the operative technique was completed the cat was immersed in a bath of saline kept at 37° C. The intestines were by this means kept covered and were at constant temperature. Movements were recorded with a fairly large piston recorder. In addition naked eye appearances were noted. Movements recorded under the influence of 0.9% sodium chloride for periods of five to ten minutes served as the normal. Small quantities varying from

(1) B. P. Babkin. Bulletin de l' Academie Imperiale des Sciences, 1916

2.5 to 5 cc. of saline were introduced into a length of gut about four inches long. The movements remained fairly uniform in character. This was confirmed on inspection; segmental and peristaltic movements were easily discerned. The amount of fluid recovered at the end of a ten minute period was never increased above that put in; in some cases evidence of absorption of the sodium chloride was obtained. In the case of hypertonic NaCl of 1.8% and 2.7% concentration, changes in the movements soon became apparent. A gradual rise in tone occurred together with more marked contractions. In both cases the fluid increased in amount in the gut lumen. With sodium sulphate the picture was slightly different and it seemed to depend on the tone of the intestinal muscle. If the tone was high, Na_2SO_4, isotonic with 0.9% NaCl, sometimes caused depression. In the majority of cases where initial tone was low isotonic Na_2SO_4 caused marked increase both of tone and movements, but in no case was there a withdrawal of water from tissues to the solution. With hypertonic solutions, Na_2SO_4 exerted a very strong action. Almost from its introduction segmental and peristaltic movements became marked, and in some cases spasm of the gut was seen. The effect on the contents was even more marked than with N_2Cl in hypertonic solutions. This was probably due to the fact that NaCl is easily absorbed while N_2SO_4 is not.

The Na_2SO_4, if left too long, may eventually produce fatigue and finally a condition not unlike paralysis of the gut.

On removing the hypertonic Na_2SO_4, and introducing normal saline the movements diminished markedly and sometimes only segmental ones were present. On renewing the 0.9% NaCl repeatedly the gut eventually recovered.

With magnesium sulphate in isotonic and hypertonic concentrations, movements disappeared completely. This is peculiar since $MgSO_4$ has a marked purgative action in man. Since the bile and pancreatic secretions were excluded from the gut, and all connections with the central nervous system were severed one can only surmise that some other agent is responsible for this salt to exert its action. The secretion was not markedly affected.

Sodium carbonate was also tested. In isotonic or hypertonic solutions the contractions were greatly increased in rate and force, especially in 10% solution spasm was produced. Unfortunately strong Na_2CO_3 solution corroded the mucous membrane of the gut, and caused it to separate completely, leaving the musculature bare, and exposed to the action of alkali. Intravenously the same action was exerted on the gut. The contents increased in amount even with the mucous membrane gone, showing that a transudate still occurred.

THE RATIO OF THE ELECTRIC UNITS OF CHARGE.—BY GEORGE C. LAURENCE, B. Sc., MacGregor Fellow in Physics, Dalhousie University, Halifax, N. S.

(Presented 19 April, 1926)

This work was undertaken to determine what accuracy could be attained in the measurement of the ratio of the electrical units of charge, using modern methods and apparatus available in the average laboratory. The method used was that of Rosa and Dorsay[1], that is, the capacity of a cylindrical condenser, calculated in e. s. units from its dimensions, was compared with its capacity in e. m. units measured in a Maxwell Bridge. A value of $2.9963\times10 \pm .05\%$ was obtained which agrees better with Rosa and Dorsay's value $2.9971\times10 \pm .01\%$—which is by far the best—than the values obtained by earlier experimenters (except that of Fabry and Perot; 2.9978). Accordingly it was thought worth while to describe the simplifications of the method which enabled it to be carried out in a small laboratory. For a general treatment of the method the

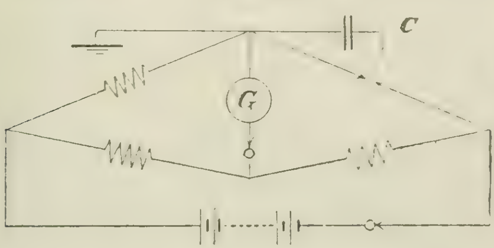

Fig: 1.

reader is referred to Rosa and Dorsay's paper,[1] the wireing diagram, however, is given in Fig. 1. The best values that have been obtained for this ratio are:

Himstead	3.0057×10 cm./sec.
Rosa	3.0000
Thomson and Searle	2.9960
Abraham	2.9913
Pellat	3.0092
Hurmezesco	3.0010
Fabry and Perot	2.9978
Rosa and Dorsay (1907)	2.9971± .01%

[1] Edward B. Rosa and N. E. Dorsay, Reprint No. 65, Bulletin of the Bureau of Standards, 1907.

Eliminating End Effects by Using a Double Condenser

The use of guard rings was obviated by making a double condenser consisting of a long and a short cylinder of equal diameter inside the one outer cylinder. (Fig. 2). By taking

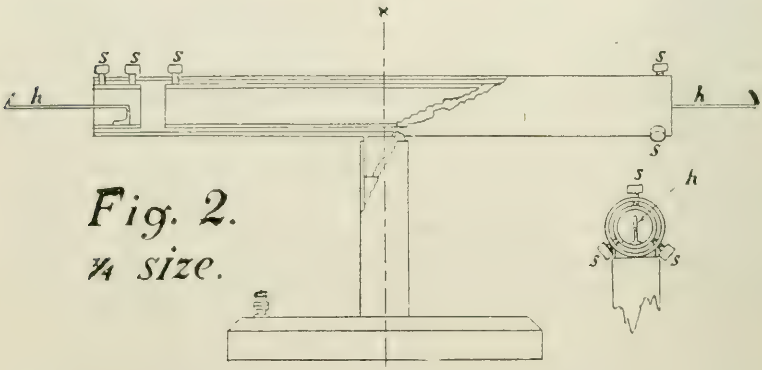

Fig. 2.
¼ size.

the difference between the capacities of the two inner cylinders end effects were satisfactorily eliminated. The cylinders were mounted so that they could be rotated about the axis x, end for end, thus putting the exposed end of the cylinder whose capacity is being measured in the same position as that previously occupied by the other cylinder, thus eliminating errors due to external electrostatic fields. While the capacity of one inner cylinder was being measured in electromagnetic units the other two cylinders were earthed. The wire hooks h, protruding from the ends of the inner cylinders served in making connections to them. The difference in capacity in electrostatic units was calculated from the expression $C=(L-S)/(2 \log R/r)$, where L and S are the lengths of the inner cylinders and r their radius, and R the radius of the outer cylinder.

An Electrical Method of Measuring the Frequency of Commutation Simultaneously with the Balancing of the Bridge

A magnetic tuning fork was used as the commutator in the Maxwell Bridge. Its frequency was measured simultaneously with the balancing of the bridge in the following manner. The fork was driven by an electric magnet and a make-and-break contact operated by a storage battery. This intermittent direct current was passed in series through the current winding of a wattmeter. The potential winding of this wattmeter was connected to the output of a motor-alternator driven at a very slightly different frequency. When alternator potential and fork current were in phase the needle of the wattmeter deflected in one direction and when out of phase in the opposite direction, so that the needle moved back and forth indicating the beat-between the two. The frequency of the beats was the differs ence between the frequency of the fork and of the alternator. The frequency of the alternator was measured with a stop-clock and a revolution counter over periods of about 15 minutes during which time the bridge was balanced and at the same time another observer counted the beats indicated by the wattmeter. The sum(or difference) of the two frequencies gave that of the fork with an error less than .05%, the stop clock being checked before and after each measurement with a good watch. A direct current ammeter and a minature lamp were also used as beat indicators, being connected so that both fork and alternator currents, superimposed on one another, flowed through them.

An Electrical Method of Adjusting the Cylinders so that they are Coaxial

A cylinder within another cylinder has a minimum capacity when it is exactly coaxial with the outside one. When the bridge was roughly balanced, decreasing the capacity of the condenser had the effect of moving the galvanometer reading to the left. So the inner cylinders were adjusted by turning the ebonite screws (s) that supported them until the galvanometer reading was moved as far to the right as it would go. By this method the cylinders could be adjusted much more easily and more accurately than by mechanical methods. This was shown by the fact that a capacity .14 m. m. f. (i. e. .12% of the total capacity, 123.50 m. m. f.) smaller was obtained with this method of adjusting, than was obtained with a mechanical method. The mechanical method consisted in adjusting the width of the space between the inner and outer cylinders at different places around the circumference by inserting a wedge therein.

Measuring the Effect of a Slight Bend in one of the Cylinders on their Capacity

The relative increase in the capacity of a cylindrical condenser caused by a small displacement x of the axis of the inner cylinder parallel to itself is $\Delta C/C = x^2/4R(R-r)$ *, provided that x is small compared with $R-r$, the difference in radius of the cylinders. Hence the capacity of an element of length dy is

$$dC = (x^2/4R(R-r)+1)\ dy\ /2\ log\ (R-r) \qquad (1)$$

It was found that the inner cylinder was slightly curved, deviating at the most about .05mm. from a straight line. Considering this curve to be parabolic, taking the axis of the outer cylinder as the Y axis, and the origin at the middle of the cylinder we get in the case of the electrically adjusted cylinders $x = (y^2-h)/M$, where M is the latus rectum and h is a constant of such a size as will make the total capacity a minimum. Integrating for the whole length of the cylinder (*from* $-L/2$ *to* $+L/2$) we get for the capacity

$$C' = (L^5/80 - hL^3/6 - h^2L)\ /\ (8M^2R(R-r)\ log\ (R/r)) + C \qquad (2)$$

where C is the capacity the cylinders would have if their axes

* loc. cit,, page 484

were straight. When we set $dC'/dh=O$ to find the minimum value of C' we get $h=L^2/12$ and equation (2) becomes

$$C'=L^5/(1440M^2R(R\text{-}r)\ \log\ R/r)+C \tag{3}$$

In the case of the mechanically adjusted condenser the two axes intersect only at the ends of the tube i. e. where the wedge was inserted, hence $x=(y^2—L^2/4)/M$ and integrating for the whole length we get for the capacity

$$C''=L^5/(240M^2R(R\text{-}r)\ \log\ R/r)+C \tag{4}$$

$$\therefore\quad C'—C=(C''—C')/5 \tag{5}$$

The correction $(C''—C')/5$ amounted to .03 m. m. f. making C=123.50 m. m. f.. The smallness of the correction justified the assumption that the curve was parabolic.

Results

The most difficult quantity to measure in finding the electrostatic capacity of the condenser was the distance between the inner and outer cylinders. This was determined to .05% by weighing the quantity of water which this space could contain. The result was checked, by two methods of direct measurement, and differed from them by less than their probable errors (.1% and .3%). The other dimensions were measured directly with calipers. The probable error in the electrostatic capacity was .07%.

Eighteen separate electromagnetic measurements of the difference in capacity of the two cylinders were made, using two different fork frequencies—90 and 126 cycles, two battery voltages—45 and 90 volts, and making similar changes in the resistances of the arms of the bridge. Two independent adjustments of the cylinders by the electrical method and two by the mechanical method were made. The results of the three measurements made with the condenser mechanically adjusted were only used in determining the size of the correction discussed in the preceeding paragraph. The mean of the fifteen results (with the cylinders electrically adjusted) had a probable error of .012%. Taking account of the errors in the resistances, the frequency, and the correction, the probable error in the electromagnetic capacity became .07%. The probable error in the ratio of the capacities is .10% and hence the probable error in the ratio of the units is .05%. The value obtained was 2.9963×10^{10} *cm./sec.*

The author is deeply grateful to Dr. H. L. Bronson for the interest he has taken, not only in this problem, but in the author's work throughout the time he has been at Dalhousie.

Liquid Hydrogen Sulphide as an Ionizing Medium.—By H. Ritchie Chipman, M. A., Ph. D., and D. McIntosh, M. A., D. Sc., Dalhousie University, Halifax, N. S.

(Presented 19 April, 1926)

Qualitative measurements of conductivities in liquefied hydrogen sulphide were made by Walker, McIntosh and Archibald[1], and a few organic substances were found to be good conductors. All these compounds were basic, and it was naturally concluded that sulphides were formed in solution. In an extensive investigation of the properties of hydrogen sulphide by Steele, McIntosh and Archibald[2], some quantitative determinations were carried out, but no inorganic salt could be found to carry the current appreciably.

In 1925 Quam and Wilkinson[3] examined certain reactions in the liquid sulphide, and made some conductivity measurements. In only a few cases were values for other than saturated solutions given, so we have thought it well to examine the conducting power of certain solutions over a suitable concentration range.

Among the compounds mentioned by Quam and Wilkinson are several inorganic substances of particular interest, and of these antimony trichloride and iodine show the greatest conductivity. We have examined these and also studied the conducting power of a number of others which we thought likely to give interesting results.

The hydrogen sulphide was made from hydrochloric acid and ferrous sulphide in a Richard's generator of the usual type. It was washed, then dried with calcium chloride and phosphorus pentoxide, and liquefied by means of carbon dioxide and ether. For qualitative experiments it was liquefied in test tubes, but in the quantitative determinations directly in the conductivity cell.

1. Trans. Chem. Soc. (London) 85, (1904).
2. Trans. Royal Soc. (A) 205, 99, (1905).
3. J. A. C. S. 47, 103, 989, (1925).

Reactions in the Liquid Sulphide.

Small quantities of the solute were put into the liquid, stirred, and the conductivity measured with a dip electrode. The following results were obtained:

Iodine immediately dissolved forming a beautiful reddish purple solution. It showed a relatively high conductivity.

Sulphur dioxide, made from sodium sulphite and dried with phosphorus pentoxide, was passed through the liquid. No visible reaction took place. A reaction, however, occurred in the gas phase, since sulphur was deposited. The solution did not conduct.

Diphenylamine and phenyl hydrazine were very soluble, but the liquids possessed no conducting power.

Urea and brucine were slightly soluble. The solutions did not conduct.

Meta-phenylenediamine chlorhydrate and glycocoll were either insoluble or only slightly soluble. The solutions showed no conductivity.

Tripropylamine and iso-tributylamine were very soluble and formed good conducting solutions. They were further examined.

Phosphorus tri- and pentachlorides were soluble but gave no conduction.

Hydrogen chloride and iodide were easily soluble in the liquified sulphide. The former conducted very slightly.

Freshly distilled antimony chloride was quite soluble, but reacted with the solvent. It gave a good conducting solution and will be referred to later.

The conductivity apparatus consisted of an ordinary Wheatsone bridge system with a Leeds and Northup potentiometer as the slide wire. A microphone hummer and a special telephone proved very satisfactory. A Dewar flask with solid carbon dioxide as a refrigerant served as a constant temperature bath.

The conductivity cell was of the form shown in the diagram (Fig. I). The electrodes were platinum, about one centimeter square, and were three millimeters apart. They were platinized in the ordinary way.

FIG I

In making measurements the cell was filled with a suitable amount of liquid, a weighed amount of the solute was introduced, and the solution stirred by cold air passed slowly through the tube A, by means of the pump designed by O. Maass. There was very little evaporation, so that this method of stirring was quite suitable for quantitative measurements. After the substance was introduced, the solution was stirred by two strokes of the pump and the resistance was measured. This was repeated until a constant resistance was obtained.

The results are given in the following tables and shown on the curves (Fig. 2).

	Dilution	Equivalent Conductivity $x10^4$
Tri-isobutylamine	17.2	6.42
	5.6	7.55
	4.10	10.1
	3.27	14.2
	2.71	14.6
Tri-propylamine	13.7	2.72
	4.61	3.65
	3.32	4.61
	2.65	6.01
	1.93	9.58
Iodine	156.5	4.86
	110.0	4.43
	77.1	3.67
	61.5	3.01
	44.2	2.27
	18.7	1.08
	13.7	0.87
	5.4	0.42
	3.3	0.28
	2.2	0.21

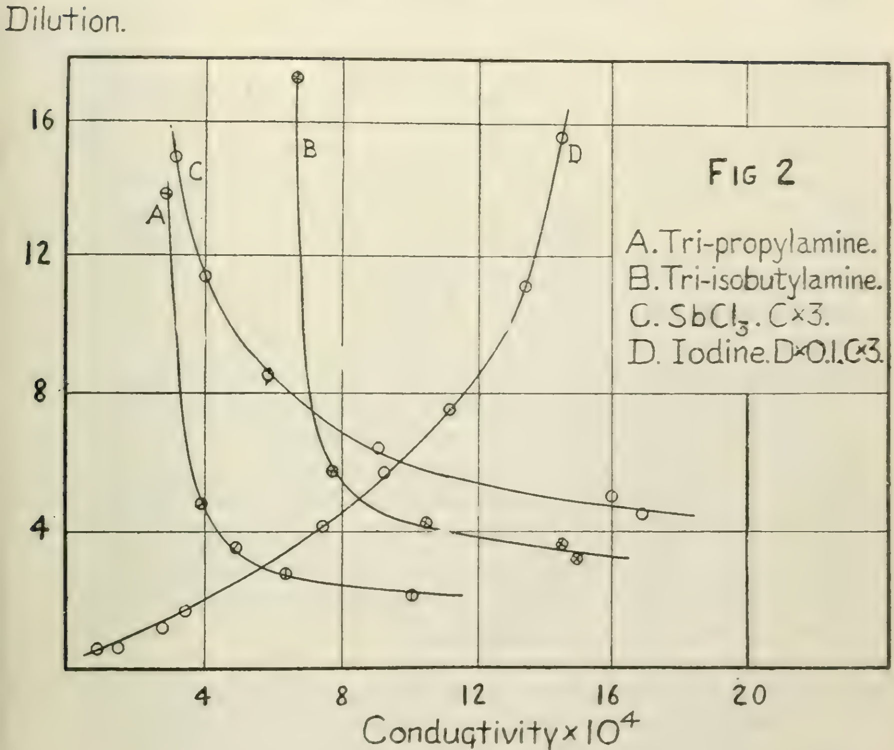

FIG 2

The conductivity curves for the amines in liquid hydrogen sulphide exhibit a form which is just opposite to that of the curves for electrolytes in aqueous solutions, that is, the conductivity increases with the concentration. Similar results were obtained for the organic substances which were examined by Steele, McIntosh and Archibald[1], and they show that this indicates the formation of a complex compound between the solute and the solvent. All the organic substances which have been found to possess conducting power when in solution in hydrogen sulphide are basic, and it would not be surprising to find evidence of compound formation. The substituted amines which have been investigated therefore behave

1. Loc. cit.

in a similar manner to all other organic substances which have been found to give conducting solutions in hydrogen sulphide.

Iodine in liquid hydrogen sulphide behaves exactly as an electrolyte in aqueous solutions, as its conductivity increases with increasing dilution and apparently tends towards a maximum value. In their paper on conductivities in liquid hydrogen sulphide, Quam and Wilkinson state that they investigated the conductivity of iodine in that solvent and reach the conclusion that the current is carried by positive and negative ions of iodine. In support of this they state that they made a transport experiment on a solution of iodine and obtained no evidence of a change in concentration at either electrode. They therefore hold to the opinion expressed by Walden that the iodine is dissociated into positive and negative ions and apparently does not form a compound with the solvent. An attempt was made to find evidences of compound formation or chemical reaction. A strong solution of iodine in liquid hydrogen sulphide was prepared and the hydrogen sulphide distilled off into water. No traces of hydrogen iodide could be found in the resulting solution and the iodine was left in the tube as a mass of small crystals. Apparently iodine does not react with liquid hydrogen sulphide, nor does its solution deposit compounds on cooling. Iodine is the only one of the halogens which shows appreciable conduction in hydrogen sulphide, and there seems to be no good reason why a liquid having a low di-electric constant should be able to cause dissociation. Mention may be made here of the fact that bromine and chlorine show affinity for ether, alcohol, etc., at low temperatures and form compounds; iodine does not.

The investigation of the conductivity of antimony chloride yielded a most interesting result. As this substances is an inorganic salt it might be expected that its conductivity curve would have the form common to all electrolytes in aqueous solutions. It was found however that the curve has the opposite forms. It would therefore be suspected that the antimony trichloride formed a complex compound with the hydrogen sulphide. Quam and Wilkinson investigated this reaction by sealing up some antimony trichloride with liquid hydrogen in a tube and leaving them for some time. They state that the salt was readily soluble and remained as a clear solution, but that on evaporation or cooling a yellow solid separated which they suspected to be a mixture of antimony sulphochloride, SbSCl, and antimony trisulphide. It was noticed that all the chloride did not dissolve, but on the addition of a further amount the conduction increased. On filtering the solution and analysing it, approximately seventy-five per cent. was found to dissolve.

To obtain evidence of a chemical reaction a solution of the trichloride in hydrogen sulphide was allowed to evaporate, and the gas was passed through water. Hydrogen chloride was found in the distillate, showing that the sulphide and chloride had reacted. We hope in the future to examine this reaction more fully, and to make molecular weight determinations of the substances mentioned in this paper by the freezing—and boiling-point methods.

Summary

1. An apparatus has been constructed to measure the conductivity of substances in liquid hydrogen sulphide, and a satisfactory method of stirring the solution has been devised.

2. The conductivity of fifteen substances in liquid hydrogen sulphide has been examined. Of the substances investigated, iodine, tri-isobutylamine, tri-propylamine, and antimony trichloride were found to possess an appreciable conductivity which was measured over a considerable concentration range.

3. It was found that all of these substances acted as if they formed complex compounds with the solvent, with the exception of iodine, which conducted the current in a similar manner to an electrolyte in aqueous solutions.

4. It is concluded that the conductivity of the solutions of the amines and antimony trichloride is due to the dissociation of a compound formed with the hydrogen sulphide, while in the case of the iodine it is due to the dissociation of the iodine into positive and negative ions.

THE AUGMENTED SALIVARY SECRETION (Abstract of Paper).—
By B. P. BABKIN, M. D., D. Sc. and P. D. McLARREN, M. D.
Department of Physiology, Dalhousie University, Halifax, N. S.

(Presented 19 April, 1926)

1. An augmented secretory effect from stimulation of the sympathetic nerve after previous stimulation of the same nerve and massage of the submaxillary gland in dog, was demonstrated.

2. Contraction of the Warthon's duct and its chief divisions, in the dog as well in as in the cat, is excluded as causative of the phenomenon of augmented secretion.

3. The volume-time curves and, derived from them, the rate curves of the salivary secretion show that different processes--secretory and motor—may occur in the submaxillary gland under stimulation of the *chorda tympani* and sympathetic nerves.

4. The *chorda tympani* nerve, of a dog and a cat, contains only secretory fibres. The sympathetic nerve contains secretory and also motor fibres for the contractile elements of the submaxillary gland.

5. A view is advanced that there are two phases in the augmented sympathetic secretion,—a mechanical phase due to the action of motor fibres in the sympathetic nerve, and a secretory phase which appears as a result of previous stimulation of either nerve.

THE DIGESTIBILITY OF WHITE OF EGG (Abstract of Paper).—
By I. G. MACDONALD and E. GORDON YOUNG, B. A., M. Sc., PH. D., Department of Biochemistry, Dalhousie University, Halifax, N. S.

(Presented 19 April, 1926)

Uniform samples of egg white separated from fresh hen's eggs have been coagulated at 100° C. for periods of time varying from 2 to 30 minutes and their digestibility has been determined *in vitro*. An artificial digestive juice has been prepared containing 2% pepsin (Fairchild) in 0.4% hydrochloric acid and a uniform concentration of 20 gms. of finely minced coagulum to 100 cc. of juice used. The pH of the solutions was kept constant at 1.6 and controls were run simultaneously. Samples were removed frequently from the digesting mixtures and analysed for the number of free amino radicles by the Sorensen formol titration and the Van Slyke gasometric methods. The conclusion was drawn that no difference exists in the rate of peptic digestion of egg white coagulated for short or long periods of time and digested "in vitro."

Solubilities and Molecular Weight Determinations in Liquid Chlorine.—By K. H. Butler, M. A. and D. McIntosh, D. Sc., F. R. S. C., Dalhousie University, Halifax, N. S.

(Presented 19 April, 1926)

The solubilities of compounds, their molecular weights, and the combinations formed by them in the non-polar liquid, chlorine, have been investigated by Beckmann, Karsten, Thomas and Depuis, Waentig and McIntosh, Mennie and McIntosh, and Biltz and Meinecke. We have done further work on this problem by a somewhat new method, taking as a measure of the solubility the rise in boiling point of the chlorine on the addition of a salt. A Beckmann thermometer, calibrated by means of an electrical resistance thermometer, and a modified Beckmann apparatus with the condenser kept cool by solid carbon dioxide and ether proved very satisfactory, and in the case of the soluble substances, enabled us to determine the ebullioscopic constant, i. e., the rise in boiling point for one gram molecule of solute in one thousand grams of solvent.

The following is a summary of the results obtained: Fifty-nine of the commoner salts were shown to be insoluble in liquid chlorine at its boiling point.

The reactions of ten of the elements were studied. In general our results agreed with those of previous observers, but certain new facts may be mentioned.

Sulphur was found to be non-reactive and insoluble in boiling chlorine; arsenic in lumps was inactive; silver, copper and zinc were unaffected; aluminium wire was quickly changed to the chloride, which remained undissolved in the liquid; iodine, phosphorus and tin reacted quite violently, but only in the last case was there a rise in the boiling point, showing that solution had taken place.

The ebullioscopic constants were found to be:

Chloroform	1.73
Carbon tetrachloride	1.76
Stannic chloride	1.72
Phosphorus oxychloride	1.59
Sulphur chloride	1.55
Bromine	2.83–2.70

APPENDIX

LIST OF MEMBERS 1925-1926

ORDINARY MEMBERS

	Date of Election
Allen, E. Chesley, School for the Blind, Halifax	Nov. 28, 1913
Babkin, Prof. Boris, M. D., D.SC., Dalhousie University, Halifax	Feb. 26, 1925
Bagnall, John Stanley, D.D.S., Halifax	Dec. 1, 1921
Bell, Prof. Hugh Philip, M.SC., PH.D., Dalhousie University, Halifax	Dec. 1, 1920
Blois, H. Hope, Principal of Bloomfield School, Halifax	Dec. 1, 1921
Borrett, Major William Coates, Dartmouth	Feb. 26, 1925
*Bronson, Prof. Howard Logan, PH.D., F.R.S.C., Dalhousie University, Halifax	Mar. 9, 1911
Cameron, Prof. John, M. D., D.SC., F.R.SS.E. & C., Dalhousie University, Halifax	Nov. 2, 1915
Chipman, H. R., PH.D., Dalhousie University, Halifax	Oct. 3, 1921
*Colpitt, Parker R., Coburg Road, Halifax	Feb. 2, 1903
Copp, Prof. Walter Percy, B.SC., Dalhousie University, Halifax	Apr. 28, 1921
Cornelia, Rev. Brother W. B., St. Mary's College, Halifax	Oct. 1, 1925
Creighton, Prof. Henry Jermain Maude, D.SC., F.C.S., Swarthmore, Penn	Jan. 7, 1908
Cunningham, Allan Rupert, M.D., Halifax	Dec. 1, 1921
*Davis, Charles Henry, C.E., New York City, U. S. A	Dec. 5, 1900
Dentith, Francis Wm. Hubert, Armdale, Halifax	Mar. 13, 1922
*Doane, Francis William Whitney, Halifax	Nov. 3, 1886
Dreyer, N. B., M.R.C.S., Dalhousie University, Halifax	Feb. 26, 1925
Forbes, J. D., PH.D., Atlantic Experimental Station for Fisheries, Halifax	Jan. 12, 1926
Forward, Charles C., Dom. Govt. Analyst, Halifax	Jan. 5, 1917
Gibbs, Prof. Owen S., M.B., CH.B., Dalhousie University, Halifax	Feb. 26, 1925
Gowanloch, Prof. James Nelson, B.SC., Dalhousie University, Halifax	Dec. 4, 1923
Greig, Arthur W., Halifax	Feb 26, 1925
Hardy, Prof. W. G. B.SC., N. S. Technical College, Haifax	Nov. 30, 1922
Henderson, Prof. Geo. Hugh, PH.D., Kings College, Halifax	Nov. 2, 1915
Johnstone, Prof. John Hamilton Lane, M.SC., PH.D., M.B.E., Dal. Univ.,Halifax	Dec. 2, 1912
Jost, Arthur Cranston, M.D., Dept. of Public Health, Halifax	June 30, 1924
King, Prof. Harold Skinner, B.A., Dalhousie University, Halifax	Nov. 30, 1922
King, Mrs. Harold S., Armdâle, Halifax	Nov. 30, 1922
Laurence, George C., B.SC., Dalhousie University, Halifax	Dec. 3, 1925
McCurdy, H. W. Princeton University, Princeton, N. J	Jan. 9, 1922
McInnes, Hector, K.C., Halifax	Nov. 27, 1889
McIntosh, Prof. Donald Sutherland, M.SC., Dalhousie University, Halifax	Mar. 9, 1911
McIntosh, Prof. Douglas, D.SC., F.R.S.C., Dalhousie University, Halifax	Dec. 4, 1923
*MacKay, Alexander Howard, B.A., B.SC., LL.D., F.R.S.C., Hon. Colonel	Oct. 11, 1885
*MacKay, George M. Johnstone, M.A., M.SC., Schneectady, N. Y., U. S. A	Dec. 28, 1903
*MacKenzie, President Arthur Stanley, PH.D., F.R.S.C., DalhousieUniversity, Halifax	Nov. 7, 1905
McKnight, Prof. William Ferrier, B.SC., N. S. Technical College, Halifax	May 4, 1923
McLatchy, Arthur C., Halifax	Feb. 2, 1923
Matheson, Donald J., B.SC., Science Master, Halifax County Academy, Halifax	Nov. 2, 1915
Munro, Lloyd A., M.A., McGill College, Montreal	Nov. 1, 1922
Murray, Prof. Forrest Hamilton, PH.D., Dalhousie University, Halifax	Dec. 4, 1923
*Nicholls, Prof. Albert G., M.D., D.SC., F.R.S.C., Halifax	Nov. 2, 1915
Nickerson, Prof. Carleton Bell, M. A., Dalhousie University, Halifax	Mar. 9, 1911
Page, William W., Halifax	Dec. 3, 1925
Piers, Harry, Curator Provincial Museum and Librarian Provincial Science Library, Halifax	Nov. 2, 1888
Read, Horace Emmerson, B.A., Halifax	Feb. 13, 1922
Redden, John Keith, Armdale, Halifax	Mar. 13, 1922
*Ritchie, Stephen Galway, B.A., D.M.D., Halifax	Oct. 3, 1918
*Robb, D. W., Amherst, N. S	Mar. 4, 1890
Robertson, William G., Halifax	Feb. 26, 1920
Sandoz, Georges A., Halifax	Feb. 26, 1925
Scammell, Harold Lambert, Pictou	Nov. 30, 1922
Schwartz, Hugh W., M.D., Halifax	Mar. 3, 1920
Sexton, Prof. Frederic H., D.SC., Director of Technical Education, Halifax	Dec. 18, 1903
*Smith, Prof. H. W., B.SC.,Truro, N. S. (Ord. Member, Dec. 1900)	Jan. 6, 1890

*Life Member

LIST OF MEMBERS

Date of Election

*Stewart, Lt. Col. John, M.B., C.M., Halifax (Senior Ordinary Member).. Jan. 12, 1885
Theakston, Prof. Harold Raymond, B.SC., Dalhousie University, Halifax........Jan. 9, 1922
Todd, Ebenezer Walter, B.A., Dalhousie University, Halifax........Nov. 27, 1919
Whyte, Earle Forrester, PH.D., Halifax........Dec. 1, 1920
*Winfield, James H., Mar. Tel. & Tel. Co., Halifax........Dec. 7, 1903
*Woodbury, William Weatherspoon, B.SC., D.D.S., Halifax........Nov. 30, 1916
*Yorston, William G., C.E., Halifax........Nov. 12, 1892
Young, Prof. Elrid Gordon, PH.D., Dalhousie University, Halifax........Nov. 27, 1919

ASSOCIATE MEMBERS

Brittain, Prof. William H , B.S.A., Macdonald College, P. Q........Nov. 2, 1915
*Churchill, Frederick C., Los Angeles, Cal., U. S. A........Apr. 3, 1919
*Connolly, Prof. C. J., PH.D., St. Francis Xavier University, Antigonish, N. S. Nov. 5, 1911
Cumming, Principal Melville, B.S.A., LL.D., Agricultural College, Truro........Nov. 2, 1915
Haley, Prof. Francis Raymond. Acadian University, Wolfville, N. S........Nov. 5, 1901
Harlow, Prof. L. C., B.SC., PH.D., Agricultural College, Truro, N. S........Mar. 23, 1905
Hatcher, Prof. Albert G., Bishop's College, Lennoxville, P. Q........Dec. 9, 1914
*MacKay, Hector H., M.D., New Glasgow, N. S........Feb. 4, 1902
Murray, Prof. Daniel Alexander, PH.D., McGill University, Montreal........Dec. 18, 1903
Shaw, Prof. Percy J., B.A., Agricultural College, Truro, N. S........Nov. 2, 1915
Smith, E. A., PH.D., F.R.S., Syracuse, N. J., U. S. A........Dec. 3, 1925
Tufts, Robie Wilfred, Wolfville, N. S ....Oct. 3, 1921
Westwood, Lieut. Ralph V., Stratford-on-Avon, England ....Dec. 5, 1918

CORRESPONDING MEMBERS

Ami, Henry M., D.SC., F.G.S., F.R.S.C., Laurier Ave., Ottawa ....Jan. 2, 1892
Barbour, Major J. H., R.A.M.C., F.L.S., London, Eng........Dec. 28, 1911
Bethune, Rev. Charles J. S., D.C.L., F.R.S.C., Toronto Ont. (Senior Corresponding Member)........Dec. 29, 1868
Cox, Prof. Philip, P.H.D., University of N. B., Fredericton, N. B ....Dec. 3, 1902
Dobie, W. Henry, M.D., Chester, England ....Dec. 3, 1897
Faribault, E. Rudolphe, D.SC., F.R.S.C., Geol. Survey, Ottawa (Assoc. Member, Mar. 6, 1888) ....Dec. 3, 1902
Ganong, Prof. William F., PH.D., Northampton, Mass., U. S. A........Jan. 6, 1890
Gates, Reginald Ruggles, PH.D., F.L.S., London, Eng........Nov. 30, 1916
Harris, David Fraser, M.D., D.SC., F.R.S.E., Dane Hill, Surrey, England........Dec. 2, 1924
Matheson, Prof. Robert, PH.D., Cornell University, Ithaca, U. S. A........Nov. 30, 1916
Mowbray, Louis L., Director of Miami Aquarium, Miami, Fla........May 3, 1907
Peter, Rev. Brother Junian........Dec. 12. 1898
Prichard, Arthur H., Cooper, Rome, Italy........Dec. 4, 1901
Prince, Edward E., LL.D., D.SC., Commissioner of Fisheries, Ottawa........Jan. 5, 1897

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*Life Member.

LIST OF PRESIDENTS

OF THE NOVA SCOTIA INSTITUTE OF NATURAL SCIENCE AFTERWARDS THE NOVA SCOTIAN INSTITUTE OF SCIENCE, SINCE ITS FOUNDATION 1862

Hon. Philip Carteret Hill, D.C.L.	31 Dec.	1862 to	26 Oct. 1863
John Matthew Jones, F.L.S., F.R.S.C.	26 Oct.	1863 "	8 Oct. 1873
John Bernard Gilpin, M.A., M.D., M.R.C.S.	8 Oct.	1873 "	9 Oct. 1878
William Gossip	9 Oct.	1878 "	13 Oct. 1880
John Somers, M.D.	13 Oct.	1880 "	26 Oct. 1883
Robert Morrow	26 Oct.	1883 "	21 Oct. 1885
John Somers, M.D	21 Oct.	1885 "	10 Oct. 1888
Prof. James Gordon MacGregor, M.A., D.SC., F.R.S., F.R.S.C.	10 Oct.	1888 "	9 Nov. 1891
Martin Murphy, C.E., D.SC., I.S.O.	9 Nov.	1891 "	8 Nov. 1893
Prof. George Lawson, PH.D., LLD., F.I.C., F.R.S.C.	8 Nov.	1893 "	10 Nov. 1895
Edwin Gilpin, Jr., M.A., LL.D., D.SC., F.G.S., F.R.S.C., I.S.O.,	18 Nov.	1895 "	8 Nov. 1899
Alexander McKay, M.A.	8 Nov.	1897 "	20 Nov. 1899
Alexander Howard MacKay, B.A., B.SC., LL.D., F.R.S.C.	20 Nov.	1899 "	24 Nov. 1902
Henry Skeffington Poole, M.A., D.SC., A.R.S.M., F.G.S., F.R.S.C.	24 Nov.	1902 "	18 Oct. 1905
Francis William Whitney Doane, C.E.	18 Oct.	1905 "	11 Nov. 1907
Prof. Ebenezer Mackay, PH.D.	11 Nov.	1907 "	12 Dec. 1910
Watson Lenley Bishop	12 Dec.	1910 "	11 Nov. 1912
Donald MacEachern Fergusson F.C.S.	11 Nov.	1912 "	13 Oct. 1915
Prof. David Fraser Harris, M.B., C.M., M.D., B.SC., D.SC., (London) F.R.SS. E. & C.	13 Oct.	1915 "	18 Nov. 1918
Prof. Howard Logan Bronson, PH.D., F.R.S.C.	18 Nov.	1918 "	8 Nov. 1920
Prof. John Cameron, M.D., D.SC., F.R.SS.E. & C.	8 Nov.	1920 "	20 Nov. 1922
Prof. Carleton Bell Nickerson, M.A.	20 Nov.	1922 "	12 Nov. 1924
Stephen Galway Ritchie, B.A., D.M.D.	12 Nov.	1924 "	4 Oct. 1926
Prof. John Hamilton Lane Johnstone, PH.D., M.B.E.	4 Oct.	1926	

NOTE—Since 1879 the Presidents of the Institute have been *ex-officio* Fellows of the Royal Microscopical Society.

The first general meeting of the Nova Scotia Institute of Natural Science was held at Halifax, on 31st December, 1862. On 24th March, 1890, the name of the society was changed to the Nova Scotia Institute of Science, and it was incorporated by an act of the legislature in the same year.

The foundation of the Halifax Mechanics' Institute on 27th December, 1831, and of the Nova Scotian Literary and Scientific Society about 1859 (the latter published its transactions from 4th January to 3rd December, 1859) had led up to the establishment of the Nova Scotian Institute of Natural Science in December, 1862.

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