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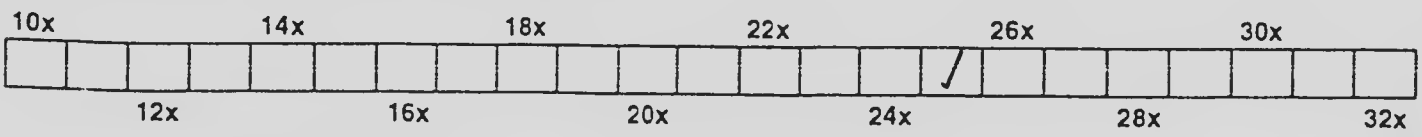

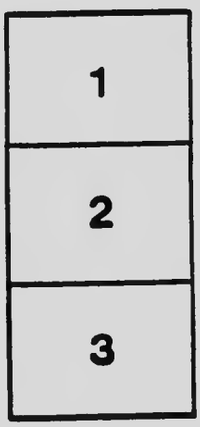

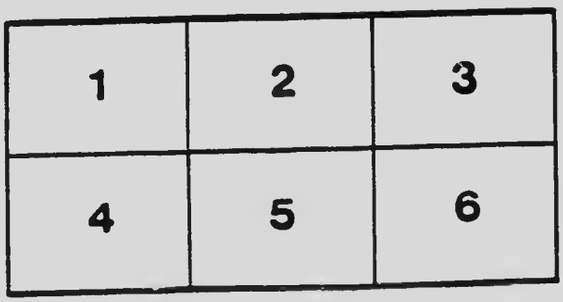

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V.—*Presidential Address. The Biological Investigation of Canadian Waters, With Special Reference to the Government Biological Stations.*

By PROFESSOR EDWARD E. PRINCE.

Dominion Commissioner and General Inspector of Fisheries for Canada.

(Read May 14, 1907.)

"How beautiful is the sea!" Cicero exclaimed in a striking passage in the "De Naturâ Deorum"....."What the number and infinitely varied forms of its inhabitants! Some contained deep in its bosom, some floating at its surface, others clinging by their shells to its rocky shores." Such were the ardent terms in which the Roman orator, a century before our era commenced, spoke of the ocean and its living inhabitants, though he little dreamed of the marvels which biological research two thousand years later would reveal to the wondering intelligence of mankind.

The investigation of the watery depths, marine and fresh-water, upon our planet, has an irresistible fascination. It is full of surprises, but its results appeal not to the imagination alone, nor merely satisfy the scientific craving for knowledge, rather do they afford practical aid of vital importance to the great industries pursued upon seas, rivers and lakes. Pre-eminently amongst modern nations has Germany realised this. France and the United States, too, have done their part, but when England handed to the German Emperor the island of Heligoland, in 1890, before any forts for defence, or new wharves for commerce were erected, a Marine Biological Station was founded for investigating the treasures of the seas around.

Though man divides the domain of nature into various fields, the divisions are wholly artificial, for nature is one, and nowhere can we find a more striking illustration of this than in the field of research with which this address is more especially concerned.

Marine Biology Benefits Fisheries.

The interdependence of all the various forms of aquatic life is, perhaps, not the least remarkable of the many impressive results of recent biological research. From the lowest and simplest vegetable forms up to the highly organised and economically valuable fishes in our waters the chain of dependence runs, and we can never hope to

satisfactorily conserve and fully develop the great resources of the deep until we have adequate knowledge of the biological content of its more important and accessible areas.

As was insisted upon and demonstrated in a masterly address delivered by Professor Ramsay Wright before the Royal Society in 1901,[1] the water is as productive acre for acre as the land, indeed more so, and until a satisfactory knowledge of the living forms floating, as the great Roman orator said, at the sea's surface, or embosomed in its depths, or clinging to its shallow shores, we shall, so far, be incapacitated from controlling and increasing the larger forms, the valuable comestible fishes upon which the fishing industries depend. These fishes, whose pursuit gives employment to the great army of Canadian fishermen, furnish a supply of esteemed food to our own and distant populations, and bring wealth to our people, through the many complex commercial enterprises included under the term "fisheries."

I cannot refrain from quoting a pregnant paragraph from the Report of the Royal Commission appointed to inquire into the Sea Fisheries of the United Kingdom, 1863, in which it is justifiably claimed that:—

"The produce of the sea around the coasts bears a far higher proportion to that of the land than is generally imagined. The most frequented fishing-grounds are much more prolific of food than the same extent of the richest land. Once in the year an acre of good land, carefully tilled, produces a ton of corn, or two or three cwt. of meat or cheese. The same area at the bottom of the sea, on the best fishing grounds, yields a greater weight of food to the persevering fisherman every week in the year. Five vessels, belonging to the same owner, in a single night's fishing, brought in 17 tons weight of fish—an amount of wholesome food equal in weight to that of 50 cattle or 300 sheep. The ground which these vessels covered during the night's fishing could not have exceeded an area of 50 acres."

"When we consider the amount of care that has been bestowed on the improvement of agriculture, the national societies which are established for promoting it, and the scientific knowledge and engineering skill which have been enlisted in its aid, it seems strange that the sea-fisheries have hitherto attracted so little of the public attention. There are few means of enterprise that present better chances of profit than our sea-fisheries, and no object of greater utility could be named than the development of enterprise, skill, and mechanical ingenuity in connection with the fishing industries."

[1] "Some Problems of Marine Biology."

Pioneer Biological Work in Canada.

But the investigation of waters so vast as those of Canada might well appal even the most stout-hearted of the devotees of science. Difficulties exist, however, not to deter but to inspire effort and, looking back over the past history of biological progress in Canada, one may at times feel disappointed at the meagre efforts and sparse results often achieved but rightly estimated we may feel justifiably proud of the pioneers who worked alone and unappreciated, and under many disadvantages, and yet gathered such a store of scientific knowledge as we in Canada possess to-day. May the *prudens questio* which stimulated them stir us, their unworthy successors!

When a boy I saw much of the venerable and rightly venerated British zoologist, the Rev. Thomas Hincks, whose monographs on hydroid and polyzoan zoology are an imperishable element in the fabric of marine biology, and I well remember the glow of delight with which he received some bottles of specimens after their long and perilous voyage from Canada, which then seemed to Englishmen as distant as Mars. That was nearly 40 years ago, and zealous observers were at work in our land then, whose specimens I saw, as later in my scientific career, I saw bottles of Annelids sent to Dr. McIntosh[1] by Dr. Whiteaves after his early dredgings in the Gulf of St. Lawrence. Mr. Hincks like his Canadian *confrères* was a solitary worker—"I am going for a holiday, get me my boots from Carley, the shoemaker," he said one day to his servant. The servant found to his amazement that the parcel containing Mr. Hincks' pair of boots measured 36 inches by 12, and might have been a young calf wrapped up in paper. The holiday was to be spent at Tenby or Torquay or some favourite resort for marine zoologists, and the boots were huge sea boots for wading in tidal pools or, working on a fishing boat amidst dredges and nets.

Northern and Southern Species in the Gulf Waters.

European naturalists were under the impression that the fauna of the shores of Canada, at least the Atlantic waters, was really of a truly Boreal character: but, over an extent of ten thousand miles of coast on the east and seven thousand on the west, a variety of faunas might be

[1] I feel bound to mention that Professor McIntosh, in a recent letter, informs me of the approaching completion of the great Monograph of the British Annelids, with its wonderful series of superb coloured plates, the work of Professor McIntosh's lamented sister, the late Mrs. Roberta Günther. This splendid and monumental work, in course of publication for over thirty years by the Ray Society of London, is an honour to that famous Society, and the *magnum opus* of the greatest of living marine biologists.

expected as great as in the waters between the Yorkshire coast and the coast of Spain, off Cape Finisterre. In the northern regions, say from Cape Chidley south through the Straits of Belle Isle to Anticosti, and even up the St. Lawrence for some distance, there occur species which belong to the Greenlandic or, as Dr. Schmitt says, the Icelandic fauna, "Dr. Henri Labonne m'a montré des brachiopodes," he says, "qu'il avait rapportés des côtes d'Islande et qui rappellent tout à fait ceux que j'ai trouvés ici."[1] Yet it was a very large specimen of *Physalia*, the tropical Portuguese Man of War, which Sir Henry Bonnycastle saw as he approached Canada from Cape Ray on August 30th, 1841, and he glowingly described its brilliant cerulean hues. Dr. Whiteaves is no doubt well justified, from his really unparalleled knowledge of the shallow and deep water fauna of our Atlantic coast, in questioning the view of Dr. A. S. Packard, that the term Syrtensian should be applied to the whole body of water, shallow and deep, of the Gulf, and Labrador, and Nova Scotia but rather that the term applies to that extension of the Boreal faura stretching from Maine, the Nova Scotia coast, the Gulf, and the outer Labrador waters across the Atlantic to Iceland and the Norway coast, from the Naze northward. It may be doubted whether, however, the term, Acadian will be found ultimately to accurately apply to the very extensive areas embracing the Grand Manan waters, Passamaquoddy Bay, Halifax Harbour, Prince Edward Island, the Magdalens, and the southern part of the Bay of Chaleurs, exclusive of the deeper parts. The great body of ice annually moving from the North Shore and possibly from Davis and Hudson Straits, down through Northumberland and Cabot Straits, and hugging the shores, occasionally remaining, indeed, on the Inverness shore of Cape Breton until June, has a potent influence on the inshore shallows, and results in that paucity of species and stunted character of specimens which have disappointed many a zealous naturalist when investigating our Gulf littoral fauna. While active forms, like fishes, and floating invertebrates, like medusæ, may mislead, faunistically, whereas non-migratory creatures like Echinoderms, Annelids, Polyzoa, Mollusks, etc., may be diagnostic, yet the recent captures of many more southerly fishes, Scomberoids, (*Scomberomorus, Poronotus, etc.,*) the Tarpon (*Tarpon atlanticus*), the Sword-fish (*Xiphias gladius*), and many sharks and dog-fishes, which favour warmer zones, must be taken as indications that bodies of warmer water interdigitate with the colder bodies sweeping from the north, and render it difficult to define faunistic areas, until the main currents off our shores have been more fully mapped out.[2]

[1] "Monographie de L'Isle Anticosti." Paris, 1904.

[2] The Tidal Survey carried on assiduously for many years by a Fellow of the Society, Dr. W. Bell Dawson, is doing much to fill the gap.

Significance of the Oyster Distribution.

The presence and absence of the oyster (*Ostrea virginica*), in certain localities, depend, we know, upon many delicate and somewhat inappreciable conditions, hence its apparently erratic distribution, and absence from most of the Nova Scotia shore and the New Brunswick side of the Bay of Fundy, over most of which coast line the Acadian fauna is recognized. Schmitt is inclined to attribute the stunted character of so many Gulf species, at any rate those along the north or Quebec shore, as due possibly to lack of food in the water "Ce nanisme," he says, "est peut-être en partie par la rareté de la nourriture résultant du peu de matières organiques en suspension et par le milieu relativement froid où l'animal ne trouve pas son optimum de croissance." The field of biological investigation is thus not merely remarkable for its geographical extent but for the complex and profoundly interesting factors, physical, chemical, etc., which determine its faunistic features.

Comparison of North Sea and Gulf of St. Lawrence.

Now, we know that such a body of water as the North Sea which is very shallow and includes a number of banks, famous as fishing grounds, has a low bottom temperature, indeed a great part of its floor, especially towards the north is covered with a stratum of cold water. This cold stratum is traced to the Polar current, while above this is the warmer inflow of the Atlantic current, still retaining something of the Gulf Stream influence. But the average depth of the North Sea is less than one hundred fathoms, over a great part of the one hundred and forty thousand square miles constituting its area; shallowing most markedly, moreover, towards its southerly margin.

The northern portions range from 160 to 306 and 400 fathoms, and still further north, deepen into the watery abyss of the Norwegian Sea, which shows 2,000 fathoms.

The famous fishing banks are much scattered; but the principal, the Dogger, lies about seventy miles directly east of Flamborough Head, Yorks, and runs north-easterly for 150 miles, being sixty miles across at its greatest breadth. The depth is only seven to twenty-four fathoms, deepening towards the north-east, and at the Great Fisher Bank increasing to forty-five and fifty fathoms. Off its southwest extremity are the Silver Pits,—a fishing bank sixty miles long,—and the depth is there twenty-five to fifty fathoms. Southeast of the Dogger are Cromer Knowle, twelve to eighteen fathoms deep, and the Leman and Dowsing Banks.

In spite of many marked differences, there has always seemed to me to be an analogy, I would say, a correspondence, between the North Sea or German Ocean, and the Gulf of St. Lawrence. I have often thought of Elisee Reclus' view that "the western coasts of Europe and Africa correspond with the eastern coast of this continent, not with the western as analogy would indicate."

Both seas are, towards the north, bound east and west by elevated ancient rock-formations, Norway and Britain alike presenting to the sea bold rugged ramparts, just as Gaspé and Newfoundland do; but there is no counterpart of Labrador in the case of the North Sea.

Both, again, become extremely shallow in their southern portions, the unresisting arenaceous beaches, of recent formation, and the friable chalk cliffs facing the German Ocean the sea perpetually devours, or as in the case of the Netherlands, large tracts of country are inundated by it just as the Chignecto Isthmus is still to some extent inundated to-day, and must formerly have been wholly submerged.

Were the Gulf and Bay of Fundy continuous?

If there was communication between Minas Basin and Halifax Harbour by the Stewiacke Valley, Grand Lake, and the lakes near Windsor Junction, to which geologists may, perhaps, raise insuperable objections, then the occurrence of oysters about Halifax Harbour, Jeddore Head, and even further east, can be understood.

The region at the head of the Bay of Fundy at any rate has been, "one of exceptional geological disturbance and complexity," as Dr. George Dawson said, and, if Prince Edward Island has been elevated not much before or after, geologically speaking, then the fauna of the Passamaquoddy waters and further south would have continuity with the waters of the Gulf of St. Lawrence. But, it may be objected that the oyster is practically absent from the Bay of Fundy proper, which forms as it were a non-ostreate region between the prolific areas of Connecticut, New York, Maryland, etc., on the south, and Northumberland Straits on the north. With the closing of the Bay of Fundy its conditions, it must be remembered, would so change that the high tides, the famous "bore," the increase in mud deposits, the stranding of ice in the shallows, and other physical, chemical, and biological changes, sufficiently account for the disappearance of the oyster. The Gulf ice would moreover not be retained in the *cul-de-sac* formed by St. George's Bay and the Inverness shore of Cape Breton. If the northern ice passed into the Gulf at all to the extent to which it does now, it would be carried, with the local fields of ice, down the Bay of Fundy, and would disappear rapidly as it passed into the warmer zones.

The average depth of the Gulf of St. Lawrence is 200 fathoms; over 300 fathoms midway between Grosse Isle, the Magdalens, and Heath Point, Anticosti; and, as Dr. Whiteaves has pointed out, more than a hundred fathoms over a considerable part of its extent.

Effect of Chignecto Upheaval on Fauna.

May it not be that the elevation which cut off communication between Chignecto Bay and Baie Verte, and between Cobequid Bay and Pictou, in other words, between the Bay of Fundy, as a whole, and the Straits of Northumberland, so affected the fauna of the waters north, i.e. the Gulf of St. Lawrence, as to leave only isolated traces of a former community of species. The Brachiopod (*Terebratulina septentrionalis*) which occurs quite plentifully in well-known patches in Passamaquoddy Bay and further south, occurs in very deep water in the Gulf, as Dr. Whiteaves has stated; the oyster occurs abundantly for several hundreds of miles south of the Bay of Fundy, but survives in the north no further than Caraquet, and, in scattered beds, all the way down to Pictou and Pugwash, while the Prince Edward Island shores are more or less an oyster bed all round.

Banks of the Gulf and Atlantic Shore.

In many ways the fishing banks of the Atlantic coast of Canada differ from the European banks referred to. They are much deeper, descending in the case of the Grand Banks to 160 fathoms, though 25 to 50 fathoms is a very usual depth. The German Bank, and Quaco Bank in the Bay of Fundy, have long been productive, but the great shelf which extends from the Seal Island grounds, off western Nova Scotia, round to Cape Breton and from the Cape North banks by way of the Magdalen Islands to Cape Gaspé, embraces the greatest fishing areas in Canada, perhaps in the world. The Grand Banks are south east of Newfoundland and are more than 600 miles long by about 200 miles in breadth, an area larger than all Italy, and the most extensive submarine elevation on our planet. The famous 'Bank codfishing' is carried on in depths of 10 to 100 fathoms, 45 to 50 fathoms being most usual; but St. Peter's Bank to the west, i.e. south of Bay Fortune, is deeper, fishing being conducted in water 130 fathoms deep. South-east of this bank is Southern Shoal Bank, and further west again is Green Bank. Towards Sable Island are Misaine Banks, and to the east, Canso Bank, while the famous Banquereau continues by the Western Bank to Sable Island Banks and south to La Have Bank and Ridges, situated between Sambro and Roseway Banks off the south eastern shores of western Nova

Scotia. The Scatari grounds and the Cape North Banks are continuous through Cabot Straits with the Gulf Banks, these banks being 75 to 110 fathoms deep, though cod-fishing is mainly confined to depths of 25 to 40 or even 60 fathoms. The Magdalen Islands form the eastern limit of fishing banks of great importance, while, to the north, Bryon Island and Bird Rocks are adjacent to splendid grounds, on which fishing is pursued in water from 14 to 21 fathoms deep. Immediately west is Bradelle Bank; Miscou, Orphan and Green Banks extending north to Gaspé. The Labrador Banks and Anticosti may be said to skirt the eastern Quebec shores, and continue as the southern and northern Labrador fishing grounds.

For three hundred years these extensive grounds have been persistently fished, and during the last fifty years not less than one hundred and fifty to one hundred and seventy-five millions of cod-fish have, as Professor Hind estimated, been taken from these waters, yet they remain the most productive cod-fishing areas known.

Most of the early popular writers included observations upon the natural history of the land;[1] but the waters are usually dismissed in curt fashion, as Zadok Thompson in one of the earliest Canadian Geographies in English, published in Canada, (at Stanstead, 1835), says "The waters of Lower Canada contain a very great variety of fishes. In the lower part of the St. Lawrence are found most of the fishes which are common to the ocean on this part of the continent, together with whales, seals, sea-cows, porpoises, etc. Most of the lakes and rivers abound in fishes, among the most important of which are sturgeon, salmon, salmon trout, shad, bass, pike, pickerel, eel, maskilonge, perch, trout, sucker, etc.," while Alex. Monro, in his admirable little school compendium of the History, Geography, and Statistics of British North America, (Montreal, 1861), though he gives an excellent list of the birds, mammals and fishes, and a botanical list also, dismisses the invertebrates with few words enumerating "lobsters, oysters, clams, mussels, razor-fish, crabs, and shrimps, all of which are found in the Gulf of St. Lawrence. Lobsters are abundant along the whole coast-line of the Gulf. Oysters are plentiful on the north east coast of New Brunswick, and south west coast of Prince Edward Island, and other places in the Gulf."

Of course some early scientific research had, it is true, been carried on in the waters of Canada, and Dr. Whiteaves has summarised the work done in his introduction to his catalogue of the Marine Invertebrata of

[1] P. H. Gosse's valuable little work, "The Canadian Naturalist," London, 1840, makes merely one or two incidental references to aquatic animals and fishes.

Eastern Canada, 1901, and I shall therefore be brief in my reference to these pioneer researches and recommend a perusal of Dr. Whiteaves' admirable outline.

Sir J. W. Dawson's Early Marine Studies.

It was as early as 1835 that Sir William Dawson collected marine animals on the shores of his native county (Pictou). His "Hand-book of Canadian Zoology," 1870, contains material that must be referred back to these youthful marine studies, but he does not appear to have published any account of his work, prior to 1858 when a popular paper, "A Week in Gaspé," was printed in the *Canadian Naturalist* (Montreal), followed by an account of sea anemones and hydroid zoophytes of the Gulf in the same journal in 1859, and a paper on "The Tubicolous Worms" of the same waters in 1860. These early dredgings were continued at intervals until 1882: but geological work during these years demanded chief attention, although an interesting study of the "Food of the Common Sea-Urchin," conducted at Tadousac, is to be found in the *American Naturalist* Vol. I, 1867. In Sir William Dawson's report on the Geology and Minerals of Prince Edward Island, a list of marine Mollusca is given by Dr. W. Bell Dawson. Dr. J. R. Willis carried on for twelve or thirteen years, from 1850 onwards, the collecting of marine shells off the Nova Scotia coast, and his first list was published by the Boston Society of Natural History in 1862, but a later list was reprinted in 1890 in the *Transactions of the N. S. Institute of Natural Science.*

Dr. Robert Bell's Investigations.

Prominent among the pioneer students of the biology of the Gulf of St. Lawrence is Dr. Robert Bell who as early as 1857 carried on marine investigations from Rimouski to Gaspé, lists appearing in the Geological Survey Reports in 1858 and 1859, some of the invertebrates being determined by Sir William Dawson. Dr. Bell continued his zoological studies in northern seas, an important contribution being printed in the Geological Survey Report 1885, the list of Mollusks obtained by Dr. Bell, in Hudson's Bay and Straits in the expeditions in 1879, 1880, 1882 and 1884 were prepared by Dr. Whiteaves, while a series of Crustaceans from Port Burwell in 1882 were described by Professor S. J. Smith.

Dr. George Dawson's Early Work.

Dr. George M. Dawson, when a student at McGill University, dredged during a summer holiday at Gaspé, and the collection then

made, with other materials, formed the basis of his first published paper. It appeared, as I mention elsewhere, in 1870, and dealt with those minute foraminiferal forms which later, in 1880, he sought for in the prolific surface waters of the Pacific. Dr. Dawson's phials of "Plankton" from Hecate Straits unfortunately perished in a fire in the West Parliamentary Block, where they were placed temporarily.

U. S. Investigations and Others.

United States' workers have been assiduous in investigating our Canadian seas, and happily there is room for all! Dr. A. S. Packard, Jr., dredged in 1860 east of Belle Isle Straits, and a list of the species secured appeared in the *Canadian Naturalist*, Dec. 1863. He extended his researches in 1864 and included the waters from a hundred miles inside the Straits of Belle Isle to Hopedale over three hundred miles up the Labrador coast on the open Atlantic. The Boston Society of Natural History published his Invertebrate Fauna of Labrador, in 1867, embracing both expeditions, 1860 and 1864, and a collection made by Professor A. E. Verrill, in 1861, off Anticosti and Mingan. Professor Verrill carried on dredging work in the Grand Manan (Bay of Fundy) waters, in 1868 and 1870, and continued them in 1872, 1877, and 1883, latterly under the United States Fish Commission. The La Have Banks and St. George's Banks were examined, as well as the deep waters south-east of Halifax, and off the western Nova Scotia coast, and in 1883 the SS. "Albatross" dredged at twenty different stations in depths of 49 to 130 fathoms, and the valuable and well-known reports in the volumes of the United States Fish Commission, the Connecticut Academy, the American Association for the Advancement of Science, and the United States National Museum, contain the results. In 1873 the British warship "Challenger," in her world-famous scientific cruise, included 31 stations off the Nova Scotia coast, and secured some notable specimens of the boreal *Astarte quadrata* and *Astarte Eschrichtii* on the La Have [illegible]. In 1876 Dr. J. A. Verkruzen made a collection of mollusca, [illegible] in Nova Scotia, and Newfoundland, publishing a small pamphlet in St. John's, Nfld., and three further accounts in Germany. The year following saw Dr. Matthew Jones' list of N. S. mollusks appear in the *Trans. N. S. Institute of Natural Science*, and Dr. W. A. Stearns, in the same year, dredged along the Labrador coast for about 120 miles from Forteau Bay, Belle Isle Straits, to Square Island, and his lists were published in the Proceedings of the U. S. National Museum, the sixth volume. Mr. L. M. Turner made collections of marine animals along the extensive shore from Hamilton Bay north to Cape Chidley,

and round into Ungava Bay to Fort Chimo. The mollusca were reported upon by Dr. W. H. Dall, in the proceedings of the U. S. National Museum, IX, 1886. Professor W. F. Ganong, a native of New Brunswick, from 1884 to 1888 collected Mollusca, Echinoderms, etc., in the rich waters of southern New Brunswick, and published a number of papers in the N. B. Natural History Society's Bulletins, and issued a popular little volume on the "Economic Mollusca of Acadia." The various Dominion Government expeditions to Hudson's Bay, though their primary object has been in recent years to determine the conditions of navigation, have always done some marine zoological work, and interesting collections have been made in 1894, 1897-8 and 1899, and the recent expedition of the "Neptune" under Mr. Low, the head of the Geological Survey, has similarly added to our knowledge of these cold northern waters. While I must omit special mention of work confined within the limits of a single group, I cannot forbear mentioning the really splendid contributions which Mr. Lawrence Lambe for so many years has made to Poriferan Zoology, the minute descriptions, and above all the exquisite plates, are a source of pride to every Canadian, and form a worthy basis for future studies of our Arctic, Atlantic, and Pacific sponges. The papers on fishes, etc., by Dr. M. H. Perley, whose first reports were made to the Legislature of New Brunswick, in 1852, and those by Mr. T. F. Knight, in 1866, to the Nova Scotia Government, were largely compilations, though valuable for their purpose, but the Rev. John Ambrose's papers on N. S. fishes, published by the N. S. Institute of Natural Science, and Dr. J. B. Gilpin's similar accounts of the Gaspereau, and other economic fishes, published by the same society, 1864-65, 1865-66 and 1866-67, are of peculiar interest. Mr. Harry Piers, of Halifax, has added to our knowledge of the fishes, and Dr. Philip Cox, of Chatham, N.B., has done valuable work in the smaller fishes, chiefly fresh-water species, though in 1895 he made a special investigation of the smelt and striped bass, under the auspices of the Marine and Fisheries Department.

Dr. Whiteaves' Deep Sea Researches.

But there is one omission, which on the principle of leaving the best to the last, I must now supply, viz., the laborious researches of that brilliant veteran in marine biology, as in fossil biology or palæontology, Dr. Joseph Frederick Whiteaves. Dr. Whiteaves began his famous dredging expeditions in 1867, just 40 years ago, and in that year and in the second succeeding year (1869) made collections inside Cape Gaspé, in the Basin, and outside the Cape, off Cap des Rosiers, the results being published in the *Canadian Naturalist*. The Natural History Society

of Montreal, to their honour, encouraged the work, and the Marine and Fisheries Department gave its countenance as well as the aid of certain Government vessels; so that three separate dredging cruises were carried out in 1871, 1872, and 1873, and I can imagine no surprise more pleasurable than that of an intelligent reader wading through all the wearisome farrago called a Government report, coming suddenly upon the report on deep sea dredgings, addressed in 1871 and 1872 to the Hon. Peter Mitchell, and in 1873 to the Hon. A. J. Smith, and finding a profoundly interesting account of arduous labours on the deeps of the Gulf of St. Lawrence. "No researches with the dredge had ever been made in the deeper parts of the River St. Lawrence or Gulf until the summer of 1871" Dr. Whiteaves states in his first report, dated Dec. 29th, 1871. When this report was published "not one-twentieth" of the material obtained had been examined, eleven large bag-fulls of mud being brought up from depths of from 100 to 250 fathoms, and yielding eight characteristic deep-water foraminifera, on a very cursory examination. At that time not more than 50 species had been determined in the Atlantic waters of Canada, and Dr. Whiteaves estimated that at least one-third more would be added, after his specimens had been diagnosed. His recent list gives about sixty-four species of these Protozoans as determined for these waters up to 1901. A number of sponges, hydroids and actinians were obtained, and very notable was the series of beautiful carmine-coloured sea-pens, *Pennatula aculeata*, Dan. from deep-water between Anticosti and the south shore of the St. Lawrence; as was the capture next year (1872) of the long *Virgularia Ljungmanni*, Kollr., while the echinoderms were remarkable, including as they did *Schizaster fragilis*, Duben and Koren, *Ophioglypha sarsii*, Lut. *Ophiacantha bidentata*, Retz. *Amphiura Sundevalli*, Mull. and Troschel, and the complex *Gorgonocephalus Agassizii*, Stimp. The annelids appeared to embrace probably 20 species; and a fine collection of crustaceans; about 20 polyzoa; and a few tunicates. Of the 26 mollusks of special interest 15 appeared to be species, new to the continent, and two new to science. The practical aspects of the work were made prominent, and over 500 stomachs of cod fish were examined to decide the nature of the food which attracted the schools to their habitual resorts.

All these reports are of inestimable value, and their character may be judged by the fact that the second report, dated January 11th, 1873, includes, apart from fishes, 190 species of invertebrates; mollusks 19; tunicates 10; polyzoa 39; crustacea 30; annelids 23; echinoderms 28; sponges about 20; protozoans about 20, in addition to a large number of annelids, etc., which were in course of determination. In 1874 a still larger list was the result of over nine weeks' work, conducted very often

under stress of stormy weather, for the species named number over 200, some series consisting only of the scarcer species secured, and omitting well-known common species. Besides a few fishes the list is as follows: tunicates 15; mollusks 54; annelids 51, the collection of worms being in Scotland undergoing examination by the famous authority Professor W. C. McIntosh; crustacea 72; polyzoa 15; echinoderms 22; hydroids 21; spouges 13; a list which included quite a number of new species in many groups, and which has grown into the imposing "Catalogue of the Marine Invertebrata of Eastern Canada," with which Dr. Whiteaves, it may be proudly claimed, ushered in the new century. Each of these valuable faunistic reports had its value largely increased by the extremely practical notes and recommendations on oyster fisheries, and on lobster, mackerel, and other important fishing industries, which formed addenda; and I may add that the force of some of Dr. Whiteaves' recommendations has not diminished with the lapse of thirty years. It would be unpardonable to overlook the last addition to the faunistic publications for the Gulf, or rather a northern portion of it, viz: Dr. Joseph Schmitt's fauna of Anticosti, forming part IV of his beautiful "Monographie de L'Ile d'Anticosti" dedicated to M. Henri Menier to whose munificence Dr. Schmitt owed the opportunity of making his very full survey of Anticosti Island. Published in Paris in 1904, it embraces the physiographic and biological features of that locality; and its marine biological portion, as the author states, especially so far as the deeper waters are concerned, owes much to the recorded dredgings of Packard and Verrill 'et surtout ceux du Dr. Whiteaves."

British Columbia Waters a Promising Field.

I had proposed speaking somewhat fully about that great, almost unparalleled field for biological research which the Pacific coast of Canada offers to the ardent zoologist. No one who has cast a dredge over the bow of a vessel into these prolific waters, crowded with exuberant life, can doubt that there is no land of promise, or to avoid the Hibernicism, no water of promise, offering greater reward to the biologist. In the course of a day's dredging, as recorded in this Society's Transactions, no less than 150 species comprising 3,000 specimens were taken in Departure Bay, near Nanaimo, many of them new species. Plankton work has been untouched there if we except the tow-nettings of Dr. George Dawson in 1885, and my own in 1894, both series of specimens suffering the same fate in the fire of 1896. Though Gould in 1856 described some Pacific invertebrates in the Pacific Railway Report, Vol. V, yet it was Dr. Philip Pearsall Carpenter's "Mollusca of the West coast of North America," presented to the British Associa-

tion in 1856, which first indicated the richness of the British Columbia marine fauna. He had, in conjunction with Gould already treated the subject in the Zool. Soc. Proc. of London in 1856, and he followed these contributions by many others, until his paper on the Acmæidæ of Vancouver, issued in 1866, in the American Journal of Conchology, Vol. II.

Mr. J. K. Lord's faunistic list, published after the conclusion of the Pacific Boundary Commission 1863, is useful but fragmentary, though Kennerley's collection made at the same time is important. Mr. John Richardson, in 1874 and 1875, collected on behalf of the Dominion Geological Survey, at various points from Victoria Harbour to Deep Bay, 90 miles further north, and he included Burrard Inlet. This collection with one privately made by Mr. R. Middleton, of Victoria, was examined by Dr. Whiteaves, who had the aid of certain specialists, and the first list including 7 hydroids, 2 alcyonarians, 10 echinoderms, 3 polyzoans, 5 brachiopods, 83 mollusca, 19 crustaceans, and was published in the *Canadian Naturalist*, Vol. VIII, 1878. Judge J. G. Swan, of Port Townsend, U.S., continued the faunistic work in B. C. waters and in Puget Sound; but to Dr. Dall we are chiefly indebted for our knowledge of the Pacific marine fauna from the time of the appearance of his catalogue of Bering's Sea and Pacific shells (Proc. Calif. Acad. Sci. Vol. 5) in 1874 down to the present time. Dr. Whiteaves has from time to time added to the list, his "Invertebrata of Vancouver Island" in the Royal Society Transactions 1886 being important. It was in 1886 that Inspector Thomas Mowat made a tour of fisheries inspection along the coast to Queen Charlotte Islands, and reported on the cod and deep-sea fishery resources. In 1893 Professor John Macoun made fine collections of marine forms at Comox, Sooke, Nanaimo, etc., but a most notable piece of work is Dr. F. C. Newcombe's Report on the Marine Shells of British Columbia (Nat. Hist. Soc. of B.C., Victoria, 1893).

Dr. Newcombe has done splendid work, especially in the marine mollusks, in studying which he dredged over a very extensive area along the British Columbia coast and published remarkably comprehensive lists. But a Fellow of this Society occupies no second place as a marine investigator in Pacific waters.[1] His collections are indeed an indication of what an accomplished zoologist, occupied with many other duties can do in this Eldorado of marine biology. Nor must John Fannin's work be forgotten: British Columbia has had few more enthusiastic lovers of nature. He was much more than a museum curator and taxidermist. The specialists of the United States have long recognized the peerless

[1] The Rev. George W. Taylor, of Wellington, near Nanaimo, B.C., who published the first of a number of lists in 1894. (R. S. Trans.).

nature of our Pacific coast waters,[1] and it may be doubted if the "Albatross" has anywhere secured, in so short a time, and with such ease, a mass of living treasures to compare with those obtained in her cruise in 1890 along the west shores of our Dominion. May the biological station sanctioned by the Dominion Government be equipped and be actively engaged in reaping the harvest of these gem-studded shores, at the earliest possible moment!

A Dominion Biological Station for British Columbia.

The project for a marine biological station for British Columbia has never been allowed wholly to remain in abeyance, and enthusiastic scientists have never ceased to harbour the hope that the Dominion Government would realise the necessity of scientific investigation in the Pacific waters as appropriately as they did on the Atlantic coast. But no public statement was made to the country until the able and far-seeing representative for Comox-Atlin, Mr. William Sloan, M.P., in a memorable speech on fishery matters declared, on January 18th, 1907, to the Federal House at Ottawa that there ought to be no delay in founding a scientific laboratory for fisheries' research on the coast of British Columbia. Mr. Sloan said that he strongly favoured a marine biological station in British Columbia, and went on to announce (Hansard Debates, 3rd Session, 10th Parliament, Ottawa, 1907) that:—"The proposed establishment of the station has been everywhere accepted as being necessary in extending a more definite knowledge as to the economic values contained in our seas and the further extending of facilities for investigation and scientific research would be beneficial to our fisheries."

Foundation of Canadian Biological Station, 1898.

When the Biological Station on the Atlantic coast was founded by the Dominion Government in 1898, it had in numerous ways a field of vast possibilities before it, though, as we have seen, many a scientific worker had "ploughed the furrow alone" during the previous fifty or sixty years. Several causes had contributed to bring about the consummation. A report of my own in 1894,

[1] Dr. Stearns and others have described the specimens obtained, in such publications as the Proc. U. S. Nat. Museum, Vol. XIII, etc., and Professor Starr Jordan's classic works on fishes include a large number of descriptions based on British Columbia examples.

Drs. Jordan and Bean, it may be added, cruised along the B. C. coast and made collections so long ago as 1880, and paid special attention to the cod and halibut resources.

had favoured a marine biological station, for attacking fishery problems in Canada as they had been attacked, and in many cases solved, in other countries; but it was a letter of Professor Knight of Queen's University, Kingston, addressed to the secretary of the Royal Society on May 6th, 1895, which gave the proposal a practical shape, and after Sir John Bourinot had referred the matter to Section IV, it was decided to bring the proposal before the British Association, which appointed a committee in 1896, the members of which met in Toronto, under the presidency of Professor Miall, F.R.S., from whom, I may be pardoned for mentioning, I received my first training in Comparative Anatomy nearly a quarter of a century ago. The committee, as constituted in Oct. 1897, consisted of Professor John Macoun, Professor T. Wesley Mills, Professor E. W. MacBride, Professor A. B. Macallum, Mr. W. T. Thistleton-Dyer, (Director of the Royal Gardens, Kew), Professor D. P. Penhallow as secretary, and myself as chairman. It held a meeting in the Botanical Laboratories of McGill University (Professor Penhallow's Department), and it was decided to memorialise the Government for support. Sir Louis Davies was, at that time, Minister of Marine and Fisheries, and gave a most kindly reception to the deputation, representing this Society, the various universities, and certain scientific bodies, whose delegates were as follows:—Toronto University (Prof. Ramsay Wright), Queen's University (Sir Sandford Fleming), Laval University (Mgr. Laflamme), McGill University (Prof. D. P. Penhallow and Prof. E. W. MacBride), Dalhousie University (Prof. B. Russell, M.P.), The Royal Society of Canada (Prof. D. P. Penhallow), Nova Scotia Institute of Science (Professor Benjamin Russell), The Canadian Institute (Prof. A. B. Macallum), Natural History Society of Montreal (Dr. F. D. Adams), and the Natural History Society of New Brunswick (Prof. Bailey).

An appropriation was passed by Parliament, and a station was built. This building has been described as resembling a Pullman car externally, and is placed upon a scow so that it could be towed from one location to another. Its total length is 50 feet, and the main laboratory is 30 feet by 15 feet in breadth, and it is provided with shelving, tables, porcelain basins, and salt-water and fresh-water supplies. A small library apartment, and other rooms, afford storage accommodation. A good working library has been collected, including the magnificent "Challenger" reports presented by the British Government through the Right Hon. Joseph Chamberlain, and a considerable series of valuable papers and reference works. A small launch, 22 feet long, and nets, dredges, &c., and an assortment of glass-ware, add to the equipment.

The Station's Nine Years' Work.

During the first two seasons at St. Andrews, N.B., Professors Knight (Queen's), A. B. Macallum (Toronto), James Fowler (Queen's), E. W. MacBride (McGill), Dr. B. B. Bensley (Toronto), Dr. B. Arthur Bensley (Toronto), Dr. Joseph Stafford (McGill), Dr. F. S. Jackson (McGill), Dr. F. H. Scott (Toronto), Professor Bailey (Fredericton), Miss Ganong (St. Stephen) Dr. A. H. MacKay (Dalhousie), and myself, attended the laboratory and, in some cases, carried on extended investigations.

A couple of seasons has been spent at each place and the locations chosen have been as follows: —

1899-1900 St. Andrews, New Brunswick.
1901-1902 Canso, Nova Scotia.
1903-1904 Malpeque, Prince Edward Island.
1905-1906 Gaspé, Quebec.

A great variety of investigations has been carried on, some of these being of prime economic and practical importance. The station has kept prominently before it, in all its work, the benefit of the fisheries, while carrying on in a thoroughly accurate and scientific way its seasonal investigations. Professor Ramsay Wright's laboratory studies of the minute floating life in Atlantic waters off Canso, which are on the eve of publication, are, one may declare, fundamental. If I may be allowed to quote from the paper, not yet issued, I should lay stress upon these minute microscopic researches, and say, in Professor Wright's own words:—

"On land the vegetable kingdom everywhere seems to be predominant, and to account amply for all the animal life which feeds on it directly or indirectly. But in the ocean, the obvious plants—the seaweeds, brown, green and red—form a mere inconspicuous fringe of vegetation along the shore, and do not extend out beyond a few fathoms in depth. Such a fringe of vegetation can practically be neglected as the basic food-supply of the animal life of the ocean, and the question comes to be, 'Whence do marine animals derive their fundamental supply of nourishment?' Living creatures are either builders or destroyers of protoplasm, or in familiar parlance, either plants or animals, and the former are necessary to sustain the life of the latter. In what form then do these necessary protoplasm builders exist in the sea and other great bodies of water?

The answer is, in the form of miscroscopic plants, often quite invisible to the naked eye and yet present in such enormous numbers, not only at the surface but through the whole of the superficial layers of

waters, some sixty fathoms deep (as far as the sun-light reaches, on the presence of which their power to build protoplasm depends) that it has been calculated that an acre of sea-water—surface measurement—furnishes as much nutritive vegetable matter as does an acre of rich meadow land in the course of a year.

No one sailing over the Atlantic suspects the presence of such a rich vegetation, and indeed it can only be disclosed by filtering the water through an exceedingly fine fabric—the finest silk gauze used by millers is that generally employed for the purpose—and this is usually done by towing a net of such a fabric behind a boat so as to insure a definite amount of water passing through it.

Investigations made in this way may be either qualitative—merely to determine the nature and relative numbers of the organisms so captured—or quantitative—to determine the absolute amount of the different kinds of organisms in a column of water of given dimensions.

It is such quantitative investigations which have rendered the statements as to the richness of the marine vegetation possible, which are made in the foregoing paragraph.

The tiny organisms obtained in this way are not all plants, many of them are animals, feeding on the former, and themselves serving as food for larger creatures."

This floating surface life must on some parts of our Atlantic coast include, in numbers beyond all imagination, the floating larvæ of mollusks like the oyster and various species of clams. Dr. Whiteaves in his deep-sea dredging report in the Gulf of St. Lawrence, 1873, gives the statement of the late Hon. W. H. Pope:—"Oysters have flourished in every tidal river and bay in Prince Edward Island," and even the reduced areas in that Province, in New Brunswick, and in Nova Scotia, still produce a crop of young whose numbers exceed the powers of man to comprehend. The propagation of the oyster justifiably claimed Professor Wright's special attention at Malpeque, and various methods of oyster culture, the collection and retention of spat, the rearing of seed oysters under control, etc., were tried, while Dr. Stafford made some important additions to our knowledge of the 'veliger' of this valued shell-fish, including the discovery of an eye or visual organ, not described before by Brooks, Ryder, or any previous authority, though in the Mussel (*Mytilus*) an eye-spot occurs, as Dr. J. H. Wilson discovered at St. Andrews in Scotland. The experiments conducted in connection with the station, in which Captain Ernest Kemp with his Government steamer "Ostrea" aided, will no doubt give some guidance to the Government in dealing with that esteemed mollusk, which is decreasing

in Canada in the proportion that the commercial demand and market value increase.

The 'saw-dust *versus* fisheries' question has been one of the most thorny problems faced by the Dominion Government during many years. *Ex cathedrâ* opinions were not wanting, but no accurate experiments had ever been carried out to reveal the actual facts, until Professor Knight, of Queen's University, Kingston, tackled the much-debated question. Professor Knight, during the whole history of the Biological Station, has been continuously at work, carrying on researches of the highest moment to the fisheries of the Dominion, and the complex saw-dust question was only one of these. The three reports either already published, or now being published, by the Government, will afford a basis for future public policy on the matter. But other hardly less pressing fishery questions have occupied Professor Knight as a member of the Biological Station's staff. He has tested the results of dynamite in pollack and cod fishing, a nefarious method which United States' poachers, and Canadians following their evil example, have illegally adopted it. of Fundy waters. Its destructive wastefulness is established by Mr. Knight's experiments, carried out at some bodily peril, and requiring unwonted skill and care. Further, the same gifted worker tried the effects of various lobster traps designed to permit the undersized examples to escape, and last year he tested practically the merits of frozen, fresh, and of salted bait, in view of the controversy carried on by fishermen all along the coast when the Government-aided bait freezers were inaugurated to assist them in months of bait scarcity. Large numbers of fishermen had stigmatized these bait freezers as a doubtful boon. The lengthy investigations of Professor Macallum, while they have their practical side, too, are of profound interest from the physiological and technical, as well as the higher theoretical and philosophical point of view, and his "Chemistry of Medusae" researches are a notable addition to the original work of Canadian biologists. The "Further Contributions to Canadian Biology" now in the press, include this paper in a brief popular form; but the original memoir, giving the detailed analyses, must be consulted in the *Journal of Physiology*, Vol. XXIV. There is such a fascination about Professor Macallum's results that I cannot forbear stating that they demonstrate specific chemical, as well as morphological, and anatomical distinctions between species of jelly-fishes; an independence of sea-water environment; and a power of selective preference for the salts of sea-water, which are most striking; and, lastly, the inorganic composition of these lowly and simply organised creatures, almost the simplest of Metazoa, reflects the composition of the water, not of the oceans of to-day, but of past geological

periods, possibly the seas of very remote geological ages. Dr. F. H. Scott took the food of the sea-urchin as a subject, and, from the examination of several hundreds of echinoderms, concluded that minute plants, protozoans, etc., formed the staple food of these creatures, where carrion and sea-weeds were not plentiful. The last-named materials were devoured if available; but it appeared improbable, as had been maintained on the western Nova Scotia shores, that extensive tracts could be wholly denuded of sea-weeds by these echinoderms. This denudation was, it may be added, regarded as the cause of the salmon and cod and other fishes forsaking the littoral regions. Some able researches were conducted by Dr. R. R. Bensley (now Professor in Chicago) including faunistic work in Passamaquoddy Bay, and Dr. B. Arthur Bensley, amongst other studies, completed a paper on "The Sardine Industry in relation to the Herring fisheries of New Brunswick," and showed that small herring, 5 to 7 inches long, formed the main part of the so-called Canadian sardine catch, upon which the flourishing town of Eastport in Maine, the centre of the sardine canning industry, largely relies for raw material.

Dr. Joseph Stafford has been the most devoted member of the staff of the station and has never missed a single season, usually being the first to arrive and the last to leave. His zeal and his scientific accomplishments justified his selection as curator of the station, and it is impossible to over-estimate the value of his unceasing labours to the institution. Dr. Stafford has paid special attention to the fauna in each of the four localities where the station has been beached, and it is possible that the collection of specimens and the faunistic lists he has in preparation will be a welcome addition to Dr. Whiteaves' invaluable list of the Eastern Canadian invertebrata. Dr. Stafford has made for himself a reputation as a specialist in Helminthology, and parasites generally, and his papers published in Germany, the United States, and Canada, bear testimony to his skilled and indefatigable powers. Amongst numerous papers by Dr. Stafford, the fruit of the work at the station, I can only mention one, as an example, viz., the paper in the "Zoologischer Anzeiger," May, 1904, on "Trematodes from Canadian Fishes," describing 58 species, belonging to no fewer than 16 new genera, and 13 new species, a very striking record in a single paper. I have referred to Dr. Stafford's interesting embryological work in oyster development, but while the station was at St. Andrews the clam industry there attracted his attention, and in 1904 appeared his report on "The Clam Fishery of New Brunswick," with four beautiful plates by Mrs. Stafford, a singularly gifted scientific artist, whose early death was a loss to Canadian science. As a fishery official I know that this report

has been of real practical value, and the Government have supplied a large number of applicants with copies of it, for it not only treats of the structure, life-history, and utilisation of the clam (i.e. the various Atlantic species), but suggests means of conserving the clam industry and of recuperating depleted beds.

At Canso and at Malpeque interesting captures of fishes were made and Mr. Geo. A. Cornish, Science Master at Lindsay Collegiate Institute, and Mr. C. McLean Fraser, of the High School, Nelson, B.C., prepared accurate descriptions, as many of the specimens differed in essential features from specimens described in current works; and Mr. Cornish has completed a descriptive list of Canso fishes. The latter worker also wrote a report on the Polyzoa of Canso; but the marine botany has not been neglected. Mr. C. B. Robinson, formerly of Picton Academy, now of the New York Botanical Garden, Bronx Park, New York, making a collection of the Algæ of eastern Nova Scotia, and a carefully prepared list is now in the press.[1] Dr. Mackay, Superintendent of Education for Nova Scotia, has also contributed a list of the Diatomaceæ of Canso. Professor James Fowler, Queen's University, has been very loyal to the station, and the staff have always been glad to welcome this Nestor of Canadian Science professors, who at three out of four locations, has made large collections of the flowering plants; and of the St. Andrews and Canso floras has completed very full lists. An important piece of original work has been that of Mr. J. C. Simpson, an able member of the staff of McGill's University assistants, who made a very thorough study of the Protozoa of Gaspé Basin waters, following in the wake of the truly eminent Dr. George Dawson who, as already mentioned, did his first original research at Gaspé, and chose the Protozoan Foraminifera, publishing a paper, his first of over a hundred and thirty papers, under the title of "The Foraminifera of the Gulf and River St. Lawrence," (*Can. Nat.*, June, 1870, and *Ann. of Nat. Hist.*, Vol. VII, 1871). My own work has covered many subjects, but only two investigations appear in the "Contributions" published from the station, one on the larval and post-larval Gaspereau, as compared with the herring and other Clupeoids, with coloured plates, now printing, and an account, in conjunction with Dr. Mackay, of the remarkable pectoral fins of the mackerel shark (*Lamna cornubica*). The work done at the station by such able workers as Professor MacBride, Professor J. J. Mackenzie and others, will, no doubt, appear in published form in further printed "Contributions" ere long. Others of the staff, who have spent longer or shorter periods at the station, including Dr.

[1] Dr. G. U. Hay's list of N. B. Algæ is the only one I know hitherto published in the Maritime Provinces.

Linville of New York, Dr. T. Slater Jackson, of Montreal, Mr. H. E. Bowser, of Kingston, Mr. A. Bruce Macallum, Toronto, Miss Ganong, St. Stephen, Dr. Etherington, Kingston, and others, will be included in a future list embracing all papers published, which in any essential way owe something to the facilities for study which the station has afforded these workers.

Stations on Atlantic, Pacific and Great Lake Waters.

The building of a permanent Atlantic station has been decided upon, and will be accomplished, at an early date. The rolling stone proverbially gathers no moss, and a constantly shifting biological station loses much by its instability. With a permanent well-equipped institution on the Atlantic coast, and one on the Pacific coast, and a third, of which I have not had time to say anything, on the Great Lakes, biological research will, surely, make up for lost time, or, if not for time lost, for time past.

If with small means, and under difficulties, great things were achieved as I have endeavoured to show, who shall say what may not be accomplished, in the immediate future, with greater facilities and with greater means?