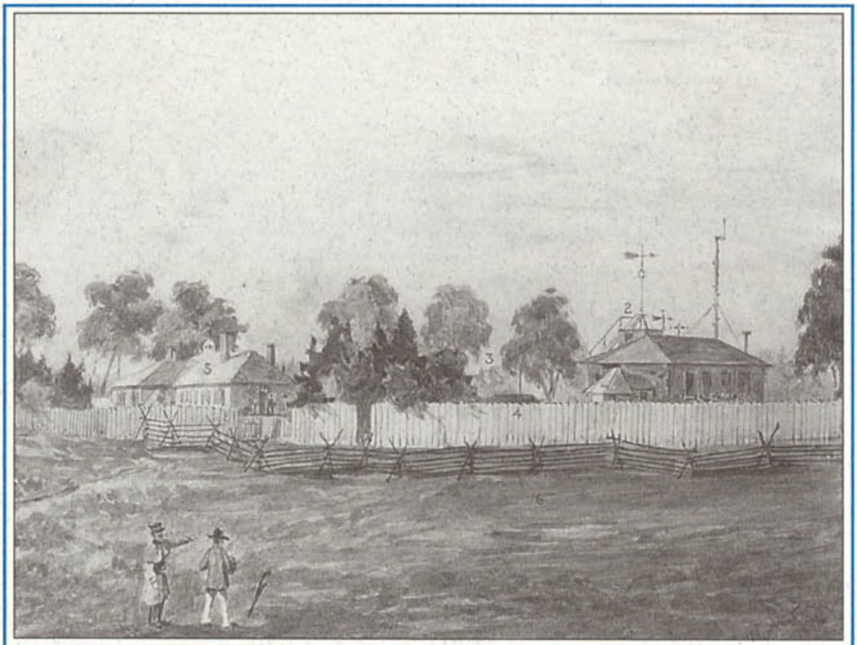
Land of Promise, Promised Land:

The Culture of Victorian Science in Canada

Suzanne Zeller



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Toronto Observatory, 1852, on the site of Convocation Hall, University of Toronto. Photograph of a water colour by William Armstrong. Courtesy of the Metropolitan Toronto Library, T 13025.

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Land of Promise, Promised Land: The Culture of Victorian Science in Canada[1]

> *An attentive eye, it is true, cannot fail to acquire information, ever new, among the countless objects of creation, at all times, and under all circumstances; but the more fully to avail ourselves of our opportunities, I would propose to you a more regular and definite course of investigation.*
>
> –P.H. Gosse, *The Canadian Naturalist* (1840)

The Canadian landscape has long held a fascination for its inhabitants. A perennial theme in the country's literature has been that of survival in a harsh northern environment, of fragile yet persistent identities impressed over time by nature's relentless challenges to everyday existence. Its history too has echoed the creative influences of geographical determinism, epitomized in Harold Innis's classic *The Fur Trade in Canada* (1930) and the Laurentian school of historians whom Innis inspired. In this view, the country took form in North America "not in spite of geography, but because of it." Landforms, resources, and river routes seemed to have shaped Canada's boundaries both by illuminating possibilities and by demarcating limitations for its political and economic existence.

Yet geographical structures alone cannot explain how people construed their experiences of the natural environment, and developed responses to it. In large part, their perceptions were conditioned by culture, the intellectual and social framework within which one not only formulates beliefs, fears, and expectations, but also identifies problems and attempts solutions. Throughout the British Empire, the United States, and even beyond, from the 1830s until after 1900, Victorian culture attributed increasing importance to science, the rational study of nature, as a dominant mode of thought. Representing not only a body of knowledge about the natural and physical world, but also an accepted method for accumulating it, science extended its authority broadly within Victorian society. Under the rubrics of natural history (which became biology and

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geology) and natural philosophy (which became physics and chemistry), science promoted empirical analyses of subjects that traditionally belonged to the more speculative realms of religion and philosophy.

Heritage of Victorian Science

A complex heritage fed the worldview of Victorian science, from sources including both the 17th-century Scientific Revolution and the 18th-century Enlightenment. The intellectual legacy of Sir Francis Bacon (1561-1626) encouraged a firm belief in the inductive method of reasoning. In Bacon's *New Atlantis* (1627), knowledge of nature generated the power to predict and control its workings, and could best accrue through data derived from observation and experiment. Baconian philosophy ultimately promised material improvement, a compelling proselytizing incentive that invited as many people as possible to participate in scientific pursuits to this desirable end.

The heritage of Sir Isaac Newton (1642-1727) added powerful mathematical support for this mechanistic view of nature. Newton's *Principia Mathematica* (1686-87) demonstrated that the universe functioned like clockwork, subject to discernible and even quantifiable laws. The predictive powers of Newton's formulations reinforced future generations' faith in the fulfilment of Bacon's earlier promise.

Furthermore, the heritage of Enlightenment thought emphasized the importance of collecting, cataloguing, and disseminating scientific information as widely and rationally as possible. Important examples included Diderot's development of the modern encyclopedia for cataloguing knowledge and making it readily accessible; and Linnaeus's universally adopted system for classifying animals, vegetables, and minerals according to species grouped in families.

As an increasingly dynamic component of European culture, science played a formative role in the history of North America. Ramsay Cook reminds us that from the 15th century, Europeans mythified the New World in Biblical terms, as a land of promise. Requiring only cultivation to reach its full potential, it seemed, this wilderness could become a veritable Garden of Eden, a promised land. Environmental historians emphasize the Eurocentric assumptions underlying this myth of the New World: dichotomized images valued garden over wilderness, 'civilization' over 'savagery,' and permanent settlement over nomadic lifestyle. Such assumptions helped to rationalize the large-scale expropriations of this land that accompanied European colonization.

Within this perceptual framework, science offered British North American colonists during the Victorian age more than a common cultural matrix for dominating their physical surroundings. It also suggested practical means for so doing. Science enabled colonists to make sense of the New World by translating and adapting the experience of the Old. Victorian science, in particular, transformed British North Americans' vision of the land they inhabited. It broadened their horizons and emboldened their expectations, breeding confidence in the potential future of a transcontinental nation designed to emulate the rapid industrial and material progress of Great Britain and the United States.

Characteristics and Contexts

Victorian science drew its power during the early 19th century from a dual set of urgent needs: the British economy needed new sources of raw materials during the Napoleonic Wars; and British colonists needed the means to master their environment. Imperial as well as colonial attempts to fulfil these requirements were shaped by important cultural factors, including the utilitarian, amateur naturalist, and natural theology traditions; new geographical trends in science; and Scottish intellectual influences.

Strong utilitarian values underpinned Victorian science, reflecting deeply practical roots in British culture. This tendency to prize what was seen to be useful intensified during the 18th-century Agricultural and Industrial Revolutions, which promoted new possibilities for material rewards through scientific applications. Science provided useful tools to increase the productivity of the land, to locate and utilize sources of mineral wealth, and even to avoid violent social upheaval after the French Revolution, by reordering society on rational principles. The success of science in enhancing wealth and stability encouraged further investment in public projects including exploratory expeditions, specialized surveys, and other organized activities such as natural history societies and museums, and industrial and agricultural exhibitions. With specific practical as well as theoretical goals in mind, Victorian society transformed science from a peripheral leisure-class activity to a fundamental basis of modern industrial civilization.

An important blueprint for transposing Victorian expectations of economic progress to British North America can be found in Lord Durham's *Report* (1840). John George Lambton (1792-1840), the Earl of Durham, visited Canada briefly as governor general of British North America in the aftermath of the Rebellions of 1837. Heir to a large estate on England's great northeastern coalfield, Durham had been thoroughly schooled in the practical role of science, especially geology and chemistry, in promoting social and material progress. Although simplistic in its ready acceptance of such direct connections, Durham's outlook linked a fashionable interest in science to his understanding of patriotism and the national good. His influential *Report* reflects the blinding power of this ideology of progress, in misperceiving as backward peoples those (including French Canadians) who did not share its utilitarian priorities.

More generally, organized scientific activities in Victorian culture derived from a passion to understand nature. A longstanding amateur naturalist tradition among educated classes in British society stimulated aesthetic as well as intellectual tastes for nature and natural objects. Natural history made it fashionable to go on nature walks, to observe plants and animals in their seasonal cycles, and to collect and classify natural specimens. Notebook, sketchpad, collecting box and butterfly net (the latter sometimes discreetly disguised as book and umbrella) became accoutrements of the genteel naturalist. Members of the aristocratic and rising commercial and professional middle classes habitually recorded sightings of flora and fauna, weather conditions, planting and gardening routines, and other eclectic information. An enormously successful example of the amateur naturalist outlook is preserved in Gilbert White, *The Natural History of Selborne* (1788), a charming collection of letters describing the natural environs of an English clergyman's parish, and one of the most frequently re-published books in the English language.

White's amateur naturalist sensibility inspired immigrants as well as visitors to British North America. Most prominently, Catharine Parr Traill's *The Backwoods of Canada* (1836) and P.H. Gosse's *The Canadian Naturalist* (1840) developed similar literary responses, using science to comprehend an otherwise bewildering new environment. "It is the most unpoetical of all lands," lamented Traill, "there is no scope for imagination...; there is no hoary ancient grandeur in these woods, no recollection of former deeds connected with the country." Traill and others found comfort in contributing to British natural history collections at the universities of Edinburgh and Glasgow, the British Museum, and various scientific societies in London. In relating North American wildflowers and songbirds to familiar European species, they also transmitted back useful scientific knowledge.

This amateur naturalist tradition also attracted some French-Canadian urban professionals, who admired aspects of the Victorian culture they shared as North Americans. Moreover, members of the French-Canadian clergy both taught and practised natural history, and communicated with European and North American naturalists. Abbé Léon Provancher (1820-92) at Saint-Joachim specialized in entomology, the study of insects. He shared a further interest in botany, the study of plants, and horticulture, the study of gardening, with Abbé Louis-Ovide Brunet (1826-76) of Laval University. Both Provancher and Brunet published their scientific findings, and popularized the importance of studying natural history.

Nor was it mere coincidence that the Anglican clergyman Gilbert White had also promoted this amateur naturalist tradition. Natural history gained social value as a pastime in Victorian culture precisely because it encouraged disciplined and useful activity. Besides preserving idle hands and minds from the devil's temptations, natural history rekindled religious faith. Within the framework of the popular tenets of natural theology, it turned the mind with awe and wonder to evidence of God's creative and beneficient design. "The world thenceforth becomes a temple, and life itself one continued act of adoration," explained the Reverend William Paley in his classic treatise, *Natural Theology* (1802). "The change is no less than this, that, whereas formerly God was seldom in our thoughts, we can now scarcely look upon any thing without perceiving its relation to him." No doubt, this form of worship became popular because it legitimized outdoor activities, even for women, and even on the Sabbath.

Natural theology intertwined nature and religion in the minds of educated people in the Victorian world until the 1860s, and in some places much longer. It joined the utilitarian and amateur naturalist traditions in weaving a broad cultural context within which upper- and middle-class Victorians attempted both to comprehend and to improve their world. Drawing from the experience of industrializing cities such as his native Birmingham, Thomas Dalton, editor of the Toronto *Patriot and Farmers' Monitor*, declared optimistically in 1834 that nature's garden would even keep the working classes out of the alehouses. "No temptation," he suggested, "could lure to the Tavern, while the prize cauliflower, the giant asparagus, the huge gooseberry, the gay tulip, or fragrant carnation demanded attention."

New geographical perspectives furthermore broadened the outlook of science during the 19th century. Captain James Cook's circumnavigations during the 1770s offered an admirable working model of geography's potent combination with science to generate useful knowledge. Cook's naturalists attained for Britain the most comprehensively documented collections of plant and animal specimens ever brought from British North America, illustrating as they did their significance within a global context. In the next generation these geographical perspectives inspired the influential Prussian scientific traveller Alexander von Humboldt (1769-1859), whose name became synonymous with a "cosmical" approach to nature. Humboldt encouraged systematic worldwide studies of natural phenomena, including distributions of climatic conditions and plant and animal species, with evidence to be gathered by standardized means whenever possible. His example in turn inspired British North Americans, from local societies in the towns to fur traders on the tundra, to appreciate their own unique geographical opportunities to contribute valuable information about the cosmos.

Finally, the culture of the Scottish Enlightenment exerted a major influence in transporting these ideas and values, through large numbers of immigrants and other travellers to British North America. Scottish society valued a system of public education that included science as a useful subject even in primary schools. A surprising number of explorers in British North America, whether fur traders, members of expeditions, or localized specimen hunters, were either Scottish-born or Scottish-educated. At the University of Edinburgh, a hub of exciting scientific debate, research, and training during the early 19th century, the professor of natural history, Robert Jameson (1774-1854), cultivated a worldwide network of contributors to form the beginnings of the Royal Scottish Museum.

Scottish examples of scientific inventory bore special significance in newly settled territories such as British North America, where even basic natural resources remained virtually unknown. Under the influence of "Agricultural" Sir John Sinclair (1754-1835), Scotland imbued Victorian science with a tradition of collecting 'statistics' (a term borrowed from the mercantilist statecraft of Frederick the Great in Prussia), using detailed surveys to assess resources and quality of life in various districts. In 1801 the governor of Nova Scotia commissioned Titus Smith Jr. (1768-1850), to survey the colony's potential for supplying the British war economy. Smith, a gardener skilled in acclimatizing British seeds to North American conditions, mapped the province's resources with detailed botanical information. With the end of Napoleon's blockade in 1815, Nova Scotians felt pressed to assess the colony's agricultural potential, and in 1819 established a provincial Board of Agriculture to oversee this practical inventorial task. This organizational pattern offered a model for other colonies during the decades that followed.

The veritable army of explorer-collectors required for larger Humboldtian scientific endeavours was recruited, trained, and dispatched as a by-product of the Napoleonic Wars. Military officers in the British Ordnance Department ranked among the most highly trained scientific practitioners of the day. The practical need in British colonies to take stock of natural resources, including timber, hemp, and foodstuffs, required by the British war effort, intensified interest in scientific investigations. After 1815, the numerous ambitious, underemployed experts were keen to demonstrate their indispensability to peacetime scientific pursuits. Resource and transportation surveys for the Rideau Canal and similar projects during the 1820s and 1830s could, they argued, incidentally aid the search for natural laws that governed the earth.

This alliance between the practical and the theoretical unleashed the forces of science with new intensity upon the land. They transformed exploration from aesthetic description to the systematic collection and classification of information and specimens in standardized forms. After 1815, the colonies, the target of a long heritage of investigations undertaken by individual collectors for European patrons, came under more specialized scrutiny than ever before. Science held out a means of both assessing the habitability of unsettled territories, and developing natural resources for the benefit of Britons at home and in the colonies alike.

Early Scientific Exploration and Organization

As war's end thus breathed new life into scientific exploration, the British Admiralty revived longstanding hopes of discovering a Northwest Passage to the Orient. An unusual polar ice breakup after 1816 offered a rare opportunity to study the shape of the earth and its magnetic properties in high latitudes. In 1818 the Admiralty and the Royal Society of London co-sponsored a polar geographic and scientific expedition commanded by Captain John Ross. Lieutenant Edward Sabine (1788-1883) of the Royal Artillery, who had served with distinction in Canada during the War of 1812, accompanied Ross as scientific officer. Sabine continued his work on a second mission in 1819 under Captain William Parry. While neither voyage successfully traced out a Northwest Passage, Sabine earned high praise for demonstrating the elliptical shape of the earth and advancing knowledge of terrestrial magnetism. He also stocked British reference collections with arctic plant and bird specimens.

Humboldt's cosmical approach to science encouraged a shift from sea to land in the exploration of British North America. Parry's ships were complemented by Lieutenant John Franklin's overland party, sent from York Factory to the Coppermine River, north to the Arctic Ocean, and east toward Hudson Bay. Franklin's surgeon-naturalist, Dr. John Richardson (1787-1865), had studied natural history with Robert Jameson at the University of Edinburgh. While Richardson broke new ground in arctic geology, he specialized in zoology, and returned with valuable specimens, especially of birds, despite harrowing agonies of exhaustion and near starvation in the Barren Grounds.

Curious about the viability of permanent settlement in northwestern North America, Richardson recorded soil and air temperatures as well as climatic influences upon vegetation. He joined Franklin's second expedition in 1825 to explore the Arctic shore more extensively. While coal samples near the mouth of the Mackenzie River struck him as "excellent fuel for a steam-vessel," Richardson seldom risked bold conclusions, preferring to supervise the meticulous collection of mosses, insects, birds, and mammals in unprecedented numbers. Like him, other collectors and travellers (including the intrepid and tragic David Douglas, who named the Douglas fir) funnelled scientific information and specimens back to Britain.

Farther south, townspeople too wondered about the nature and potential of their surroundings. In an age when intellectual life rested largely on conversation, they organized natural history societies on the models of London, Edinburgh, Boston, and New York. In Pictou, Nova Scotia, the Reverend Thomas McCulloch (1776-1843) and other collectors catalogued native plants, forming the nucleus of the Pictou Literary and Scientific Society. At Halifax the lieutenant governor, Lord Dalhousie, and his wife cultivated amateur naturalists from among local naval officers and the professional and middle classes. When Dalhousie became governor-in-chief of British North America, he patronized the Literary and Historical Society of Quebec, founded in 1824. Similar social groups founded the Natural History Society of Montreal in 1827, as well as the short-lived Beothick [sic] Institution at St. John's, Newfoundland, in 1828 and Literary and Philosophical Society of Upper Canada at York (Toronto) in 1830. Many more such local societies followed suit in later decades.

These societies shared in the amateur naturalist tradition, often from the perspective of natural theology. They met for lectures and **conversaziones**, assembled lending libraries and museums, organized local excursions, and solicited essays on natural history. They promoted utilitarian goals by advocating scientific inventories of the country, including the interior of the continent, with an eye to assessing its commercial, mineral, and agricultural potential. The results of these collective efforts, often submitted to British (and later American) scientific authorities, reached a new pinnacle in the publication of John Richardson's *Fauna Boreali-Americana* (4 vols., 1829-37) and W.J. Hooker's *Flora Boreali-Americana* (2 vols., 1833, 1840). These descriptive catalogues marked a coming of age in the study of the geographical distribution patterns of British North American animals and plants, respectively.

Natural history societies also sought information about the country's climate, hoping to test longheld (and often contradictory) assumptions about settlement potential in northern regions. A body of myths had grown from earlier climatic theories absorbed by Enlightenment culture and sustained by its leading authorities. On the one hand, the influential

Comte de Buffon (1707-88) in France had interpreted differences between European animals and their (often smaller) North American counterparts as a "degeneration" caused by the impact of extreme climate upon descendants of Eurasian migrant species. Buffon's *Histoire naturelle* (1746) fuelled European scepticism about the longterm future of immigrant societies in North America.

On the other hand, many immigrants also subscribed to more positive myths of climatic progress. In one version, Canada's climate would improve with clearing and cultivation of the land. This assumption, widespread among pioneer settlers, derived authority from Edward Gibbon's widely admired *History of the Decline and Fall of the Roman Empire* (1776). Gibbon applied a popular image of Canada as "an exact picture of ancient Germany," a frigid forest despite the temperate latitudes it shared with France and England, to deduce that ancient Europe had been much colder. Its climate, he believed, had been ameliorated by permitting sunshine to reach the soil. Gibbon's history fixed for several generations an optimistic expectation of the eventual climatic improvement of Canada. Pioneer settlers attacked the backwoods vigorously, among their reasons the amazing optimism that each chop of a tree would improve the climate, if only incrementally. Both the Natural History Society of Montreal and Toronto's (Royal) Canadian Institute (founded in 1849) continued for decades to collect meteorological and other relevant data on this important question. When the accumulated evidence justified no favourable conclusion by the late 1850s, Canadian nationalists and others during the age of Confederation revived Gibbon's other climatic assumption, that the prevailing cold imbued the colonies' northern inhabitants with special virtues of physical hardiness and political liberty.

Growth of Scientific Institutions

By the 1840s, local natural history societies' lobbying for broad material goals sprouted state-sponsored scientific projects. In British North America the most prominent examples of this organizational trend included two new scientific institutions, the Toronto geomagnetic and meteorological observatory, established by the Imperial government in 1839, and the Geological Survey of Canada, funded by the province in 1841.

The key figure behind the Toronto observatory was, once again, Edward Sabine. Pursuing Humboldt's cosmical approach to terrestrial magnetism, with its important practical applications to navigation, Sabine convinced British authorities to support an Imperial chain of observatories worldwide. Viewing the earth and its atmosphere as a scientific laboratory, Sabine planned to plot patterns of geomagnetism in relation to weather conditions. Each station received standardized instruments, with military officers assigned to report their observations to him in England. Sabine expected ultimately to derive a universal law of geomagnetism resembling Newton's law of gravitation.

British North America's proximity to the magnetic north gave Toronto particular prominence in Sabine's network. He was hoping to identify dual north poles: one of intensity, where magnetic force was greatest; and one of verticity, where compass needles dipped 90 degrees. In 1843 the Toronto observatory served as the base station for an overland magnetic survey to the Arctic Circle. Lieutenant J.H. Lefroy (1817-90) of the Royal Artillery, with one assistant and ten crates of instruments, spent an arduous winter taking regular magnetic readings with meticulous care, sometimes every hour and occasionally every two minutes, day and night. This tedious work under adverse conditions helped to pinpoint the pole of intensity, and amassed geomagnetic data for further investigations.

Lefroy then returned to direct the Toronto observatory. Like Sabine, he valued cooperation with American scientists to track continental weather patterns. He also hoped to recruit observers throughout the continent to report magnetic and meteorological readings to Toronto. Although he was only marginally successful in enlisting military officers and fur traders to his scientific cause, Lefroy's interests meshed with those of Egerton Ryerson, Chief Superintendant of Public Schools in Canada West (Ontario). During the 1850s Ryerson established a series of grammar school meteorological stations, standardized and directed by the Toronto observatory, requiring headmasters (some enthusiastic, others disgruntled) to take regular meteorological readings as part of their professional duties. Upon leaving Canada in 1853, Lefroy also persuaded both the Canadian Institute and the Canadian government to continue his scientific work.

The provincial government's amenability derived from the success of its other scientific institution, the Geological Survey of Canada. Geology enjoyed increasing theoretical sophistication and consensus in Victorian Britain, especially after the publication of Charles Lyell's *Principles of Geology* (3 vols., 1830-33). Lyell's synthesis popularized a "uniformitarian" theory of geological change over far longer periods of time than previously imagined, through natural forces that still continued to operate. This comprehensive theory helped to explain the geographical distribution of minerals indispensable not only to agriculture (limestone, gypsum), but moreover to industrialization (coal, iron ore).

Geology's growing scientific authority was also reflected in American state geological surveys from the 1820s, with the Geological Survey of

Great Britain following suit in 1835. Many British North Americans identified these surveys as paths to industrialization and economic progress, and hoped to enjoy similar gains by matching American and British initiatives. A quintessential Victorian science, because it combined theoretical advances with practical dividends, geology was rapidly transformed in Victorian culture. In particular, the gentleman amateur geologist gave way to the entrepreneurial professional engaged in a powerful ideology forged by the values of industrial civilization.

New Brunswick became the first British colony to appoint a provincial geologist, commissioning Abraham Gesner (1797-1864) in 1838 to locate coal supplies comparable to Nova Scotia's extensive endowments. Optimism generated by Gesner's reports encouraged the similar appointment of J.B. Jukes (1811-69) in Newfoundland in 1839. Jukes's negative prognosis for coal prospects in Newfoundland resulted in the withdrawal of government support for his survey, a lesson to future provincial surveyors on the importance of holding out hope to the public whom they served.

With coal abundant in adjacent colonies and states, could it not rightly be expected in the province of Canada? The legislature of the newly united province in 1841 voted survey funds to find out, and in 1842 appointed a native Montrealer, William E. Logan (1798-1875), as director. Logan's family held business interests in Montreal, with some political clout. Trained in natural history at the University of Edinburgh, he had then managed his uncle's copper works at Swansea, South Wales. Logan was also famous in scientific circles. To facilitate the practical search for fuel to smelt the copper, he had applied uniformitarian principles to explain the long-sought origins of coal. He convinced Canadian members of the commercial and professional classes, anxious for opportunities to expand the colony's capital base, that he, if anyone, could locate the precious fuel for them.

With a one-year grant that could hardly scratch the surface of Canada's complex geology, Logan planned not only to continue funding of his survey, but also to extend its boundaries. Working initially with only one assistant, he divided the province into western, eastern, and northern geological districts. Logan soon concluded that, since the entire colony lay below all known carboniferous strata, no coal would ever be found in the province. Yet this disappointing verdict, he realized, would seriously disillusion the Canadian public, thereby discrediting his entire scientific enterprise. In his reports Logan instead emphasized the probability of locating valuable metal ores, including iron and copper, in the Precambrian Shield of the province's northern division. He later named these rocks

"Laurentian" and "Huronian," establishing Canadian nomenclature for these formations wherever else they existed on the globe.

Just as important, Logan shrewdly grasped the means of securing precious metals from provincial coffers. He masterfully displayed Canadian minerals and geological structures at London's Crystal Palace Exhibition (1851), earning Canada rave notices and international prestige. A brilliant reprise at the Paris Exposition (1855) won him a knighthood, the Wollaston Medal of the Geological Society of London, and induction into the French Legion of Honour. Logan's well-orchestrated performances on the international stage enhanced Canadian pride and economic optimism, through the promise of foreign investment that politicians, business leaders, and journalists had been seeking.

New Visions of the Northwest

While the prestige of Logan's survey highlighted Canada's potential, the fundamental question remained: without coal resources to fuel industrialization, and with agricultural settlement reaching its northern limit at the Canadian Shield, how could the country sustain a modern economy? Sir J.W. Dawson (1820-99), principal of McGill College and a geologist of international reputation, observed in the *Canadian Naturalist and Geologist* in 1858 that, despite many divisive factors in British North America, a unifying influence could be found in the land's natural endowments. "As naturalists," he explained, "we hold its natural features as fixing its future destiny, ... and regard its local subdivisions as arbitrary and artificial." In this light, one attractive possibility was to construct a transcontinental nation like the United States, stocked from sea to sea with natural resources. During the 1850s this expansionist vision was promoted by an ambitious combination of romantic patriots and commercial interests who aimed to transfer to Canadian jurisdiction the vast northwestern territories monopolized by the Hudson's Bay Company. As Doug Owram has explained in *Promise of Eden* (1980), the success of this expansionist project rested upon an extraordinary transformation of traditional images of these northwestern lands as unsuitable for settlement. Victorian science reinforced these perceptual changes just as the company's charter came up for renewal.

Canadian expansionists turned first to geology for a positive reassessment of the Great Northwest. Encouraged by the uniformitarian outlook, with its regard more for geological than political boundaries, William Logan had long dreamed of extending his provincial geological survey throughout British North America. In 1851 the explorer John Richardson also analyzed the surface structures of British North America from a sweeping continental perspective, urging a systematic geological survey of the Northwest. More importantly, in 1855 the Geological Society of London published an essay and a coloured map depicting a vast coalfield along the entire length of the Rocky Mountains to the Arctic Ocean. The author, A.K. Isbister, the Scottish-educated son of a fur trader, believed that the Hudson's Bay Company suppressed such information to discourage settlers from its lands. In 1857 his supposed coalfield reappeared on an official map of British North America published by the Canadian Crown Lands Department,[2] providing another incentive for northwestward expansion.

Expansionists also laid claim to evidence from climatology, especially recent applications of isotherms. Inspired by Humboldt's search for worldwide distribution patterns, isotherms on maps were lines joining places of equal temperature. Whereas only recently the Northwest had been marked "unknown" on Humboldt's maps, the Crown Lands Department's map of 1857 marked lines not only of equal temperatures, but also of the northern limits of common plants and animals. That same year Lorin Blodget, a meteorologist for the Smithsonian Institution in Washington, synthesized similar data accumulated by John Richardson, J.H. Lefroy, and others. Blodget's *Climatology of the United States and of the Temperate Latitudes of the North American Continent* offered a continental interpretation of climatic patterns, noting that summer isotherms slanted northwestward from Toronto. In both interpretations, the Great Northwest was as amenable to agricultural settlement as the province of Canada had been. Such strong scientific sanction induced even the uncommitted more readily to accept expansionist arguments, especially since American supporters of Manifest Destiny were also eyeing the territory's potential.

Victorian science served similar political purposes in British and Canadian exploring expeditions sent to the Northwest to gather further information in 1857 and 1858. Captain John Palliser, commanding the British party, took along a botanist, a geologist, a magnetician, and an astronomer. His report disappointed Canadian expansionists by demarcating an arid section in present-day Alberta and Saskatchewan (Palliser's Triangle), and admitting that westward travel from Canada was far easier through the United States. Yet Palliser's scientists also documented timber and coal supplies that seemed to justify the construction of a Pacific railway through British territory. Moreover, they

[2] The map (B-24) is in the Public Archives of Ontario.

interpreted the wide dispersion of plant species as indicative of agricultural potential.

Two Canadian expeditions, under George Gladman in 1857 and S.J. Dawson in 1858, expected more positive results. They included the geologist H.Y. Hind (1823-1908) of Trinity College, Toronto, a well-known expansionist publicist. Drawing eclectically from several sciences, Hind assessed agricultural and transportation prospects from Canada to Red River, and thence to the Saskatchewan River. Driven more by enthusiasm than by concrete evidence, he raised the region's summer isotherms higher still than Blodget's. As Francis Parkman's *The Oregon Trail* (1849) had done for the American midwest, Hind popularized the image of a "fertile belt," extending its northern manifestation from Lake of the Woods to the Rocky Mountains. Palliser's *Report* and Hind's *Narrative* enjoyed longstanding authority well beyond the expansionist hothouse of Toronto, suggesting the general need for new concepts to capture the unique geographical realities of the prairie, with a scientific vocabulary to convey them.

It was not at all clear how much weight any one science should carry in the appraisal of complex landscapes. Canadian botanists added a further dimension to the expansionist cause when they too entered the fray. John Macoun (1831-1920), a self-educated botanist from Belleville, Ontario, set out to challenge prevailing assumptions of subarctic growing conditions beyond the northern shore of Lake Superior. Macoun learned from George Lawson (1827-95), an Edinburgh-trained professor of natural history at Queen's University and founder of the Botanical Society of Canada (1860), to recognize localized cooling effects of water and rock. One visit in 1869 convinced Macoun that while subarctic plants grew within a hundred metres of Lake Superior, the vegetation became modified farther back from the frigid waters. He believed that an extensive temperate region separated local subarctic conditions near Lake Superior from those in arctic latitudes. As naturalist to the Geological Survey of Canada from 1877, Macoun often used science tendentiously to promote the federal government's determination to settle the Great Northwest as quickly as possible.

Another Botanical Society member, J.C. Schultz, an expansionist leader of the Canadian Party at Red River and critic of the Hudson's Bay Company's monopoly, shared Macoun's confidence. Schultz had studied natural history with George Lawson at Queen's, and he sent back plants to document their geographical distribution. He co-founded the Institute of Rupert's Land (1862), a natural history society comprised mainly of company officers, which soon succumbed to political tensions that culminated in Canada's clumsy attempts to annex the Great Northwest in

1869. Part of the arrogance with which its new governor, William McDougall, and his teams of land surveyors laid claim to the territory stemmed from their conviction that Victorian science justified Canada's northwestward advance as inevitable. In vigorously supporting agricultural settlement in these northwestern lands, botany supplanted both meteorology and geology as the scientific spearhead of expansionism in Victorian Canada after Confederation.

The Reception of Darwin

Scientific developments joined these political agendas to propel Victorian science in new directions after mid-century. Among the most important was Charles Darwin's theory of *The Origin of Species by Means of Natural Selection* (1859). Darwin (1809-82), a well-known British naturalist, served aboard the HMS *Beagle* on a five-year circumnavigation of the globe during the 1830s. It was the ultimate Humboldtian experience. As a result, he amassed firsthand evidence of geographical patterns in the global distribution of plant and animal species. Synthesizing important insights gained from Paley, Lyell, Thomas Malthus, and others, Darwin interpreted these patterns to explain the origins of species themselves.

From three axioms (individuals in nature tend to vary; variations are hereditary; and existence constitutes a struggle for survival) and many examples, Darwin proposed an evolutionary process through a mechanism he called natural selection. New species arise, he argued, because random variations make survival possible for some individuals rather than for others in a given environment. The survivors then pass their characteristics on to offspring. Over time variations accumulate, differentiating future generations from their ancestors enough to warrant their classification as entirely new species.

Darwin's theory shocked his contemporaries because it challenged fundamental assumptions in Victorian culture. If nature functioned randomly, then did God not design each species? Did nature not result from His beneficient plan? Was progress not inevitable? Was humanity simply part of nature, instead of above it? Unlike the polarized debate that resulted in both Britain and the United States, British North American naturalists' reception of Darwin's theory proved considerably more muted.

For while Canada harboured one of the most prominent scientific strongholds of anti-Darwinian resistance, the geologist J.W. Dawson, his vociferous opposition did not elicit vigorous debate. Dawson, passionately committed to defending the fortress of natural theology, rejected Darwin's science on two grounds. First, the incompleteness of the fossil record prevented Darwin from actually demonstrating the transmutation of even one species. Second, Dawson rejected the form in which Darwin presented his theory, as a violation of the Baconian inductive approach in scientific method. Dawson's resistance was echoed by Léon Provancher, who founded the journal *Le Naturaliste canadien* in 1868 not only to encourage popular interest in natural history, but also to publicize his conviction that Darwinism flouted the tenets of Christian faith. In contrast, other British North American naturalists remained remarkably taciturn on the subject. In the half-century after Dawson first determined to rout Darwin's challenge to the traditional partnership of natural history and natural theology, no strong public defender of evolution by natural selection emerged in British North America.

Historians have often interpreted this silence as consensus in an immature colonial community. A.B. McKillop, in *A Disciplined Intelligence* (1979), exposed the intellectual underpinnings of a powerful "moral imperative" in English-Canadian culture. Similarly, French-Canadian culture has been characterized as dominated by a rising ultramontanism that identified faith, language, and traditional agrarian values with national survival. Spokespersons in both cultures thus recoiled from the disturbing religious implications of Darwinian science. Indeed, Carl Berger estimated in *Science, God, and Nature in Victorian Canada* (1983) that, among naturalists in this country, a tide turned in favour of evolution only after 1900.

Yet there is evidence of scientific responses to Darwin's theory that eluded the consensus considerably earlier, apparently with impunity, in three phases. The first phase, during the 1860s, affirmed an accord in British North America that was, nevertheless, not monolithic. In 1860 J.W. Dawson's negative review of *The Origin* in the *Canadian Naturalist and Geologist* was echoed to some extent at least at the University of Toronto, by both the archaeologist Daniel Wilson (1816-92) and the mineralogist E.J. Chapman (1821-1904), in the *Canadian Journal of Industry, Science, and Art*. Yet botanists nevertheless took up Darwinian themes, albeit indirectly, and during these years quietly adapted their researches accordingly.

For unlike geology, botany's geographical tradition funnelled direct evidence into Darwin's theory, in illuminating worldwide patterns of plant distribution. Indeed, by virtue of its northern location, British North America became an important testing-ground for Darwinian corollaries. Inspired by the British botanist J.D. Hooker, one of Darwin's earliest supporters, other scientists investigated circumpolar patterns of plant geographical distribution as remnants of the Ice Age. Hooker's theory of "creation by variation" mobilized a small community of British North American botanists under the influence of George Lawson, who left Queen's for Dalhousie University in 1863. These geographical botanists also included Louis-Ovide Brunet of Laval University, who collected plants at remote places and contributed specimens to the Darwinian researches of Asa Gray at Harvard University.

The second phase, after Darwin's *Descent of Man* (1871) drew the human species explicitly into his evolutionary theory, found a forum in new literary magazines such as the *Canadian Monthly and National Review*. A growing materialism in physical sciences, signalled by John Tyndall's notorious Belfast Address to the British Association for the Advancement of Science (1874), traced life's origins to inorganic compounds and even single atoms. Darwin's organic theory paled in comparison. In response to these alarming developments, evolution's gradual accommodation in English Canada occurred within a conservative intellectual context of philosophical idealism. Postulating a divine Creator as prime mover in the world, this evolutionary philosophy provided a popular bulwark against religious doubts raised by modern science. Under the guidance of John Watson (Queen's University) and others, it spread as "practical idealism" into the school systems through teacher training and textbooks. To counter the rampant individualism usually associated with Social Darwinism, universities and public schools in Canada instead emphasized commitment to community for the moral evolution of society and the nation.

Moreover, a new generation of scientists trained in Darwinian methods was also reaching maturity. They included Ramsay Wright (1852-1933) in biology at the University of Toronto; G.M. Dawson (1849-1901) (a son of J.W. Dawson trained by Thomas Huxley, Darwin's vociferous defender, at the Royal School of Mines in London), at the Geological Survey of Canada; and D.P. Penhallow (1854-1910), an American-trained botanist appointed to McGill University in 1883. These natural scientists shared a modern scientific spirit with James Loudon (1841-1916) in physics at Toronto, and other admirers of the German research ideal. They rejected religious priorities as unwarranted interference in scientific research "for its own sake."

Amateur naturalists appreciated Darwin too. Gerald Killan's biography of *David Boyle* (1983) documents the fascinating intellectual journey of a Scottish blacksmith who became Canada's foremost archaeologist at Toronto's Royal Ontario Museum. A school-teacher in Elora, Ontario, during the 1870s, Boyle became passionately interested in Darwinian biology. He urged its inclusion in the elementary-school curriculum as part of a local "intellectual awakening" which he promoted almost single-handedly. The entomologist William Couper of Montreal and the beekeeper Allen Pringle of Selby, Ontario, also studied insects from avowedly

Darwinian perspectives during the 1870s. William Brodie (1831-1909), a Toronto dentist, founded the Toronto Entomological Society in 1877. He studied nature in evolutionary and environmental terms, even while professing scepticism of natural selection. Brodie later pioneered Darwinian approaches to psychology through his studies of insect consciousness.

The third phase, after the mid-1880s, witnessed a remarkable profusion of positive references to Darwin. This fanning-out process began slowly, as Ramsay Wright's *Introduction to Zoology* (1889) permeated Canadian high schools. It increased apace during the 1890s, laying groundwork for a sea change that came, albeit stealthily, before 1900. During the 1890s university curricula at Toronto, Mount Allison, New Brunswick, Queen's, McGill, and Dalhousie all introduced evolutionary biology, as older professors of natural history left the scene. Through their professional journals, Canadian entomologists also entertained broader discussions of Darwinian applications to their work. Shortly after 1900, Darwinian influences in Canadian science ranged from developments in human pathology to the improvement of field crops and even to the biochemical origins of life itself.

In literature, Darwinian themes inspired the popular genre of nature-writing best exemplified by Ernest Thompson Seton's *Wild Animals I Have Known* (1898). An avid reader of Darwin and Huxley, Seton (1860-1946) drew inspiration from William Brodie, a family friend with whom he had rambled as a boy through Toronto's environs while Brodie spun original nature stories. Seton's characters, human and animal alike, were governed by a stern ecological ethic of survival.

Carl Berger has shown, furthermore, that by the 1890s evolutionary interpretations had been extended to Canadian history and culture, as philosophical idealism and imperialism had intensified. They did so, often with Social Darwinian overtones that utilized neo-Lamarckian and Spencerian ideas of "survival of the fittest," interpreting the development of Canadian society through struggle in a harsh northern environment. After 1900, industrial expansion and material progress in Canada, as elsewhere, helped to diffuse these Social Darwinian approaches farther afield to applied and social sciences, as exemplified in educational and industrial psychology as well as in eugenics movements. Far removed from the pioneers' backwoods, eugenicists grew concerned that life in modern cities no longer eliminated "the unfit in the struggle for existence." They attempted to involve the state in limiting the proliferation of undesirable elements in Canadian society that failed to suit their own preferred images of the nation.

Partner to Industry

Besides these offshoots of Darwin's evolutionary theory, other important aspects of late Victorian science altered Canadians' experiences, perceptions, and expectations of the land they inhabited. As Confederation and transcontinental nationhood fulfilled naturalists' wildest inventorial dreams, the vastness of these new territories overwhelmed even established expansionist institutions like the Geological Survey. In addition, recurring economic recessions after 1873 intensified competition for limited resources to fund not only scientific inventories, but also growing demands for scientific research.

As science cut loose from its traditional moorings in natural theology, it also became increasingly professionalized. Its activities gravitated from local societies to universities and other research institutions, including private industries and government departments. The Royal Society of Canada, an elite academy founded in 1882, sponsored international scientific projects, including Sir Sandford Fleming's initiative to standardize global time-reckoning; anthropological surveys; observations of the transit of Venus; and cooperation in International Polar Years. In reorganizing natural history through subgroupings and other forms of fragmentation, amateur naturalists acknowledged a further trend in Victorian science, the growth of specialization. The body of knowledge had reached unmanageable proportions, necessitating a division of labour through new scientific disciplines and subdisciplines.

As late Victorian culture blended imperceptibly into modernity, this transition was marked by accelerating industrialization, urbanization, and migrations of peoples hoping to improve their material prospects. Increasing numbers of Canadians dwelled in cities, removed from the natural environment —now cottage country— that had defined their predecessors' existences. While science, technology, and capitalism continued to reshape modern lifestyles, the contributions of science now derived as much from physics and chemistry as they had once done from geology and botany.

In particular, the chemical development of aniline dyes and other synthetic compounds during the late 19th century underlined the importance to a modern society of scientific applications through technical education and industrial research. A powerful drive for modern efficiency underpinned the establishment of a Commission on Conservation by

Wilfrid Laurier's Liberal government in 1909. At the same time, industrialists and others, including the Royal Canadian Institute, rallied to extend scientific endeavours from primary resource sectors of the traditional economy into industrial research, to encourage secondary manufacturing in pulp and paper, steel, and other industries.

The experience of the Great War laid bare the conflicting goals underlying these various scientific applications, of rational resource management versus rapid material progress. As the technological and chemical competitive edge of modern warfare weighed in with frightening decisiveness on the side of the enemy, the British Imperial War Cabinet shifted Dominion commitments toward scientific and industrial research. In 1916 Robert Borden's Conservative government appointed an Honorary Advisory Council of academics, industrialists, and ministers with portfolios involving science and technology, forming the nucleus of the National Research Council established in 1925. The NRC's mandate to coordinate government, science, and industry in stimulating industrial research, especially to encourage applied chemical researches, is said to have marked a turning-point in the demise of earlier conservationist goals. The environmental historian Michel Girard has observed in this context that "science, like everything else, is subject to fashion." After the lessons and sacrifices of the Great War, consumer-oriented Canadians came to regard science as "an instrument to provide unlimited growth, rather than sustainable development" in the postwar world.

Victorian science imbued earlier visions of Canada as a promised land with an intensity and momentum that were sustained deep into the 20th century. Promises of pathways discovered and lands possessed, of natural laws discerned and climate improved, of resources located and prosperity ensured, all confirmed Baconian claims that knowledge is power to improve the material quality of life.

These developments did not dispel some older myths. When the country's climate did not improve perceptibly with settlement, let alone urbanization, some nationalists reiterated earlier claims that its physical rigours strengthened the Canadian character. In 1909 Sir George Parkin, writing on Canadian railway development in the *Scottish Geographical Magazine*, still made virtue of the cold as protection from undesirable immigrants and assurance of the country's evolutionary ascendance:

> A stern nature takes hold of this type of man when he comes to Canada and imposes upon him a relentless discipline. It either develops in him the virtues of energy, prudence and foresight which he lacks, or it kills him ... Apply that

process for a century to a country and you will have a survival of the fit which ensures to it . . . the traditional strength of the northern races.

Yet others remained unconvinced of Canada's greater destiny. In 1890 Sir J.W. Dawson decried the abuses of Darwinian evolution by "civilizers" who, as the self-appointed "enemy of wild nature," exterminated species with impunity. Instead of extolling the northwestward march of "civilization" as inevitable, Dawson feared in modern science a "westward march of exhaustion" of both the land and its resources. In many ways an archetypical Victorian scientist who appreciated with exceptional clarity the alchemical powers of science to transform our perceptions, Dawson quite consciously parted from the mainstream of modern science at a critical juncture. "Nature," he had recognized soon after Confederation, had "already taken hold of the mind of Young Canada," and was "moulding it in its own image." Among Dawson's intellectual heirs in the 20th century, the social scientist Harold Innis set out to explore still deeper interchanges between the land and its inhabitants. From the crucible of Victorian science, he agreed, neither had emerged unscathed.

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