

SATURDAY OBSERVER

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SATURDAY, DECEMBER 19, 2009

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The so-called Copenhagen Accord sets out a general agreement for reducing emissions of greenhouse gases. 'We have much further to go,' U.S. President Barack Obama said of the deal that fell far short of ambitions for the UN-led summit.



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The January 2009 cover of Trends in Ecology and Evolution shows an artist's conception of marine life in the Ediacaran Era.

Lost world

Elkanah Billings was Canada's first official paleontologist. In 1872, the Ottawa man identified a specimen that would solve one of the greatest unknowns of evolution. It took almost a century for the world to catch up with his ideas



BY RANDY BOSWELL

It's an impression in stone about the size of a dime, a circular trace of some living thing from primeval Canada — to be precise, a sandstone outcrop in downtown St. John's, N.L. — that has played a starring role in two epic stories separated by about 570 million years.

One is a whodunit from the dawn of complex life on Earth, a mystery about the emergence of animals — and the rise and demise of their ancestors — that baffled even Charles Darwin, the man who famously shed the light of science on the origin of species.

The other is a tale of premature genius and posthumous redemption for a 19th-century Ottawa polymath named Elkanah Billings, son of one

of the city's original settlers.

A would-be lawyer and sometime journalist — he edited and wrote for this very newspaper 155 years ago — Billings gained a notable place in Canadian history as the country's first official paleontologist.

But only recently, and very belatedly, has his remarkable role in helping to solve one of the great unknowns of evolution — "Darwin's Dilemma" — come to be fully un-

derstood. And this year, as the world marks the bicentennial of Darwin's birth and the 150th anniversary of his world-altering masterwork, Billings' own legacy has come into sharper focus.

Canadian scientists probing a series of fossil beds along the Newfoundland coast and in the Mackenzie Mountains and Yukon are illuminating what they call a "lost world" of bizarre, animal-like organisms that vanished mysteriously as more advanced creatures — including the ancestors of humanity's own branch of life — began to slither out of the oceans onto dry land during the Cambrian age that began some 540 million years ago.

Elkanah Billings died in 1876. Soon after, scientists were refuting his contention that something more than bacteria-scale organisms existed in deep rock deposited below — and therefore eons earlier than — the Cambrian age, widely seen at the time as the beginning of complex life on Earth.

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WESTJET

Lost world: Life in the primordial world

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Among those at the forefront of recent "pre-Cambrian" fossil investigations are Queen's University paleontologist Guy Narbonne and two of his former students — Marc Laflamme, an Aylmer, Que., native now teaching in the geology department of Yale University, and Laurentian University paleontologist Elizabeth Turner.

Their Canadian studies and other findings in Africa, Australia and elsewhere have added to a small but rapidly growing body of knowledge about the era of life before the "Cambrian explosion" of animal species, best known from B.C.'s famous Burgess Shale gallery of fossilized trilobites and countless other varieties of extinct, 500-million-year-old creatures.

The earlier, Precambrian phase of evolution known as the Ediacaran Period — first glimpsed and vaguely recognized by Billings in those Newfoundland fossils 137 years ago — is preserved in rocks between 540 million and 630 million years old.

Only during this decade did the global scientific community approve the Ediacaran as the first major revision to the calendar of Earth's history in more than a century. It was a stunning and long-overdue vindication of Ottawa's pioneer paleontologist, who first theorized — in a solitary stance among his doubting contemporaries — that the strange, ring-like markings from Newfoundland might be faint relics of a more sophisticated, multicellular form of life before such life was supposed to exist.

Elkanah Billings seemed destined to make a lasting mark on the world. His father, Bradish Billings, was the enterprising, American-born lumberman who opened the future Ottawa to settlement during the early 1800s. His mother, teacher Lamira Dow Billings, pioneered Ottawa's educational, medical and charitable institutions.

Their most bookish son was born in 1820, and his schooling in early Bytown and later in New York led him to a career in law but a passion for writing and science. Billings penned articles about geology and the emerging discipline of paleontology — the study of fossils — for the fledgling *Citizen* and other publications before and after Confederation.

He even founded his own scholarly journal, *The Canadian Naturalist and Geologist*, which was printed on the newspaper's presses in the heart of a grubby provincial town that was on the road to becoming a national capital.

Billings' self-taught command of natural history convinced William Logan, founder of the Geological Survey of Canada (GSC), to appoint him as the country's first government paleontologist in 1856.

Billings would go on to collect and document hundreds of fossils from the Ottawa area and beyond, "showing an almost instinctive aptitude for identification and classification," his GSC biography notes.

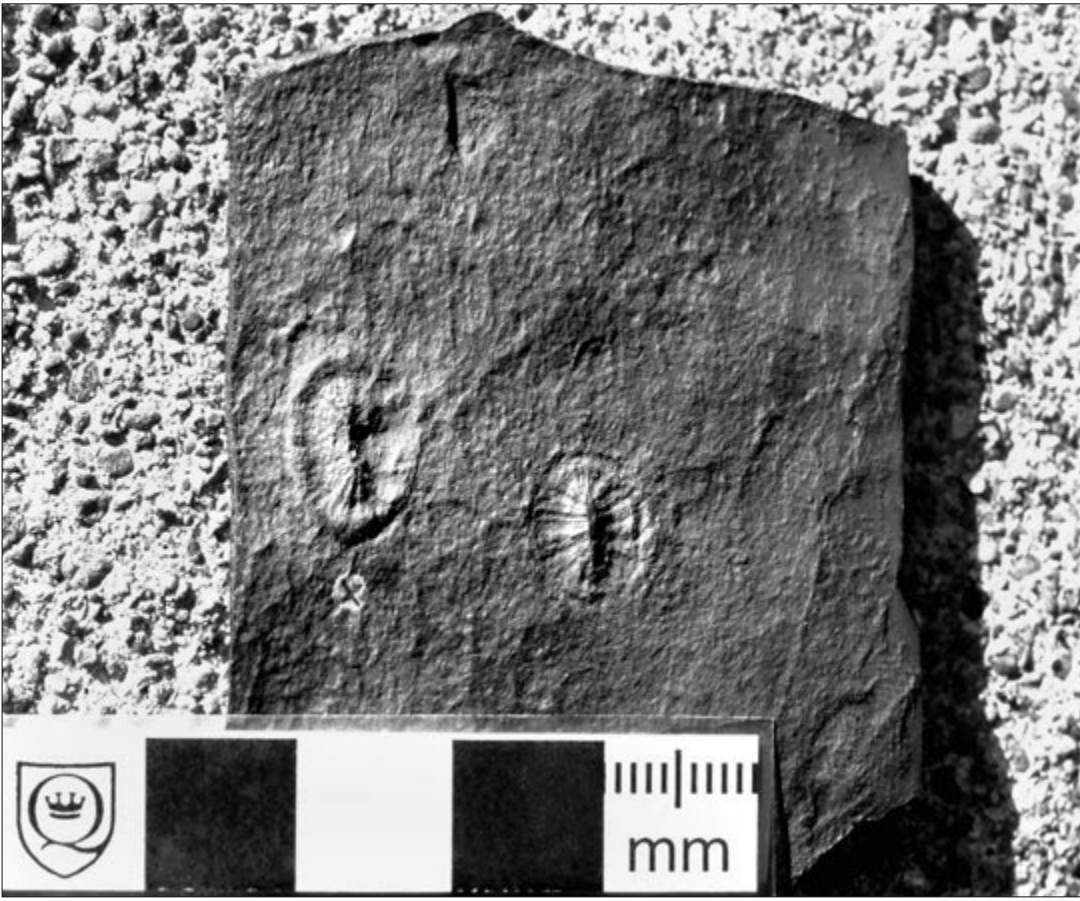
At a time when Darwin was probing the origins of life and evolution (*On the Origin of Species* was published in 1859), Billings and Logan were among the vanguard of Victorian scientists gathering clues — deemed crucial for Canada's intellectual and economic development — about the Earth's structure, mineral resources and biological history.

Billings' preference for fieldwork over bureaucratic administration apparently rankled Logan at times. In 1869, the director sent a memo to Billings that stated: "Your constant absence from the office is a worrying annoyance, particularly as I have reason to suspect that it does not arrive from rheumatism."

But along with stolen daytrips in search of fossils, Billings reviewed specimens sent to Ottawa from across Canada and — during the early 1870s — Newfoundland, then still a British colony.

One rock sample in particular intrigued him. The specimen had been collected by Newfoundland geologist Alexander Murray, who found the round patterning — presumably a trace of some mechanical process from the rock's formation — useful for identifying an ancient layer of bedrock far below the fossil-rich Cambrian.

Billings detected something more than marks left by a bubbling gas. In an 1872 paper published in the journal he founded,



The fossils above, collected from a sandstone outcrop in downtown St. John's, N.L., are specimens of *Aspidella terranovica* — the long-extinct sea creatures first identified as living organisms and named in 1872 by Ottawa paleontologist Elkanah Billings.

Below, the original site of the historic discovery as it exists today in downtown St. John's.



Billings identified the circular imprints as "small ovate fossils" of some unknown Precambrian organism — perhaps a kind of mollusk — and sketched a picture of the find.

He also gave a name to the alleged fossil: *Aspidella terranovica*, the latter part of the Latin binomial referring to the future Canadian province where the specimen, about 570 million years old, was discovered.

Billings died in 1876. Soon after, scientists were refuting his contention that something more than bacteria-scale organisms existed in deep rock deposited below — and therefore eons earlier than — the Cambrian age, widely seen at the time as the beginning of complex life on Earth.

"What cannot be doubted is that he saw those fossils with a clarity that no one did for more than half a century," says Narbonne. "Billings saw these fossils, he knew they were soft-bodied, he knew he was seven kilometres below the base of the Cambrian. He named them anyway — the first described Precambrian animal or animal-like fossil in the world. Then it got forgotten."

Among the doubters were legendary U.S. paleontologist Charles Walcott, who would gain global fame in 1909 as the discoverer of the Burgess Shale fossil bonanza.

"Walcott himself said it was inorganic, and everyone followed suit," says Narbonne.

"Only a very few years earlier, Darwin had spent half a chapter in the *Origin of Species* wondering why there were no Precambrian animal fossils," he adds. "It's been called Darwin's Dilemma ever since, and the first clue to the solution of Darwin's Dilemma happened during Darwin's lifetime and was defined by Billings — and because it was almost immediately pooh-poohed by the powers that be, Darwin probably never heard of it."

What Darwin was forced to acknowledge in his celebrated treatise, *On the Origin of Species*, was a rather glaring hole in the theory: He couldn't explain adequately where animals came from. Complex life forms seemed to appear suddenly, out

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of nowhere, at Cambrian-age fossil sites around the world, Darwin observed.

So where were their more primitive ancestors? How could relatively large, fairly sophisticated critters like trilobites show up in the fossil record without having evolved from simpler organisms whose remains should also have been petrified and preserved in older stone?

"To the question why we do not find rich fossiliferous deposits belonging to these assumed earliest periods, I can give no satisfactory answer," Darwin conceded, insisting the Cambrian trilobites surely "descended from some one crustacean, which must have lived long before."

The lack of proof of such ancient predecessors, Darwin admitted, "may be truly urged as a valid argument against the views here entertained."

The British scientist did believe that "during these vast periods" before the Cambrian era "the world swarmed with living creatures." But he hypothesized that telltale fossil sites either remained to be discovered or were too deeply buried to be found.

"I look at the geological record, as a history of the world imperfectly kept, and written in a changing dialect; of this history we possess the last volume alone, relating only to two or three countries," Darwin wrote in one of the most famous passages of the book. "Of this volume, only here and there a short chapter has been preserved; and of each page, only here and there a few lines. Each word of the slowly-changing language, more or less different in the successive chapters, may represent the forms of life, which are entombed in our consecutive formations, and which falsely ap-

pear to us to have been abruptly introduced."

In the end, says Narbonne, Darwin concluded that the absence of Precambrian fossils was "inexplicable and may be truly regarded as an objection against his theory. But he was unaware that an Ottawa paleontologist was about to come up with the first solution to that problem."

Darwin's Dilemma would remain unsolved for generations. Even today, says Narbonne, fossils of Precambrian organisms — including *Aspidella terranovica* — are considered "diamonds" among paleontologists, rare treasures that offer tiny, fragmentary windows into some of the darkest and most distant corners of Earth history.

But the light has begun to shine through, with Narbonne and other Canadian scientists — in the probing spirit of Elkanah Billings — leading the way.

Science warmed very slowly to Billings' 1872 insight about life in the primordial world, but interest in the 19th-century notion has heated up quickly in the 21st.

Narbonne points out that the second time a geologist described an Ediacaran-age fossil was in 1930 in Namibia. Another was documented in 1947 in Ediacara — a hilly region in Australia that would eventually lend its name to the suite of Precambrian species that began with Billings' identification of *Aspidella terranovica*.

Gradually, researchers came to recognize that rock layers older than 540 million years — and at dozens of sites around the world — were yielding distinctive, animal-like fossils pre-dating the more developed species of the Cambrian. The organisms — attached to the seabed and frequently fern-like in appearance, yet living in deep water too dark to permit photosynthesis — seemed to function like animals by ingesting nutrients, the way sponges do.

"It took almost a century," says Narbonne, "for the world to catch up with Billings' idea."

In 2000, Narbonne and two co-investigators revisited Billings' original identification of *Aspidella* and firmly concluded the disc-like impression in rock was not a "mechanical suction mark"

or some other non-biological imprint but a fossil cross-section of a creature's seafloor base or "holdfast."

They published a paper declaring it the world's "first named Ediacaran body fossil." Billings' judgment that rock layers "bearing *Aspidella* were pre-Cambrian in age, and thus pre-dating the oldest known shelly fossils, has been vindicated despite doubts expressed in the intervening 130 years," the authors insisted.

Narbonne recalls a subsequent gathering of top paleontologists in Newfoundland where he and his collaborators expected to be strongly challenged over their defence of Billings and his *Aspidella* discovery.

"All the top experts in the world were there. We had assembled all the material on a table, and the word was out that the knives had been sharpened for us," he says. "The experts looked at it for about 20 minutes and said: 'OK, looks good.' So it's been remarkably well-received. No one has doubted our conclusion that it was organic."

A spate of journal articles followed from Narbonne and other scientists bolstering the case for a clear Precambrian fossil record before 540 million years ago. A committee steered by the Queen's University scientist soon convinced the International Commission on Stratigraphy to formalize the "Ediacaran Period" as a separate chapter in the planet's history alongside the Cambrian, Devonian and Jurassic ages.

Further Narbonne-led discoveries along Newfoundland's eastern shores have prompted the Canadian government to nominate the richest fossil bed — Mistaken Point — as a UNESCO World Heritage Site, potentially joining the Burgess Shale on the globe's premier list of cultural and natural treasures.

And the line of scientific inquiry initiated by Billings in the 19th century is taking diverse directions today. In May, Turner and her fellow researchers found chemical traces of what may be 850-million-year-old, sponge-like animal life — far older than *Aspidella* and its fellow Ediacaran species — in the mountains of the Northwest Territories.

Laflamme has co-authored several studies this year, including one published in August that offered a new theory on how key families of Ediacaran organisms fed by osmosis — thriving for millions of years as stationary nutrient absorbers before mobile Cambrian predators moved in and ended the party.

Some mystery surrounds the extinction of the Precambrian creatures. But Laflamme sees the Ediacarans as "direct competitors" — and then victims — of the more advanced animals that emerged on Earth around the 540-million-year mark.

"These are the guys who were directly competing for food and for space to tether or anchor on the seafloor," he says. "The Cambrian explosion is often touted as the greatest radiation of animals, but it also represents the first mass extinction in the rock record of large, morphologically complex organisms."

He describes *Aspidella* and its cousins as "weird and wonderful" but doomed species — "aliens in a prehistoric world, one that would be strange and unfamiliar to any modern biologist."

Narbonne isn't as convinced that Ediacaran organisms represent only an evolutionary dead end.

"Most are demonstrably failed experiments," he says, "but some of them" — here he refers to early molluscs and possible worm-like species — "appear to be ancestors of the things we see around us."

For his own research achievements, Narbonne was named the 2009 winner of Canada's top prize for paleontology — the Elkanah Billings Medal. He confesses to a measure of hero worship when it comes to the founder of his profession in Canada, and owns a first edition copy of one of Billings' books.

He says one of Billings' greatest legacies may prove to be his long-unheralded launch of Ediacaran studies.

"It really is a very exciting place to be right now. Along with the origin of life, origin of humans and feathered dinosaurs, it's one of the major, pivotal fields in paleontology. And it started with Elkanah Billings," says Narbonne. "This is a Canadian who did something very remarkable on the world stage that nobody remembers."