

Magic of Burgess Shale continues to amaze

LYNN MARTEL KOOTENAY

"Lynn, you missed it!"

Darn. Just seconds earlier, I was watching Jean-Bernard Caron diligently tap, tap, tap his chisel against a seam binding layers of rock together.

Now two halves lay in his lap like pages of an open book, with a well-defined imprint of a fossil that had been, after being sealed in stone for 500 million years, suddenly exposed to daylight. And in that moment his chisel hit the sweet spot, I'd turned to view another interesting specimen uncovered earlier. No worries, Caron assured me, discoveries such as this well-preserved specimen of *Sidneyia inexpectans* happened many times a day at Marble Canyon.

"Every hour is something interesting," Caron said. "It doesn't stop."

The Marble Canyon Burgess Shale site is situated at 2,000 metres on a mountainside in Kootenay National Park. Having visited by helicopter with several other journalists a few days earlier, I'd accepted Caron's invitation to hike up and camp overnight.

As curator of invertebrate paleontology with the Royal Ontario Museum, Caron established the research site in July for six weeks with a crew of 12 professors, grad students and qualified volunteers working 10-day shifts with a few days off. While a helicopter had delivered all the necessary camping supplies, food and power tools, nearly every trip to begin or end a shift had required hiking – without a trail.

Setting off from the parking lot, within minutes I was clambering over waist-high deadfall, concentrating on one step at a time not to sprain an ankle on the rocks, roots, branches and ruts, and shoving my body through willow tangles and bushy young pine trees sprouting up from soil regenerated by a forest fire that roared through the area in 2003.

Making the two-hour off-trail bush-whack, I concluded, was a lot like the work required to excavate fossils – slow, deliberate, methodical, tedious, and eventually, rewarding – as I discovered when I finally reached camp just in time to feast on hot pasta.

Waking to frost on the ground, I joined the crew for a quick breakfast in the kitchen tent. Then, helmets and grimy coveralls on, Caron and his colleagues hiked 15 minutes to a rock outcrop with lunches, Thermoses, knee and butt pads in their packs. By 9 a.m., the tap tap, clink clink of chisels on hard stone rose from the mountainside as cars whizzed along Highway 93 in the valley bottom, oblivious to the action overhead.

Named for Burgess Pass (christened in 1886 for a deputy minister of the Interior), Burgess Shale fossils were first discovered in Yoho National Park in 1909 by Charles D. Walcott of the Smithsonian Institute. What makes the Burgess Shale fossils so exceptional and valuable to science is that soft tissues – not just the more commonly found mineral parts such as bones – have been exceptionally well preserved.

Since then, more than 75,000 fossil specimens have been collected from the Walcott Quarry and a dozen more Rockies sites by paleontologists bearing special Parks Canada permits.

Overall, these fossils provide an unparalleled window into the early evolutionary



Grad student Jesse Chadwick from Montana State University in Bozeman (left) and fellow volunteer Joe Moysiuk (University of Toronto) meticulously search for fossils at the Marble Canyon Burgess Shale site.

LYNN MARTEL PHOTO

history of marine animals in the time period following the Cambrian Explosion. In 1980, the Burgess Shale was designated a World Heritage Site and Parks Canada bears international responsibility for the protection and preservation of the sites and the fossils collected from them.

"We are very fortunate these sites are in national parks," Caron said. "They won't be pillaged, they will be protected for future generations."

And, he added, Parks Canada staff were especially helpful in establishing the researchers' camp close to the excavation site – complete with an electric bear-proof fence.

The Marble Canyon site was discovered in 2012 by Robert Gaines, associate professor of geology at Pomona College in California, and Cedric Aria, a University of Toronto PhD candidate working with Caron during a research expedition at the nearby Stanley Glacier site (earlier this summer, Parks Canada launched guided interpretive Burgess Shale tours at Stanley Glacier).

The Marble Canyon site was identified by following the same Stephen Formation geological layer (aka the Burgess Shale), down the valley. A two-week reconnaissance camp there yielded 3,000 specimens representing 55 species, 12 of them new to science.

Among the greatest treasures have been worms. Closely related to starfish, sea urchins and sea cucumbers, and then one step further, to humans, those worms are a field of specialty for Chris Cameron, invertebrate zoology professor at the University of Montreal. Like many of his peers, Cameron's fascination with fossils was ignited in childhood, when his grandmother showed him a book about Yoho's Burgess Shale.

"This has been an experience of a lifetime for me," Cameron said. "When I heard (Caron) had some 500 million-year-old acorn worms, my jaw dropped. The similar-

ity to those living today is astonishing."

Carma Nanglu, a University of Toronto grad student whose PhD project is on worms, was equally excited.

"It's one of the most abundant fossils here, but almost nonexistent in other places," Nanglu said. "Now we have the opportunity to see some internal features. I'm excited to look at them through the microscope."

Because they are so fragile, in the entire history of the fossil record only three acorn worms have been found, and those specimens only date back as far as the dinosaurs. The Marble Canyon site has yielded thousands of 500 million-year-old ones. The magic of the Burgess Shale is how creatures were buried so rapidly their fragile bodies – sometimes including antennae, gills, fins, appendages and guts – weren't destroyed.

"In the Pre Cambrian, more than 80 per cent didn't have mineralized body parts," Gaines said. "There's something magical happening here to preserve this level of fossil record. It's great to have this record at this point in the fossil record, exactly the period we needed it."

For his PhD project, Aria is focussing on understanding the Burgess Shale's best-known creatures.

"These are the very early forms that give us the forms we have today," Aria said. "Some of them have intriguing morphology. My goal is to understand the how all this happened and how those forms became extinct."

Just four metres high, the Marble Canyon quarry's layers represent tens of thousands of years, with the same species found in the top and bottom layers. The best fossils have been found in the lowest layers, where the rock is unusually hard for limestone, requiring a variety of power tools to force apart.

"It's a lot like a time capsule - a series of time capsules," Caron said. "You have these wonderful fossils in some of the worst rock layers to extract them from. The rock is

super hard and it breaks at oblique angles. That's been one of the surprises this year. I volunteered at Walcott for three summers. It's much easier there, the rock comes apart easily, you can follow the beds more easily. But scientifically, these are really important."

Approaching a foot-high, metre-square slab at the quarry's base, Caron pierces a horizontal row of holes with a jackhammer. Next, rock dust swirling, Aria helps Caron wield a larger jackhammer, rock shuddering until finally the top layer breaks off. Then with crowbars, saws, hammers and chisels, smaller pieces holding fossils are extracted.

"Sometimes you're not lucky, you go right through a fossil, but there's no way around that," Caron said. "But, we have very good glue. If you want to study a fossil, you need more than one specimen. Each specimen shows a different angle. If we're lucky, one out of 100 specimens shows something special."

Every fragment is collected, packaged and carefully labelled for transport so it can be studied in detail back in the lab. Some fossils are no bigger than a grain of rice; *Sidneyia* can be as long as 25 centimetres. Parks Canada will keep a few for interpreters to use. By the end of this summer's work, Caron expects to have 80 species from this site, including a half-dozen new ones. Work has already begun to follow up on a paper published last February in the journal *Nature Communications*.

"That tells you how rich and important this site is," Caron said. "If we only had Walcott Quarry, that might be misleading. We know Walcott relatively well, but we don't know how it evolved, how it changed. The more sites we find with soft-bodied animals, the more we learn. There are few sites in the world with this level of preservation. We think it's the start of a major wave. We're quite excited about this."