

# THE CALVIN Spark

THE MAGAZINE FOR  
ALUMNI AND FRIENDS  
OF CALVIN COLLEGE

FALL 2013



## A Whale of a Tale

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An ancient whale jaw emerges.

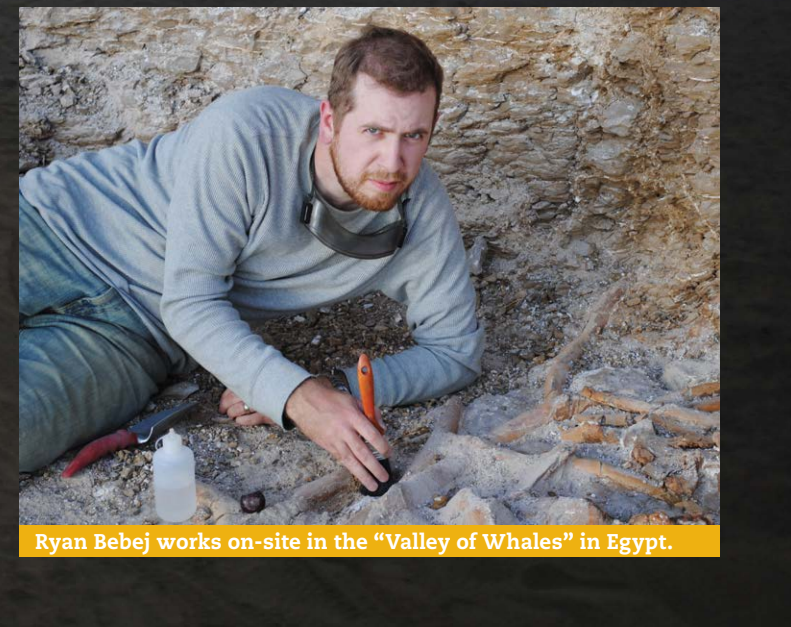
**R**yan Bebej sits in his office at Calvin, surrounded by books and photos and the other trappings of academia that a biology professor might be expected to have, including more than a dozen animal skulls. He discusses paleontology and evolution with a visitor, specifically the fossils of whales from millions of years ago found in Pakistan, India and Egypt over the past three decades or so.

As he talks he's rarely at rest. He pulls up images on his computer from the hundreds he has on file, including photos and illustrations of fossils that he took part in unearthing and fossils that he helped put together. He leaps from his seat to the whiteboard on the wall to grab a dry erase marker and do the math on surface area versus volume and how those two equations figured into regulation of body temperature during the transition of whales

from mammals that lived on land to mammals that eventually lived exclusively in the water.

He's animated, even when he's sitting down. He leans in to press a point and then leans back to observe his visitor's reaction. Later, as he walks down a flight of stairs to check on his summer research assistant, Calvin senior Melissa Braun, he offers his visitor a tongue-in-cheek apology.

"Sorry," he says with a grin. "As you can probably tell I don't at all get excited about this stuff." "This stuff" is his exploration of how a mammal, the whale, came to leave the land to become a marine animal, and it has become not just Bebej's life work as a researcher, but also his passion. Indeed, he might say it's become his vocation, a term he did not fully understand until he first came to Calvin as a student in 2001 and took a Prelude DCM ("Developing a Christian Mind") course designed to introduce



Ryan Bebej works on-site in the “Valley of Whales” in Egypt.

God brought about His marvelous, varied and rich creation. I love sharing these insights with students, fellow Christians and even non-believers, as it allows them to appreciate how the biodiversity that we have on Earth today is only part of the story—that the story of life on this planet is even richer when we look at it in the context of deep time.”

That’s why this past summer, Bebej and Braun spent 40-plus hours a week studying the tails of a variety of animals, painstaking work that they hope will contribute to a larger, worldwide project designed to understand the details of how whales adapted over millions of years to live exclusively in the water.

“The fossil record (of whales) indicates that they are descended from ancestors that lived on land,” he said. “In recent decades, this strange and seemingly counterintuitive transition has become one of the most prominent examples of macroevolution, but many details remain to be uncovered.”

One of those details is the evolution of tail-powered swimming: How did an animal with both fully developed front and hind legs (as was the case for the earliest whales), and what might be described as a traditional land-animal tail, transition into a creature with only vestigial hind leg bones and a powerful tail built for propulsion?

The fossils of ancient whales and the skeletons of modern-day creatures like dolphins and river otters provided clues for Bebej and Braun this summer, research work that saw them toiling not just in the labs of De Vries Hall on campus, but also at the University of Michigan, home to Bebej’s mentor, world-class paleontologist Philip Gingerich, and at the Smithsonian in Washington, D.C., which houses one of the world’s finest collections of modern whale skeletons.

Bebej notes that in the past three decades, the fossil record of the earliest whales has grown substantially, due in large part to the work of Gingerich and his students (including Bebej, who earned his PhD under the supervision of Gingerich), with almost all of the most significant fossils found in India, Pakistan and Egypt, where Bebej worked in 2009.

“There are currently over 50 different species of ancient fossil whales called archaocetes that bridge the gap between fully aquatic whales and their four-legged, land-living ancestors,” he said. “Many of these fossils are incomplete, but several of them are virtually complete, preserving incredible details of anatomy that allow paleontologists to reconstruct how these animals lived their lives.” These remarkable specimens document such trends as the reduction of the hind limbs (from legs that were used for walking to tiny vestigial limbs), the origin of the blowhole (from nostrils that were at the tip of the nose in the earliest whales), and the drastic shortening of the neck (which is important for efficient swimming).

Although the earliest whales don’t look much like modern whales, they have anatomical traits that identify them as whales, said Bebej, including many concentrated in the ear region that even today are possessed only by modern whales. The connection of these earliest whales to modern whales has also



students to some of the hallmarks of the Reformed faith (Bebej grew up in Princeton, Ill., in an Evangelical Covenant church). After that course he was nurtured by a steady stream of Calvin professors who helped him wrestle with the challenges of being a Christian scientist, challenges he said could have caused him to jettison his faith had he not been at Calvin.

“Growing up, I viewed science in general—and evolution specifically—as hostile to the Christian faith,” he said. “But when I was exposed to evolution as an undergraduate at Calvin, I began to understand that modern science need not be incompatible with an orthodox Christian faith—that science could be pursued by Bible-believing Christians, even as an act of worship. My work as a scientist has allowed my faith to blossom in ways that I never could have imagined. Today I take great joy in understanding the history of life on Earth, as it allows us to gain insights into how



Ryan Bebej and student researcher Melissa Braun at the University of Michigan Museum of Natural History with *Maiacetus inus*, a fossil whale from Pakistan

Photo: Jorie Antuma

been supported by the recovery of dozens of fossil species that fill in the gap between the oldest forms and more derived, fully aquatic whales. But one aspect of early whale evolution that is still poorly understood is the evolution of tail-powered swimming. Mammals with four legs swim very inefficiently, said Bebej, effectively using what one might call a doggy paddle. Whales, however, have a highly efficient way of swimming, but it requires a specialized spine, reduction of the hind limbs and the development of a broad, horizontally flattened tail fluke—a very different anatomy from that possessed by four-legged mammals.

“Because how an animal navigates its environment affects virtually every aspect of its life, elucidating the details of how this swimming mode evolved is one of the keys to understanding how the earliest whales adapted to life in the water,” Bebej said.

And while Bebej hoped that he and Braun would make good progress this summer, he also hoped that Braun would learn about and develop a passion for the hard work of science, just as he did first at Calvin and then at Michigan.

“The best way to learn science is by doing science,” he said. “Student research is a natural extension of classroom teaching. One of the best parts about doing research with students is giving them hands-on experience and allowing them to dive into a topic in detail. In doing this, we can expose students to the latest research in an area and give them a chance to seek answers to questions for which nobody currently knows the answer. How exciting is that!”

So far, so good, said Braun, a native of Rochester, N.Y., who, like Bebej, fell in love with Calvin the first time she saw it.

“Calvin felt right and like home,” she recalled of her first visit to campus, “especially the geology department as well as the biology department. The way professors interact with students in a close and caring way was and still is very important to me.”

Last year Braun did research in the geology department (she

is a geology major and biology minor) and “loved every minute of it.” This summer’s work helped her get a taste of what she thinks she might like to make her vocation someday: dinosaurian paleontology.

“Scientific research is great because you get to work on things you really enjoy and want to learn more about,” she said. “For me, applying things I learn in a real, hands-on way is the best way for me to retain the information and feel comfortable using it in a scientific environment. I hope to continue to better understand various ways to do paleontological research and to become more comfortable with computer program-related methods of research.”

For Bebej, offering his student researchers the possibility to pursue work that might become their vocation is practical but also philosophical: his way of thanking the mentors who did the same for him, especially during his graduate school days.

He said he will never forget his first trip to Egypt, to a place called Wadi Al-Hitan (the name means “Valley of Whales” in Arabic), home to some of the highest concentrations of well-preserved whale fossils in the world. It was a place Gingerich had been visiting for 30 years, so when Bebej got the chance to work there in 2009, he was thrilled.

“It became a dream of mine to visit Wadi Al-Hitan,” he recalled. “My first morning there, I couldn’t sleep, so I got up before the sun came up and spent some time walking around where we were staying, as the desert was lit up pretty well by a mostly full moon. I explored some of the nearby hills and got to watch the sunrise turn the desert into a bright golden color. I remember sitting there and thinking about how different the region is today, how the desert I was sitting in used to be underwater and teeming with ocean life! The whale fossils were plentiful as I explored the area in those first few days, but so were fossils of sawfish, turtles, sharks and countless invertebrates. As I saw more and more fossils, it actually became a lot easier to imagine the area as an ancient sea. And,

**“All truth is God’s truth, and discovering details about the world God created need not erode our love and devotion to Him, let alone our belief in Him.” —Ryan Bebej**

of course, as a Christian, my sense of awe and wonder at God’s creative activity continued to grow.”

Thanks to his work in Egypt and further years of study, Bebej is becoming an expert on a group of whales called *remingtonocetids*. In fact, he was asked to work on a recently discovered fossil that has anatomical characteristics that are very similar to some previously named species, thus allowing it to be identified as a *remingtonocetid*, but also with some characteristics that are unique and indicate that it was unlike all of the other archaeocetes that have been discovered thus far. His reward for his work will be that he gets to name the new creature. He says simply: “When we have something like this that is unique to science, then we get the chance to give it a name.”

But his colleagues note that the honor is a significant one.

Said Gingerich: “Ryan wrote his PhD dissertation on the early whale family, *Remingtonocetidae*, from Pakistan based on specimens my research group collected there, and then he worked with me for a season in Egypt. So when we found the first *remingtonocetid* in Egypt, he was an obvious one to study it. It is an honor to name a new fossil whale, and this is an honor Ryan earned.”

For his part Bebej finds his greatest satisfaction in being part of God’s creation story in a way that brings together his gifts and his passion.

“While there are many Christians who possess an evolutionary perspective on creation, there are relatively few who work specifically in the fields of evolutionary biology and paleontology. But it is clearly very important for Christians to have a voice in these fields,” he said. “First, it provides us with an opportunity to contribute to knowledge in these disciplines, which in itself can be a holy vocation. But performing solid scientific work also provides us with credibility among our non-Christian colleagues, which increases the chances for dialogue, the formation of relationships and the removal of unnecessary barriers, which could contribute to bringing others into the body of Christ.

“In addition, performing studies in these fields can provide encouragement for other Christians, emphasizing that we as Christians have nothing to fear in our search for truth. All truth is God’s truth, and discovering details about the world God created need not erode our love and devotion to Him, let alone our belief in Him. Investigations like these provide insight into His creative work and provide us with even more reason to worship Him.” **S**

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Bebej and Braun examine a fossilized tail.



Photo: Jorie Antuma