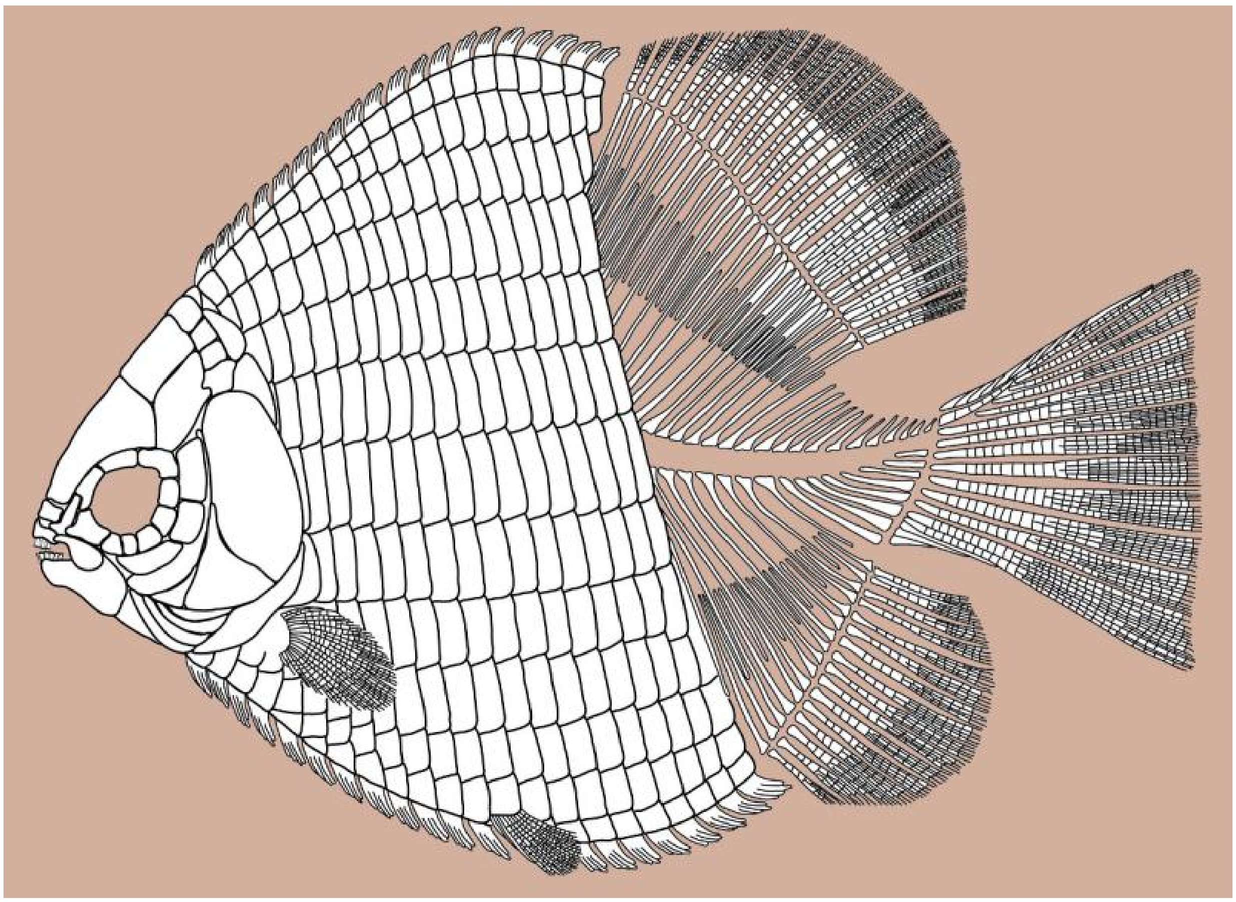
Veggievore fish of the Triassic

September 26 2016, by Andrew Farke



Skeleton of Hemicalypterus. Credit: Gibson 2016. CC-BY

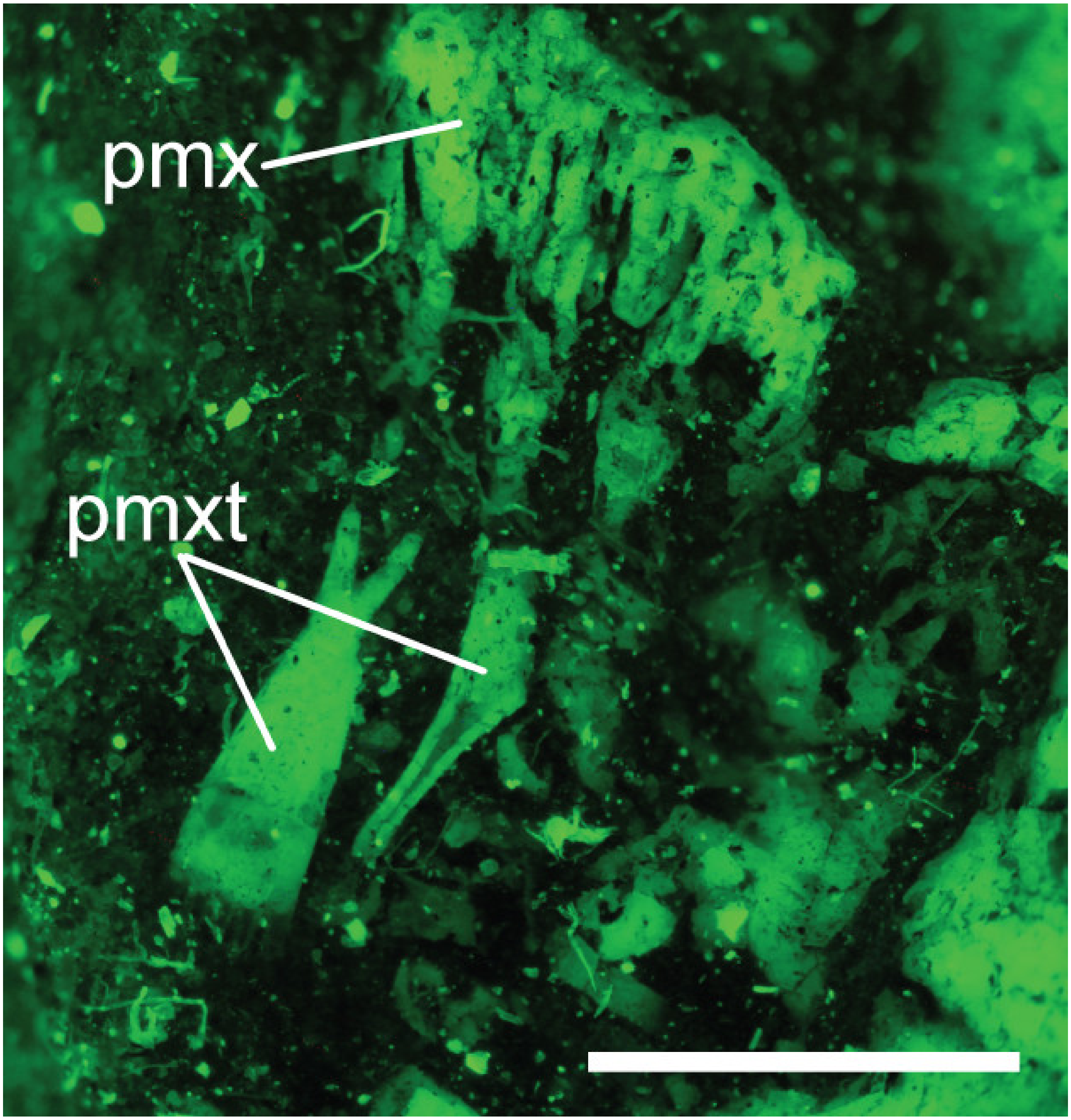
Fish have a bit of a boring reputation among many vertebrate paleontologists–too many bones, too hard to identify, not as charismatic as dinosaurs, etc., etc. But, this is entirely undeserved (and I say that as a dinosaur paleontologist, too)! The ins and outs of fish evolution are truly fascinating, bolstered by a phenomenal fossil record. Fish have an astounding array of body shapes and sizes, with an unparalleled ecological and geographic distribution. Consequently, fish are an excellent group in which to study adaptation and evolutionary transitions.

Co-blogger Sarah Gibson, based in the Department of Geology and the Biodiversity Institute at the University of Kansas, has made her mark studying fish that swam in the lakes and streams of North America during the dawn of the dinosaurs. Tremendous changes were happening in the world at this time, with the breakup of Pangaea and its associated environmental impacts. Although the land critters get most of the attention, fish were a happening group during the Triassic/Jurassic transition, too.

One of these early Mesozoic fish was Hemicalypterus, known from fossils first uncovered in Utah in the 1960s. It wasn't terribly big–at about 6.5 cm (2.5 inches) long, it would have fit comfortably into your typical home aquarium. Yet, Sarah's study of newly discovered fossils revealed some surprising details–including the fact that Hemicalypterus may have evolved herbivory tens of millions of years before other fish did. Sarah was kind enough to answer a few questions about this work, outlined below. I hope you'll agree that Hemicalypterus was a pretty cool little fish!

Hemicalypterus weiri has been known for awhile; what makes a restudy of this organism so important? How does it fit into the broader realm of fish work?

SG: It's important to revisit and restudy old organisms, especially when you find new information about them. And Hemicalypterus, when it was described in the 1960s, was incomplete. The new fossils we discovered in the past twelve years gave so much additional information than what Bobb Schaeffer (who named Hemicalypterus) had access to back then that it warranted a redescription. And more importantly, the evolutionary relationship of Hemicalypterus to other ray-finned fishes has never been considered within the context of a phylogenetic analysis, so no one really had a good idea of what it was closely related to. My paper in PLOS is the first to suggest where Hemicalypterus fits in the evolutionary relationships of lower ray-finned fishes. It's important to consider these taxa! They may not have living relatives so they often get overlooked, but in the broader realm of fish work, these fishes were evolving in ways that could impact our understanding of the evolutionary history of fishes today. They were also moving into novel ecological niches, such as herbivory, long before we ever thought fishes did, so that, too, gives us clues about the environment at the time, the ecology, and the feeding behaviors and niches of early ray-finned fishes.



The weird spork-shaped teeth of Hemicalypterus, indicated as “pmxt”. One of the upper jaw bones, the premaxilla, is also shown here (pmx). The bone is green because it was photographed under fluorescence, however, the hypermineralized toothlets on the end of the teeth do not fluoresce. Credit: Gibson 2016, CC-BY

As you discuss in the paper, congruent with other previous work, the teeth of Hemicalypterus suggest it was potentially herbivorous. What kinds of plants might it have been feeding on? When did other fish evolve herbivory?

SG: I think the best analogy for what the teeth of Hemicalypterus look like is that each tooth looks like a little "spork", with a recurved spatulate crown and tiny little toothlets on the end. The teeth are also pretty delicate, so Hemicalypterus was probably not crushing invertebrates or some other hard prey. When I first discovered the teeth while prepping newly collected fossils, I had no idea what a tooth with this type of morphology would be used for because I had never seen anything like it in any of the fossil fishes I was familiar with. So I started looking at modern fishes, and found that quite a few living fishes in several families and in different habitats have a similar tooth morphology, and they all use their teeth to scrape algae off of a rocky or woody substrate. They are all herbivorous or at least partially herbivorous, with algae the predominant part of their diet. Some living examples are fishes such as freshwater algae-scraping ciclids and marine surgeonfishes and butterflyfishes. So, Hemicalypterus was also likely scraping algae! There's a great video [shown below] of an algae-scraping cichlid (Labeotropheus) in the wild in Africa displaying this specific feeding behavior, and I suspect Hemicalypterus was doing something similar.

Before discovery of this type of tooth morphology in Hemicalypterus, it was generally accepted that herbivory in fishes did not evolve until around 50 million years ago, in the Eocene. In deposits from the Monte Bolca Formation, many fishes are preserved that are extinct relatives of living herbivorous teleost fishes (such as rabbitfishes, surgeonfishes, etc.), and some of these fossils from the Monte Bolca Formation have a similar tooth morphology. There are also isolated teeth with similar multicuspid edges from Cretaceous deposits in Africa in Asia, but no one really hypothesized that these belonged to herbivorous fishes. But

Hemicalypterus is from the Triassic! Regardless, it is the oldest potential evidence for the evolution of herbivory in fishes!

There are a whole ton of new specimens of Hemicalypterus weiri in your paper–what has happened to give us this new bounty of scientific information?

SG: Hemicalypterus fossils are mostly found in southeastern Utah in the Chinle Foration. When fish fossils were discovered in the Chinle in Utah in the mid-20th century, it was kind of by accident. USGS Geologists were exploring for uranium deposits, and documented fish fossils in some layers. The American Museum of Natural History and the Smithsonian National Museum of Natural History made a big push in the 1950s and 1960s to collect and describe fishes and other fossils from the area. But more recently there has been a strong, collaborative effort to thoroughly assess and document the geology and biodiversity of the Chinle Formation in Utah and how it all relates to other Chinle Formation deposits elsewhere. Researchers from the University of Utah, the St. George Dinosaur Discovery Site at Johnson Farm (in St. George, Utah), Petrified Forest National Park, and other institutions, have been going out to southeastern Utah to survey, map, and collect fossils from this region. I'm lucky to be the resident fishy person in this collaboration! The work has produced hundreds of fish fossils, and in addition to my work on Hemicalypterus, I've described a new genus and two new species of semionotid fishes (Lophionotus sanjuanensis and L. chinleana), and am currently working with colleages, as well as for my own dissertation, on other fishes from the sites. There's a lot of cool fishy critters to come!

Two of the unusual “spork”-like teeth of Hemicalypterus on a specimen under normal light. Credit: Sarah Gibson

One thing I've always wondered is why some paleontologists put that little dagger or cross (†) in front of their extinct study taxa. But, at least in dinosaurs (and most mammal papers I've read), it's not really common practice. Why are fish workers so weird? Is it a cultural thing?

SG: Ha! Well, fish workers can be a little bit weird sometimes! But it's really because ichthyology and paleoichthyology cross over far more than probably any other sub-disciplines of vertebrate zoology or paleontology, due to the fantastic fossil record for fishes (they just happen to live in the perfect place for deposition and preservation) and the fact that fishes are still one of the most (if not the most) abundant vertebrate on the planet today! Good ichthyologists take into consideration the fossil record when trying to resolve evolutionary relationships of their respective groups or when estimating the time of divergence of a clade, and likewise good paleoichthyologists consider living taxa in their studies of fossil taxa, their evolutionary relationships, and evolutionary history. But because there are so many living and extinct taxa in any given fish clade, the dagger (†) just helps clarify that this fish/family/order is completely extinct. It's not a mandatory practice, just a courtesy to help ichthyologists keep track. I try to use it consistently when I'm publishing in a journal that is not solely paleontology (because it would be a redundant practice in a paleontology-specific journal).

It's also not limited to fish scientists; other paleontologists often use the dagger to indicate extinct taxa when they, too, have living representative taxa. It would be quite silly to see the † on Tyrannosaurus rex because there are no living tyrannosaurids, so no need to clarify!

What was your favorite part of working on this project?

SG: I think the best part of working with Hemicalypterus was discovering the teeth. I really had a double-take moment while prepping the fossils in the lab at the University of Kansas. When I first saw the teeth, in particular a row of five or so on the lower jaw, I really couldn't figure out what I was looking at! Was it an error? Was it another animal? Was it fake!? Is this a prank?! What is going on!?! (All real thoughts) When I realized that those in fact were the teeth, I freaked out, in a good way! I think I ran around the museum telling anyone I saw what I had found! That kind of excitement is hard to convey in a dry scientific text, but it's the kind of thing that makes research worth it!

More information: Sarah Z. Gibson et al. Redescription and Phylogenetic Placement of †Hemicalypterus weiri Schaeffer, 1967

(Actinopterygii, Neopterygii) from the Triassic Chinle Formation, Southwestern United States: New Insights into Morphology, Ecological Niche, and Phylogeny, *PLOS ONE* (2016). DOI: 10.1371/journal.pone.0163657

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