A publication of the Rochester Academy of Science FOSSIL SECTION

The FOSSILETTER

VOL. 36 Number 4 February 2020

February Meeting

The February section meeting is on Tuesday, February 4, Brighton Town Hall Downstairs Meeting Room, 2300 Elmwood Ave.

Fossil Section Member Michael Grenier will present a slide-show talk on "Latest Dinosaur Research in 2020: New Findings in Dinosaur Evolution, the End-Cretaceous Extinction, Eggs & Babies, Evolution of Flight & Feathers, & Other Amazing Finds."

Michael, a member the Society of Vertebrate Paleontology, will present both recently published as well as some not-yet-published cutting-edge advances in bird, pterosaur, and dinosaur research. He will discuss new fossils preserving the skin, feathers, internal organs, and even proteins of dinosaurs and ancient birds; new T.rex facts, polar dinosaurs, eggs and baby dinosaurs, the development of flight in Mesozoic birds, the End-Cretaceous Extinction, newly-found species of dinosaurs and birds, dinosaur tracks, and much more. The talk will not be technical and is family friendly.

Bring a friend, visitors are welcome.

President's Report

by Dan Krisher

The Section's December meeting was held on 12/3 and featured the annual pizza party and Show-n-Tell. A wide range of fossils were on display and the event was well attended.

As is tradition, the Section did not have a January meeting. On January 12 the Section was scheduled to participate in the WinterFest at Mendon Ponds Park however due to weather conditions the event was postponed.

April Outreach Program

By Dan Krisher

Jennifer Luisi, the Vice-President, Cobbles PTA has asked us to return for Family Science Night at Cobbles Elementary School in Penfield. I accepted and we will have our fossil display at the event. We always look forward to the enthusiasm their students show as we answer questions and provide a great hands-on educational experience. This event is scheduled for Wednesday, April 15th from 6pm to 8pm.

Membership Renewal Time

We are still awaiting many of our members to make their renewal of membership (which expired 12/31/2019). If you have not, please renew at your earliest convenience. A membership form was sent with the November newsletter, or you can get one at **rasny.org/mbform.pdf**.

Mendon Ponds Park WinterFest

The January "Heat Wave" led to WinterFest being cancelled (maybe time for another paleo-global warming article?). It has been rescheduled for Sunday, Februuary 23rd. We will be there promoting science knowledge to the general public, along with the Mineral and Astronomy sections. We do this outreach program every year.

We will have two 8-foot tables with a variety of identified fossils from New York State and from elsewhere across the globe. We have handouts and fossils the children can take.

If you can please join us to help, even if only for an hour or two, or if you want more information, please contact Dan Krisher at 585-698-3147 or by email at **dlkfossil@gmail.com.**

Fossil Section hosts a crowd at the Mendon Park Winterfest Saturday 1/13/2019. Photo by Fred Haynes

We Have a Winner!!

The final tickets were put in for those who made donations at our December meeting, and we pulled a winner for the gorgeous book, ***A History of Life in 100 Fossils***, featured in the October newsletter. The winners were a couple who attended Ashley Pollock's talk in November and liked it so well that they made a donation and got raffle tickets for their generosity. The winners are Laurie and Chad Fitter. They will be at our February meeting to hear about dinosaurs and collect their new book.

Thank you to everyone who made donations to the section. We gave out all 30 tickets and raised $52 (after giving out extra tickets to those who donated $10). All proceeds went into the treasury to fund future programs.

Book Review

If you ask anyone who studies the evolution of Devonian tetrapods who the leading authority is, they will doubtless tell you that it is Jenny Clack of Cambridge University, where she is Emeritus Professor of Vertebrate Palaeontology. Among other discoveries, it was she and her team who first found remains of the well-known Devonian tetrapods *Acanthostega* and *Ichthyostega* in 1987, during an expedition to East Greenland. *Acanthostega* is a transitional, water-bound primitive tetrapod. Her research work in this field has been outstanding and well-recognized.

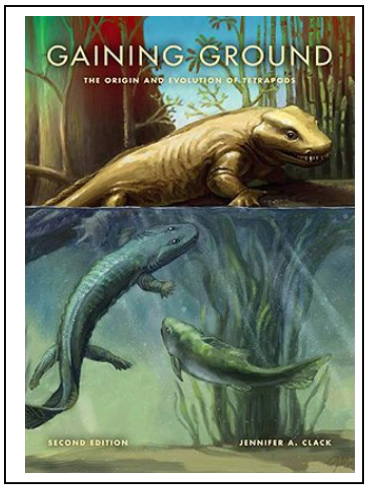
Dr. Clack was awarded the *Daniel Giraud Elliot Medal* from the U.S. National Academy of Sciences, the *T. Neville George Medal* by the Geological Society of Glasgow; elected a *Fellow of the Royal Society*, a *Foreign Honorary Member* of the American Academy of Arts and Sciences, and an *Honorary Foreign Member* of the Royal Swedish Academy of Sciences. She was awarded an honorary *Doctor of Science* (DSc) degree by the University of Chicago in 2013, in which she was described as "*an internationally preeminent paleontologist whose research has profoundly changed the understanding of the origin of terrestrial vertebrate life*." In 2018, she was awarded the Palaeontological Association's most prestigious award, the *Lapworth Medal*.

Dr. Jennifer A. Clack of Cambridge University

With that, I am happy to present my recently acquired **Gaining Ground: The Origin and Evolution of Tetrapods (Second Edition),** by Jennifer A. Clack: Indiana University Press, 2012, 523 pp., which I will have at the February meeting to lend, and just in time for our March Science Olympiad program, in which these creatures are prominently featured. IUP provides the following:

"Around 370 million years ago in the Devonian (in popular imagination, the Age of Fishes), a distant relative of modern lungfish began a most extraordinary adventure—emerging from the

water and laying claim to the land. Over the next 70 million years, this tentative beachhead had developed into a worldwide colonization by ever-increasing varieties of the four-limbed creatures known as tetrapods, the ancestors of all vertebrate life on land. Jennifer Clack's ground-breaking book tells the complex story of their emergence and evolution. Beginning with their closest relatives, the lobe-fin fishes such as lungfishes and coelacanths, Clack defines what a tetrapod is, describes their anatomy, and explains how they are related to other vertebrates. She looks at the Devonian environment in which they evolved, describes the known and newly discovered species, and explores the order and timing of anatomical changes that occurred during the fish-to-tetrapod transition." This is, therefore, your ancestor also.



This second edition was published six years after the discovery of *Tiktaalik*, and that species and others discovered in the early 21st Centruy are included. The book is organized into ten chapters: 1. Introduction: The Origin and Evolution of Tetrapods. 2. Skulls and Skeletons in Transition (an introduction to the skeletal anatomy of animals in the fish-to-tetrapod transition). 3. Relationships and Relatives: The Lobe-Fin Family (the tetrapods' closest relatives). 4. Setting the Scene: The Devonian World (The Devonian period opened onto a world far different from the present day. In the earliest stages, over 400 million years ago, even the oxygen content of the air was different from today.) 5. The First Feet: Tetrapods of the Famennian (East Greenland provides the most detailed knowledge of Devonian tetrapods.) 6. From Fins to Feet: Transformation and Transition (At one end is *Eusthenopteron,* a fish and at the other end is *Dendrerpeton,* an early tetrapod belonging to the temnospondyls group. The problem embodied in the phrase "the fish–tetrapod transition" is how evolution proceeded from one to the other.) 7. Emerging into the Carboniferous: The First Phase (At the end of the Devonian, a major extinction event hit most groups of vertebrates, both marine and nonmarine.) 8. East Kirkton and the Roots of the Modern Family Tree (A small former mining town called Bathgate, about 20 miles from Edinburgh, Scotland, has recently been made famous in the paleontological world for being the location of a window through which to view an extraordinary episode in evolutionary history. At the edge of a housing estate lies a quarry where in the 19th century a rock called the East Kirkton Limestone was dug out.) 9. The Late Carboniferous: Expanding Horizons (During the Late Carboniferous, the continents, which had slowly moved southward through the Devonian and Early Carboniferous, changed direction and began to rotate. Gondwana and Euramerica gradually collided, initiating the formation of the supercontinent Pangaea. Euramerica, positioned in the tropics, was covered by a vast swamp forest.) 10. Gaining Ground: The Evolution of Terrestriality (Dr. Clack considers the evolution of several key aspects of tetrapod biology and how they became truly adapted to terrestrial life.)

Fossil News (as long as we're on the topic)

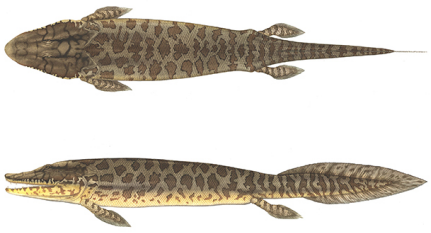
How fish fins evolved just before the transition to land, by Matt Wood.
(www.sciencedaily.com/releases/2019/12/191231111856.htm)

Research on fossilized fish from the late Devonian period, roughly 375 million years ago, details the evolution of fins as they began to transition into limbs fit for walking on land. This study by paleontologists from the University of Chicago used CT scanning to examine the shape and structure of fin rays while still encased in surrounding rock. The imaging tools allowed the researchers to construct digital 3D models of the entire fin of the "fishapod" *Tiktaalik roseae* and its relatives in the fossil record for the first time. They used these models to infer how the fins worked and changed as they evolved into limbs.

Much of the research on fins during this key transitional stage focuses on the large, distinct bones and pieces of cartilage that correspond to those of our upper arm, forearm, wrist, and digits. Known as the "endoskeleton," researchers trace how these bones changed to become arms, legs and fingers in tetrapods (all four-legged creatures, including those with arms or wings, and those that lost their legs). The delicate rays and spines of a fish's fins form a second, no less important "dermal" skeleton, which was also undergoing evolutionary changes in this period. These pieces are often overlooked because they can fall apart when the animals are fossilized or because they are removed intentionally by fossil preparators to reveal the larger bones of the endoskeleton. Dermal rays form most of the surface area of many fish fins but were completely lost in the earliest creatures with limbs. "We're trying to understand the general trends and evolution of the dermal skeleton before all those other changes happened and fully-fledged limbs evolved," said Thomas Stewart, PhD, a postdoctoral researcher who led the new study. "If you want to understand how animals were evolving to use their fins in this part of history, this is an important data set."

Fossil cast of a fin from a juvenile Sauripterus taylori*, a late Devonian fish with primitive features of tetrapods. (Image by Matt Wood)*

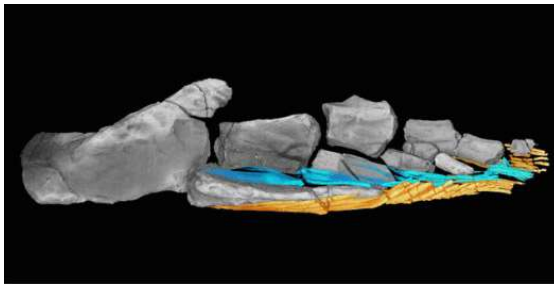
Stewart and his colleagues worked with three late Devonian fishes with primitive features of tetrapods: *Sauripterus taylori*, *Eusthenopteron foordi,* and *Tiktaalik roseae.* A team led by U. Chicago paleontologist Neil Shubin (senior author of the new study) discovered *T. roseae* in 2006. *Sauripterus* and *Eusthenopteron* were believed to have been fully aquatic and used their pectoral fins for swimming, although they may have been able to prop themselves up on the bottom of lakes and streams. *Tiktaalik* may have been able to support most of its weight with its fins and perhaps even used them to venture out of the water for short trips across shallows and mudflats. "By seeing the entire fin of *Tiktaalik* we gain a clearer picture of how it propped itself up and moved about. The fin had a kind of palm that could lie flush against the muddy bottoms of rivers and streams," Shubin said.



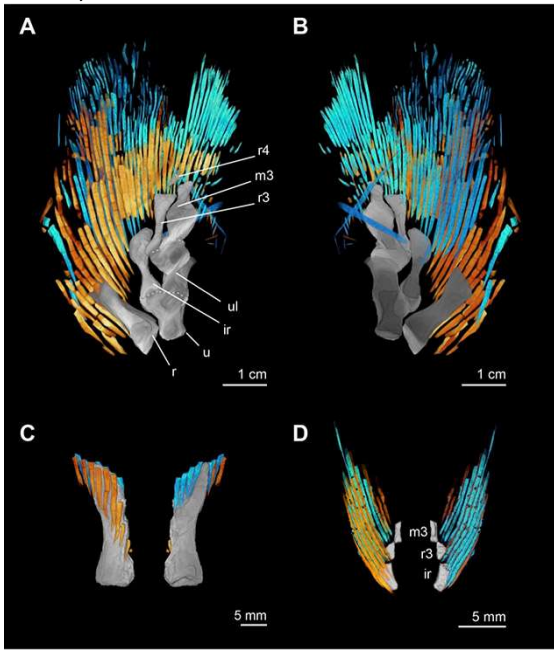
Tiktaalik roseae*, a 375-million-year-old "fishapod" has features of both fish and four-legged tetrapods. (Image by Flick Ford)*

The team scanned specimens of these fossils while they were still encased in rock, then they reconstructed 3D models that allowed them to move, rotate and visualize the dermal skeleton as if it were completely extracted from the surrounding material. The models showed that the fin rays of these animals were simplified, and the overall size of the fin web was smaller than that of their fishier predecessors. Surprisingly, they also saw that the top and bottom of the fins were becoming asymmetric. Fin rays are actually formed by pairs of bones. In *Eusthenopteron*, for example, the dorsal, or top, fin ray was slightly larger and longer than the ventral, or bottom one. *Tiktaalik*'s dorsal rays were several times larger than its ventral rays, suggesting that it had muscles that extended on the underside of its fins, like the fleshy base of the palm, to help support its weight.

"This provides further information that allows us to understand how an animal like *Tiktaalik* was using its fins in this transition," Stewart said. "Animals went from swimming freely and using their fins to control the flow of water around them, to becoming adapted to pushing off against the surface at the bottom of the water."



A CT scan of Tiktaalik*'s fin skeleton, showing its dorsal rays (yellow) and ventral rays (cyan). (Image Tom Stewart)*



CT images showing the dermal rays of the pectoral fin of Eusthenopteron*, another late Devonian fish with primitive features of tetrapods. (Image Stewart, et al, PNAS)*

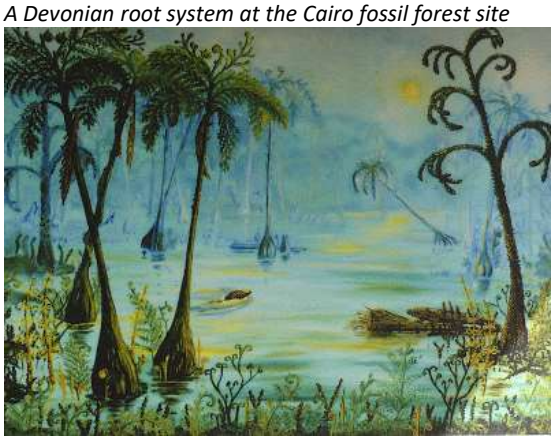
Stewart and his colleagues also compared the dermal skeletons of living fish like sturgeon and lungfish to understand the patterns they were seeing in the fossils. They saw some of the same asymmetrical differences between the top and bottom of the fins, suggesting that those changes played a larger role in the evolution of fishes. "That gives us more confidence and another data set to say these patterns are real, widespread and important for fishes, not just in the fossil record as it relates to the fin-to-limb transition, but the function of fins broadly."

This paper (Thomas A. Stewart, Justin B. Lemberg, Natalia K. Taft, Ihna Yoo, Edward B. Daeschler, Neil H. Shubin. **Fin ray patterns at the fin-to-limb transition**. *Proceedings of the National Academy of Sciences*, 2019; 201915983 DOI: 10.1073/pnas.1915983117 University of Chicago Medical Center) is available for download at www.pnas.org/content/pnas/early/2019/12/24/1915983117.full.pdf.

385-million-year-old forest discovered
(www.sciencedaily.com/releases/2019/12/191219142820.htm)

While sifting through fossil soils in the Catskill region near Cairo, New York, researchers uncovered the extensive root system of 386-million-year old primitive trees. The fossils, located about 25 miles from the site previously believed to have the world's oldest forests, is evidence that the transition toward forests as we know them today began earlier in the Devonian Period than typically believed. The Cairo fossil forest covered an area of at least 3,000 m^2, and is one or two million years older than the Devonian

A Devonian root system at the Cairo fossil forest site



Gilboa Forest Recreation from Rt 990V Kiosk

fossil forest at Gilboa, also in New York and around 40 km away from the Cairo site.

"The Devonian Period represents a time in which the first forest appeared on planet Earth," says first author William Stein, emeritus professor of biological science at Binghamton University. "The effects were of first order magnitude, in terms of changes in ecosystems, what happens on the Earth's surface and oceans, in global atmosphere, CO2 concentration in the atmosphere, and global climate. So many dramatic changes occurred at that time as a result of those original forests that basically, the world has never been the same since."

Stein and collaborators have been working in the Catskill region in New York, where in 2012 they uncovered "footprint evidence" of a different fossil forest at Gilboa, which, for many years has been termed the Earth's oldest forest. The discovery at Cairo, about a 40-minute drive from the original site, now reveals an even older forest with dramatically different composition.

The Cairo site presents three unique root systems, leading Stein and his team to hypothesize that like today, the forests of the Devonian Period were composed of different trees occupying different places depending on local conditions.

First, Stein and his team identified a rooting system that they believe belonged to a palm tree-like plant called *Eospermatopteris*. This tree, first identified at the Gilboa site, had relatively rudimentary roots. Like a weed, *Eospermatopteris* likely occupied many environments, explaining its presence at both sites. But its roots had relatively limited range and probably lived only a year or two before dying and being replaced by other roots that would occupy the same space. The researchers also found evidence of a tree called *Archaeopteris*, which shares a number of characteristics with modern seed plants.

"*Archaeopteris* seems to reveal the beginning of the future of what forests will ultimately become," says Stein. "Based on what we know from the body fossil evidence of *Archaeopteris* prior to this, and now from the rooting evidence that we've added at Cairo, these plants are very modern compared to other Devonian plants. Although still dramatically different than modern trees, yet *Archaeopteris* nevertheless seems to point the way toward the future of forests elements."

Stein and his team were also surprised to find a third root system in the fossilized soil at Cairo belonging to a tree thought to only exist during the Carboniferous Period and beyond: "scale trees" belonging to the class Lycopsida. "What we have at Cairo is a rooting structure that appears identical to great trees of the Carboniferous coal swamps with fascinating elongate roots. But no one has yet found body fossil evidence of this group this early in the Devonian." Stein says. "Our findings are perhaps suggestive that these plants were already in the forest, but perhaps in a different environment, earlier than generally believed. Yet we only have a footprint, and we await additional fossil evidence for confirmation."

Moving forward, Stein and his team hope to continue investigating the Catskill region and compare their findings with fossil forests around the world. "It seems to me, worldwide, many of these kinds of environments are preserved in fossil soils. And I'd like to know what happened historically, not just in the Catskills, but everywhere," Says Stein. "Understanding evolutionary and ecological history -- that's what I find most satisfying."

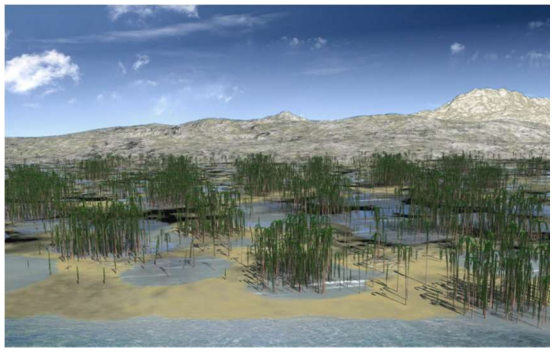
This paper (William E. Stein, Christopher M. Berry, Jennifer L. Morris, Linda VanAller Hernick, Frank Mannolini, Charles Ver Straeten, Ed Landing, John E.A. Marshall, Charles H. Wellman, David J. Beerling, Jonathan R. Leake. **Mid-Devonian Archaeopteris Roots Signal Revolutionary Change in Earliest Fossil Forests**. *Current Biology*, 2019; DOI: 10.1016/j.cub.2019.11.067) is available for download at www.cell.com/current-biology/pdfExtended/S0960-9822(19)31569-6

Researchers discover oldest fossil forest in Asia
www.sciencedaily.com/releases/2019/08/190808111435.htm

The Devonian period also saw evolutionary progress in plants. Chinese researchers describe the largest example of a Devonian forest in this 2019 paper, made up of 250,000 square meters of fossilized lycopsid trees, recently discovered near Xinhang in China's Anhui province. The fossil

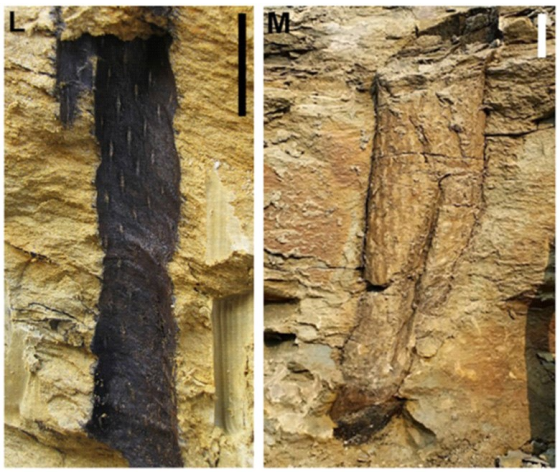
forest, larger than Grand Central Station, is the earliest example of a forest in Asia. Although larger, it is also younger than the New York forests at Gilboa and Cairo, being from the Famennian age in the Late Devonian, dated at about 372–359 Ma. The large in situ forest was found in Xinhang, Anhui, China, and includes locally dense stands of lycopsid plants.

Lycopsids resembled palm trees, with branchless trunks and leafy crowns, and grew in a coastal environment prone to flooding. These lycopsid trees were normally less than 3.2 meters tall, but the tallest was estimated at 7.7 meters, taller than the average giraffe. Giant lycopsids would later define the Carboniferous period, which followed the Devonian, and become much of the coal that is mined today. The Xinhang forest preserves the early root systems that made their height possible. (Another 380 million year old Devonian fossil forest was found in Svalbard, a cluster of Norwegian islands in the Arctic Ocean, and published in 2015.)



Wang et al (2019) Figure 7. Reconstruction of Xinhang Forest Landscape. Monospecific lycopsid forest in coastal habitat.

"The large density as well as the small size of the trees could make Xinhang forest very similar to a sugarcane field, although the plants in Xinhang forest are distributed in patches," says co-author Deming Wang, professor at Peking University. "It might also be that the Xinhang lycopsid forest was much like the mangroves along the coast, since they occur in a similar environment in comparable ecologic roles."



Wang et al (2019) Figure 4 (L) Helically arranged leaf bases in parasiticides. (M) Thick stem. PKUB16062.

The fossilized trees are visible in the walls of the Jianchuan and Yongchuan clay quarries, below and above a four-meter thick sandstone bed. Some fossils included pinecone-like structures with megaspores, and the diameters of fossilized trunks were used to estimate the trees' heights. The authors remarked that it was difficult to mark and count all the trees without missing anything.

"Jianchuan quarry has been mined for several years and there were always some excavators working at the section. The excavations in quarries benefit our finding and research. When the excavators stop or left, we come close to the highwalls and look for exposed erect lycopsid trunks," says Wang, who, with Qin, found the first collection of fossil trunks in the mine in 2016. "The continuous finding of new in-situ tree fossils is fantastic. As an old saying goes: the best one is always the next one."

This paper (Deming Wang, Min Qin, Le Liu, Lu Liu, Yi Zhou, Yingying Zhang, Pu Huang, Jinzhuang Xue, Shihui Zhang, Meicen Meng. **The Most Extensive Devonian Fossil Forest with Small Lycopsid Trees Bearing the Earliest Stigmarian Roots**. *Current Biology*, 2019; DOI: 10.1016/j.cub.2019.06.053) is not available for download, but a copy can be had from the editor.

CALENDAR OF EVENTS

February
Tuesday February 4, FOSSIL MEETING 7:30 PM Brighton Town Hall Auditorium 2300 Elmwood Ave.
Michael Grenier will present a slide-show talk on "Dinosaur Research in 2019." Visitors welcome.

March
Tuesday March 10, FOSSIL MEETING 7:30 PM Brighton Town Hall Auditorium 2300 Elmwood Ave.
Science Olympiad coaching session for middle- and high-school students. Please help.

Visitors are welcome to all Fossil Section meetings! Refreshments are served. For more information and the latest updates check the RAS Website (**www.RASNY.org**). You can also contact Dan Krisher at DLKFossil@gmail.com or John Handley at jhandley@rochester.rr.com for further information.

ROCHESTER ACADEMY OF SCIENCE FOSSIL SECTION

Monthly meetings are held the first Tuesday of each month from October to December and from February to May at 7:30 pm at the Brighton Town Hall, Community Meeting Room, 2300 Elmwood Avenue, Rochester, NY unless otherwise listed.

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The FossiLetter is published before each meeting month of the year. Please send submissions to mgrenier@frontiernet.net or by U.S. Postal Service mail to 692 Maple Drive, Webster, NY 14580. Deadline for submissions to the Fossiletter is the 15th of the month.

For scheduling changes and the latest updates please check the RAS Website (www.rasny.org) and click on the Fossil Section link. Last minute updates can also be found on the *General Announcements* page of the Academy Website.

"One small step for a fish, one giant leap for fish-kind!"
Tiktaalik rosea *Model by Tyler Keillor, Winner - Lanzendorf Paleoart Prize, 3-Dimensional Art, Society of Vertebrate Paleontology, 2008.*