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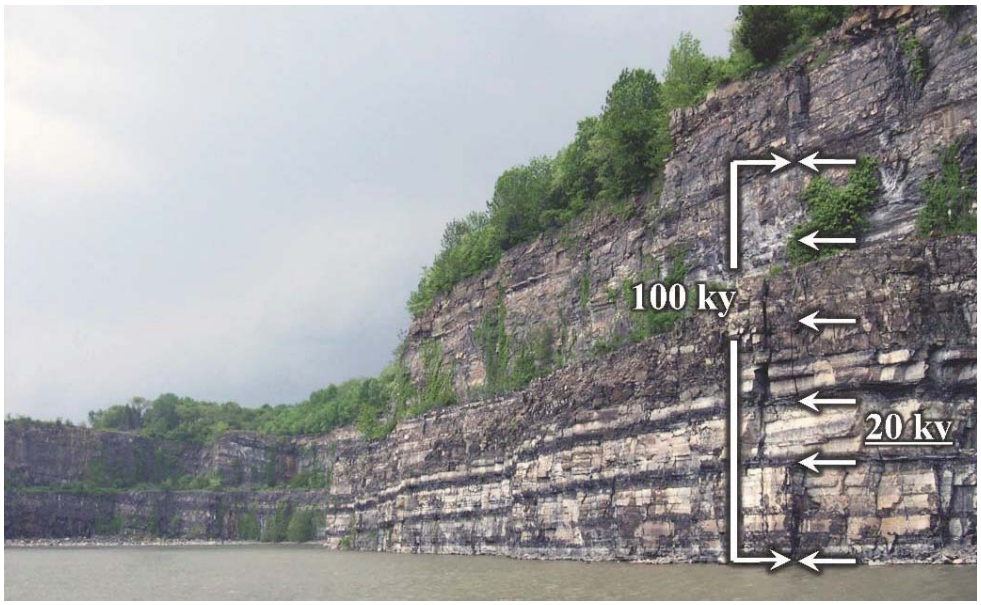

Cyclic sedimentation in the Lockatong Formation, Eureka quarry, Bucks County, Pa. (ky, 1,000 years) (see announcement on page 12).

—Photograph by Paul Olsen

EDITORIAL

New Chapters

Gale C. Blackmer, State Geologist
Pennsylvania Geological Survey

The approach of fall always puts me in mind of new chapters. I guess 30 years of living on an academic schedule does that to a person. A quick look at our demographics will tell you that the Bureau is on the verge of a new chapter. According to the official retirement projections from Human Resources, 29 percent of the staff is currently eligible to retire, and an additional 32 percent will become eligible over the next four years. It's enough to give a Bureau Director pause. Now, we all know that our geologists have a reputation for working long past their official "retirement age," so they won't all leave at once. Still, the turnover is beginning. We have had three retirements already this year—Gary Fleeger, Supervisor of the Stratigraphic Studies Section and glacial geologist; Tom Whitfield, "GIS guy"; and Elizabeth Lyon, our administrative assistant. While we miss all of them, Elizabeth's departure had the most immediate and global impact. After all, the clerical staff is the engine that keeps us humming. When a geologist retires, their work essentially stops. When the administrative assistant leaves, somebody else has to pick up the purchasing duties (thank you, Connie), the timekeeping duties (thank you, Renee) and the myriad of other things that we had taken for granted (thank you, everyone).

The flip side of people leaving, though, is that we gain the opportunity to step back and look at the work we are doing now and the work we should be doing moving forward, and then make adjustments as we hire new people. In this season of agencywide complement caps, we are fortunate that the executives in the Department of Conservation and Natural Resources have been generous in allowing us to fill our vacancies. Craig Ebersole joined us in June as a new "GIS guy." Kristen Hand and Steve Shank have moved into vacated supervisor positions. Each one brings their own unique set of experiences, skills, and interests to their job. By the time this issue is released, we should be into the search for a new glacial geologist. We are looking for a skill set that intersects with Gary's, but one that also brings a different capability. And I just received permission the day I write this to hire a new administrative assistant! I hope we can find a firecracker similar to Elizabeth to keep us all in line.

At the same time that the staff is starting to turn over, the Bureau is developing a new strategic plan. Our last plan was put together 20 years ago, so it is definitely time for a new chapter. Now a little more than halfway through the process, we are already applying some of the things we have learned to improve the way we do our work. Next up is the plan itself, which will provide direction for the kind of work we do going forward. This plays nicely into the determination of how to use those new staff members, doesn't it? Stay tuned as the saga continues.

Gale C. Blackmer

Reflections on *Petalodus,* a Common Late Paleozoic "Shark"[1] Tooth Found in Western Pennsylvania's Rocks

John A. Harper
Pennsylvania Geological Survey (retired)
and
Carnegie Museum of Natural History

INTRODUCTION

Pennsylvania's Paleozoic rocks provide paleontologists and collectors with a wide variety of plant and invertebrate fossils, such as leaves, stems, brachiopods, corals, and mollusks. Perhaps less well known are the many varieties of vertebrate remains that have been found in the state. Examples of these include Late Silurian jawless fish plates in the Wills Creek Formation in Perry County; remains of Late Devonian amphibians in the Catskill Formation at the famous Red Hill locality in Clinton County; remains of Late Pennsylvanian mammal-like reptiles found in the Glenshaw Formation in Allegheny County; and Triassic dinosaur footprints preserved in sandstones of the Gettysburg Formation in Adams and York Counties. These fossils typically are not as abundant as invertebrate or plant fossils, but using a little perseverance while searching a fossil site might net you some fish scales, spines, or teeth. This is especially true of the Mississippian, Pennsylvanian, and Permian rocks in western Pennsylvania and adjacent areas of the Appalachians, where both marine and nonmarine rocks have provided numerous vertebrate remains, particularly those of fish. Well-preserved, mostly complete specimens of small bony fish have been found in coal that formerly was mined near Cannelton, Beaver County. Similarly, Middle Pennsylvanian rocks at the famous Linton, Ohio, fossil site provided vertebrate paleontologists with an assemblage of nearly 40 vertebrate taxa, including a variety of fish and small aquatic amphibians, as well as some very rare tetrapod taxa adapted for living on land (Hook and Baird, 1988). Sites such as these were rare to begin with, and most of them are no longer available for collecting. The Mississippian and Pennsylvanian marine rocks of western Pennsylvania, however, are exposed in many locations where, along with corals, bryozoans, brachiopods, mollusks, trilobites, and echinoderm plates, one can occasionally find the teeth of "sharks" having names like *Campodus, Cladodus, Deltodus, Helodus,* and *Petalodus* (Figure 1).

Petalodus (Figure 1E) in particular, a large, spade-shaped tooth[2], is a relatively common and easily identifiable fossil of the class Chondrichthyes (cartilaginous fish having well-developed jaws). Hamm and Cicimurri (2005) considered it to be the most common "shark" fossil found in Late Paleozoic marine rocks. Chondrichthyans have skeletons (other than teeth) made of cartilage rather than bone, and since cartilage doesn't fossilize well, it is difficult to find the remains of these fish in the fossil record. Class Chondrichthyes is divided into two subclasses: Elasmobranchii, which includes the sharks, rays, and skates (Figures 2A, 2B, and 2C); and Euchondrocephali (Lund and Grogan, 1997), which includes the Recent chimaeras (Figure 2D) plus a variety of fossil forms that include the Paleozoic Petalodontiformes (Figures 2E and 2F), to which *Petalodus* belongs. Some researchers have suggested

[1] Throughout this article, where the word "shark" is placed in quotes, it is because the fossils referred to are not from actual sharks, but rather are from fish related to today's sharks and rays.

[2] The name *Petalodus* is a combination of the Greek words *petalon,* meaning a leaf, and *odontos,* meaning a tooth. I prefer to think of the teeth as being shaped like a thick rose petal, thereby giving its name a more appropriate meaning in modern English.

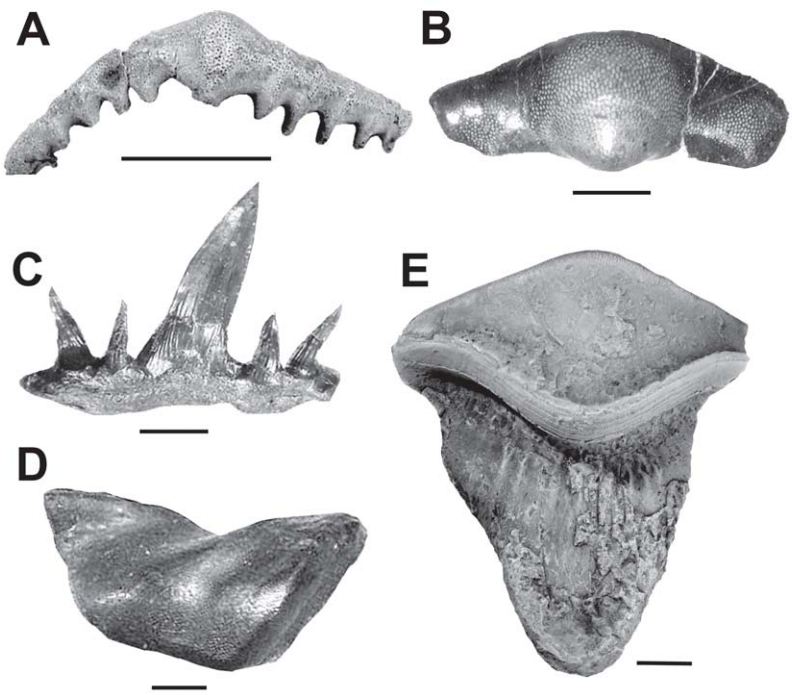

Figure 1. Photographs of some common Pennsylvanian "shark" teeth from western Pennsylvania. A, Campodus; *B,* Helodus; *C,* Cladodus; *D,* Deltodus; *E,* Petalodus. *Scale bars, 5 mm.*

that the petalodonts might have been closely related to skates and rays (e.g., Woodward, 1888; Miller, 1957). Flattened skatelike and raylike body plans have evolved several times within Chondrichthyes, however, so there is no reason why the petalodonts must have been closely related to the elasmobranchs.

Most petalodonts are known primarily, or entirely, from their isolated teeth[3], although there actually are petalodont fish that are well known from almost complete articulated specimens. *Belansea* (Figure 2E), for example, had a laterally compressed body for an active, free-swimming lifestyle (Lund, 1989). *Janassa* (Figure 2F), on the other hand, had a more raylike or skatelike vertically compressed body, suggesting a bottom-dwelling lifestyle (Zangerl, 1981). These fish appear to have been quite common in ancient seas ranging in age from the Late Devonian through the Permian. *Petalodus* is well known especially from Early Mississippian through Early Permian rocks throughout the northern hemisphere.

PETALODUS PEDIGREE—OWEN AND AGASSIZ

The eminent British anatomist Sir Richard Owen (1804–92) (Figure 3A) coined the name *Petalodus* as a subgenus of *Psammodus,* a group of fossil fish that another eminent scientist, Louis Agassiz (see below), had named previously (*Petalodus* has since been recognized as a separate genus unrelated to *Psammodus*). Owen is best remembered today for coining the word "Dinosauria" and for his outspoken opposition to Darwin's theory of evolution by natural selection. Despite this latter scientific "black eye," he is generally considered to have been one of the greatest comparative anatomists in history. Born in Lancaster, England, Owen started on his path to biological stardom at the age of 16 as an apprentice to a local surgeon; four years later he became a medical student at the Royal College of Surgeons (Owen,

[3] Dr. David Berman, Curator Emeritus of Paleozoic Vertebrates at the Carnegie Museum of Natural History, shared a note with me that he had received from another well-known vertebrate paleontologist who called the teeth of petalodonts "Cheshirian," referring to the Cheshire Cat of Lewis Carroll's *Alice in Wonderland.* Carroll described the cat as just a toothy grin floating in thin air as the rest of its body faded away.

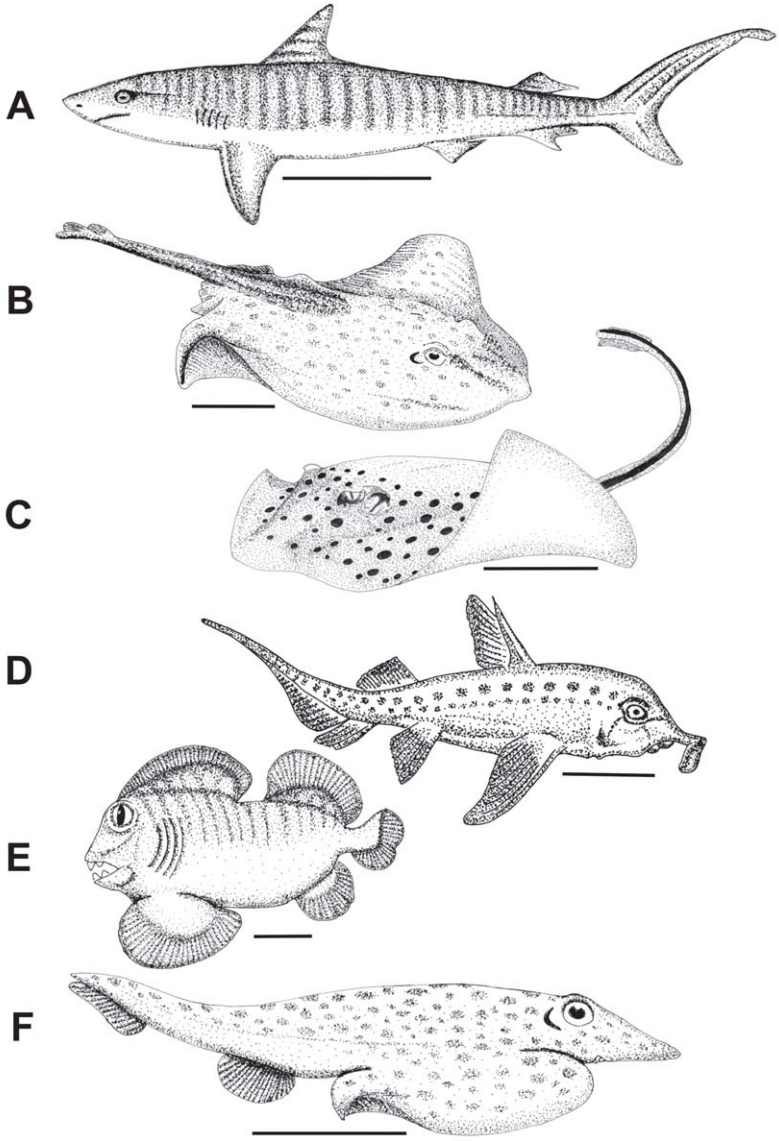

Figure 2. Some of the many varieties of fossil and Recent chondrichthyans. Representative members of the Elasmobranchii include the tiger shark (A), the winter skate (B), and the ribbontailed stingray (C). Representative members of the Euchondrocephali include chimaeras such as the elephantfish (also called ghost shark) (D), and petalodonts Belantsea *(E) (drawing based partly on Lund, 1989) and* Janassa *(F) (reimagined as a skatelike fish). Scale bar for A, 5 ft; all other scale bars, 5 in.*

1894). Although he thought about being a physician when he completed his studies in 1822, his interest in anatomy, plus some recommendations from a leading physician of the day, led him to become an assistant curator at the Hunterian Museum at the Royal College. During his tenure there he prepared an important series of catalogs, which gave him a wealth of knowledge about comparative anatomy. He gave up all desire to be a practicing physician and spent the remainder of his life as a research scientist.

Like Richard Owen, Louis Jean Rudolf Agassiz (1807–73) (Figure 3B), another icon of comparative anatomy, as well as of geology, displayed an early interest in living things. When it came time to decide what to do with his life, he chose to study medicine. He received his Doctor of Medicine degree from

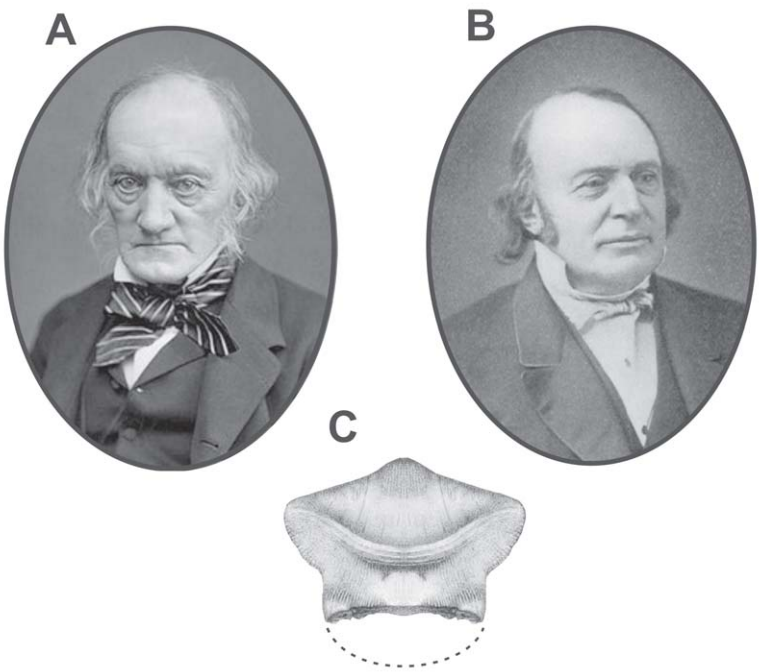

Figure 3. Portraits of the nineteenth century's most eminent anatomists, and an illustration of a tooth made famous by them. A, Sir Richard Owen (modified from Owen, 1894); B, Louis Jean Rudolf Agassiz (modified from Anonymous, 1898); C, Chomatodus acuminatus *Agassiz, the type species of* Petalodus.

the University of Munich in 1830, but his interest in animals led him instead on the path of zoological research (Anonymous, 1898). He soon moved to Paris, where he studied geology under Alexander von Humboldt and zoology under Georges Cuvier. As a result, he became interested in both the geological and zoological aspects of organisms, especially fishes. In 1832, he was appointed Professor of Natural History at the University of Neuchâtel in Switzerland, where he published five amazing volumes of *Recherches sur les Poissons Fossiles* (*Research on Fossil Fish*) between 1833 and 1843, work that secured his zoological legacy. But Agassiz is also well known in the geological community for his pioneering work on glaciers. He was the first to propose the scientific concept of the Ice Age. His research in the Alps resulted in the publication of *Études sur les Glaciers* (*Studies on Glaciers*) in 1840, yet another seminal work. In 1847, after having visited Harvard University, Agassiz emigrated to the United States and accepted the Chair of Zoology at the Lawrence Scientific School at Harvard. It was here that he was instrumental both in establishing the world-renowned Museum of Comparative Zoology and in training some of this country's leading scientists of the late nineteenth and early twentieth centuries.

Owen's (1840) new "subgenus" was based on a tooth that he named *Petalodus hastingsii,* which is now recognized as a junior synonym of a tooth that Agassiz (1838) had named *Chomatodus acuminatus* (Figure 3C), making Agassiz's species the type for the genus. Unfortunately, some paleontologists still consider *Petalodus hastingsii* to be the type species. To make matters even more confusing, the spelling of *hastingsii* is sometimes given as *hastingsiae* or *hastingsae* (see, for example, Lund and others, 2014).

OH, THE SHARK HAS PRETTY TEETH, DEAR, AND HE SHOWS THEM PEARLY WHITE[4]

Agassiz's generic concept of *Chomatodus* included teeth in which the bases of the crowns are surrounded by a series of concentric folds. Such teeth typically are elongated and compressed, and some have sharp edges as in the teeth of some modern sharks. Owen (1840, p. 61) recognized that some of

[4] With apologies to Bertolt Brecht.

Agassiz's *Chomatodus* teeth were shaped into thin, sharp ridges quite different from more typical *Chomatodus* teeth, for which he erected the new genus *Petalodus.*

Petalodus teeth are characterized by having short, spadelike crowns and tongue-shaped roots that typically are two to four times longer than the crowns (Hamm and Cicimurri, 2005) (Figure 4). The crown is thicker at the base and thinner toward the top where it becomes a cutting edge. The side facing toward the outside of the mouth (called "labial") is slightly convex and the side facing into the mouth (called "lingual") is either straight or slightly concave. The crown is often preserved with a series of tiny overlapping ridges above the root.

Vertebrate paleontologist Richard Lund of St. Joseph's University in Philadelphia and his colleagues have spent years describing articulated specimens of petalodonts from the Mississippian Bear Gulch Limestone of Montana. These have provided paleontologists with a basic zoological concept for the group as a whole. For example, in *Belantsea* (Figure 2E) and its relatives, tooth size and symmetry decrease toward the back of the jaw (many petalodonts had teeth of different sizes and shapes, a condition called heterodont dentition). Lost teeth were replaced by new ones growing in rows inside the mouth, as in modern sharks, but these new teeth were smaller and less functional until they were needed.

Complete sets of teeth have never been found for *Petalodus,* so an indisputable reconstruction is essentially impossible, although some people have tried to reconstruct the fish based on its relationship to other petalodonts. Hansen (1996), on the basis of a large collection of isolated teeth from Ohio, attempted a reconstruction of a *Petalodus* jaw. He suggested that *Petalodus* had nine teeth in the upper jaw, with one large, symmetrical tooth located at the front and four others arranged toward the back on either side. Eight somewhat smaller teeth in the lower jaw were offset relative to the teeth in the upper jaw. Tooth size and symmetry decreased toward the rear of the jaws in this reconstruction (Figure 5A). When the fish was biting, these teeth would have slid past each other at their lateral edges where any slicing function would have taken place. Lucas and others (2011), however, suggested that Hansen's reconstruction was incorrect. They determined that *Petalodus* teeth from New Mexico had far more wear and tear on the tops of the crowns than on the lateral edges, and that the "scooped out" shapes of the crowns would allow for the crowns to more easily slide past each other (as in Figure 5B). Their revised reconstruction of the dentition of *Petalodus* had equal numbers of teeth in both the upper and lower jaws aligned vertically, enabling the crowns to slide past each other and more effectively slice soft tissue (see Figure 5C).

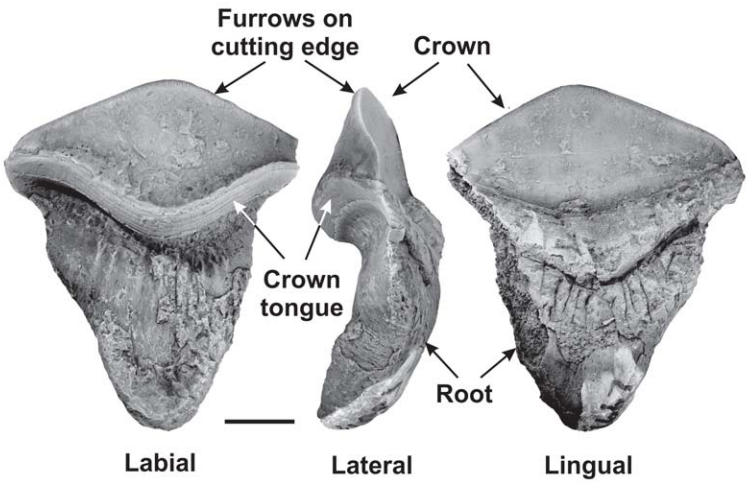

Figure 4. Three views of a Petalodus ohioensis *tooth and some simple terminology. Left, labial (side toward the lip) view. Center, lateral view with the labial side facing to the left. Right, lingual (side toward the tongue) view. The specimen is in the collections of the Carnegie Museum of Natural History, Section of Vertebrate Fossils (CM 41667). Scale bar, 5 mm.*

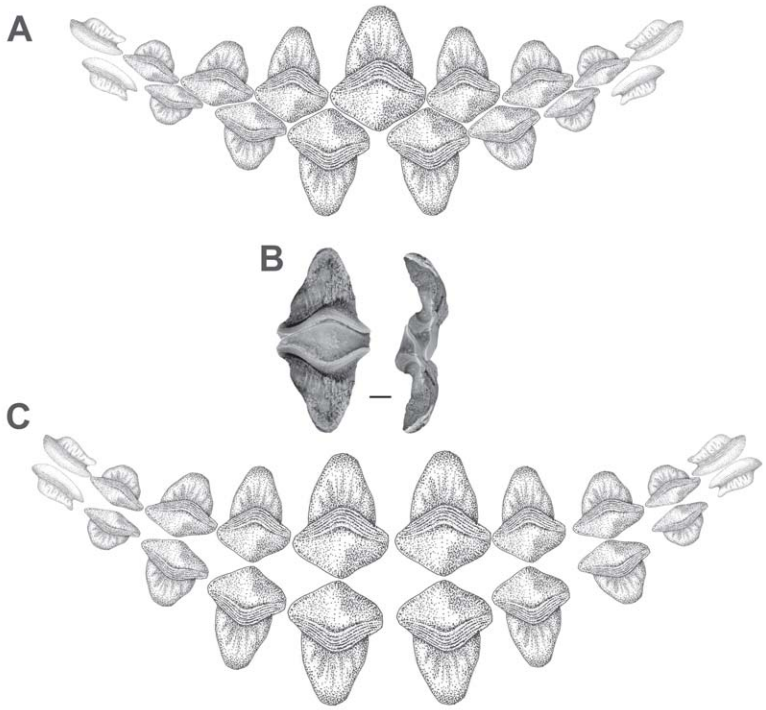

Figure 5. Possible Petalodus *dental reconstructions. A, A proposed reconstruction of jaw arrangement with the upper teeth contacting the lower teeth only at the lateral margins of the crowns (based on Hansen, 1996). B, A pair of teeth in contact, overlapping, with the crowns sliding past each other in order to shear prey, as advocated by Lucas and others, 2011 (photograph of CM 41667; bar scale, 5 mm). C, A revised reconstruction of jaw arrangement based on the concept of Lucas and others (2011).*

YUMMM!

The question now arises: with teeth like these, what did the petalodonts eat? As an undergraduate (many, many years ago!), I found my first *Petalodus* tooth in an outcrop of black shale associated with the Pine Creek limestone outside of my hometown of Coraopolis (near the Greater Pittsburgh International Airport). Back then, the prevailing philosophy seemed to be that *Petalodus* was a "shell cruncher," a fish that chewed up clams and brachiopods lying on the seafloor. I always thought the shape of the teeth was more reminiscent of shark teeth, however, suggesting that *Petalodus* had been an active predator, possibly the "Jaws" of the Late Paleozoic.

Not everyone agreed that the petalodonts were "sharks." Malzahn (1968) and Hodnett and others (2011) thought that some must have been opportunistic bottom feeders because preserved stomach contents in *Janassa* (Figure 2F) included fragments of shelled invertebrates, such as brachiopods, crinoids, foraminifera, and crabs. Hodnett and others (2011) further suggested that *Megactenopetalus,* another petalodont, may have been a slow-moving ambush predator. Hansen (1985) and Elliot and others (2004) felt as I did, that *Petalodus* was an active sharklike predator. In fact, Hansen and Mapes (1990) reported *Petalodus* tooth-shaped bite marks on a Pennsylvanian orthocone cephalopod from Oklahoma, although they would not rule out the possibility that the marks were made by some other fish. But then there's *Belantsea* (Figure 2E), which vaguely resembles a parrotfish, an herbivore (the teeth of the two fish are distinctly different). Thus, it is obvious that the petalodonts were not a "one size fits all" category of fish, and that they are related less by dining habits than by tooth form.

SO, WHAT'S IN A NAME?

About 35 species of *Petalodus* have been named since Owen (1840) proposed the genus. Twenty of those species are still more or less accepted, but many are Lower Carboniferous species from Europe that most likely are synonyms of *Petalodus acuminatus.* James M. Safford (1853) named the first North American *Petalodus* tooth from Pennsylvanian rocks near the town of New Concord, Muskingum County, Ohio (the bedrock in New Concord is Glenshaw Formation). His "report" was only a few sentences long and included two drawings of the tooth, with a very brief reference to the cutting edge. Safford published the specimen as *Getalodus ohioensis.* The generic name most likely was a printer's error because Louis Agassiz himself identified the tooth for Safford. Today, the scientific community accepts it as *Petalodus ohioensis.* Safford was merely the first to name a *Petalodus* species in North America. Following his short note, paleontologists named and described a new species from Carboniferous rocks of the northern hemisphere every four or five years through the end of the nineteenth century, 17 in all; five of them were from the Pennsylvanian of North America. The first of these was *Petalodus allegheniensis* Leidy (1856) from the Brush Creek marine zone (Glenshaw Formation) along the Allegheny Portage Railroad in Cambria County (Harper, 2016). Only three species were named and described in the twentieth century, among them an Upper Devonian microfossil from China that can be assigned only questionably to *Petalodus,* and *Petalodus jewetti* Miller (1957), which seems to have been given a new name simply because it was found in Kansas where no petalodont had been reported previously.

Robb (2003) pointed out that *Petalodus* teeth typically are isolated and fragmentary at best, and the multitude of species names most likely resulted from the fish having variably shaped teeth dependent on where they had grown in the fish's jaws (Figure 5). Those with high crowns would have grown toward the front of the jaw, whereas those with low crowns would have grown toward the back. Thus, the plethora of names most likely includes synonyms of one or two valid species. Hansen (1985), for example, suggested that the dominant Mississippian (Early Carboniferous) species of *Petalodus* (e.g., *P. hybridus* St. John and Worthen, 1875, from the St. Louis Limestone of Illinois) is *P. acuminatus,* whereas Safford's *P. ohioensis* is the dominant Pennsylvanian (Late Carboniferous) and Early Permian species; all other species would be synonyms of those. Ivanov and others (2009) and Ivanov and Lucas (2011) went so far as to suggest that *P. ohioensis* probably is a synonym of *P. acuminatus,* meaning that only one valid species of *Petalodus* existed from the Early Mississippian through the Permian, a span of more than 100 million years. This seems highly unlikely to me, considering that the average life span of a species ranges from about 10 million years for some invertebrates to about one or two million years for vertebrates. Even the prospect that *P. acuminatus* and *P. ohioensis* could have survived through the entire Early and Late Carboniferous, respectively, hardly seems plausible.

QUO VADIS *PETALODUS?*

Whether *Petalodus acuminatus* and *Petalodus ohioensis* represent two different fish from different geological ages, or just different teeth from a single species, has yet to be established. To my knowledge, no one has ever found a high-crowned *P. ohioensis*-type tooth in the Mississippian where *P. acuminatus* is "common." Maybe someday someone will find a jawful of *Petalodus* teeth, or better yet, a complete fish, which would solve many problems associated with the genus. In the meantime, because no one can contradict me with any certainty, I offer Figure 6 as my own concept of a possible reconstruction of *Petalodus,* a sharklike predatory fish chasing a tasty meal in the Late Pennsylvanian seas of Allegheny County.

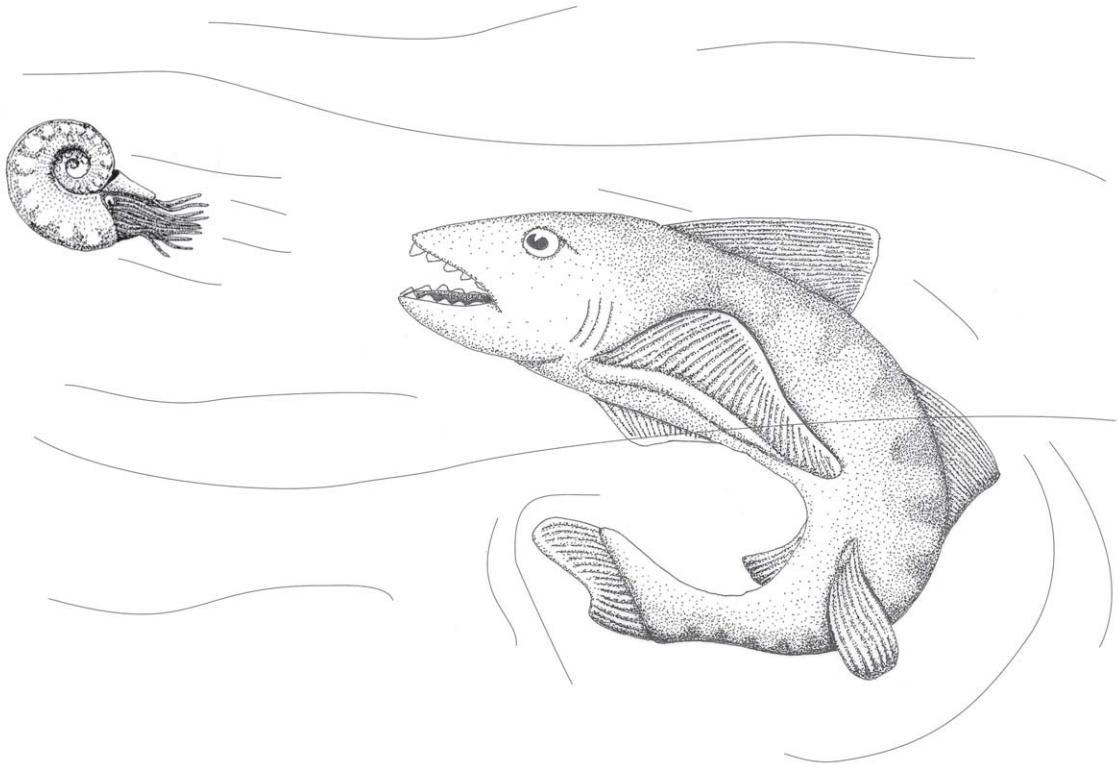

Figure 6. One possible reconstruction of Petalodus *as a sharklike fish living an active predatory lifestyle in the Late Paleozoic seas.*

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ANNOUNCEMENT

83rd Annual Field Conference of Pennsylvania Geologists

TEMPORAL, TECTONIC, CLIMATIC AND ENVIRONMENTAL CONTEXT OF THE TRIASSIC-JURASSIC RIFT SYSTEM OF EASTERN NORTH AMERICA: EMERGING CONCEPTS FROM THE NEWARK RIFT BASIN

The 83rd Annual Field Conference of Pennsylvania Geologists will be held on Friday and Saturday, October 5 and 6, 2018, and will concern the geology of the Newark rift basin. Preconference trips will be held on October 4. The headquarters hotel for this year's conference is the Homewood Suites by Hilton in Center Valley, Pa. (3350 Center Valley Parkway, Center Valley, PA 18034, 610–351–6400). The leaders for the field conference are Paul Olsen (Lamont-Doherty Earth Observatory, Columbia University), Martha Withjack and Roy Schlische (Rutgers University), and Frank Pazzaglia (Lehigh University).

The Mesozoic Newark basin stretches across southeastern Pennsylvania from the Delaware River to the northeastern tip of Lancaster County. The focus of this conference will be on the basin in upper and central Bucks County, where the sedimentary, igneous, metamorphic, and tectonic history are well exposed in the local quarries. Topics to be discussed include the geometry and evolution of the basin, the distinct cyclic sedimentation related to climate history (see cover photograph), and their relevance to environmental geology, groundwater and arsenic, and carbon sequestration. Additional stops will feature diabase related to the Central Atlantic Magmatic Province (CAMP) and its associated contact metamorphism. Oddly, the Newark basin has never been the focus of a field conference; it is hoped that this trip will spur additional interest, studies, and mapping in one of the more rapidly growing parts of the state.

A variety of preconference trips is also planned. Excursions include a tour of the nearby nineteenth century Ueberroth and Hartman zinc mines, a caving trip, a look at the Quakertown diabase sill, a geo-biking tour of the Saucon Rail Trail, and a groundwater remediation study in fractured bedrock at a former military base.

For more information about the Field Conference, go to www.fcopg.org.

BUREAU NEWS

Staff Changes

CRAIG M. EBERSOLE. Craig Ebersole joined the Bureau's Geologic and Geographic Information Services Division in June 2018. A relative youngster, he graduated in 2009 from Juniata College with a B.S. degree in geology and went straight to work as an environmental consultant. His consulting days took him throughout Pennsylvania and occasionally into Maryland and West Virginia, performing field work to support the characterization and remediation of subsurface contamination. When not in the field, he honed his Geographic Information System (GIS) skills by managing geospatial data, preparing geologic and hydrogeologic maps, and earning a postbaccalaureate certificate in GIS.

In 2015 he joined the Pennsylvania Department of Environmental Protection's (DEP) Safe Drinking Water Program. There he served as DEP's southcentral region Source Water Protection (SWP) lead and primarily assisted community water systems to develop SWP Plans through the Source Water Protection Technical Assistance Program. He also worked on cases in which public water sources were at risk.

When he is not dabbling in GIS software or talking about geology, he can be found hiking, biking, reading science fiction, or traveling (usually to look at impressive rocks). Craig and his wife, Liz, live in Lancaster County.

GARY M. FLEEGER. Gary M. Fleeger, chief of the Stratigraphic Studies Section, retired on March 30, 2018, completing 22 years to the day at the Bureau (he started on April Fool's Day, 1996), and 30+ years of service to the commonwealth. Gary received degrees in geology from Bucknell University and the University of Illinois at Urbana-Champaign. Inspired by growing up while Moraine State Park was being developed, his training and main interest was in glacial geology.

Gary started with the Bureau in the Hydrogeology Section. While there, he wrote a new edition of Educational Series 3, *The Geology of Pennsylvania's Groundwater,* coauthored Educational Series 6, *Pennsylvania and the Ice Age,* completed a statistical study of the hydrogeologic and water-well construction characteristics of the rock units of Pennsylvania, revised the park guide for Moraine and McConnells Mill State Parks, and completed a study of the hydrogeologic effects of the magnitude 5.2 Pymatuning earthquake that occurred in September 1998.

Early in his tenure at the Bureau, Gary was elected as Secretary-Treasurer of the Field Conference of Pennsylvania Geologists, which he has attended every year since 1975. He was in charge of the logistics of this annual conference for the next decade, and commonly edited the guidebook. In addition, he organized, led about half of the stops, and edited the guidebook for the 1995 Field Conference.

Eventually, Gary transferred to the Geologic Mapping Division, where he began a program of constructing maps of bedrock topography beneath glacial sediments in northwestern Pennsylvania. In order to do that, it was necessary to determine locations for 40,000+ water wells in an area for which there were only analog well records, and to digitize the data so that GIS could be used to assist in the mapping. The water-well data are now mostly in the Pennsylvania Groundwater Information System, or PaGWIS. In addition, he represented the Bureau in the Great Lakes Geologic Mapping Coalition for 10 years, starting with the year that Pennsylvania joined the coalition.

With his retirement, he notes that there is no glacial geologist and no alumnus of Illinois on the Bureau staff for the first time in 61 years.

He plans to continue work with the Bureau and with Moraine and McConnells Mill State Parks as a volunteer, and also to travel in the United States (he has two states left to visit) and abroad. He hopes to hike a few more state high points and do more kayaking as well.

THOMAS G. WHITFIELD. After 32.4091 years of public service, Tom Whitfield retired on April 13, 2018. Tom grew up in Greensburg, Pa., and went to West Virginia University (WVU) to pursue a career in chemical engineering. Shortly after entering WVU, Tom changed majors to geology, graduating in 1974. Tom's first job was with a geophysical logging company based in Indiana, Pa. He was a well-log analyst, cased-hole specialist, and occasional truck driver. Tom was "the company geologist," working the oil and gas fields of Pennsylvania, Ohio, and West Virginia. Tom then took a job with U.S. Steel Corporation as a coal exploration geologist in southern Illinois. For the next six years, Tom and another geologist explored a nearly 23,000-acre coal block, drilling nearly 200 core holes. Tom and his growing family then returned to Indiana, Pa., where he became an assistant station manager for a different geophysical logging company. Two years later, a downturn in natural-gas prices caused the station to close.

In January of 1986, Tom began working for the Pennsylvania Department of Environmental Resources (DER) (now Department of Environmental Protection, or DEP), Bureau of Oil and Gas

Management. One of his assignments was to convert its massive collection of paper records of well permits and other items to a digital database format for DER's centralized computer system. Tom was then promoted and assigned to implement the Orphan and Abandoned Oil and Gas Well Plugging Program, a program that is still in operation today.

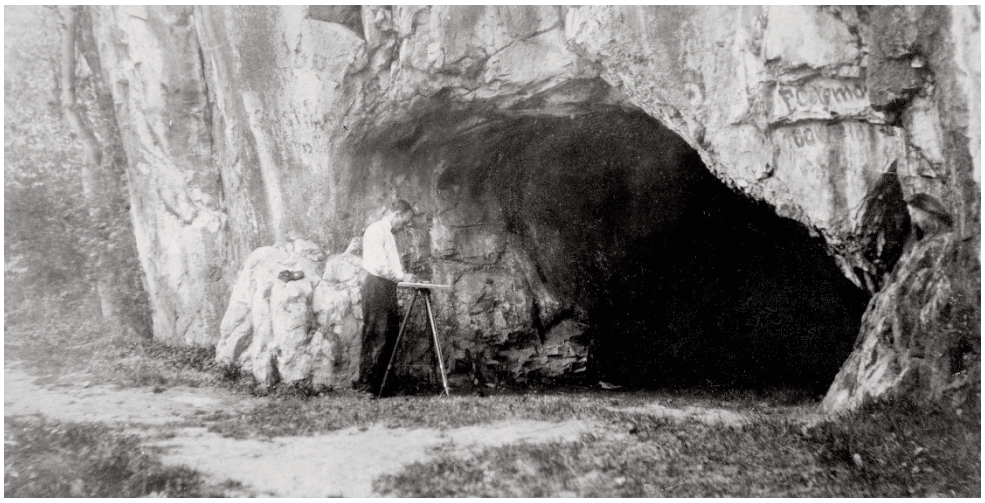
In 1991, a commonwealth budget crisis caused Tom to be "bumped upstairs" to the Pennsylvania Geological Survey. For the first year or so, he worked on a coal analysis database. In 1992, Director Don Hoskins asked Tom if he would be interested in working with a new technology called Geographic Information Systems (GIS). Tom agreed, and that is where he stayed for the next 26 years. Over those years, Tom was involved in many aspects of GIS analysis and digital mapping. Many of Tom's projects involved collaborative work and support of Bureau staff in their projects. Tom also worked with those outside the Bureau, including other commonwealth agencies, Pennsylvania Spatial Data Access (PASDA) digital web portal, academia, and the U.S. Geological Survey. Tom was a technical advisor to those using PAMAP data. He developed numerous derivative datasets from lidar data, including a way of using a slope-only raster set to detect features below the tree canopy not normally seen. He also developed a tool to repair holes and missing raster data in digital elevation model (DEM) datasets.

Tom is author or coauthor of numerous publications having GIS-related components. His biggest accomplishment was as co-compiler of the digital version of the *Bedrock Geologic Map of Pennsylvania* (1:250,000), also known as *Map 1,* and the associated geodatabase, published in 2001. Tom has given a number of GIS-related presentations at Digital Mapping Techniques workshops. He has also presented talks at various meetings of the Geological Society of America and the American Association of Petroleum Geologists.

Many may know Tom from the Field Conference of Pennsylvania Geologists, where he was past Chairman and Vice-Chairman. He also handled the public address system. But his most important job was driving the coffee and donut wagon!

In retirement, Tom plans on staying busy. He has become one of the many volunteers at the Bureau, hoping to keep his GIS skills active and to help anyone needing GIS advice. As part of this process, he recently became a volunteer GeoMentor, a national cooperative effort to help educate students and teachers on aspects of GIS and the importance of geospatial information in the world today. Tom is also a certified Emergency Medical Technician and a 30-year volunteer with a local ambulance company, which he plans to continue for the foreseeable future. Tom will also carry on with other duties as assigned, including traveling with his wife and spending time with family.

A Look Back in Time



Former Bureau geologist Marchant "Mike" Shaffner is shown surveying the Conodoguinet cave in Carlisle in May 1930. Shaffner is seen here using a plane table to create a map of the cave. Shaffner went on to do mapping and to author publications on the Smicksburg, New Florence, and Donegal quadrangles. Photograph taken by former Bureau geologist Ralph Stone.

To learn more about Marchant "Mike" Shaffner or the Conodoguinet cave, please see the following:

Edmunds, W. E., 1990, In memoriam—Marchant Nissley Shaffner (1897–1990): Pennsylvania Geology, v. 21, no. 5, p. 2–3.

Schmid, K. W., 2015, Conodoguinet cave, Carlisle, Pennsylvania: Pennsylvania Geology, v. 45, no. 3, p. 3–11.

To see more photographs from the Bureau's archives, please visit the library's Historical Photographs Collection page.

RECENT PUBLICATIONS

Open-File Miscellaneous Investigation **(August 2018)**

- Water Depth of Stephen Foster Lake—Mount Pisgah State Park, Bradford County, Pennsylvania

Open-File Miscellaneous Investigations **(June 2018)**

- Water Depth of Greenwood Lake—Greenwood Furnace State Park, Huntingdon County, Pennsylvania
- Water Depth of Parker Lake—Parker Dam State Park, Clearfield County, Pennsylvania
- Water Depth of Tuscarora Lake—Tuscarora State Park, Schuylkill County, Pennsylvania
- Water Depth of Locust Lake—Locust Lake State Park, Schuylkill County, Pennsylvania

Calling All Authors

Articles pertaining to the geology of Pennsylvania are enthusiastically invited.

Pennsylvania Geology is a journal intended for a wide audience, primarily within Pennsylvania, but including many out-of-state readers interested in Pennsylvania's geology, topography, and associated earth science topics. Authors should keep this type of audience in mind when preparing articles.

Feature Articles: All feature articles should be timely, lively, interesting, and well illustrated. The length of a feature article is ideally 5 to 7 pages, including illustrations. Line drawings should be submitted as CorelDraw (v. 9 or above) or Adobe Illustrator (v. 8 or above) files.

Earth Science Teachers' Corner: Articles pertaining to available educational materials, classroom exercises, book reviews, and other geologic topics of interest to earth science educators should be 1 to 2 pages in length and should include illustrations where possible.

Announcements: Announcements of major meetings and conferences pertaining to the geology of Pennsylvania, significant awards received by Pennsylvania geologists, and other pertinent news items may be published in each issue. These announcements should be as brief as possible.

Photographs: Photographs should be submitted as separate files and not embedded in the text of the article.

Submittal: Authors may send their article and illustrations as email attachments to RA-pageology@state.pa.us if the file sizes are less than 6 MB. For larger sizes, please submit the files on CD–ROM to the address given below. All submittals should include the author's name, mailing address, telephone number, email address, and the date of submittal.

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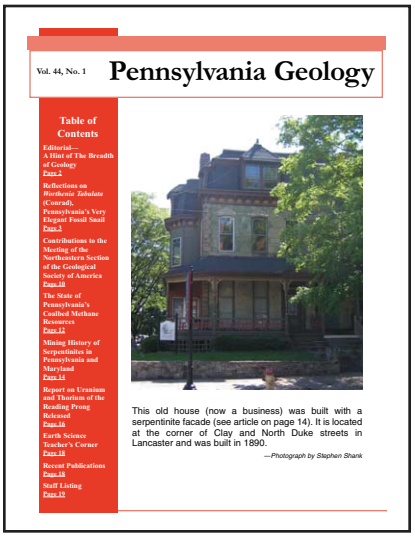
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This old house (now a business) was built with a serpentinite facade (see article on page 14). It is located at the corner of Clay and North Duke streets in Lancaster and was built in 1890.

—Photograph by Stephen Shank

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