ISSUE VII JULY 2006

NARG Newsletter

North America Research Group

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The Bone Wars

Edward Drinker Cope

Othniel Charles Marsh

The Bone Wars were an infamous period in the history of paleontology when the two pre-eminent paleontologists of the time, Edward Drinker Cope and Othniel Charles Marsh, were competing to see who could find the most, and most sensational, new species of dinosaur. This competition was marred by bribery, politics, violations of American Indian territories, and virulent personal attacks.

The Bone Wars were triggered by the 1858 discovery of the holotype specimen of Hadrosaurus foulkii by William Parker Foulke in the marl pits of Haddonfield, New Jersey. It was the first nearly-complete skeleton of a dinosaur ever found, and sparked great interest in the new field of paleontology. The skeleton was sent to the Academy of Natural Sciences in Philadelphia, where it was named and described in 1858 by Joseph Leidy, who was perhaps the leading paleontologist of the time.

Cope worked for Leidy, and soon was working in the marl pits of southwest New Jersey. Together they made a number of discoveries, including the second almost-complete skeleton of a dinosaur, a carnivorous Dryptosaurus aquilunguis. They made arrangements for the companies digging up the marl, which was being used as a fertilizer, to contact them whenever any fossilized bones were unearthed. Cope moved to Haddonfield to be near the discoveries, and soon rivaled his mentor in fame.

At the time, Marsh was a professor at Yale University (which was still called Yale College), in New Haven, Connecticut, studying fossilized dinosaur tracks in the Connecticut Valley. As the first American professor of paleontology, the discoveries in New Jersey were of intense interest. He visited Cope, whom he knew from the University of Berlin, and was given a tour of the discovery sites. Together they unearthed some new partial skeletons, but the rivalry started soon after when Cope learned that Marsh had secretly returned and bribed the marl company managers to report any new finds directly to him.

In 1870, the attention shifted west to the Morrison Formation in Kansas, Nebraska, and Colorado, which during the Cretaceous was on the shore of a great sea. Since both were wealthy — Cope was the scion of a wealthy Quaker family, and Marsh was the nephew of George Peabody, for whom Yale's museum is named — they used their own personal wealth to fund expeditions each summer, and then spent the winter publishing their discoveries. Small armies of fossil hunters in mule-drawn

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Marsh Expedition of 1870

Radiocarbon Dating

Radiocarbon dating is a radiometric dating method that uses the naturally occurring isotope carbon-14 to determine the age of carbonaceous materials up to ca 60,000 years. Within archaeology it is considered an absolute dating technique. The technique was discovered by Willard Frank Libby and his colleagues in 1949 during his tenure as a professor at the University of Chicago. Libby estimated that the steady state radioactivity concentration of exchangeable 14C would be about 14 disintegrations per minute (dpm) per gram carbon (ca. 230 mBq/g). In 1960, Libby was awarded the Nobel Prize in chemistry for his method to use carbon-14 for age determination.

Basic Chemistry

Carbon has two stable, nonradioactive isotopes: carbon-12 (^{12}C), and carbon-13 (^{13}C). In addition, there are tiny amounts of the unstable isotope carbon-14 (^{14}C) on Earth. Carbon-14 has a half-life of 5730 years and would have long ago vanished from Earth were it not for the unremitting cosmic ray impacts on nitrogen in the Earth's atmosphere, which forms more of the isotope. When cosmic rays enter the atmosphere, they undergo various transformations, including the production of neutrons. The resulting neutrons participate in the following reaction on one of the N atoms being knocked out of a Nitrogen (N_2) molecule in the atmosphere:

$$^{1}n + {}^{14}N \rightarrow {}^{14}C + {}^{1}p$$

The highest rate of carbon-14 production takes place at altitudes of 9 to 15 km (30,000 to 50,000 ft), and at high geomagnetic latitudes, but the carbon-14 spreads evenly throughout the atmosphere and reacts with oxygen to form carbon dioxide. Carbon dioxide also permeates the oceans, dissolving in the water. For approximate analysis it is assumed that the cosmic ray flux is constant over long periods of time; thus carbon-14 could be assumed to be continuously produced at a constant rate and therefore that the proportion of radioactive to non-radioactive carbon throughout the Earth's atmosphere and surface oceans is constant: ca. 1 part per trillion (600 billion atoms/mole). For more accurate work, the temporal variation of the cosmic ray flux can be compensated for with calibration curves. If these curves are used, their accuracy and shape will be the limiting factors in the determination of the radiocarbon age range of a given sample.

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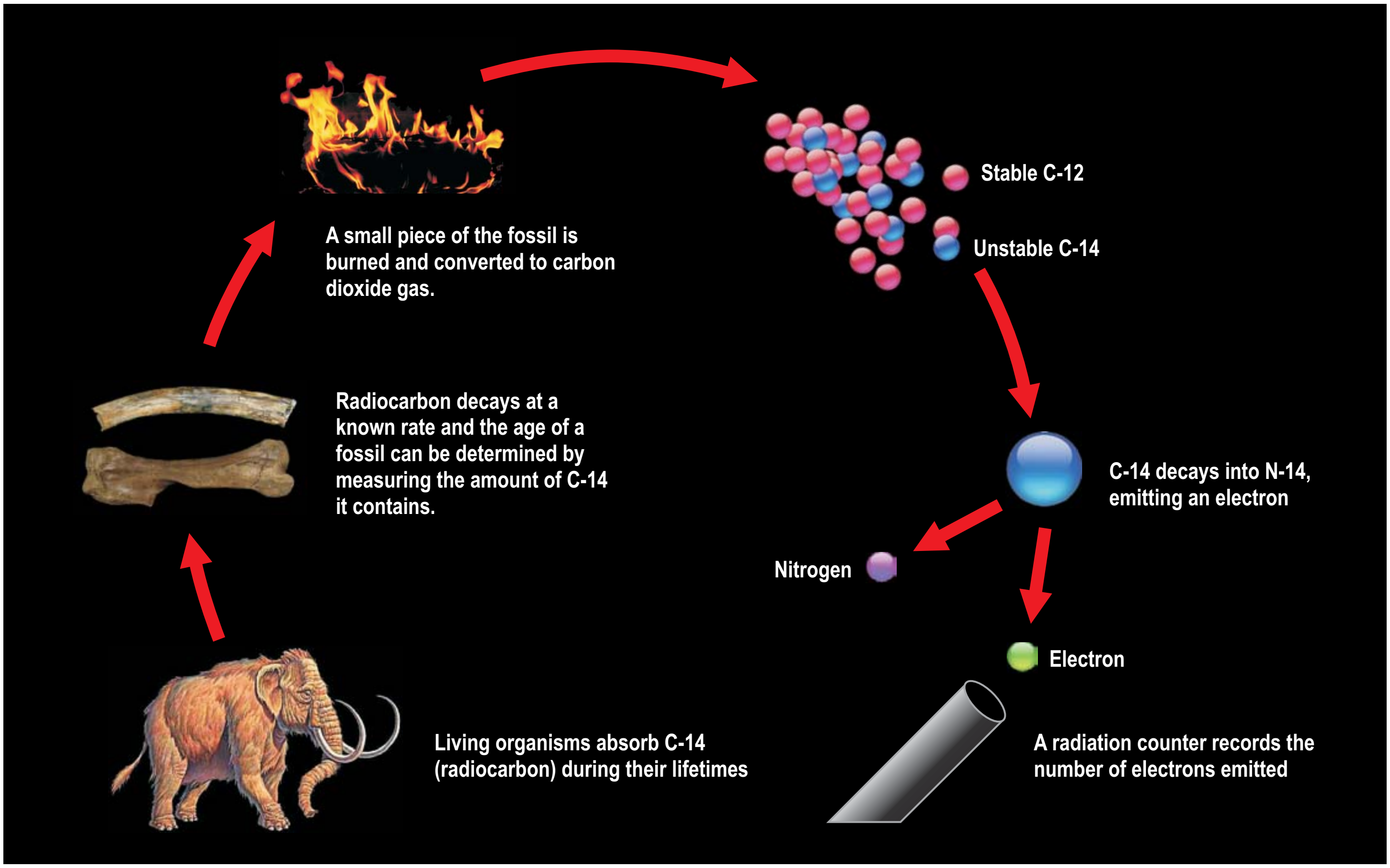

NARG's Radiocarbon Dating Fund

NARG is seeking your donations for the Radiocarbon Dating Fund. To date, $125.00 of the needed $700.00 has been raised but we're not there yet. The money raised will be used for dating a specimen that may be from the late Pleistocene as there is uncertainty of its age.

Contributions can be sent to:
North America Research Group
Radiocarbon Dating Fund
P.O. Box 2207
Beaverton, OR 97075-2207

Trip Report: NARG Travels Back in Time for a Trip to the Beach

By Aaron Currier

NARG members Andrew Bland, Andrew Burkholz, Bill Sullivan, and Aaron Currier joined Dr. William Orr of the Condon Museum at the University of Oregon, on a guided tour of Oregon's Oligocene shoreline on Saturday, July 8. The field trip near Scotts Mills was hosted by Dr. Ellen Bishop and the Oregon Paleo Lands Institute. Other participants included Fred Mosedale, Paula and Reid (9) Conlee, and Robin and Hannah (9) Brumbaugh-Cunningham.

Dr. Orr knows the Northwestern corner of the Willamette Valley well, having researched, mapped, and collected fossil material for publications over the past two decades. In fact, Dr. Orr is quite passionate about the legacy of his research in this area, and it shows in his enthusiasm as an educator and his choice to homestead along one of the streams that parallels what used to be the Oregon Coast 35 million years ago. Dr. Bishop, a self-described petrographer, also understands the Oligocene extensively. She professionally represents the John Day Formation near Fossil, Oregon, which is of course famous for terrestrial Oligocene ecosystems. Following introductions, a brief discussion of Oregon geology, and an overview of the days' itinerary, the group departed Brooks at 9am.


Stop 1: Lake Labish

The first stop was Lake Labish, which is now a fertile farmland rather than a body of water. During Pleistocene times, the area was part of the Willamette River until flood and glacial deposits filled it in, changing the course of the river further west. Over time the former river bed became a swampy grazing land for animals such as the great mammoths and mastodons, predatory dire wolves and sabertooth cats, and the peculiar giant ground sloths. Along with opportunities for food, there were circumstances for death resulting in a present-day gravesite for the prehistoric beasts. Although the age of the fossils is comparable to the La Brea tar pits, unlike La Brea it is not rich with predators. It reflects a more common pyramid ratio of predators to prey suggesting it was an area where many different animals likely died from various natural causes. Occasionally a freshly tilled field will produce a bone or two of one of these long-extinct inhabitants of the Willamette Valley.

A second stop on the way to the Oligocene destination was a roadside view of Mt. Angel Butte, a fault "pop-up." As the Farallon Plate split during plate-tectonic subduction, the trailing end, now known as the Juan de Fuca plate, created the Columbia River Basalts (CRBs). Simultaneously, parallel faults running through the area provided an opportunity for allochthonous lava flows from the CRBs to squeeze up from below and form these "flower structures." Subsequently, tertiary soil deposits and plant growth have nearly disguised the fault. However, examining

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NORTHWEST FOSSIL FEST

August 12, 2006 ~ 10am to 4pm

Inspire, Inquire, Interact

- Attend one of the several presentations and learn about the Pacific NW's geology and paleontology.
- Kids, have you ever wanted to find your own fossil? Stop by the "Screen for Shark Teeth" demonstration and find a fossilized shark tooth. You can also give the "Geologic Time Machine" a spin or learn how to "Grow Your Own Living Fossil".
- Have you found a fossil and would like to know what it is? Bring it in and we'll try and help you identify it.
- View fossils on display from the Pacific NW
- Visit the Fossil Preparation Demonstration to see how professionals clean and prepare fossils.
- Tour the world famous Rice collection of minerals.

When

Saturday, August 12th, 2006
10am to 4pm

Where

Rice NW Museum of Rocks and Minerals
26385 NW Groveland Drive
Hillsboro, Oregon 97124

Directions

West of Portland, Off Hwy 26 West, Exit 61 North.
Take first turn West on to Groveland Drive.

Admission

(includes museum entry)
Adults: $5.00
Seniors: $4.50
Students: $3.50
Under 6: Free

The Bone Wars Adventure

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wagons were soon sending quite literally tons of fossils back East.

But their discoveries were accompanied by sensational accusations of spying, stealing workers, stealing fossils, and bribery. Among other things Cope repeatedly accused Marsh of stealing fossils, and was so angry that he stole a train full of Marsh's fossils, and had it sent to Philadelphia. Marsh, in turn, was

Working in the Bone Cabin Quarry during the first year, 1898

so determined that he stole skulls from American Indian burial platforms and violated treaties by trespassing on their land. He was also so protective of his fossil sites that he even used dynamite on one to prevent it from falling into Cope's hands.

They also tried to ruin each other's professional credibility. When Cope made a simple error, and attached the head of an Elasmosaurus to the wrong end of the animal (the tail, instead of the neck), he tried to cover up his mistake. He even went so far as to purchase every copy he could find of the journal it was published in; but Marsh, who pointed out the error in the first place, made sure to publicize the story. Marsh was no more infallible, however. He made a similar error, and put the wrong head on the skeleton of an Apatosaurus (which was still being called the Brontosaurus). But his error was not discovered for more than a hundred years. In 1981, the Peabody Museum finally acknowledged the mistake, and exhibits around the world had to be redone.

By most standards, Marsh won the Bone Wars. Both made finds of incredible scientific value, but while Marsh discovered a total of 86 new species, due in part to his discovery of the Como Bluff site, near Medicine Bow, Wyoming (one of the richest source of fossils known), Cope only discovered 56. Many of the fossils Cope unearthed were of species that had already been named, or were of uncertain origin. And while the species Marsh discovered include household names, like the Triceratops, Allosaurus, Diplodocus, and Stegosaurus, even Cope's most famous discoveries, like the Dimetrodon, Camarasaurus, Coelophysis, and Monoclonius were more obscure. But their cumulative finds defined the field of paleontology; at the start of the Bone Wars, there were only nine named species of dinosaur in North America; and some of their theories — like Marsh's argument that birds are descended from dinosaurs; or "Cope's law", which states that over time species tend to get larger — are still referred to today. After the Bone Wars, there were around 150 species.

Cope is widely regarded as the more brilliant scientist, but more brash and careless. He was so prolific, publishing more than 1,200 scientific papers, that he set a record he still holds to this day. Marsh in turn was colder, more methodical; but the better politician — he moved easily among the members of high society, including President Ulysses S. Grant and the Rothschilds. He even befriended Buffalo Bill Cody and the Lakota Indian chief Red Cloud.

Their rivalry lasted until Cope's death in 1897, but before the end, they both ran out of money. Marsh got Cope's federal funding cut off (including his funding

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First discovery of the hind limb of the dinosaur Diplodocus

Radiocarbon Dating

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Plants take up atmospheric carbon dioxide by photosynthesis, and are eaten by animals, so every living thing is constantly exchanging carbon-14 with its environment as long as it lives. Once it dies, however, this exchange stops, and the amount of carbon-14 gradually decreases through radioactive decay.

$$^{14}C \rightarrow {}^{14}N + {}^{0}\beta$$

By emitting a ß particle(Beta decay), carbon-14 is changed into stable (non-radioactive) nitrogen-14. This decay can be used to get a measure of how long ago a piece of once-living material died. However, aquatic plants obtain some of their carbon from dissolved carbonates which are likely to be very old, and thus deficient in the carbon-14 isotope, so the method is less reliable for such materials as well as for samples derived from animals with such plants in their food chain.

Measurements and scales

Measurements are traditionally made by counting the radioactive decay of individual carbon atoms by gas proportional counting or by liquid scintillation counting, but these are relatively insensitive and subject to relatively large statistical uncertainties for small samples (below about 1g carbon). If there is little carbon-14 to begin with, a half-life that long means that very few of the atoms will decay while their detection is attempted (4 atoms/s) /mol just after death, hence e.g. 1 (atom/s)/mol after 10,000 years). Sensitivity has since been greatly increased by the use of accelerator-based mass-spectrometric (AMS) techniques, where all the ^{14}C atoms can be counted directly, rather than only those decaying during the counting interval allotted for each analysis. The AMS technique allows one to date samples containing only a few milligrams of carbon.

Raw radiocarbon ages, i.e. not calibrated are usually reported in years "before present" (BP). This is the number of radiocarbon years before 1950, based on a nominal (and assumed constant - see "calibration" below) level of carbon-14 in the atmosphere equal to the 1950 level. They are also based on a slightly off historic value for the half-life maintained for consistency with older publications.

Radiocarbon labs generally report an uncertainty, e.g., 3000±30BP indicates a standard deviation of 30 radiocarbon years. Traditionally this includes only the statistical counting uncertainty and some labs supply an "error multiplier" that can be multiplied by the uncertainty to account for other sources of error in the measuring process. Additional error is likely to arise from the nature and collection of the sample itself, e.g., a tree may accumulate carbon over a significant period of time. Such wood, turned into an artifact some time after the death of the tree, will reflect the date of the carbon in the wood.

The current maximum radiocarbon age limit lies in the range between 58,000 and 62,000 years. This limit is encountered when the radioactivity of the residual ^{14}C in a sample is too low to be distinguished from the background radiation.

The Bone Wars Adventure

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from the U.S. Geological Survey), and Cope had to sell part of his collection. Marsh in turn had to mortgage his home, and ask Yale for a salary to live on.

While their collective discoveries helped define the budding new field of study, the race also had some negative effects: Their animosity and public behavior harmed the reputation of American paleontology in Europe for decades.

Como Bluffs dinosaur graveyard, 1934

Trip Report: NARG Travels Back in Time for a Trip to the Beach

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parallel geologic patterns in the surrounding farmlands shows evidence of this repetitive volcanic activity.

Arriving in Scotts Mills, a small rural town in the western foothills of the Cascade Mountains, our group began an examination of the ancient shoreline environment, evident by the presence of various representative geologic features. The Scotts Mills Formation overlays the Little Butte Volcanics and is divided into three members -- Marquam, Abiqua Creek, and Coal Creek. Each member depicts the changing ecosystem during approximately 10 million years of the Oligocene period. Occasionally exposures of these members intertwine with each other as well.

A short wade down Beaver Creek, a tributary to Butte Creek, brought the group to an exposure of the Marquam Member; the earliest layers of the Scotts Mills formation. From 35 to 32 million years ago, with the ancient seawater rich in calcium carbonate, limestone sedimentary deposits formed on volcanic mounds off shore. A prolific colonization of barnacles, along with other marine organisms, was preserved in the solidified sediments. This is evidence of a shallow, high-energy shoreline. Additionally, the underlying Little Butte Formation - represented by hard volcanic seastacks - poke up like fingers and were also colonized by animals. However, the fossils did not preserve well because of excessive wear and erosion.

Just upstream from where Beaver Creek branches from Butte Creek, the Little Butte seastacks prominently stand out. It is not easy to imagine, however, standing along the shore looking out to sea with headlands towering behind. With Butte Creek running parallel to the ancient shore, deciduous trees mixed with massive old-growth conifers in every direction, and Pleistocene soil deposits masking much of the rock formations, time and geologic activity have altered the "beach" scene beyond typical recognition.
For a closer look at the paleontological record of the Marquam Member, the group visited an early 20th Century basalt quarry mine. The quarry is now overgrown with large trees, which gave appreciated relief from the hot noon sun. Fossil specimens were found throughout the surrounding forest floor, including worm burrows, a brachiopod, pelecypods, barnacles, a large gastropod, and some carbonized driftwood.

Dr. Orr explained that part of the fossiliferous formation was actually a siltstone made of volcanic ash, not limestone. He referred to the fossiliferous portion of the formation as a lag deposit. The water and its contents were "mixed up" and subsequently flocculated, or graded by mass as it settled. He pointed out a basalt sill parallel to the bedding plane. Not only had it caused "dipping down" and "sweeping up" of the above sedimentary layers, but it also "cooked" some of the fossils in the bottom layers, resulting in fossil remnants trapped in the basalt itself.

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Stop 2: Mt. Angel Butte

Stop 3: Heading down to Beaver Creek

Stop 4: Standing on one of the Sea Stacks

Fossil Gallery

We have a small formation here in Northern California that we call "The Moonstone Formation". Its only about 1 million years old, but the sediment is very sandy and absolutely full of shells of clams, snails, oysters and lots of other stuff too, but a long time ago I would bring home gallons of this material to screen and find lots and lots of the smaller fossils. While I was dong that, I happened to find these little round shiny things??? I thought they may be pearls, but I've only found 3 or 4 oysters there. But millions and millions of mussel shells can be found there, and some quite HUGE!!! Then a few years later I met a fellow who really knew his pearls!! He told me that some freshwater clams make pearls and he also mentioned that mussels could make free floating round pearls too!! I was flabbergasted!!! I, like most folks, just thought that it was the oyster that made pearls. I was wrong!!! So, now I have some SUPER COOL FOSSIL PEARLS from mussels!! Wow!! It took me many hours to go through the material and find these 9 pearls, but it was well worth it! Someday, I'm gunna have a jeweler make some kind of jewelry for my wife out of these!!! Now how cool is that??? Simply WOW!!! Enjoy. Ron Bushell

A few years ago, a fellow fossil hunter took me to a little unknown fossil crab site. It had rained very hard the night before, so we knew the creek water level was going to be high. Once we hiked down into this canyon in the State of Washington and got into the creek, we started working our way downstream. No one brought any waders or hip boots, so we were in our everyday shoes and getting very wet. We went about 200 yards and came across a bank that had some concretions in it. I started pulling out some concs out of the bank and my friend was finding some under water in the creek. I just happened to look over as he cracked this one concretion open with his mini sledge. A piece came off the side and I instantly saw a crab elbow sticking out, but the other piece went flying into the creek! I was aghast!!! He did find the other piece, and he was one heck of a good guy and gave it to me. We then worked our way down some more and crossed over a HUGE logjam and even found a few more concs. Then we started to go further down stream and I slipped and fell. My pick hammer was hanging off a leather loop from my belt and I fell onto that breaking several ribs. I was half on the bank and half in the water and the water was very cold. I knew this was something bad, because I couldn't breath for a several seconds, and when I tried to roll over on my side I realized that I couldn't move. I look downstream to see the other 3 fellas going around a curve in the creek. I thought I might be there for a while. It was only a few minutes when someone came back to see where I was. It took me only about 25 minutes to get there, but it took me almost 2 and 1/2 hours to work my way back. Every single step hurt, but being about 280 pounds in weight and deep in a canyon, I knew I had to get myself out of there. My buddy took my pack and I just took each and every step super slowly!!! Every left step was PAIN!!! I was about a 10-hour drive from home and even driving hurt. It took about 3 weeks before I could actually get around and start fossil prepping. After about 30 hours, the photo is of the crab concretion that this guy broke open in the creek. It was worth it for me, but I could've done without all the pain. This crab is known as Pulalius vulgaris, is Eocene in age and comes from the Lincoln Creek Formation. This crab is still one of my favorites!!! Enjoy. Ron Bushell

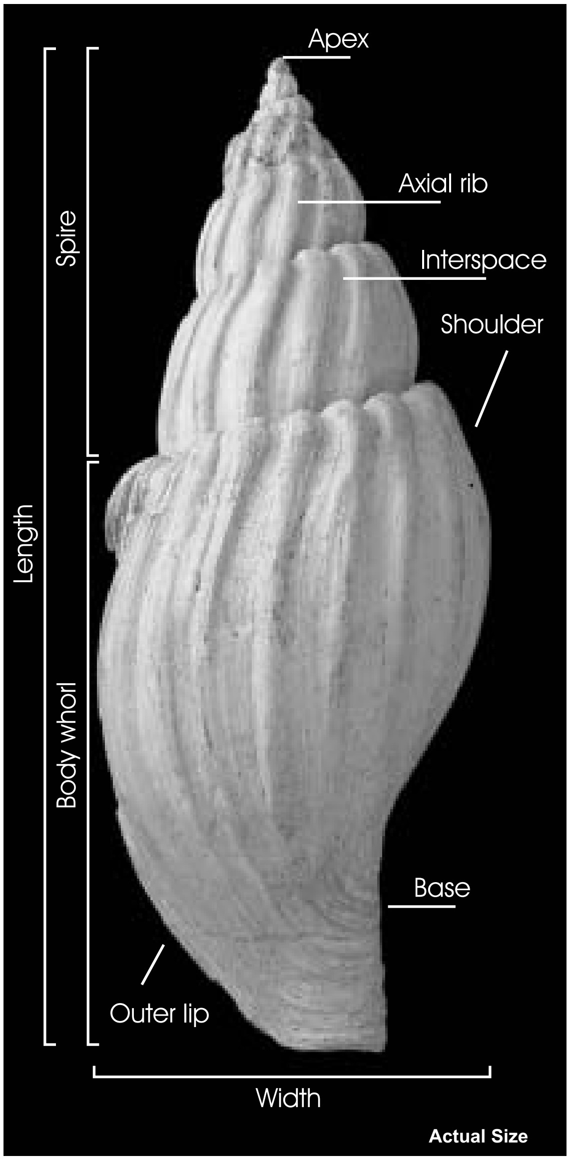
If you have a fossil you'd like showcased in the Fossil Gallery email the image along with a sentence or two of information to: fossilgallery@narg-online.com.

Fossil Gallery

Here's quite a collection of fossil submitted by Tim Fisher, which where collected earlier this year from the NW Washington to Central Oregon

1. Callianassa (mud shrimp) Astoria Formation
2. Callianassa (mud shrimp) Astoria Formation
3. Fusinus, Alsea Bay
4. Branchioplax washingtoniana, Neah Bay
5. Branchioplax washingtoniana, Neah Bay
6. Branchioplax washingtoniana, Neah Bay
7. Mytilus (mussel) and leaf, Slip Point
8. Metasequoia cone, John Day Formation

Featured Fossil
Musashia indurata



Musashia indurata is the largest gastropod found in the Astoria Formation with some specimens measuring over 6” in length. The primary shell characteristic of the *Musashia indurata* are the strong, rounded axial ribs. Each whorl has between 18 to 21 ribs with the interspace nearly as wide as the rib.

Pleistocene Fossil Deposits in Woodburn, Oregon

By Aaron Currier

Notes from a Lecture and Field Trip hosted by Allison Stenger, Director of Research Institute of Archeological Studies June 1 and July 15, 2006

About 10 to 12 thousand years ago, the Willamette Valley looked a little different than it does now; but not so different that we wouldn't recognize it. Certainly the development of technology and artificial habitat for humans wouldn't occur until around hundred and fifty years ago, but the natural environment started looking more like what we see today. The repeated deluge of flood waters from Lake Missoula had ceased and the ice age was drawing to a close. The Willamette River settled into its new path, leaving bogs and backwater swamps where it once flowed. One major part of the ecosystem was a lot different, however. The animals that roamed the land were quite unlike what we might see today. Large bison, mammoths, mastodons, camels, ground sloths, dire wolves, and large raptor birds the size of cars were regular visitors to these swamps.

View of Woodburn Dig from Lincoln Park

Fortunately for paleontologists today, the remains of these extinct animals are being discovered preserved right where they lived... and died. Professional, meticulous excavations are now yielding an amazing record of these creatures,

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Pleistocene Fossil Deposits in Woodburn, Oregon

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Orientation at the site

Dr. Stenger explaining dig

Volunteers at work

leading to detailed illustrations of what life was like here in the valley before modern tribes of humans arrived.

Allison Stenger, Director of Research at the Institute of Archeological Studies is currently leading an excavation in Woodburn at a location known for it's concentration of preserved bones. The specimens, mostly disarticulated, were trapped in an anoxic layer of silt and peat, and covered by a deposit of thick, sticky, wet clay. With a regular crew of volunteer paleontologists, along with occasional guests, tons of material is carefully being sifted through in hopes of finding specimens of not only mammals, but possibly early humans. The research team has had much success.

Reports from the past ten years of excavations are suggesting the animals were typically browsers and grazers. Unlike the La Brea Tar Pits in Los Angeles where the predator to prey ratio is 80% to 20%, the Woodburn bogs are more representative of a typical ecosystem with 80% prey and 20% predators. With supporting evidence, such as the horizontal stratification of wind-blown silt covering the specimens, it is believed that the animals died, not by drowning or other catastrophic events, but by natural causes.

In addition to animals, the evidence has been discovered to confirm the presence of humans. Charcoaled buffalo bones were found, suggesting "buffalo wings" might have been on the prehistoric menu. More exciting than that however, is the discovery of human hair that is not related to any current Native American tribes. The theory is that the population from that time is gone. Based on all the evidence, that particular DNA line ended around 11,500 years ago. The traditional "Native American Tribes" we know today didn't arrive in the valley until around 8,000 years ago.

Stenger's theory for the extinction of the Woodburn ice age mammals was caused by:

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Happy Birthday NARG

In June 06' NARG turned 3 years old. It seems like just yesterday when a few of us were sitting around a campfire in Central Oregon kicking around the idea of forming a group such as this. So far NARG has exceeded our expectations and we're excited in the direction it has taken.

A year in review

Last year we saw our membership double and can now count over 60 members. And just as we envisioned, NARG is a diverse and dynamic group with members of all ages and experience. NARG also saw the addition of several Advisors and we want to thank them all for the encouragement, guidance, and time they have given.

NARG meetings have been kept informal as designed and have seen increased attendance each month. We'd like to thank the members who take the time to attend and participate in the meetings. There have been some great guest speakers and it's NARG's goal to have each meeting to be an educational experience for all.

A lot of fuel was burned driving around the countryside on field trips. In addition to finding world-class fossils, several important and significant discoveries were made, which have appropriately been donated to our Advisors.

If only one word could be used to describe a paleontologist, avocational or professional, it would be passionate. NARG was formed because of this passion and is part of what drives us today. Unfortunately passion seems to be a double-edged sword and, in the guise of cooperation, NARG has been poked a few times. What doesn't kill you makes you stronger, and here we are. Resolute in our mission, NARG will continue to promote, educate, and contribute to the paleontologic record of the Pacific Northwest.

Looking forward

The next 12 months look very busy for NARG. For the past 3 years NARG has participated in the Fossil Fest in Newport, Oregon. This year NARG is coordinating a complimentary show in the Portland Metro Area. We hope the “Northwest Fossil Fest” will become and annual event and as successful as the Fossil Fest.

Other than membership dues, there is no other source of funding for NARG. If not for the generosity of several members, NARG would not have been able to accomplish much of what it has done. We are looking for ways to raise funds, which will enable NARG to finance research projects, produce educational material, and participate in events and exhibits.

We look forward to the year ahead and to new friends, associations, and discoveries that will be made.

Sincerely,

NARG Board of Directors

Trip Report: NARG Travels Back in Time for a Trip to the Beach

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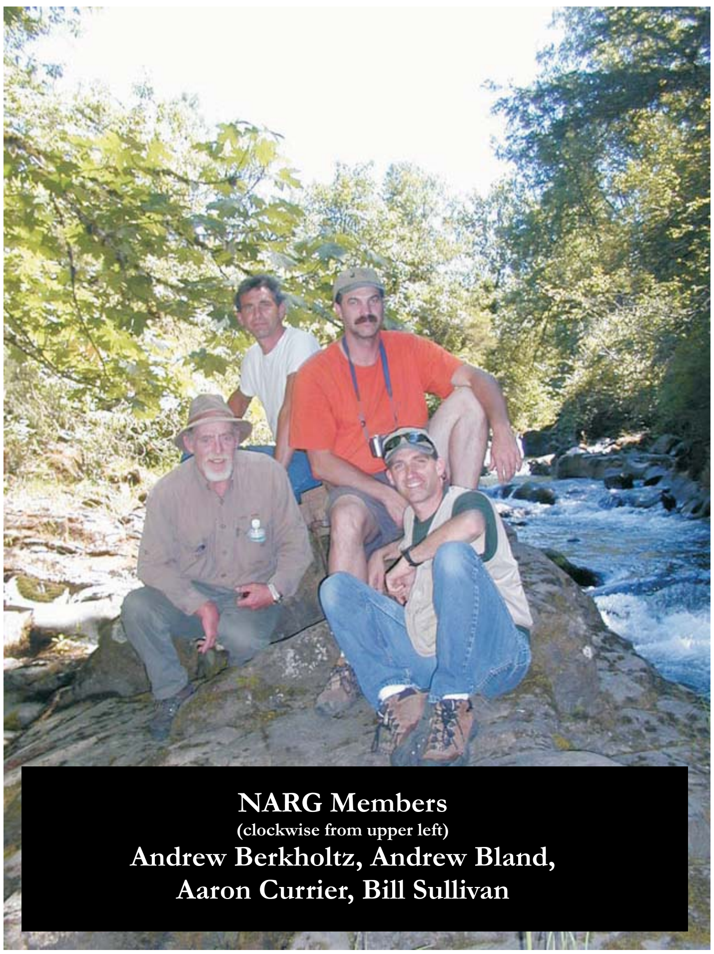
After a quick lunch and further review of the geologic formations previously visited, one more stop was made to examine the Abiqua Member of the Scotts Mills Formation, which overlays the Marquam Member. Dr. Orr pointed out how a large crack had formed along the fault line and subsequent erosion by the stream resulted in a series of cascading waterfalls running through this unusual geologic feature. A nearby cliff wall exposed evidence of coastal sand dunes, much like those in Florence, Oregon today. Typically fossils are not found in these layers, nor is there silt. There is, however, clumps of calcareous concretions and almost-pure quartz sand, which to a geologist most surely describes a dune environment.

The final member of the Scotts Mills is the Coal Creek, also known as Crooked Finger. The tour did not include a visit to an exposure. However, it was explained as the last of the layers to be deposited and actually contains coal deposits. In the recent past, the coal was commercially collected and burned to acquire potash for agricultural use.

In summary, it takes a special knowledge of the area to recognize and identify the characteristics of an ancient shoreline. With a point in the right direction and an examination of the evidence, it is imaginable that it was a nice day at the beach... only 35 million years ago.



NARG Members
(clockwise from upper left)
Andrew Berkholtz, Andrew Bland,
Aaron Currier, Bill Sullivan

Brachiopod Plate

Gastropod

Fault Line

Pleistocene Fossil Deposits in Woodburn, Oregon

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Chunk of peat layed open but no treasures


View of volunteers at dig

stress to the animal populations due to climate changes; hunting by early humans; and most importantly, disease. Herd populations had to join together to share habitat. Decreased food supplies resulted in unhealthy populations and a decrease in immunity to disease. Immunity to disease is a critical component to any healthy population. Otherwise, eventually all animals and people are erased from the universe's database.

On a warm July Saturday, members of NARG (Andrew Bland, Steven Bland, Andy Burcholz, Bill Sullivan, Aaron Currier, Tami and MacKenzie Smith) visited the Woodburn dig site to get a first-hand glimpse of the excavation process. Andy, Aaron and MacKenzie even volunteered for a few hours to assist the research crew. Although mostly seeds and beetles were found by NARG members, others in the team did unearth a few bird bones and a single large mammal bone that afternoon.


MacKenzie working away


Nice insect found my MacKenzie

Trilobite Ecology and Ancient Environments

By S. M. Gon III

Half a billion years ago, the Earth's marine environment was certainly not the same as it is today. It is likely that the ocean's chemistry, including salinity, was different, and the configuration of the ocean basins and continents was entirely unlike our modern globe, because of continental drift.

Biotic environments (the living community of plants and animals) were also different. While there were many species of marine plants and animals, many groups prominent today were missing, or poorly represented. For example, in the Cambrian and Ordovician, there were no jawed fishes, and Crustaceans (crabs, shrimps, etc.) which dominate the arthropod fauna of today's oceans, were present, but not prominent.

Trilobites were among the most prominent of the Paleozoic marine arthropods, and they have only been found in oceanic fossil beds. No freshwater forms have ever been found. They occupied many different ocean environments, from shallow flats and reefs, to deeper ocean bottoms, and even the water column, as floating plankton or free-swimming forms. While a few were wide-ranging pelagic species, most were regional, and their global paleogeography is a fascinating study of how living forms track their changing environments over geological time. Trilobites from different habitats often had specialized forms that were presumably adaptations to their environment.

Trilobite tracks (*Diplichnites*)

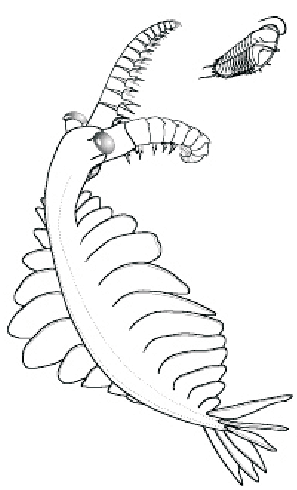
It is thought that the majority of trilobites were bottom-dwellers, crawling on the sea floor, or within complex reefs, acting as roving predators on smaller invertebrates or as slow scavengers on organic debris.

A Bumastoid trilobite crawling on the benthos. From the Virtual Silurian Reef.

They were able to dig into the bottom sediments in search of food and to conceal themselves from predators. Perhaps some were herbivores on beds of algae (seaweed), or browsers on corals, sponges, or bryozoans. Some may have been filter feeders, orienting with the current and extracting plankton and organic debris.

This image of oncocerid nautiloids. From the Virtual Silurian Reef

Nautiloids were probably important predators of trilobites. Trilobites certainly were important prey for larger creatures. At first these were large invertebrates, such as predatory worms, nautiloids, sea scorpions (eurypterids), crustaceans, and perhaps Anomalocaridids. When fishes developed and flourished in the Devonian, we can be sure that trilobites were hard pressed by these new predators. A hard exoskeleton and the ability to enroll protected trilobites from predators and sudden unfavorable environmental changes.



This image ©2000 by S. M. Gon III

Focus on Anomalocaris: Trilobite bane?

Anomalocaris was the largest predator of the early Cambrian seas. An active, swimming, proto-arthropodan hunter with large eyes and grasping anterior limbs, the fossils of *Anomalocaris* and related species have been found in Canada, China, and other locations bearing Cambrian age strata. At about half a meter body length it was probably capable of swallowing most trilobites whole, and with a ring-like mouth lined with sharp projections, might have bitten ragged chunks out of prey. Trilobites with wounds attributable to *Anomalocaris* have been found, but some say the hard exoskeleton of trilobites probably was more than a match for *Anomalocaris*' mouthparts, which were better suited to ingesting soft worms raked from the mud.

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Trilobite Ecology and Ancient Environments

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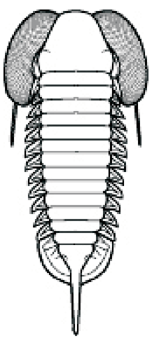
To the left, I have adapted a reconstruction of *Anomalocaris* from a 1996 paper by Desmond Collins (*J. Paleontology 70(2)*:280-93) describing the history of speculations and reconstructions of *Anomalocaris* and *Laggania* (another Anomalocaridid). Note how the eyes of *Anomalocaris* could swivel on flexible stalks, offering stereoscopic guidance for the flexible pair of anterior limbs. Each limb was armed with spines with which to grasp and skewer victims. The round mouth is only partially shown under the head, behind the eyes. Large lateral fins probably moved in undulating waves, while rear fins provided stabilizing and turning capabilities.

There is certainly a very wide range of body forms associated with trilobites. There are extremely spiny species, and ones entirely smooth and devoid of spines. There are species (such as the telephinid *Opipeuterella* shown at left) with huge eyes and narrow bodies that seem adapted to swimming in the pelagic (open ocean) water column. Other species (such as the trinucleid *Cryptolithus*, shown at right) were eyeless, with wide bodies and supporting structures such as long genal spines, that seem adapted for a dark benthic (ocean bottom) habitat. Some of the speculations on lifestyle and function of body shapes and features may never be clearly confirmed, but what we do know is that trilobites were extremely successful, found in a very wide variety of ocean habitats, and probably occupied many, if not all of the ecological niches that crustaceans do today. That being the case, we know of planktonic, free-swimming, benthic (bottom-dwellers), burrowing, reef-dwelling, and even parasitic crustaceans, and all of these forms have been attributed to trilobites as well.

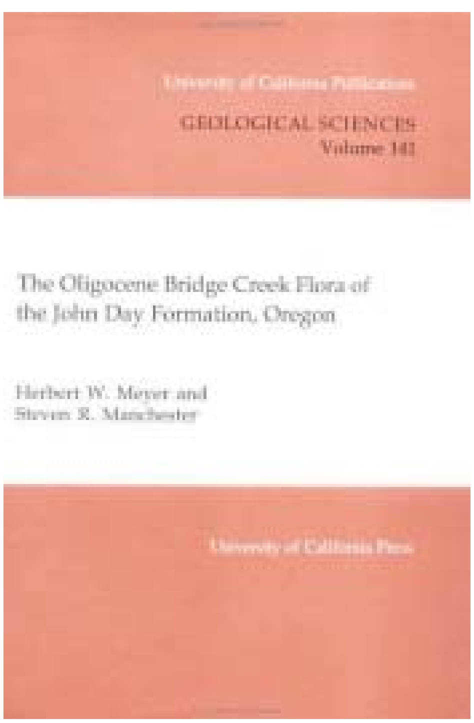


Opipeuter pelagic

Next Issue: Trilobite Morphology

The Oligocene Bridge Creek Flora of the John Day Formation, Oregon

By Herbert W. Meyer and Steven R. Manchester



The early Oligocene Bridge Creek flora of the John Day Formation in north-central Oregon provides a classic example of the temperate deciduous forest that developed in the mid-latitudes of the Northern Hemisphere immediately following the major temperature decline of the latest Eocene to earliest Oligocene.

This comprehensive systematic revision of the Bridge Creek flora is based on large collections of megafossil specimens from the John Day and Crooked River basins. The flora was found to be more diverse than previously recognized, with at least 125 species. At least 11 genera are extinct, but the majority are extant members of deciduous forests. The flora was derived from a variety of sources and represents a classic example of the broadleaved deciduous forests that became

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