ISSUE IX APRIL 2007

NARG Newsletter

North America Research Group

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Marine Reptile - *Metriorhynchus*

Metriorhynchus was approximately 3 metres long. It was a highly modified aquatic predator which had evolved from its cousins, the land living crocodiles. Apart from its long snout, body and tail, it bears little resemblance to the conventional crocodile shape. *Metriorhynchus* wasspecially adapted to an aquatic way of life with flippers to replace the legs and a vertical fin at the end of its tail to help it swim.

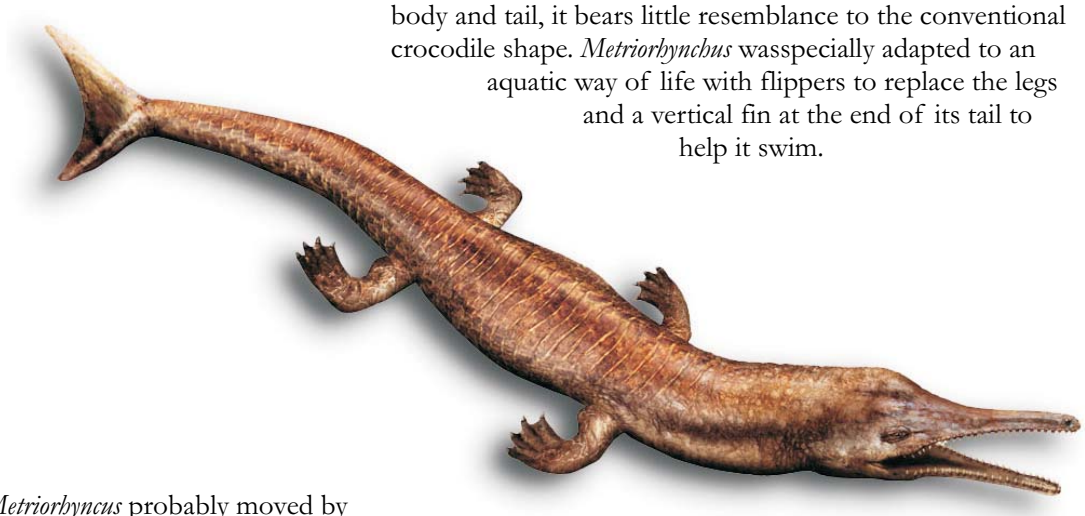

Illustration by Jon Hughes

Metriorhyncus probably moved by sideways beatings of its tail and it had evolved to be more flexible and mobile than its land-living relatives, making it faster in water. Its skin was also less scaly and more flexible than that of the land-crocodiles, reducing its resistance through the water.

Jurassic crocodile found in Oregon

University of Oregon Press

EUGENE, Ore.—(March 19, 2007)—An ancient sea-going crocodile has surfaced from the rocks of Crook County in eastern Oregon. Really.

Its discovery by the North American Research Group (NARG), whose members were digging for Jurassic-age mollusks known as ammonites, is another confirmation that the Blue Mountains consist of rocks that traveled from somewhere in the Far East, says retired University of Oregon geologist William Orr, who was called in to examine the find for the state.

The remains – about 50 percent of a 6- to 8-foot reptile, including long, needlepoint teeth – were found imbedded in Jurassic rock on private property in the Snowshoe Formation of the Izee Terrane south of Dayville, Ore. Rocks containing the fossils were slowly cut out of the rock, after NARG members realized that the linear appearance of the fossils in the region's hard rocks suggested that a whole creature had been found, Orr said.

"This taxon was a crocodile-like creature but had a fish tail," said Orr, a NARG adviser and

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Inspire, Inquire, Interact

- Attend a presentations and learn about the Pacific NW's geology and paleontology. Guest speakers include Dr. William Orr, Dr. Jeff Myers, and Dr. Ellen Morris Bishop.
- Kids, have you ever wanted to find your own fossil? Try your hand at screening for shark teeth or participate in a fossils hunt. Plus other fun and educational activities like growing your own living fossil. (Fossil Hunt times: 11am, 2pm)
- 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.

NORTHWEST FOSSIL FEST

Saturday, August 11th, 2007

When

Saturday, August 11th, 2007
10am to 4pm

Where

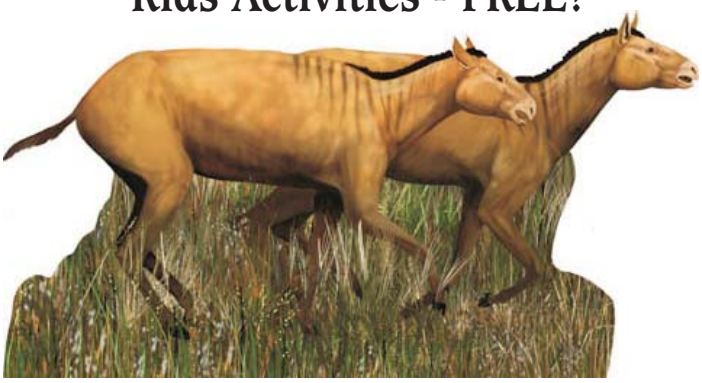
Rice NW Museum of Rocks and Minerals
26385 NW Groveland Drive
Hillsboro, Oregon 97124

Directions

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

NW Fossil Fest Admission - FREE!

Kids Activities - FREE!



For more information visit www.narg-online.com

TUCSON AREA FOSSIL, GEM, MINERAL AND LAPIDARY SHOW

Robert Rosé

In February 2007, my wife and I visited Tucson to attend fossil, gem and mineral venues present all over town. Since we had been there in 2006 we knew the routine. From January 26 through February 11 there were more than 40 shows in Tucson, Arizona in which vendors, both retail and wholesale, sold fossils, gems, lapidary products, beads, minerals, and associated equipment. What we did to start was to go to the Executive Inn Motel to get our SHOW books and pamphlets. They are all free and give full information on dealers and show sites. The bible is the 500 page Tucson Show Guide which is nice to have but not practical to haul around all day. Therefore you get the Tucson ez-guide which is smaller and easier to use. For us fossil addicts you then need to get the Guide to Fossil Dealers and Events, only 40 pages and very useful.

Each year the Tucson show is the first part of February. Since it is built around the Tucson Gem and Mineral Society show, which is always the second weekend in February, you can figure when to go. The Society show is in the downtown convention center. The other venues are at motels and tent sites all around town and begin selling about ten days before the second weekend. Look on your calendar to figure when you want to go depending what you want to see.

The best venues for fossils are at Inn Suites and Ramada Ltd. motels. Here you will find the finest specimens. You will find other fossils in tents and rooms at other motels but most will be second tier material.

At the Inn Suites in the Copper Ball Room large fossils were displayed including a ten foot long completely articulated shark from the Cretaceous, large palm frond with fish from the Eocene Green River Formation, complete restorations of several large dinosaurs and brightly colored ammonites from Canada.

In the individual rooms you could see amazing specimens. One fellow from Germany had two complete pterasaurs about a foot in length. He had prepared the specimens and pointed out the delicate hand bones and skin pattern between the fingers. These were museum quality. He also had very nice large crabs from Italian Eocene and crinoids from Germany. Other dealers had large and delicate crinoids on limestone slabs and some crinoid slabs with brachiopods. Fossil wood was common and came from many countries. There was some very unusual wood from Australia and Africa. Expensive too!

If you are into trilobites there were plenty around. Many from Morocco, although not generally labeled and many from the United States. Not sure you can trust the Moroccan material for authenticity. My suggestion is take a specialist if you want to spend some money for Moroccan trilobites. I bought Devonian specimens, one really nice one and others to practice my preparation on.

The sexy fossils are easily found but you have to hunt for the more mundane brachiopods, bryozoans, pelecypods, gastropods, and the like. Some dealers in motel rooms specialized in one or two items only. These could be wood from a specific locality or Cenozoic vertebrates from the Western US. Amazing how expensive some of this material can be! How about $125 for one Megalodon tooth. It was complete and a beauty but too expensive for me. To find the specimens you are interested in you have to visit many motel rooms if you do not know specific names of dealers that might have what you want. This sounds like the hard way to do it but what fun to see all the different things people are selling. Eventually you will see something you just have to have!

Jurassic crocodile found in Oregon

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director of the Thomas Condon State Museum of Fossils at the University of Oregon. "This creature lived in Jurassic times, so it's 150 to 180 million years old. It probably lived in an area from Japan to East Timor, somewhere in the western Pacific in a tropical estuarine environment."

The remains of the crocodile, believed to be from the species Thalattosuchia and member of the Metriorhynchids group, now belong to the state, Orr said. The remains will be displayed on loan to the Rice Northwest Museum of Rocks and Minerals in Hillsboro, Ore., after undergoing an expected two-year analysis at the University of Iowa. The Hillsboro museum is operated by NARG, whose members are private researchers with experience and interests in paleontology, paleonbotany and geology who study the Pacific Northwest. NARG is based in Beaverton, Ore.

Andrew Bland, one of nine NARG members seeking fossils, first located the crocodile bones during a weekend trip in October 2005. "I followed the bone fragments I was finding up hill a few feet to the area they were weathering out of," Bland wrote in a group newsletter. "I started to dig and found more bone material. It was hard for me to stop digging, as I wanted to uncover more."

Thalattosuchia, a predator believed to have been common around much of the world during the Jurassic Period (142 million to 208 million years ago) was named in 1901 by German researcher Eberhard Fraas. Based on locations where fossils have been found, scientists have theorized that Thalattosuchians may have moved from semi-aquatic freshwater reptiles into fully ocean forms.

Fossils similar to the Oregon crocodile appear today in many areas around South China, Orr said.

Orr theorizes that the remains in Oregon migrated eastward in rock by continental drift, a theory of land movement in geological time now encompassed under plate tectonics. Terrane formations, such as those where these fossils were found, are believed to be portions of the earth's crust riding apart of a plate that is pushed upward at contact with another plate.

The reptiles' short stubby legs would have allowed them to move about land, where they may have laid eggs. But also, the creatures may have had webbed feet, which, in combination with the fish-like tail, would have made them rapid swimmers, allowing them to hunt along the surface of aquatic environments, scientists have theorized.

Fossils from other crocodile families and other reptiles, especially ichthyosoaurs, from the Mesozoic Era (65 million to 248 million years ago) have been found previously in Oregon, but none have been as old as the newly found crocodile, Orr said.

"While fossil marine crocodiles frequently occur in Jurassic rocks of Europe and Africa, they are scarce in North America," Orr and his wife Elizabeth L. Orr, a courtesy research assistant in the department of geological sciences, noted in their book "Oregon Fossils." And while these reptiles lived during the age of dinosaurs, only a single fragmentary dinosaur bone, from the Cretaceous Period (65 million to 144 million years ago), has been discovered in the state.

The new discovery, Orr said, suggests that dinosaur fossils "must be out there somewhere, but we just haven't looked hard enough."

Fossil Collecting

Fossil collectors must adhere to rules and regulations established by owners or managing agencies of the lands on which they wish to collect. Federal laws prohibit the collection of higher vertebrate fossil material without a permit. Collecting of common invertebrate and plant fossils is permitted on public lands except within the boundaries of US National Parks, Oregon State Parks, Oregon Forestry, or Oregon Fish and Wildlife lands. Before collecting, check first with federal, state, and county laws for additional rules that may govern the area you wish to visit. Fossils collected from public lands are to be for personal, educational, and scientific purposes and may not be exploited commercially. To access or collect on privately owned lands, collectors must contact and obtain permission from the owners prior to entering the property. Please respect the wishes of private land owners, observe the rules, and be courteous otherwise future access may be denied to everyone.

Untrained but observant people can and do frequently discover fossil of great significance, so keep your eyes open. It's important that new and significant finds are reported to the scientific community to provide an opportunity for them to be studied.

Oregon Fossils - Dating using Invertebrates

Elizabeth L. Orr, William N. Orr

Because they are so abundant in marine rocks, fossilized invertebrate shells are of particular importance for determining the age of strata. However, geologists working in Europe in the 19th century were slow to see the value of fossils as tools to measure geologic time. It wasn't until 1808 when the stratigraphy of the Paris basin was worked out that the usefulness of mollusks was recognized. The first molluscan chronologies were based on European species, and early efforts to apply these successions elsewhere in the world failed because, like most modern plants and animals, fossils tend to have only limited geographic distribution. Paleontologists soon realized that it would be necessary to establish local successions of fossils for the use in the immediate vicinity. These were later followed by correlations between far-flung regions to produce a global chronology.

In Paleozoic and Mesozoic rocks, the coiled shells of ammonites are among the best time markers for earth history. Since they evolve rapidly and move about globally owing to their swimming ability, ammonites are natural tools for age dating. One drawback to the use of ammonites is they tend to inhabit open ocean settings and are less frequent in reefs or near shore sediments.

Geologic time chronologies for the Cenozoic era, covering the interval from 66 million years ago to the present, were determined in 1833 by British born geologist Charles Lyell, whose text, Principles of Geology, set the direction that geologic thinking would take in the mid 19th century. Lyell began establishing a uniform faunal history of the marine Tertiary in Europe, basing his definition of the Eocene, Miocene, and Pliocene epochs on the percentage of fossil species that are found still living today in each of these intervals. After counting the number of fossils species in a formation, Lyell would calculate what percentage of these had living representatives. A high number of modern equivalents in a fauna would reflect younger strata. Thus the Eocene would have fewer modern species that the Pliocene. The Paleocene, Oligocene, and Pleistocene epochs were later added and subdivided from Lyell's original three epochs.

In spite of the shortcomings of Lyell's percentage method, this strategy was initially used on the West Coast to approximate the Tertiary epochs here. The first chronologies were developed in California and were based on the name of the geologic rock formation where the characteristic fossils were found, and not on spans of time or stages. This confusion of time and rock concepts led to an unfortunate situation where, for example, the Vaqueros Stage was distinguished by the fossils that are found in rocks of the Vaqueros Formation. Since rock units or formations frequently extend over more than one time interval or have different ages at various locals, the Vaqueros Formation includes the Miocene but extends into the late Oligocene as well. Because of the reliance on rock components and not a range of time, considerable irregularities were apparent on the chronologic charts between what were rock units or formations and what were time units or stages.

This problem wasn't resolved until 1944, when Charles Weaver of the University of Washington chaired a committee of 21stratigraphers and paleontologists who prepared a master time-stratigraphic framework for all of the Pacific Coast Cenozoic. Standard European time designations were largely ignored by the committee. Among the results of this early effort of "science by committee"
, microfossils [mainly foraminifera] were recognized along with megafossils [mostly mollusks] for their important role in West Coast stratigraphy. The awakening of interest in foraminifera, as reflected in stratigraphic charts, accompanied the rapid growth of the petroleum industry at the end of World War II. It was realized that foraminifera are especially useful with marine layers, which tend to be rich in microfossils, yet often lacked stratigraphically definitive megafossils, and visa versa. Pulling together prior work of numerous paleontologists, the committee's graphic presentation of 21 separate stratigraphic sections from California to Mexico, through Oregon, Washington, and into southern British Columbia was a critical step in the comparison of stages and formations.

The process of fine tuning and adjusting rock correlations is ongoing locally as well as internationally, particularly when new paleontological and radiometric data emerges. Warren Addicott of the U.S. Geological Survey and John Armentrout of Mobil Explorations revised, formalized, and refined the West Coast Tertiary and Quaternary time scale in 1981 with the publication Pacific Northwest Cenozoic Biostratigraphy. Compiled for an annual meeting of the Geologic Society of America, this important paper focused on carefully defined and updated time scales since Weaver's work, placing local chronologies and stratigraphy into a world-wide framework. The COSUNA chart Correlation of Stratigraphic Units of North America that included the regional Correlation of Cenozoic Stratigraphic Units of Western Oregon and Washington accessed and incorporated further data in 1983. These charts further today's stratigraphic standards.

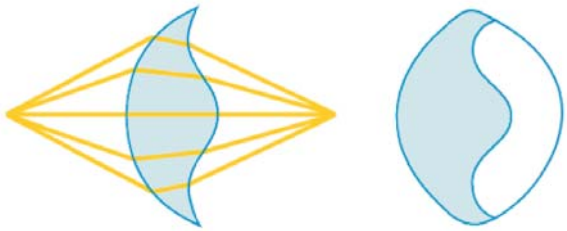
The Trilobite Eye

By S. M. Gon III

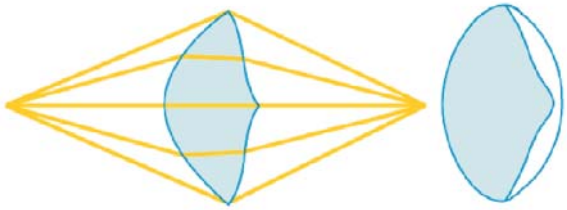
Trilobites developed one of the first advanced visual systems in the animal kingdom. The majority of trilobites bore a pair of **compound eyes** (made up of many lensed units). They typically occupied the outer edges of the **fixigena** (fixed cheeks) on either side of the **glabella**, adjacent to the **facial sutures**. At least one **suborder** of trilobites, the **Agnostina**, are thought to be **primarily eyeless**. None have ever been found with eyes. In contrast, a few **secondarily eyeless** species (in which a clear evolutionary trend toward reduced eye size with eventual disappearence of eyes altogether) have developed within several groups, even those known for large, well-developed eyes (*e.g.,* Phacopina).

The advantage of good eye design

Compound eyes in living arthropods such as **insects** are very **sensitive to motion**, and it is likely that they were similarly important in **predator detection** in trilobites. It has also been suggested that **stereoscopic vision** was provided by closely spaced, but separate eyes. **Vertebrate lenses** (such as our own) can change shape (accomodate) to focus on objects at varying distances. Trilobite eyes, in contrast, had **rigid, crystalline lenses**, and therefore no accomodation. Instead, an internal **doublet structure** (two lens layers of different refractive indices acting in combination) corrected for focusing problems that result from rigid lenses. The shapes of some trilobite lenses, in fact, match those derived by optical scientists over 300 million years later to answer similar needs. Compare, for example, the optical designs of the 17th century physicists Descartes and Huygens shown below, with those of two trilobite species. The result is that, even without the benefit of accomodation, the rigid trilobite doublet lens had remarkable **depth of field** (that is, allowed for objects both near and far to remain in relatively good focus) and minimal **spherical aberration** (distortion of image).



Descartes' lens design for minimal aberration (above left) is found in the lens of the trilobite *Crozonaspis (right)*
Light ray paths (yellow) entering the lens from the left come into focus a short distance to the right of the lens (blue).
In the eye of *Crozonaspis*, an intralensar body (white) further corrects focus after passing through the outer lens layer (blue).



Huygens' lens design for minimal aberration (above left) is found in the lens of the trilobite *Dalmanitina* (right)
both images ©1999, 2000 by S. M. Gon III, modified from Clarkson and Levi-Setti 1975

Three types of trilobite eyes

There are three recognized kinds of trilobite eyes: **holochroal**, **schizochroal**, and **abathochroal**. The first two are the major types, with the great **majority** of trilobites bearing holochroal eyes, and the distinctive schizochroal eye a recognized innovation of the **Phacopida**. Holochroal eyes are characterized by **close packing of biconvex lenses** beneath a **single corneal layer** that covers all of the lenses. These lenses are generally hexagonal in outline and range in number from one to more than 15,000 per eye! Schizochroal eyes on the other hand are made up of a few to more than 700 relatively **large**, **thick lenses**, each covered by **a separate cornea**. Each lens is positioned in a conical or cylindrical mounting and is separated from its neighbors by **sclera** (cuticular exoskeleton material) that extends deeply, providing an anchor for the **corneal membrane**, which **extends downward** into the sclera, where it is called intrascleral membrane.The abathochroal eye (Jell 1975) is seen in

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The Trilobite Eye

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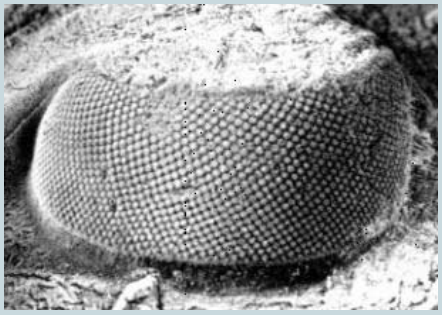
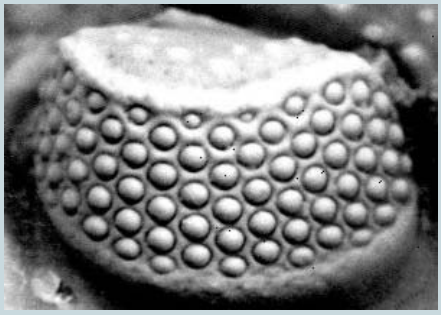
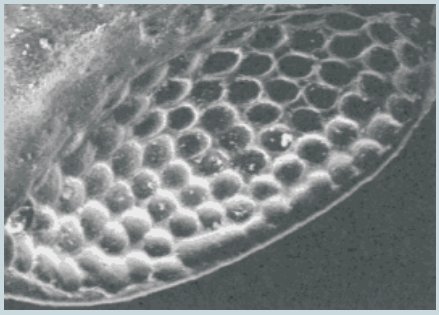
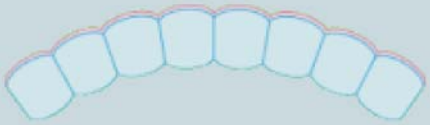
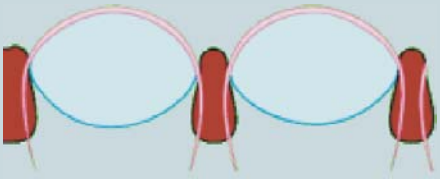
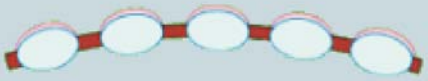
only a few Cambrian trilobites and is somehat similar to the schizochroal eye, but differs in some important respects: the **sclera is not thick**, and the corneal membrane does not extend downward, but ends at the edge of the lens. The table below illustrates and contrasts the characters of the three eye types.

Holochroal eye	Schizochroal eye	Abathochroal eye
		
found in nearly all Orders few to very many lenses (to >15,000!) Lenses typically small, numerous one corneal layer covers all lenses lenses in direct contact with others no sclera between lenses corneal membrane covers surface only	found in some Phacopida only typically fewer lenses (to ca 700) lenses much larger, fewer each lens bears an individual cornea lenses separated from each other sclera between lenses very deep corneal membrane extends into sclera	found in Cambrian Eodiscina only few lenses (to ca 70) lens size small, not numerous each lens bears an individual cornea lenses separated from each other interlensar sclera not deeper than lenses corneal membrane ends at lens margin
		
cross section reveals: no sclera between lenses (blue) single cornea (pink) covers all lenses corneal membrane on surface only	**cross section reveals:** sclera (brown) between lenses very deep one cornea (pink) per lens (blue) corneal membrane extends into sclera	**cross section reveals:** sclera (brown) not deeper than lenses one cornea (pink) per lens (blue) corneal membrane ends at lens edge

How did schizochroal eyes evolve?

All early trilobites (Cambrian), had holochroal eyes and it would seem hard to evolve the distinctive phacopid schizochroal eye from this form. The answer is thought to lie in ontogenetic (developmental) processes on an evolutionary time scale. **Paedomorphosis** is the **retention** of ancestral **juvenile** characteristics into **adulthood** in the descendent. Paedomorphosis can occur three ways: **Progenesis** (early sexual maturation in an otherwise juvenile body), **Neoteny** (reduced rate of morphological development), and **Post-displacement** (delayed growth of certain structures relative to others). The development of schizochroal eyes in phacopid trilobites is a good example of post-displacement paedomorphosis. The eyes of immature holochroal Cambrian trilobites were basically miniature schizochroal eyes. In Phacopida, these were retained, via delayed growth of these immature structures (post-displacement), into the adult form.

Variations in trilobite eyes

As with other aspects of the trilobite body, there was a **huge variation** of size and form among trilobite eyes, which in many cases seems related to the ecological life style of different species. The figures below show some of these variations. Many of the earliest trilobite eyes were **cresentic**, such as those of the Corynexochid *Polypleuraspis*. A conical section of **schizochroal eyes** gave species such as *Phacops* an excellent **field of vision**. In some trilobites, such as the free-swimming **pelagic** trilobite *Opipeuterella*, the eyes were so large that they **dominated the cephalon**, providing a 360 degree visual field. Specialized forms,

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About NARG

The Pacific Northwest is a region that extends from Northern California through Oregon, Washington and British Columbia to inland Idaho. In order to fully comprehend the complex geology of this area more research is necessary. Paleontologic contributions are a key component of this research. NARG's mission is to promote and educate the public on the paleontology of the region and to contribute to paleontologic research. Our organization consists of members of all ages and experience with interests and professions in the fields of paleontology, paleobotany, and geology.

By forming associations with professionals, NARG has a base of advisors who provide instructional guidance and consultation. Advisors also give direction to areas where NARG can make contributions to the fossil record. NARG is committed to doing whatever is necessary to ensure that fossils are available to be studied and enjoyed by future generations.

NARG schedules numerous field trips throughout the year and finds are frequently donated to the public domain for scientific study and display. NARG has monthly meetings held at the Rice Museum in Hillsboro, Oregon. NARG also coordinates the annual Northwest Fossil Fest. For more information about NARG visit our website at: Www.narg-online.com

Pectin from the Empire Formation (Miocene)

The Trilobite Eye

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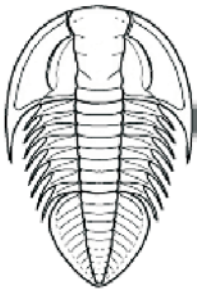
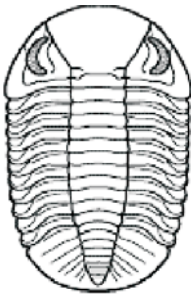
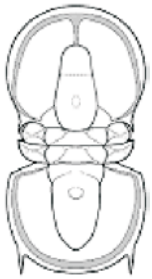
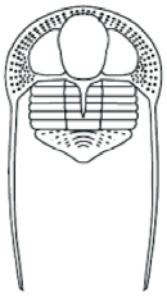
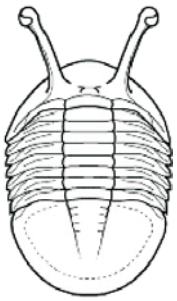
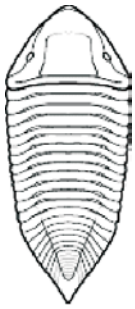
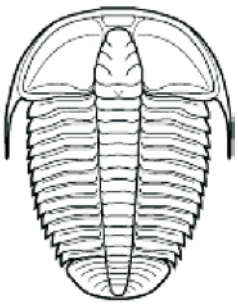
such as *Agnostus,* seem to have been **entirely blind**. Others, such as the Trinucleoid *Cryptolithus* were **bottom feeders** with a large, pitted **sensory fringe**, and eyes were **reduced** or lost. In species moving through a **benthic** layer of loose debris or algal growth, eyes raised above the body **on stalks** could peer about for danger, such as in the strange Russian Asaphoid *Neoasaphus (left).* Species living on the bottom in deeper waters would have little or no need for eyes at all, and species with reduced eyes, such as *Trimerus* and **secondarily lost eyes**, such as *Conocoryphe* are the result.

Polypleuraspis cresentic eyes	*Phacops* schizochroal eyes	*Opipeuterella* large holochroal eyes	*Agnostus* primarily eyeless
			
Cryptolithus secondarily eyeless	*Neoasaphus* stalked eyes	*Trimerus* reduced eyes	*Conocryphe* secondarily eyeless
			

Evolutionary Loss of Eyes

Although eyes are normally an extremely important survival feature, there are situations under which loss of eyes might occur. For example, trilobites that took advantage of deep-water **benthic** (bottom-feeding) habitats where light was dim or lacking might have gradually lost their eyes without suffering an adaptive disadvantage. Such eyeless trilobite assemblages are called **atheloptic**. Such evolutionary trends are repeatedly seen in a variety of trilobite orders, and two examples are shown below. In both cases, these are Devonian trilobites that started with ancestors bearing large, functional eyes. In one sequence, eyes of a Phacopid clade were lost, and facial sutures associated with eyes were also reduced and marginalized. In the other example, involving a Proetid clade, eyes were also reduced and lost, but the basic facial suture pattern was retained. In the figures below (after Fortey & Owens 1999), the eyes are shown in blue and facial sutures in red.

The image to the left is a remarkable multiple of *Conocoryphe sulzeri*, a secondarily eyeless ptychopariid from the Czech Republic.

continued on page 11

Stonerose Interpretive Center & Eocene Fossil Site

Stonerose Interpretive Center: Stonerose is the name of a fossil site, a place where impressions of plants, insects and fish that lived in and around a large lake nearly 50 million years ago can now be found in a large shale deposit. These fossils are the result of events that happened long before there were people to observe them.

Stonerose Interpretive Center is located at 15-1 N. Kean Street, on the corner of Kean Street and Highway 20 W., across from the city park in beautiful Republic, Washington. The fossil site is just a short walk from the Interpretive Center.

For more information please contact us at: (509) 775-2295, or visit us on the web at: www.stonerosefossil.org

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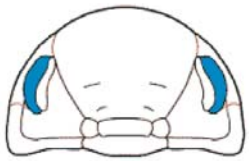
The Trilobite Eye

continued from page 9

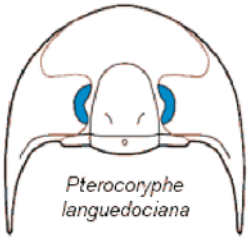
Eyes large and typical

The ancestral *Phacops* species had large eyes and typical phacopid proparian facial sutures



Phacops sp.

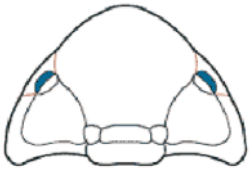
The proetid *Pterocoryphe* had large eyes associated with opisthoparian sutures.



Pterocoryphe languedociana

Eyes reduced in size

Reduction of eyes and a migration forward on the cephalon is seen in the descendant *Cryphops*.



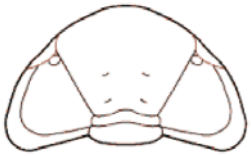
Cryphops acuticeps

Greatly reduced eye size marked the genus *Pteroparia,* descendant of *Pterocoryphe.*

Pteroparia oculata

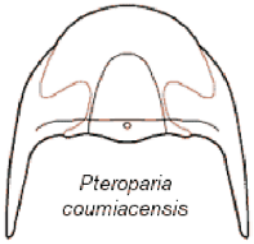
Eyes lost entirely

Eventually the eyes were lost althogether and the sutures were left along the anterior margin of the cephalon in the genus *Trimerocephalus*.



Trimerocephalus dianopsoides

Although the eyes are entirely lost in this *Pteroparia* species, the facial suture patterns are largely unchanged.



Pteroparia coumiacensis

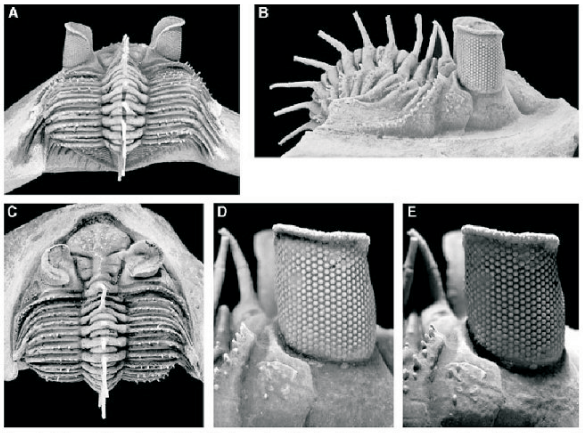


Fig. 1. *Erbenochile erbeni* (Alberti). Devonian (Emsian) Timrahrhart Formation (Jebel Gara el Zguilma, near Foum Zquid), southern Morocco. (**A**) Posterior view showing overhanging eyeshades. (**B**) Lateral view. (**C**) Dorsal view. The headshield is 32 mm across. (**D**) Side view detail of right eye showing lenses under optimum illumination, and (**E**) how the eyeshade cuts out light from above, when directed as a parallel beam above the palpebral lobe.

Devonian trilobite with an eyeshade

In September 2003 Fortey and Chatterton reported on a remarkable trilobite: *Erbenochile erbeni*, a Moroccan acastoid with an extremely well-developed schizochroal eye borne on tall, columnar palpebral lobes, rimmed with an eyeshade. This is another recent documentation of a remarkable development of the optical organs in trilobites.