The Paleontograph

A newsletter for those interested in all aspects of Paleontology
Volume 3 Issue 5 December, 2014

From Your Editor

Welcome to the fifth and final issue for the year. I hope you all have had a good holiday season so far and that you have a Happy New Year.

After months of semi retirement, I've just progressed to full retirement from my job of almost forty years. Words cannot express...., well they can but I won't bore you.

The Tucson show is fast approaching and I am looking forward to that. I always enjoy getting out the cold New York winter weather and getting warmed up for a week or so. And the fossils aren't bad either. Now that I have more time, I'm going to take the drive and see what I can see on the way out and back.

I'll leave now so you can check out this issue.

The Paleontograph was created in 2012 to continue what was originally the newsletter of The New Jersey Paleontological Society. The Paleontograph publishes articles, book reviews, personal accounts, and anything else that relates to Paleontology and fossils. Feel free to submit both technical and non-technical work. We try to appeal to a wide range of people interested in fossils. Articles about localities, specific types of fossils, fossil preparation, shows or events, museum displays, field trips, websites are all welcome.

This newsletter is meant to be one by and for the readers. Issues will come out when there is enough content to fill an issue. I encourage all to submit contributions. It will be interesting, informative and fun to read. It can become whatever the readers and contributors want it to be, so it will be a work in progress. TC, January 2012

Edited by Tom Caggiano and distributed at no charge

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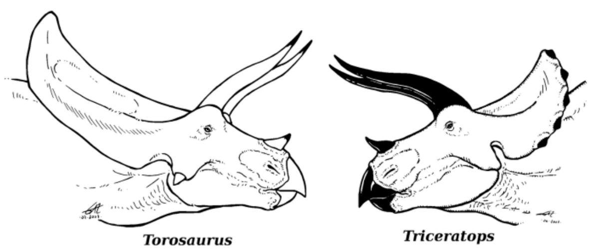
Two Species of Triceratops Represents Change with Time.

Bob Sheridan July 25, 2014

Triceratops is everyone's second favorite dinosaur. It is a very large ceratopsian with a small nasal horn and two long brow horns. As with all ceratopsians, it had a neck frill and a sharp beak.

Triceratops lived in North America during the last few million years of the Cretaceous. Up to only a few decades ago, there were up to 16 named species of Triceratops based on small variations in morphology. It has been proposed since the late 1980s that there might be only a single Triceratops species, with the differences being explained by age or sex. More recently, and still a matter of fierce controversy, it has been proposed that Triceratops, Nedoceratops, and Torosaurus represent different life stages of the same animal, the last being the most mature form. The most widely accepted current idea is that there are two contemporaneous species of Triceratops: *T. horridus* (long brow horn, short nose horn, long beak) and *T. prorsus* (shorter brow horns, longer nose horn, shorter beak).



Today's story is about Triceratops specimens in the Hell Creek Formation (HCF) in Montana. The HCF is about 90 meters thick and represents a span of 1-2 million years. The fact that there are many Triceratops skulls excavated throughout the HCF, and that one can finely divide the HCF by time, gives an opportunity to study the evolution of a dinosaur over a few million years. Such a study is described by Scannella et al. (2014). These authors divide the HCF into three parts: U3, M3, and L3 for the Upper (most recent), Middle, and Lower (oldest) third. They looked to see if there were any trends in the skulls of the 50 specimens of Triceratops skulls associated with each division. The clearest trend seems to be with the nasal horn core; on the average it gets longer with later times. A lesser trend is with the beak; it becomes shorter with time. Orbital cores do not show a clear change.

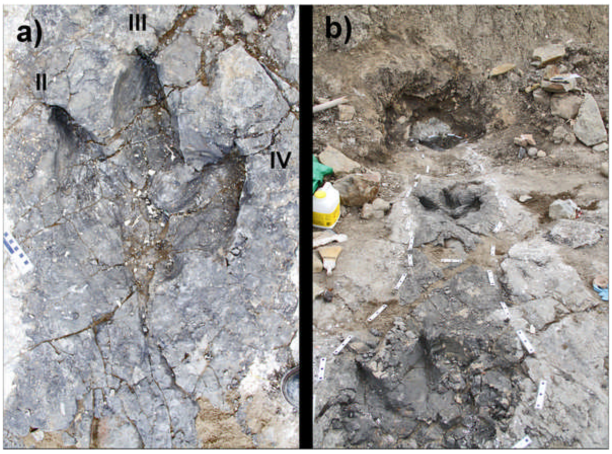
Another way of looking at that information is that *T. horridus* lived during L3, *T. prorsus* lived in U3, and some intermediate form lived in M3. The most straightforward interpretation is that *T. horridus* evolved into *T. prorsus*. However, it is hard to eliminate other possibilities such as that *T. prorsus* evolved elsewhere and replaced *T. horridus* in Montana. The classic idea that the *T. horridus* and *T. prorsus* represent different ages or sexes of the same animal is looking unlikely.

Sources:
Scannella, J.B.; Fowlera, D.W.; Goodwinc, M.B.; Horner, JR.
"Evolutionary trends in Triceratops from the Hell Creek Formation, Montana"
Proc. Natl. Acad. Sci. USA 2014, 111, 10245-10250.

Tyrannosaur Trackway

Bob Sheridan, August 11, 2014

I am coming across a great deal of literature on trace fossils literature lately. An article from last month's PloS ONE (McCrea et al., 2014) describes what appears to be a partial trackways of large theropods from the Latest Cretaceous of British Columbia. There are three trackways in this description: Trackway A is four meters long and consists of three footprints. Trackway B consists of a single footprint, and Trackway C consists of two footprints. The surface onto which the footprints were made seems to be fairly firm (like clay), since there is no obscuring of footprint features (as one would find in mud). More footprints may be at the site, but have not yet been excavated. The footprints have been assigned a new ichnotaxon Bellatoripes ("warlike foot").



The footprints in all tracks are more or less pointing in the same direction and the trackways are within a few meters of each other. Individual footprints are 50-60cm long and about 50 cm wide. Some of them show skin impressions, indicating that these are true footprints and not underprints. The beginning and end footprints of trackway A, which correspond to the left foot seem to be missing the outmost part of the medial toe (hence the word "pathology" in the title of the paper). One footprint shows "striations", which the authors explain as being produced as the foot slid forward when it was being placed on the ground, and sliding backward as it was being removed from the ground.

There are several formulas for estimating the hip-height of an animal given the length of its footprint. There are also formulas for estimating the walking speed of a bipedal animal given its stride length. Bellatoripes would be about 2.3 meters at the hip and walking at 7 km/hr. The authors use the length and "robustness of the track" (area of a footprint divided by its length), plus the calculated hip-height to establish that Bellatoripes was probably made by an adult tyrannosaur of the size of Albertosaurus, Gorgosaurus, or Daspetosaurus. (Which are typically 30ft long--not quite as large as Tyrannosaurus.) Assuming the assignment is correct, since there are growth series of these tyrannosaurs, one can even estimate the approximate age of the animals: 25-29 years. Sometimes the tracks of giant ornithopods can look like theropod tracks, but there are no giant ornithopods known from British Columbia at that time. One cannot completely eliminate that Bellatoripes represents the footprints of a young Tyrannosaurus, but we would not expect their footprints to not be as robust (i.e. as thick for a given length).

The authors compare Bellatoripes to about other tracks of several other large theropods. Theropod trackways are common, and individual footprints of very large theropods are known, some bigger than Bellatoripes, but this is the first trackway of a known tyrannosaur.

Since all the trackways seem to have the same wear and depth and seem to be going in the same direction and do not cross each other, the inference is that the trackways were created by three theropods walking together in parallel. Hence the headlines in the popular press that these trackways prove "tyrannosaurs hunted in packs." However, as with any trackway evidence, one has to keep in mind other plausible scenarios like: a tyrannosaur walked by, then a few hours later another tyrannosaur walked in the same direction, then a few hours later another did the same.

Sources:

McCrea, R.T.; Buckley, L.G.; Farlow, J.O.; Lockley, M.G.; Currie, P.J.; Matthews, N.A.; Pemberton, S.G. "A 'Terror of Tyrannosaurs': The First Trackways of Tyrannosaurids and Evidence of Gregariousness and Pathology in Tyrannosauridae" PloS ONE 2014, 9, e103613

Is There Something Special About Maniraptor Evolution?

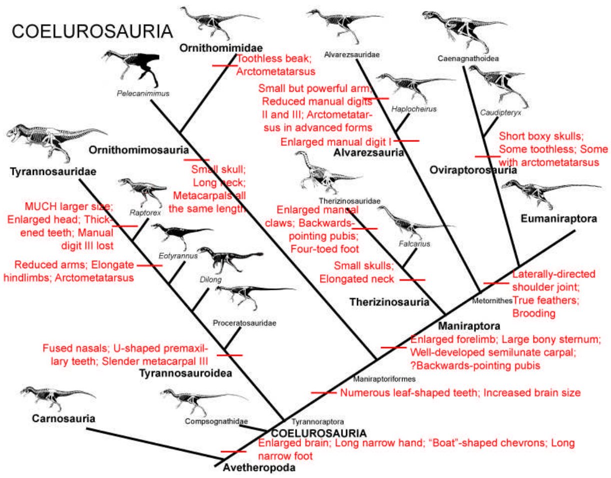
Bob Sheridan, August 17, 2014

Within a few months I can across two articles about the same topic: the fact that the maniraptor branch of theropods, the one most closely related to birds, has many members smaller than average for other dinosaurs existing at the time, and whether there is a continuous trend toward smaller maniraptors with time. One article is from May 2014 "PLoS Biology" (Benson et al.) and one is from August 1, 2014 "Science" (Lee et al.).

Benson et al. compiled a database of dinosaur body masses, which (if you count birds as dinosaurs) range from a few hundredths of a kilogram to nearly 100,000 kilograms. They divided dinosaurs into five groups: Ornithiscia (Iguanodon, Triceratops, Stegosaurus, etc.), Sauropodomorpha (sauropods and prosauropods, e.g. Diplodocus and Plateosaurus), non-maniraptorans Theropods (Allosaurus, Tyrannosaurus, Ceratosaurus, etc.), non-avian Maniraptoran (Oviraptor, Troodon, Velociraptor, Therizinosaurus, Alvarezsaurus etc.), and Avialae (i.e. extinct and living true birds). A graph of body mass vs. time shows that only birds (which start in the Late Jurassic, but appear in large numbers in the Early Cretaceous) regularly get below 1kg. At the other extreme, the sauropods regularly get over 10,000 kilograms starting in the Late Jurassic.

The major question is whether non-avian maniraptorans are smaller than other dinosaurs. Actually in this analysis the median mass for a non-avian maniraptoran is not very different from other types of dinosaurs, for example early Ornithiscians. It is the range in mass among maniraptorans that is large, probably larger than any other class of dinosaur. That is, maniraptorans could be very large (e.g. Gigantoraptor at 2000 kg) or very small (e.g. Parvicursor at 0.1 kg).

Given the phylogenetic tree of dinosaurs, their masses, and their dates, one can calculate the rate of change in size for dinosaurs). Averaged over all dinosaurs, the rate of change in size for dinosaurs has been declining from the Triassic to the Late Cretaceous. However, non-avian maniraptors and true birds seem to fall off this trend and have a higher rate of change than expected, with the highest rate of change occurring in the Early Cretaceous.



The authors tie their results to the ecological idea of "niche saturation." That is, dinosaurs changed in size more during the Triassic (by growing larger) to fill all available "jobs" for land animals, but once all the "jobs" where filled by dinosaurs, there was no impetus to change size, and the rate of changing size decreased. Maniraptorans and birds somehow escaped this "niche saturation," presumably continuously finding new "jobs."

Lee et al. compiled a database of 100 theropod taxa, but included over 420 skeletal characters. One important character is the log of the femur length, which can be measured directly, and is expected to be proportional to the total mass of the animal. One can "climb" a phylogenetic tree and successively pick out the one branch that leads to birds. One can look at the average of the log of femur length for that branch, and the origin of the branch has a time associated with it. Therefore one can generate a graph of average log femur length vs. time. There is generally not much change in the average from ~240 Myr. to ~180 Myr. (it stays steady at about 400 millimeters), but after that the average falls quickly (to as low as 80 millimeters at ~160 Myr.). That is, there is not much change until we get to the origin of maniraptorans, which the authors refer to as the "bird stem lineage." Clearly, theropods were getting smaller on the average a long time before the first bird appeared. One weakness of this graph is that the variation around the average is not presented, so we do not know if their results are showing that theropods are all getting smaller, or only that the range in size in maniraptorans is getting larger, consistent with the observations of Benson et al.

Cont'd

Maniraptors Cont'd

These authors also measure rates of evolution, but unlike in Benson et al. they have a very large number of characters, rather than just mass, and can consider all of them. However, the timing of the evolutionary change is about the same: the highest rate occurs in the Early Cretaceous.

In studies of this type, that shows a trend over a large period of time, one should always be worried about potential artifacts that make the object of study look special when it may not be. Artifacts could be due to several causes, two of which are: "What we pay attention to." and "What fossils are preserved." We pay attention to birds because they are the only surviving dinosaurs. We know birds need to be small to fly, so you would expect to see a shrinking trend in their ancestors (albeit not necessarily over 40 Myr). If we picked out some other branch of small dinosaurs that survived to the end of the Cretaceous, would we see similar long-term trends?

Another concern is that we know about many small (feathered) theropods and birds only because of especially well-preserved fossil sites in China, most of which date to the Early Cretaceous. So is the apparent "burst of evolution" in the Early Cretaceous due to the fact that something special happened, or is it just because the Early Cretaceous is the only time a large variation in theropod size is visible in the fossil record?

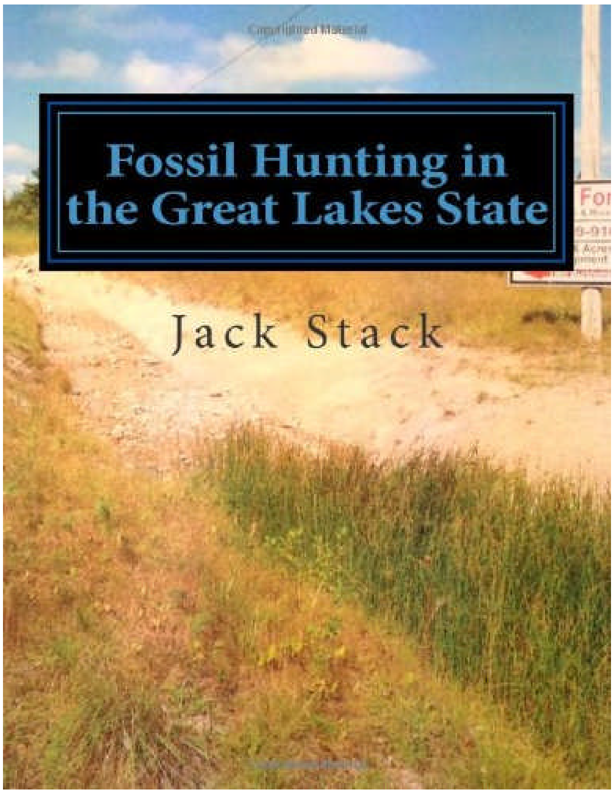
Sources:

Benson, R.B.J.; Campione, N.E.; Carrano, M.T.; Mannion, P.D.; Sullivan, C.; Upchurch, Evans, P.D.C. "Rates of dinosaur body mass evolution Indicate 170 million years of sustained ecological innovation on the avian stem lineage." PLoS Biology 2014, 12, e100183

Lee, M.S.Y.; Cau, A.; Naish, D.; Dyke, G.J. "Sustained miniaturization and anatomical innovation in the dinosaurian ancestors of birds." Science 2014, 345, 562-566.

Fossil Hunting in the Great Lakes State

A New Book By Jack Stack



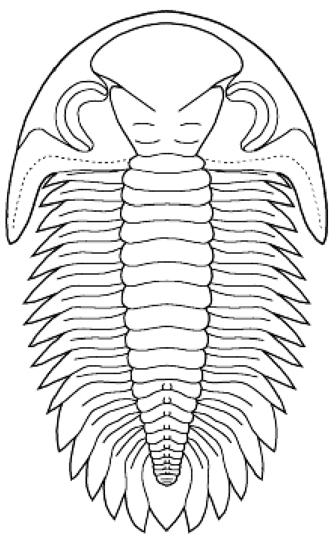
Fossil Hunting in the Great Lakes State is a detailed guide to both Michigan fossil hunting and fossil hunting in general. The book starts with a general introduction to fossil hunting, providing the reader with the background they need to fully appreciate any fossils they find. The second half of the book is a detailed guide to Michigan's fossil sites, fossils, and prehistoric history. Giving the reader an in depth look at the best fossil sites in Michigan and the tools to fully appreciate what can be found in Michigan. This includes a photographic identification guide and general information on the animals the fossil represent. This book is meant to be a guide for both the budding and experienced fossil hunter looking to experience the natural wonders Michigan has to offer. Fossil Hunting in the Great Lakes State is now available on Amazon for $16.56.

OBSERVED ASTEROPYGINAE AND OSTRACOD ASSOCIATION

Thomas C. Buckley

Abstract:
This is a preliminary investigation into the association between ostracods and the trilobite subfamjly Asteropyginae, family Acastidae, order Phacopida. It has been observed that this association does not occur with other trilobite families. Statistics will be shown to prove this out. Is the association between the Asteropyginae and ostracods just a random grouping or evidence of a parasitic, symbiotic, or predator – prey relationship? Specimens within the author's personal collection of trilobites, primarily Phacopids, were examined and note was taken of the existence or absence of ostracods. It will be shown that a statistically significant percentage of Asteropyginae are associated with ostracods when compared to other trilobites, primarily the Phacopidae. A discussion will examine the possible causes of this association.

Introduction:
It has been casually noted that the association with ostracods is more common with the Asteropyginae than with other trilobites. A typical Asteropygin is shown below.



Rhenops

The comparison will be made primarily with other Phacopids such as *Eldredgeops rana* and *Dipleura dekayi*. The primary ostracod noted was *Cytherellina puntulifera.*

To the best of the author's knowledge no other study of the association mentioned has been done. The purpose of this paper is to show that this association does exist, that it is much more common in the Asteropyginae than it is among other trilobites, particularly the other Phacopids, and finally, the possible reasons for this association. The results of this study may lead to further studies and to a better understanding of certain aspects of trilobite behavior.

Materials and Methods:
Specimens were selected from the author's personal collection of trilobite specimens. These came from the "A" group meaning that they were prepped and catalogued. The "B" group, not used for this study, are primarily duplicates and unprepared specimens. A total of 128 trilobite specimens were used. 53 were Asteropygnae and 66 were other Phacopids and 9 were Trinucleidae. All specimens were collected and prepared by the author. All of the author's group "A" trilobites were used in this study.

Each specimen's matrix was examined for the presence of ostracods. If even one ostracod was detected it was counted as a positive result. If no ostrcods were observed the specimen was viewed as having a negative result. It should be noted here that specimens having only 1 ostracod were rare. In most cases positive specimens had a few or many ostacods.

Localities:
NUMBER OF SPECIMENS PER LOCATION

Phacopidae Asteropygnae Trinucleidae

	P	A	T
Eighteen Mile Creek	19	16	
Briggs Road, Madison Cty., NY	12	2	
Penn-Dixie Quarry, Hamburg, NY	17	4	
Shedds Road, Madison Cty., NY	4		
Swopes Farm, Mountour Cty., PA	4		
Deep Springs, Madison Cty., NY	4		
Highland Mills RR, Orange Cty., NY	1		
Seven Stars, Juanita, PA	5		
Antes Gap, PA			9

Cont'd

Ostracod cont'd

The number of ostracod – containing (positive) specimens was then expressed as a percentage of the total number of specimens in each family. The results were then analyzed and discussed.

Results:

The total number of Phacopidae specimens examined was 66 with the number of Phacopid specimens containing ostracods being 44. This gives the number of positive Phacopidae specimens expressed as a percentage of all Phacopidae specimens as 10.6%.

The total number of Asteropygnae specimens examined was 53 with the number of positive Asteropygnae specimens was 28. This gives the number of positive Asteropygnae specimens expressed as a percentage of all Asteropygnae specimens as 52.8%

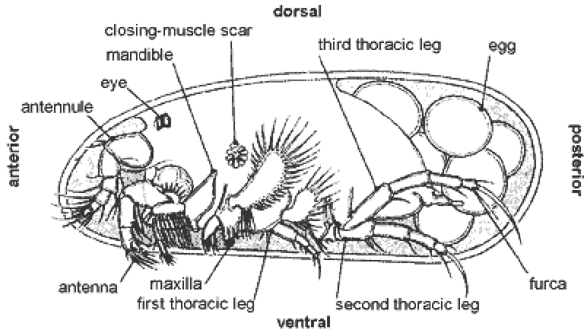
There were no ostracods found on any of the Trinucleidae specimens. It can therefore be stated that there are significantly more associations between ostracods and Asteropygnae than there are between ostracods and Phacopidae.

Discussion:

It has been shown that the number of associations between ostracods and Asteropygnae is significantly greater than that between ostracods and other trilobites, particularly other Phacopids. A discussion of the possible reasons for this and their implications follows.

One possible explanation is the existence of a symbiotic relationship between ostracods and the Asteropygnae. Hart & Hart, 1974 suggests that ostracods' "tiny size and narrow shells are ideally suited to living in the tiny spaces on the gills and thoraxes of crayfish, amphipods and crabs (and trilobites?). They have specially adapted thoracic limbs and antennae to grab hold of their hosts. Although the exact relationship between the entocytherids (ostracod family) and their hosts is not clear, it is thought that in return for a safe place to live, the ostracods help to keep the bodies of their hosts clean"

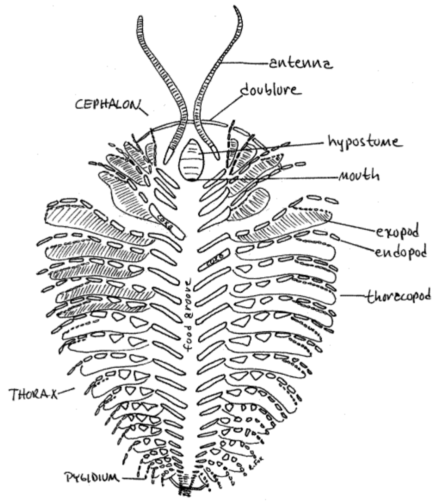
Following the preceding line of thought, one can assume that in at least some of the relationships, ostracods processed the cleaned detritus as food. Thus resulting in a true symbiotic relationship.



Ostracod Anatomy

As the primary information source of trilobite appendages is the study of the legs and gills of *Triarthrus eatoni,* and to a limited extent, *Cryolithus,* evidence of a symbiotic relationship cannot be proved. This will be the case until soft tissue preservation is discovered in the Asteropygnae.

The next possible explanation to be examined is viewing the ostracods as trilobite food. One aspect of trilobite morphology which would influence the type of food it processed is the type of hypostome. Predatory trilobites, per Fortey and Owens, would of necessity have hypostomes firmly attached to the anterior doublure. This would provide a firm base against which the final processing of food could occur before being passed into the mouth. Since Asteropygnae and the rest of the Phacopids all possessed conterminant (attached to anterior doublure) hypostomes, this can be ruled out as a distinguishing feature differentiating the Asteropygnae from the rest of the Phacopids.



Trilobite ventral anatomy showing the Hypostome

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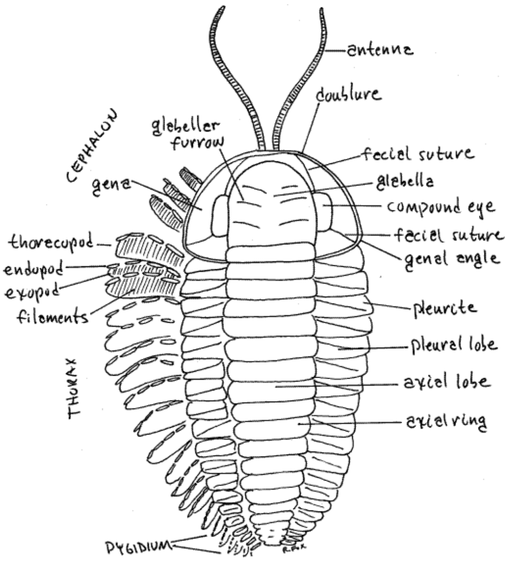
Ostracod Cont'd

Another physical trait among trilobites is the size of the glabella. Fortey and Owens suggested that larger glabellae were indicative of a predatory lifestyle in that the larger glabella would be more suited to the ingestion of larger chunks of food. A smaller glabella would be more indicative of a detritus feeder as the size of food particles would be much smaller. In addition, the spiney nature of the trilobite legs would be ideal for tearing up larger prey items and passing them forward to the hypostome. Phacops have a much more inflated glabella than the Asteropygnae indicating that Phacops were more likely to injest larger prey items such as worms. The Asteropygnae were more suited to dealing with very small prey such as ostracods. Whether the Asteropygnae actually consumed ostracods is still undetermined.



Trilobite dorsal anatomy showing the Glabella

Some Ostracods from the Gault Clay of England

Conclusions:

It has been determined that an association seems to exist between ostracods and the Asteropygnae that doesn't exist between ostracods and the other Phacopids. Due to the lack of preserved appendages of the Asteropygnae, it cannot be determined if a symbiotic relationship existed. This would most easily be documented by the appearance of ostracods on the gills of the trilobites.

As for the possibility of ostracods forming part of the diet of Asteropygnae, this will have to wait for definitive proof such as the presence of ostracod carapaces in trilobite coprolites.

Additional studies need to be conducted measuring the concentration of ostracods on a given piece of matrix. A quantitative measurement such as the number of ostracods per square centimeter would be appropriate.

For now let's just say that ostracods and the Asteropygnae enjoyed each other's company.

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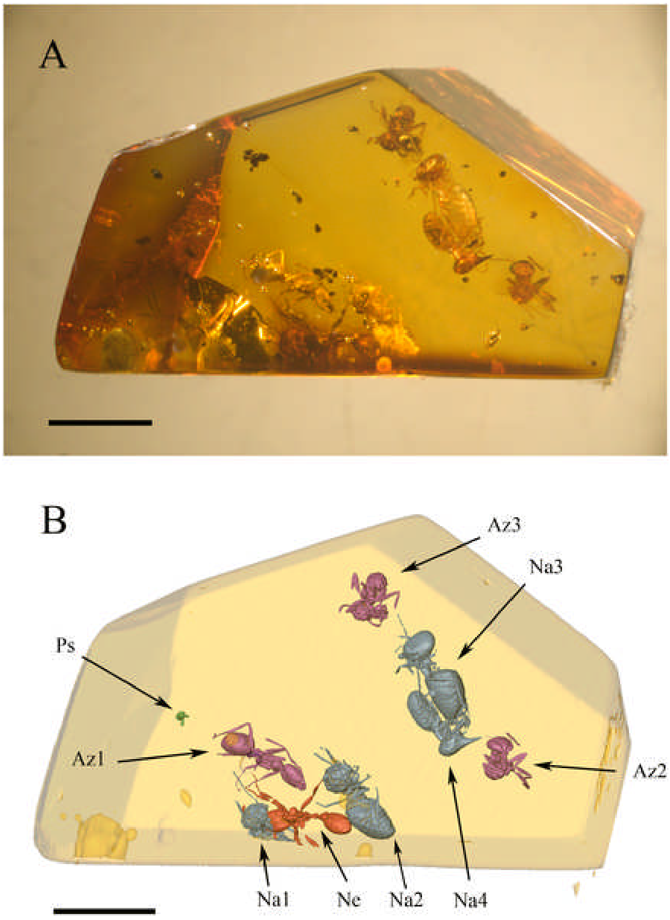
Recent Discoveries in Mexican Amber

Bob Sheridan, September 5, 2014

Amber, as fossilized tree resin, is an excellent place to look for the remains of small animals and plants preserved in three dimensions. In earlier days, to examine the "inclusions" one had to polish a window onto the surface to get a clear view with a microscope. This, of course, worked only with amber that was more or less clear. Now it is common to do high-resolution x-ray tomography (or CT scan if you prefer the medical application) on a sample of amber and thereby generate a virtual model on a computer. This allows many types of analysis that were not possible before, and does not require the amber to be optically clear.

Amber is found in many places (Dominican and Baltic amber being the most common), but I had not heard of Mexican amber before a week ago. Today I will report on two recent publications about fossils arthropods in Mexican amber, specifically from Chiapas, one of the southernmost Mexican states. The first paper is by Coty et al. (2014). These authors describe a small (1.6 cm long) chunk of clear amber from the Totolapa amber deposit, which is dated somewhere between the Late Oligocene and Early Miocene. One interesting aspect found by the CT scan, and also confirmed by optical microscopy is that planar "flow boundaries" are seen within the chunk; these are slightly more dense than the amber as a whole. It appears the chunk was formed by eight separate flows, presumably happening at different times. Only two of the flows have insect inclusions. Interestingly, in one flow the specimens are more dense than the amber, and in the other flow, they are less dense. One possibility that the less dense inclusions are just hollow exoskeletons of dead insects, while the more dense inclusions were alive when they were trapped in the amber.

The amber chunk contains 9 insects: 4 termites, 4 ants (3 of one type, 1 of another), plus 1 bark louse. The termites are identified as soldiers of the genus Nasutitermes, which has 260 living species. That genus is not previously seen in Mexican amber, but has been seen in Dominican amber. One type of ant is Azteca, a species of ant that lives in trees in the tropics of South America. Extant Azteca make their living as ambush predators. The second type of ant, of which there is one example, belongs to the genus Neivamyrmex. This genus is known from Dominican amber. Extant Neivamyrmex are "army ants" that live in North and South America. The key feature of army ants is that they have no permanent nests, but move over the landscape in swarms.



This is the first time that ants and termites have been found in the same chunk of amber, hence the word "syninclusion" in the title of the paper. Among living species, Azteca ants do sometimes live in Nasutitermes nests. There are also cases of termites living in ant nests. In this chunk of amber we see the Neivamyrmex holding a Nasutitermes in its mandibles. Thus, we can construct a scenario of army ants raiding a nest that contains both termites and ants. If the scenario is true, we can trace the nest sharing behavior of some ants and termites to the Miocene. Of course, I would think, the scenario of three types of insects coincidently being on the same tree branch at the same is also very plausible.

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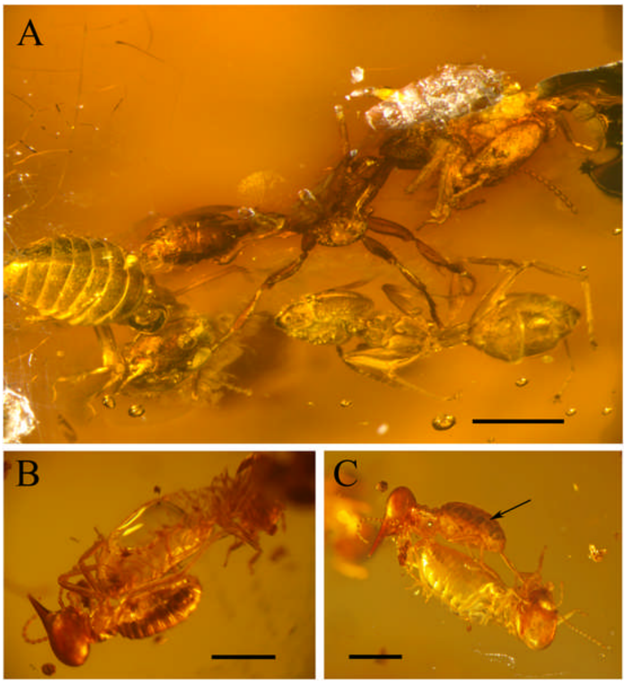

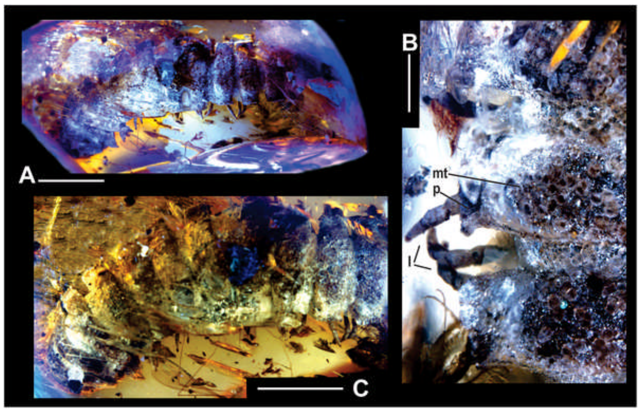

These new species belong to the polydesmidian family of millipedes, which is largest order with 3,5000 extant species. They are known as "flat-backed millipedes because each body segment has a lateral keel. Extant polydesmidian millipedes usually have a bright coloration to warn predators that they are toxic. This group of millipedes has prominent gonopods, which are modified legs for transferring sperm. Hence, it is easy to tell the sex: the specimen of *Anbarrhacus adamantis* is male, and the specimen of *Maatidesmus paachtum* is female.

Now for our other paper. Riquelme et al. (2014) describe two specimens of amber from the Guadalupe Victoria site in Chiapas. These specimens are also dated to the Miocene. These authors use CT scanning, but make a point that they also used infrared-reflected photomicrographs, which is a method that allows chemical analysis of a surface. However, no results of the infrared technique are presented.)

One specimen is clear amber about 1.2 cm long. It contains an intact millipede, which the authors have named *Anbarrhacus adamantis* ("amber millipede with diamond patterns"). The other specimen, a little over 2 cm long, contains the head and trunk of a millipede which the authors have named *Maatidesmus paachtum* ("stony-backed amber millipede"). It appears that brown pigment has been preserved in both millipedes and the inside of their bodies is dense by CT-scan, i.e., their organs have been preserved.

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