

M.A.P.S *Digest*

Official Publication of
Mid-America Paleontology Society
<http://www.midamericapaleo.org>

Volume 44, Number 1
Jan.-April 2021



“A LOVE OF FOSSILS BRINGS US TOGETHER”

Calendar

NOTE 1: Both the MAPS EXPO and CVRMS Show dates are tentative and dependant on the status of COVID-19.

NOTE 2: Until further notice, all MAPS monthly meetings will be held virtually via ZOOM, NOT in-person in Trowbridge Hall. Check the website and watch for e-mails for further information.

2021

October 22-24 (REVISED DATE)

MAPS EXPO XLII

Location: Orr Building

Illinois State Fairgrounds

Springfield, Illinois

Theme: Ordovician II

Keynote Speaker: Dr. Dennis R. Kolata

Topic: The Platteville Formation Fauna of the Upper Midwest U.S. - A Snapshot of the Great Ordovician Biodiversification Event

****EXPO Info & Registration Next Digest Issue**

www.midamericapaleo.org

November 6-7 (REVISED DATE)

CVRMS Show

Location: Hawkeye Downs, Cedar Rapids

Theme: Meteorites

www.cedarvalleyrockclub.org

Contributions to Digest Needed

The Digest editors encourage the members to submit articles for publication in the Digest issues. The Digest is for the members and should reflect their interests. If you have specimens that you collected and would like to share with other members or would like to describe a favorite collecting site, please write an article in Word, Times New Roman size 12 font, single spaced with one inch margins, and send to the editors. Photos and diagrams can be e-mailed separately or incorporated in the article.

John: Fossilnautiloid@aol.com

Chris: CDCozart@aol.com

Call for Papers

The theme for the **2021 EXPO** is the **Ordovician II**. Any paper dealing with fossils, stratigraphy, or site-specific paleontology of the Ordovician Period would be appreciated. The papers should be in Word, Times New Roman, size 12 Font, single spaced with one inch margins, and e-mailed to one of the Digest Editors by the **last week of June 2021**. Diagrams/Photos can be sent separately or imbedded in text. **We have room for 1-2 additional papers.**

John: Fossilnautiloid@aol.com

Chris: CDCozart@aol.com

DUES INFO

Please send your \$20 2021 MAPS dues to:

Dale Stout

2237 Meadowbrook Drive S.E.

Cedar Rapids, Iowa 52403

About the Cover

Trilobites in the cover photo are from the Rapid Member, Cedar Valley Formation, Devonian Period in Johnson County, Iowa. The pygidium and thoracic segments in the upper right corner of the photograph belong to the trilobite *Crassiproetus crassimarginatus* while the remaining trilobites are *Eldredgeops (Phacops rana) norwoodensis*. This specimen was collected and photographed by MAPS president Marvin Houg.

**Mid-America Paleontology Society Meeting
Zoom November 9, 2020**

Present: Marv Houg, John Catalani, Tom Williams, Doug DeRosear, Jim Preslicka, Karl Stuekerjuergen, Bob Rondinelli, Dale Stout, Tiffany Adrain (scribe).

Tiffany Adrain gave a presentation on “Caring for your Fossil Collection.”

Marv brought the meeting to order at 8.38pm.

Tiffany circulated the Minutes of the July 2020 meeting previously. Bob moved to accept Minutes, Karl seconded. Minutes approved.

Jim gave a brief Treasurer’s Report: \$2176.87 in savings; \$11072.60 in checking. The last Allegra bill is still to be paid. All scholarships have been distributed except to the University of Iowa. Bob moved to approve the report, Doug seconded. Treasurers Report approved.

Expo 2021. Due to the ongoing Covid-19 pandemic, Marv suggested moving the postponed MAPS Expo (Theme: The Ordovician) to the weekend of October 22-24, 2021:

- Marv will contact Sharpless to book this date if free.
- John will communicate with Keynote Speaker Dennis Kolata.
- Tom will send John his contact lists of dealers.
- Marv will contact Dan Cooper about the proposed date.
- Marv will confirm Expo 2021 date and date of Cedar Valley Rocks and Minerals Society Show in 2021 with John for listing in the next Digest Newsletter.
- Tom asked about holding the 2022 Expo in April, which was agreed, and will contact the proposed speaker for the original 2021 Expo to see if they are willing to participate in 2022.
- John advised the Board to start soliciting 2022 Expo Digest papers in early 2021, as there will be a shorter timeframe after the October 2021 Expo.

Social Media: Tiffany will assist Jim with MAPS website and create video snippets based on tonight’s presentation, as well as a web and pdf version of “Millie and Sam’s Fossil Hunt” as the books are sold out.

Marv will contact Bob Kurdelmeyer who offered to look after the MAPS Facebook page.

MAPS Officers: The current slate of Officers will roll over to 2021 due to the pandemic.

Next meeting: Virtual, November 23rd at 7 pm. Tiffany will send a Zoom link.

John motioned to adjourn the meeting. Jim seconded. Meeting adjourned at 9.23pm.

Mid-America Paleontology Society Board Meeting Minutes Zoom 7:00 PM December 21, 2020

Present: Marv Houg, John Catalani, Tom Williams, Doug DeRosear, Jim Preslicka, Karl Stuekerjuergen, Dale Stout, Chris Cozart, Dan Cooper, Sharon Sonnleitner, Tiffany Adrain (scribe).

Information on possible venues:

- Karl reported that the Burlington Auditorium is too small.
- Iowa Hall at the Davenport Fairgrounds is 22,000 square feet but costs \$1,500 per day, \$6 per table, \$1 per chair, \$15 per electrical outlet, and security at \$25 per hour (has to be theirs).
- Augustana - no luck with Athletics Hall. Did do a show at the Clarion there but it's now closed. It was too small anyway.
- Southeast Community College is doubtful.
- Marv called the Putnam Museum. No one is there on Monday or Tuesday, so will call back.
- The Eastside sports complex in Peoria has a full-size gymnasium but unloading is difficult because you have to take the elevator to access the gym.

Orr Building Illinois State Fairgrounds:

- Facilities: The Orr Building has HVAC. The Illinois and Exposition buildings are older. The Exposition building does not have HVAC and the Illinois Building has columns in the way.
- Cost: Orr Building \$1,175 (\$3,600 for 3 and a half days) plus cleaning charge. Includes a day to set up ourselves. We do not have to take the tables down, cleaning does that. Can borrow electrical cords from Loess Club who can help with setup.
- Table rates: usually dealers pay \$30 for base table and \$10 for each extra table; \$10 for each table set up on Thursday night. About half of the dealers set up on Thursday night.
- Security: No security is provided by MAPS on Thursday night. The Fairground is locked at night and has 24-hour security during rounds. Loess Club just goes with what security the fairgrounds has. The Orr Building is locked at night. MAPS security may be able to stay inside - Tom will check.
- Expo times: Friday and Saturday are really busy. Dealers leave early on Sunday usually. Keep to the three days.
- Silent auction: needs donations.
- Motel Show: Northfield Hotel ballroom holds 300 people. May be ok with motel show. If so, Dan will get April 2022 motel show booked in and check motel availability for weekend of October 22-24, and see what conference room availability they have, if we can use that for the auction and how much it costs.
- Dan will contact dealers who don't like Sharpless to see if they will return to Expo for October dates at Orr Building.
- Admission charge: Loess Club made \$2,500 charging \$2 per adult and \$1 concessions, but need to get people to work the door.
- Tom will give Marv contact for the Orr Building. Marv will ask about policy for cancellation. Jim will send deposit.
- John will send out Digest addendum with update on the new date and place for Expo 2021.
- Sales tax at Northfield Hotel will be higher than at Fairground.
- Orr building is open at 7 a.m. until 5.00 or 6.00 p.m., have to be out before they lock the main Fairground Gates.

John moved that the 2021 Maps Expo should be held on the 22nd - 24th October 2021 at the Orr Building, Springfield, Illinois pending cost confirmation and further evaluation of pandemic. Chris seconded. Motion carried.

Jim has received return deposit from Sharpless for 2021.

General agreement to raise table prices (i.e., keep same price for shorter tables).

Advertising: Do the Fairgrounds have a sign? Would we be able to put road signs around? We could ask for sponsors.

John said the EXPO Digest is going okay and could take a couple more papers. The speaker and topic for 2022 must be ready to go for the Expo 2021 Digest.

Next meeting will be on Zoom on Wednesday 30th of December at 7:30 p.m.

Mid-America Paleontology Society Board Meeting Zoom 7:30 PM December 30, 2020

Present: Jim Preslicka, Tiffany Adrain (scribe), Doug Derosear, Dale Stout, Ed Wagner, Rick Poropat, Robert Rondinelli, Dan Cooper, Karl Stuekerjuergen, John Catalani, Tom Williams.

Marv brought the meeting to order at 7.40pm.

Member news: Jo Ann Goode passed away last week.

Marv introduced Ed Wagner who is familiar with the set up at the Orr Building, and Rick Poropat who represents fossil collectors in Saint Louis area.

Digest newsletter: John asked for a list of officers. Directors rolled forward so that Karl is director for 2023. Everyone else is the same as there was no election in 2020 due to the pandemic. John requested that everyone review the Digest addendum that he sent out. John has list of dealers to send registration materials to immediately and wants to send addendum right now. Please send any dealer emails you know to John so he can send out information to anyone who might want to come to Springfield looking for new dealers and ones who have stopped coming.

Future Expo dates: Discussion about whether Expo should be held in October permanently. Could ask dealers about date on addendum. Dan said he would check with dealers, but any date could have a conflict and he has no objections to October. Spring has many conflicts (Easter, Mother's Day); the Cincinnati show is always the week before Mother's Day so would clash with Expo in 2022. Dealers are just collecting and preparing material in the Spring whereas there is usually good material available in the Fall. The Loess Club show is always the first full weekend of October (1 -2 October in 2022); third weekend of the month is the Fort Wayne/IN show. If MAPS Expo stays around October 22- 2022 same weekend or 14 to 16 October, we can lock in booking for the Orr Building for five years.

John motioned to change the Expo date permanently to October. Tom seconded. Motion carried. John will add announcement that the MAPS Board has approved future Expos to be in October at the Orr Building on the Expo registration form to be sent out in May.

Expo 2021:

- Marv asked Ed about concessions and the cleanup crew (he has a list of vendors available from the Fairgrounds). Ed said the Loess Club might be interested in doing concessions and will put together a menu and price list. All About Cleaning does the Loess Club show clean up for \$600 (includes table breakdown, putting away chairs, and general cleaning).
- MAPS will have a contract for the Orr Building and pay a deposit of 1/3 of the cost. Tom will organize the contract by the first week in January and let Jim know how much to make the check out for.
- Tom said make sure Paleo Prospectors and other donors of auction items know we are a 501c(3) organization now.
- Tables First three 6ft tables are \$30 each, additional tables (maximum of 6 total) are \$40 each. Tables are included in cost of Orr Building so we don't need to charge extra for tables on Thursday. The doors of the building can be opened for trucks to drive in and unload.
- Wi-Fi at the Orr Building is good, there are electrical outlets on walls and pillars and parking is free.
- Admission and activities: Admission will be free on Sunday. Loess Club charges \$2.00 per adult, \$1.00 for seniors and kids under 12, and usually raise about \$2,600 from 2200 people. Signs can be put up to direct visitors to the right entrance to pay. Hourly door prizes will require extra helpers. There is a sound system in the building. Loess Club hires someone with a wireless microphone setup to interface with it. Need to identify space and provide a screen for programs. Rick said it's possible to get help from the St Louis/Mo club.
- Sales tax: Sale tax in fairgrounds is 6.25%. There's a simple event form available for anyone without an Illinois tax number. Can we put the out on the dealers' tables? Motel show will be 9.75% tax.
- Northfield Motel: Dan looked at prices. Friday night conference room (6800 ft) use is free with 30 guests. MAPS needs a room for Saturday night for live auction for up to 100 people. Dan will check motel availability for October 2022 onwards. Dan said October 20th to 24th, 2021 there are 50-60 rooms available at ground level. Block room rate for dealers is \$92-\$99 block for dealers. Dan will ask about a MAPS block rate but the price is reasonable anyway. A room will need to be reserved for the Keynote Speaker.
- John will send Rick and Dan a copy of the preliminary Digest and send out to the dealer list by the end of next week, mentioning that dealers can drive into the building to set up
- Ed will send CAD drawing of Orr Building to Marv.
- Tom will talk to PRI
- Advertising: Marv will ask about using advertising signage at the Fairgrounds. The Illinois Times is a weekly freebie paper with a Fall guide that comes out in August. Most of advertising is social media, e.g., Facebook, and local school systems which can distribute about 10,000 flyers electronically. Loess Club has contact person (Mary) who does that for the school system. TV networks: Channel 20's Friday night news, WAND TV. Dan and Ed recommend collecting emails on the door and doing a mass mailing (they physically mail out their flyers) for the next year.

John needs articles for April-May Digest. Marv has asked Sharon Sonnleitner to create a directions map for the Orr Building and the motel for that issue.

Tiffany will invite colleagues to give a talk at upcoming meetings.

John proposed to adjourn the meeting, Dale seconded, meeting adjourned c. 9.00 pm.

An Unusual Mixture of Artiodactyl Bones from the Early Oligocene

Bill Morgan

We recently collected a group of Oligocene-age mammalian bones from an exposure of the Orella Member of the Brule Formation. The fragile, partially surface-exposed bones were collected within a block of supporting matrix and incorporated into a protective plaster cast. Since no additional bones were observed outside the matrix block, it is assumed all the bones at the site were collected.

Later, when the cast was opened, additional, weathered, mostly fragmented, and incomplete bones were also found buried within the matrix block. Unexpectedly, they include bones of least three different mammalian species all of which belong to the Order Artiodactyla.

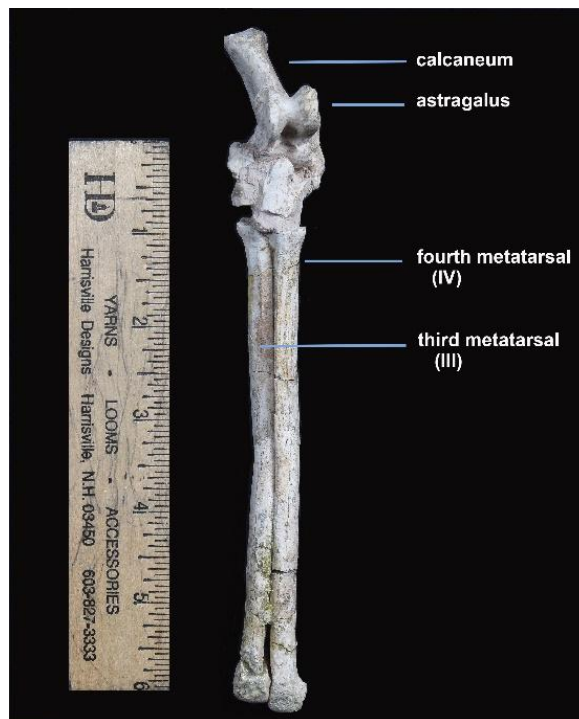


Figure 1

Many of the bones belong to an Oligocene-age camel *Poebrotherium wilsoni*, the most abundant camel found in the Oligocene (Prothero, 1996). The best evidence supporting this conclusion is provided by a partially articulated left hind foot (Figure 1) which has only two functional metatarsals, i.e., the third (III) and fourth (IV) (Prothero, 1996). This feature is not only a major characteristic of the Artiodactyla, but also primitive camels such as *Poebrotherium* are among the first artiodactyl species to manifest this trait (Carroll, 1988).

A close up of the foot (Figure 2) shows that both metatarsals are articulated with their anatomically correct tarsal bones, e.g., metatarsal III is articulated with the cuneiform, and metatarsal IV is articulated with the cuboid (Scott, 1940). Both metatarsals are robust, of extended length, and separate along their lengths further supporting the conclusion that the hind foot bone belongs to *Poebrotherium wilsoni*.

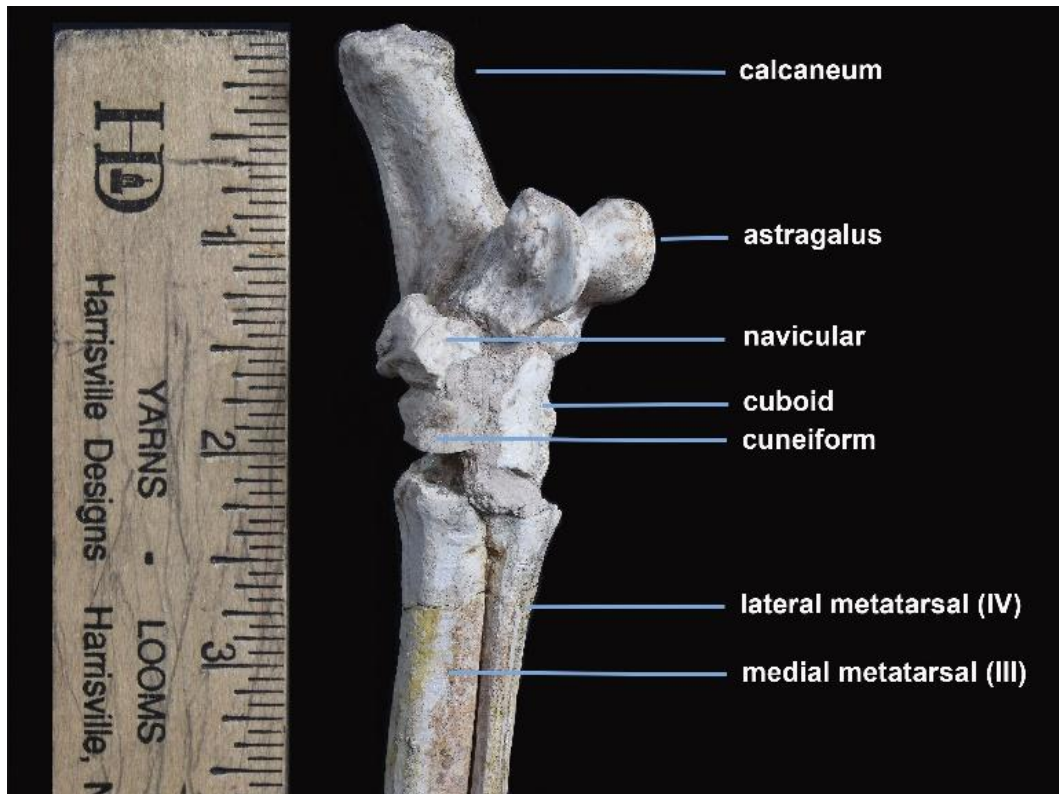


Figure 2

Leptomeryx, a primitive Oligocene-age deer, also has only two functional metatarsals (Scott, 1940). On the other hand, *Leptomeryx*, as well as other ruminants of the Oligocene, characteristically have navicular and cuboid tarsal bones which are fused while these same two bones in *Poebrotherium wilsoni* are separate (Carroll, 1988) (Webb and Taylor, 1980). The clear separation of the navicular and cuboid tarsals in the hind foot in Figure 2 further supports the decision that it belongs to *Poebrotherium wilsoni*.

The matrix also yielded two sets of weathered, partial mandibles (Figure 3). Although incomplete, each set includes parts of both the right R and left L rami. The figure shows all of the rami in a lateral view, and all the teeth are labeled in the right ramus of each mandible.

The rami of the mandible immediately adjacent to the size marker (Figure 3) are attributed to *Poebrotherium wilsoni*. Among the distinguishing characteristics (Scott, 1891), are the comparatively large, long, and narrow rami, and the presence of selenodont premolar and molar teeth as defined by Ungar (2010).

Two premolars P3 and P4 are preserved on the left mandibular ramus but only P4 is present in the right ramus (Figure 3). The second premolar is not preserved in either ramus. The premolars are slender, long antero-posteriorly, and roughly the same height as the first molar (M1). They also have sharp slightly anteriorly deviating cusps.

The molars are tall, especially the second (M2) and third (M3) (Figure 3), and all three molars have deep enfoldings which divide them into separate lophs. M1 and M2 have two and M3 has three lophs.

Although detached, the anterior-most end of the right ramus is preserved along with the first premolar (P1) and canine (C) and the third incisor (Figure 3). The first premolar is peg-like while the canine is

closely associated with the third incisor (Prothero, 1996). The space or diastema which separates P1 from both C and the more distal premolars is a defining feature of *Poebrotherium wilsoni* (Scott, 1891) (Prothero, 1996).

The particularly small, narrow, slender rami strongly suggest that the second mandible belongs to *Leptomeryx evansi*. Seven species are reported in the literature, but only *Leptomeryx evansi* is believed to be present in the Orella (Heaton and Emry, 1996). Each ramus has three preserved premolars (P2-P4) and three molars (M1-M3). It is interesting that the preservation of these same teeth is found in the majority of the mandibles of *Leptomeryx evansi* that are collected while P1 is rarely seen (Heaton and Emry, 1996).

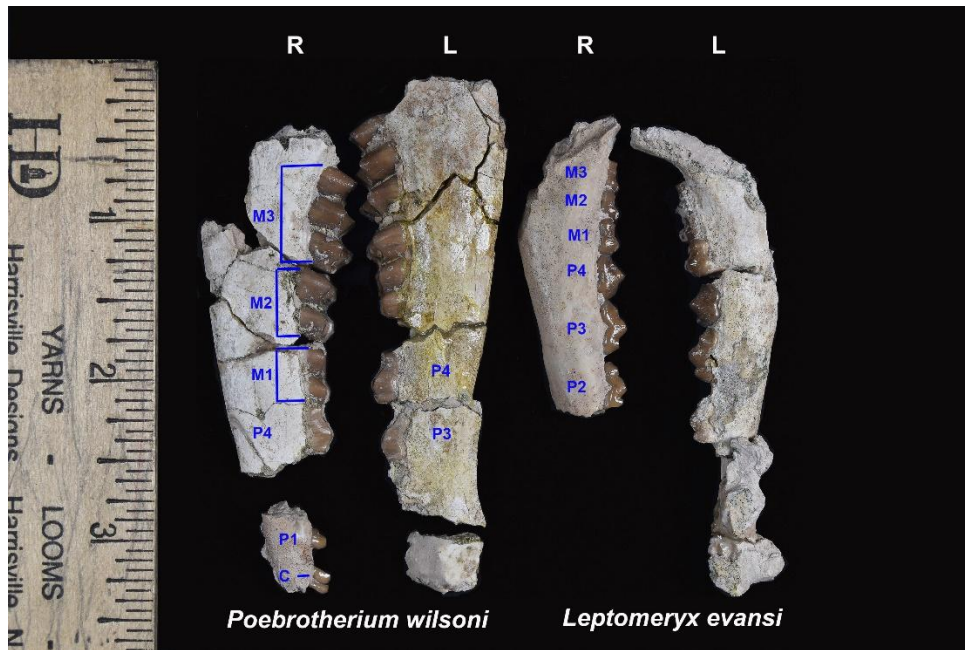


Figure 3

The premolars are long and slender and have three pointed cusps with the middle cusp being the most prominent (Figure 3). As described by Webb and Taylor (1980), the molars are selenodont but very small, comparatively broad, and with short brachydont crowns.

Two femurs were also recovered (Figure 4). The femoral heads are of similar size and morphologically mirror images, which strongly suggests that they are from the same animal.

Only the head of the right femur is preserved. Although the left femur is weathered, the femur head, shaft, and the medial and lateral condyles which articulate with the tibia are preserved (Figure 4). The shaft is broken; and the broken ends are eroded. As a result, the ends do not fit together, and the true length of the shaft cannot be accurately ascertained. However, when the two broken ends are roughly aligned, the femur is at least 203 millimeters in length. This length and the long and slender morphology of the femoral shaft suggests that the left femur, as with most of the bones in this collection, belongs to *Poebrotherium wilsoni*.

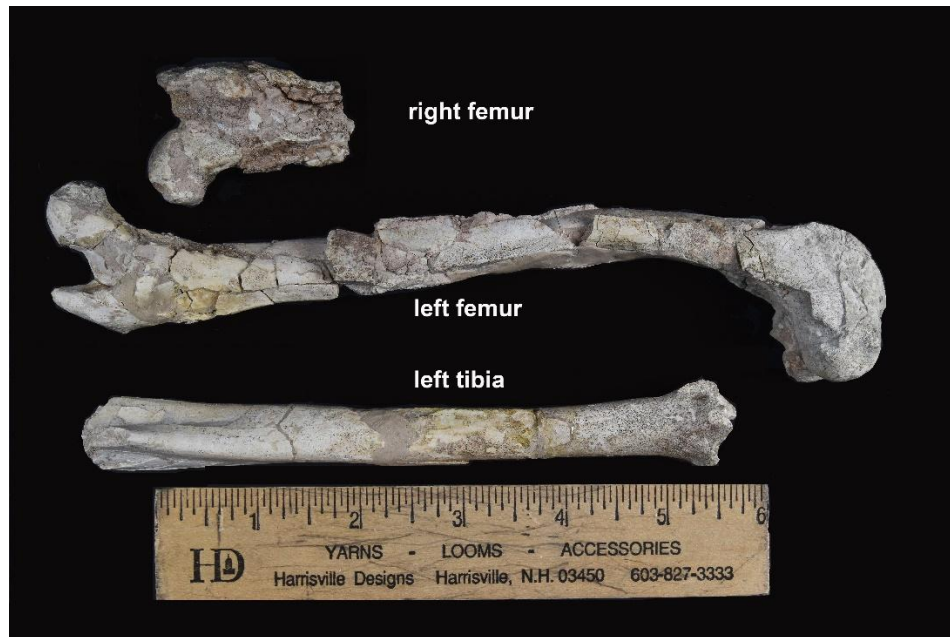


Figure 4

The left tibia is straight and slender (Figure 4). The bone is 88 mm in length but in life would have been significantly longer as much of the proximal end is totally eroded away. Fortunately, the inferior or malleolar region of the tibia is preserved, and the near perfect articulation of this end with the astragalus of the hind limb (Figure 1) supports the conclusion that the tibia belongs to *Poebrotherium wilsoni*.

The proximal ends of the radius and ulna of a right forelimb were also found (Figure 5). Neither bone is complete as the distal ends of both are weathered away. The ulna is 150 mm in length and the radius is 124 mm long. Although they are not physically fused, the ulna and the radius align very tightly with one another such that no intervening interosseous space is evident. This intimate relationship along the length of the two shafts is characteristic of *Poebrotherium wilsoni* (Scott, 1891).

The ulna includes the olecranon process which with the head of the radius forms the articulation site with the humerus, the single upper bone of the forelimb. Distal to its articulation with the radius, the shaft of the ulna becomes progressively more flattened with a more laterally facing surface (Figure 5), a feature previously described in the literature (Scott, 1891). The effect is to produce a widening groove on the lateral surface of the ulna. As result, at its broken end the ulna is 16 mm wide but only 5 mm thick.

The head of the radius is largest at its proximal end, 26.7 mm X 14.1 mm, and its shaft becomes smaller and more oval shaped, 13.5 mm X 11.6 mm, at its broken distal end.

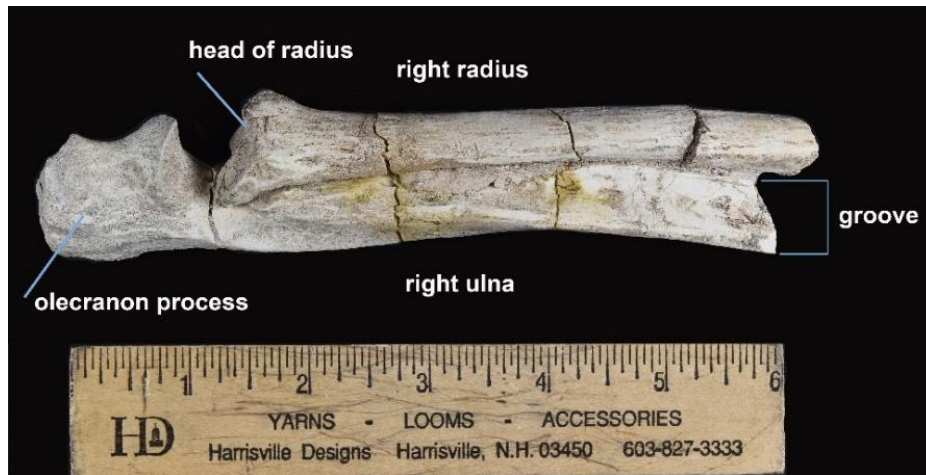


Figure 5

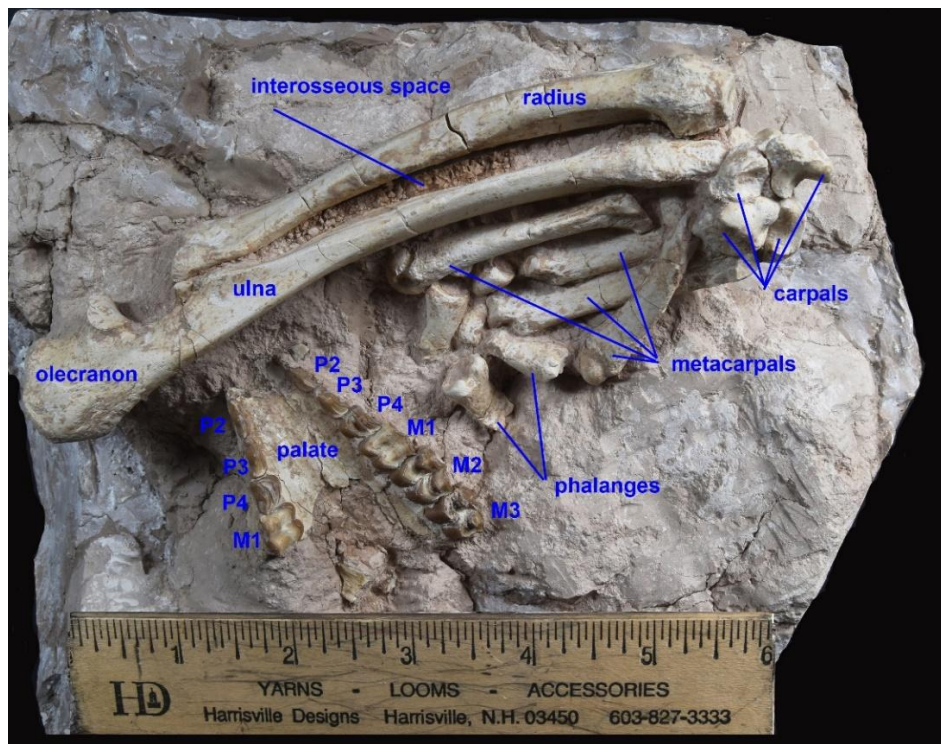


Figure 6

The deepest part of the matrix yielded a large group of bones with characteristics clearly suggesting that they belong to yet a third species. The bones include an intact and articulated ulna and radius whose shafts, unlike those attributed to *Poebrotherium wilsoni* (Figure 5), are separated by an intervening clearly visible interosseous space (Figure 6). Although they are not a distinguishing feature, there are also number of carpal or wrist bones located at the distal end of the radius and ulna.

Another distinguishing feature of the bones seen in Figure 6 is the presence of 4 metacarpal bones while *Poebrotherium* species have only two (Scott, 1891). In addition, the metacarpal bones are short; the lengths of the 3 most easily measurable in the figure are 44, 57 and 70 mm, respectively. By comparison, the metacarpals of *Poebrotherium wilsoni* are long, more than eighty percent the length of the metatarsals (Prothero, 1996).

Since it is very unlikely that the limb bones belong to *Poebrotherium* and they are much too large to belong to *Leptomeryx*, to what species do they belong? Based on another specimen in the author's collection, it is likely that the limb bones belong to *Merycoidodon culbertsoni*, a common species found in the Orella.

The inverted partial skull buried in the matrix (Figure 6) consists of the right and left maxillary bones. Although they are very weathered and the anterior regions are missing, some of the hard palate and the right and left dentaries are preserved *in situ*. The partial left dentary includes all 3 molars (M1, M2, M3) and 3 of 4 premolars (P2, P3, P4) while the right dentary retains only M1 and P2, P3, and P4.

The teeth are much too small to belong to *Merycoidodon culbertsoni* and much too large to belong to *Leptomeryx evansi*. On the other hand, the teeth are all selenodont and the molars are low crowned brachydonts, which suggests that the partial skull belongs to *Poebrotherium wilsoni* (Scott, 1891). This conclusion is further supported by the close interdigitation of these teeth with those of the respective right and left rami of the *Poebrotherium* mandible shown in Figure 3.

It is highly unusual to find remains of three separate species within a relatively small block of matrix. This, plus the relatively poorly preservation and fragmentation of many of the bones, suggests that the species were originally separate from one another and were subsequently redeposited together, perhaps secondarily to rainwater runoff. Alternatively, they may be part of the refuse collected in a predator's den.

References

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Feathers, Wings, and the Temporal Paradox

John A. Catalani

I really love collecting fossils (surprise, surprise). To me, working in the field is one of the major attractions of paleontology. All aspects of paleontology are important but it all begins in the field collecting specimens. Therefore, I am always on the alert for reports in the literature of any fossil discoveries that not only stand on their own merits as spectacular finds but also provide significant information on how life evolved on Earth. Additionally, new technologies and investigative techniques are allowing researchers to amass even more information from fossil specimens--data that aid paleontologists in their quest to understand how these animals lived their daily lives. We must always remember that the inanimate fossils we collect were once living creatures subject, just as present day organisms are, to the vagaries and vicissitudes of the natural world--a process that shaped the complex behavior needed to interact with their environments. And by placing each organism of a fossil assemblage in its behavioral and environmental context, paleontologists are able to recreate the ecosystem in which these creatures lived.

In recent years one of the most contentious debates in vertebrate paleontology has been the hypothesis that birds evolved from theropod dinosaurs. As we all know, *Archaeopteryx* is one of the most iconic fossils ever discovered. Although not on a direct line to modern birds (often referred to as avian dinosaurs), it was and is the earliest theropod/bird so far recognized that was capable of powered flight, albeit flight with limited proficiency. It also displayed features of both birds (asymmetrical flight feathers) and dinosaurs (toothed jaws and bony tail). Unfortunately, the age of *Archaeopteryx* also presented paleontologists with a bit of a conundrum--no feathered theropod dinosaurs, the group from which birds supposedly evolved, had ever been discovered that were *older* than *Archaeopteryx*. This situation even had its own catch phrase--“temporal paradox” (ok, so scientific catch phrases take a bit of getting used to). Temporal paradox was a central argument to those not accepting the theropod origin of birds--birds, in the form of *Archaeopteryx*, appeared *before* the feathered dinosaurs that were supposed to be their ancestors. This was, however, a false and negative assumption and a prime example of that old maxim “absence of evidence is not evidence of absence”. You see, at the time, the vast majority of feathered non-avian theropods (along with some early birds) had been discovered in the rocks of the Jehol Group located in Liaoning Province, northeast China, and all were Early Cretaceous in age--millions of years *younger* than the Jurassic aged *Archaeopteryx*. This paradox, however, reflected several factors of the fossil record and the Jehol deposits. First, the fossil record is frustratingly incomplete, something every paleontologist must accept and deal with. Second, the fossils of the Jehol Group reflect the verdant environment in which the animals lived and the low-energy lake deposit setting in which the animals were incorporated into the sediments. These factors favorably conspired to provide paleontologists with abundant and spectacularly complete fossil animals in which even integumentary structures such as feathers and fur were preserved.

Then in late 2009 this conundrum was resolved. A paper was published that described the first feathered pre-*Archaeopteryx* non-avian theropod fossil and pretty much put an end to any remaining doubt that birds descended from theropod dinosaurs. Dongyu Hu and colleagues reported in *Nature* that a fully-feathered pre-*Archaeopteryx* theropod had been found in 151-161 million year old rocks of the Tiaojishan Formation from western Liaoning Province, China. Actually, the crow-sized creature, named *Anchiornis huxleyi*, had been previously described from a poorly preserved, incomplete skeleton in early 2009. The newly discovered specimen is, however, nearly complete and displays an extensive covering of feathers. As stated above, most of the rocks and superbly preserved fossils of Liaoning Province are Early Cretaceous in age. *Anchiornis huxleyi*, however, comes from rocks of the Late Jurassic Period. These rocks have been dated at between 161 and 151 million years--25 to 35 million years *older* than the Early

Cretaceous feathered dinosaurs and, most importantly, older than *Archaeopteryx*, which is found in rocks no older (and probably a bit younger) than 150 million years. (Since then, a second, *Archaeopteryx*-size non-avian theropod, *Xiaotingia zhengi*, has been discovered in the same Formation as *Anchiornis* and described by Xing Xu and colleagues.)

Anchiornis has been described as being “profusely feathered” with a variety of feather types. The larger, body contour and wing feathers (two types of filamentous feathers are also present) were well-formed with a central shaft (rachis) and branching vanes, referred to as pennaceous feathers. However, these vanes were symmetrically arranged about the central shaft and were, therefore, not flight feathers. True flight feathers on extinct and extant birds are asymmetrical allowing for a rotation of the feather during power strokes of the wings. Although *Anchiornis* could not fly there would be nothing preventing the animal from gliding.

But, in my opinion, the most interesting characteristic of *Anchiornis*, aside from the obviously impressive array of body feathers, of course, is the presence of feathers on the legs and feet--*Anchiornis* had four “wings”. The presence of theropods with feathers on all four limbs has been encountered before most notably with *Microraptor gui* (Early Cretaceous, Liaoning Province). The authors of the *Anchiornis* paper posit that four wings may have been an essential first step in the evolution of flight-capable feathers, wings, and powered flight. They cite that a four-winged configuration is present in “at least one basal member of each of the three major paravian groups”--*Microraptor* in the dromaeosaurid lineage, *Anchiornis* in the troodontid lineage, and *Pedopenna* in the avian lineage that led to true birds. Additionally, as one might expect, the hind wings of the more derived *Microraptor* were aerodynamically more efficient than those of *Anchiornis*. From this initial four-wing design, true two-winged flying birds evolved by a continued development of forelimb feathers coupled with a simultaneous reduction of hind limb feathers. (As an aside, early photos and drawings of *Archaeopteryx* show leg feathers that were, unfortunately, removed during extensive preparation.)

So why are there so many feathered dinosaurs alive and kicking in the Early Cretaceous *after* the appearance of the first bird and so few before the appearance of *Archaeopteryx*? Aside from the incompleteness of the fossil record and the unusually abundant and well-preserved fossils of the Jehol Group described above, there are two (probably more but these are my favorites) possibilities that I will comment on. One is that the phylogenetic lines, some including non-avian feathered dinosaurs that could not fly and some including members of the avian lineage, simply continued into the Cretaceous with subsequent branching that produced new forms. This would easily explain the co-occurrence of avian and non-avian dinosaurs. Another possibility has been suggested several times in the past. This scenario considers these flightless feathered dinosaurs true birds that were descended from *flying* birds but that had simply lost the ability to fly (similar to ostriches and emus today). The first described example of lost flight ability involved the feathered dinosaur *Caudipteryx*. In a lovely example of creative speculation, Terry Jones (not the one from Monty Python) and his colleagues compared various characteristics of *Caudipteryx* to those of true theropod dinosaurs and extant cursorial (ground-dwelling/flightless) birds. The evidence pointed to a closer relationship between *Caudipteryx* and cursorial birds than between *Caudipteryx* and theropods. The authors then speculated that *Caudipteryx* was a Cretaceous cursorial bird derived from an earlier bird ancestor that possessed flight--in other words, *Caudipteryx* was a true bird secondarily adapted to cursoriality. Although this possibility has been challenged, the idea endures not only as an exceptional example of creative speculation but also as a still-viable reason why there were so many non-flying feathered theropods/birds living in the Early Cretaceous alongside flying birds.

Now that almost everyone accepts the assertion that birds evolved from theropod dinosaurs, particularly after the discovery and analysis of *Anchiornis*, one of the most controversial questions yet to be resolved in bird evolution is, what function did feathers originally serve? Feathers must have given

early non-avian theropods some type of competitive advantage to offset the unwieldiness of the added bulk to relatively small animals. Fossil evidence has revealed that a variety of primitive, non-flight feathers (filaments, down-like, symmetrical, etc.) appeared on non-avian dinosaurs long before flight feathers developed, which makes perfect sense since asymmetrical flight feathers are very specific in construction. Therefore, it is a certainty that feathers originally evolved to serve some purpose other than flight and were only later co-opted for flight. Two functions for primitive feathers immediately come to mind: display and insulation. Other examples of feathered dinosaurs display elongate tail feathers only on, presumably, males and were, again presumably, used in courtship displays similar to the long tail feathers on males of the genus *Confuciusornis*, an Early Cretaceous flying bird.

Recently, in a study of the feathers of *Anchiornis huxleyi*, Quanguo Li and colleagues tested the wing and contour feathers of *Anchiornis* by utilizing the extreme magnification of a scanning electron microscope to identify several types of melanosomes--pigment-bearing protein-based organelles that contain melanin and contribute, as do other compounds, to the color in the feathers of modern birds. The authors concluded that *Anchiornis* was boldly colored with grey to black body contour feathers, white and black mottled wing feathers resulting in striped wings, and grey feathers on the sides of the head crest framing a hind-crown of longer reddish-orange feathers. The conclusion was that feathers probably evolved for display in attracting mates and repelling rivals rather than for insulation, although, certainly, insulation must have turned out to be a bonus for early small-bodied, fully-feathered endothermic theropods.

This illustrates that continued field work to uncover new specimens and state-of-the-art technology to analyze fossil specimens, along with creative speculation, can provide us with a glimpse of these fascinating non-avian feathered dinosaurs and early birds not just as significant fossils but as vibrantly colored, living animals that displayed instinctive behaviors not that much different than today's animals. And this is the hallmark of our science--the merging of old-fashioned field work and new technologies to reveal a long-dead world complete with ecosystems every bit as complex and fascinating as those in place today.

Further Reading

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