THE BRODIE CLUB

ROYAL ONTARIO MUSEUM OF ZOOLOGY

THE 1,048th MEETING OF THE BRODIE CLUB

The 1,048th meeting of the Brodie Club was held at 7:30 pm on Tuesday, May 3, 2011 in Room 432 of the Ramsay Wright Laboratories of the University of Toronto.

Chair: Bill Crins
Secretary: R. Addison/Seymour

The meeting was attended by 24; 21 members and 3 guests.

Roll Call:
Present: E. Addison, R. Addison, Bertin, Bodsworth, Boswell, Crins, Dunn, Eadie, A. Falls, B. Falls, D. Hussell, J. Hussell, Iron, A. Juhola, H. Juhola, Machin, Pittaway, J. Rising, Seymour, Speakman, Tasker.

Regrets: Abraham, J. Bendell, Y. Bendell, Bousfield, Currie, Gray, Larsen, Lumsden, N. Martin, N. Martin, McAndrews, Reading, T. Rising, Strickland, Sutherland, Tomlinson.

Guests: Sachi Schott, guest of D. Hussell; Guy Duval of Joliette Quebec, and Paola Cisneros, San Marco Univ., Lima, Peru, who is moving to Dalhousie to start an MSc on anchovies, guests of Oliver Bertin.

Minutes: Please correct the date in the minutes of meeting 1,047. It was recorded as February 15, 2011 and should be changed to April 19, 2011. Minutes were moved for approval by Jim Rising and seconded by Ed Addison.

Announcements and New Business

- Jean Iron inquired if the club should follow up on the proposal made by Locke Rowe at the last meeting. Bruce Falls suggested that there is not a rush and that we form a subcommittee in the fall to pursue the direction the club may take.

- Jean Iron reminded members that the annual Field Trip and Picnic will not take place in June, but will be September 10 and 11. Members will be contacted by e-mail during the summer re plans to attend. The Outing Committee is made up of George Bryant, Jean Iron and Trudy Rising.

- Ricky Dunn commented that she was a "committee of one" to gather member bios and will be getting started on that.

- Bruce Falls announced that September 20, 2011 will be the traditional members' night. Members are reminded that this is an opportunity to share some "bits of natural history" with other club members. The October meeting will be held October 18. The speaker will be Jeremy MacNeil from University of Western Ontario. His topic is Lepidoptera Migration in Response to Habitat Change.

SPEAKER

The guest speaker, Kevin Seymour, is a member of the BRODIE Club. Kevin was introduced by Bruce Falls.

B.Sc. in Biology/Geology, Queen's University, 1980.
M.Sc., Geology, University of Toronto, 1983
Ph.D., Zoology, University of Toronto, 1999

"Kevin is an Assistant Curator in Vertebrate Paleontology and is Collections Manager for the ROM's famous collection of fossil vertebrates.

Born and raised in Ottawa, Kevin has worked at the ROM since 1983, and completed his Ph.D. while working at the Museum. His dissertation research examined the South American small cats (taxonomy, morphology, palaeontology) to better understand the evolutionary relationships of this group. He has done fieldwork collecting fossil vertebrates in Canada, the United States and Mexico.

Kevin's research interests include the Quaternary faunas of eastern North America, especially Ontario, and the evolution of the North and South American cats. He was coordinating curator for the new Reed Gallery of the Age of Mammals, and was also heavily involved in the planning for the new James and Louise Temerty Galleries of the Age of Dinosaurs." (from the ROM website)

"What the Fossil Record tells us about the Evolution of Flight and Ecolocation in Bats."

Bats are unique amongst mammals because they fly and echolocate (use sound to find their prey). The origin of bats has long been a mystery. Even though the fossil record of bats stretches back over 50 million years, it has been of little help in elucidating the origin of bats, because even the earliest complete fossil bats known are essentially modern in structure. It had been demonstrated on skull morphology that already described Eocene fossil bats from Germany and Wyoming could echolocate. Stomach contents of some of the well-preserved German fossil bats showed that they were eating nocturnal flying prey such as moths or beetles. So in the evolution of bats, which came first, flight or echolocation, or did they evolve hand-in-hand? There was much speculation but no data.

Kevin and his colleagues published a paper in Nature (including the front cover) on February 14, 2008, which changed all that. This paper announced the discovery of the world's most primitive fossil bat, *Onychonycteris finneyi* (which means Finney's clawed bat), one that showed that bats gained the ability to fly **before** they gained the ability to echolocate.

The first example of this species was excavated from the Green River Formation in Wyoming some years ago, and had been sold into private hands (where it remains). The dealer, who excavated, prepared and sold the original, also molded the fossil before he sold it, allowing him to sell casts of this fossil. Kevin purchased one of these casts for the ROM gallery (where it is today), but knew that it was important to science and as yet undescribed, so he tried to locate the current owner of the original, to no avail. According to international rules of nomenclature, without a real specimen in a recognized repository, this new kind of fossil bat could not be described (i.e. based on just a cast). The next route then was to hope a second individual of this extinct species might be excavated, and to obtain it for the ROM. Kevin attended the annual rock, mineral and fossil show in Tucson, Arizona several years in a row and talked to all the dealers who excavated quarries in the Green River Formation. This approach paid off when he got a call from Bonny Finney of the Fossil Lake Fish Company. She thought she had excavated the second individual of this species… and she was correct. Kevin ended up naming the fossil after her, because she did several important things: she recognized it for what it was on only a small portion of exposed wing; she offered this fossil for sale to the ROM only, and waited while Kevin applied for and got a grant to purchase it; she x-rayed it at a local hospital to demonstrate it was all in the rock; and she resisted preparing it, so the preparation could be done at the ROM. A grant from the Louise Hawley Stone Charitable Trust at the ROM provided the funds to purchase this extraordinary fossil.

The fossil was ably prepared by ROM technician Ian Morrison. It had all the features of a flying bat: elongated finger bones, flattened and expanded rib cage, a faceted scapula, robust clavicle, keeled sternum and even a calcar (a cartilaginous spur on the heel that supports the membrane between the hind leg and tail), a suite of features only possessed by bats within the Mammalia. It differed, however, in other features: it had claws on all five fingers, it had strange limb proportions (relatively long hind limbs and relatively short forelimbs- unlike any living mammal), features not found in any living bats. As well, the well-preserved underside of the skull showed that it **lacked** three key features that all living echolocating bats possess today: an enlarged cochlea (important for receiving the echolocation signals), an enlarged region on one of the inner ear bones, the malleus (called the orbicular apophysis, also thought to be important for receiving signals), and an expanded and flattened tip on one of the throat bones, called the stylohyal (which aids a bat in making vocalizations). A fourth feature also lacking in this fossil but present in all echolocating bats was demonstrated by Veselka et al. in 2010: an articulation of the stylohyal bone with the tympanic part of the cochlea.

Veselka et al. (2010) also challenged the view that *Onychonycteris* could not echolocate. They showed the importance of the conformation of the stylohyal in living echolocating bats. In response, Kevin and his colleagues then re-surveyed several genera from every family of extant bats, and demonstrated that the articulation of the stylohyal with the tympanic always occurs with the expanded and flattened tip of the same bone, thereby showing that this suite of features was actually one character. Either a bat has all the four features and echolocates, or it has none of the features and it does not echolocate. Although on one side of the *Onychonycteris* fossil, the stylohyal bone appears to be lying on the tympanic in about the correct position, it is preserved in a different position on the other side of the skull. Kevin and his colleagues maintain that the position of the stylohyal is due to the vagaries of fossil preservation, and neither position may have been its real position in life. In any case, the stylohyal of *Onychonycteris* lacks the expanded and flattened tip, and a true articulation with the tympanic. They maintain that the best supported hypothesis based on all available evidence is still that *Onychonycteris* could not echolocate.

A phylogenetic analysis showed that *Onychonycteris* was at the base of the bat radiation, as the most primitive bat, and since it could fly and not echolocate, then this was the primitive condition for bats. Most morphological data suggests the bat ancestor came from within the group containing primates, tree shrews and gliding lemurs. Most (but not all) molecular data suggests the bat ancestor came from within the group containing the ungulates, carnivores and insectivores. At this point, the ancestor of bats is still unknown.

One interesting implication of this phylogenetic tree is that if it is correct, then the non-echolocating fruit bats of present-day tropical areas must have had echolocation but subsequently lost it during evolution. Echolocation is physiologically expensive, so by discarding this, it probably allowed fruit bats to gain larger body size. If they were going to successfully forage off fruit year-round, they would need to be living in tropical areas. Today all fruit bats are large and live only in tropical areas.

What could we guess a bat was doing that had claws on all its fingers, could fly, but not echolocate? We might guess that it was a diurnal rather than a nocturnal feeder. It may have flown between trees, and then used its clawed fingers to assist in clambering up tree trunks to glean insects. It may have used its clawed forelimbs to aid in roosting, rather than using the hind limbs that many bats use today to hang upside down.

Kevin has provided the following references:

- Seymour, K. 2008. Batting order. ROM Magazine 41(3): 24-29.
- Simmons, N.B., K.L. Seymour, J. Habersetzer and G.F. Gunnell. 2008. Primitive Early Eocene bat from Wyoming and the evolution of flight and echolocation. Nature 451:818-821.
- Veselka, N. et al. 2010. A bony connection signals laryngeal echolocation in bats. Nature 463: 939-942.
- Simmons, N.B., K.L. Seymour, J. Habersetzer and G.F. Gunnell. 2010. Inferring echolocation in ancient bats. Nature 466: E8-E9
- Veselka, N. et al. 2010. Reply to article above. Nature 466: E9.

QUESTIONS:

Q. R.Dunn: Would echolocation not intrinsically precede flight?
A: This was the latest accepted view in the literature before we studied this fossil. But this fossil shows us that the answer is no. So it would not necessarily need to happen that way- there is a ground shrew that uses tongue clicking.

Q. B. Falls: There are lots of birds that can catch insects without echolocation: could you not speculate that your bat could fly and use flight to catch insects without having to echolocate?
A: Yes, we can speculate. Perhaps they caught insects on the wing during the day. Perhaps flight and echolocation developed hand-in-hand or one may have developed before the other. All we can do is examine fossil evidence which might support one theory or the other. Studies on teeth have not been done yet; these may help us understand the possible diet of these earliest bats.

D. Hussell: Could these bats have been diurnal and evolved into nocturnal behaviour as they developed echolocation?
A. Yes… that is basically what we are proposing must have happened.

Eadie: Oilbirds are nocturnal fruit eaters. When they are flying you can hear a high clicking sound. Also, in the South Pacific Aitu Island there are Swiftlets that echolocate as soon as they come into cave; using echolocation for navigation.
A. In bats, echolocation is doing double duty: it is used both for food location and for navigation in caves or tight spaces. Whales use an adaptation of sound production for communication as well.

Q. E. Addison: Who was Louise Hawley Stone?
A. She was a Toronto millionaire with a great passion for Far Eastern antiquities. In her later life she bought and donated many items to the ROM. She bequeathed 100% of her estate to the ROM with the interest to be available to support purchases and publications. The interest is fanatastic for special purchases and was used to purchase this fossil bat.

Q. R. Dunn. What was the cost of "the bat"?
A. It was surprisingly little, and although I mentioned the price at the meeting, I don't think I should put that in print here. I had worked with the fossil finder several times and she knew I was looking for a 20-clawed bat. She later had other more lucrative offers, but kept to her original agreement with the ROM. Some dealers are less scrupulous.

Q. R. Dunn. What makes a fossil illegal?
A. Every country has its own rules and definitions; it is a political hot potato. In China and Argentina, fossils found are the property of the state and none are to leave the country. However, they will do exchanges between recognized institutions. In Morocco there are absolutely no rules and this encourages fossil trade. There is everything in between. In Alberta, a land owner needs a permit to collect fossils on his own land; in the USA, a fossil found on privately owned land belongs to the landowner.

Q. O. Bertin: When buying and selling fossils, are there problems with authentication?

A. There sometimes are. Caveat emptor! It depends on your knowledge and the dealers' knowledge. You come to know those dealers you can trust, just as in the art world!
Q. F. Bodsworth: Do there appear to be lower limits to size of prey that echolocation is capable of detecting?
A. Don't know… what they have in their stomach might give us some indication of that. Big pterosaurs are thought to have been primarily fish eaters, and some have been fossilized with fish in their gullet, but so far we don't have evidence for smaller pterosaurs. Some think these smallest sparrow-sized pterosaurs may have been eating insects. As with birds, assumedly little tiny bats would be eating smaller insects.

Q. P. Cisneros: Insects were found in stomach contents. If they had no echolocation and their flying skills were very limited, how did they catch their food?
A. We must assume they used smell or sight.
Is there any morphological evidence pointing either way?
There is little to go on. The eyes sockets on these fossil bats are squashed so orbit size, which might give us an indication of nocturnal or diurnal vision, can't be checked. This is a line of research to be followed in the future.
In living birds, eye orbit can be correlated to life style… is it applicable to fossil birds and reptiles?
Yes! Recent work on both fossil birds and fossil reptiles has shown this to be the case.

Q. J. Hussell: Echolating bats have muscles that" turn off their ears" when they ping. Is there any fossil evidence that would indicate this?
A. This is called self-deafening. It is a very neat system in living bats. It is primarily under muscle control, and so far we haven't found boney structures that correlate with this in the fossil bat.

Q. O. Bertin: Can you correlate dentition with echolocation? With insectivorous bats, molars look good; in fruit eating bats, incisors are often lost to form a tube for sucking.
A. Research hasn't been done on this yet. We hope in the future to study the dentition of *Onychonycteris* in order to gain just this sort of insight.

Jean Iron thanked Kevin on behalf of the club. She noted that his talk has opened up almost as may questions as answers, and commented on his lucid presentation and great visuals.
Kevin shared reprints of the article which appeared in Nature 14 February, 2008.

NOTES & OBSERVATIONS

B. Falls reported a woodchuck in his neighbor's yard and a Turkey Vulture on the neighbor's lawn.
J. Rising saw Siskins, Purple Finches, "the usual stuff" at his cottage but no warblers there yet.
E. Machin reported a Fox Sparrow.
R. Dunn noted some warblers at Long Point.
D. Hussell has a colleague with photos of what looks to be a hybrid Snow Bunting x Longspur.

J. Iron was at Carden alvar at dusk on Monday, May 2. She observed Yellow Rails and heard them tapping at 9 PM. They replied to the ticking sounds of two stones tapped together. Also observed was a male Least Bittern.
Juholas recently returned from Victoria, BC. *A. Juhola* reported they observed a heron with an eel in its beak flying over Oak Bay Marina. The eel was around the heron's beak and was consumed following a struggle of about 20 minutes.
F. Bodsworth noted that they are reporting about 80 species of birds per day down on Lake Erie and that there was a Spotted Towhee and a Harris' Sparrow there all winter.
B. Crins reported that *Don Sutherland* had located a Louisiana Water Thrush in Peterborough County and that it was still there three days later.
O. Bertin shared a copy of the Ontario Sailor Magazine, March 2011. An article titled "Beloved Charlie the swan dies in mishap" can be found on pages 38-39.

CORRESPONDENCE

oliver.bertin@utoronto.ca
Sun, May 15, 2011 at 11:08 AM
Subject; from Brodie 1018 !!!!
I just noticed this note in an ancient copy of the minutes....

- Kevin Seymour published a paper on early bats in Nature on Feb. 14. At last count, the story was picked up by 159 newspapers, television and radio stations, with a total audience of perhaps 100 million people. The publications included The Globe & Mail, the Toronto Star, The London Daily Telegraph, the Guardian, BBC, CBC (radio, television and internet), The Discovery Channel and, of course, Nature.

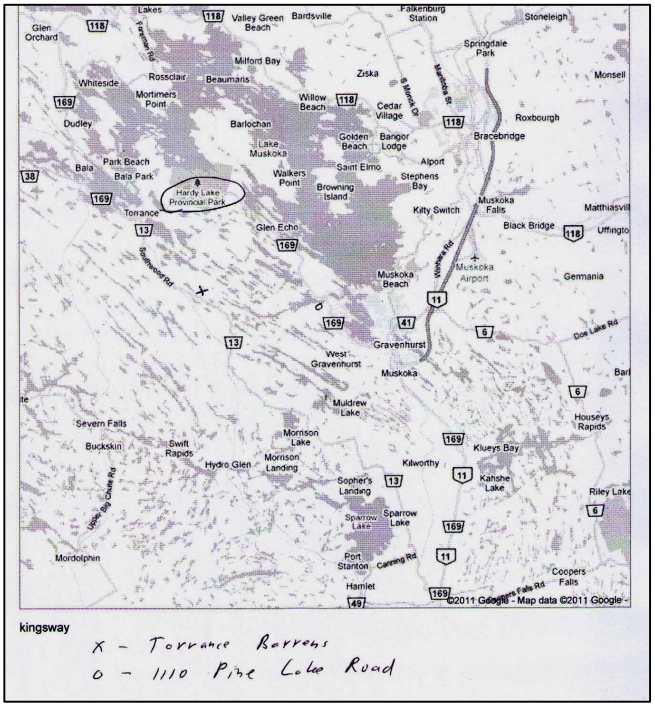
The meeting was adjourned at 9:10

NEXT MEETING

The next meeting will be held Tuesday, September, 20th at 7:30 pm in Room 432 of the Ramsay Wright Zoological Laboratories. It is the traditional "members' night".

2011 BRODIE CLUB PICNIC & FIELD TRIP

This year the BRODIE Club picnic and field trip takes a departure from the traditional date of mid- June. Instead it will take place on Sat. Sept.10 and Sun. Sept.11.
A map to the area and the original flyer from the Outing Committee of George Bryant, Jean Iron and Trudy Rising are provided for your information.
Members planning to stay overnight Friday and/or Saturday are encouraged to book accommodation early as there are several other major events in the area that weekend.
Members will be contacted in August to get an estimate of numbers.



2011 Brodie Club Outing

Torrance Barrens

Muskoka

Saturday/Sunday
10 and 11 September 2011

Meet Saturday at 10:30 a.m.

Torrance Barrens Conservation Reserve Parking lot
~8 km southwest of Torrance on Muskoka Road 13

Leader: George Bryant

Torrance Barrens are spectacular in fall with lots of colour and no bugs. Expect to see asters, goldenrods, shrubs and Atlantic Coastal plants. Butterflies, dragonflies, mammals, herptiles and birds will all still be evident. There are several trails, walking is easy — one does not have to walk far to see lots. Bring lunch and wear hiking boots.

Dinner Hosts

George and Stephanie Bryant invite all to dinner at their cottage on nearby Pine Lake

After Dinner Star Gazing

George and Stephanie's cottage is close to Torrance Barrens Dark Sky Reserve

Overnight Accommodations

Trudy and Jim Rising can accommodate several people at their cottage

Hotels and Motels in Gravenhurst

Sunday

George Bryant will lead a half day outing to nearby Hardy Lake (a "reserve" provincial park). We will take an excellent 2 km trail with interesting views and entirely different flora and fauna.

Getting there

Gravenhurst is ~150 km (1 ½ hrs) from junction of Hwy 400 and 401; Torrance Barrens parking lot ~25 km (1/2 hr) from Gravenhurst