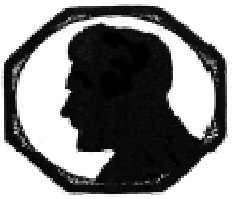
THE BRODIE CLUB



ROYAL ONTARIO MUSEUM OF ZOOLOGY

THE 996TH MEETING OF THE BRODIE CLUB

The 996th meeting of The Brodie Club was held on Oct. 18, 2005 in Rm. 432 of the Ramsay Wright Zoological Laboratories at the University of Toronto.

Chairman: Sandra Eadie
Secretary: Oliver Bertin
There were 23 members and 7.5 guests.

Rosemary, Emily and Pete Addison, Melissa Rose and Jeremy Hussell, guests of Ed Addison. Jeremy is the son of member David Hussell.

Reagan Johnson, wife and guest of Marc Johnson, and the future Johnson Jnr., who attended his first Brodie Club meeting

Shawn Doran, guest of Kevin Seymour

The minutes of the 995th meeting were approved with minor changes.

ELECTIONS:

The results of the annual elections were:

- FON Representative: Trudy Rising, replacing George Bryant who asked to step down due to his other commitments.
- Treasurer: Arnie Juhola agreed to continue.
- Secretary: Oliver Bertin agreed to continue. He thanked the many members — in particular Ed Addison, Trudy Rising and Michael Boyer — who have volunteered to take the minutes during his periodic crises.
- Archivist: Kevin Seymour agreed to join Sandra Eadie
- Membership: Kevin Seymour will join Ann Falls, George Bryant and JenniferYoung
- Program: Jim Rising will join Jock McAndrews, Bruce Falls, Hugh Currie, Fred Bodsworth and Marc Johnson
- Environment: There were no volunteers.

NEW BUSINESS:

Eadie said her committee is making great progress organizing the 1,000th anniversary meeting on Feb. 21, 2006 at the Faculty Club. There is a great speaker, oceanographer/geologist Steve Scott of U of T, and also a great location at the Faculty Club. But some more details still need to be arranged. She asked for volunteers who would be interested in helping out in some way, in particular someone who can organize

a photographer to take the celebratory group photographs for the archives with the appropriate lighting equipment. The anniversary committee includes Jennifer Young, Bruce Falls, Ann Falls, Kevin Seymour and Ed Addison.

Aarne Juhola sent regrets for not attending the meeting and asked Bertin to collect membership dues in his absence. A few members are still owing — $10 for members and $15 for families.

Bertin has only one address change since the last distribution of the membership list. Kevin Seymour has moved to 5 Warland Ave. Toronto, ON M4J 3E8. His home phone number is 416-429-8568. Work remains 416-586-5754 and kevins@rom.on.ca.

The next meeting will be held at 7:30 pm on Nov. 15 in Room 432 of the Ramsay Wright Zoological Laboratories at the University of Toronto. The speaker will be Prof. Paul Herbert, Canada Research Chair in Molecular Biodiversity at the University of Guelph. Over his career, Paul has served as Director of the Great Lakes Institute at Windsor, as Chair of the Department of Zoology at the University of Guelph, and as Chairman of the Huntsman Marine Science Centre in St. Andrews. He is currently Director of the Biodiversity Institute of Ontario and of the Canadian Barcode of Life Network. He has received varied national and international awards for his investigations in evolutionary biology. The latter research has led to the publication of more than 240 papers and to his election as a Fellow of the Royal Society of Canada.

MEMBERSHIP COMMITTEE:

We support Rosemary's application and feel she would be an asset to the Brodie Club.

Bruce Falls, Membership Committee

Application to become a member of the Brodie Club.
Submitted October, 2005
Rosemary Addison

I have hesitated to submit an application because my natural history knowledge is of a very general nature and the members of the club all seem so accomplished. However, I very much enjoy attending the meetings as a guest and find that I learn something every time. A plus of my becoming a member is that Ed will not have to report that he has a guest and Oliver will not need to record my name as such at each meeting!

Much of my understanding of nature has been by osmosis- learning from the knowledge of others and from natural history books.

My first mentor was my father — an Englishman who came to Canada during WW 2 and became enthralled by the beauty of the natural spaces. Dad took his growing family on picnics, hikes and camping. Because he was not brought up in Canada, Dad's knowledge of Canadian species was very limited, but he instilled in me a love of, and comfort with, the out-of-doors.

During these formative years, we always lived within earshot of the shores of Lake Huron — Bayfield, Goderich and Kincardine and that is my "home" landscape.

I was in the charter year of the new University of Guelph and graduated with an Honours B.Sc. in biology in 1969. For several summers, I worked as a research assistant. One summer, I assisted Dr. Walt Wilde in development of orchard habitats to marginalize the negative impacts of insect pests. For a number of years, I worked for Dr. Roy Anderson and his students, including Ed, first studying the biology of nematode parasites in skunks and snails and later trapping beaver and studying the nematode parasites in beaver, mosquitoes and

other biting arthropods at the Wildlife Research Station in Algonquin Park.

I took a teaching degree at OISE in Toronto and then spent one year as a technician in an electron microscope lab at the Ontario Veterinary College at Guelph.

The remaining part of my working career was in education. I began as a Phys. Ed and Science teacher at the high school level. Following that I was fortunate to work as a teacher at the Burlington Outdoor School.... a day programme for K-Grade 8 students in York Region. While there, I had the opportunity to work on a daily basis with young people in the outdoors and tried to open their eyes, ears, and senses of touch and smell to the wonders of nature. Many of the students would never have been in a woodlot or a field before.

After staying at home with a young family, I returned to teaching as a school librarian/ computer teacher for K-Grade 8 students.

I have a particular fondness for wild flowers and maintain a small corner of our garden for wild flowers.

It would be an honour to become a member of the Brodie Club.

Respectfully submitted,
Rosemary Addison

SPEAKER:

Member Kevin Seymour Assistant Curator in the Section of Palaeobiology, Department of Natural History, Royal Ontario Museum. He kindly offered to edit his talk for publication in the minutes.

SOUTH AMERICAN CATS
or
Morphological variation, phylogeny and possible ancestry of the South American small cats: Can the missing *Lynx* be identified?

The evolution of the cat family over the past 40 million years is known in broad outline, but the details of their relationships are quite sketchy. Cats are defined on skull characters, as their dentition and skeleton are relatively conservative. Virtually all living cats have the same teeth (some have lost a small upper premolar), and all have the same bones, although the lynxes have a short tail. Even limb proportions are surprisingly similar; exceptions are the cheetah (as a cursorial predator, it has elongated limbs), and the jaguar (as an ambush predator, it has shorter robust limbs). Most casts are intermediate in body proportions, such as the cougar.

So, how are fossil cats identified, if even the living species are so similar? And is morphological variation taken into account when choosing characters for phylogenetic analysis?

The living species are:

Leopardus jacobita: Andean Mountain cat, a rare, poorly known, high altitude specialist;
Leopardus wiedii: Margay, a smaller, spotted arboreal species;
Leopardus pardalis: Ocelot, the largest, best known species; the largest sample of this species is available in museums;
Oncifelis colocolo: Pampas cat, has variable pelage, some are spotted and some are not;
Oncifelis tigrina: Oncilla, superficially resembles margay; *(Ed: see diagram below. The illustrated Oncilla was 50 cm long with a 30 cm tail, weighing 2.25 kg)*

Oncifelis geoffroyi: Geoffroy's cat, flecked spots on a pale background;
Oncifelis guigna: Kodkod, similar to Geoffroy's cat but smaller and darker.
As outgroups:
Herpailurus yagouaround: Jaguarundi, a superficially weasel-like cat; although South American in distribution it appears to be more closely related to the cougar than the other SASC;
Felis catus: Domestic cat (old world heritage).

In order to study the variation in one group of living cats, a large sample of skulls of all 8 living species of the South American small cats (SASC) was studied. Forty cranial, mandibular and dental characters were scored on each of 1762 skulls. All characters mentioned in the literature (on fossil or recent cats) were used, plus some new characters. Characters were examined with three possible uses in mind:

for identification (ideally unique characters)

for phylogenetic analysis (these characters must offer grouping information)

1. for comparison with fossils, primarily dental characters.

Also age variation was investigated, by studying a large sample of ocelots (almost 400) from one locality (eastern Ecuador). First the skulls were separated into 5 relative relative age groups, defined on dental development, suture fusion, and sagittal crest development. ANOVA (analysis of variance, a statistical test) showed age variation to be a major source of size variation, greater than sexual or geographic variation. There is no surprise that variation from juvenile to adult is significant, but variation from adult to old adult was most significant! When compared with the adult, the old adult has broader zygomatic arches, narrower postorbital constriction, larger occipital and sagittal crests. Ontogenetic variation may account for much of the subspecific variation that has been described in this species, but that is another story!

Secure species identification was a major chore. An individual specimen couldn't be scored and included in the analysis until it was securely identified, yet it couldn't be identified until you knew which characters to use to identify it. This vicious circle could be broken only with familiarity, and three mammal collections were critical for this: Field Museum of Natural History in Chicago, Michigan State University Museum in East Lansing, Michigan and the ROM, although 21 were visited in total, in Europe and North America. Excluding ocelots (which are bigger and easy to ID on size alone), there was over 10% misidentification (107 of 986) in museum collections. This group has obviously given others trouble in the past!

All investigated characters were polymorphic (appearing in more than one form) for almost all species, although sometimes polymorphism was small. Therefore, one needs a combination of characters to identify cat skulls.

Of the 40 characters, 30 showed some stability and were possibly useful for identifications. These were used to construct a key to the identification of SASC skulls. Ten characters were ubiquitous or too polymorphic so as not to be useful in identifications. Only 17 of the original 40 showed possible grouping information. Of

these 17, only 3 are dental and none are in the mandible, an important fact later when assessing the fossil record of this lineage.

To these 17 were added 5 non-skull characters from the literature: 2 chromosome characters, and 3 morphological characters from Salles (1992)(one skin character, one ear ossicle character and one milk dentition character): for a total of 22 morphological characters.

In other words, more than half of the original morphological characters were eliminated as either too variable or not useful for phylogenetic analysis! This study may serve as a general warning to those who only examine a few individuals before undertaking a phylogenetic analysis.

Cladistic analysis on this morphology data, gaves 1 most parsimonious tree. However, tree could not be rooted so that the specified ingroup was monophyletic, and the indices (CI and RI) were low. Bootstrap test gave little resolution, it produces a 50% majority rule consensus tree with support for only one clade (*pardalis*-*wiedii*). This was not a strong, or particularly useful tree.

Cladistic analysis on DNA data gives a different story. Portions of the 16S rRNA, ATP8 and NADH5 dehydrogenase genes of the mitochondrial genome were used. Published DNA sequences were used, and using ancient DNA extraction protocols, sequences were obtained from museum skins of the rarest species, for which no frozen tissues were available. Cladistic analysis on these 52 characters produces one most parsimonious tree, and the specified ingroup was monophyletic, with higher CI and RI. A bootstrap produces a 50% majority rule consensus tree with high support for all clades. This is a better tree!

For a total evidence approach, the morphology and DNA matrices were combined; the most parsimonious tree produced is identical to the DNA tree. A bootstrap still gives two clades, *Leopardus* and *Oncifelis*, and ingroup is monophyletic. Studies have shown that it is not necessarily true that the larger DNA dataset will swamp the smaller morphological dataset.

The *Oncifelis* clade is supported by 2 morphological characters (both reversed in *O. guigna*), the *Leopardus* clade is supported by no morphological characters, and only one morphological character supports SASC (chromosomal), although 10 DNA characters do. Therefore although this may be a good tree (and may even be the correct tree) it means we can't IDENTIFY a skull to genus. This tree is cautiously accepted. We must therefore reluctantly conclude, as have other before that "SASC are not a good source of character information".

On to fossils! In South America there is only one pre-Late Pleistocene fossil of a small cat, *F. vorohuensis*. Three primary and 9 secondary characters were originally described for this fossil. In order to investigate the validity of these characters, they were included in the original 40 surveyed on SASC. Five were found to be too polymorphic to be systematically useful in SASC, 2 were age variations, 6 were due to breakage or were not actually present as described. When put into context of the known variation in SASC, only 1 of the original 12 characters was possibly useful, plus 4 additional characters of the17 possibly useful morphological characters which could be scored on this fossil, making a total of only 5 characters of the 22 for phylogenetic analysis.

So where might this fossil be placed within the SASC? With the inclusion of this species in the cladistic analysis, the already weak morphological tree loses resolution; the

consensus is three equally most parsimonious trees. This means that the fossil could be placed in one of 3 places; there are not enough characters for secure placement in a clade.

All other SASC fossils appear to be Late Pleistocene or Holocene and can be assigned to living species. Most are very fragmentary, and identifications even to living species are precarious. There is just not enough associated material.

Where did the SASC come from? Obvious answer is North America. Felines are first recorded in South America about 2 million years ago(mya). Land bridge connects the continents about 3 mya, small feline fossil record in NA dates to approx 5-6 mya. It has been suggested, biochemically, that SASC lineage might be 6-10 my old. The question is: Might the SASC radiation be recognizable in the fossils of NA prior to land bridge formation 3 mya? On a similar quest, others have found evidence of the SA canid radiation in NA prior to land bridge formation. This question is intertwined with the origin of the NA genera *Lynx* and *Puma*, in particular the similarly-sized *Lynx* (hence the missing *Lynx* of the title).

How is *Lynx* to be recognized? Compared to *Puma* or SASC, *Lynx* has long hind legs, small head relative to body length, short tail, ear tufts, and the loss of the upper second premolar (P2). As other features are rare as fossils, loss of P2 has become synonymous with evolution of *Lynx*.

However, loss of P2 is a recurring theme in felid evolution, not just in lynxes. Besides *Lynx,* three living SASC were found to be essentially lacking P2 (in two genera). Although loss of P2 still may be useful in the definition of a clade (e.g. can be part of the diagnosis of *Lynx*, regardless of what is going on in other clades of cats), it cannot be used for *identification* of a fossil in particular, as it is not unique to one clade of cats.

How are we to identify N.A. fossils as belonging to *Puma*, *Lynx* or SASC if we can't rely on P2? As fossils are first identified as members of a certain species and then assigned to a genus, one might argue that this question is essentially one of relationships and not morphology. In other words, perhaps one should first establish the relationships of these species, via a cladistic analysis, and then evaluate where on the tree a certain fossil should be placed. Biochemically, the relationships of these genera have been elucidated: *Lynx*, *Leopardus* and *Puma* are not that closely related. We also now know that morphology is not a good source of phylogenetic info. Things do not look encouraging!

Which species are the possible ancestors of the SASC? Only four species are known in NA late Miocene to early Pliocene record. Morphological characters useful for discerning phylogeny are essentially lacking in these fossils, as they consist largely of dental-bearing elements, usually lower jaws, and these are conservative in structure.
Since there are few useful phylogenetic characters, a morphometric definition of *Lynx*, *Puma*, and SASC was sought. For this approach, the multivariate statistical test called Discriminant Functions Analysis (DFA) was used. DFA is a multivariate statistical test used to find a linear combination of attributes that maximizes the separation of 2 or more groups. First, three groups were defined on known skulls: *Leopardus*, *Lynx* and *Puma*. Based on the developed DFA, a posterior probability of membership in each of the three generic groups was calculated for a series of fossils. Do fossils fall into one of these groups statistically?
'Felis' lacustris – falls within *Puma* as others have suggested

'Felis' rexroadensis - overlaps *Leopardus* and *Lynx*; although others have suggested *Lynx*; *Leopardus* is still a possibility, but there is no definitive answer from this analysis.
'Felis' longignathus - closest to *Lynx* but does not fall into any group
'Felis' proterolyncis – is closest to *Lynx*, might be the "missing *Lynx*"
None of the fossils fall exclusively into morphometric definitions of *Leopardus*.

Conclusions:
Part 1:
1. Osteologically, cats are variable yet conservative; one needs several characters in combination for a secure identification.
2. character variability needs to be assessed before a phylogenetic analysis
3. skull morphology is not a good source of phylogenetic information in SASC
4. possible SASC ancestor cannot yet be identified with the present fossil material.

Part 2:

Some preliminary thoughts were presented on a new fossil cat specimen, perhaps 2/3 complete. It was uncovered in 1998 by a big scraper on a job constructing a planned community, in city of Chula Vista, San Diego County, California It is a least 3.5 million years old, maybe older, which puts it in the Upper Pliocene.
All the morphological evidence (limb proportions, hand and foot proportions, tail length and presence of P2) says: "Not *Lynx*, just generalized cat".

Two things that need to be done are:
1) identify the specimen and
2) figure out which lineage of cats it is related to.
This report is a work in progress, as study is not yet complete.

Since known fossil species are defined on upper or lowers ONLY, separate analyses of upper and lowers were done, and then combined to maximize info and see where the fossil lies within the DFA defined on the living genera.
Using upper teeth - San Diego specimen falls close to *Lynx*
Using lower teeth - San Diego seems to be *Lynx*. San Diego specimen also falls close to '*Felis*' *longignathus*, and using lowers only, this is a probable identification for this fossil.

However, when upper AND lower teeth are combined, the new fossil falls far outside of *Lynx*, *Leopardus* or *Puma.* All that can be said at this point is that the relationships are not yet clear; the combination of measurements demonstrate that it is not like any of the living New World morphogenera, except in the lower jaw, where it appears to be lynx-like, but as demonstrated by the skeleton, none of the skeletal features in this new fossil are lynx-like.

Next, a detailed comparative character study of postcranial osteology is required, searching for characters, since this IS the first good fossil skeleton of a NA small cat, here is a chance to study postcranial osteology in detail.

Preliminary conclusions on Part 2:

1. DFA on lower dentition suggests this fossil might be identified as the species '*F.*' *longignathus*
2. DFA on upper OR lower suggests this fossil might be assigned to the genus *Lynx*
3. However, using postcranial proportions and presence of P2, this fossil cannot be identified as belonging to *Lynx*

4. DFA on combined upper AND lower dentition indicates the fossil cannot be assigned to the genus *Lynx*

The speaker was thanked by Jock McAndrews.

NOTES & OBSERVATIONS:

- Jim Bendell saw 150 Sandhill Cranes beside the road on a recent trip to Madison, Wisc. They were apparently connected to a "magnificent" international crane centre near Madison where two former biology students have set up a crane sanctuary. They have many different species of crane, including Whoopers.
- McAndrews displayed a core sample taken from Crawford Lake last winter. The samples show evidence of Canada Goose pellets and eutrophication at the 12,000 BP level, indicating the presence of Aboriginal Peoples and farming.
- Ron Pittaway has noted a big southward movement of Boreal Chickadees, as far south as Lake Ontario, for the first time in 25 years. He said he wasn't sure why it is happening.
- Ed Addison saw a Ruffed Grouse in his yard in downtown Aurora, only the second time in 25 years.
- Bruce Falls displayed two books on caterpillars. *Caterpillars of Eastern North America* by David Wagner, Princeton Field Guides, 512 pp, about $25, is probably the best book on the subject, with hundreds of species. *Photo Field Guide to Some Caterpillars of Southern Ontario*, by Ian Carmichael and Ann Vance, St. Thomas Field Naturalist Club 74 pp, about $10, is a smaller field guide that fits the pocket.
- Bendell said Peterson has also published a mid-priced book on caterpillars.
- Seymour has been seeing many more Turkey Vultures than usual, sometimes in groups of 20.
- Seymour commented on the incidence of wild cats in eastern North America. Cougars are apparently doing well in Manitoba and can be expected in northwestern Ontario. There have been sighting in New Brunswick. Unfortunately, there are many false sightings and some confirmed sightings that are not reported because the observers fear ridicule. One person saw a leopard near Marathon. It had escaped from a zoo. A dog found a tiger jaw in an Aurora park, a particularly strange find.
- Seymour saw a roadkill oppossum near Minesing Swamp, west of Barrie. They have been reported as far north as Sault Ste. Marie, but the far northern ones have probably been carried north in a truck. They are unlikely to survive the winter.
- Ellen Larsen saw a fisher near the Head River, near Carden Alvar, adding to the evidence that this species is moving south.
- Bertin has seen beavers, muskrats, painted turtles, Northern Pike, Black-crowned Night Herons and Osprey in Toronto Harbour, in addition to the usual suspects.

Olympia's Forest

By Yorke Edwards
Our Western Correspondent

When looking through south windows on clear days, we see a distant row of Olympian Mountains. Hidden behind that row, there are

two other mountain rows. Facing south behind each row there is a river running west to the sea. Those three rivers are said to flow through the thickest forests in North America.

Some also say that those forests are the wettest in the world. Among the trees are some that grow high up 200 ft., and some have the widest tree trunks perhaps ever seen. Measured around some of the biggest trunks 4 1/2 feet from the ground, there is a Douglas fir trunk that is 17 ft. 8 ins around, a Sitka spruce sits at 16 ft. 3 in., and a western hemlock at 9 feet. Nature also decorates many trees with sheets of moss and lichens that hang from their branches. Scattered through the forests there are fallen trees that died when in lowered ground water, then fell. Seeds sometimes fall into wet and rotting logs or stumps, then the seeds grow trees, going up while their roots grow down through the rotten wood below them into the ground. Later, the old stump crumbles away leaving the tree's roots visible. They look like legs.

In the forest, there are open areas because there are thin soils on rock. Such places, if wet, are crowded with small Sitka alder trees, their brown bark with patches of white lichens. On drier ground nearby, there are big-leaf maples, some with horizontal limbs with thick blankets of hanging moss that can hold hundreds of pounds of rain water.

The driest soils have some small- and broad-leafed trees. The finest to me are the arbutus tree. It is called 'the madrona' in the USA. Those trees live best on rocky places, so are not often among other trees. These beauties have smooth and almost shiny green bark usually holding bright red coils of old bark. They live scattered in the edges of some forests but are mostly seen alone on rocky seashores. They live from Vancouver Island down into California, and not far inland from the sea.

Another tree, the Pacific yew, hides in forests and always seems to be alone or in small groups. Once it was called useless, but suddenly it became 'gold' when it was found that its bark holds 'taxol', a cure for cancer. When the many strippers of its bark found a yew they cut it down to collect the bark. On lucky days when a bark-hunter cut down nine trees, he won about $100. People are saved by yews while yews soon vanish. But not in Olympic National Forest.

Driving high up onto one of the park's mountains, there are meadows for miles of wild flowers, unusual birds, rare mammals, and also a restaurant, but that is another story. Y

NEXT MEETING:

The next meeting will be held at 7:30 pm on Nov. 15 in Room 432 of the Ramsay Wright Zoological Laboratories at the University of Toronto. Prof. Paul Herbert of the University of Guelph will speak on the "Barcode of Life."

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