newsletter

Florida Paleontological Society, Inc.

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FLORIDA PALEONTOLOGICAL SOCIETY, INC.

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Annual dues for FPS are $3.00 for persons under age 18 and $6.00 for persons over age 18. Persons interested in FPS membership need only send their names, addresses and appropriate dues to Howard H. Converse at the Florida State Museum. Please make checks payable to FPS. Members receive a membership card and the bimonthly FPS Newsletter.

Newsletter Policy: All news items and photographs related to paleontology in Florida are welcome. The deadline for each issue is the 15th of the month before publication. The editor reserves the right not to publish submissions and to edit those which are published.

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Volume 2 Number 3 NEWSLETTER June 1985

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N O T I C E

The FPS Annual Meeting
will take place at the
University of Florida,
Gainesville, on Saturday,
October 5th in
the J. Wayne Reitz Union.
TIME: 8:00 A.M.

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GOVERNOR BOB GRAHAM DEDICATES LIVE OAK MUSEUM-PARK COMPLEX IN APRIL

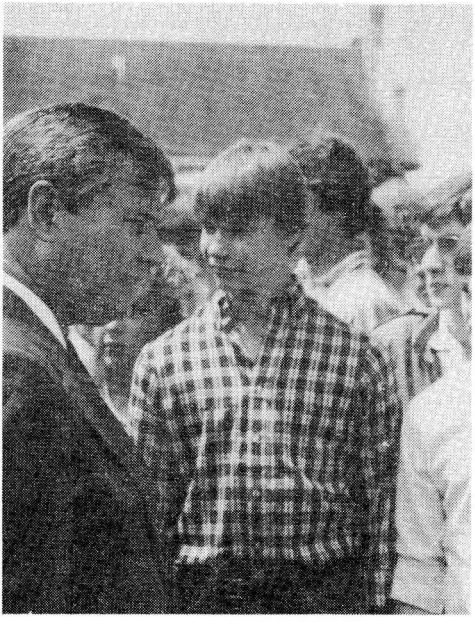
by Carol Herring

Calling the efforts of the citizens of Suwannee County toward saving the railroad passenger depot and establishing a Museum-Park Complex "a beautiful statement of pride", Governor Bob Graham personally dedicated the project on April 26, 1985.

In the historic spirit of the occasion, Governor Graham arrived at the site riding the Live Oak Fire Department's 1918 vintage fire truck and immediately began shaking hands with delighted school children who were on hand to "see the Governor".

"I cannot dedicate this building," Graham said. "The people have already dedicated this building with their will to preserve this beautiful representation of what the community is all about."

Governor Graham presented a state flag and Don Allen, aide to Congressman Don Fuqua, presented a U.S. flag that had flown over the Capitol in Washington. Allen also noted that commendations to the Steering Committee would be entered in the Congressional Record.



At right: Gov. Graham with Live Oak schoolchildren.

The Governor received a "Save the Depot" T-shirt, a large penny and an honorary membership on the Suwannee County Historical Commission as souvenirs of his visit.

After the ceremony, Governor Graham took time to enjoy the exhibits of the Suwannee County Historical Museum which depict the natural and human history of the North Florida county. The Museum is currently housed on the second floor of the Old City Hall, the third building of the Museum-Park Complex.

Note: Corrections in the Museum-Park Complex story which appeared in the April Newsletter are as follows. The house mover is the Hygema House Movers and the realty company selling t-shirts is Crapps Realty. Correct information on the Complex's financing is: "So far, almost $56,000 of the needed $86,000 has been raised. Pride In Action, a non-profit organization for downtown improvement, purchased the property where the depot now stands for

$25,000 and assumed a mortgage for the balance of the cost of moving. When the Museum-Park Complex project is completed and the mortgage satisfied, the property will be deeded to the Suwannee County Historical Commission." The editors apologize for the errors in the April story.

THE PEACE RIVER OPERA by Frank Garcia

I used to think that an opera was a group of over-stuffed people singing in different languages. The shrill of a human voice just didn't appeal to me as music. Don't get me wrong, I love music, especially classical music. But like the majority of people, I never listened to opera.

As I quickly slid through one of the many doors of my life, a very dear friend introduced me to an opera that has become one of my all-time favorite pieces of music, "The Pearl Fishers" by the French composer Bizet. You're probably wondering what in the world this story has to do with a column of Fossil Facts and Philosophy. Let me explain.

Last Saturday, feeling a little down, I decided to go scuba diving for fossils in the Peace River. I went to the Canoe Outpost in Arcadia and rented a canoe. After loading my gear into the craft, I readied myself for a day of adventure and wonder. Just for the heck of it, I put on my stereo head-phones and the tape of "The Pearl Fishers" and turned the volume up. I paddled swiftly upstream against a sweat-creating current.

The opera tells the story of an island where pearl divers live. Two male divers both fall in love with the princess of the island. It ends in tragedy with a love-sacrifice by one of the divers. As I paddled around a bend in the river and was greeted by two bid Blue Herron standing majestically, the beauty of the music and the drama of the story began to unfold.

I heard nothing but the opera. Slowly the swaying moss-draped trees and the clear blue sky molded into the music. The wilderness became the stage and the many varieties of birds in the trees and even the fish beneath my canoe, became the performers.

As I paddled through some rapids, I spotted phosphate gravel that contained 20-million year old shark teeth. With the music of the opera still playing in my ears, I slipped out of the canoe into knee-deep water and carefully picked up my "pearls". A chorus of beautiful feminine voices sang as I floated below an overhead train trestle. Just past the trestle, I looked up and saw two birds, beautiful blue King Fishers. What an experience in harmony to watch the King Fishers hovering above me as I listened to the two male voices sing their melancholy song.

Five miles down the river I decided to stop and put on my diving gear. Even though I had put my stereo away, the music still played in my head as I sank beneath the surface of the water. I swam through and around huge fallen Cypress trees. The fish seemed strangely attracted to me and the opera played on in my mind. I opened my nylon mesh bag and gently placed more "pearls" (shark teeth) into it. As I stroked my hand across the silty river bottom and the current carried away the disturbed silt, a million-year old elephant leg came into view. Gently cradling the Mammoth leg, I slowly headed up to the surface admidst a lively chorus of bubbles as the music played within me and the bubbles and I rose to the surface together, penetrating but not violating the quiet river.

Lying on the bank of the river later, I took my gear off and set my treasures on the shore. After the coolness of the river it felt good to bask in the warm Florida sunlight. My sharks' teeth seemed to

glow in the golden rays. After listening once more to "The Pearl Fishers" I took the canoe and headed downstream. A delicate flock of Snowy White Egrets swooped down above my head as the "Pearl Princess" sang her song.

Huge boulders on the bottom of the clear river seemed to glide past me, giving me a sense of motionlessness in the canoe, even though I was moving siwftly with the current. I continued to look for the fossil-bearing phosphate and found more shark teeth, along with some camel, elephant and horse teeth to add to my cache of jewels.

On my way back, I passed many canoers enjoying their trip down the river. I don't think any of them could have enjoyed the trip more than I, however, as none of them had "The Pearl Fishers", starring Mother Nature.

If you are a person who loves the outdoors and hates the opera, please do yourself a favor and listen to this Bizet classic. You will be delighted and so much the richer for it. Listen to it at some quiet place and, wherever you go, listen carefully. That particular place will be yours alone forever. That Saturday the Peace River belonged to me.

HOW TO FEED AND CARE FOR A FALSE SABER CAT

(continued from April issue) by S. David Webb

HOW BARBOURFELIS LIVED

Paleontology is the study of ancient life, and paleontologists are scientists who study fossils. One of the most challenging subjects paleontologists ponder is how animals, now lifeless and extinct, moved and behaved when they were alive. Since no person has ever seen Barbourofelis alive - indeed no humans existed ten million years ago when Barbourofelis lived - the entire subject depends on interpretations of fossil remains. Two fundamental

assumptions that give the paleontologist license to make such interpretations are:

1) that the fossil remains do indeed represent once-living animals; and
2) that the bones, muscles, nerves and teeth that biologists study in living animals operated in broadly similar manner in their extinct cousins.

When a person has actually dug at the Love Bone Bed (or similar fossil quarry) and has seen it yield up vast numbers of well-preserved bones and teeth of diverse animals now vanished from Florida, these assumptions become completely convincing. There is no doubt that false saber cats lived here along with rhinos and other strange beasts. The interesting question is how they lived.

The answers to such questions must come from the bones of Barbourofelis and from its environment registered by the fossil site. That is why the museum maintains a large collection of fossil remains and carefully excavates fossil sites. The first important step was to repair, sort, count and catalog all of the fossils from the Love Bone Bed and the second was to assemble the bones of Barbourofelis to represent the skeleton of a once-living animal. The whole collection of Barbourofelis numbered about 1000 catalogued specimens. A composite skeleton, representing the average-sized mature animal, is gradually selected by articulating each bone with other adjacent bones, in a kind of three-dimensional jigsaw puzzle. In this manner, the bones of the museum's unique Barbourofelis skeleton were selected.

But selecting the bones of the skeleton provides merely a framework for inferring how Barbourofelis lived. The bones also give many other kinds of information including proportions, probable positions and mobility of various joints, and the size and position of muscles attached to the bones.

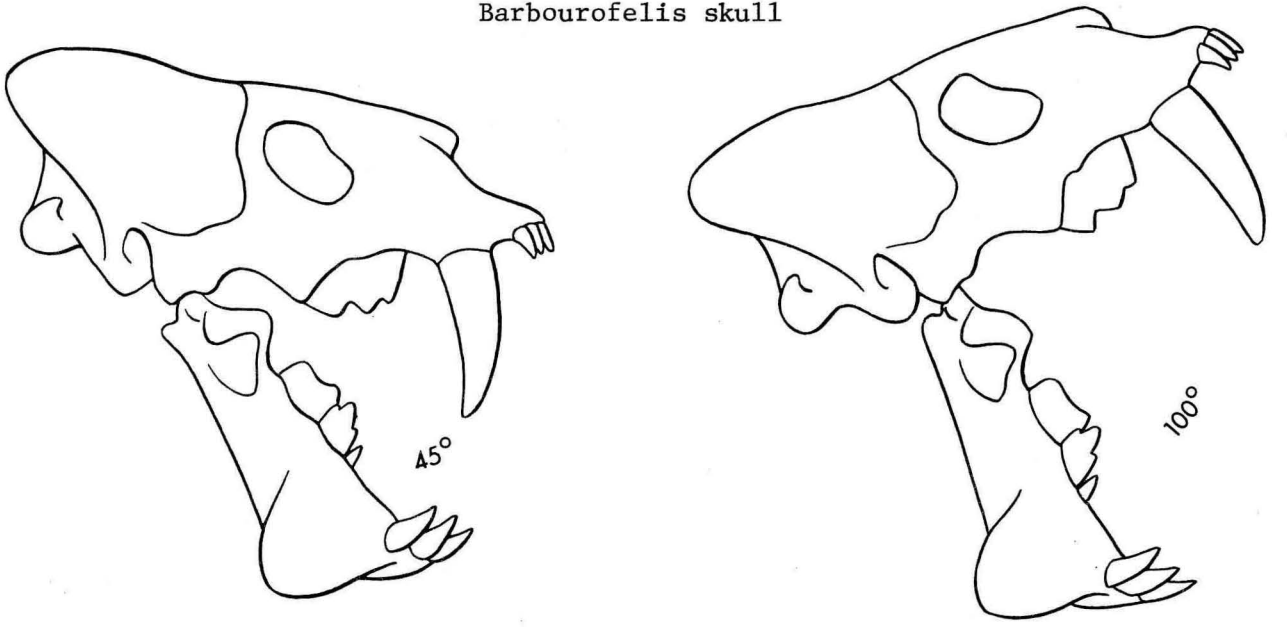
Using many such subtleties, the possible poses and movements of the head, jaws, torso, limbs and feet are deduced. Numerous sketches of probable life positions are drawn and compared with those of living animals. (See Figures 2, 3 and 4, p. 8-10.)

The most remarkable features of Barbourofelis are seen in its dentition, notably its large serrate-edged sabers and its long blade-like cheek teeth. The incisors are notable for their long pointed shapes and for the vertical cutting surfaces that interlock between upper and lower incisors and also the lower canines. The normal grinding teeth were either lost or altered for shearing. No other animal past or present had every bit of every tooth surface honed into cutting edges.

The skull exhibits a number of modifications that evidently supported the use of the sabers in a powerful downward stabbing motion. The wide and deep muzzle helps strengthen the front of the skull. Unlike any other carnivores Barbourofelis has its eye socket (orbit) closed by a postorbital bar; presumably this reinforced the cranial vault where the sabers are rooted. The jaw articulation (glenoid fossa) is set well below the normal level, presumably to allow the jaws to open much wider than is possible in other mammalian carnivores. Likewise, the back of the lower jaw has a low profile (with low coronid and angular processes) which also helped increase the gape. The estimated maximum angle of the gape in Barbourofelis is more than ninety degrees which would place the lower jaw back against the throat if the skull were held horizontally. Any further gape would dislocate the jaw. One may envision this saber cat not merely dropping the jaw but also throwing its head upward some 20 degrees or so in preparation for stabbing. If so, the jaw would then stand nearly vertically during maximum gape. The power of the stabbing motion is indicated by the massive neck muscle insertion areas low on the posterior and

Figure 2

Barbourofelis skull

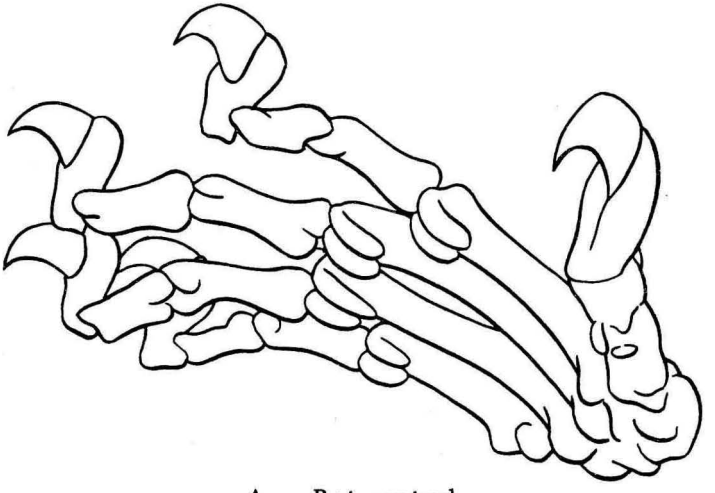


A. Jaw partly opened in position for eating

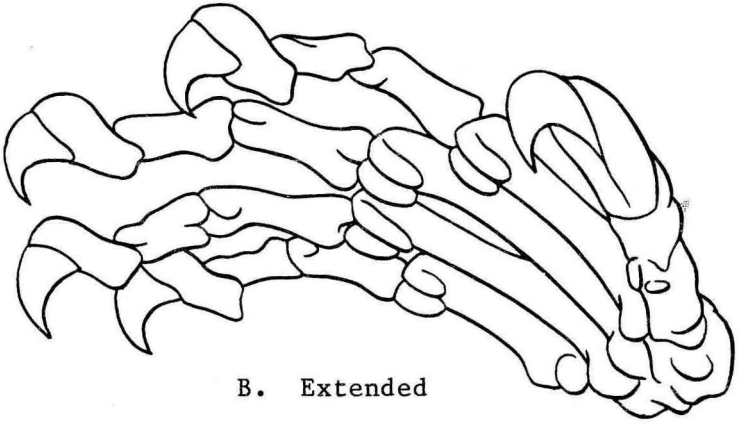
B. Jaw fully gaped in position for stabbing

Figure 3

Right Fore Foot

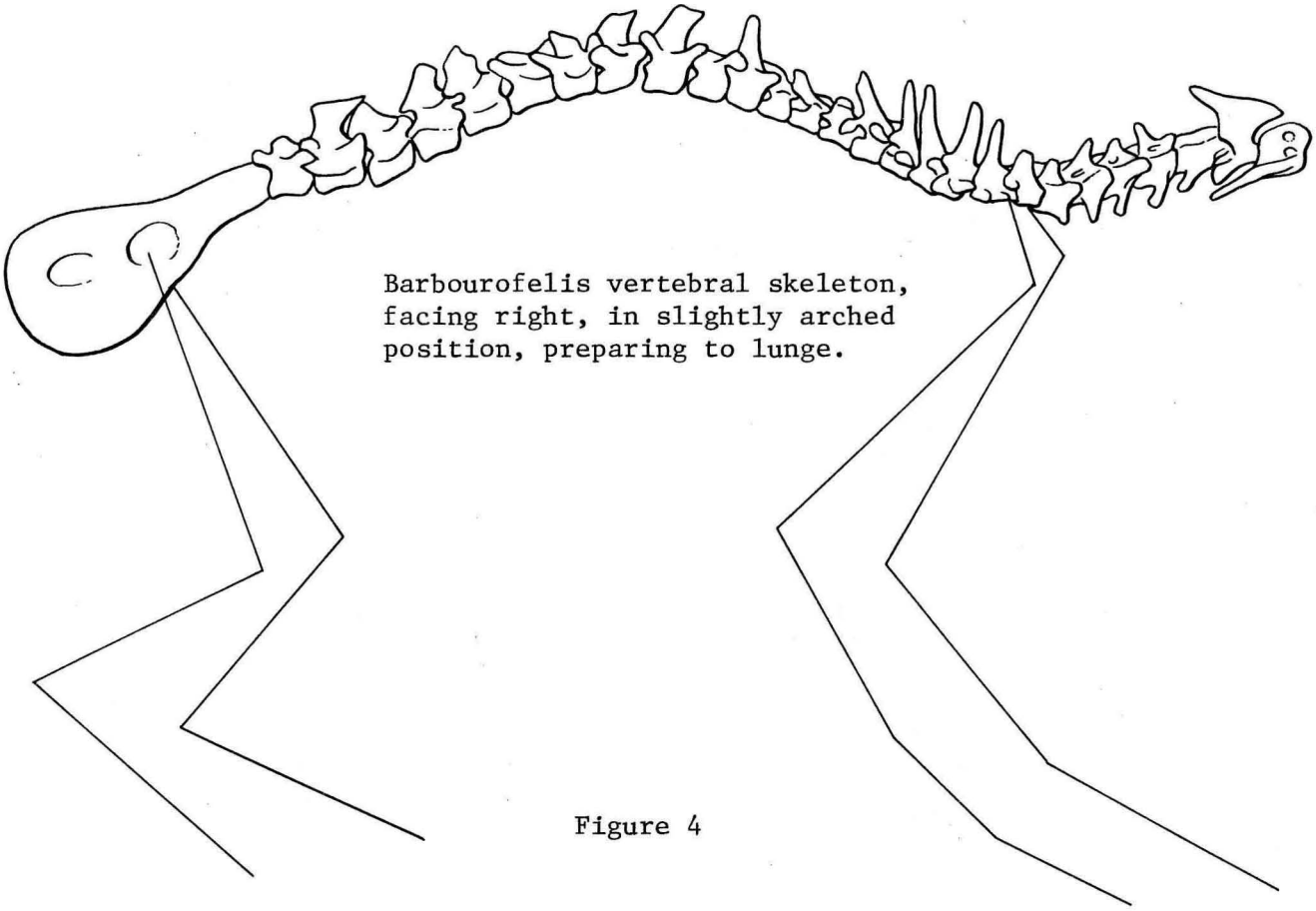


A. Retracted



B. Extended

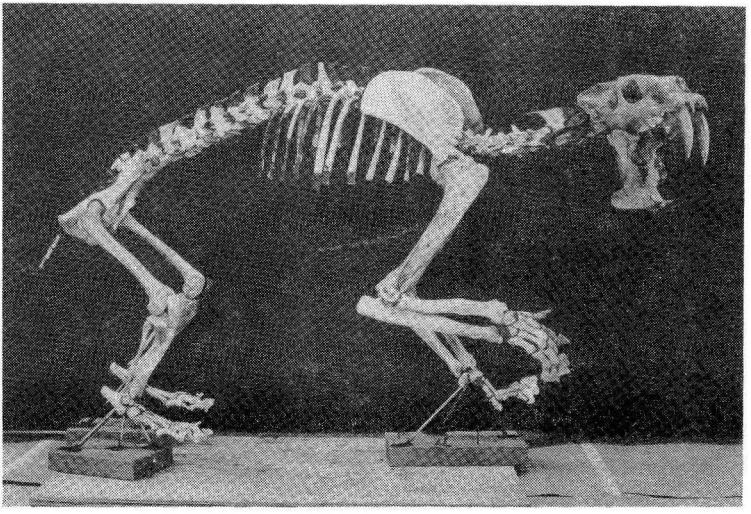
Bony claw cores represent about half of the full claw length. (Illustrations on pp. 8-10 are by Wendy Zomlefer, Florida State Museum.)



Barbourofelis vertebral skeleton, facing right, in slightly arched position, preparing to lunge.

Figure 4

posterolateral parts of the skull (especially the mastoid and paroccipital processes). These muscles would rotate the head downward around the neck. The joint at the back of the skull (occipital condyles) and the first neck vertebra (atlas) form an unusually powerful hinge joint which permitted the sabers to strike downward without danger of dislocation. Clearly the skull and teeth show this animal to be an efficient predator on large prey animals.



BARBOUROFELIS SKELETON PUT TOGETHER BY PREPARATOR DAN CORDIER AT THE GAINESVILLE, FLORIDA OAKS MALL FEBRUARY 1985 - APRIL 1985

HOW TO FEED BARBOUROFELIS

Barbourofelis probably ambushed its prey from thickets. Of course, the exact manner in which it hunted and ate its prey is suppositional, based on the knowledge of its boney anatomy and on the situation in which its fossils are found. The short limbs and relatively weak hindquarters indicate that it could not have run down its prey in open country. And the unexpected abundance of saber cats in the

Love Bone Bed suggests that they tended to lurk in wooded areas near the stream site.

The sabers are the obvious points of Barbourofelis' attack on its prey. The powerful forelimbs grabbed the prey and its ten large claws fastened the cat firmly in position. Even if the prey were a startled rhinoceros that began to gallop away, the cat could remain fixed on its shoulder or flank to deliver the fatal blow. The head was raised as the claws sunk in, and then it was flexed downward powerfully sinking the narrow serrated sabers into the flesh.

The moment when the sabers drove downward into its prey was as crucial for the saber cat as for its prey. If either of the sabers (which were only five mm wide near the tip and grooved along the inside) were to hit a bone or get jerked sideways during the death slash, it would surely snap. For this reason, the preferred target for the slash was probably the soft belly region of the prey. The next best spot was the throat or lower neck region with its exposed jugular vein. An attack anywhere near the legs would have been too dangerous for Barbourofelis sabers'.

Another crucial problem for this great predator was how to extricate its sabers quickly from its prey. The long pointed incisors helped by tearing away the flesh between the two sabers, a distance of about 50 mm (two inches). The lower incisors and canines (eight teeth in all) snapped shut interlocking with the six upper incisors and shearing meat along each edge. The effect of this jaw closure was to free the sabers and to rip out a hole about three inches in diameter from the prey. Hemorrhage and shock would surely follow immediately. This important adaptation of pointed interlocking incisors is found in false saber cats such as Barbourofelis but not in true cats such as Smilodon.

WHY BARBOUROFELIS IS A FALSE SABER CAT

Saber-fanged carnivores have appeared several times in the history of life, although none is still living. The most famous saber cats are those like Smilodon that lived in the Pleistocene and died out about 10,000 years ago; they are closely related to true cats such as lions, jaguars and domestic cats (family Felidae). Barbourofelis, on the other hand, belongs to a distinct group of carnivores, in a different family from modern cats, that appeared some 35 million years ago in the Oligocene. Paleontologists since the last century have often placed them in their own family, the family Nimravidae, informally known as false saber cats, including Nimravus, Dinictus and Hoplophoneus.

In some technical details, such as the construction of the ear region, the false saber cats resemble the dog family (Canidae) more than they do the cat family (Felidae). In several other respects, however, such as their retractile claws and blade-like cheek teeth, they give evidence of sharing an ancient ancestry in common with the true cats.

With respect to the presence of large sabers still other extinct groups of carnivorous mammals should be mentioned. These include Paleocene and Eocene members of the early order Creodonta, known as Apatelaelurus and Machaeroides (Gazin, 1946); and the remarkable South American possum derivative Thylacosmilus (Turnbull, 1978).

HOW BARBOUROFELIS LOVEI GOT ITS NAME

The false saber cats had a long successful history in North America and Eurasia. In the midst of their history (early to mid-Miocene) there is a curious gap of about ten million years when they are unrecorded in North America. When they reappear in North America as a larger more progressive form with closed postorbital bars, they are recognized

as the genus Barbourofelis. Various species of this genus have been discovered in North America. The last and largest is Barbourofelis fricki from Nebraska. An intermediate sized species, first discovered at the Love Bone Bed in Florida, was named Barbourofelis lovei. The name and type description were published in 1981 by Dr. Jon Baskin, then a graduate student at the University of Florida. It is the only species of the genus Barbourofelis known from an essentially complete skeleton.

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NOMINATIONS FOR 1985-86
Florida Paleontological Society Officers

The Nominating Committee consisting of Mr. Don Serbousek, Mr. Ben Waller and Dr. David Webb has submitted the following slate of FPS officers for 1985-86:

President-elect	Don Serbousek
Vice President	Phil Whisler
Treasurer	Mary Poage
Secretary	Anita Brown
Board of Directors	Larry Martin
	Don Lorenzo
	Ben Waller

According to Article V, Section 5, of the FPS By-Laws "Nominations of candidates for office, in addition to those presented by the Nominating Committee, may be submitted to the Secretary in writing no later than September 1 of each year, and any such nominations received shall be voted on at the Annual Meeting."

Bessie Hall will automatically become President for 1985-86.

THE "ROSETTA STONE" FOR MAMMALIAN EVOLUTION IN SOUTH AMERICA by Larry G. Marshall, Christian de Muizon, Mireille Gayet, Alain Lavenu, and Bernard Sigé (Reprinted from National Geographic Research, Spring 1985, pp. 273-288.)

A taxonomically diverse fossil fauna with small- and medium-sized vertebrates was recovered from the Late Cretaceous (Maestrichtian) age El Molino Formation (Puca Group) at Tiupampa, south-central Bolivia. Among the known taxa--many new to science-- are selacians, actinopterygians, lungfish, amphibians, lizards, snakes, turtles, crocodiles, birds, and mammals. The known mammal fauna contains at least seven taxa (five marsupial and two placental); it includes a larger number and more complete specimens

than the other three Late Cretaceous mammal faunas known in South America (two from Argentina, one from Peru). In this regard the Tiupampa local fauna is the single most important Late Cretaceous mammal fauna yet known on that continent. In fact, this local fauna can be regarded as the paleontological "Rosetta Stone" that has the demonstrated potential for clarifying many pressing issues about the origin, phylogeny, and biogeographic history of many South American mammal groups, in particular, and other vertebrate groups, in general.

BACKGROUND

Elsewhere in South America

A major issue regarding the mammal fauna of South America is its origin. Did some of all living fossil groups evolve in situ from Cretaceous (or earlier) ancestors in South America; or, did some or all come from stocks that had immigrated to South America from elsewhere (i.e., North America, Africa, or Australia via Antarctica)? Knowledge of Late Cretaceous age (75 to 66 Ma [millions of years ago]) mammal faunas in South America is crucial for understanding the biogeographic histories and phylogenetic relationships of these groups.

Until recently the earliest record of fossil mammals in South America was confined to knowledge of faunas from rocks of middle Paleocene age in Argentina and Brazil (for a review of this literature see Marshall, Hoffstetter, & Pascual 1983; for a time scale of Cenozoic land mammal ages see Marshall in press). Four localities yielding mammals of Late Cretaceous age are now known (two in Argentina, one in Bolivia, one in Peru), and the specimens from these local fauna provide paleontologists with a glimpse of what mammalian life was like before the Age of Mammals on that continent.

The two localities in Argentina--one in the Los Alamitos Formation and one in the Coli-Toro Formation--are based on isolated finds of one specimen each. An isolated upper molar (M^3) was collected in association with dinosaurs near Arroyo Verde in the Los Alamitos Formation, Río Negro Province. Bonaparte and Soria (1983) named the tooth's owner Mesungulatum houssayi, although it was neither properly described nor figured and the name is a nomen nudum. These authors assigned this animal to the placental order Condylarthra, and tentatively to the family Arctocyonidae. The second Argentine find is represented by a partial edentulous mandible of a didelphoid marsupial that was collected from the Coli-Toro Formation at Ingeniero Jacobacci in Rio Negro Province, Patagonia (personal communication from Rosendo Pascual to Ch. de Muizon, 1982). The geology and age of the associated fauna are discussed by Pascual and Bondesio (1976) and Rosendo Pascual is presently studying the specimen at the Museo de La Plata, La Plata, Argentina.

Prior to September 1982, the only local fauna of Late Cretaceous age in South America that yielded multiple remains of fossil mammals was from the Vilquechico Formation at Laguna Umayo near Lake Titicaca, Peru (Figure 1). Based on the presence of charophytes (Braniša, Grambast et al. 1969) and dinosaur eggshell fragments (Sigé 1968), and on stratigraphic relationships (Audebaud et al. 1976, Portugal 1974), this local fauna and formation are confidently regarded as Maestrichtian (latest Cretaceous) in age. The vertebrate fauna, only partially described, includes lungfish (Lepidosirenidae, Lepidosiren cf. paradoxa), actinopterygian fish (cf. Miletes, cf. Hoplias, cf. Percichthyidae), frogs (?Leptodactylidae), turtles (?Roxochelys sp.), dinosaur eggshells, placental mammals (Perutherium altiplanense, Perutheriidae, Notoungulata; and a condylarth, Condylarthra), and various marsupial mammals of the superfamily Didelphoidea (Peradectes

austrinum, ?Didelphidae indeterminate 1, Didelphidae indetermiante 2, ?Pediomyidae indeterminate 1, and Didelphidae or Pediomyidae indeterminate) (Bonaparte & Powell 1980; Crochet 1979, 1980; Grambast et al. 1967; Rage 1981; Sigé 1968, 1971, 1972).

Tiupampa

Between 18 September and 5 November 1982, a National Geographic-sponsored French-U.S. team of geologists and paleontologists discovered a new mammal-bearing locality of Late Cretaceous (Maestrichtian) age in Bolivia. The locality is in the El Molino Formation at Tiupampa near the pueblo of Vila Vila in south-central Bolivia.

(Two of the place-names used hear must be clarified. Tiupampa is a local name used by Quechua Indians. Tiu- is the Quecha name for "sand", and pampa is a Spanish word that is best translated in this context as "place where" or "region". Vila Vila is the old name of the pueblo which is still used by most residents, while Villa Viscarra [which literally means General Viscarra's city] is currently used by cartographers as the new name for the same pueblo. Herein Vila Vila is used for the pueblo name and Villa Viscarra is used for the name of the nearby fossil locality.)

Eight specimens of partial jaws or teeth were collected during five days of surface prospecting, and an additional 13 specimens were recovered subsequently during screen washing of about 400 kg of fossiliferous rock matrix at the Laboratoire de Paléontologie, University of Montpellier, France. Seven taxa--five marsupial and two placental--have been identified among these 21 specimens. The known mammal fauna from Tiupampa includes a larger number and more complete specimens than the Late Cretaceous faunas from Argentina and Peru combined. In this regard the Tiupampa local fauna is the single most important Late Cretaceous mammal locality yet known in South America. In fact, this local

fauna can be regarded as the paleontological Rosetta Stone that has the demonstrated potential for clarifying many pressing issues about the origin, phylogeny, and biogeographic history of many South American mammal groups.

THE QUEST

The Vilquechico Formation of Peru was known to contain depositional environments favorable for the preservation of small- and medium-sized freshwater and terrestrial vertebrates. This formation is located along the margin of the Andean Basin, a large structure covering northwest Argentina, southwest Bolivia, and southern Peru (Reyes 1972). The Andean Basin includes rocks of marine, freshwater, and continental origin of Late Cretaceous and early Tertiary age (Martinez 1980). If Late Cretaceous faunas containing freshwater and terrestrial vertebrates occur in the Peruvian part of the Andean Basin, then similar types of environments and faunas should predictably occur elsewhere in the basin. With this reasoning a field program was organized to search for Late Cretaceous vertebrates in the Bolivean Andean Basin, concentrating efforts along what was believed to be the margin of the basin.

The lithologic units in the Andean Basin have been given different names in Argentina, Bolivia, and Peru. Recent ongoing studies of rocks and faunas throughout the basin demonstrate the time equivalence of many of these units. Based on faunal content and regional geologic studies, the Vilquechico Formation of Peru is now confidently correlated with the El Molino Formation of Bolivia (Cherroni Medieta 1977). By chance, the El Molino Formation was the only Late Cretaceous formation in Bolivia known to contain a vertebrate fauna. Thus effort was concentrated on the El Molino Formation in the belief that it afforded excellent opportunities for yielding the faunas desired.

The El Molino Formation is in the Puca Group, the upper part of which includes (from oldest to youngest) the Aroifilla (in part), Chaunaca, El Molino, and Santa Lucía Formations (Cherroni Medieta 1977, Lohmann & Braniša 1962). Knowledge of previously reported fossil remains (Branisă, Grambast et al. 1969; Braniša, Hoffstetter, Freneix et al. 1966) supplemented the new material, permitting a secure Maestrichtian-age assignment for the El Molino Formation.

Paleogeographic reconstructions of the El Molino Formation are given by Bonaparte & Powell (1980), Cherroni Medieta (1977), Martinez (1980), and Russo & Rodrigo Gainza (1965). The most common lithology in the center of the basin--as near Potosi--is a calcarous sandstone with intercalations of mudstones, the base of which is characterized by a thick level of the stronatolite Pucalithus (Braniša, Hoffstetter, & Signeux 1964). On the margin of the basin--as near Vila Vila and Torotoro--the sediments are predominantly red beds which erode to form extensive badland exposures.

In view of the paleogeographic setting, three areas of the El Molino Formation were surveyed: two localities near the pueblo of Vila Vila, 90 km southeast of Cochabamba (Villa Viscarra about 2 km south of Vila Vila, and Tiupampa about 6 km southwast of Vila Vila); the area around the pueblo of Torotoro, 95 km southeast of Cochabamba and 20 km southwest of Vila Vila; and two localities (Agua Clara, Hotel Cordillera) near the pueblo of Lagunillas, 60 km northwest of Potosi. The fossils collected during this survey were ultimately obtained on loan from the paleontology section of the Centro de Tecnología Petrolera (CTP) of Yacimientos Petroleras y Fiscales de Bolivia (YPFB) and were catalogued with numbers of the Institut de Paléontologie, Muséum National d'Histoire Naturelle (MNHN), Paris, France.

VERTEBRATE FAUNA FROM THE EL MOLINO FORMATION

Lower Vertebrates

From near the base of the El Molino Formation of Torotoro, Cappetta (1975) describes a selacian fauna which indicates a Maestrichtian age. The known taxa include Pucapristis branisi, Ischyrhiza hartenbergeri (Sclerorhynchidae, Euselachii); Dasyatis branisai, D. molinoensis, D. schaefferi (Dasyatidae, Rajiformes); and Pucabatis hoffstetteri (Myliobatidae, Rajiiformes). At the same locality, but from near the top of the formation, are abundant trackways of dinosaurs (Braniša 1968). At least five kinds of dinosaurs including theropods and sauropods are represented (P. Taquet personal communication) although these have not yet been formally described. Plaster casts of some of these trackways were collected and are in the MNHN collection.

Stratigraphic sections of the El Molino Formation at Villa Viscarra and Tiupampa record the lithology of the rocks and the known fossil levels (Figure 4). A tentative correlation of these sections is based primarily on the presence of a gastropod-rich limestone believed to be the same in both; it is located 120 m above the base of the formation at Villa Viscarra and 90 m above the base of the formation at Tiupampa. The rocks in both sections are primarily red to white sandstone with intercalations of clays and mudstones. The presence of abundant root casts in some levels and of dark organic-rich levels in others, indicates marshy to palustral depositional environments. The abundance of channels and the frequent occurrence of distinct but not rapid lateral facies changes, indicates general deposition in a low-energy regime, possibly overbank to deltaic in origin.

At Villa Viscarra a fossil level located low in the section, about 100 m above the base and characterized by Pucapristis Schaeffer (1963), yielded a

selacian fauna identical to that described by Cappetta (1975) from the base of the El Molino Formation at Torotoro (H. Cappetta personal communication). Actinopterygian fish from this level include a pycnodont (Pycnodontidae, Pycnodontiformes), Lepidotes (Lepidotidae, Semionotiformes), cf. Lepisosteus (Lepisosteidae, Ginglymodi), cf. Rhineaster (Ariidae, Siluriformes), a new genus (cf. Ictaluridae, Siluriformes), and cf. Miletes (Serrasalmidae, Characiformes). The first four taxa are also recorded from the El Molino Formation at Agua Clara and Hotel Cordillera; both locations are regarded as Maestrichtian in age (Gayet 1982a, b, c). An indeterminate pleurodire turtle (F. de Broin personal communication) and two indeteriminate crocodiles (A. de Ricqlès personal communication) are also known from this level.

Also from Villa Viscarra, but from a level of about 150 m above the base of the formation, were collected several specimens of the turtle ?Roxochelys vilavilensis (Pelomedusidae, Pleurodira) (de Broin 1971). Roxochelys is also known from the Bauru Formation in Brazil and from the Vilquechico Formation in Peru (Bonaparte & Powell 1980), both regarded as Late Cretaceous in age. One specimen of a small crocodile from this level is referred by E. Buffetaut (personal communication) to Cynodontosuchus cf. rothi (Baurusuchidae, Sebecosuchia), a species found with dinosaurs in the Neuquen Group of Argentina (Bonaparte & Powell 1980).

The vertebrate fauna from Tiupampa is exceptionally rich in specimens and taxa. Two primary fossil levels were sampled, although indeterminate fragments of turtles were observed throughout the section, especially toward the top.

The first level is a limestone located about 90 m above the base of the formation. Vertebratea are represented only by the selacian Dasyatis schaefferi, a species also known from the lower levels at Villa

Viscarra and Torotora (Cappetta 1975, personal communication).

The second level at Tiupampa, and the one regarded as the most significant of all the levels sampled, occurs between 110 m and 140 m above the base of the formation. The fauna thus far recorded includes actinopterygians, lungfish, frogs, lizards, snakes, turtles, crocodiles, birds, and mammals.

Actinopterygians are represented in seven orders and at least 10 families, some recorded for the first time in South America. These are: gars (Lepisosteidae, Ginglymodi), Enchodus oliveirai (Enchodontidae, Salmoniformes), cf. Phareodus (Osteoglossidae, Osteoglossiformes), cf. Eohiodon (Hiodontidae, Osteoglossiformes), cf. Rhineaster (Ariidae, Siluriformes), new genus (cf. Ictaluridae, Siluriformes), cf. Rhodsia (Characidae, Characiformes), cf. Miletes (Serrasalmidae, Characiformes), cf. Hoplias (Erythrinidae, Characiformes), and cf. Percichthyidae (Perciformes).

Enchodus, a marine fish, is important for correlation and age determination. Based on the smoothness of the teeth, the fossils are apparently referable to E. oliveirai Maury (1930), a species known only from rocks of Maestrichtian age in the Congo, Morocco, and Brazil (Reboucas & Silva Santos, 1956, J. Signeux personal communication).

The other actinopterygians from Tiupampa were not previously recorded from the rocks of Late Cretaceous age, and two points were considered in assigning them to Maestrichtian. First, they were compared with the fish fauna from Hotel Cordillera, confidently regarded as Maestrichtian (Gayet 1982a, b, c); and second their paleobiogeography was considered. (To be continued in the August issue.)

Coming in August: more lower vertebrates, mammals, marsupials, placentals, and vertebrate fauna from the Santa Lucia Formation.

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