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RECENT DISCOVERIES OF LATE TERTIARY  
MARINE MAMMALS IN FLORIDA

GARY MORGAN AND ANN E. PRATT



A Publication of the  
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Florida State Museum, University of Florida  
Gainesville, Florida 32611

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## SPRING FPS MEETING

The spring meeting was hosted in the Bone Valley by Frank Garcia and the IMC Company. On April 23rd the FPS gathered at Joe Larned's BONE VALLEY MUSEUM for a full day of fun, fossils, and food. By 8:30 AM, the group numbered just over 300 strong, a record attendance at any FPS meeting. The caravan of cars, as it departed westward and then northward, was longer than the town of Bradley Junction. The first stop was the CHICORA MINE of International Minerals and Chemicals, Inc. Mr. Jim Watson, hosting for IMC, provided tours of a shut-down dragline and access to a rich Bone Valley mine-face. The search was fun and remarkably fruitful (Fig. 1). Many specimens of proboscideans, sirenians and sharks were found. Nearly everyone found something to treasure. Within an hour, a storm from the Gulf of Mexico had moved inland, carrying strong gusty winds into the mine. As there had been no recent rains, the sand was carried violently by the winds. The group bravely battled the equivalent of a classic Sahara sandstorm. Many continued collecting with kerchiefs or jackets hooding their faces. Finally, toward noon, Frank Garcia with his loudspeaker called the caravan to move on to the second stop. The next stop was a few miles to the northwest at IMC's New Wales mine. It was their Hospitality House, where FPS members could shelter themselves from the sandstorm, look at their fossils, swap yarns, clean the grit from their faces, and enjoy a barbeque meal.

Following the barbeque there was a very brief meeting. Frank Garcia presented Jim Watson of IMC with an exact replica of "the horned wonder," the unique moose-sized skull of a new genus and species of four-horned extinct ruminant found at IMC's Tiger Bay Mine. The brass plaque includes the statement "To IMC, with gratitude from F.P.S." This skull is now prominently mounted in the Lakeland office of IMC. The FPS is indeed grateful to IMC and Frank Garcia for an excellent spring tour of the Bone Valley.



Fig. 1. The exposed faces and spoil piles of the Bone Valley Formation at IMC's Chicora Mine yielding many good specimens to FPS members at the Spring meeting. (Photos courtesy of Ray Robinson, St. Petersburg Chapter).

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#### FPS ANNUAL MEETING

The Annual Meeting of FPS will be Saturday, October 1st, at 8:00 AM at the University of Florida Student Union.



Fig. 2. FPS members making their way toward IMC's Hospitality House at the New Wales Mine for cleanup and barbeque.

RECENT DISCOVERIES OF LATE TERTIARY  
MARINE MAMMALS IN FLORIDA

GARY S. MORGAN AND ANN E. PRATT<sup>1</sup>

Among discoveries brought to the attention of Florida State Museum (FSM) paleontologists during the last year were two partially articulated skeletons of marine mammals, one from south Florida and the other from the northern part of the state. Although isolated fossils of marine mammals are commonly found in Florida, articulated or associated skeletons are rarely encountered.

In the summer of 1982, Chris Kreider and FPS members Robin and Jan Brown discovered the associated skeleton of a very large whale in the early Pliocene Tamiami Formation in Lee County. The skeleton was entirely submerged in four feet of water in a small tributary of the Caloosahatchee River.

The second find was an early Miocene sea cow discovered in June 1982 by Kim Hyde and Cliff Maxwell in the Hawthorn Formation bordering the Suwannee River in Columbia County, only 25 miles south of the Georgia border.

Field parties from the FSM helped in the excavation of these two important finds. Because both skeletons were partially articulated, care was taken to map bone positions before their removal. In addition, vertebrate and invertebrate fossils found in association with the skeletons were collected to help in determining the age of the fossils and the types of marine environments in which they were deposited.

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Gary Morgan is a Biologist in Vertebrate Paleontology, Florida State Museum; Ann Pratt is a graduate student in the Department of Zoology, University of Florida.

HICKEY CREEK WHALE  
Discovery and Excavation

The whale skeleton was discovered in July 1982 by Chris Kreider while he was swimming in a 4-foot deep pool in Hickey Creek, a small tributary of the Caloosahatchee River in eastern Lee County. Chris initially found a portion of the occipital (posterior) region of the skull protruding from the surrounding sediment of the early Pliocene Tamiami Formation. Over the next month, Chris, Dr. Robin Brown and Jan Brown (the owners of the property), and the Brown's son Steve removed large amounts of sediment from the bottom of the creek and exposed most of the back part of the skull, along with a large number of vertebrae. The Browns visited the FSM in August with a sample of fossils they had removed from the creek. It was immediately obvious that they had discovered the remains of a very large whale. Arrangements were made at that time for FSM paleontologists to visit the site and assist in the excavation of the skull.

In September 1982 a field crew from the Museum consisting of Gary Morgan, Diderot Gicca, Richard Hulbert, and Ann Pratt traveled to Hickey Creek to begin removal of the skeleton. The week we spent at Hickey Creek was not nearly enough time to complete the excavation and a second trip was necessary. Gary Morgan, Richard Hulbert, Dave Webb, Ken Wilkins, Henry Setzer, and Joe Latvis were the crew on the second trip.

As an underwater dig of this magnitude had never been attempted by FSM paleontologists, we experimented with various techniques before actually removing any bones from the creek. Most of the digging was accomplished by teams of two divers, one to do the actual digging and the other to operate a low pressure stream of water to loosen and drive away silt and sand. The major problems encountered in digging underwater included disposing of large amounts of sediment and coping with clouding of the water caused

by fine sediment particles. The latter problem was partially solved by the use of a small electric trolling motor which, when hand held directly above working divers, created enough current to carry the turbid water downstream. To deal with the large amount of sediment removed in excavating the skull, a bucket brigade composed of volunteers from the Lee County Nature Center aided in the emptying of buckets filled by the divers. The volunteers also washed the matrix through window screen sieves, and removed all vertebrate fossils, such as shark teeth, ray plates and fish vertebrae.

After a bone was exposed, it was assigned a field number, identified, and mapped. The mapping procedure, discussed in the appendix, was accomplished using a plastic measuring tape and a waterproof compass (See Fig. 3). A map of the whale skeleton is shown in Fig. 4.

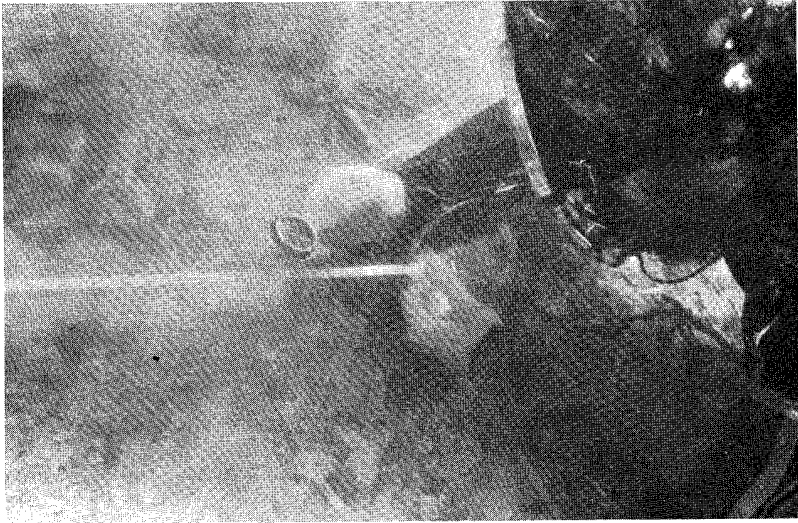


Figure 3. SCUBA diver Richard Hulbert uses waterproof compass and measuring tape to map whale skeleton under water.

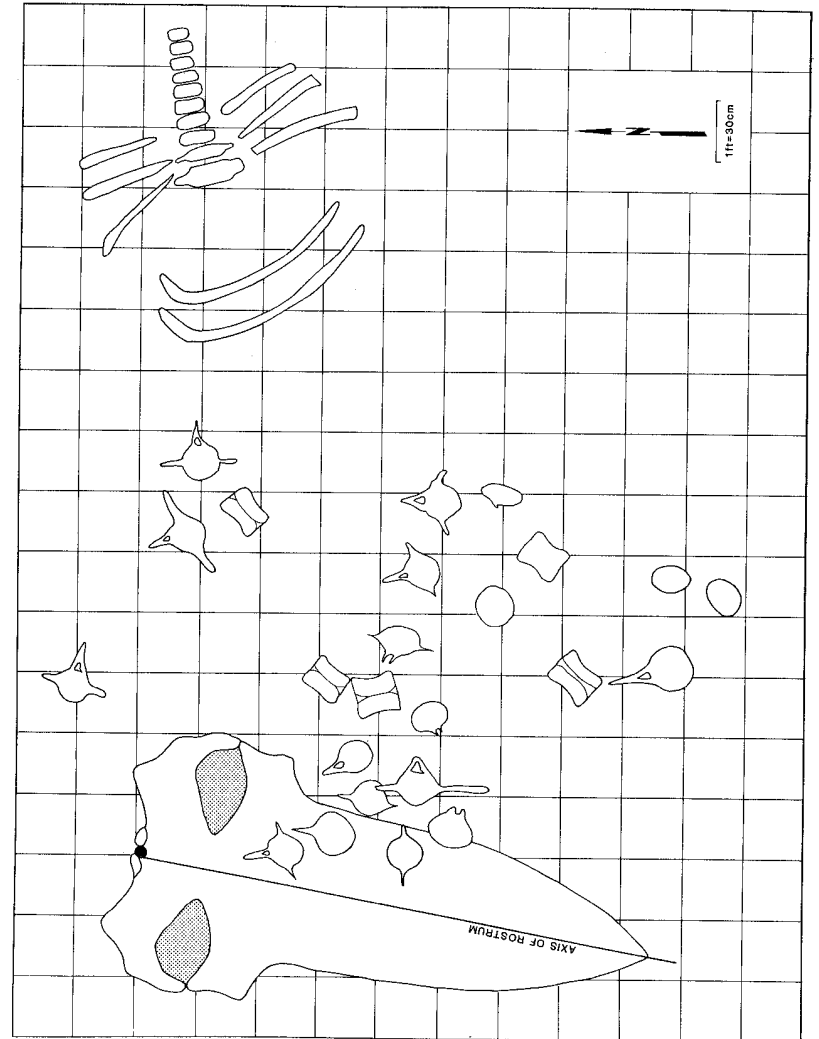


Figure 4. Map of Hickey Creek whale skeleton.

It was necessary to protect many of the skeletal elements with jackets before attempting to remove them. It was not feasible to use the standard plaster bandaging technique used in terrestrial excavations, as the plaster washed downstream before it had time to set-up. This problem was solved by the use of Scotchcast (TM), a strong, but very light, fiberglass bandage manufactured by the 3M Company, that sets up readily underwater. Dr. Brown contacted the 3M Orthopedic Division in St. Paul, Minnesota, and they generously agreed to donate a large supply of Scotchcast to our project. In addition, Dick Staloch, Senior Professional Services Coordinator for 3M, flew to Fort Myers to instruct workers on the use of the bandage. Dick, an avid SCUBA diver, also took an active part in the digging and removal of the skeleton.

Because the Scotchcast bandage was so strong, it was not necessary to apply a thick layer. Instead, we completely encased the bones in only a few layers. The vertebrae were relatively easy to jacket and remove, but the skull presented a monumental task. The posterior region of the skull was 5 feet wide and weighed in excess of 500 pounds. Therefore, we decided to remove the skull in sections along lines of major existing breaks. In order to remove the fragile sections intact, the bone had to be encased completely in Scotchcast (Fig. 5). Several tunnels were dug underneath the skull so the divers could pass the bandages from one to another beneath it, thus totally wrapping the skull. After completely encasing the section in Scotchcast, we allowed half an hour for the bandage to set. Then a team of four people carefully lifted the 200-300 pound section of skull off the creek bottom and carried it ashore. So far, in our two trips to Hickey Creek we have removed the entire posterior region of the skull in three large sections and jacketed and removed 19 vertebrae, including six cervical and anterior thoracic vertebrae in a single jacket. Parts of the whale skeleton still awaiting removal include the rostrum of the skull and at least 10 more vertebrae.

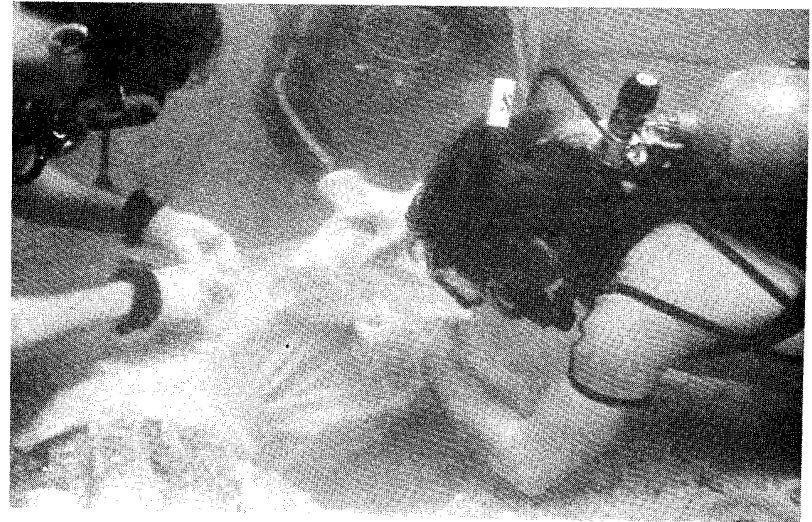


Figure 5. SCUBA divers wrap portion of whale skull in Scotchcast (TM) bandages.

After returning to the Museum with the whale, it took several months to remove the bones from the fiberglass jackets, prepare them from the surrounding matrix, and finally to repair and, when necessary, restore the various elements. Most of the preparation was done by Diderot Gicca, Russell McCarty, a preparator in the FSM Vertebrate Paleontology lab, and David Goldman, a University of Florida geology undergraduate student. Although the calcareous marl of the Tamiami Formation was relatively soft underwater, the preparators quickly realized that upon drying it became an extremely hard, cement-like substance. Using the preparator's classic tools, the chisel and hammer, the hard matrix was slowly and carefully removed from the bone.



### Paleontology of the Whale

Whales, dolphins, and porpoises are classified in the mammalian order Cetacea. The Cetacea can be further subdivided into three suborders: Archaeoceti--an extinct group of primitive whales with serrated cheek teeth; Odontoceti--the toothed cetaceans, including all living species of dolphins, porpoises, sperm whales, and beaked whales; and Mysticeti--the baleen or whalebone whales. It is to the third suborder, the Mysticeti, that the Hickey Creek whale belongs. Baleen whales are characterized by the total lack of teeth in adults and, in most modern species, by their tremendous size. Instead of teeth, they possess long fringed, keratinous plates composed of a substance similar to that of our fingernails, called baleen or whalebone, hence the two common names for the group. These baleen plates are attached to the roof of the whale's mouth and are used to filter planktonic crustaceans (krill), other invertebrates, and fish from sea water.

Baleen whales first appeared in the Oligocene epoch about 35 million years ago, but they did not become common until the Miocene. Members of the extinct family Cetotheriidae were the common mysticetes of the Miocene. At the end of the Miocene and into the Pliocene, cetotheres were replaced by the modern groups of baleen whales. Living mysticete whales are divided into three families: Balaenidae (right and bowhead whales), Eschrichtiidae (gray whales), and Balaenopteridae (humpback, blue, fin, sei, and minke whales). Based on the overall structure of the skull and, the ear bone or auditory bulla, the Hickey Creek whale belongs to the Balaenopteridae, the family that includes the largest animals ever to inhabit the earth. For a more complete summary of the fossil whales of Florida, see Plaster Jacket Number 29 by Gary Morgan.

The entire skull of the Hickey Creek whale has not yet been removed, but measurements taken underwater while it was still in place in the sediment confirm its large size. The intact portion of the skull measures just over 9 feet (3 meters) in length and 5 feet (1.5 meters) in breadth across the posterior end (see Fig. 6). The rostrum or snout, the underside of which would have been the site of attachment for the baleen plates, is badly damaged, but its maximum breadth would have been about 3 feet (1 meter). Only two fragments of the lower jaws have been recovered thus far. Nineteen vertebrae have already been removed from the creek and at least 10 additional vertebrae have been located and mapped. Large baleen whales have anywhere from 40 to 65 vertebrae, so at least half of the total number have been accounted for. The largest vertebra is from the lumbar region and measures 8 inches (21 centimeters) across the centrum. Among the bones located thus far,

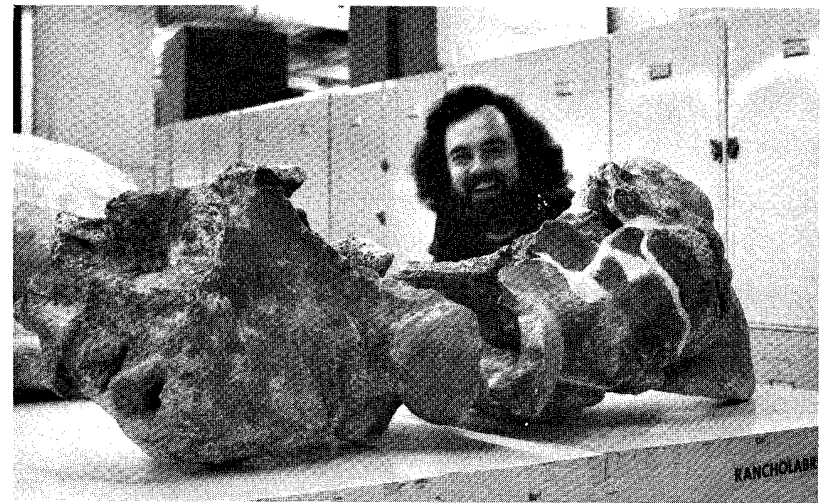


Figure 6. Intact posterior region of Hickey Creek whale skull--occipital condyles and foramen magnum are at bottom center of picture (paleontologist for scale).

the only portions of the skeleton still in articulation were the five posterior cervical and four anterior thoracic vertebrae, and several anterior ribs. Further probing in the surrounding sediments of the Tamiami Formation will undoubtedly bring to light additional elements. The major bones still to be discovered include the remainder of the mandibles and the front limb or flipper bones (scapula, humerus, radius, ulna, etc.).

One of the more diagnostic bones in the baleen whale skull is the auditory bulla or "ear bone" (see Fig. 7). Both auditory bullae are present in the Hickey Creek whale. Dr. Frank Whitmore of the U. S. Geological Survey in Washington, D.C., was kind enough to compare one of the auditory bullae from the Hickey Creek whale to bullae of modern whales in the collections of the Smithsonian Institution. He reports that the bulla belongs to Balaenoptera, the genus that includes the living blue, fin, sei, and minke whales. Several differences, including the smaller size of the ear bone relative to the overall

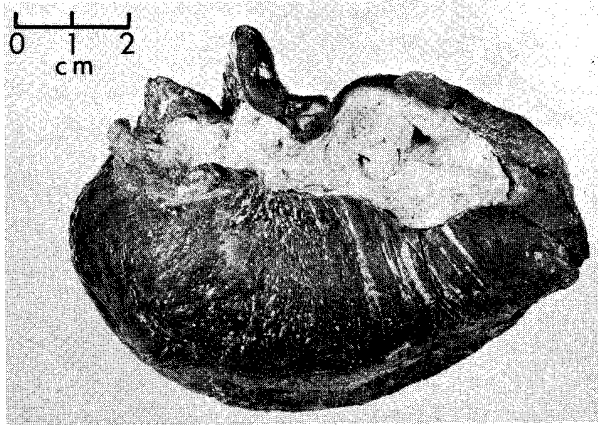


Figure 7. Auditory bulla of Hickey Creek whale.

skull length, would indicate that the Hickey Creek whale belongs to an extinct species of Balaenoptera. The well known whale paleontologist, Remington Kellogg described an extinct species of Balaenoptera, B. floridana, from early Pliocene sediments of the Bone Valley Formation in Polk County. Unfortunately, B. floridana is known only from a lower jaw, while just two fragments of lower jaw of the Hickey Creek Balaenoptera have been recovered. Nonetheless, comparison of several mandibular measurements in these two whales confirms that the Hickey Creek whale was considerably larger than the Bone Valley species, indicating that there were at least two species of Balaenoptera in Florida during the early Pliocene. Based on skull length relative to total body length in living whales of the genus Balaenoptera, the Hickey Creek whale would have been between 40 and 50 feet long. It is comparable in size with two living species of medium-sized Balaenoptera, the fin whale (B. physalus) and the sei whale (B. borealis).

#### Age and Paleoecology of the Whale

During the course of excavating the whale skeleton, a large amount of sediment from the Tamiami Formation was screen-washed to recover other vertebrate fossils. Figure 8 shows a representative sample of the vertebrate fossils found with the whale. The most abundant fossils are teeth of tiger sharks (Galeocerdo cuvieri), bull sharks (Carcharhinus leucas), and sharpnose sharks (Rhizoprionodon), and the crushing mouth plates of eagle rays (family Myliobatidae) and porcupine fish (Diodon). Less common species of sharks include the lemon shark (Negaprion brevirostris), an extinct mako shark (Isurus hastalis), and the extinct Hemipristis serra. Sting rays (family Dasyatidae) are represented by several dermal denticles, while bony fish remains include the serrated teeth of barracuda (Sphyraena barracuda) and the curious "incisor" teeth of trigger fish (Balistes) and porgies (family Sparidae). A



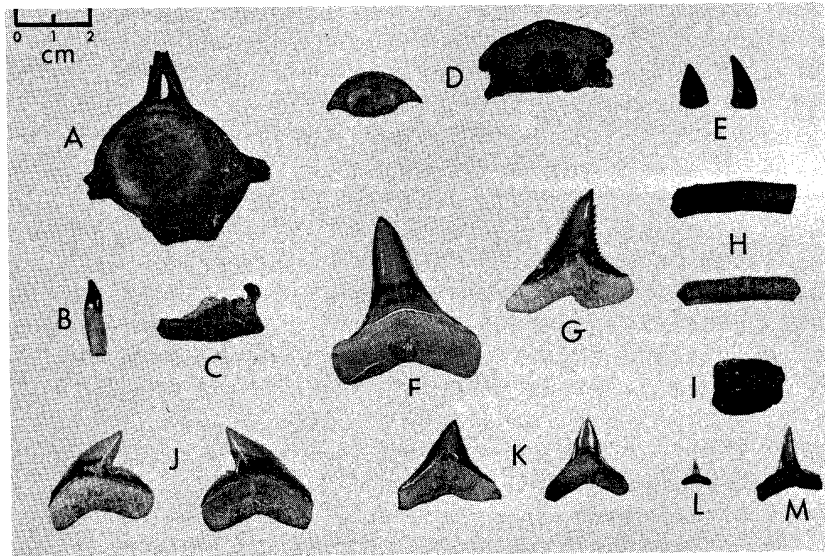


Figure 8. Early Pliocene marine vertebrate fauna from Hickey Creek whale site. A, B, C: Vertebra, tooth, and auditory bulla, respectively, of a small odontocete cetacean (dolphin); D: crushing plates of a porcupine fish (*Diodon*); E: teeth of a barracuda (*Sphyraena barracuda*); F: tooth of an extinct mako shark (*Isurus hastalis*); G: tooth of an extinct shark (*Hemipristis serra*); H: crushing mouth plates of an eagle ray (family *Myliobatidae*); I: dermal denticle of a stingray (family *Dasyatidae*); J: teeth of a tiger shark (*Galeocerdo cuvieri*); K: teeth of a bull shark (*Carcharhinus leucas*); L: tooth of a small species of *Carcharhinus*; M: tooth of a lemon shark (*Negaprion brevirostris*).

small odontocete cetacean, probably a dolphin of the family *Delphinidae*, is represented by several teeth, vertebrae, and an auditory bulla. A much smaller baleen whale, similar in size to *Balaenoptera floridana*, is represented by a single isolated periotic (inner ear bone).

The great majority of the species present in the Pliocene vertebrate fauna from Hickey Creek are still alive today, so comparisons with the modern fauna provide useful information on the habitat preferences of the various species, and ultimately on the ecological conditions present at the time the whale died. Tiger, bull, lemon, and sharpnose sharks are all typical of shallow inshore waters in warm tropical or subtropical seas. The first three species commonly enter bays and estuaries, while the tiny sharpnose shark (maximum length of 3 feet or 1 meter) is confined to shallow, nearshore waters. Tiger and bull sharks, the two most common large sharks found in association with the whale skeleton, are well known for their scavenging habits. The large number of their teeth found in direct association with the whale skeleton, along with obvious shark tooth marks on a number of the ribs provides strong evidence that sharks fed on the whale. It is doubtful that sharks preyed upon and killed this large whale. Instead, they probably fed on the bloated carcass after it had floated into shallow water. The remainder of the vertebrate fauna, especially the rays, porcupine fish, trigger fish, and barracuda are all found most commonly in shallow nearshore waters in tropical seas.

Invertebrate fossils were also collected from the Tamiami Formation, not only to help determine the geological age of the whale, but also to give an indication of the environment in which it was deposited. The most abundant invertebrate fossils represented are oysters (*Ostrea*) and large barnacles (*Balanus*). A small pecten or scallop (*Chlamys*) is also fairly common. The remainder of the invertebrate fauna consists only of casts and molds, as the original shells have been dissolved by acidic groundwater. Among the casts and molds, colonial corals and gastropods (snails) of the genera *Turritella* and *Conus* are the most common. A partial shell of the rare gastropod *Ecphora quadricostata* was an especially important find, as it helped pinpoint the age of the sediments as early Pliocene,

approximately 5 million years old. The fossil invertebrates, especially the corals, also indicate shallow water tropical conditions.

The sediments of the Tamiami Formation in which the whale was deposited consist of greenish clays and cream-colored calcareous marls that appear to have accumulated in quiet, shallow marine waters relatively close to land. The large proportion of clay and other land-derived material in the Tamiami Formation indicates that a large river probably entered the sea in this vicinity, although no terrestrial or freshwater vertebrates of Pliocene age have been recovered from the whale site. The area of deposition in the vicinity of Hickey Creek during the Pliocene may have resembled a large shallow marine embayment, much like present-day Tampa Bay.

#### SUWANNEE RIVER SEA COW Discovery and Excavation

In early June 1982, Kim Hyde and Cliff Maxwell, students at Lake City Community College, discovered several fossilized ribs protruding from the bank of the Suwannee River while they were canoeing near White Springs. They removed one of the ribs and brought it to the FSM for identification. The rib was immediately identified as that of a sea cow by its extreme density and characteristic shape.

On June 26, an FSM crew consisting of Gary Morgan, Richard Franz and Cathy Puckett, met Kim and Cliff in White Springs to pinpoint the exact location of the skeleton. The FSM party was accompanied by Dr. Daryl Domning from Howard University, Washington, D.C., a specialist on fossil and Recent sea cows and by Ron Ceryak, a hydrologist with the Suwannee River Water Management District. Unfortunately, in the three weeks since the skeleton had been discovered, torrential rains had caused the Suwannee River to rise three feet and the skeleton was underneath a foot or so of rapidly flowing water. The crew decided that excavation at that time was impossible, but we were

able to determine that the find was indeed a partially articulated sea cow skeleton, and that at least a portion of the skull was present.

It was not until the end of November that the water level in the Suwannee River had finally fallen sufficiently to once again expose the skeleton. On a sunny Sunday morning an FSM field party consisting of Gary Morgan, Ann Pratt, Richard Franz, and Cathy Puckett returned to White Springs to remove the skeleton. The sandy sediments of the early Miocene Hawthorn Formation were damp enough to allow easy digging and within several hours, trenches had been dug around the three major regions of the skeleton. Exact locality data were recorded, photographs were taken, and the entire skeleton was mapped (Fig. 9). Three plaster jackets were made using burlap strips soaked in plaster. Metal rods were wrapped into the jackets to add extra support and to aid in carrying the large, heavy jackets. One jacket contained the skull, while the other jackets contained only ribs and vertebrae.



Figure 9. Gary Morgan (left) and Richard Franz (right) put a plaster jacket on the sea cow skull, while Ann Pratt (center) maps the remainder of the skeleton.

Preparation of the skull and skeleton was not difficult as the sediment was soft and the bone was dense and hard. Upon removal of the sediment surrounding the skull, we discovered that the skull was almost 100% complete, including two tiny tusks, a rare find in fossil sea cows. In addition to the skull, the completely articulated series of cervical vertebrae were found still attached to the occipital condyles. Several thoracic vertebrae were also enclosed in the jacket with the skull, along with one of the lower jaws. The remaining two jackets contained mostly ribs, along with several partial vertebrae. Apparently, most of the vertebrae and the front limbs had been eroded away prior to the discovery of the skeleton.

#### Paleontology of the Sea Cow

Sea cows are the only members of the unique mammalian order Sirenia. Sirenians and cetaceans are the only totally aquatic mammals, i.e. they spend their entire lives in the sea. Living members of the Sirenia include only four species: three species of manatees, including the familiar Florida manatee (Trichechus manatus), and the dugong (Dugong dugon), a more pelagic sea cow found in the Indo-Pacific region. All Recent sirenians are aquatic herbivores, feeding primarily on marine grasses, algae, and floating aquatic plants. Sea cows are characterized by the loss of hind limbs and the development of a horizontal fluke at the posterior end of the body for locomotion. Perhaps the most diagnostic character of sirenians is their extremely dense, heavy bones, especially the ribs. Because their dense bones preserve so well, sea cows have an excellent fossil record that continues almost uninterrupted from the middle Eocene to the present.

The oldest sea cows known from Florida are found in middle Eocene limestones in Citrus and Levy counties and are about 45 million years old. During the interval between the late Eocene and the beginning

of the Miocene (about 23 million years ago), sea cow fossils are extremely rare in Florida. By the early Miocene and continuing into the late Miocene (5-8 million years ago), sea cows were common in the warm, shallow seas in and around Florida. Although dugongs are presently restricted to the Old World, all Miocene sea cows known from Florida were dugongs (family Dugongidae), not manatees. Three genera and five species of Miocene dugongs have been described from Florida: Halitherium olseni, an early Miocene species known from a nearly complete skeleton collected in the Hawthorn Formation along the Suwannee River, barely 5 miles downriver from the site of the new sea cow; Hesperosiren cratagensis, a middle Miocene species represented by several skeletons from Fullers' Earth mines near Quincy in Gadsden County; and three middle to late Miocene species of Metaxytherium.

Metaxytherium is the most widespread and abundant Miocene dugong in Florida. Several articulated skeletons of Metaxytherium floridanum have been collected in the last few years by Frank Garcia from the Bone Valley Formation in Polk County. Another nearly complete skeleton of Metaxytherium was collected in the Hawthorn Formation within the city limits of Gainesville. For a more complete summary of Florida's fossil sea cows, see Plaster Jacket Number 15 by Roy Reinhart.

Based on the structure of the skull, cheek teeth, and tiny conical tusks, the Suwannee River sea cow appears to be an early Miocene representative of Metaxytherium (Fig. 10). According to Daryl Domning, who had an opportunity to examine the skull and skeleton during a recent trip to Gainesville, the Suwannee River sea cow is closely related to a species of Metaxytherium from the middle Miocene Calvert Formation of Maryland and Virginia and also shows affinities with Hesperosiren.

The skeleton of the Suwannee River Metaxytherium includes a complete skull, a partial mandible, all the cervical vertebrae, two thoracic vertebrae, and 16 ribs (see Fig. 11 for a map of the bones). The

completeness of the skull, including very delicate structures, the articulated cervical vertebrae, and the undisturbed position of the ribs, would indicate that the sea cow, unlike the whale, was buried rapidly and the bones were not scattered by predators or scavengers. Most of the ribs, several of the vertebrae, the mandible, and the frontal region of the skull on one side had already suffered some erosion. Apparently the remainder of the ribs, vertebrae, the front limbs and the other mandible had previously been eroded away by the fast-flowing waters of the Suwannee River.

#### Age and Paleoecology of the Sea Cow

Two teeth of an extinct tiger shark (Galeocerdo aduncas), were found in direct association with the sea cow skull and the tooth of a nurse shark (Ginglymostoma) was uncovered beside the cervical vertebrae. All the sediment removed from the three

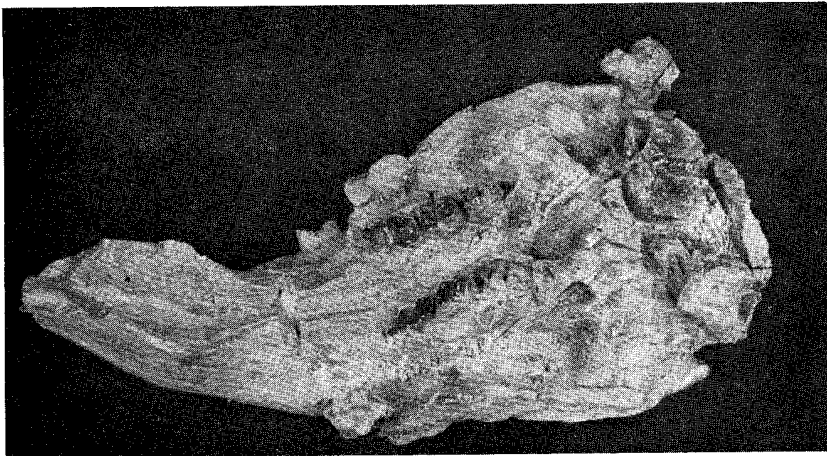


Figure 10. Skull of Suwannee River sea cow (anterior to the left).

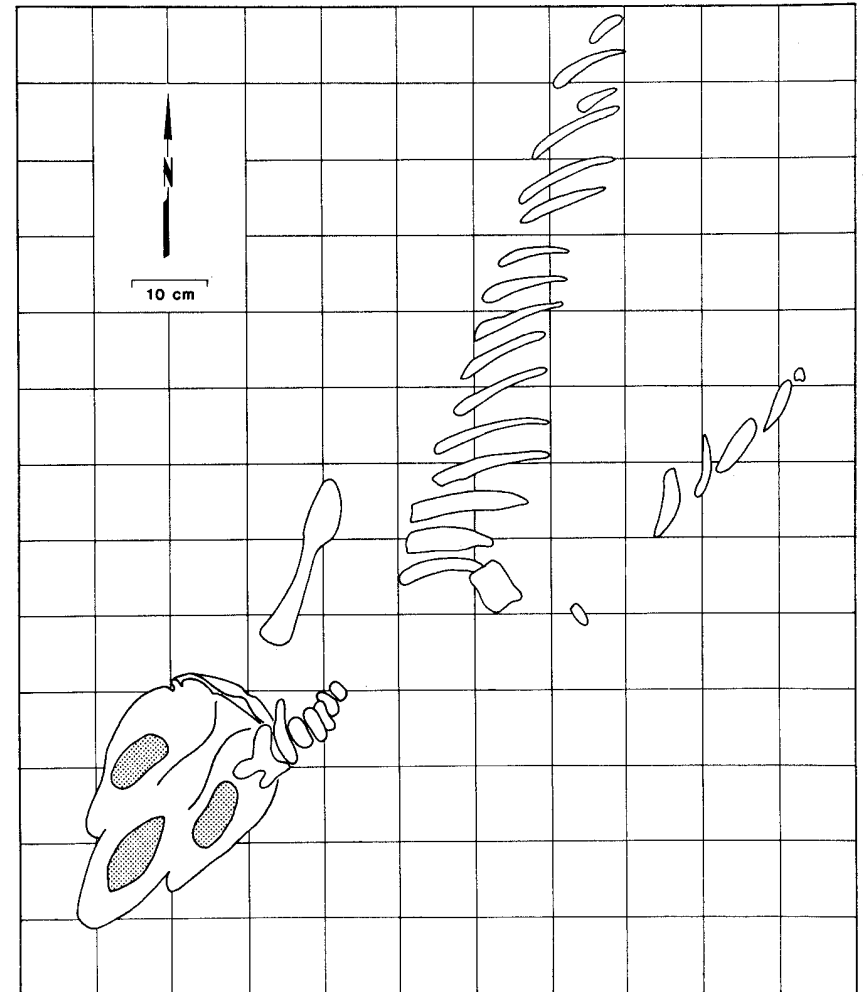


Figure 11. Map of Suwannee River sea cow skeleton.

jackets during preparation was washed through screens to obtain the microvertebrates associated with the sea cow skeleton. Numerous teeth and vertebrae of small sharks, rays, and bony fish were picked from the matrix after washing. Teeth of the tiny sharpnose shark Rhizoprionodon and a small species of the shark genus Carcharhinus were common, as were crushing mouth plates of eagle rays (family Myliobatidae) and pavement teeth and dermal denticles of stingrays (family Dasyatidae). Among the bony fish, only teeth of barracuda (Sphyrna barracuda) were positively identified, although several more species are represented by isolated teeth and vertebrae.

The most surprising and certainly the most significant fossil found in the sediment surrounding the dugong skeleton was the isolated tooth of a small rodent. This tooth belongs to a member of the family Heteromyidae, a group that includes the kangaroo rats and pocket mice of the western United States. The tooth is from a primitive heteromyid closely related to Proheteromys magnus from the early Miocene (Hemingfordian) Thomas Farm fauna in Gilchrist County. A similar species also occurs in the early Miocene (Arikareean) Buda fauna in Alachua County. This tooth is significant for two reasons. First, it establishes the age of the sea cow skeleton as early Miocene, approximately 18-22 million years old, based on comparisons with similar heteromyid rodent teeth from early Miocene terrestrial vertebrate faunas elsewhere in Florida. Second, it provides direct evidence of a land vertebrate in an otherwise strictly marine fauna. This single tooth, along with the limb element of a frog, tells us that the sea cow skeleton was deposited very close to land. Sediments of the Hawthorn Formation a mile or so downstream from the sea cow site have produced the vertebra of a medium-sized land carnivore and the pelvis of a small camel or deer-like artiodactyl. The preservation of delicate bones of terrestrial animals in a marine environment suggests strongly that these sediments of the Hawthorn Formation were deposited in quiet, shallow, nearshore waters.

The associated fauna of sharks, rays, and bony fish also indicate deposition in a shallow, inshore environment. Sharpnose sharks and nurse sharks are confined to shallow nearshore marine habitats, while most myliobatid rays and stingrays are shallow water bottom dwellers. Although tiger sharks and barracudas do occur in deeper water, they too are more typical of inshore waters in tropical seas. Both the Suwannee River sea cow and the Hickey Creek whale were deposited in quiet, warm, shallow, nearshore waters, as indicated by the associated vertebrate faunas. The presence of terrestrial mammals and an amphibian in the vicinity of the sea cow site suggests deposition very near land, perhaps in an estuarine habitat near the mouth of a river.

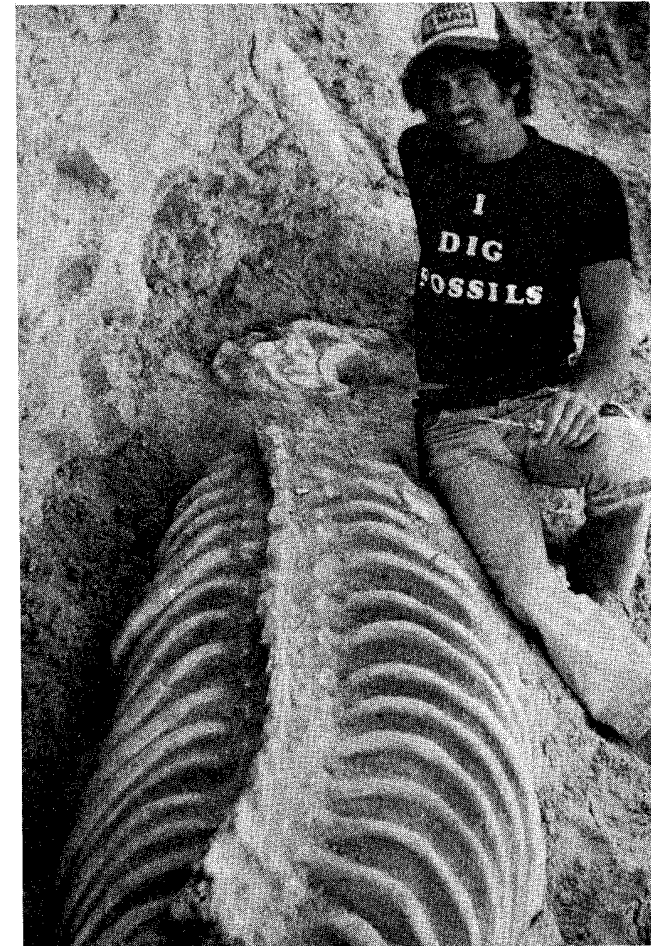
#### OTHER RECENT DISCOVERIES OF FOSSIL MARINE MAMMALS IN FLORIDA

Besides the two major finds discussed above, many other important specimens of fossil marine mammals have been collected in Florida during the past two years and donated to the Florida State Museum. Rick Carter and Danny Bryant have contributed many specimens from the Bone Valley Formation in Polk County, including a complete cetothere whale mandible, a long-beaked dolphin skull, and teeth, a skull fragment, and several postcranial bones of the rare Bone Valley seal. Eric Kendrew has also donated a number of marine mammals from the Bone Valley Formation, including two long-beaked dolphin skulls, a walrus tusk, and a sea otter mandible. Other discoveries of Bone Valley cetaceans include a large baleen whale mandible donated by Larry Martin and a complete uncrushed braincase of a long-beaked dolphin contributed by Larry Lawson. John Howell found the skull of a small baleen whale near Clewiston in Hendry County. Burkett Neely of the U. S. Fish and Wildlife Service donated a partial skull of the Atlantic gray whale found on Jupiter Beach, the only skull of this extinct whale ever collected in Florida. Brian Ridgway has given us several baleen whale fossils from

the Toy Town Dump site in St. Petersburg (see Plaster Jacket Number 40). Cliff Jeremiah donated a large sample of baleen whale ear bones from dredging sites along the St. Johns River in Jacksonville. Bobby Guerriere and Nat Fuller contributed two interesting dolphin beaks and a dugong tooth from the Hawthorn Formation in Gainesville. Paul Heinerth and Terry Leitheuser gave the Museum several vertebrae and ribs of the rare Eocene sea cow Protosiren that they collected 80 feet underwater while cave diving in Pasco County. Art Poyer donated a skullcap of Protosiren he collected in a limestone quarry in Citrus County. Roger Portell very recently discovered a partial skeleton of the Eocene archaeocete whale Zygorhiza in a limestone quarry in Lafayette County. Mike Stallings and Chris Runk helped several FSM crews collect a large series of manatee fossils from the Oklawaha River in Marion County. Frank Garcia and vertebrate paleontologists from the Smithsonian Institution, in particular, Daryl Domning, have also made many important discoveries of fossil marine mammals in Florida during the past few years. As a result of Daryl's interest in fossil sea cows, Frank and he have collected a number of well-preserved skulls and skeletons of Metaxytherium in the marine sediments of the lower Bone Valley Formation in Polk County (see photo). They have also collected several nice skulls and mandibles of cetotheres and long-beaked dolphins from this same unit.

These recent discoveries have added significantly to our knowledge of the fossil history of marine mammals in Florida. Through the generous donations of amateur paleontologists and interested citizens around the state, we are now able to document this history more completely than ever before. There is still much to be learned, however, about our state's marine mammals, especially those from the Eocene, Oligocene, and early Miocene. If you come across skulls or skeletons of whales, dolphins, sea cows, or seals, paleontologists at the FSM would greatly appreciate knowing about them. When a skull or skeleton is discovered, the best policy is to leave it

undisturbed. Marine mammal fossils, especially whales, are often very large and extremely fragile and, thus, are difficult to collect without assistance.



FRANK GARCIA with an almost perfect dugong skeleton in Phosphoria Mine, now being studied at the Smithsonian Institution in Washington, D.C.



## APPENDIX: MAPPING FOSSIL ASSEMBLAGES

Any fossil skeleton or group of associated bones can be accurately mapped. All that is needed is the right equipment and a basic grasp of geometry. Mapping a fossil assemblage provides information that otherwise would be lost if the bones were simply removed in the field. In the two examples discussed in this PJ, the maps of the sea cow and the whale provide insight as to the possible mode of death of each animal and the environment of deposition. The map of the whale was particularly useful. As it was not possible to view the entire skeleton underwater, the map was the only means by which an accurate overall picture of the distribution of the skeletal elements could be obtained.

Bones that are not in direct association in a skeleton may also be mapped. A permanent record of bone orientations and positions may help determine the predepositional events, such as scavenging or stream winnowing, that affected the original bone concentration. The procedure described below is for use in mapping a discrete assemblage of bones that can be removed in one field day. Larger scale mapping procedures require the establishment of a permanent grid system.

## MATERIALS NEEDED:

1. Non-metallic meter tape or some type of measuring tape (metal will affect compass).
2. A compass (preferably a Brunton compass, but almost any field compass will work).
3. Indelible marker that writes on bones (we use a #2 rapidograph pen with permanent black ink).
4. Field book or graph paper, pencil, protractor.

Figure 12 represents a fossil assemblage to be mapped. Before beginning the formal map, it is very important to record accurate locality information, such as name of deposit (if known), township, county, map section, and location relative to major roads or bodies of water.

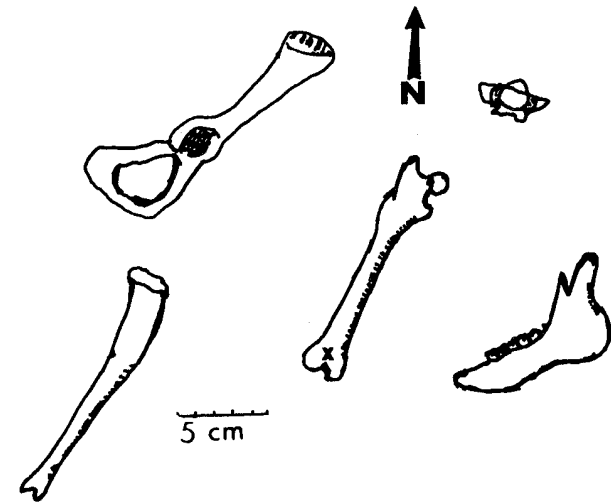


Figure 12

Bone #	Bone id.	Bone Length	Angle from ref. point	Distance from ref. point	Angle of bone	End meas. + orientation
1	Femur	13cm	—	—	30° E of N	Distal-SW
2	Tibia	15cm	300° E of N	10cm	205° E of N	Proximal-NE
3	Jaw	9cm	283° E of N	7cm	60° E of N	Anterior-SW
4	pelvis					

Figure 13

## RECORDING MAP DATA

Before beginning, familiarize yourself with the compass. The simplest way to interpret the readings is by picturing a large circle divided into four equal wedges. If North is at the top of the circle, the first wedge clockwise from North to East (0 to 90 degrees East of North) may be considered the Northeast sector. The wedge from East to South (90 to 180 degrees East of North) is the Southeast sector and so on. Any line sighted with the compass will be pointing into one of the four sectors, and the angle it forms relative to North will be read as an angle from 0 to 359 degrees East of North.

1. Determine North using your compass. On your field map, draw an arrow indicating North (this arrow should always point to the top of the page).
2. Choose a likely looking element to be your reference bone. Pick some distinctive feature of this bone and mark it with an X. This X will be the reference point, and all other bones in the deposit will be mapped relative to this one point. On your map, draw a small X. In our example (Fig. 12) the distal end of the femur has been chosen as the reference point.
3. Set up your notebook for taking data (see Fig. 13). Preparing the notebook before you begin insures that you will not forget to take an important measurement.
4. Label your reference bone with the number 1, and write its identification in your field notes. Measure the bone and record its length and width. Using the compass, determine the angle formed by the bone relative to North. Read this angle from your reference point. In our example (Fig. 14), on the femur, the reference point is lying in the Southwest sector and the bone is heading Northeast. To place the bone on your map, use a protractor to determine the angle

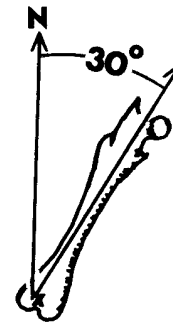


Figure 14

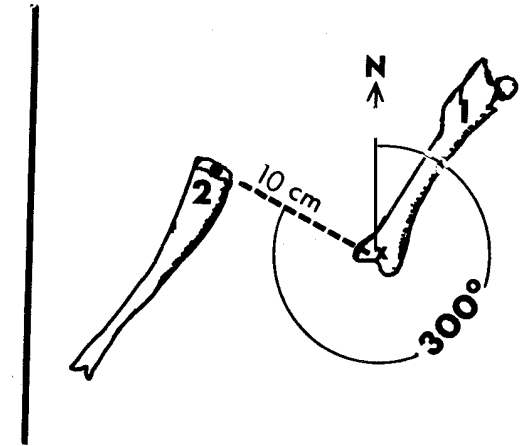


Figure 15

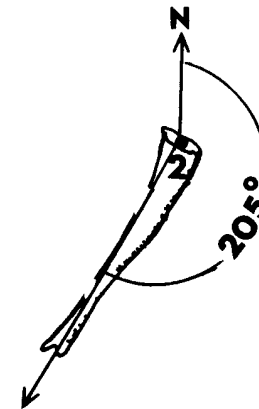


Figure 16

formed by the bone from the X. Draw in the line, making it the correct length. Sketch in the bone outline around this line.

5. Measurements on the remaining bones now require two steps: (A) determining a bone's position relative to the reference point, and (B) reading the bone's compass orientation relative to North.

(A) Choose the next bone to be mapped. Mark one end of this bone with a dot, and label the element #2. Record its measurements and identification. To determine the location of the dot on bone #2 relative to the reference point, lay your meter tape between this dot and the X on the reference bone. Note the distance between the two points, and sight along the tape to obtain the angle formed by the tape relative to North. Read this angle from the reference point. Using your protractor, map the dot on bone #2 on your field map. In our example (see Fig. 15), the line formed by the tape (indicated by dotted line) is running into the Northwest sector from the reference X. Along this line, bone #2 is 10 centimeters from the X on bone #1.

(B) From the dot on the bone, determine the bone's orientation relative to North (see Fig. 16). In our example, the line from the dot on the proximal end of the tibia along the long axis is  $205^\circ$  East of North (the angle is read from the Northeast end of the bone). Plot this angle on your map and sketch the bone in around it.

Procedures 5A and 5B are now repeated for the remaining bones; make sure each bone has a number and a reference dot. Bones may be removed as they are mapped, providing the reference bone remains in place until all other bones are mapped.