I. The New Important Research Result

“A Triassic female marine reptile *Keichousaurus hui* gave birth to live young (viviparous) 230 million years ago”

Finally, the truth is revealed. Pregnant reptiles illustrate how their prehistoric ancestors gave birth.

The two extremely rare fossils of pregnant marine reptiles from middle Triassic of the Mesozoic Era are carefully housed in the NMNS indicating that this type of marine reptiles gave birth to live young (viviparity). Therefore, paleontologists denied the possibility that they came ashore to hatch eggs. The fossil reptiles *Keichousaurus hui* had been expedited by the evolution of a movable pelvis, which helped the mothers bear live young. Each fossil specimen preserved to six embryos.

This fossil discovery has been the first evidence to directly prove and elaborate on the reproduction strategies and methods among Sauropterygians (including Ichthyosaur and *Plesiosaurus*). Sauropterygians were the largest and the most diverse group of animals amongst the marine reptiles in geological history. They lived from 250 to 65 million years ago dominating almost the entire Mesozoic Era. Since the first description of a *Plesiosaurus* in 1821, thousands of related Sauropterygian marine reptile specimens have been collected all over the world (including the Mesozoic in China). However, no direct evidence has been detected to determine whether they came on shore to hatch eggs (oviparity) like sea turtles, or gave birth in the water to live young (viviparity) like the Ichthyosaurs (1846) and Mosasauroids (2001). Even though many scientists have proposed hypotheses and speculations about viviparity, which occurred in *Plesiosaurus*, Pachypleurosaurus (including the Keichousaurus in this report) and Nothosaurus, there has not been direct and effective evidence to prove that they are right so far.

This study is based on the two gravid specimens (NMNS-cyn2002-01 and NMNS-VL.191, respectively) of *Keichousaurus hui* Yong (1958) excavated from the Guanling Formation near Sinyi, the province of Gueijhou, China in the late Middle Triassic (Anisian-Ladinian, 230 million years ago). These specimens are extraordinarily well preserved. They provide clear evidence of sexual dimorphism in Sauropterygians, and indicate that Sauropterygians and their close relatives did give birth to live young in water (viviparity). The findings further help researchers imply that the presence of a movable pelvis (the attachment between the pelvic girdle and the sacrum) in Pachypleurosaurus from evolution revealed a possible reproductive pattern. It can be explained that other related Sauropterygian marine reptile species also had a movable pelvis (good for adaptation and movement), which answers questions about their reproductive method. The anatomical feature of the *Keichousaurus* specimens enabled them to bear offspring in the dangerous ocean.

Dr. Cheng, Yen-nien worked on the two specimens with Dr. Wu, Xiao-chun at the National Museums of Canada in Ottawa and Dr. Ji Qiang from the Chinese Academy of Geological Sciences, Beijing, and published the results in Volume 432 of *Nature* in November 2004. After three months of dedicated prepared by Dr. Cheng it is easy to see the embryos in one of the specimens. The other specimen was generously lent from the Paleowonders Mineral and Fossil Museum, situated in Banciao, Taipei for our research purpose. The study indicated that the embryos were in a malpresentation (breech presentation) which led the paleontologists to believe that the mothers died of dystocia.

Why did the reptiles go back to the sea? How did they use locomotion to move in the water? How did they search for food? How did they reproduce and nurture offspring and grow? Were they endothermic? Why did the Sauropterygians go extinct? The answers to these questions need further investigation.
II. Important Rock and Mineral Specimens from Donations

Geological specimens are either collected by the staff or purchased from foreign or domestic specimen dealers. Some specimens are also donated from college/university professors, enthusiastic amateurs, students or the public. Over the past two years, the Museum has received more than four thousand pieces of geological specimens resulting in a diverse and abundant collection, and the Museum expresses its gratitude for the generous donations from all over the world. Here are some examples of donations the Museum has accepted:

(1) Donation made by Professor Chen, Ju-chin

Dr. Ho, kung-suan received a phone call from Professor Chen, Ju-chin in June 2004, indicating that he would like to contribute all the rock and mineral specimens, academic journals, and research papers and books he had collected throughout his life to the Museum. This has been his second philanthropic contribution since 2003.

Professor Chen, a respectable figure in the fields of geology and oceanography, specializes in geochemistry, marine geology, and petrology. He has devoted himself in the Institute of Oceanography at the National Taiwan University after completion of his studies in the U.S. He not only is a good teacher, but also chaired the second-term director of Institute and the president of Geological Society of China located in Taipei. He is a remarkable researcher and keeps good interpersonal relationships with people, setting an outstanding example for the later generations.

Professor Chen has donated more than 560 important domestic and foreign specimens, powder, and thin sections of rocks and minerals, sediments, and deep-sea manganese nodules as well as 800 research papers and journals concerning geology over the last two years. The Museum was even more impressed and touched by Professor Chen’s generosity to send the aforementioned items over on trucks at his own cost. Among the specimens, there are andesite and basalt from Taiwan, Taiwan’s offshore islands, Sea of Japan, and the Philippine Sea; granite from Kinmen and Matsu as well as sediment from shallow- and deep seas around Taiwan. Part of the collection is the crucial rock and mineral specimens from other countries (such as the mantle peridotite xenoliths found in the Antarctic), and the deep-sea manganese nodules are rare and precious.

Professor Chen was a pioneer devoting his studies on the manganese nodule in Taiwan. The manganese nodules are deposited by enrichment of manganese, iron, cobalt, nickel, copper, lead, molybdenum, vanadium, and titanium. These metallic elements are essential alloy materials in the industry, which are now in large demand in this high-tech era. Therefore, manganese nodules are regarded as an important mineral resource. "R/V Chiu-Lien" the first marine exploration ship in Taiwan, discovered manganese nodules approximately 10-20 centimeters across on the Philippine Sea floor 2,900 and 5,700 meters deep to the east of Taiwan. Professor Chen and his students carefully studied the mineral composition, chemical characteristics, and growth rates and published many research papers regarding the discovery.

Professor Chen was also of Dr. Ho advisor and has collaborated with and always supported the Geology Department. The Department would like to express its deepest gratitude to him for he has donated his collected specimens and complete geological journals for the Museum’s permanent collection. The Museum carefully preserves and manages these properties for the generations to come.
(2) Donation made by Professor Yen, Tsang-Po

In spring 2004, Professor Ma, Guo-fong at the National Central University mentioned that Professor Yen, Tsang-Po left some specimens and literatures in the Institute of Geophysics, National Central University. She asked if the Museum would like to take them in. We were extremely thrilled and took the offer without a second thought.

Professor Yen remains a prominent figure in the field of geology dedicating himself to field surveys of igneous, metamorphic rocks, and mineral deposits. Yen started his studies in geology since the Japanese occupation, and his collection must have been significant. Dr. Gong, Shou-yeh and Wang, Shih-wei spent two days sorting the collection in Jhongli in April, 2004.

Professor Yen's collection of minerals, rocks, and sections totals more than 700 pieces among which include the very rare native gold from Rueifang and Jinguashih, iolite from Lyudao, and zircon from Guansi, Hsinchu, not to mention metallic mineral specimens from Korea and Japan that the Museum never had.

Furthermore, there are 54 well-preserved geological maps, which were finished during the Japanese colonial period, are considered valuable evidence of Taiwan's geological history. Most of the current maps from that time are not well preserved due to regular use. However, these 54 maps look as good as new. They might be the most complete geological maps from early in the history in Taiwan.

Unfortunately, the notes and symbols in the numerous unpublished scripts, working maps and some specimen labels are incomprehensible. It is a pity that later generations cannot understand these clues that reflect Yen's observations and thinking. We should learn from this lesson—keep records of one's research, document and place them appropriately and become the collective properties of human beings. Otherwise, all the time-consuming studies will not be carried on and will be wasted. To prevent similar disasters from repeating themselves, the National Central University donated these specimens to NMNS, and we are grateful for its generosity.

(3) Donation made by Professor Yang, Houng-yi

Professor Yang, Houng-yi is a well-known petrologist in Taiwan. He dedicated more than 30 years to teaching in the Department of Earth Sciences at the National Cheng Kung University after earning his doctoral degree from Ohio State University. On January 31, 2004, he retired with honors. During decades of teaching and research, he focused on petrology, geochemistry, and refractory materials. In recent years, he led one of the NSC's large-scale integrated projects—a study on the mineralogy of igneous and metamorphic rocks in the Cilian suture zone. He should be given credit for the development of Taiwan's studies on rocks and minerals.

One or two years before Professor Yang's retirement, he managed thousands of rock and mineral specimens that were used for research and contributed them to the Museum. In addition to the igneous rocks from Taiwan and Penghu Islands, there are mineral specimens from Chungbuk, Kyonggi, and Busan/Pusan in Korea; molybdenite in Canada; ashes from Mount St. Helens in the U.S. and chromite from Zambales, the Philippines. Professor Yang labeled and proofread the scientific name, field number, and collection locality, and other detailed information of each specimen. He also specified elaborately which specimens had been studied by which students of his, indicating Yang's serious attitude not only toward research samples but also meticulous scholarship and research and setting a good example for us.
III. Important Fossil Specimens from Purchases

The Department had gathered a few magnificent fossil specimens over the past two years (2003-2004). In 2003, we obtained a Triassic Ichthyosaur, which was discovered in Xingyi, Guizhou, China. It belongs to the Mixosauridae family, but its exact classification needs further study. We obtained it as rock slabs. It took a half year to recover the whole fossil. Part of the recovery efforts were demonstrated in the exhibit hall, so the public could actually see how the fossils were prepared and recovered. This demonstration was very popular. The recovered specimen is a 410 cm long and 230 cm high plate, with a 3-D head stood out of the plate, which is extremely appealing.

Another important result in 2003 was the collection of four pieces of dinosaur fossil including the skull of *Tarbosaurus*, skull of *Ankylosaurus*, a buried group of *Oviraptors*, and the skeleton of little *Tyrannosaur*. They were all excavated from the Cretaceous strata in Mongolia. The *Ankylosaur* and little *Tyrannosaur* could be a new species that have never been recognized, and deserve further study. The specimens of *Oviraptors* show that they probably cared for their offspring. The four specimens are displayed in the Dinosaur Gallery now.

In the beginning of 2004, with the subsidies for Service Upgrade Project from the Social Education department of the Ministry of Education, the Division had a crew to the Tucson Mineral and Fossil show in the U.S. to collect the specimens for future exhibitions at the Geology Hall. The most important result of this trip is the obtaining of the fossil of *Microraptor gui*, which was also known as the “four-winged dinosaur” on the cover of the January 23 issue of the journal *Nature*. The *Microraptor gui* was dated at 125 million years old (Early Cretaceous). It had fully developed modern feathers on both the forelimbs and hind limbs. The finding provided a crucial information on the study of the origins of flight. There are two competing hypotheses that attempt to explain the origin of flight: “tree-down” and “ground-up”. The “tree-down” hypothesis states that the ancestors of birds first lived in trees. They would have sprung from branch to branch to progressively develop the gliding ability. Its proponents speculate that the evolutionary transition to birds include four-winged phases. The “ground-up” hypothesis suggests that birds’ ancestors were ground-dwelling animals that would have begun to flap while running at high speed that eventually resulted in flight. The discovery of “four-winged dinosaur” is thought to be a support of the “tree-down” hypothesis. Another significant specimen collected in this trip is the skull of *Mosasaur*. Mosasaur was a kind of huge marine reptile which existed in Late Cretaceous. Like its closest living relatives, lizards, Mosasaurs belonged to the Order Squamata. The 1.2 meters long skull shows two rows of pterygoid teeth at the back of upper jaw. It would be an attractive exhibit.

In the end of 2004, the Division gained another eight pieces of fossils for the future exhibition of the planned Geology Hall. They included mammoths *Platybelodon*, Ichthyosaurs, fossil crocodile, fossil crinoid and the *Thalattosaur*. Mammoths are one of the representing animals of the Ice Age. They are indispensable exhibits in museums and appealing topics in textbooks. *Platybelodon*, known as “shovel-tusker,” was characterized by its huge, shovel-like lower jaw and broad lower incisors. Scientists speculate that the shovel-like lower jaw may have been used to dig into the boggy bottoms and scoop up aquatic plants in the wet prairies. The *Thalattosaur* fossil is another interesting specimen. With 3-D preserved skull, it is perfect for scientific study and exhibition.