The first crocodyliform (Archosauria: Crocodylomorpha) from the Early Cretaceous of Korea

Mesozoic crocodyliform remains have been discovered from several Asian localities, including India, Thailand, China, Japan, Inner Mongolia and Pakistan, but are represented by isolated and incomplete skeletons[1–12].

A right mandible of a crocodyliform was discovered from the lower part of the Early Cretaceous Dongmyeong Formation (Barremian) in South Korea during November 2001 (Figures 1 and 2). The right mandible (KPE 40005; Department of Earth Science Education, Kyungpook National University) is incomplete and poorly preserved posteriorly (Figure 1). The mandible is relatively robust and preserves most part of the right dentary. A groove-like ornamentation is present on the lateral surface of the mandible. The surface sculpture having a rough and pitted texture, is one of the crocodyliform characters. The right mandible is curved and slightly bowed in the lateral external view (Figure 1 *a*). The splenial is damaged and incomplete. The posterior portion of the splenial is still covered by matrix (Figure 1 *c*). The length and width of the preserved portion in the right mandible are 126.5 mm and 11.5 mm respectively. The lower jaw retains only a dentary tooth (fourth) that shows fine longitudinal lines. None of the alveoli is preserved. The fourth tooth is curved labially and oval in section at the base. The pointed tooth of KPE 40005 is longer (6.3 mm) than wide (4.7 mm). The preserved crown of the tooth, which is responsible for killing and piercing the prey, is compressed laterally and serrated finely at the anterior edge. The fine striation of the crowns is typical for most anterior teeth of crocodyliforms. The right mandibular symphysis is stout (more than 30 mm) and solid. The presence of typical crocodyliform ornamentations on the jaw, longitudinal lines on the tooth, and overall morphological characteristics are strong evidence for the attribution of crocodyliform. A more detailed identification is impossible because the skull is missing.

The faunal assemblage from the Dongmyeong Formation (= Jinju Formation) is represented by fish remains, pterosaur teeth, dinosaur tracks, plants, bivalves and turtle remains[13–16]. The Dongmyeong

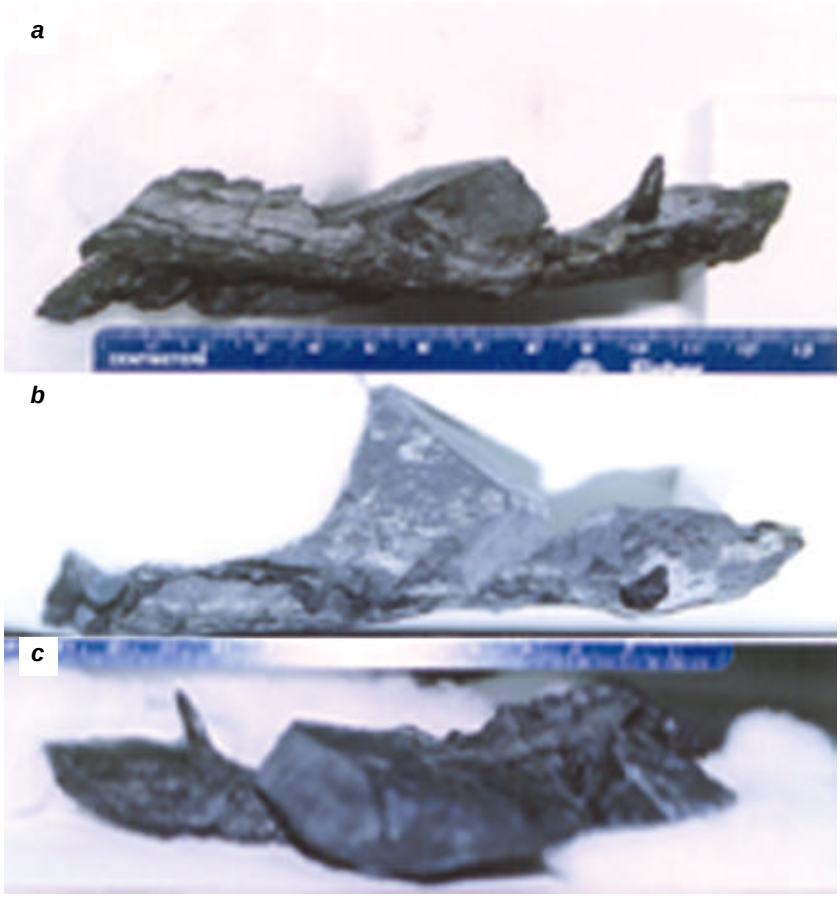

Figure 1. Mesozoic crocodilian mandible with a tooth from the Dongmyeong Formation, KPE 40005 (scale: cm). ***a***, External lateral; ***b***, occulsal; ***c***, internal lateral views.

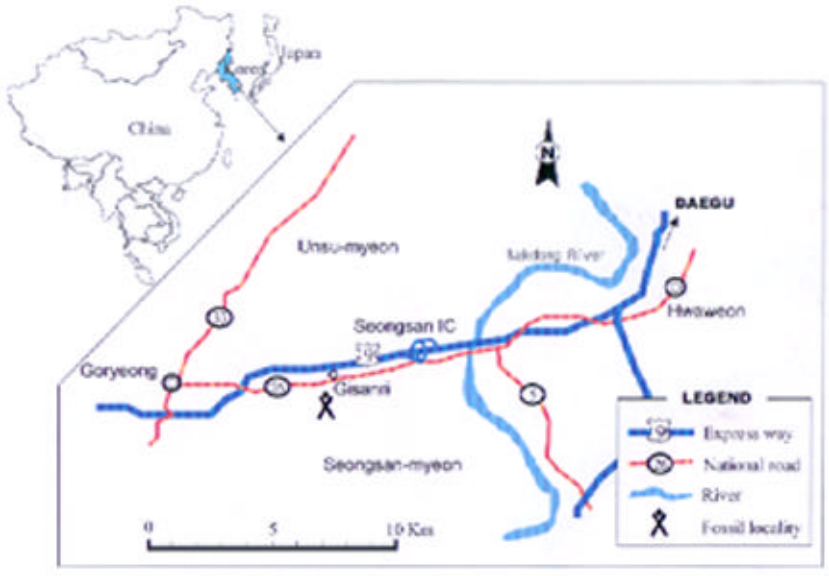

Figure 2. Location of the Early Cretaceous crocodyliform locality in South Korea.

Formation also produces insect fossils, including an earwig (order Dermaptera). The fossil earwig was identified as a pygidicranoid (suborder Forficulina)[15]. The Dongmyeong Formation, approximately 125–135 million years old, consists of grey sandstone, yellow sandstone, massive mudstone, dark grey shale and conglomerate[13–16]. The bed containing the KPE 40005 is a black mudstone and has produced a pterosaur tooth and non-marine bivalves. The bivalves include *Plicatounio naktongensis*, *Trigonioides jaehoi*, and *Nagdongia soni*[17]. The associated faunal assemblages indicate a freshwater environment of deposition. A black shale above the black mudstone has yielded a 15-cm long fish and insect fossils.

An incomplete crocodyliform tooth (KPE 3616) was reported from the Hasandong Formation (Hauterivian–Barremian) in the Gyeongsang Supergroup of South Korea and its diameter is about 0.9 cm at the base[17]. KPE 3616 has well-developed longitudinal lines on the surface and indicates a characteristic of crocodyliform. However, KPE 3616 is in a poor condition, retaining only the base of the tooth.

Indian crocodyliforms from the Deccan Intertrappean beds near Rangapur, Andhra Pradesh represents three types of teeth[3]. Teeth of the type III show a similarity with KPE 40005 in having carinae-bearing pointed apices[3].

Three crocodyliforms, *Shantungosuchus brachycephalus*, *Paralligator sungaricus* and *Edentosuchus tienshanensis*, were discovered from the Early Cretaceous of China[18]. KPE 40005 is more robust than the three Chinese species. The symphysis of *Sunosuchus junggarensis* from the Upper Jurassic of China is elongated, occupying about 45% the length of the dentary[19]. The symphysis of KPE 40005 is relatively short, occupying about 25% of the length of the dentary. *Chimaerasuchus paradoxus* from the Lower Cretaceous of Hube, China has ~ 135–140 mm long mandible and a spatulate mandibular symphusis[6]. The lateral surface of the right mandible in *C. paradoxus* is weakly sculptured with pits, short groove-like ornamentation and ridges, but the surface sculpture disappears posteriorly, while that of KPE 40005 is well developed on the lateral surface. In the lateral view, the dentary of the KPE 40005 differs from *Rugosuchus nonganensis* from the Lower Cretaceous of Song-Li Plain, China in having a slightly bowed dentary. The dentary of *R. nonganensis* is not bowed and is relatively shallow[7].

The crocodyliforms were more abundant and widespread during the Cretaceous than today because the conditions were warmer than the present[20]. Two mesocuchian families, Atoposauridae and Goniopholidae, have been distributed worldwide and show similarities to modern crocodiles[21].

The recent discoveries of vertebrate fossils, including dinosaur teeth (theropod and sauropod), dinosaur eggs (sauropod and ornithopod), turtles and pterosaurs suggest that Korea will continue to yield more vertebrate remains. The discovery of Cretaceous crocodyliform remains from the freshwater environment is significant to reconstruct a Korean Mesozoic fauna. The Mesozoic crocodiles occupied an ecological niche as a predator but had competed with other terrestrial vertebrates including carnivorous dinosaurs. Based on the records of theropod claws and teeth in Korea, medium-sized theropod existed during the Early Cretaceous. More complete cranial and postcranial skeletons are needed for identification of Korean Mesozoic crocodyliforms. The discovery of Cretaceous crocodilian remains calls for a comprehensive excavation in the locality.

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ACKNOWLEDGEMENTS. We thank Drs S.-Y. Yangn (Kyungpook National University), K. Kim and D.-K. Choi (Seoul National University) for helpful discussion and assistance. We thank the anonymous reviewers for helpful suggestions and constructive comments. This work was supported by the Korean Research Foundation Grant J.-D.L.

Received 23 October 2002; revised 3 March 2004

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