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Fossil *Albizia* Legume (Mimosaceae) from the Miocene Duho Formation of the Yeonil Group in the Pohang Area, Korea

Jong-Heon Kim*

Department of Earth Science, College of Education, Kongju National University,
182, Shinkwan-dong, Kongju 314-701, Korea

Abstract: Fossil legumes of *Albizia miokalkora* Hu et Chaney (Mimosoideae) were found in the Miocene Duho Formation of the Yeonil Group distributed along the coast of Yeonil Bay in the Pohang area. The legume is flat and long and has 5-7 rounded seeds. The legumes of *Albizia miokalkora* are rare in the Cenozoic floras of the world and only known to Middle Miocene of East Asia. The fossil *Albizia* may use one of the important taxa to construct the biogeographic history of East Asia. This discovery is the first record of *Albizia* from the Neogene strata of Korea.

Keywords: legume, *Albizia miokalkora*, Mimosoideae, Miocene, Pohang

Introduction

The Mimosaceae is well represented in the fossil floras of Asia, Europe, and North America by vegetative and reproductive remains of both extinct and extant genera. The family includes approximately 40 extant genera and 2,000 species that are mostly distributed from tropical to subtropical regions. As already mentioned by Crepet and Dilcher (1977), leaflets of Mimosaceae have been reported from strata as early as the Lower Cretaceous (Fontaine, 1889) and there are several reports of Upper Cretaceous leaflets (e.g., Berry, 1914). A large number of mimosoid leaflets, fruits, seeds, and isolated flowers have been reported from the Eocene and Oligocene strata of North America (e.g., Berry, 1930; Crepet and Dilcher, 1977; Graham and Dilcher, 1995). The palynological records of Mimosaceae are relatively abundant and diverse in the Eocene floras of Africa (e.g., Caccavari, 1996).

Nevertheless, many taxa of Mimosaceae have been reported from the Upper Cretaceous and early Tertiary; reliable generic determinations are few since early workers ignored details of fine venation and cuticle (Herendeen and Dilcher, 1990). Consequently, it is impossible to evaluate the significance of these reports to mimosoid evolution. The status of the Mimosaceae during the Cretaceous and early Tertiary is poorly understood (Crepet and Dilcher, 1977).

The taxonomic diversity of fossil mimosoid legumes has been recognized in the Eocene and Oligocene floras of North America (Herendeen and Dilcher, 1990), but it appears to be more abundant in the Miocene than Eocene or Oligocene in East Asia. According to Polhill et al. (1981) and Raven and Polhill (1981), the main radiation of Leguminosae (Mimosoideae, Casalpinioideae, Papilionoideae) occurred during the Neogene and was associated with climate changes that may have promoted the conquest of new environments.

So far, despite the large number of fossil plants were found from the Neogene strata of Korea, the fossil record of Leguminosae is generally poorly documented. Only 4 genera and 4 species have been known (Huzioka, 1972). This paper deals with the description of *Albizia miokalkora* first found in the Pohang Basin of Korea. This fossils provide evidence for the occurrence of the Mimosaceae in Korea during the Miocene.

*Corresponding author: E-mail: jongheon@kongju.ac.kr
Tel: 82-41-850-8295
Fax: 82-41-850-8299

Material and method

Three legumes of *Albizia miokalkora* Hu et Chaney (Mimosoideae) were collected from the upper part of the Duho Formation, Yeonil Group distributed at the northern beach, Duho-dong, Pohang City, Kyeongbug Province (129°24'50"E, 36°04'03"N). These legumes are preserved as impressions in mudstones at a locality where fossil dicotyledonous leaves and marine faunas are abundant. *Albizia* legumes were examined and compared from all known legumes of Asia and North America. The specimens examined here will be kept at the Department of Earth Science, College of Education, Kongju National University.

Startigraphy and age of the Yeinil Group

The Neogene strata of the Pohang Basin are distributed in the southeastern coast of South Korea, and has divided into the Yangbuk and Yeonil Groups in ascending order (Kim, 1987). The former consists predominantly of basalt, volcanic tuff, conglomerate, sandstone, shale and lignite, while the latter mostly of clastic sediments of marine origin. The Yangbuk Group is equivalent to the Changgi Series of Tateiwa (1924).

Since Tateiwa's (1924) geological investitation on the Pohang Basin, some geological and palaeontological studies have been carried out by Korean geologists (Um et al., 1964; Kim, 1965; Yoon, 1975, 1976, 1992; Lee and Lee, 1986; Yun, 1986; Chung and Choi, 1993). Further palaeontological references are shown in Lee (1987) and Kim (1997). As shown in the correlation of stratigraphic sequence of the Yeonil Group in the Pohang Basin (Yoon, 1998), the stratigraphic division of the Yeonil Group suggested by some authors are different from each other. In the present study, the writer uses the stratigraphic terms which are suggested by Yun (1986). According to Yun (1986), the Yeonil Group is divided into the Chunbuk conglomerate, Hagjeon, and Duho Formations in ascending order. The fossil locality is shown in Fig. 1.

The geological age of the Yeonil Group based on

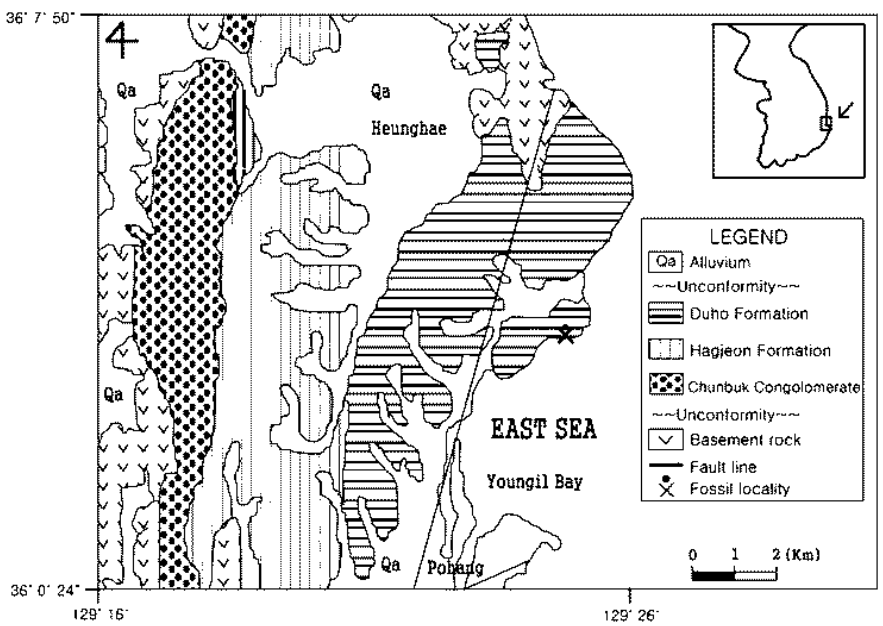

Fig. 1. Geologic map of the Pohang Basin (partly redrawn after Yi and Yun, 1995) and fossil locality.

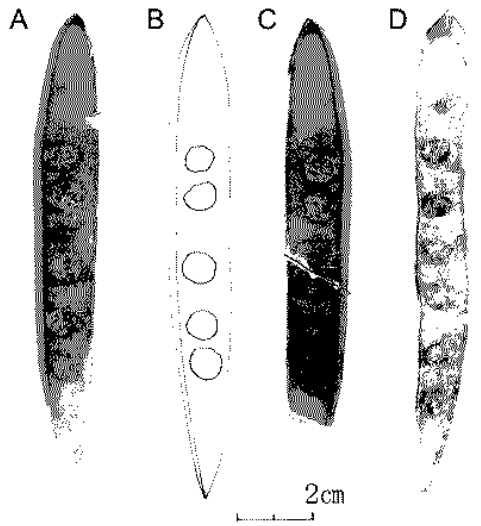

Fig. 2. A-D. Fossil legumes of *Albizia miokalkora* Hu et Chaney. A: A indehiscent legume bearing 5 seeds (KNU-20030692), B: Drawn from 2A, C: Counter part of 2A (KNU-20030689), D: A legume bearing 7 seeds (KNU-980025)

the fossil plants and faunas and microfossils has generally been considered to be Middle Miocene (e. g., Tateiwa, 1924; Kanehara, 1936, Huzioka, 1972; Yoon, 1975; Yun, 1981; Chun, 1982).

Systematic description

Order Fabales

Family Mimosaceae

Genus *Albizia* Durazzini, 1772

Albizia miokalkora Hu et Chaney

Fig 2. A-D.

1940 *Albizia miokalkora* Hu et Chaney, Hu et Chaney, p. 50-51, pl. 27, Fig. 6 (leaf)

1975 *Albizia miokalkora* Hu et Chaney, Hayashi, p. 23, pl. 14, Fig. 1; pl. 15, Fig. 9, 10.

1975 *Gleditsia miosinensis* Hu et Chaney, Hayashi, p. 24; pl. 15, Fig. 1 (legume).

1978 *Albizia miokalkora* Hu et Chaney, Academy Sinica, p. 103, pl. 87, Figs. 1, 2; pl. 90, Figs. 5, 6

1978 *Albizia miokalkora* Hu et Chaney, Tanai, p. 346, Figs. 1, 2 (Hayashi's pl. 15, Fig. 1, 10).

Material: KNU-20030692, KNU-20030689(counter part), KNU-19980025

Description: Three legumes were collected. Legume is flat, long and narrow and nearly parallel-sided for the most part, narrowing gradually at both tips. The largest one exceeds over 10 cm in length and 1 cm to 1.3 cm in width. Seed chambers are small and ovate in shape, 5 mm to 6 mm in the widest part, and 5 to 7 in number in one legume.

Distribution and occurrence: Three legumes of *Albizia* were obtained from a single locality of the Duho Formation in association with fossil dicotyledon leaves and other marine fauna.

Remarks: Fossil legumes of *Albizia* are very rare in East Asia. In East asia, two species of *A. miokalkora* Hu et Chaney, and *A. bracteata* Dunn. are known from the Miocene strata of China and Japan. Only the former species has been found in association with its legumes. Although the present specimens have not been found in organic connection with their leaves, the present legumes are safely referable to those of *Albizia miokalkora* Hu and Chaney in all features. *Albizia miokalkora* was established for isolated single leaflet by Hu et Chaney (1940) from the Miocene Shanwang Formation of Shandong, China, together with *Albizia bracteata* Dunn. Institute and Paleobotany, and Institute of Geology and paleontology (1978) described legumes of *A. miokalkora* from the same locality mentioned above. *Albizia bracteata* Dunn. has been known from the late Miocene to early Oligocene strata of Yunnan. However, its legume has not been found. *Albizia* sp. (pl. 90, Fig. 5) figured by Institute and Paleobotany, and Institute of Geology and paleontology (1978) is represented by its single fragment legume without any description and exact locality. It is difficult to make its macroscopical comparison with the Korean species.

Similar species to the Korean species were described in Japan by Hayashi (1975). Hayashi (1975) described three legumes and some leaf fragments as *Gleditsia miosinensis* Hu et Chaney from the Miocene strata of Iki Island of Japan. He also

described leaf fragments as *Albizia miokalkora* Hu et Chaney from the same locality mentioned above. Later Tanai (1978) regarded one of legumes (pl. 15, fig. 1) of *Gleditsia miosinensis* described by Hayashi (1975) as *Albizia miokalkora* Hu et Chaney. The legume of Japan species is similar in form and size to that of Korean species, but the legume of Japan species is somewhat broader and have more number of seeds than that of Korean species.

The legumes of *Albizia miokalkora* Hu et Chaney have been compared with other legume genera and are similar to fossil legumes of *Eliasofructus* and Acacia. *Eliasofructus* was established by Herendeen and Dilcher (1990) from the Eocene and Oligocene of North Ameria. The presence of longitudinal wrinkles near the margins of *Eliasofructus* legumes is particularly characteristic of this genus. A short thick funiculus is present in *Eliasofructus* legumes whereas *Albizia miokalkora* is lacking. A thick funiculus is present in other genera of the Mimosaceae such as *Parkia* (in part), *Pseudoprosopis*, *Adenanthera*, *Stryphnodendron* and *Xylia* (Gunn, 1984). *Acacia capitonica* Hollick described from the Eocene of Lianing, China (Inst. Bot. and Inst. Geol. and Palaeont., 1978), is characterized by its short and bread pods.

According to Lee (2002), two extant species of *A. kalkora* (Roxb.) Prain and *A. julibrissin* Durazzini, are distributed in Korea. The former is characterized by its large-sized and broad legumes. The latter is similar in size of legume to fossil *A. miokalkora* Hu et Chaney.

Sometimes the differences of the preservation make it difficult to determine whether outlines of seeds or seed chambers are present, and whether the legumes are dehiscent or indehiscent. According to Herendeen and Dilcher (1990), several lines of evidence suggest that the fossil legume was indehiscent. Attenuate legume margins and inconspicuous sutures are features of indehiscent legumes. Fossil legumes that were elastically dehiscent have a prominent oblique striation on the valves, a feature that is lacking in the present fossils. Strong evidence for the indehiscence of these legumes is provided by specimens (Fig. 2 A-D) in which a thin band of sediment separates two layers of organic remains which represent the two valves of the fossil legume.

The outlines of seed chambers are clearly seen on the legumes of *Albizia miokalkora*, but such funiculus as *Eliasofructus* is not seen. The relatively large size of the seed chambers suggests that the legumes were mature.

Discussion and conclusion

Although the organic connection between leaves and legumes has not been found, it is no doubt that the present legumes are those of *Albizia miokalkora*. Accordingly it is clear that there existed Mimosaceae in the Miocene strata of Korea.

The vegatative and reproductive records of *Albizia* are very rare in the Cenozoic floras. According to Tao et. al. (2000), the genus *Albizia* has been known from the Middle Miocene to Early Pliocene strata of Shanxi (*A.* sp.), Yunnan (*A. miokalkora*, *A. bracteata*), Shandong (*A. miokalkora*) of China. *A. miokalkora* also has been known from the Middle Miocene strata of Japan (Hayashi, 1975). In particularly, *Albizia miokalkora* is restricted in occurrence to the Middle Miocene of China and Japan. The three specimens of *A. miokalkora* were found from the Duho Formation of the study area. Accordingly, the presence of *Albizia miokalkora* as well as those of other megafossil and microfossil reconfirms that the age of the Duho Formation is Middle Miocene. The presence of the commom occurrence of *Albizia miokalkora* in Korea, China and Japan, indicates that there were some interchanges among these regions, even though there were topographic or oceanic barriers between them.

As already mentined by Tayler and Tayler (1993), despite of the large numbers (14,000 extant species) of the Leguminosae, the fossil record is generally poorly documented. Numerous taxa of Leguminosae of all three subfamilies are known from the Middle Eocene of North Ameriaca

(Herendeen, 1992). The pollen record of *Albizia* is also documented from the Eocene of Africa (Caccavari, 1996). The presence of *Albizia* pollens in a Eocene deposits indicates that this genus was probably already well-advanced in terms of evolution and dispersal during this period.

According to Huzioka (1972), approximately 79 genera and 140 species of fossil plants have been discovered from the Neogene strata of Korea. However, Neogene records of Leguminosae from Korea are uncommon. Only 4 genera and 4 species have been recognized to Leguminosae. Today, the extant genus of *Albizia* has a world wide distribution and consists of 50 species that are mostly distributed in tropical and subtropical regions with two occuring in Korea [*A. julibrissin* Durazzini and *A. kalkora* (Roxb.) Prain]. Both species extend into Japan, China, East Asia and further into India. While the fossil records of *Albizia* are very rare, it is a striking contrast to the large number of extant species. Judging from the distribution of extinct and extant *Albizia* in East Asia, the Yeonil flora might have flourished under the warm temperate climate. Palynoflora data indicate that the climate was wet subtropical to cool temperate during the deposition of the Yeonil Group (Chung and Choi, 1993).

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