



# Insect herbivory and plant defense on ginkgoalean and bennettitalean leaves of the Middle Jurassic Daohugou Flora from Northeast China and their paleoclimatic implications

Yu-Ling Na<sup>a,b</sup>, Chun-Lin Sun<sup>a,b,\*</sup>, Hongshan Wang<sup>c</sup>, David L. Dilcher<sup>a,b,d</sup>, Zhen-Yuan Yang<sup>e</sup>, Tao Li<sup>a,b</sup>, Yun-Feng Li<sup>a,b</sup>

<sup>a</sup> Research Center of Palaeontology & Stratigraphy, Jilin University, Changchun 130026, Jilin, China

<sup>b</sup> Key Laboratory for Evolution of Past Life and Environment in Northeast Asia (Jilin University), Ministry of Education, Changchun 130026, Jilin, China

<sup>c</sup> Florida Museum of Natural History, University of Florida, Gainesville, FL 32611, USA

<sup>d</sup> Department of Geology, Indiana University, Bloomington, IN 47405, USA

<sup>e</sup> School of Resources and Civil Engineering, Northeastern University, Shenyang 110819, Liaoning, China

Received 14 April 2017; received in revised form 15 August 2017; accepted 28 August 2017

Available online 4 September 2017

## Abstract

Interactions between terrestrial arthropods and plants play a significant role in terrestrial ecosystems. Research on plant–insect interactions through geologic time provides valuable information for studying insect behavior and plant structure, understanding their coevolution, as well as analyzing climate change. In this paper, we choose fossil ginkgoalean and bennettitalean leaves as the plant hosts to study insect herbivory in the Middle Jurassic Daohugou area. Seven damage types of four functional feeding groups have been identified. Of the four functional feeding groups, margin feeding is the most common, indicating an abundance of insects with chewing mouthparts. Ginkgoalean leaves, probably because of their chemical defense, suffered less severe insect damage than bennettitalean leaves. Physical defense has also been observed in various genera of the bennettitalean leaves. Significantly, leaves of *Anomozamites* had a shaggy indumentum on the abaxial leaf surface and long stiff hairs along the rachis protecting them from insect herbivory. Our results indicate that the climate in the Middle Jurassic of the Daohugou area was relatively warm and humid. This work contributes to the study of plant–insect coevolution in the Daohugou Biota and provides more proxy data for understanding the Middle Jurassic paleoclimate and paleoenvironment in Daohugou area.

© 2017 Elsevier Ireland Ltd Elsevier B.V. and Nanjing Institute of Geology and Palaeontology, CAS. Published by Elsevier B.V. All rights reserved.

**Keywords:** Mid-Mesozoic; Daohugou Flora; Plant–insect interaction; Ginkgoales; Bennettitales; Paleoclimate

## 1. Introduction

Terrestrial arthropods (primarily Insecta), with an estimated 5–10 million species (Ødegaard, 2000), and their interactions with plants are important in terrestrial ecosystems. Extant plant–insect interactions have received great attention, usually for commercial purposes, such as in agriculture and forestry industries. Through geologic time, plants and insects have also maintained close interactions that are mainly revealed by evidence from fossil leaf remains. The research on their interactions

provides valuable information for studying insect behavior, plant structure and coevolution.

Both insect and plant diversity respond to the changing climate, with the result that insect herbivory is influenced by various environmental parameters, including temperature and moisture, both in modern and geologic times (Wilf et al., 2001). In general, tropical plants endure more intense herbivory than those in temperate zones, unless they adopt physical or chemical defensive strategies (Coley and Aide, 1991; Coley and Barone, 1996). Additionally, a seasonally dry climate can lead to a lesser intensity and lower diversity of insect attack (Janzen, 1973; Windsor, 1978; Frith and Frith, 1985; Marquis and Braker, 1994). Climate can also affect the representation of damage types in a region. For instance, a higher diversity of galls

\* Corresponding author at: Research Center of Palaeontology & Stratigraphy, Jilin University, Changchun 130026, Jilin, China.

E-mail address: [clsun@jlu.edu.cn](mailto:clsun@jlu.edu.cn) (C.L. Sun).

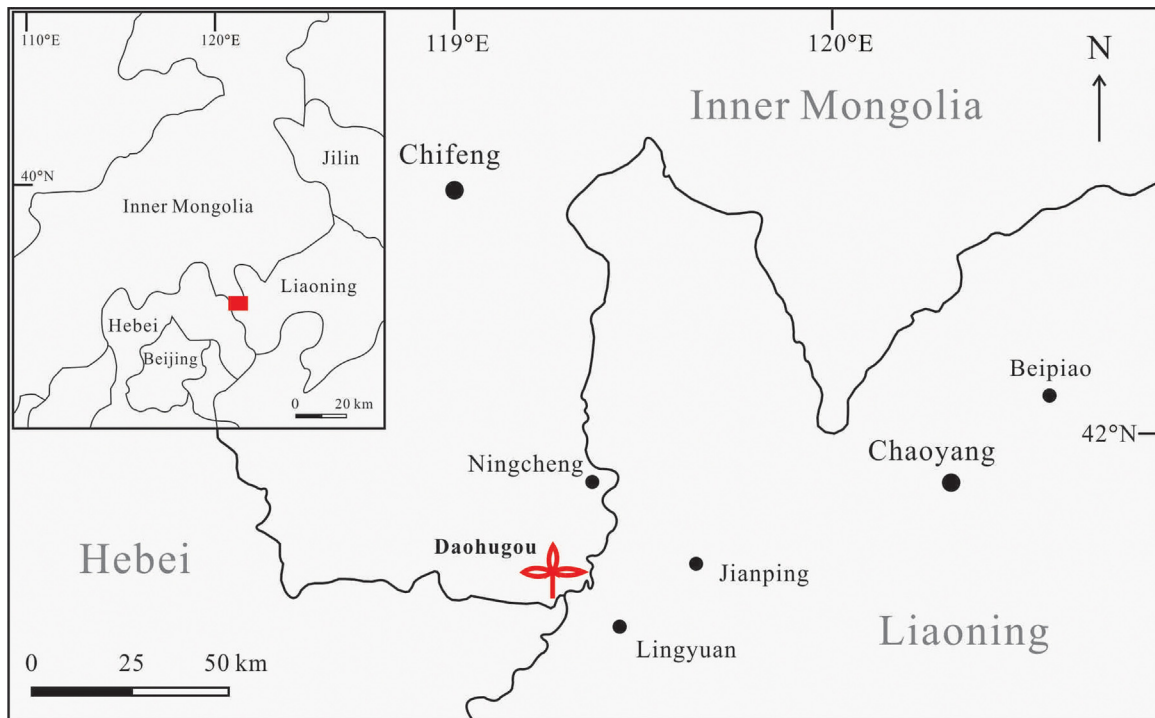


Fig. 1. Sketch map showing the fossil locality.

usually occurs in dry habitats (Fernandes and Price, 1992; Price et al., 1998). Consequently, detailed research on insect herbivory can provide significant data for understanding paleoclimate of a single locality, and for analyzing climate change throughout an interval of geologic time.

The history of plant–insect interactions can be traced to the late Silurian–Middle Devonian, at which time herbivory originated and diversified (Labandeira, 2007, 2013a, 2013b). During the Late Pennsylvanian (ca. 318–299 Ma), insect herbivory expanded (Labandeira, 2013a). Throughout geologic history, the end of the Cretaceous to Paleogene is also a conspicuous interval when the most intensive insect damage and the highest number of DTs (damage types) were represented, probably due to warm global conditions and the rise of angiosperm-dominated forests (Wilf et al., 2001; Wappler et al., 2009; Currano et al., 2010). However, reports on middle Mesozoic plant–insect interactions remain limited (e.g., Genise and Hazeldine, 1995; Ash, 2000; Scott et al., 2004; Wilf et al., 2006; Labandeira, 2010; Osborn and Taylor, 2010; Wang et al., 2012; Feng et al., 2014; Na et al., 2014; Ding et al., 2015; McLoughlin et al., 2015; Sun et al., 2015; McLoughlin and Bomfleur, 2016). Only Ding et al. (2015) focused on the quantitative analysis of damage types on fossil leaves from northeastern China. The middle–late Mesozoic spans that interval when gymnosperms were gradually replaced by angiosperms as the dominant plants. This transition deeply influenced insect herbivores (Labandeira, 2014). The Late Jurassic is also marked by significant climatic events represented by the overall warming of the climate (Vakhrameev, 1991), affecting the origin and differential, extinction or survival of plants and insects, as well as the variety of their interactions in variable degrees. Therefore, further in-depth research on plant–insect

interactions from the middle Mesozoic localities is needed to better understand insect herbivory, plant defense, and climate change during this interval.

The Daohugou area is located in Ningcheng County, Inner Mongolia (Fig. 1), where a suite of fossiliferous deposits with mainly lacustrine facies are found. During the past two decades, numerous exquisitely-preserved fossils, representing all important Jurassic animal and plant groups, have been discovered in this area, and have attracted the attention of paleontologists around the world (e.g., Wang, 2000; Ji and Yuan, 2002; Ren, 2002; Zhang et al., 2002; Shen et al., 2003; Zheng et al., 2003; Ji et al., 2006; Jiang, 2006; Pott et al., 2012b; Na et al., 2014, 2015; Sun et al., 2015). Among them, insects, with ca. 490 species in 120 families and 17 orders, and plants, with 56 species in 37 genera, are the best documented (Ding et al., 2015; Na et al., 2017). However, the relationships between these two important groups are barely known, except for a few reports (Na et al., 2014; Ding et al., 2015; Sun et al., 2015).

In this study, fossil leaves of the Ginkgoales and Bennettiales from the Middle Jurassic Daohugou Flora were selected as the plant hosts to study insect herbivory, mainly because (1) they are two of the most important plant groups during the mid-Mesozoic, and (2) almost all the insect damage categories are known on leaves of these two orders, probably due to preservation and collection biases. Based on detailed examination of insect damage types on the fossil leaves, insect herbivory and plant defense strategies are discussed. This work contributes greatly to the study of plant–insect coevolution in the Daohugou Biota, and provides important evidence for understanding the paleoclimate and paleoenvironment in the Daohugou area during the Middle Jurassic.

Download English Version:

<https://daneshyari.com/en/article/8916544>

Download Persian Version:

<https://daneshyari.com/article/8916544>

[Daneshyari.com](https://daneshyari.com)