Review of Palaeobotany and Palynology 156 (2009) 418–435

Contents lists available at ScienceDirect

Review of Palaeobotany and Palynology

journal homepage: www.elsevier.com/locate/revpalbo

Comia and *Rhachiphyllum* from the early Permian of Sumatra, Indonesia

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ARTICLE INFO

Article history:
Received 11 December 2008
Received in revised form 7 April 2009
Accepted 10 April 2009
Available online 17 April 2009

Keywords:
Comia
Rhachiphyllum
Supaia
Autunia
callipterids
peltasperms
Jambi
Indonesia
Cathaysia
Early Permian

ABSTRACT

Recent expeditions to the Early Permian formations of Jambi, Sumatra, have produced material of a new species of peltasperm affinity, *Comia variformis* nov. sp., with a remarkably broad morphological range that touches on several other Permian taxonomic groups. It is found in association with material attributable to the callipterid genus *Rhachiphyllum*, in addition to *Supaia*-like material and an *Autunia* fructification, corroborating a peltasperm affinity.

Palaeogeographic relationships of the morphologies found in *C. variformis* and the other material show strong relationships with North China and even the Angaran region, suggesting a migration zone running from the North China Block to the West Sumatra–West Myamar terrane.

1. Introduction

1.1. Early Permian climate and tropical plant ecology

Changes in climate during the Late Carboniferous to Early Permian caused a major transformation in the vegetation of the tropical lowlands. Water-dependant plant groups mostly disappeared and more drought-resistant seed fern and other gymnosperm lineages appeared and claimed an increasingly dominant role (Gastaldo et al., 1996; DiMichele and Phillips, 1996; DiMichele et al., 2001; Cleal and Thomas, 2005). Subsequently, the Early Permian saw a high diversification of these plant groups (Wang, 1996; DiMichele et al., 2005, 2006).

From the Latest Carboniferous and Early Permian onwards, associations dominated by peltasperms and other seed plants become increasingly common (Kerp, 1996, 2000; DiMichele et al., 2005, 2008). These associations are generally found in deposits belonging to, or stemming from habitats with drier conditions and better-drained soils, than found in the coal swamp environment. Evidence of seasonal drought is commonly found (DiMichele et al., 2006; Montañez et al., 2007). These changing ecological circumstances would have led to more adaptations in water-use efficiency for the vegetation, as is demonstrated by features in their morphology (for example, Krings et al., 2005), than was common in the wetter swamp or swamp margin habitats.

Much of the earliest, large-scale occurrences of these more mesoxeric seed fern/gymnosperm assemblages took place in the western part of Euramerica (Mamay and Breed, 1970; DiMichele et al., 2000, 2001, 2005). Genera belonging to the gigantopterids, the callipterids, *Comia* and species belonging to the *Protoblechnum*/*Compsopteris*/*Supaia*-complex, are found as a part of Early Permian assemblages in the USA (Texas and Utah), Mexico and Venezuela, that appear to be indicative of seasonally dry conditions (Weber, 1997; DiMichele et al., 2006; Chaney and DiMichele, 2007; Ricardo-Branco, 2008).

Compared to the Euramerican region, Cathaysia seems less affected by the changing climate. During the Late Carboniferous and Early Permian, lycopsids remain a dominant factor in the Cathaysian wetland vegetation (Ziegler, 1990; Shen, 1995), while disappearing from the Euramerican tropics. Although similar seed fern and gymnosperm assemblages are found in the Early Permian of Cathaysia and Euramerica, the Texas and Utah floras show a closer resemblance (on a generic level) to the Middle Permian Cathaysian floras than to the European palaeofloras of the Early Permian (Shen, 1995; DiMichele et al., 2005; Hilton and Cleal, 2007). This similarity is difficult to align with the heterogeneity of the Early Permian tropical

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doi:10.1016/j.revpalbo.2009.04.007

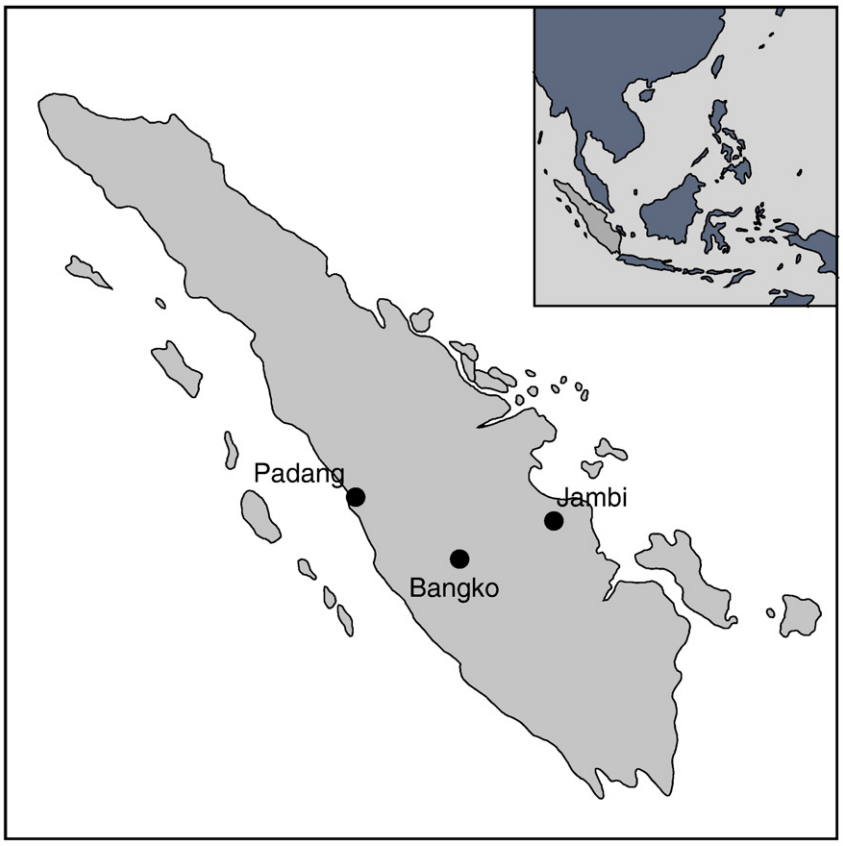

Fig. 1. Map of the island Sumatra, Indonesia. The small town of Bangko indicated, in the neighbourhood of which all the localities are situated.

climate, where ever-wet conditions persisted in part of the Cathaysian region, while the western Euramerican part of the tropical zone became increasingly arid (Ziegler, 1990; Patzkowsky et al., 1991; Ziegler et al., 2003; Hilton and Cleal, 2007).

1.2. The Jambi flora

The so-called Jambi flora is a compression/impression flora of the Early Permian Mengkarang Formation from the province of Jambi in Sumatra, Indonesia. It was first elaborately described in 1935 by Jongmans and Gothan and interpreted as a Late Carboniferous Euramerican flora with Cathaysian elements. In a reinvestigation of the existing collection by Van Waveren et al. (2007), the material was reinterpreted as an Early Permian Cathaysia-type flora, an interpretation that had already been suggested by Posthumus (1927), albeit on different grounds. It contains Euramerican elements, and is particularly similar to North and Northwest Chinese floras in species composition. Gondwanan species are entirely absent (Van Waveren et al., 2007).

The composition of the floral assemblages of the Mengkarang Formation (Van Waveren et al., 2005; Booi et al., 2008) suggests a division into (at least) two separate associations that are distinct in both species composition and ecology. The first is a typical Late Carboniferous-type swamp flora, containing Lepidodendrales, pecopterids, sphenopsids and *Cordaites*. The second is a flora that is dominated by a variety of seed ferns and other gymnosperms, such as *Macralethopteris*, callipterids, *Sphenopteris*, taeniopterids and gigantopterids, next to rarer, more hydrophilous elements such as sphenopsids and pecopterid ferns. This latter assemblage is interpreted as a more mesic flora occurring in slightly better-drained soils, and as representing plants that are occasionally washed in from higher lying ground (Van Waveren et al., 2005; Booi et al., 2008). Although very different in species composition, the associations are broadly comparable in both diversity and preservation of the fossils suggesting a taphonomically comparable amount of transport. The two assemblages alternate in the formation and thus are interpreted as two distinct floras that inhabited neighbouring environments.

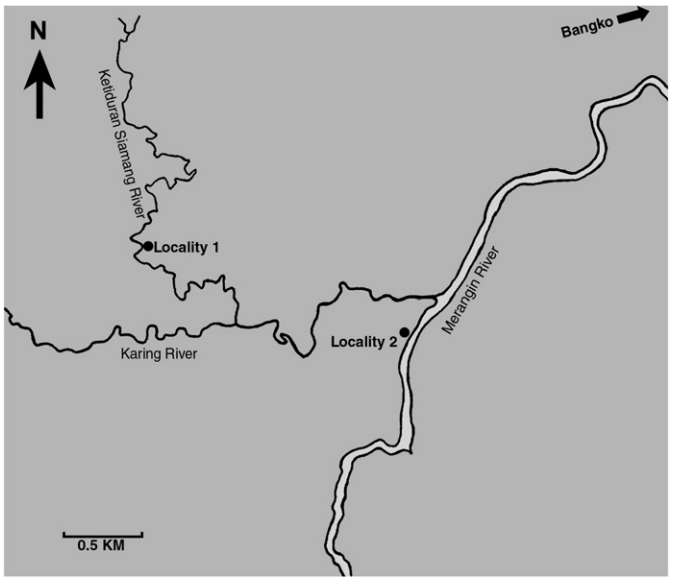

Fig. 2. Map of the two localities where the material was found. Locality 1 along the Ketiduran Siamang River, locality 2 along the Merangin River.