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# A palynological study on Upper Palaeozoic sediments in the palaeosuture zone area (W. Yunnan, China) and its phytogeographical significance

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Several important findings of Late Palaeozoic palynomorphs in the different blocks of West Yunnan have been made in the present palynological investigation. The *Granulatisporites frustulentus* assemblage (Playford, 1976), typically distributed in Gondwana subcontinent, has been found in Sipaishan, Gengma. It could be roughly divided into the *Grandispora spiculifera* assemblage (Tournaisian) and the *Anapiculatisporites largus - Lycospora pusilla* (Visean) assemblage respectively, which have been correlated with those in West Europe and Australia. An attempt has been made to correlate these Gengma assemblages to the standard West Europe miopore zones of BP, PC(?) and Pu. Some Early Permian miopores have been recovered in Haibang, Ali and Kongshuhe, Tengchong respectively. The miopores found in Haibang are characterized by some Carboniferous relict genera, such as *Lycospora*, *Densosporites*, but dominated by *Protohaploxypinus*, *Striatopodocarpites*, which are the typical representatives in Gondwana palynological province. *Jayantisporites pseudozonatus* and *Microbaculispora tentula*, typically distributed in the Lower Permian of the Collie Basin, Western Australia, and Karoo Basin in South Africa, have been found in Kongshuhe, Tengchong. Therefore, it is obvious that the Gondwana microflora had once arrived in Tengchong and even in the Changning-Menglian belt in West Yunnan during Early Carboniferous and Early Permian. In Simao block, North Hemisphere palynomorphs were dominated in Late Carboniferous Namurian section and Late Permian Dengkong section without the mixture of Gondwana-type palynomorphs.

The miopore similarities of western Yunnan with both West Europe and Australia in Early Carboniferous and with Australia solely in Early Permian indicate that West Yunnan was perhaps located much further to the west (Early Carboniferous) and south than the previous continent reconstruction. Such a miopore conclusion seems to coincide with the palaeomagnetic data analysis.

**Key-words**—Palynology, Phytogeography, Upper Palaeozoic, W. Yunnan.

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सारांश

पुरासूचर मंडल क्षेत्र (पश्चिम यूनान, चीन) में उपरि पुराजीवी युगीन अवसादों का परागाणविक अध्ययन तथा इनका पुराभौगोलिक महत्व

यांग वीपिंग

इस शोध-पत्र में पश्चिम यूनान के विभिन्न खंडों से प्राप्त अनंतिम पुराजीवी युगीन परागाणविकरूपकों का अध्ययन किया गया है। गोंडवाना उपमहाद्वीप में सामान्यतः मिलने वाली *ग्रेनुलेटिस्पोराइटिस फ्रस्टुलेन्टस* समुच्चय (प्लेफोर्ड 1976) गेंगमा में सिपाईशान से भी प्राप्त हुई है। यह क्रमशः *ग्रेन्डिस्पोरा स्पीक्यूलिफेरा* एवं *एनापिकुलेटिस्पोराइटिस लार्गस-लाइकोस्पोरा पुसिल्ला* नामक समुच्चयों में विभक्त की जा सकती है जो कि ऑस्ट्रेलिया एवं पश्चिम यूरोप से तुलनीय है। इन गेंगमा समुच्चयों की मानक का पश्चिम यूरोप के गुरु बीजाणविक मंडलों से तुलना का प्रयास किया गया है। टेंगचोंग में हाइबांग, अली एवं कोंगशुहे से कुछ परमियन बीजाणु भी प्राप्त हुए हैं। हाइबांग से उपलब्ध बीजाणुओं में *लाइकोस्पोरा*, *डेनसोस्पोराइटिस* नामक कुछ बीजाणु प्रजातियाँ विद्यमान हैं लेकिन ये *प्रोटोहैप्लोक्सोपिनि* तथा *स्ट्रिआटोपोडोकापाईटिस* से प्रभावी हैं जो कि सामान्य रूप से गोंडवाना के परागाणविक प्ररूप हैं। *जयन्तिस्पोराइटिस स्यूडोजोनेटस* एवं *माइक्रोबेक्यूलिस्पोरा टेनदुला* जो कि पश्चिमी ऑस्ट्रेलिया में कोली द्रोणी के अधरि परमियन कल्प में तथा दक्षिण अफ्रीका में कारु द्रोणी में सामान्यतः मिलते हैं, टेंगचाँग में कोंगशुहे से भी प्राप्त हुए हैं। अतः यह स्पष्ट है कि गोंडवाना वनस्पतिजात का प्रारम्भिक कार्बनीफेरस एवं प्रारम्भिक परमियन काल में टेंगचाँग एवं पश्चिम यूनान में पदार्पण हुआ था।

पश्चिमी यूनान से उपलब्ध सूक्ष्मबीजाणुओं की पश्चिम यूरोप एवं ऑस्ट्रेलिया के प्रारम्भिक कार्बनीफेरस से प्राप्त परागाणुओं की समानता से प्रदर्शित होता है कि पश्चिम यूनान उस समय और पश्चिम एवं दक्षिण की ओर स्थित था। इस अध्ययन के परिणाम पुराचुम्बकीय विश्लेषण से प्राप्त आँकड़ों से घनिष्ठता इंगित करते हैं।

THE primary aim of this study is to provide information which could aid in the geological interpretation of this critical area, especially its stratigraphy and phytogeography. The study is concerned with the Upper Palaeozoic palynology of the suture zone area between Gondwana and Laurasia plates, especially in Tengchong (Kongshuhe), Gengma (Sipaishan), Lancang (Xiaolaba, Ali), Mengla (Namutian), Mojiang (Dengkong) in Western Yunnan, S.W. China. The study reports the first palynological investigation from these areas involving reasons for undertaking the present study, palynostratigraphy and the application of palynological study to the biogeography and tectonics.

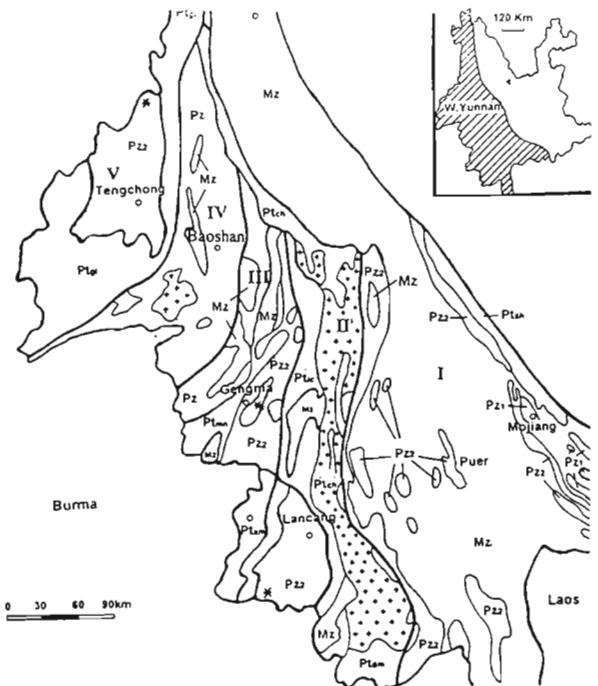
Based upon the distribution and development of strata and fossils, together with the presence of deep faults, three basic zones in terms of stratigraphic regionalization in West Yunnan can be recognized (see Text-figure 1). In brief, the east zone (geological block I) is called as the Lanping-Puer zone, in which the Mesozoic strata are extensively distributed and some Late Palaeozoic strata are also present in its west margin close to the Lincang granite (geological block II). The middle zone (geological block III), the Gengma-Menglian zone, is also dominated by the Late Palaeozoic strata, yielding abundant Late Palaeozoic and even Triassic fossils as revealed by recent geological study. Some workers prefer this zone to be the Changning-Menglian belt in terms of tectonopalaeoogeography. The west zone (geological block IV & V), the Baoshan-Tengchong block, shows particularly well exposed Palaeozoic outcrops. The Tengchong subzone, however, dominated by the Late Palaeozoic is termed as geological block V close to Myanmar, while the remaining part of this zone is the Baoshan block in the east (geological block IV).

This contribution from the above areas unravels the Late Palaeozoic phytogeography of this relatively unknown and tectonically critical region.

All the specimens are housed in the Nanjing Institute of Geology and Palaeontology, Academia Sinica, China.

**PALYNOSTRATIGRAPHY**

Palynological samples were collected from the main sections of Carboniferous and Permian in each of the above mentioned blocks. An interesting



Mz-Mesozoic; Pz-Palaeozoic; Pz<sub>2</sub>-Upper Palaeozoic; Pz<sub>1</sub>-Lower Palaeozoic; Pt-Proterozoic; Pt<sub>1a</sub>-Gaoigongshan Gr.; Pt<sub>1b</sub>-Menglong Gr.; Pt<sub>1c</sub>-Ximeng Gr.; Pt<sub>1d</sub>-Lancang Gr.; Pt<sub>1e</sub>-Chongshan Gr.; Pt<sub>1f</sub>-Damenlong Gr.; Pt<sub>1g</sub>-Shuanggou Gr.; r-Granite; I-Lanping-Puer Block; II-Lincang Granite; III-Changning-Menglian Belt; IV-Baoshan Block; V-Tengchong Block; \*-Samples' Locality;

**Text-figure 1**

miospore assemblage was recovered from Kongshuhe section in the Tengchong block, which is dominated by *Microbaculispora tentula*, *Jayantispores pseudozonatus*, *Punctatisporites gretensis*, *Verrucosisporites subsaccata*, *Vittatina fasciolata*, *Horridotriletes tereteangulatus*, *Procoronaspora spinosa*, *Protohaploxylinus* sp., *Propinguispora praetholus*, *Brevitriletes* sp., *Cordaitina* sp., *Spelaeotriletes* sp. and *Retusotriletes* sp. They could be partially correlated to those in the Lower Permian of Karoo Basin, South Africa (Anderson, 1977) and Collie Basin, Western Australia (Backhouse, 1991).

Very abundant and significant miospore assemblages, i.e., the uppermost Devonian *Retispora lepidophyta* assemblage, the Tournaisian *Grandispora spiculifera* assemblage and the Viséan *Anapiculatisporites largus-Lycospora pusilla* assemblage have been recovered from Longba section in the Gengma block, which could be correlated mainly with Laurasia miospores (Higgs *et al.*, 1988, 1992) and partially with Gondwana ones (Playford, 1976, 1978) as well.

Several Early Carboniferous to Early Permian miospore assemblages from the Lincang block have been recovered in recent palynological investigation. Early Carboniferous miospores: *Vallutisporites ciliaris*, *Convolutispora venusta*, *C. florida*, *Punctatisporites ornatus*, *Leiotriletes tumidus*, *Verrucosisporites nitidus*, *Colatisporites denticulatus*, *Retusotriletes mirabilis*, *Laevigatosporites vulgaris*, *Cristatisporites menendezii*, *Anapiculatisporites redactus*, *Granulatisporites frustulentus*, *Tricidari-sporites phippisae*, *Racemospora cumulata*, *Lycospora pusilla*, *Baculatisporites fusticulus*, *Retusotriletes mirabilis*, *Waltzisporea* sp., *Diatomozotriletes* sp. were found in Nanduan section of Ali in the Lincang block (someone would prefer this to be the Changning-Menglian belt, Liu *et al.*, 1989), of which 28 per cent could be compared with the Gondwana ones.

Late Carboniferous miospores from the Xiaolaba section in the same block (or belt) contains the following elements: *Convolutispora tessellata*, *Laevigatisporites vulgaris*, *Punctatisporites punctatus*, *P. rotundus*, *Florinites ovalis*, *F. minutus*, *Calamospora pullida*, *Lycospora rotunda*, *Granulatisporites granulatus*, *Schopfiipollenites* sp., *Microreticulatisporites* sp., *Pityosporites* sp., *Foveolatisporites* sp., *Acanthotriletes* sp., *Dictyotriletes* sp., *Cyclogranisporites* sp. and *Verrucosisporites* sp. Some Lower Permian miospores were obtained in Haibang, Ali of Lincang block as well. They were dominated by north hemisphere spores and pollen such as *Laevigatosporites vulgaris*, *L. minor*, *Lundbladisporea* cf. *gigantea*, *Columinisporites peppersii*, *Florinites* cf. *occlusus*, *Vittatina* cf. *fasciolata*, *Punctatisporites minutus*, *P. gretensis*, *Cordaitina* sp., *Brevitriletes* sp., *Cycadopites* sp., *Densosporites* sp., *Protohaploxylinus* sp., *Pityosporites* sp. and *Lycospora* sp. The following species found in West

Yunnan were also reported from Western Australia, e.g., *Striatopodocarpites cancellatus*, *S. multistriatus*, *Protohaploxylinus limpidus* and *Weylandites lucifer*. Therefore, the Gondwana-derived spores and pollen once arrived in Lincang block (or Changning-Menglian belt) during Early Carboniferous to Early Permian. In the Simao block, North Hemisphere palynomorphs were dominated in Late Carboniferous Namurian section and Late Permian Dengkong section, the former one yielding *Limitisporites* sp., *Calamospora microrugosa*, *Cras-sispora trychera*, *Florinites mediapudens*, *Laevigatisporites vulgaris*, *L. perminutus*, *Punctatisporites aerarius*, *P. minutus*, *Waltzisporea* sp., *Lycospora pusilla*, *Verrucosisporites microtubercosus*, the latter one presented by *Jansoniuspollenites ovatus*, *J. cf. J. ovatus*, *Alisporites taenialis*, *A. ovatus*, *Cordaitina* sp. and *Protohaploxylinus* spp.

## PHYTOGEOGRAPHY

Since it would directly contribute to the study of plate tectonic in this geologically interesting area, the palaeobiogeography of Upper Palaeozoic in western Yunnan has been the attraction for many geologists for a long time. Before this current study of microfloral phytogeography, most palaeobiogeographical researches in western Yunnan had been based upon megafossils including fauna and flora. Late Carboniferous and Early Permian periods in western Yunnan is significant for comparative palaeontological and palaeobiogeographical analyses. A possible Gondwana floral member *Glossopteris*? spp. associated with *Taeniopteris*? sp., *Pecopteris* spp., *Sphenophyllum*? sp., *Carpolithus* sp., *Sphenopsis* axis or *Paracalamites* sp. (identified by Prof. Li Xingxue in Fang Zongjie, 1991) were once reported in Anpaitian near Yongde county, in

## PLATE 1

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| <p>1-6. <i>Microbaculispora tentula</i> Tiwari 1965; 1. distal view, median focus, i-750; 2. proximal view, high focus, i-750; 3. proximal view, median focus, i-750; 4. proximal view, median focus, i-750; 5. proximal view, median focus, i-750; 6. distal view, median focus, i-750.</p> <p>7, 8. <i>Horriditriletes tereteangulatus</i> (Balme &amp; Hennelly) comb. Backhouse 1991; 7. distal view, median focus, i-750; 8. proximal view, median focus, i-750.</p> <p>9. <i>Retusotriletes</i> sp., proximal view, high focus, i-800.</p> <p>10. <i>Altitriletes densus</i> Venkatachala &amp; Kar 1968; proximal view,</p> | <p>median focus, i-800.</p> <p>11. <i>Brevitriletes</i> sp., distal view, median focus, i-750.</p> <p>12, 15. <i>Propinguispora praetholus</i> Price 1983; 12. proximal view, high focus, i-750; 15. lateral view, median focus, i-800.</p> <p>13, 14. <i>Vittatina fasciolata</i> (Balme &amp; Hennelly) Bhardwaj 1962; 13. proximal view, median focus, i-750; 14. distal view, median focus, i-800.</p> <p>16, 17. <i>Pseudoreticulatispora confluens</i> (Archangelsky &amp; Gamero); 16. distal view, high focus, i-750; 17. proximal view, median focus, i-750; 18. proximal view, high focus, i-750.</p> |
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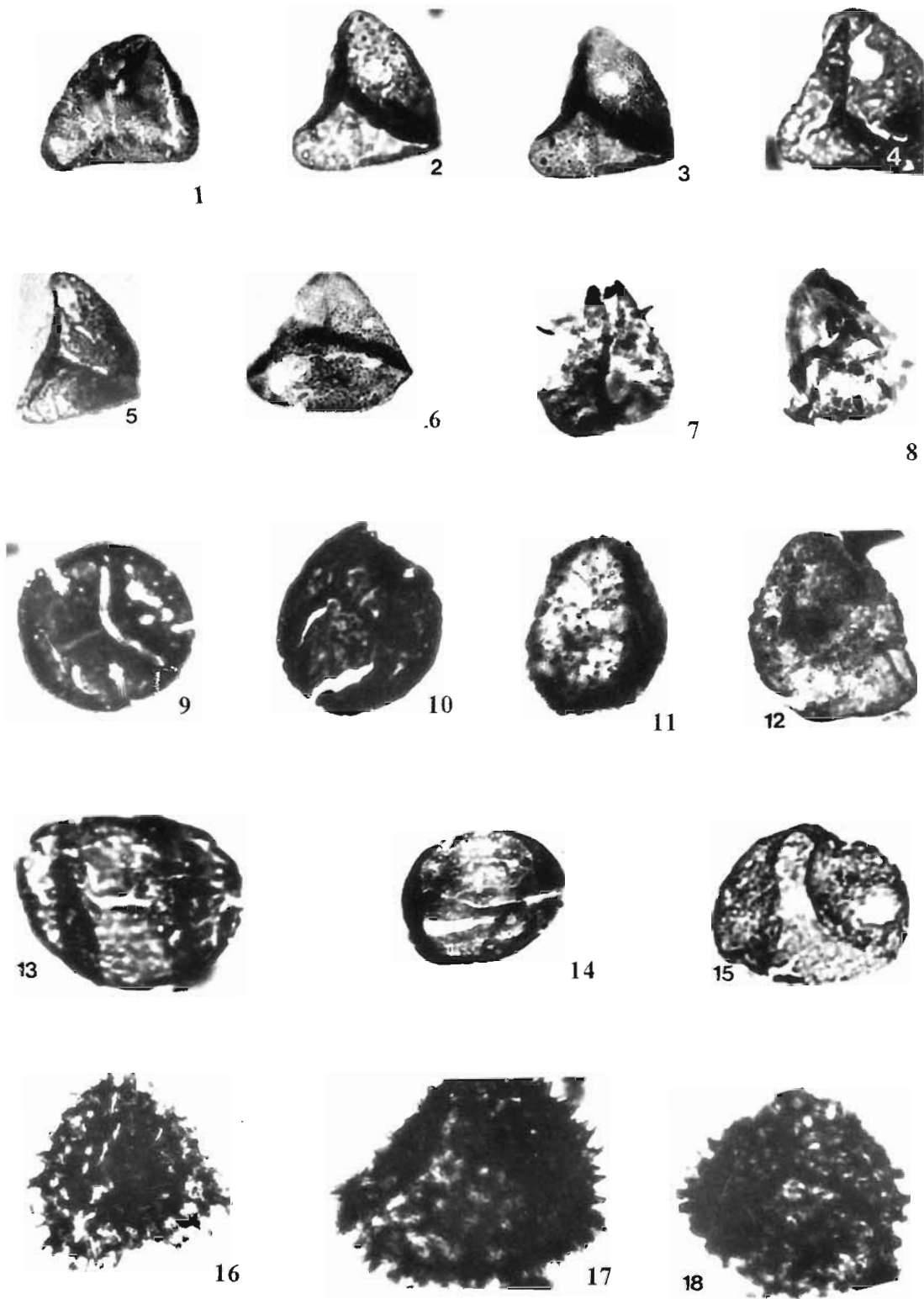


PLATE 1

Xiaoheihe of Mengding and Cizhulin of Hewai in the Baoshan Block. Authentic Cathaysian floral species were found in the Simao Block, e.g., *Neuropteris* spp. in Early Carboniferous Mamushu section of Mengla, *Pecopteris* spp. in the Late Carboniferous Baliu section of Mojiang, Early Permian *Cladophlebis* spp. in the Lazhuhe section of Lanping, *Gigantopteris* spp. in the Late Permian Dengkong section of Mojiang. So far, there were no convincing reports about cold water *Eurydesma* fauna in Tengchong and Baoshan blocks. The finding of typical Gondwana miospores in glacial sequences in Tengchong Block would fill in the gaps in palaeobiogeography in West Yunnan. The possible Gondwana-type spores and pollen were also obtained from Lincang Block (or Changning-Menglian belt), which could mean that they were once situated in a area with quite close relations to Gondwanaland.

Some Chinese geologists considered the Tengchong and Baoshan blocks to be northern part of the Gondwanaland in both petrographic and biotic features (e.g., Wang, 1983; Han & Wang, 1983; Fang, 1983; Liang *et al.*, 1983; Huang & Chen, 1987; Xu & Yang, 1988). However, Zhan Lipei (1982) separated the Baoshan Block from Tengchong Block and considered it to be of South China biotic province. Song Xueliang (1982) attributed the Baoshan Block to be south marginal sea of Angara. Fang Zongjie (1991) put the Baoshan Block into the Sibumasu biotic province which is the fourth province of Tethyan realm and distinguished from tropical Cathaysian biotas but Gondwana cold-water biotas as well. The Sibumasu biotic province derived from the Sibumasu Block was first established by Metcalfe (1984). Fang (1991) claimed that no reliable Gondwana cold-water biota elements or authenticated glacial deposits were

known from the Baoshan Block, while the Dingjiazhai pebble-bearing layer of glaciomarine facies was actually a product of debris flow. He also determined those specimens originally identified as *Eurydesma* as *Schiziodus* (Fang *et al.*, 1990).

The spores and pollen in Tengchong Block were recovered from the equivalent horizons of the black pyritic shale, which was correlated by Wopfner and Jin with the organic rich deglaciation sequence observed elsewhere in Gondwana (Wopfner & Diekmann, 1992). The palynological assemblage TP zone in Tengchong is correlated in this paper with *Pseudoreticulatispora confluens* (*Granulatisporites confluence*) Opper-zone, which was placed in the Aselian by Foster (1986), in the black carbonaceous/bituminous marine Treachery Shale representing the deglaciation sequence in the Bonaparte Gulf Basin in Western Australia and Northern Territory. Therefore, the occurrence of Lower Permian Gondwana-type spores and pollen in Tengchong strongly supports the conventional reconstructions of Gondwana placing the Tengchong Block and Bonaparte Gulf Basin at lower latitudes than other basins (Wopfner, 1994). Subsequent temperature elevation permits carbonates with fusulinids (*Triticites* sp., *Quasifusulina* sp.) deposited at a juxtaposition of Tethys shores.

There are so far no convincing reports of Gondwana cold-water biotas in Baoshan Block since the Early Permian cool-water fauna reported by Waterhouse (1982) is most likely of a temperate nature (Dickins, 1985). If we accept Wopfner's proposal that the Baoshan Block was once located in a more proximal position and originated from a volcanic rift complex adjacent to the Indian part of Gondwana, there must have existed some cold/cool water fauna

## PLATE 2

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| 1. <i>Calamospora</i> sp., proximal view, median focus, i-750.   | 11. <i>Striatoabieites multistriatus</i> , proximal view, median focus, i-750.  |
| 2. Spore -A, proximal view, high focus, i-750.   | 12. <i>Brevitriletes cornutus</i> , distal view, median focus, i-750.   |
| 3, 5. <i>Gondisporites wilsoni</i> ; 3. proximal view, median focus, i-750; 5. proximal view, high focus, i-750. | 13. <i>Laevigatosporites colliensis</i> , proximal view, median focus, i-750.   |
| 4, 8. <i>Indotriradites niger</i> ; 4. proximal view, median focus, i-750; 8. proximal view, high focus, i-750.  | 14, 15. <i>Columinisporites</i> sp. cf. <i>C. peppersii</i> ; 14. proximal view, median focus, i-750; 15. proximal view, high focus, i-750. |
| 6. <i>Converrucosisporites naumoviae</i> , proximal view, median focus, i-750.                                   | 16. <i>Striatopodocarpites cancellatus</i> , proximal view, high focus, i-750.  |
| 7. <i>Horriditriletes tereteangulatus</i> , proximal view, median focus, i-750.                                  | 17. <i>Flornites eremus</i> , proximal view, high focus, i-750.   |
| 9, 10. <i>Weylandites lucifer</i> ; 9. proximal view, median focus, i-750; 10. distal view, high focus, i-750.   | 18. <i>Striatopodocarpites fuscus</i> , proximal view, high focus, i-750.   |
|  | 19. <i>Protobaploxypinus limpidus</i> , proximal view, median focus, bi-750.  |

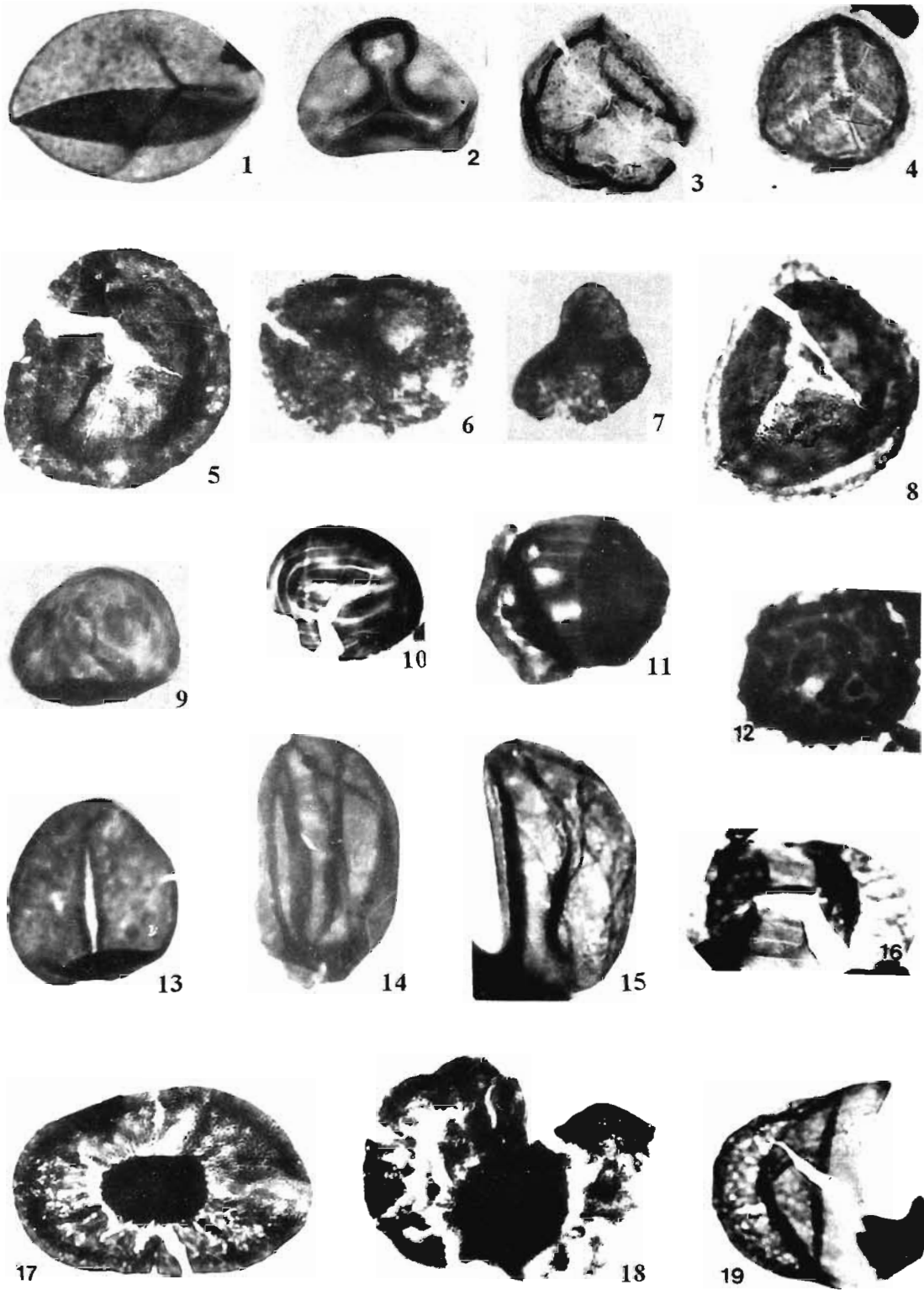


PLATE 2

or even Gondwana-type spores and pollen in the Late Palaeozoic glaciogene sequence in the Baoshan Block. Unfortunately, no spores and pollen were found so far. It might be the reasons for the explanation that Baoshan Block separated from Gondwana earlier than Tengchong Block did (Wopfner & Jin, 1993). So it is still too early to determine whether Baoshan Block is a part of Gondwana or not.

Spores and pollen commonly occurred in western Australia are also obtained in about 20 per cent of total palynomorphs in Haibang, Ali of the Lincang Block (to the east of the Baoshan Block). Although further conclusion and implication could not be made by now due to the insufficient data, this could at least imply that the Gondwana-type palynomorphs once arrived in this belt. Combined with finding of the Lower Carboniferous Gondwana-type spores (diagnosed by Dr L. Gao) in the Nanduan Group and cool radiolaria assemblage (claimed by Dr Q. Feng) in the Lower Laba Group in this same geological belt, the Lower Permian Gondwana palynological discovery in Haibang, Ali is likely to support the following hypothesis that the Lincang block might be an exotic Gondwana-derived terrane (Liu *et al.*, 1993).

### CONCLUSION

The present palynological investigation in western Yunnan shows a good potential to contribute the application of phytogeography and plate tectonic in the above paleosuture zone area through spores and pollen contents. Both palynostratigraphy and petrography in the so-called glacio-marine sequences could be thoroughly correlated each other in between the Bonaparte Gulf Basin of western Australia and the Tengchong block, W. Yunnan. Therefore, the Tengchong block could be attributed to peripheral of Gondwanaland together with some part of western Australia. The mixture of palynological contents at Early Carboniferous in Gengma and Early Permian in Lincang block combined with radiolaria assemblage might suggest that the Gengma and Lincang blocks surrounded at different time the Gondwana continental craton, belonging to Gondwana domain in terms of tectonics, although the biota features showed the mixing circumstances.

### REFERENCES

- Anderson JM 1977. The biostratigraphy of the Permian and Triassic. Part 3. A review of Gondwana palynology with particular reference to the northern Karoo Basin, South Africa. *Bot. Surv. S. Afr. Mem.* **41**: 1-133.
- Backhouse J 1991. Permian palynostratigraphy of the Collie Basin, Western Australia. *Rev. Palaeobot. Palymol.* **67**: 237-314.
- Bureau of Geology and Mineral Resources of Yunnan 1990. *Regional geology of Yunnan Province*. Geol. Publ. House, Beijing (in Chinese with English Summary).
- Dickins JM 1985. Palaeobiofacies and palaeobiogeography of Gondwanaland from Permian to Triassic. In: Nakazawa K & Dickins JM (Editors)—*The Tethys*: 83-92. Tokai Univ. Press.
- Fang Zongjie 1990. Some new knowledges about Western Yunnan geology. *Chinese Sci. Bull. sin.* **35**(5): 363-365.
- Fang Zongjie 1991. Sibumasu biotic province and its position in palaeotethys. *Acta palaeont. sin.* **30**(4): 512-532.
- Fong Runsen & Fan Jiancai 1993. Some new research on the geological characteristics in the Western Yunnan. *Geosci. Graduate School, China Univ. of Geosci.* **7**(4): 394-401.
- Foster CB 1986. A review of Early Carboniferous - Early Permian palynological assemblages from selected samples of the Bonaparte Basin. *Unpublished Palynological Report, AGSO - Open File*.
- Geological Survey of Yunnan 1982. Explanatory notes of Geological Map Menglian sheet (1:200,000). Geol. Publ. House, Beijing.
- Han Tonglin & Wang Naiwen 1983. Carboniferous glacio-marine deposits in northern Xizang (Tibet). *Bull. Chinese Acad. geol. Sci.* **7**: 41-50 (in Chinese with English Abstract).
- Higgs K, Clayton G & Keegan JB 1988. Stratigraphic and systematic palynology of the Tournaisian rocks of Ireland. *Geol. Surv. Tre. Spec. Pap.* **7**: 93.
- Huang Jiqing & Chen Bingwei 1987. *The evolution of the Tethys in China and adjacent regions*. Geol. Publ. House, Beijing.
- Jin Xiaochi 1994. Extent and timing of the Permo-Carboniferous glacio-marine deposits bearing units in southwestern China. In: *Abstracts IGCP-321, Fourth International Symposium and Field Excursion*, Seoul: 43-46.
- Kemp EM, Balme BE, Helby RJ, Kyle RA, Playford G & Price PL 1977. Carboniferous and Permian palynostratigraphy in Australia and Antarctica: a review. *B.M.R. J. Aust. Geol. Geophys.* **2**: 177-208.
- Liang Dingyi *et al.* 1983. Permo-Carboniferous Gondwana-Tethys facies in southern Karakorum, Nagari, Tibet. *Earth Sci. J. Wuhan College of Geology* **1**(19): 9-27 (in Chinese with English Abstract).
- Liu Benpei, Feng Qinglai, Fang Nianqiao, Jia Jinhua & He Fuxiang 1993. Tectonic evolution of Palaeo-Tethys Poly-Island-Ocean in Changning-Menglian and Lancangjiang belts, southwestern Yunnan, China. *Earth Sci J. China Univ. Geosci.* **18**(5): 529-539 (in Chinese with English Abstract).
- Metcalfe Z 1984. Stratigraphy, palaeontology and palaeogeography of the Carboniferous of Southeast Asia. *Mem. Soc. geol. France, N.S.* **147**: 107-118.
- Nie Zetong, Song Zhimin, Jiang Jianjun & Liang Dingyi 1993. Biota features of the Gondwana affinity facies and review of their stratigraphic ages in the Western Yunnan. *Geosci. J. Graduate School, China Univ. Geosci.* **7**(4): 384-393.
- Playford G 1976. Plant microfossils from the Upper Devonian and Lower Carboniferous of the Canning Basin, Western Australia. *Palaeontographica* **B158**: 1-71.
- Tiwari RS 1964. New miospore genera in the coals of Barakar Stage (Lower Gondwana) of India. *Palaeobotanist* **12**: 250-259.



- Tiwari RS 1965. Miospore assemblages in some coals of Barakar Stage (Lower Gondwana) of India. *Palaeobotanist* **13** : 168-214.
- Wang Yizhao 1983. Characteristics and significance of Carboniferous gravel beds in Tengchong and Baoshan areas, western Yunnan. *Contributions to the geology of the Qinghai-Xizang (Tibet) Plateau* **11**(71-77) (in Chinese with English Abstract).
- Waterhouse JB 1982. An Early Permian cool-water fauna from pebbly mudstones in South Thailand. *Geol. Mag.* **119**(4) : 337-432.
- Wopfner H & Diekmann B 1992. Zentralblatt. *Geol. Palaont.* : 2689-2701.
- Wopfner H & Jin Xiaochi 1993. Baoshan and Tengchong blocks of western Yunnan (China) in the Late Palaeozoic mosaic of the eastern Tethys. *In : Abstracts IGCP-321, Symposium, Kuala Lumpur* : 47-49.
- Wopfner H 1994. Late Palaeozoic climates between Gondwana and western Yunnan. *IGCP 321, Fourth International Symposium and Field Excursion, Seoul* : 127-131.
- Wu Haoruo *et al.* 1989. Carboniferous and Permian radiolaria<sup>4</sup> in the Menglian area, western Yunnan. *Acta Micropalaeont. sin.* **6**(4) : 337-343.
- Xu Guirong & Yang Weiping 1994. Permian palaeobiogeography. *In : Palaeobiogeography of China*, China Univ. Geosci. Press, Wuhan (in Chinese).
- Yang Weiping 1993. A palynological investigation into Upper Palaeozoic rocks in the suture zone area (W. Yunnan, China) between Gondwana and Laurasia plates and its geological significance. *Unpublished Ph.D Thesis* - a joint study in between China University of Geosciences and Sheffield University, U.K.