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Palaeovegetation and palaeoclimate during middle Late Palaeolithic age of Lingnan area, China

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ABSTRACT

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The fossil spore-pollen recovered from middle Late Palaeolithic age (i.e. late Middle Pleistocene to Late Pleistocene) of Lingnan area of China are mainly distributed in the Pearl River Mouth Basin, Pearl River Delta, Shenzhen, Zhanjiang, Leizhou Peninsula and Hainan Island. As revealed by the fossil spore-pollen, the vegetation of Lingnan area during the late Middle Pleistocene to Late Pleistocene comprised mainly of subtropical evergreen broad-leaved forest, evergreen and deciduous broad-leaved mixed forest, and coniferous forest. During the early Late Pleistocene, the area experienced transgression of sea, and climate became hot leading to the development, of mangrove vegetation in the littoral area. On recession of sea, near the end of Late Pleistocene, climate became cooler and drier and the mangrove forest diminished significantly. Thus, the above mentioned luxuriant vegetation and subtropical climate in middle Late palaeolithic age suggests existence of favourable conditions for early *Homo sapiens* activities in the Lingnan area.

Key-words—Pleistocene, Middle Late Palaeolithic age, Palaeovegetation, Palaeoclimate, Lingnan area of China.

चीन के लिंगनन क्षेत्र की मध्य-अंतिम शिली काल के दौरान पुरावनस्पति एवं पुराजलवायु

जिन जियानहुआ एवं लीओ वेन्बो

सारांश

चीन के लिंगन क्षेत्र के मध्य-अंतिम शिली काल (अर्थात अंतिम मध्य अत्यंतनूतन से अंतिम अत्यंतनूतन) से प्राप्त बीजाणु-पराग जीवाश्म मुख्यतः पर्ल नदी माऊथ द्रोणी, पर्ल नदी डेल्टा, शेन्ज़हें, ज़्हानजियांग, लीज़ोहो प्रायद्वीप एवं हैनन द्वीप में छितराए हैं। जैसा कि बीजाणु-पराग जीवाश्म से प्रकट हुआ, अंतिम मध्य अत्यंतनूतन से अंतिम अत्यंतनूतन के दौरान लिंगनन क्षेत्र की पुरावनस्पति मुख्यतः उप उष्णकटिबंधीय सदाहरित चौड़ी-पत्ती वन, सदाहरित व पतझड़ी चौड़ी-पत्ती मिश्रित वन, और शंकुधारी वन सन्निहित है। प्रारंभिक अंतिम अत्यंतनूतन के समय, क्षेत्र ने सागर का अतिक्रमण सहा तथा वेलांचली क्षेत्र में मैंग्रोव वनस्पति के विकास की ओर अग्रसर होती हुई जलवायु गर्म हो गई। सागर का प्रतिसार होने पर, अंतिम अत्यंतनूतन के समापन के लगभग जलवायु शीतल एवं शुष्क हो गई तथा मैंग्रोव जंगल सार्थक रूप से कम हो गए। निष्कर्ष में, मध्य-अंतिम पुराशिली काल में उपर्युक्त वर्णित विपुल पुरावनस्पति एवं उपउष्णकटिबंधीय जलवायु लिंगनन क्षेत्र में प्रारंभिक होमो सेपीएन्स सक्रियताओं हेतु अनुकूलीय स्थितियों की विद्यमानता सुझाती है।

मुख्य शब्द—अत्यंतनूतन, मध्य-अंतिम पुराशिली काल, पुरावनस्पति, पुराजलवायु, चीन का लिंगनन क्षेत्र।

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INTRODUCTION

THE Lingnan area is situated in the tropical to subtropical zone and is located in southern China (18°10'-24°87' N, 108°37'-117°82' E). In this region, a number of Palaeolithic historic sites have been found, especially during the last 10 years. A good number of Palaeolithic tools, animals and *Homo sapiens* fossils have been recovered from the area. Moreover, silicified rice grains more than one million years old have also been excavated. Hence, Lingnan is an important area for the study of the origin of human culture, agriculture and domestication of animals.

In the early developmental stage of human civilization, primitive *Homo sapiens* had to try their best for survival in the natural environment. Therefore, natural environments are very critical for the early development of human civilization. In middle Late Palaeolithic age, i.e. from the late period of Middle Pleistocene to Late Pleistocene, due to tectonic uplift of Tibet Plateau and the late Quaternary glaciation, the climates across greater part of the China turned cold and dry. However, temperature remained warm in the Lingnan as in subtropical region. Further, wide distribution of river networks, a number of limestone caves and abundant biodiversity in the Lingnan area provided favourable conditions for early *Homo sapiens* activities in the area. These beneficial conditions could promote development of civilization in the Lingnan area.

BRIEF HISTORY OF THE LINGNAN AREA

In terms of geotectonics, the Lingnan area belongs to the fold system of south China. Impact of the Himalayan orogeny in Cenozoic appeared as uplifting effect on the Lingnan area. Himalayan orogeny can be divided into three phases: the 1st phase started in late Eocene, about 37 million years ago, the 2nd phase occurred in Miocene, about 10 million years ago, and the 3rd phase began in Pleistocene, about 1.5 million years ago. The general landform of the Lingnan area acquired the present features in the early Quaternary. Thereafter, flood erosion, incision and denudation occurred in most parts of the Lingnan area. The landform of the Lingnan area has remained largely unchanged after the late Middle Pleistocene and Late Pleistocene, (Bureau of Geology and Mineral Resources of Guangdong Province, 1988).

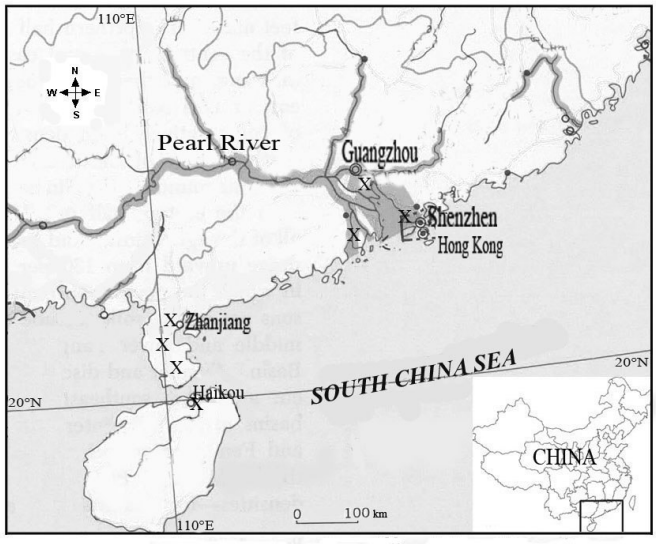

Fig.1—Localities of spore-pollen fossils in middle-late palaeolithic age of Lingnan area, China.

High and steep Nanling Mountains in the North limit the air exchanges between two sides of the mountains. During the Quaternary glacial age when the global climate turned extremely cold, Nanling Mountains effectively checked the northern cold winds and made the Lingnan area conducive for the growth of good vegetation. During the late Middle Pleistocene and Late Pleistocene, subtropical climate continued to prevail in the Lingnan area.

SPORE-POLLEN ASSEMBLAGE OF THE LINGNAN AREA

Spore-pollen of late Middle Pleistocene and Late Pleistocene were largely recorded from several localities of the Lingnan area, such as the Pearl River Mouth Basin, Pearl River Delta, Shenzhen, Zhanjiang, Leizhou Peninsula and Hainan Island (Shen *et al*., 1989; Lei *et al*., 1992; Chen *et al*., 1993; Zheng & Zhou, 1995; Zheng & Wang, 1998; Wang & Zhang, 1998; Zhang & Yu, 1999; Jiang *et al*., 2002). The assemblages consist of angiosperms (mainly dicotyledonous and monocotyledons), pteridophytes and a few gymnosperms. Spore-pollen assemblage found in the Lingnan area comprises the following taxa: Angiopteridaceae: *Angiopteris*; Pteridaceae: *Acrostichum aureum* Linn.; Osmundaceae: *Osmunda*; Lygodiaceae: *Lygodium*; Gleicheniaceae: *Dicranopteris* and *Diplopterygium*; Cyatheaceae: *Cyathea*; Pteridiaceae: *Pteridium*; Dennstaedtiaceae: *Microlepia*; Dicksoniaceae: *Cibotium barometz* (Linn.) J. Sm.; Pteridaceae: *Pteris*; Polypodiaceae: *Polypodiodes*; Cycadaceae: *Cycas*; Pinaceae: *Pinus*, *Keteleeria* and *Tsuga*; Podocarpaceae: *Dacrydium pierrei* Hickel and *Podocarpus*; Juglandaceae: *Juglans*, *Engelhardtia* and *Pterocarya*; Betulaceae: *Betula*, *Alnus* and *Carpinus*; Fagaceae: *Castanea*, *Quercus*, *Castanopsis*, *Lithocarpus* and *Cyclobalanopsis*; Ulmaceae: *Celtis* and *Ulmus*; Moraceae: *Ficus*; Proteaceae: *Helicia*; Polygonaceae: *Polygonum*; Chenopodiaceae: *Chenopodipollis*; Magnoliaceae: *Magnolia*; Lauraceae: *Cinnamomum*; Theaceae: *Schima*; Hamamelidaceae: *Liquidambar* and *Altingia*; Leguminosae: *Pterolobium punctatum* Hemsl; Euphorbiaceae: *Mallotus*; Anacardiaceae: *Rhus*; Aquifoliaceae: *Ilex*; Elaeocarpaceae: *Elaeocarpus*; Tiliaceae: *Tilia*; Myrtaceae: *Syzygium*; Sonneratiaceae: *Sonneratia caseolaris* (Linn.) Engler; Rhizophoraceae: *Bruguiera*

gymnorrhiza (Linn.) Savigny, *B. sexangula* (Lour.) Poir., *Ceriops tagal* (Perr.) C. B. Bob., *Kandelia candel* (Linn.) Druce, *Rhizophora apiculata* Bl., *R. stylosa* Griff and *R. mucronata* Lamk.; Nyssaceae: *Nyssa*; Ericaceae: *Rhododendron*; Myrsinaceae: *Aegiceras corniculatum* Blanco.; Sapotaceae: *Chrysophyllum*; Symplocaceae: *Symplocos*; Rubiaceae: *Randia*; Asteraceae: *Artemisia*; Potamogetonaceae: *Potamogeton*; and Ranunculaceae, Saururaceae, Piperaceae, Cruciferae, Rutaceae, Samydaceae, Araliaceae, Oleaceae, Gesneriaceae, Cyperaceae, Gramineae and Palmae.

PALAEOVEGETATION AND PALAEOCLIMATE CHARACTERISTICS

Based on comprehensive palynological studies of the late Middle Pleistocene and Late Pleistocene sediments of the above mentioned places, the reported vegetation has been classified into six types (Shen *et al*., 1989; Chen *et al*., 1993; Zheng & Zhou, 1995; Zheng & Wang, 1998; Wang & Zhang, 1998; Li, 1998; Zhang & Yu, 1999; Jiang *et al*., 2002). Palaeovegetation and palaeoclimate characteristics of each type are given below:

Type I- The component plants of this palaeovegetation type includes a lot of temperate elements such as *Quercus*, *Castanopsis* of Fagaceae, *Alnus* and *Carpinus* of Betulaceae, *Tilia* of Tiliaceae, and some coniferous species, as well as subtropical *Liquidambar* of Hamamelidaceae. The herbaceous species in the assemblage mainly represent Polypodiaceae, Chenopodiaceae and Asteraceae. The assemblage reflects existence of evergreen broad-leaved forest in north of mid-subtropical zone. During the period, the climate was warm and humid, and the annual average temperature was 15º-18 ºC, similar to the current climates in the region along the middle and lower reaches of Yangtze River drainage area to Shanghai and Hangzhou.

Type II- The dominant plants in this type were *Quercus* and *Castanopsis* of Fagaceae. Many tropical and subtropical taxa belonging to Palmae, Myrtaceae, Proteaceae, Moraceae, Rutaceae and Hamamelidaceae appeared. Forest floor was covered by plants belonging to family Pteridaceae, Polypodiaceae, Gramineae and Gesneriaceae. The assemblage reflected a warmer and more humid climate than before and the annual average temperature ranged from 18º-21ºC, similar to the evergreen broad-leaved forest in south of mid-subtropical zone.

Type III- This palaeovegetation type was an evergreen and deciduous broad-leaved mixed forests in south of northern subtropical zone. The climate was basically warm and humid, but temperature was lower compared to the present. The annual average temperature and precipitation were 14º -16ºC and 1000-1500 mm, respectively. There were many temperate plant species such as *Quercus*, *Castanea*, *Castanopsis*, *Cyclobalanopsis*, *Alnus*, *Carpinus*, *Betula*, *Celtis* and some coniferous species, also some subtropical species such as *Juglans*, *Pterocarya*, *Magnolia* and *Liquidambar*. The plants of Gramineae, Polypodiaceae and Lygodiaceae were also present.

Type IV- The type was dominated by abundant species of *Quercus* and *Castanopsis* of Fagaceae, *Pinus* of Pinaceae, *Dacrydium* and *Podocarpus* of Podocarpaceae and *Cycas* of Cycadaceae. This palaeovegetation type also contained tropical and subtropical taxa such as *Elaeocarpus*, *Pterolobium*, *Ficus*, *Randia*, *Altingia*, and species of Palmae, Sapotaceae, Euphorbiaceae and Araliaceae. Occurrence of Rhizophoraceae pollen and *Acrostichum* spores indicated that this region was affected by sea and the weather could be hot and humid, the annual average temperature and precipitation were 18º-21ºC and 1100-2000 mm, respectively, which was similar to the present day climate. This palaeovegetation type reflects evergreen broad-leaved forests in south of mid-subtropical zone and coniferous forests in subtropical zone, and mangroves along the sea coast.

Type V- This type mainly consisted of species of evergreen *Castanopsis* and *Quercus* of Fagaceae, *Elaeocarpus* of Elaeocarpaceae, *Cyathea* of Cyatheaceae as well as plants of Polypodiaceae. The pollen of the following plants have been reported: *Sonneratia caseolaris*, *Bruguiera gymnorrhiza*, *Kandelia candel*, *Rhizophora apiculata*, *Aegiceras corniculatum* and *Acrostichum aureum*. The assemblage indicate warmer and more humid climate in the early Late Pleistocene. The vegetation was monsoon evergreen broad-leaved type in lower subtropical zone and along the sea coast a large area was covered by mangroves.

Type VI- In this palaeovegetation, *Quercus*, *Castanea*, *Castanopsis* and *Cyclobalanopsis* of Fagaceae, *Alnus* and *Betula* of Betulaceae, *Pinus* of Pinaceae regained their dominant role. In addition, there were abundant species of Hamamelidaceae, Euphorbiaceae, Gramineae, Cyperaceae, Polypodiaceae and Lygodiaceae. This indicates that towards the end of Late Pleistocene, the climate became cool. The annual average temperature and precipitation were 14º-16ºC and 1000-1500 mm, respectively. This type of vegetation represented the evergreen and deciduous broad-leaved mixed forests in northern subtropical zone.

CONCLUSIONS

During middle Late Palaeolithic age, i.e. from late period of Middle Pleistocene to Late Pleistocene, due to uplift of Tibet Plateau and the late Quaternary glaciation, the climate across most regions in the China turned cold and dry. However, high and steep Nanling Mountains effectively hindered cold winds from the north and the temperature remained warm in Lingnan area, as in subtropical region. Nevertheless, temperature in general remained lower as compared to the present day temperature. The palaeovegetation types reflect subtropical evergreen broad-leaved forest, evergreen and

deciduous broad-leaved mixed forest and coniferous forest. In the early Late Pleistocene when marine transgression occurred, the climate turned warm and humid, which was similar to the present day climate which led to the development of mangrove vegetation along coastal areas. At the close of Late Pleistocene, sea regressed and climate became cooler and drier, and the mangrove forests diminished significantly. Thus, the occurrence of luxuriant vegetation and subtropical climate in Lingnan area at the middle Late Palaeolithic time provided favourable conditions for early *Homo sapiens* activities in the area.

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