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RECENT ADVANCES IN FLORISTIC PLANT GEOGRAPHY IN CHINA

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Floristic plant geography is a discipline which examines the present and past distribution and composition of all plants in a certain area or a country, the origin and evolution of plants on the basis of geological history, especially some important events, e.g. movements of plates, changes between sea and continents, glacier history and emergence of mountains, and its impact on the flora. As a subject, floristic pant geography is based on plant taxonomy, plant chorology, systematic botany, historical plant geography and plant ecology, and is closely related to geology, palaeobiology, palaeogeography and palaeoclimatology. To a great extant, the development of floristic plant geography depends on achievements made in such fields as plant taxonomy, chorology and systematics. Therefore, the study of plant taxonomy is unexceptionably the precursor of Chinese floristic plant geography.

Botanical discoveries made by European researchers in China can be traced back to earlier 18th century, while modern Chinese plant taxonomy and geography did not start until the 1910s. Tsoong Kuan-kwang (the first Chinese collation of plants), Chien Sung-shu, Chun Wong-young, Hu Hsen-Hsu and Ching Ren-chang were among the pioneers. Hu first studied the forest floras of southeast China in 1926. Liou published a paper of plant geography of north and west China in 1934. Li proposed a scheme of phytogeographical divisions of China with special reference to the Araliaceae in 1944. They made important contributions to modern Chinese floristic geography although their works were incomplete. Since the 1960s, Wu Cheng-yih and some other scientists have published a series of papers in plant geography of China, elucidating the floristic characteristics and phytogeographical divisions of China. They are of fundamental importance on Chinese floristic geography. At the same time, a joint effort was made in producing a 80-volume Chinese Flora, which is due to be finished very soon. On this background, a keynote project, Floristic Geography of Chinese Seed Plants, sponsored by the National Natural Science Foundation of China (NSFC) and co-chaired by C.Y. Wu of Kunming Institute of Botany of the CAS, H.T. Chang of Sunyatsen University and A.M. Lu of the CAS Institute of Botany, was initiated in 1990. It aimed at investigating floristic geography in China national-wide in conjunction with palaeobotanical clues. The project was divided into four sub-projects: (1) Studies on floristic geography of endemic families and genera in China; (2) Floristic geography of some important and poorly-known regions; (3) Development and evolution of the China flora since the Cretaceous, particularly since the Cenozoic; and (4) Origin, diversification and geographical distribution of the most important families and genera of the Chinese flora.

Under the supervision of the co-chairs and the academic organizing panel, more than 200 taxonomists, geographers and palaeobotanists from all over the country were involved in this five-year program. Fieldwork and floristic geographic analyses were carried out in 20 regions throughout the country, including Medog region in southeast Tibet, Dulongjiang region in northwest Yunnan, Chingling region in central China and the Islands and isles in the South China Sea region. Comprehensive studies were made on 247 endemic genera, 56 important familiés (or genera) and some palaeofloras of China. An attempt was made to better understand the time and place of the origin of the Angiosperms, to sort out the origin and evolutionary history of the Chinese flora and to reconsider the present

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phytogeographical divisions of China. As a result, the following new theories of assumptions are presented:

1. The origin of the Angiosperms

It is believed that the origin of the Angiosperms could generally be polyphyletic, polychronic and polytopic. The time of origin could be as early as the Jurassic, or even earlier, between the Jurassic and the Triassic. From the point of view of vacariance biogeography, it could be related to the forming of the Pacific Ocean.

It is commonly accepted that the Angiosperms may be originated not earlier than the Early Cretaceous. However, there is no satisfactory explanation in understanding the "exploration" of the Angiosperms during the Late Cretaceous. The fact is that the fossil records of plant are integrated reflection of ancient plants in their natural environments and fossilization of those plants at that time and space. Therefore the fossils can not reflect the absolute age of them. On the basis of analyzing plant phylogeny and geographic distribution, with special reference to the discontinuity distribution between the North and South Hemispheres or that across the Pacific, it is possible to trace some critical information. In all probability, the Early Cretaceous may be not the time of Angiosperm origin but that of their development.

Special attentions were paid to some 40 families of the subclass Magnoliidae (sensu lato) and other 20 families at various phylogenetic levels. Phylogenetic analyses and studies on geographic distribution showed that the majority of the Magnoliidae was evolved before the separation of the "Pangea" which was eventually happened during the Late Jurassic. One of the main stocks of the subclass, the Magnoliales and Illiciales were distributed on Laurasia, while another stock, the Winterales, Eupomatiales, Himantanthales and Degeneriales were on Gondwana. The two stocks may have begun to be differentiated on the Pangea, and developed separately forming paraphyletic groups. The present distribution of Annonaceae is Pantropic. In the Old World Tropics it ranges from southeast Tibet, central China, southern part of East China, southwards to 33° S in South Africa. In the New World it extends from the Great Lakes bwtween the United States and Canada , southwards to 27°S in Argentina and Chile. This distribution pattern can hardly be explained by immigration theory. In spite of lack of fossil evidence, it may be derived that the Annonaceae was originated in Pangea, while the early and later differentiation could also be happened in the Gandwana and its dispersal to the southern and the eastern Laurasia could be occurred at a later stage. Based on data not only from morphogenesis, ontogeny and phylogeny, but also from historical distribution, the orders and families of the primitive angiosperms are not all at the same primitive level. Some primitive character states may remain in a taxon, meanwhile some derived character states may also be developed in the same taxon during evolutionary process. Good examples include Annonaceae, Papaveraceae (especially *Corydalis*). The primitive angiosperms could be differentiated at a very early stage into polyphyletic groups which could be diversified by means of polychronic-polytopic evolution, and some of the them still being strongly diversified at present time. In short, the present-day seed plants are also a section of phylogenetic process. It is therefore necessary to establish a polyphyletic-polychronic-polytopic system of classification of the Angiosperms.

2. East Asia is an independent floristic kingdom

East Asia was usually treated as a floristic region of Holartic floristic kingdom (Good, 1974; Takhtajan, 1978, 1980). The East Asiatic Floristic Kingdom is proposed after comprehensive studies carried out during the operation of this project. There are 29 endemic families in East Asia, including Ginkgoaceae, Cephalotaxaceae, Sciadopityaceae, Trochodendraceae, Cercidiphyllaceae, Eupteleaceae, Glaucidiaceae, Circaeasteraceae, Euryalaceae, Sargentodoxaceae, Nandiaceae, Pteridophyllaceae, Eucommiaceae, Rhoipteleaceae, Stachyuraceae, Sladeniaceae, Dipentodontaceae, Plagiopteraceae, Bretschneideraceae, Podoaceae, Pottingeriaceae, Davidiaceae, Aucubaceae, Torricelliaceae, Carlemanniaceae, Trapellaceae, Triplostegiaceae and Hostaceae, three of which are ancient Gymnosperms, 18 being monospecific, 9 oligospecific and only one polyspecific. They are mostly, if not all, lineage of relict nature in terms of phylogenetic relationships. Some lineage of primitive Angiosperms, e.g. Magnoliales, Ranales and Hamamelidales, could be traced in East Asia. The endemism at generic level is very rich with over 600 genera restricted to East Asia. These genera include many famous "living fossils", e.g. *Ginkago biloba,*

Metasequoia glyptostroboides and *Cathaya argentophylla.* Diplopanax of the Araliaceae may be not well-known, but is closely related to an extinct Euroean Mastixioid genus, *Tectocarpa.* Molecular systematics suggests that *Diplopanax* is also a genus of the Mastixioidae. There are also many intermediate genera there, being in key positions connecting primitive and advanced groups during phylogenetic process. East Asia is at lest an important center of differentiation of seed plants. The Holartic flora (*sensu stricto*) could be derived from the East Asian flora. The Palaeotropic flora would be the development of the tropical elements of the East Asian flora before the Cretaceous under modern tropical environments, in which only a few are primitive, such Itoa and triplostepaceae distributed as a relict only in the mountain of Eat Malaya. The Tethyan subkingdom in the sense of Takhtajan (1986) should also be raised to a separate kingdom, compared with other regions of the Holarctic *sensu lato.* In general, the East Asian flora well represents the past of the Angiosperm flora of the Tertiary and before. In contrast, the floras of other regions of the Holartic may be developed later tha nor directly derived from the East Asian flora.

3. The majority of the Chinese flora was *in situ* originated

A conclusion was reached that there were 30,586 species of present-known seed plants in China, belonging to 3,155 genera of 343families. The numbers of endemic species, genera and families of China were 17,300, 247, and 5, respectively. We could therefore assume that the majority of the Chinese flora was *in situ* originated. Among the eight centers of distribution, East China, central China, Yunnan-Guizhou-Guangxi and Hengduan Shan Mr. Regions are centers of origin.

The earliest reliable floras of the Angiosperms were uncovered in Jixi Basin in northeast China by G. Sun et al. (1992), with 5 monospecific genera of dicotyledons from the Early Cretaceous. The pollen flora of Magnoliaceae from the Early Cretaceous in The Tarim Basin of Xinjiang show early differentiation between *Magnolia* and *Michelia.* Integrated studies on extant plants also suggests that during the Cretaceous, a junior form of the Chinese flora may be established and the differentiation of south and north floras in China could also be happened, so could the dry-hot region. A series of orogenic movements since the Tertiary, especially the emergence of the Himalayas and the Tibetan plateau and the separation of the Islands of Taiwan and Hainan from the Chinese mainland, had changed the general situation of atmospheric circulation and geomorphologic pattern, and sped up the interchange and /or isolation between the mountain floras of China and those of adjacent regions. During that time, the regional divergence of the Chinese flora initially formed.

4. A new system of phytogeographical division of China is established

Diels studied the phytogeography of western China (1913) and made the first attempt of phytogeographical divisions in China. This was followed by Hu, liou, Li and Handel-Mazzetti. However, their schemes were only partial or very rough. The first complete system of phytogegraphical divisions of China was outlined by Wu (1979), with 23 recognized regions representing seven subkingdoms of two kingdoms.

Based on studies on geographic distributions of Chinese plants as a whole at species level, in particular studies of endemism and vicariant species, a new system of phytogeographical divisions in China was proposed, in conjunction with palaeogeographic, palaeoclimatological and vegetation data. Within China, four kingdoms, i.e. Holartic, East Asiatic, Palaeotropic, and Tethyan; seven subkingdoms, i.e., Sino-Japanese, Sino-Himalayan, Tibetan Plateau, Eurasian forest, Eurasian steppe, Asiatic desert and Malaysian, were represented. The subkingdoms are further divided into 24 regions and 49 sub-regions.

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