

A floristic analysis of the Chinese *Fabaceae* with emphasis on the Sino-Himalayan region

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ABSTRACT: In the *Fabaceae* (s.str.) 106 genera and 1294 species are known to be native in China, occurring particularly in SW and NW China. The genera are mainly in the *Desmodieae* (18 Chinese genera/27 worldwide genera), *Galegeae* (13/20), *Hedysareae* (4/7), *Trifolieae* (6/7), *Phaseoleae* (27/84) and *Thermopsideae* (3/6) but also occur in 13 other tribes, the latter comprising 35% of the Chinese *Fabaceae* genera.

The floristic elements at the generic level were found to comprise a tropical element (61 genera, 57.5%) and a temperate element (45 genera, 42.5%). At the species level, the family is largely composed of North Temperate species in China (500, 38.6%) followed by Pantropical species (310, 23.9%), with members of other elements comprising no more than 10% of the total in each element.

The richest province in China for the family is Yunnan (67 genera, 423 spp.), followed by Xinjiang (32 genera, 345 spp.), Sichuan (47 genera, 284 spp.), Xizang (41 genera, 252 spp.), Guangdong (55 genera, 225 spp.), Guangxi (47 genera, 223 spp.) and Guizhou (55 genera, 218 spp.). These most abundant regions are in SW China, i.e. the Sino - Himalayan Region, and NW China, i.e. the Irano - Turanian Region. The genera endemic to the Sino - Himalayan region of China are *Salweenia* (1, Xizang), *Craspedolobium* (1, SW China), *Cochlianthus* (2, Himalayas), *Butea* (4, Indo - China), *Gueldenstaedtia* (11, Sino - Himalayas), *Campylotropis* (45, Himalayas), and *Tibetia* (6, SW China). There are many species endemic to this region, especially in the genera *Astragalus* (300 spp., mainly W China) and *Oxytropis* (75 spp., mainly W China).

KEYWORDS: *Fabaceae*, floristic analysis, Sino - Himalayan region.

Introduction

The *Fabaceae* (or *Papilionaceae*), the third largest family after *Compositae* and *Orchidaceae* among the flowering plants, is composed of about 440 genera and about 13,000 species worldwide. The main areas of diversity in growth form and systematic

composition are the Planalto of Brasil, Mexico, E Africa, Madagascar and the Sino - Himalayan region (POLHILL et RAVEN 1981). There are about 106 genera and 1294 native species belonging to the family in China, widely distributed from tropical to temperate areas, but especially in the South West (Yunnan, Xizang, Sichuan, Guizhou) and the North West (Xinjiang, Nei Mongol, Gansu).

There has been some floristic research on the family overall (POLHILL et RAVEN 1981), but very little on its Chinese representatives. This work mainly contributes to the floristic analysis of the Chinese *Fabaceae*, with emphasis on members from the Sino - Himalayan region, which are considered at the levels of the tribe, genus and species. Suggestions on further work of the family in China are also made.

Some Problems

As much taxonomic work has been done on Chinese *Fabaceae* as on many other taxa, this was mainly by western workers before the 1950's and by Chinese more recently. Of the latter, Prof. WANG FAZHAN and TANG TSIN (1955) edited the work of 14 Chinese taxonomists to complete the first monograph of the Chinese *Leguminosae*. Since then, in the preparation of *Florae Reipublicae Popularis Sinicae* (FRPS) and local floras (cf. MA 1989, 1992, 1993), most of the genera were revised (CHANG 1984 a, b; FANG and ZHENG 1989; FU 1982 a, b; FU P.Y. 1987; HO 1980; 1983 a,b; TSOONG and MA 1981; TSUI 1979, 1984; WEI 1984, 1985 a, b; XU 1985; YANG 1980, 1983; YANG and HUANG 1979, 1981). Although these floras have not yet been fully published, some of this work has appeared. However, China is a large country and more studies in modern plant taxonomy still have to be done, so much more information is needed, particularly at the species level, but also at the generic level.

In addition, there is a communication problem, since some important research work in the family published in Chinese is difficult for western students to comprehend and vice versa. For example, the series report of the First International Conference on Legumes, 'Advances in Legume Systematics' (POLHILL and RAVEN 1981), recorded the Chinese *Fabaceae* (as the subfamily) as comprising no more than 100 genera, and recent new genera such as *Podocarpium* (YANG and HUANG 1979) and *Tibetia* (TSUI 1979) are not included in it. On the other hand, taxa such as *Swainsona*, (not occurring in China), are still mentioned in some Chinese taxonomic works (cf. MA 1991). It will be valuable to summarise the numbers of *Fabaceae* in the World and in China. The following work, however, is a preliminary statistical analysis on the floristics of Chinese *Fabaceae*.

Analysis of distribution

In Table 1 are summarised the distribution regions of the Chinese *Fabaceae*. There are 31 tribes in the family of which only 18 occur in China (58.1%) and 106 genera among 440 in the world (24.1%). The Chinese elements are mainly in the some advanced tribes such as *Phaseoleae*, *Desmodieae*, *Galegeae*, *Hedysareae*, *Trifolieae* and *Thermopsidaeae*. In these tribes 72 genera (67.9%) of Chinese *Fabaceae* genera are included. These genera can be divided into two distribution elements: Tropical element (*Phaseoleae*, *Desmodieae*), and Temperate element (*Galegeae*, *Hedysareae*, *Trifolieae* and *Thermopsidaeae*).

Tab. 1. Representation of the tribes of the family in China and the World.**

Tribes	No. of genera (China/World)	Main distribution regions
<i>Phaseolae</i>	27/84	Tropics and subtropics
<i>Desmodieae</i>	18/27	Mainly tropics (Indo-China)
<i>Galegeae</i>	13/20	Northern temperate
<i>Tephrosieae</i>	11/50	Mainly Tropics
<i>Sophoreae</i>	7/48	Tropics
<i>Trifolieae</i>	6/7	Eurasia
<i>Aeschynomeneae</i>	5/25	Tropics and temperate
<i>Hedysareae</i>	4/7	Northern temperate
<i>Thermopsidaeae</i>	3/6	Northern temperate
<i>Dalbergieae</i>	2/19	Tropical America
<i>Crotalarieae</i>	2/16	Africa
<i>Vicieae</i>	2/5	Temperate
<i>Psoraleae</i>	1/6	Wide distribution
<i>Indigofereae</i>	1/4	Africa, Asia and S. America
<i>Loteae</i>	1/4	Mainly northern temperate
<i>Abreae</i>	1/1	Pantropics
<i>Cicereae</i>	1/1	Mediterranea
<i>Euchresteeae</i>	1/1	SE and E Asia
Total no.	106/331*	

* Excluding *Spongiocarpella* by YAKOVLEV et SVIAZEVA (1987).

** based on the system of POLHILL et RAVEN(1981).

Status of genera and species: According to D.L. WU et al. (1982) and WU and WANG (1981), the native genera of Chinese *Fabaceae* can be divided into 5 generic types (GT) and 11 distribution forms (DF)(see Table 2). This table shows that:

a, The generic elements of Chinese *Fabaceae* are mainly composed of 5 types, Pantropical (20, 18.9%), W - C Asia (12, 11.3%), Tropical Asia (14, 13.2%), Tropical Asia - Australasia (12, 11.3%), and E. Asia (11, 10.4%), i.e. the tropical elements comprise 43.4% and the temperate elements 21.7% respectively.

b, The species elements of Chinese *Fabaceae* are dominated by North Temperate elements (500, 38.6%), followed by Pantropical elements (310, 23.9%); the others not accounting for more than 10%.

Local distribution. Based on up-to-date collections, the distribution of genera and species among 28 Chinese provinces is shown in Table 3 (see also Figs. 1. and 2.).

From table 3 it can be seen that the richest province both in genera and species of Chinese *Fabaceae* is Yunnan, containin 63.2% of total genera and 32.7% of total Chinese species, followed by Xinjiang, Sichuan, Xizang, Guangdong, Guangxi, Guizhou, Gansu, Hainan etc. It can also be seen that the most abundant occurrence of the family in China is in Southwest China (Yunnan, Xizang, Sichuan, Guizhou) and Northwest China (Xinjiang, Gansu, Nei Mongol). Floristically the two regions span two elements; SW China belongs to the Sino - Himalayan Region (C. Y. WU 1979, 1991) and NW China to the Irano - Turanian Region (TAKHTAJAN 1981).

Tab. 2. The Generic Types (GT) and the Distribution Forms (DF) of Chinese Fabaceae.

DF (gen. & sp.)	GT (no. sp.) monogenous only 1	small gen. 2-10
PANATROPICS (20 gen., 310 sp.)		<i>Teramuss</i> (1/8)
OLD TROPICS (9 gen., 97 sp.)	<i>Pycnospora</i> (1/1)	
TROP. ASIA and AUSTRALASIA (12 gen., 42 sp.)	<i>Dicerma</i> (1/1) <i>Pongamia</i> (1/1)	<i>Christia</i> (5/10), <i>Codariocylyx</i> (2/2), <i>Glycine</i> (6/9), <i>Phylacium</i> (1/3), <i>Phyllodium</i> (4/6), <i>Tadehagi</i> (1/3)
TROPICAL ASIA (14 gen., 36 sp.)	<i>Mecopus</i> (1/1) <i>Teyleria</i> (1/1) <i>Trifidacanthus</i> (1/1)	<i>Afgekia</i> (1/3), <i>Antheroporum</i> (2/2), <i>Butea</i> (2/4), <i>Fordia</i> (1/10), <i>Geissaspis</i> (1/3), <i>Nogra</i> (1/3), <i>Sarcodum</i> (1/3), <i>Shuteria</i> (5/6), <i>Urariopsis</i> (2/2)
TROP. ASIA and TROP. AFR. (6 gen., 43 sp.)	<i>Parochetus</i> (1/1)	<i>Bowringia</i> (1/4)
MEDITERRAEAN (4 gen., 24 sp.)		
W.-C. ASIA (12 gen., 29 sp.)	<i>Evermannia</i> (1/1) <i>Halimodendron</i> (1/1)	<i>Ammodendron</i> (1/6), <i>Ammopiptanthus</i> (2/2), <i>Alhagia</i> (1/3), <i>Calophaca</i> (4/6), <i>Eremosparton</i> (1/3), <i>Sphaerophysa</i> (2/2)
E. ASIA and N. AMER. (8 gen., 73 sp.)		<i>Amphcarpaea</i> (3/3), <i>Apios</i> (6/10), <i>Cladrastis</i> (5/6), <i>Kummerowia</i> (2/2), <i>Wisteria</i> (4/6)
NORTH TEMPERATE (8 gen., 500 sp.)		
OLD TEMPERATE (2 gen., 72 sp.)		
E. ASIA (SINO-HIMAL. and SINO-JAP.) (11 gen., 68 sp.)	<i>Craspedolobium</i> (1/1) <i>Salweenia</i> (1/1) <i>Stracheya</i> (1/1)	<i>Cochlianthus</i> (2/2), <i>Euchresta</i> (4/4), <i>Piptanthus</i> (3/3), <i>Priotropis</i> (1/2), <i>Tibetia</i> (6/6)
TOTAL NUMBER: 106 gen., 1294 sp.	12 gen., 12 sp.	33 gen., 84 sp.

Tab. 2. - continued

middle gen. 11-50	large gen. 51-100	much large gen. more than 100
<i>Abrus</i> (1/15) <i>Canavalia</i> (4/50) <i>Galactina</i> (3/50) <i>Pterocarpus</i> (2/20) <i>Sesbania</i> (5/50)	<i>Clitoria</i> (2/70) <i>Dalbergia</i> (30/100) <i>Derris</i> (25/70) <i>Mucuna</i> (15/100) <i>Ormosia</i> (35/100) <i>Zornia</i> (2/80)	<i>Aeschynomene</i> (1/150), <i>Crotalaria</i> (40/600), <i>Desmodium</i> (35/300), <i>Eriosema</i> (2/130), <i>Erythrina</i> (4/108), <i>Indigofera</i> (80/800), <i>Rhynchosia</i> (13/200), <i>Tephrosia</i> (10/400)
<i>Alysicarpus</i> (5/30), <i>Flemingia</i> (18/30), <i>Ormocarpum</i> (1/20), <i>Psoralea</i> (1/20), <i>Smithia</i> (5/30), <i>Uraria</i> (10/20)	<i>Millettia</i> (40/100)	<i>Vigna</i> (16/150)
<i>Atylosia</i> (7/35) <i>Dendrolobium</i> (4/12) <i>Dunbaria</i> (9/15) <i>Whifordiodendron</i> (1/15)		
<i>Pueraria</i> (11/20) <i>Spatholus</i> (6/15)		
<i>Dumasia</i> (12/14) <i>Macrotyloma</i> (1/25), <i>Ophresia</i> (12/13)	<i>Dolichos</i> (16/60)	
<i>Medicago</i> (7/50)	<i>Ononis</i> (2/75)	
<i>Melilotus</i> (5/20)	<i>Trigonella</i> (10/80)	
<i>Chesneya</i> (10/20) <i>Cicer</i> (2/40) <i>Colutea</i> (2/28)		<i>Onobrychis</i> (2/130)
<i>Lespedeza</i> (30/50) <i>Podocarpium</i> (11/20) <i>Thermopsis</i> (12/23)		
<i>Sophora</i> (23/50)	<i>Hedysarum</i> (40/100) <i>Lotus</i> (7/100)	<i>Astragalus</i> (300/2000), <i>Lathyrus</i> (15/150), <i>Oxytropis</i> (75/300), <i>Trifolium</i> (5/250), <i>Vicia</i> (35/150)
<i>Glycyrrhiza</i> (7/20)	<i>Caragana</i> (65/80)	
<i>Campylotropis</i> (30/45) <i>Gueldenstaedtia</i> (11/12) <i>Maackia</i> (8/12)		
33 gen., 276 sp.	13 gen., 289 sp.	15 gen., 633 sp.

Tab. 3. Numbers of *Fabaceae* genera and species in 28 Chinese provinces**

Prov.	Yunnan	Xinjiang	Sichuan	Xizang	Guangdong	Guangxi	Guizhou
No. gen.	67	32	47	41	55	47	55
No. sp.	423	345	284	252	225	223	218
		*		*		*	
	Gansu	Hainan	Taiwan	Nei Mongol	Henan	Shaanxi	Fujian
	33	43	48	30	36	33	48
	181	165	164	162	158	146	133
		*	*	*	*		*
	Hebei	Anhui	Ningxia	Jiangxi	Hubei	Jiangsu	Qinghai
	27	34	22	33	33	33	17
	119	105	101	100	99	97	97
	*	*	*		*	*	
	Zhejiang	Liaoning	Hunan	Shanxi	Heilongjiang	Shandong	Jilin
	29	20	27	25	14	17	17
	96	92	90	87	46	45	40
		*					

*The province with the star mark means that the figure has been revised by the local flora based on the author's statistic work; other completed according to Distribution of Chinese Legume (CHEN and WU 1981, WU 1982).

**There are 31 regions at the province level in China. We use 28 for taking Beijing and Tianjin into Hebei and Shanghai into Jiangsu for statistic purpose only.

Discussion and conclusion

Determination of distribution forms

In phytogeographic literature it can find considerable debate about phytogeographic distribution of the world. Recently, GOOD (1974), TAKHTAJAN (1969, 1978, 1986), C.Y. WU (1979, 1991) and C.Y. WU and K.S. WANG (1981) have contributions on this topic, but there are considerable differences of opinion among them, especially with regard to scales and grades. In this paper, the determination of the phytochorions forms are mainly adopted from the concept of TAKHTAJAN (1986), compared with the concept of C.Y. WU (1979, 1991) on the Southwest China - Sino - Himalayan subregion, one of two subregions of East Asia region (WU 1979, 1991). From the statistic analysis of Chinese *Fabaceae*, the subdivision of East Asian Region by WU (1979, 1991) is more suitable than Takhtajan's concept since the Chinese species of *Fabaceae* mainly distributed in Southwest China (Sino - Himalayan Region) and in Northwest China (Irano - Turanian Region)(See fig. 2). From Fig. 2, one could get an impression that the Chinese *Fabaceae* are more centred in Sino - Himalayan Subregion than in Sino - Japanese Subregion in East Asia. From this apoint the general of East Asian Region should be divided into two subregion as WU's concept (1979, 1991)(see also fig. 3).

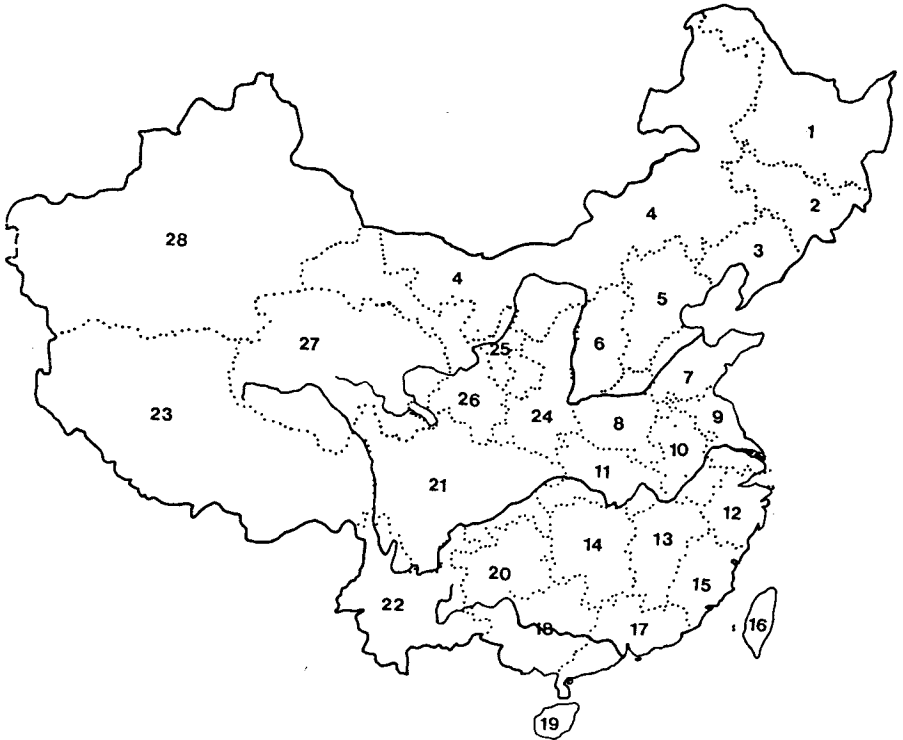


Fig. 1. Map of the administrative divisions of China: 1, Heilongjiang; 2, Jilin; 3, Liaoning; 4, Nei Mongol; 5, Hebei; 6, Shansi; 7, Shandong; 8, Henan; 9, Jiangsu; 10, Anhui; 11, Hubei; 12, Zhejiang; 13, Jiangxi; 14, Hunan; 15, Fujan; 16, Taiwan; 17, Guangdong; 18, Guangxi; 19, Hainan; 20, Guizhou; 21, Sichuan; 22, Yunnan; 23, Xizang; 24, Shaansi; 25, Ningxia; 26, Gansu; 27, Quinghai; 28, Xinjiang; The three largest cities are included in Hebei (Beijing, Tianjin) and Jiangsu (Shanghai) respectively for statistics only; moreover, NE (1-3), N (4-6), C (7-14), S (15-19), SW (20-23), NW (24-28) China, are used in this paper.

Definition and discussion of the generic distribution form

This question is much more complex than the former because the determination involves not only origin and evolution, but is delimited by modern distribution. We have not solved the former, and still lack complete information about the latter. In this case, it is problem to deferminate the status of some difficult genera. In this way we had to use the pattern of modern distribution, i.e. the size of the genus and its centre of distribution. In some cases e.g. in the genus *Ormosia* (35/100), most species are distributed in E. South America, E. Asia to NE Australia (POLHILL 1981, MABBERLEY 1987). This distribution form is difficult to compare with most Chinese species form used in this paper. However, we had to place it into Pantropic Distributed Form since it occupied both The Old Tropical World and The New Tropical World; and, moreover,

most of 35 Chinese species is in the tropical and subtropical regions in China (ZHANG 1987). Some other genera, as *Indigofera* and *Crotalaria*, are also placed into Pantropic Distributed Form (WU 1991, POLHILL 1981) though some species of them may extend into Temperate Region (MABBERLEY 1987). An interesting East Asian distribution form is represented by *Campylotropis* and *Euchresta*. Though both genera belong to East Asian Element, *Campylotropis* is centred in Sino - Himalayan Subregion and *Euchrestais* centred in Sino - Japan Subregion (Fig. 4). For the genus *Euchresta* with 4 species only (CHEN et al., 1992), though distributed over the Asia, all of the 4 species distributed in Sino - Japan Subregion and the distribution form still belongs to East Asian Element since it does not appear in Malaya (excluding Java), Tropical Asia, and does not pass the Walla line (CHEN et al., 1992)(see also Fig. 4). On the other hand, in the genus *Campylotropis* (30/45, Fu 1987), most of the species are distributed in SW China (Sichuan, Yunnan) and Himalayan Region, including South Xizang, undoubtedly, it is a Sino - Himalayan Element of East Asia distribution form, compared with *Euchresta* discussed above (see also fig. 3). In the temperate form, we placed *Lotus* (7/100), *Lathyrus* (15/150), *Astragalus* (300/2000), *Vicia* (35/150) as many authors had done (MABBERLEY 1987, POLHILL 1981, GOOD 1974) since its major distribution center is in the North Temperate zone though some species may extend into the Andes, South Hemisphere. On the other hand, cosmopolitan genera are not among Chinese *Fabaceae*, not even *Astragalus* (2000 spp.), one of the eight largest genera of flowering plants, for it does not occur in Australia (GOOD 1974).

Floristic characters

From the analysis of distribution, we can conclude that there are only two indigenous generic elements in Chinese *Fabaceae*, the tropical element representing 57,5% (including Pantropics, Tropical Asia, Tropical Asia - Australasia, Old Tropics, and Tropical Asia - Tropical Africa) and the temperate element representing 42,5% (including North Temperate, Old Temperate, Mediterranean, E. Asia and N. Amer., W.-C. Asia and East Asia). Analysis of the species shows that the North Temperate element is the largest in China, with 500 species representing 38.6% of the total Chinese species, followed by Pantropics with 310 species (23.9%), the others being each below 10%. In this way we can conclude that the species elements of the Chinese *Fabaceae* are mainly temperate, especially in *Astragalus* (300/2000)(FU 1982a, b, Ho 1983a, b, Ho 1980, Li 1989) *Oxytropis* (75/300), *Caragana* (65/80), *Hedysarum* (45/60) etc. These genera show wide ranges of morphological diversity through their distribution regions, frequent with adaptation to xerophytic and alpine conditions. They represent the typical elements of the Chinese *Fabaceae*.

Differentiation centre

The largest tribes of Chinese *Fabaceae* are *Phaseoleae* (27/84 genera, China/World), *Desmodieae* (18/27) of the Tropical element and *Galegeae* (13/20), *Hedysareae* (4/7), *Trifolieae* (6/7) and *Thermopsidaeae* (3/6) of the Temperate element. In the tropical element, there are several small genera shared by China and its southern neighbours, such as *Butea* (2/4), *Cochlianthus* (2/2), *Nogra* (1/3), *Teyleria* (1/1),

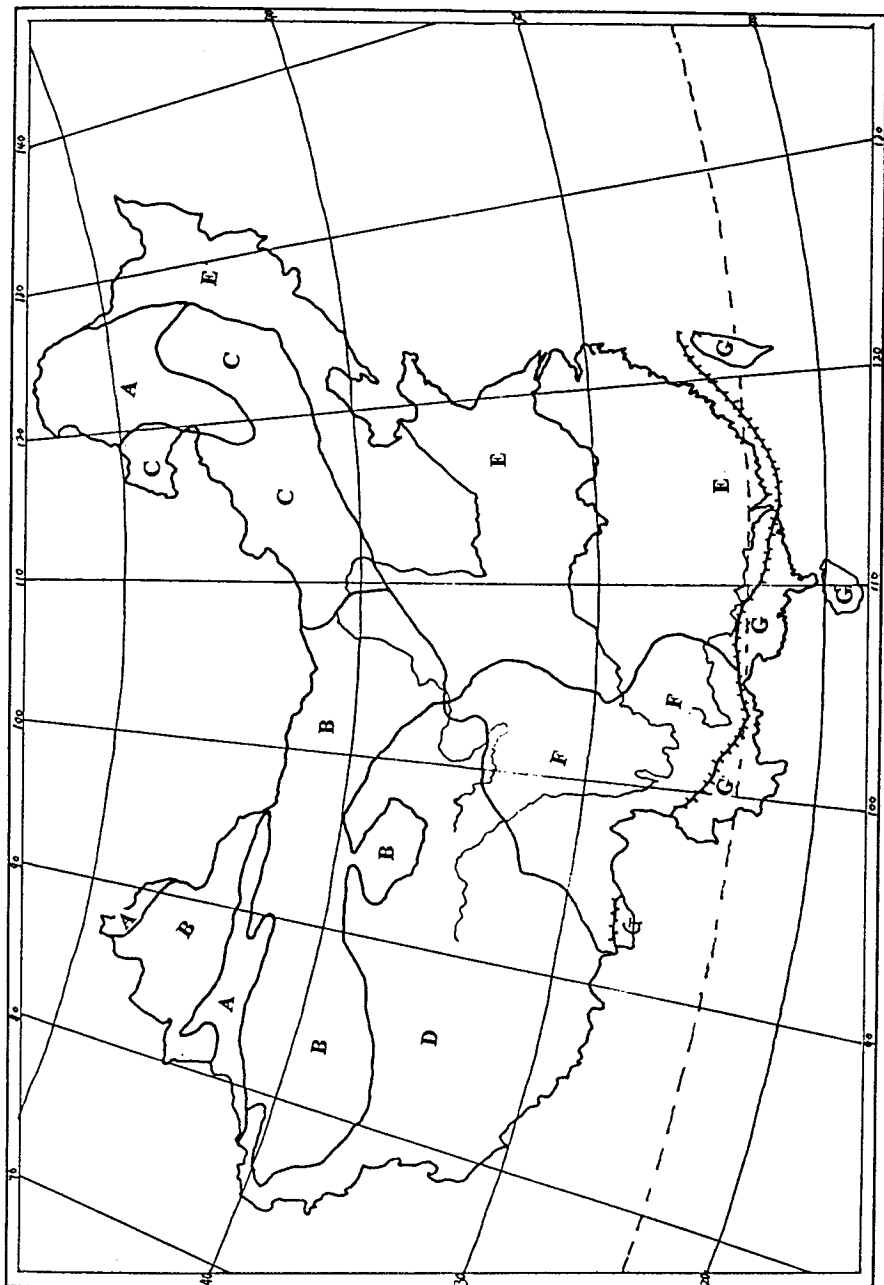


Fig. 2. Phytogeographic distribution of the Chinese flora (from WU ZHENGYI 1979). A: Eurasia forest subkingdom; B: Asiatic desert subkingdom; C: Eurasia steppe subkingdom; D: Qinghai - Xizang (Chinghai - Tibet) plateau subkingdom; E: Sino - Japan forest subkingdom; F: Sino - Himalayan forest subkingdom; G: Malaysian subkingdom.

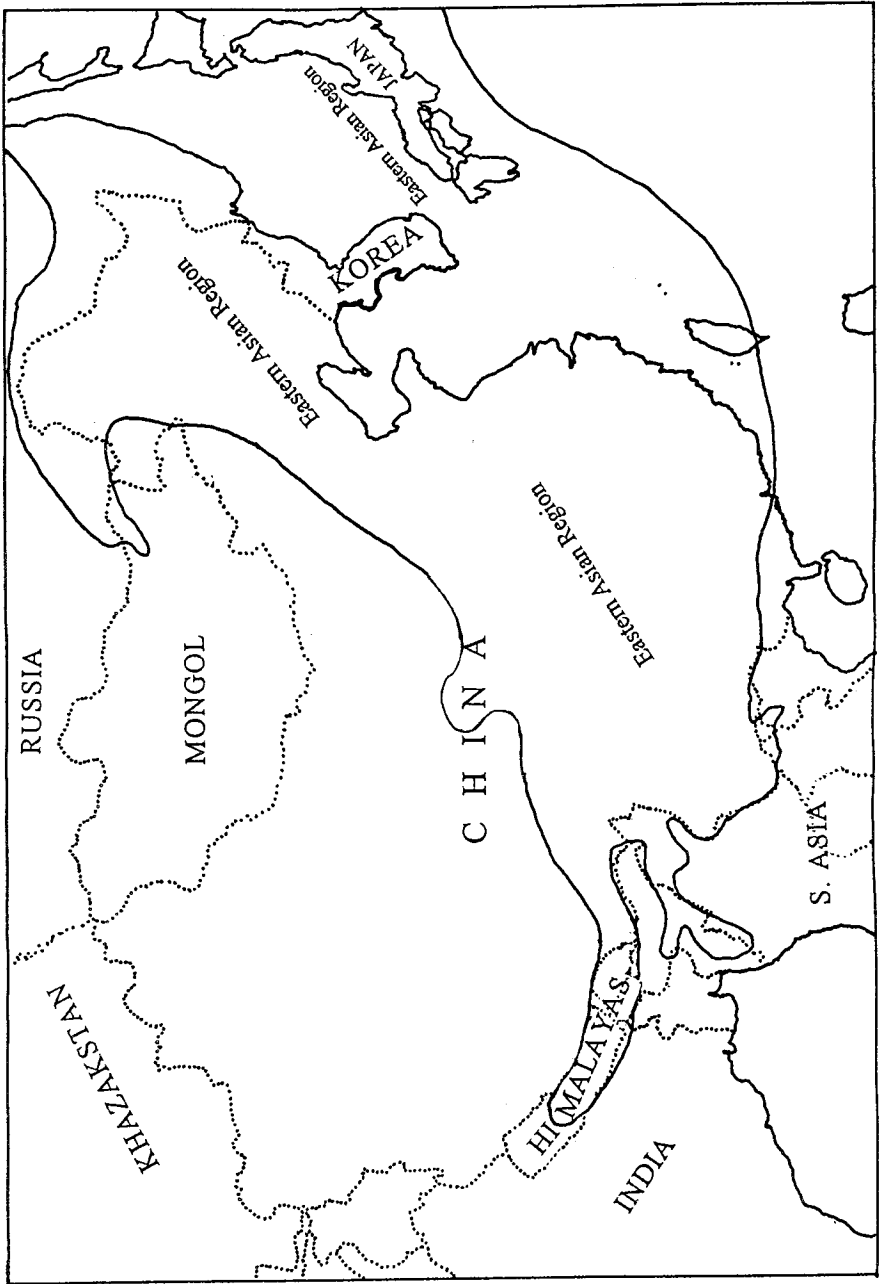


Fig. 3. Floristic Division of The World: Eastern Asian Region.
(from TAKHTAJAN 1978).

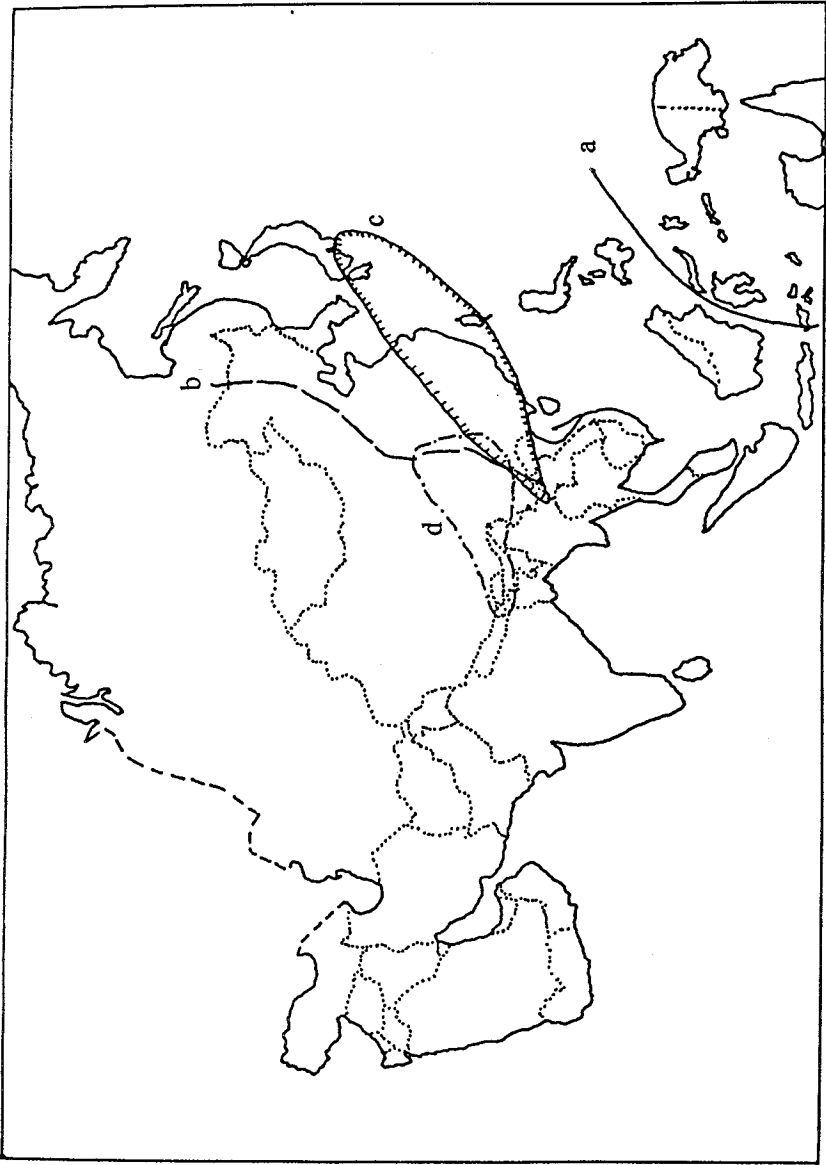


Fig. 4. Distributions of *Euchresta* and *Campylotropis* with two important phyto-geographical lines: a, Wallace Line; b, the division line between Sino - Himalayan Subregion and Sino - Japan Subregion; c, The main distribution centre of *Euchresta*; d, the main distribution centre of *Campylotropis*.

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