CHINESE GEOGRAPHICAL SCIENCE
Volume 4, Number 3, pp.232–241, 1994
Science Press, Beijing, China

# A STUDY ON THE FLORISTIC PLANT GEOGRAPHY OF XISHA ISLANDS, SOUTH CHINA ①

Xing Fuwu (邢福武) Li Zexian (李泽贤) Ye Huagu (叶华谷)
Chen Binghui (陈炳辉) Wu Delin (吴德邻)
*(South China Institute of Botany, The Chinese Academy of Sciences, Guangzhou 510650, PRC)*

**ABSTRACT:** Xisha Islands is situated on the South China Sea, at 15° 46′ –17° 08′ N. and 111° 11′ –112° 54′ E., with an altitude of 2.6–15.9m. The major types of vegetation are the evergreen coral island forest, and beach vegetation. The major types of vegetation are the evergreen coral island forest, scrub forest and beach vegetation. The dominant species of the forest communities are *Pisonia grandis, Guettarda speciosa, Scaevola sericea and Messer schmidia argentea*.There are 212 species of wild vascular plants belonging to 52 families and 147 genera in this area, of which there are 4 families, 4 genera and 5 species of pteridophyte and 48 families, 143 genera and 207 species of Angiosperms. The main families of the flora are Poaceae, Papilionaceae, Cyperaceae, Euphorbiaceae, Malvaceae, Rubiaceae, Nyctaginaceae and Boraginaceae etc. According to the geographical distribution, Spermatophytic genera in Xisha Islands may be classified into 9 types, of which pantropic genera accounts for 70% of total genera. At specific level, elements of Tropical Asia to Tropical Australia are dominant part in the forest communities. In this area there is no species endemic to itself. Many primitive taxa such as Gymnosperms, Anonaceae and many others are not found in the flora. Comparing the composition of the flora with those of 6 neighboring regions, the flora of Xisha Islands is quite similar to those of Hainan Island. The similarity indices of genera and species are 98.46% and 94.09% respectively. *Indigofera chunianas* is endemic to the two regions.

**KEY WORDS:** Xisha Islands; floristic plant geography

①This project is supported by National Natural Science Foundation of China.



© 1994-2011 China Academic Journal Electronic Publishing House. All rights reserved. http://www.cnki

## I. INTRODUCTION

The Xisha Islands is situated on the South China Sea, at 15° 46′ −17° 08′ N and 111° 11′ −112° 54′ E. Its latitude approximatesto that of the northern Part of the Philippine Archipelago,It lies on about 200 nautical miles off southeast of Hainan Island. Theislands consist of more than thirty islands and reefs, with analtitude of 2.6–15.9m. The total area of the islands is approximately7.28km$^2$. The highest island is Shidao Island and thelowest is Yongxing Island, with an ares of 1.85km$^2$, while Zhongdao Island is only 0.05km$^2$, The shapes of the islands are mostlyoval or circular, with higher edge and lower centre.

Its climate is tropics. The annual average temperature inYongxing Island is 26.5℃. The average temperature of the coldest month (January) and the hottest (June) are 22.9℃ and 28.9℃ respectively. The highest and lowest temperature are 33.6℃ and 15.3℃ respectively. The annual average evaporation and relative humidity are 2495.9mm and 81% respectively. The annual average precipitation is 1506mm. The rainy season is from June to November and drier season from December to May.

Four botanical collections have been made by Chinese collectors, the first by Prof. Zhang Hongda of the Zhongshan University, Guangzhou, who spent ten days in the islands in 1947 and collected about 35 species[1–2]the second by Prof. Wu Huimin and his colleagues in South China Institute of Botany, Academia Sinica, who stayed in the islands about one month in 1974, and collected about 167 species of vascular plants[3]; the third by Prof. Zhong Yi of the Hainan Teacher's College, who spent about one month in the Islands to investigate the whole islands and secured about 291 species in 1987, and another month on a second trip in 1990[4]; the fourth by the authors of this paper who visited the islands in 1992, and secured about 316 species[5–6]. The present paper is largely based on collections of our own, with some materials based on earlier collections.

## II. VEGETATION

The vegetational types in the islands are the evergreen coral islands forest, shrub forest and beach vegetation. The characteristic species of the forest communities are *Pisonia grandis, Guettarda speciosa, Scaevola sericea, Messerschmidia argentea*, Terminalia catappa, Sophora tomentosa, Thespesia pupulnea. The herbaceous vegetation are mainly distributed from the drift–sand zone to the beach dike behind the sand beach, their dominant species are *Ipomoea pescaprae, Euphorbia atoto, Launaea sarmemtosa, Vigna marina, Vitex trifolia var. simplicifolia, Thuarea involuta, Wedelia biflora, Triumfetta procumbens*, of which *Ipomoea pescaprae*is one of the pioneers. The cultivated vegetation are mainly *Cocos*



© 1994-2011 China Academic Journal Electronic Publishing House. All rights reserved. http://www.cnki

*nucifera*forest and *Casuarina equisetifolia*forest, very rarely *Leucaena glauca*forest.

**Table 1 Constituents and habits of the flora in Xisha Islands**

| Categories | Constituents | | | Habits | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Tree | | Herbs | | Vines | |
| | Number of families | Number of genera | Number of species | Number of species | Percentage in total species | Number of species | Percentage in total species | Number of species | Percentage in total species |
| Pteridophytes | 4 | 4 | 5 | – | – | 5 | 2.36 | – | – |
| Dicots | 40 | 103 | 144 | 32 | 15.09 | 94 | 44.34 | 18 | 8.49 |
| Monocots | 8 | 40 | 63 | 1 | 0.47 | 62 | 29.25 | – | – |
| Total | 52 | 147 | 212 | 33 | 15.56 | 161 | 75.95 | 18 | 8.49 |

**Table 2 The distribution patterns of genera and species of Angiosperms in the Xisha Islands**

| Distribution patterns | Number of genera | Percentage in total general* | Number of species | Percentage in total species* |
|---|---|---|---|---|
| 1. Cosmopolitan | 13 | – | 4 | – |
| 2. Pantropic | 91 | 70.00 | 57 | 28.08 |
| 3. Tropical Asia and tropical America disjuncted | 11 | 8.46 | 7 | 3.45 |
| 4. Old World Tropic | 9 | 6.92 | 34 | 16.75 |
| 5. Tropical Asia and Tropical Australasia | 4 | 3.08 | 43 | 21.18 |
| 6. Tropical Asia to Tropical Africa | 9 | 6.92 | 13 | 6.40 |
| 7. Tropical Asia | 4 | 3.08 | 41 | 20.20 |
| 8. North Temperate | 1 | 0.77 | – | – |
| 9. Old World Temperate | 1 | 0.77 | – | – |
| 10. Endemic to China | – | – | 8 | 3.94 |
| Total | 143 | 100.00 | 207 | 100.00 |

* Exclude the genera and species of conmopolitan

## III. FLORA ANALYSIS

So far as we know, there are 316 species of vascular plants (104 cultivated species included) belonging to 82 families and 211 genera in the islands, the wild vascular plants amount to 52 families, 147 genera and 212 species, of which 4 families, 4 genera and 5 species are Pteridophytes and 48 families, 143 genera and 207 species are Angiosperms (Table 1).

The families with more than 5 species are Grammineae (28 ganera, 41 species), Papilionaceae (14 genera, 20 species), Cyperaceae (5 genera, 13 species), Euphorbiaceae (5 genera, 11 species), Malvaceae (5 genera, 11 species) Compositae (8 genera, 9 species), Convolvulaceae (5 genera, 9 species), Amaranthaceae (5 genera, 7 species), Caesalpiniaceae (4 genera, 7 species), Vervenaceae (6 genera, 6 species), Solanaceae (3 genera, 5 species), Portulacaceae (5 genera, 5 species). But the species in the families mentioned above are mainly of herbs and vines and not the dominant species in the forest communities,while the



© 1994-2011 China Academic Journal Electronic Publishing House. All rights reserved. http://www.cnki

dominant species are of Rubiaceae, Nyctaginaceae, Boraginaceae, Combretaceae, Goodeniaceae and Guttiferae.

According to the geographical distribution[7], spermatophytie genera in the Xisha Islands may be classified into 9 types (Table 2) and almost all of them are tropical distribution, of which Pantropic genera accounts for 70% of total genera, most of them are important elements in their forest communities, such as *Pisonia, Calophyllum, Terminalia, Guttarda, Morinda, Scaevola,Cordia* and *Suriana* etc. There are 11 genera of Tropical Asia to Tropical America, of which *Messerschmidia*is very common in the islands. About 9 genera of old World Tropical distribution occur in the islands, such as *Pandanus, Pemphis*and so on. There are 4 genera of Tropical Asia to Tropical Australia in the islands, excluding *Cerbera*as tree, other are herbs. About 9 genera of Tropical Asia to Tropical Africa have been found in the islands, of which *Cocciniaand Hewittia*are climbing plants growing commonly in the islands. *Tamarindus*and *Andrographis*belongs to the elements of Tropical Asia, which may have been accidentally introduced by fishmen.*Eragrotis*and *Launaea*are the temperate genera occurring in the islands, the latter is a very common element in the open sandy beach.

At the specific level, elements of Pantropic and Tropical Asia to Tropical Australia are dominant part in the flora. The former, such as *Ipomoea pescaprea, Ipomoea tuba, Lippia nodiflora*and *Hedyotis corymbosa*etc., are common herbs and vines in the Xisha Islands. The latter, such as *Pisonia grandis, Terminalia catappa, Guettarda speciosa, Messerschmidia argentea, Morinda citrifolia, Suriana maritima*and*Pemphis acidula*etc., are the dominant species in their communities. About 34 species of old World Tropical elenemts occur in the islands, of which*Calophyllum inophyllum, Cordia subcordata and Scaevola sericea*are very common species. There are 41 species of Tropical Asia distribution, which are mainly herbs and vines, such as *Sida veronicaefolia, Euphorbia thymifolia, Caesalpinia mimax*and*Borreria articularis*etc. The elements of Tropical Asia to Tropical America and Tropical Asia to Tropical Africa amount to 20 species. *Portrulaca pilosa, Tridax procumbens*and *Hyptis suaveolens*belong to the former class; *Portulaca quadrifida, Coccinia cordifolia*and *Indigofera nummularifolia*belong to the latter. There are 8 species endemic to China, such as *Sida chinensis, Chloris formosana*and *Indigofera chuniana*, all these species were perhaps introduced by fishmen from Hainan Island or taiwan, on local endemic species was found. Such characteristic may be ascribed to the fact that it is a very young flora in the historic phytogeographical aspect.

## IV. THE DISTRIBUTION OF PLANTS IN DIFFERENT ISLANDS

According to our collections in 1992 and earlier materials, numbers of species of wild



© 1994-2011 China Academic Journal Electronic Publishing House. All rights reserved. http://www.cnki

vascular plants in different islands are roughly as follow as: about 187 species occur in Yongxing Island, 54 species in Dongdao Island, 46 species in Shanhu Island, 44 species in Jinyin Island, 41 species in Chenhang Island, 38 species in Ganquan Island, 33 species in Jinqing Island, 28 species in Beidao Island, 25 species in Nandao Island, 23 species in Zhaoshu Island, 22 species in Shidao Island and 20 species in Zhongdao Island, 17 species in Guangjin Island and 5 species in Zhongjian Island. About 118 species occuring in Yongxing Island are not recorded from other islands, such as *Ficus virens, Rhynchosia minima, Cardiospermum halicacabum, Bacopa monmieri, Eulophia campestris*and *Abrus precatorius*etc. The plants occuring in other islands are almost common to Yongxing Island, but a few species such as *Premna corymbosa, Vermomia patula, Bidens Pilosa, Scaevola hainanensis, Pharbitis indica*and *Pemphis acidula*occur in Dongdao Island only, *Opuntia dilleniis* found only in Shanhu Island and *Evolvulus alsinoides*is recorded only from Ganquan Island, and *Arthraxon hispidus var. cryptatherus*occur in Jinyin Island only. The number of species occuring in the islands may be concerned in its altitude and area, as well as activities of mankind. A numerous species occur in Yongxing Island, which may be concerned in its larger area. On the other hand, the island is the political, economic and cultural centre of the Xisha Islands, many plants are accidentally introduced by man from neighboring regions. Only 5 species occur in Zhongjian Island, which may be ascribed to its lower altitude.

## V. THE FLORA RELATIONSHIPS

According to historical geology, the Xisha Islands is very young in age, all plants of the islands are immigrated by various means from the neighboring continents and islands. Therefore, its flora is quite similar to surrounding regions (Table 3).

**Table 3 Comparison of the floristic elements of Angiosperms in the Xisha Islands and its surrounding regions**

| Regions | Genera shared with the Xisha Islands* | Species shared with the Xisha Islands* | Similarity index of general | Similarity index of species |
|---|---|---|---|---|
| Hainan | Indo–China Peninsula | 128 | 191 | 98.46 |
| | Malaysia | 126 | 178 | 96.92 |
| | Indonesia | 125 | 174 | 96.15 |
| | Philippines | 123 | 171 | 94.62 |
| | Taiwan | 123 | 164 | 94.62 |
| | Micronesia | 122 | 159 | 93.85 |
| | S.E.Polynesia | 112 | 99 | 86.15 |
| | Hawaii Islands | 80 | 56 | 61.54 |
| | Bonin Islands | 90 | 38 | 69.23 |
| | | 51 | 29 | 39.23 |

* Exclude the genera and species of cosmopolitan.



© 1994-2011 China Academic Journal Electronic Publishing House. All rights reserved. http://www.cnki

As shown in Table 3, the flora of the Xisha Islands is most affinitive to Hainan Island. The similarity indices of genera and species are 98.46% and 94.09% respectively. A large number of species are common in both regions, such as *Sophora tomentosa, Morinda citrifolia, Messerschmidia argentea, Cordia subcordata,Guettarda speciosa, Scaevola sericea*and *Euphorbia atota*etc. With recent intensive botanical exploration in Hainan, a numerous new recorded plants have been discovered, of which the discovery of *Pisonia grandis, Lepturus repens, Pemphis acidula, Trianthema portulacastrum*and *Boerhavia erecta*is very interesting. In China these species were formerly known only from the Xisha Islands and Taiwan, the discoveries of these species in hainan indicate the close relationship of the floras in those three regions. On the other hand, about 10 species occuring in the Xisha Islands have not been found in Hainan, such as *Triumfetta procumbens, Sida parvifolia, Vigna maritima, Suriana maritima, Pharbitis indica*and *Caealpinia mimax*etc., which may be ascribed to its geographical position.

The flora of the Xisha Islands is also quite similar to those of Indo–China, Malaysia, Indonesia and the Phillippines. The similarity indices of species are 87.6%, 85.71%, 84.24% and 80.79% respectively, many species, such as *Morinda citrifolia, Messerschmidia argentea, Guettarda speciosa*and *Scaevola sericea*etc. are common in those regions, but some species occuring in the Xisha Islands such as *Myoporum bontides, Caelsapinia mimax*and *Scaevola hainanensis*have not been recorded from Malaysia, Indonesia and the Phillippines, while *Suriana maritima, Boerhavia erect, Sida parvifolia*and *Triumfetta procumbens*etc. have not been found in Indo–China.

Many plants occuring in the Xisha Island are also common in Taiwan, such as *Terminalia catappa, Guettarda speciosa, Messerschmidia argentea, Morinda citrifolia, Ipomoea pescaprae, Scaevola sericea, Sophora tomentosa, Thespesia populnea, Calophyllum inophyllum, Vigna marina, Clerodendron inerme, Pandanus tectorius, Pemphis acidula*and *Lepturus repens*etc., of which *Sophora tomentosa, Messerschmidia argentea*and *Guettarda speciosa*are merely distributed to the south of Taiwan. *Vigna marina*is also recently found in the shore of Guangdong, but not recorded from Hainan Island. It is noteworthy that many tropical shore plants, such as *Sophora tomentosa, Thespesia populnea, Vigna marina, Calophyllum inophyllum, Guettarda specionsa, Messerschmidia argentea*and *Taminalia catappa*etc., are distributed from the tropical region northward through southeast Asia to Taiwan, but never reached the shore of the East China Sea and the Yellow Sea of China.

Micronesia which lies to the east of the Philippines, including more than 1,400 islands, islets and reefs, with a covering of coral rock, is quite similar to the Xisha Islands in geological aspect. Floristically, besides the widespread tropical shore plants occurring in two re-



© 1994-2011 China Academic Journal Electronic Publishing House. All rights reserved. http://www.cnki

gions, many other plants, such as *Achyranthes aspera, Boerhavia diffusa, passiflora foetida, Corchorus acutangulus, Waltheria americana, Euphorbia thymifolia, Cassia occidentalis, Cassytha filiformis, Evolvulus alsinoides, Bacopa monnieri, Clerodendron inerme, Fimbristylis spathacea*and *Cenchris calyculatus*etc. are also common to the two regions. On the other hand, some genera only occur in the Xisha Islands, but not in Micronesia, such as *Opuntia, Sebastiania, Sindora, Dentella, Launaea, Tridax, Lippia, leucas, Bothriochloa, Brachiaria, Chloris, Dichanthium*and *preotis etc.*

The southeastern Polynesia includes Marquesas, Society Islands, Tuamotus, Austral Islands, Rapa, Mangareva, Oeno, Pitcairn and Henderson etc., which lies to the southeast of the Hawaiian Islands. Though the island group is far separated from the Xisha Islands, yet there are many plants common to the two regions, such as *Amaranthus viridid, Pemphis acidula, Pisonia grandis, Triumfetta procumbens, Euphorbia atoto, Canavalia maritima, Rhynchosia minima, Guettarda speciosa, Wedelia biflora, Bacopa monnieri, Ipomoea congesta, ipomoea obscura, Stachytrpheta jamaicensis, Lepturus repens*and *Thuarea involuta*etc., but these species as mentioned above have not yet recorded from the Hawaiian Islands. In Hawaiian flora, only 38 species also occur in the Xisha Islands, such as *Cassytha filiformis, Sesuvium portulacastrum, portulaca oleracea, Tribulus cistoides, Oxalis corniculuta, Boerhavia diffusa, Passiflora foetida, Terminalia catappa, Calophyllum inophyllum, Waltheria americana, Abutilon indica, Thespesia populnea, Phyllanthus niruri, Abrus precatorius, Sophora tomentosa, Morinda citrifolia, Scaevola sericea, Cordia subcordata, Messerchmidia argentea*and*Ipomoea pes-caprae*etc., but those plants are also recorded from the southeastern Ploynesia. At the specific level, the flora of the Xisha Islands is more affinitive with southeastern Polynesia than with the Hawaiian Islands, which is probably due to ocean current. On the other hand, the Hawaiian Islands is a oceanic islands, where a number of species are endemic. The proportion of endemic Angiosperms is 81.42% in Hawaii. The floristic relation between the Xisha Islands and the Hawaiian Islands is mainly at generic level, many genera are common to the two regions, such as *Gomphrena, Pisonia, Malvastrum, Acalypha, Caeaslpinia, Cassia. Erythrina, Indigofera, Mucuna, Vigna, Hedyotis, Heliotropium, Pharbitis, Myoporum, Lippia, Pandanus*etc.

The Bonin Islands lies to the north of the Marianne Islands and the south of Japan, its flora is very different from the Xisha islands. Many tropical shore plants, such as *Pemphis acidula, Triumfetta procumbens, Euphorbia atoto, Sophora tomentosa, Vignamarina, Suriana maritima, Guettarda speciosa, Cordia subcordata, Clerodeneron inerme, Thespesia populnea*and *Pisonia grandis*etc. are found in the Xisha Islands, but not yet found in the Bonin Islands. On the other hand, many plants occur in the Bonin Islands, but have no record from the Xisha Islands, specially many temperate genera, such as *Corydalis, Sedum, Capsella, Rhododendron, Vaccinum, Buthriospermum, Ajuga, Artemisia*and *Astter*etc. Those



© 1994-2011 China Academic Journal Electronic Publishing House. All rights reserved. http://www.cnki

examples indicate that the temperate genera have a great influence upon the flora of the Bonin Islands, but some plants are common to the two regions, such as *Lepturus repens, Cassytha filiformis, Calophyllum inophyllum, Terminalia catappa, Ipomoea pescaprae, Messerschmidia argentea, Morinda citrifolia, Scaevola sericea*and *Wedelia biflora*etc.

## VI. FORMATION AND DEVELOPMENT OF THE FLORA

In the islands there is on endemic genus or species. In other words, there is no plants which originated from the local regions. All plants are immigrants. Most of them were undoubtedly introduced purposely or accidentally by man, others were introduced through natural means, such as migratory birds and wind, specially ocean current, while the original immigrants were probably introduced by ocean current, such as *Pemphis acidula, Guettarda speciosa, Terminalia catappa, Scaevela sericea, Cordia subcordata, Messerschmidia argentea, Ipomoea pescaprae, Canavalia maritima, Calophyllum inophyllum*and *Thespesia populnea*etc. Some plants by the transmission of minute fruits which attached to the feet or the feathers of migratory birds, such as *Pisonia grandis, Boerhavia diffusa, Boerhavia ercta, Tribulus cistoides*and *Tribulus terretris*.A few species of ferns, such as *Phymatodes scolopendria, Neprolepis biserrata,*and *Eupatorium odoratum, Tridax procumbens*may have been introduced by wind. We may reasonably assume that the vascular plants occuring in the islands are no more than 50 species before the advent of man.

Since the arrival of man, a large number of species have been introduced into the islands by man in his migration and in the intercommunication between the islands and its neighboring regions, especially Hainan Island. Before 1932, I—tants in the islands, but the Hainanese fishmen often voyaged in fishing boat to the islands, where they temporarily stayed, from 1932 to 1945 the islands were occupied at first by the French and later by the Japanese, but at that time only a few cultivated plants such as *Cocos nucifera, Ricinus communis*and *Brassica chinensis*were introduced. After the advent of the Chinese Navy and Hainanese inhabitants, a numerous species have been rapidly introduced from Hainan Island and other regions of China, The number of species were collected by Chinese collectors in different periods as the following: 35 species were collected by Zhang Hongda in 1947[1]; 213 species (including 47 cultivated plants) by Wu Huimin and his colleagues in 1974[3]; 291 species (including 92 cultivated plants) by Zhong yi in 1987[4]and 316 species (including 104 cultivated plants) by the present authors in 1992[5–6], while each time additional species were chiefly found in Yongxing Island where the activities of man has been very frequent. It is obvious that the mankind played an important role in spreading plants. In 316 species occurring in the Xisha Islands, about 262 species were manifestly introduced by man, either purposely or accidentally, the former is for economic reasons, about 32.9% in total species, including edible plants, medical plants, fibre plants and ornamental plants, the



© 1994-2011 China Academic Journal Electronic Publishing House. All rights reserved. http://www.cnki

latter is accidentally introduced, about 48.10% in total species, such as *Cyperus rotundus, Portulaca oleracea, Amaranthus viridis, Acalypha lanceolata, Euphorbia thymifolia*etc. In recent time many buildings have been erected and most of building materiols even including sand have been transported form Hainan Island, therefore, many plants have been brought into the Xisha Islands from Hainan Island, such as *Mullugo nudicaulis, Triumfetta grandidens, Cassia pumila, Abrus precatorius, Atylosia scarabaeoides, Indigofera hirsuta, Indigofera nummularifolia, Rhynchosia minima, Eragrostis zeylanica, Perotis indica, Eulophia campestris, Commelina diffusa, Cardiospermum halicacabum*etc. With the increasing of communication facilities between these two regions, more Hainanese plants will be brought into the Xisha Islands in the future. But due to the activities of man, the primary coral forest will be destroyed in order to clear the land for building and agricultural purposes, many woody plants will decrease in quantity. According to our estimation, about 10 species occuring in the islands were in the rare or endangered category, such as *Suriana maritima, Pemphis acidula, Scaevola hainanensis*and *Pisonia grandis*. They must be strictly protected.

## VII. DISCUSSION AND CONCLUSION

According to our present work, we can get some general conclusions as follows:

1. It has been shown by the specific analysis that all plants are strictly tropical elements, the flora mainly consists of widespread tropical shore plants as *Pisonia grandis, Guettada speciosa, Morinda citrifolia, Scaevola sericea, Messerschmidia argentea, Terminalia catappa*and *Sophora tomentosa*etc. In floristic division, the flora belongs to South China Sea region, Malaysia subkingdom, Palaeotropic kingdim.

2. An analysis of the spermatophytic genera indicates that pantropic genera is the largest part, with 70% of total genera. At specific level, Tropical Asia to Tropical Australia elements is a dominant constituent in the forest communities.

3. The islands is rather poor in flora, so far, a total of 212 species of wild vascular plants have been known from the islands. On the other hand, there are no endemic genus or species. Primitive taxa as Gymnosperms, Anonaceeae and many others are not found in the flora, which may be ascribed to its very young flora in geological aspect.

4. Comparing with neighboring region, the flora's largest affinity is with Hainan Island, which is due to their shorter distance in geographical position and the frequent human activities between the two regions as well.



© 1994-2011 China Academic Journal Electronic Publishing House. All rights reserved. http://www.cnki

## REFERENCES


[1] Chang H T. The Vegetation of the Paracel Islands. Sunyatsenia, 7(1–2): 75–88, 1948.

[2] 张宏达. 西沙群岛的植被，植物学报，16(3): 183–190, 1974.

[3] 广东省植物研究所西沙群岛植物调查队. 我国西沙群岛的植物和植被，北京：科学出版社，1977. 73–112.

[4] 钟义. 海南省西沙群岛植物资源考察，海南师范学院学报，3(1): 49–63, 1990.

[5] 邢福武, 吴德邻, 李泽贤, 等. 西沙群岛植物资源调查，植物资源与环境，2(3): 1–6, 1993.

[6] 邢福武, 李泽贤, 吴德邻. 海南岛南部甘什岭植物区系的初步研究，植物研究，13(3): 227–242, 1993.

[7] 吴征镒. 中国种子植物的分布区类型，云南植物研究增刊，(4): 1–139, 1991.

[8] Backer C A. Flora of Java. 1963–1968, Vol.I–III.

[9] Forest B H B. Flora of southeastern Polynesia. Hawaii:1931–1935,Vol. I–III.

[10] Henry N R. The Flora of the Malay peninsula. London:1922–1925, Vol. I–V.

[11] Hillebrand W F. Flora of the Hawaiian Islands. 1888, 652–673.

[12] Kanehira R. An enumeration of Micronesian plants. Journ. Depart. Agr. Kyushu Imp. Univ. 1935, 4(6):473–464.

[13] Lecomte M H. Flora Generale De L Indo–Chine, Paris:1907–1946, I–VII and Supplement.

[14] Li H L. Flora of Taiwan. 1975–1979, Vol. I–V.

[15] Merril E D. An enumeration of Philippine flowering plants, Manila: 1925–1926, Vol.I–IV.

[16] Nakai T. The Flora of Bonin Islands. Bull. Biogeogr. Soc. Jap. 1930, 1:249–278.




© 1994-2011 China Academic Journal Electronic Publishing House. All rights reserved. http://www.cnki