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PHYTOGEOGRAPHICAL AFFINITIES OF SOUTHERN TAIWAN

Hui-Lin Li and Hsiuan Keng

With eight text-figures

I. Introduction

The phytogeographical relations between Taiwan or Formosa and the Philippines have been discussed in an illuminating essay by Professor Merrill (*25*). In that he emphasizes the great differences between the two floras in spite of their geographical proximity. Subsequently, the interesting fauna and flora of two small islands, Ho-shao-tao (Kasyoto)[1] and Botel Tobago or Hung-tou-yu (Kotosho), which lie in the Pacific southeast of Taiwan, are made known by several Japanese biologists, such as Kano (*14, 15, 16*), Sasaki (*31*), and Kanehira (*12*). Their general similarities to the southern, rather than to the Taiwan fauna and flora have lead the first named author to propose extending the Neo-Wallace or Merrill and Dickerson's Line northward to pass between the main island of Taiwan and these two small islands.

The advisability to go so far to draw a sharp line cutting of biogeographically these adjacent islands from Taiwan is open to question. Scrutinizing the problem botanically, this is hardly the logical conclusion and is evidently due to neglect taking into consideration the characters of the flora of southern Taiwan. A critical study of the floristic nature of this part of the island shows that here lies the keynote to many problems of phytogeography concerning Taiwan as well as its adjacent regions.

II. General nature of the flora.

The region under consideration is the extreme southern portion of Taiwan island, a portion generally known as Hunchuen (Kosyun) Peninsula. The northern limit of this region may be tentatively defined as along the southern shore of the Feng-kong-chi (Hukukei) and Mou-tan-chi (Botankei), corresponding more or less to present district boundaries.

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[1] Geographical names in brackets refer to Japanese pronounciationse.

To show the characteristic feature of this flora, we may analyse first the primeval forests of the extreme southern tip, located between Da-bang-lu (Taihanroku) and O-lung-bi (Garanbi). Sasaki (32) tabulates a total of 106 woody Spermatophytes and gives the following figures for the component elements:

Philippines	63 species	59.4%
China	57 〃	53.8%
Malay	51 〃	48.1%
Liukiu	47 〃	44.3%
India	41 〃	38.7%
Others		

This table reveals the notable fact that Philippine elements far exceed southern mainland Chinese elements in number. Sasaki suggests this as due to the dispersion of seeds of tropical and subtropical trees and shrubs by ocean currents.

Using Sasaki's material, but bringing the names up-to-date and revising the distributional data, a table showing the distribution of these woody plants is given at the end of this paper (see Appendix). The result confirms in general Sasaki's conclusions:

Philippines	61 species	57.5%
China	58 〃	54.7%
Malay	52 〃	49.0%
Liukiu	48 〃	46.1%
India	41 〃	38.7%
Australia	34 〃	32.0%
Pantropics	26 〃	24.5%
Endemics	19 〃	17.9%
Japan	14 〃	13.4%

Not only the primeval coastal forests of the extreme southern tip, but the flora of the whole of Hunchuen Peninsula shows similar characters. Close relationship with the Philippine flora is particularly evident.

In comparing the families, genera and species of Hunchuen Peninsula with that of Taiwan proper (henceforth known for the whole island excluding Hunchuen Peninsula), it reveals the apparent independent nature of the former. Their relationship is not particularly intimate. While inquiring further into the distribution of plants between Hunchuen Peninsula and the Philippines, Hoshao-tao and Botel Tobago, it shows that there are marked floristic affinities between Hunchuen and these latter three regions.

The independent nature of the Hunchuen flora can first be shown by the relatively large number of strictly endemic plants. There are at least 44 species of ligneous plants that are confined to the Peninsula and nowhere else including Taiwan proper. A list of these endemic species is given below.

Anneslea fragrance var. lanceolata Hay.
Aristolochia kankoensis Sasaki
Capparis formosana Hemsley
Capparis Kanehirai Hay.
Capparis oligostemon Hay.
Capparis tenuifolia Hay.
Castanopsis Matudai Hay.
Castanopsis stello-spina Hay.
Cinnamomum reticulatum Hay.
Clematis dolichosepala Hay.
Clematis garanbiensis Hay.
Clematis Owatarii Hay.
Cordia Kanehirai Hay.
Cyclobalanopsis tomentosicula Hay.
Dalichos kosyunensis Hosokawa
Drypetes hieranense Pax & Hoff.
Drypetes Yamadai Kaneh. & Sasaki
Ehretia resinosa Hance
Entada koshunensis Hay. & Kaneh.
Euonymus pallidicifolia Hay.
Fagraea Sasakii Hay.
Ficus Swinhoei Hay.
Gleditschia formosana Hay.
Gonocaryum diospyrosifolium Hay.
Hypericum trinervia Hemsley
Ilex ardisioides Loesner
Itea parvifolia Hemsley
Jasminum elegans Yamamoto
Machilus obovatifolia Kaneh. & Sasaki
Medinilla formosana Hay.
Myrica adenophora Hance var. Kosanoi Hay.
Neolitsea buisanensis Yam. & Kaneh.
Piper Kawakami Hay.

Schima superba var. kankoensis H. Keng
Smilax planipedunculata Hay.
Styrax Hayataianum Perkins
Symplocos koshunensis Kaneh.
Syzygium formosana Mori
Syzygium kuskusensis Mori
Tarenna Hayataiana Kaneh.
Ventilago elegans Hemsley
Viscum filipendulum Hay.
Zanthoxylum pistaciflorum Hay.

III. Relationship with the Taiwan flora

Professor Merrill (25) has shown that there are seven families, *i. e*, Valerianaceae, Dipsacaceae, Monotropaceae (Pyrolaceae), Diapensiaceae, Styracaceae, Myoporaceae and Phylidraceae, of Taiwan plants that are not found in the Philippines. The discovery of a Philippine species, *Styrax philippinese* Merr. & Quis.[2] in 1935, removes Styracaceae from the list. Our present knowledge shows that out of 173 families of Taiwan plants, there are 16 families that are not found in the Philippinese. These include 4 families of Gymnosperms, 11 of Dicotyledons and 1 of Monocotyledons as follows:

1. Cephalotaxaceae
2. Amentotaxaceae
3. Taxodiaceae
4. Cupressaceae
5. Betulaceae
6. Lardizabalaceae
7. Trochodendraceae
8. Papaveraceae
9. Geraniaceae
10. Callitrichaceae
11. Pyrolaceae
12. Diapensiaceae
13. Myoporaceae
14. Valerianacaceae
15. Dipsacaceae
16. Philydraceae

Among these 16 families, all but one, the Diapensiaceae which has one species, *Shortia exappendiculata* Hayata, that extends to the mountains in the farthest north of Hunchuen Peninsula, are also not found in the Peninsula. Undoubtedly families that are present in Taiwan proper but do not occur in Hunchuen Peninsula are far more numerous.

According to the census of 1936 (23) there are about 1079 genera of Spermatophytes in Taiwan. A preliminary survey shows about of 287 of them

2 Mori in Botany and Zoology 3: 2180, 1935, proves this as synonymous with *Styrax kotoense* Hay., a species known from Botel Tobago.

are not found in the Philippines. Out of these 287 genera, only 40 occur in Hunchuen Penuisula. That is, of all Taiwan genera that are not present in the Philippines, 247 genera or 86.2% of the total are also not found in Hunchuen Peninsula.

Another fact of great phytogeographical importance is the many continental. temperate or boreal families which are well developed in Taiwan proper but are of subordinate positions in the Philippine and Hunchuen floras. In Taiwan proper, such families as Pinaceae, Rosaceae, Umbelliferae, Sorophulariaceae, Labiatae and Liliaceae are all well developed in both genera and species. But these large families are only poorly represented and do not occupy prominent positions in the floras of both Philippine and Hunchuen.

Professor H. H. Hu (*11*) has pointed out an interesting fact. In the whole island of Hainan, the Genus *Rosa* is not in existence. This is equally true in the case of the Hunchuen flora. In Taiwan, there are 10 species of the genus but none indigenous to Hunchuen Peninsula. Inquiring further into the family Rosaceae as a whole, additional informations are revealed. There are 133 species (including varieties and subspecies) belonging to 25 genera in the whole island of Taiwan. Of these 25 genera, 18 of them are found only in Taiwan proper and not in Hunchuen. Among the remainings, only 5 genera occur in both regions, and 2, *Osteomeles* and *Pygeum*, are present only in Botel Tobago. Of the 133 species, 126 species are present in Taiwan proper with 94 of them endemic, while only 7 species are found in Hunchuen, with one (a variety) endemic (marked by*). These 7 species are as follows:

Eriobotrya deflexa Nak. var. buisanensis Kaneh. & Sasaki
* Eriobotrya deflexa Nak. var. koshunensis Kaneh. & Sasaki
Photinia taiwanensis Hay.
Pyracantha Koidzumi Rehder
Rhaphiolepis liukiuensis Nakai
Rubus euphlebophyllus Hay.
Rubus Lambertianus Ser. subsp. xanthoneurus Focke.

The above discussion shows that in spite of the fact that Taiwan proper and Hunchuen are directly contiguous and without any natural barrier between them, the two regions show striking differences in their floristic compositions. The flora of Hunchuen, when considered in relation with that of the rest of the island of Taiwan, is more or less independent in its nature. This apparently is not due to the effect of latitudinal differences alone. The following discussion concerning its floristic ralation with Ho-shao-tau, Botel Tobag, and

the Philippines will serve to demontrate further this point.

IV. Relationships with the Philippines, Ho-shao-tau and Botel Tobago.

The floristic relationships between the flora of Hunchuen Peninsula on the one hand and the floras of the Philippine Inlands, Ho-shao-tau and Botel Tobago on the other can best be illustrated by listing ligneous plants common to these various regions as follows:

(1) Species common to Hunchuen Peninsula, Ho-shao-tau, Botel Tobago and the northern Philippines are as follows. Three species are endemic to this region (marked by*). The distribution of *Aglaia elliptifolia* Merr. is shown in Fig.1.

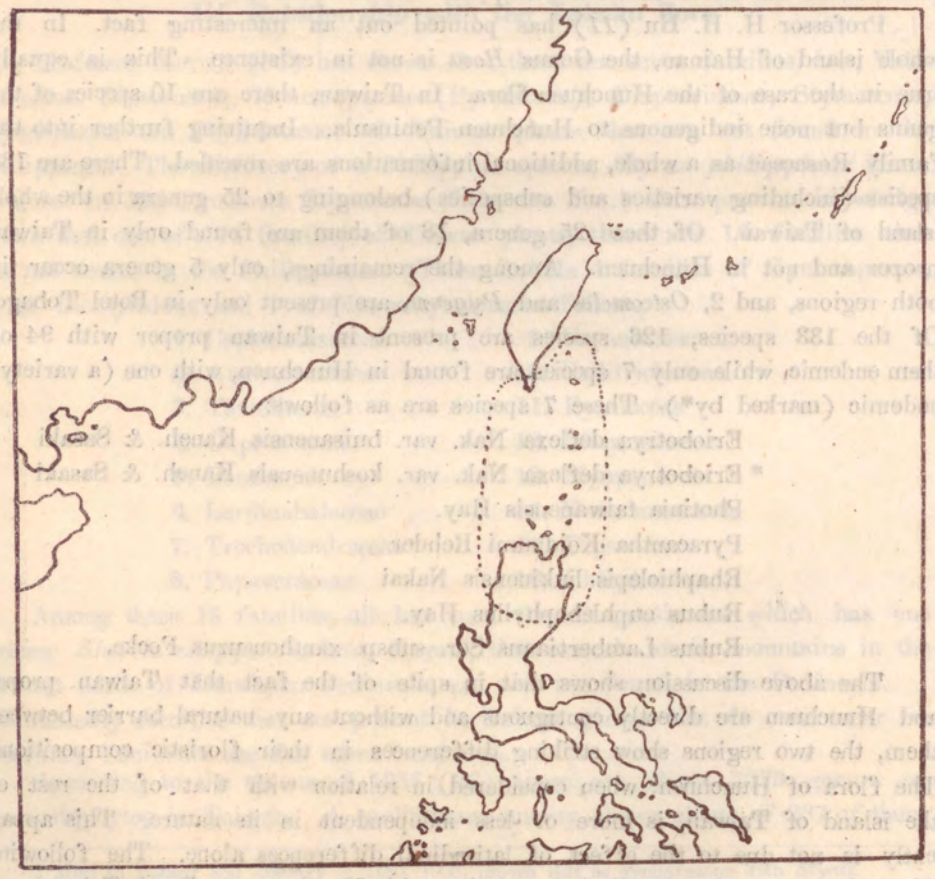


Fig. 1. The range of *Aglaia elliptifolia* Merr.

* Acacia confusa Merr.
* Aglaia elliptifolia Merr.
* Astronia Cumingiana Vidal
Colubrina asiatica Brong.
Guettarda speciosa L.
Maba buxifolia Pers.
Morinda citrifolia L.
Pemphis acidula Forster
Terminalia Catappa L.
Uncaria setiloba Benth.

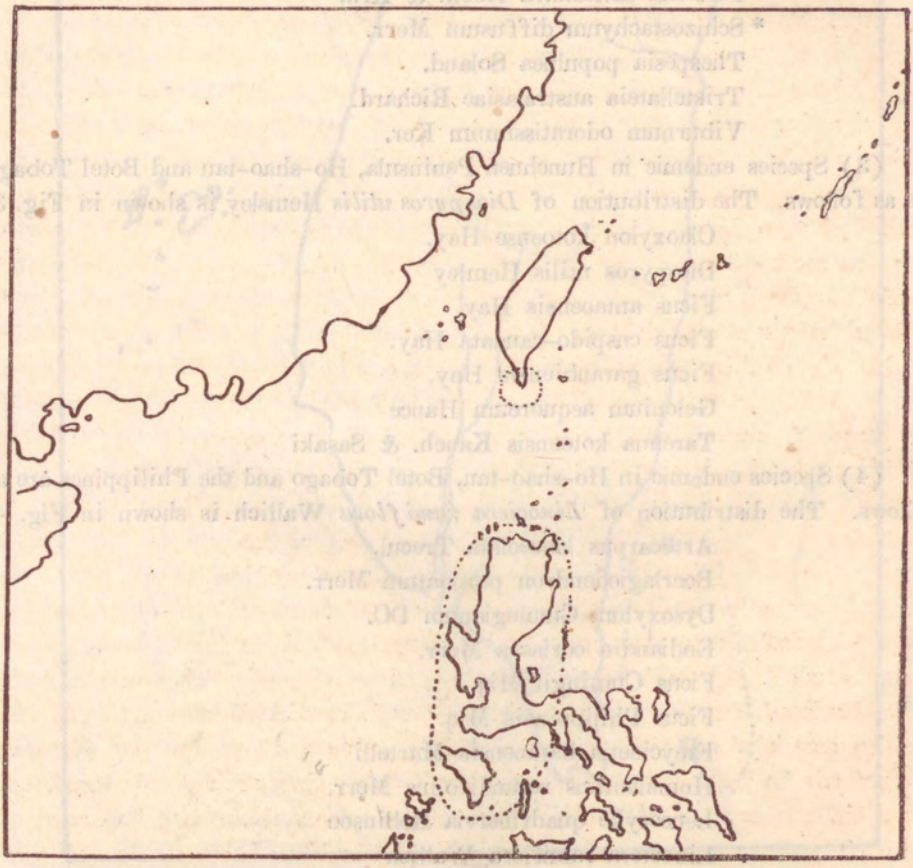


Fig. 2. The range of *Goniothalamus amuyon* Merr.

(2) Species common to Hunchuen Peninsula and the northern & western parts of the Philippines are as follows; 3 species are endemic to this general region. The distribution of *Goniothalamus amuyon* Merr. is shown in Fig. 2.

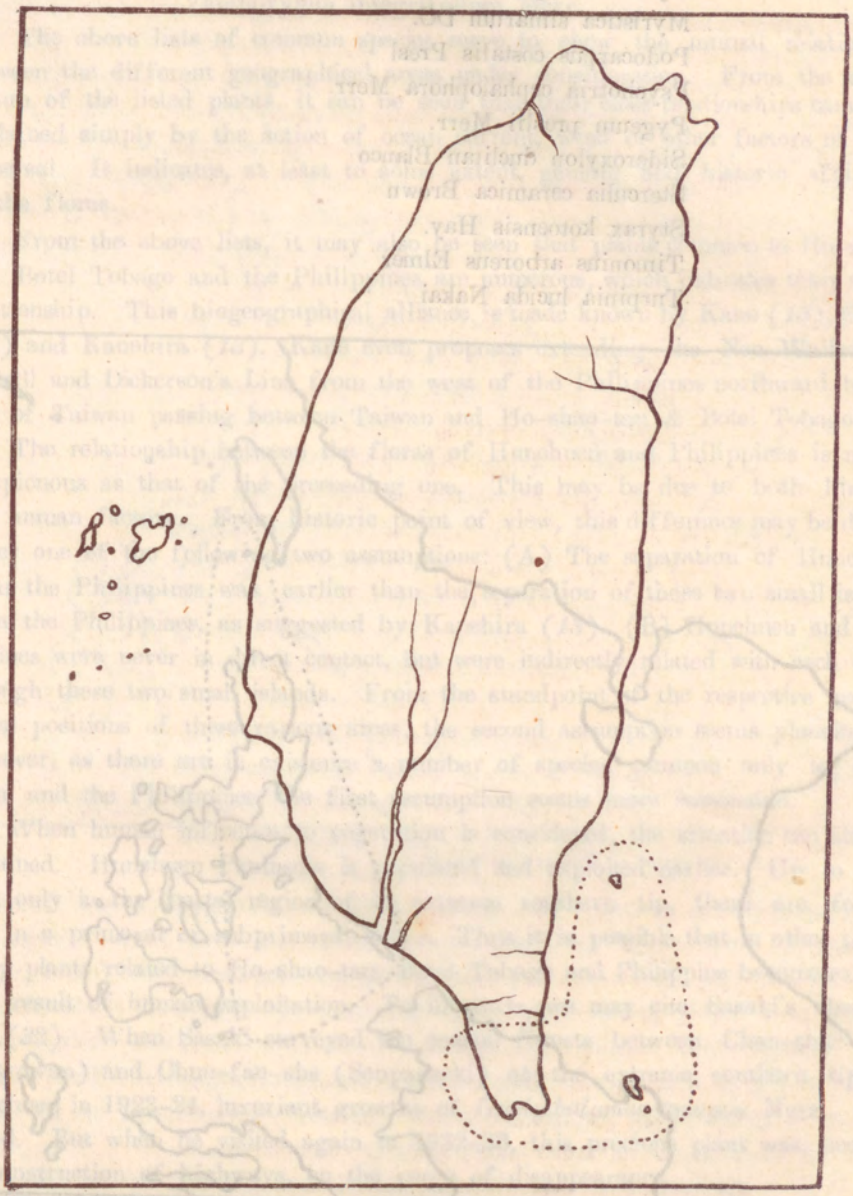
Decaspermum fruticosum Forster
Deeringia amaranthoides Merr.
Dolichos uniflorus Lamarck
* Goniothalamus amuyon Merr.
Hernandia ovigera L.
* Illigera luzonensis Merr.
Lithosanthes biflora Blume
Parsonia helicandra Hook. & Arn.
* Schizostachyum diffusum Merr.
Thespesia populnea Soland.
Tristellateia australasiae Richard.
Viburnum odoratissimum Ker.

(3) Species endemic in Hunchuen Peninsula, Ho-shao-tau and Botel Tobago are as follows. The distribution of *Diospyros utilis* Hemsley is shown in Fig. 3.

Claoxylon kotoense Hay.
Diospyros utilis Hemley
Ficus antaoensis Hay.
Ficus cuspido-caudata Hay.
Ficus garanbiensis Hay.
Gelonium aequoreum Hance
Tarenna kotoensis Kaneh. & Sasaki

(4) Species endemic in Ho-shao-tau, Botel Tobago and the Philippines are as follows. The distribution of *Linociera ramiflora* Wallich is shown in Fig. 4.

Artocarpus lanceolata Trecul.
Boerlagiodendron pectinatum Merr.
Dysoxylum Cumingianum DC.
Endiandra coriacea Merr.
Ficus Cumingii Miq.
Ficus Philippinsis Miq.
Freycinetia batanensis Martelli
Homalanthus rotundifolius Merr.
Leucosyke quadrinervia Robinson
Linociera ramiflora Wallich
Macaranga dipterocarpifolia Merr.



Flg. 3. The range of *Diospyros utilis* Hemsley

Myristica cagayanensis Merr.
Myristica simarum DC.
Podocarpus costalis Presl
Psychotria cephalophora Merr.
Pygeum preslii Merr.
Sideroxylon duclitan Blanco
Sterculia ceramica Brown
Styrax kotoensis Hay.
Timonius arboreus Elmer
Turpinia lucida Nakai

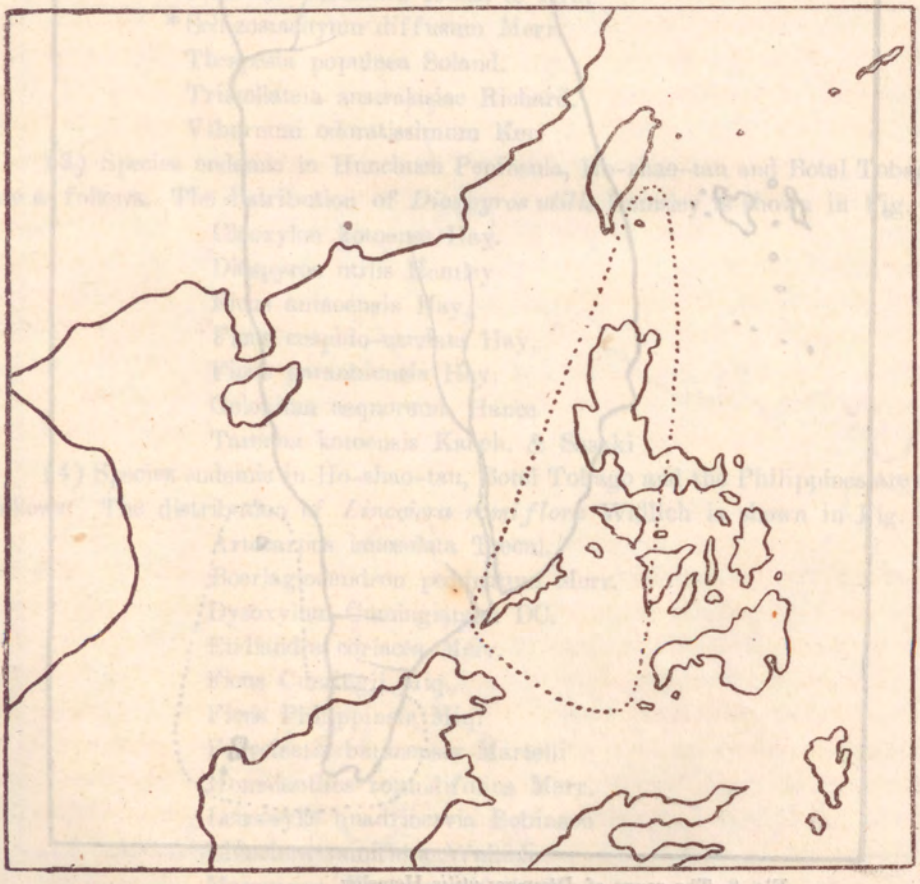


Fig. 4. The range of *Linociera ramiflora* Wallich

Wendilandia luzonensis DC.
Zanthoxylum integrifolium Merr.

The above lists of common species serve to show the mutual relationship between the different geographical areas under consideration. From the varied nature of the listed plants, it can be seen that their close relationships cannot be explained simply by the action of ocean current, wind or other factors of plant dispersal. It indicates, at least to some extent, genetic and historic affinities in the floras.

From the above lists, it may also be seen that plants common to Ho-shao-tau, Botel Tobago and the Philippines are numerous, which indicates their closer relationship. This biogeographical alliance is made known by Kano (*15*), Sasaki (*31*) and Kanehira (*13*). Kano even proposes extending the Neo-Wallace or Merrill and Dickerson's Line from the west of the Philippines northward to the east of Taiwan passing between Taiwan and Ho-shao-tau & Botel Tobago.

The relationship between the floras of Hunchuen and Philippines is not as conspicuous as that of the preceeding one. This may be due to both historic and human factors. From historic point of view, this difference may be due to either one of the following two assumptions: (A) The separation of Hunchuen from the Philippines was earlier than the separation of these two small islands from the Philippines, as suggested by Kanehira (*13*). (B) Hunchuen and Philippines were never in direct contact, but were indirectly related with each other through these two small islands. From the standpoint of the respective geographical positions of these various areas, the second assumption seems plausible. However, as there are in existence a number of species common only to Hunchuen and the Philippines, the first assumption seems more reasonable.

When human influence to vegetation is considered, the situation can also be explained. Hunchuen Peninsula is populated and exploited earlier. Up to present, only in the coastal region of its extreme southern tip, there are forests still in a primeval or subprimeval status. Thus it is possible that in other parts, many plants related to Ho-shao-tau, Botel Tobago and Philippine become extinct as a result of human exploitation. To illustrate, we may cite Sasaki's observation (*32*). When Sasaki surveyed the coastal forests between Chon-chao-wan (Basyowan) and Chun-fan-she (Senpanseki) at the extreme southern tip of Hunchuen in 1923–24, luxuriant growths of *Goniothalamus amuyon* Merr. were found. But when he visited again in 1932–33, this precious plant was, because of construction of highways, on the verge of disappearance.

The range of distribution of two plants, *Rourea volubilis* Merr. (Fig. 5)

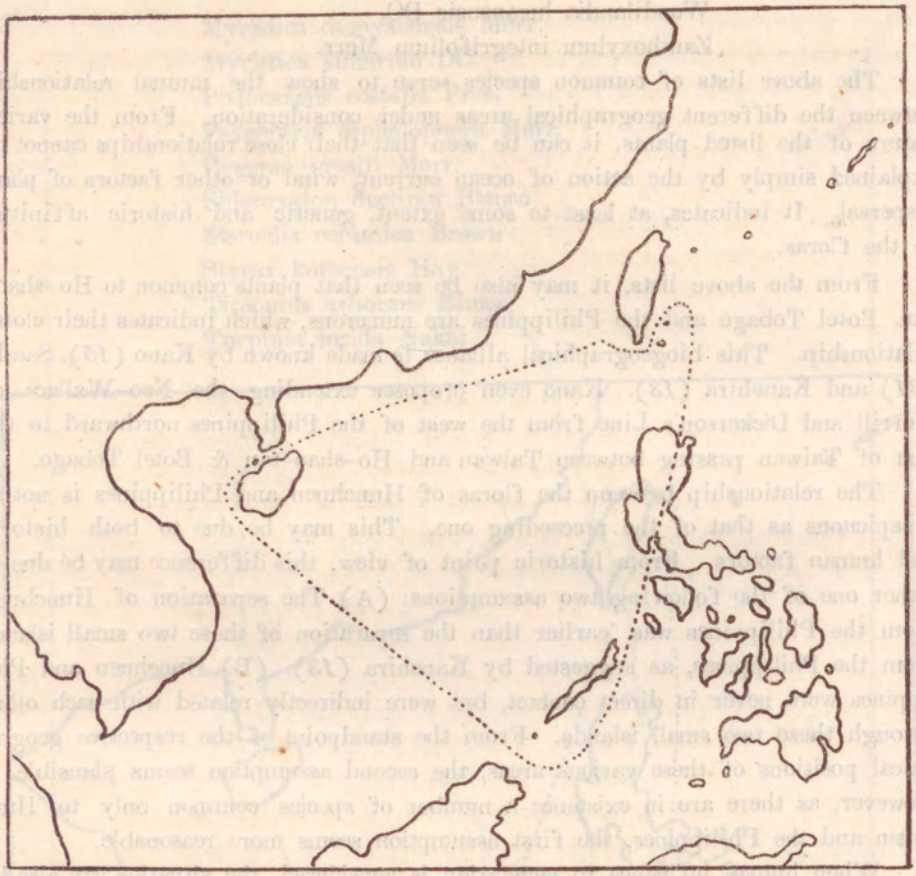


Fig. 5, The range of *Rourea volubilis* Merr.

and *Pterospermum niveum* Vidal, seems instructive. Both plants are found in Hainan, the northwest of the Philippines, Ho-shao-tau, and Botel Tobago, all areas surrounding Hunchuen, but these plants are singularly not found in the latter. It is highly probable that their absence is the result of eradication by man. (The floristic relationship between Ho-shao-tau and the Philippines is not so strong as that between Botel Tobago and the Philippines. This, besides because of geographical location, is mainly due to human factors, as the vegetation of Ho-shao-tau is much more severely exploited.)

It thus can been seen that although the floristic relationship between Ho-shao-tau, Botel Tobago and Philippine is prominent, nevertheless, this relation-

ship is not exclusive to these three areas. Furthermore, this relationship is not as strong and outstanding as sometimes emphasized. (*29, 31*) The suggestion of extending the Neo-Wallace Line to pass through Taiwan and these two small islands, therefore, is not entirely in accord with the natural condition.

It is to be noted the family Dipterocarpaceae and some others, so characteristic of the Philippines and islands farther west and south, are not found in either Botel Tobago and Ho-shao-tau (*26*). Also to be noted is the abundance of endemic ligneous species of these two small islands as listed below: (B = Botel Tobago; H = Ho-shao-tau)

Alyxia insularis Kaneh. & Sasaki (H)
Acalypha kotoensis Hay. (B)
Ardisia kotoensis Hay. (BH)
Callicarpa kotoensis Hay. (B)
Chisocheton Kanehirai Sasaki (H)
Cinnamomum kotoensis Kaneh. & Sasaki (B)
Cyrtandra kotoensis Hosokawa (B)
Elaeagnus kotoensis Hay. (B)
Euonymus Miyakei Hay. (B)
Excoecaria Kawakamii Hay. (BH)
Ficus caudato-longifolia Sata (B)
Ficus cuneato-nervosa Yamamoto (BH)
Ficus Hayatae Sata (B)
Ficus Kusanoi Hay. (BH)
Geniostoma kasyotense Kaneh. & Sasaki (H)
Glochidion kotoense Hay. (B)
Gynura elliptica Yabe & Hay. (BH)
Ilex Kusanoi Hay. (BH)
Ixora Hayatai Kaneh. (B)
Laportea kotoensis Hay. (BH)
Litsea Kawakamii Hay. (B)
Microtropis kotoensis Koidz. (B)
Murraya omphalocarpa Hay. (BH)
Mussaenda kotoensis Hay. (B)
Neolitsea kotoensis Kaneh. & Sasai (BH)
Pinanga Tashiroi Hay. (B)
Pittosporum viburnifolium Hay. (B)
Rubus kotoense Hay. (B)

Syzygium kashotoensis Mori (BH)

Instead of extending the Neo-Wallace Line, a natural floristic region can be drawn to include Hunchuen Peninsula, Ho-shao-tau and Botel Tobago. This region can be looked upon as a place of mutual approach and assemblage of southern Chinese and Philippine elements. In other words, it may be seen as the dividing belt of these two floral regions. In the north, the flora of Taiwan proper is mainly composed of southern Chinese elements, the proportion of Philippine elements being very insignificant. On the other hand, in the south, southern Chinese elements are few in the Philippines. The defining of this floristic region seems to be a more reasonable disposition than extending the Neo-Wallace Line to the east of Taiwan.

It is to be further explained that although Hunchuen, Ho-shao-tau and Botel Tobago show strong mutual floristic affinities, there are more or less actual differences between these areas. To group them together as a natural region is speaking in terms of similar regions as represented by Taiwan proper and the Philippines. This natural region intervenes between the latter two and represents an area of commingling of elements from these two regions. At the same time, it serves as a zone of demarcation of these two larger floral regions.

V. Floristic affinities of Taiwan

Students of plant geography present different opinions concerning the affinities of Taiwan with neighbouring floristic regions. In general these opinions fall into 3 groups: (1) that the relation is closest with the Japanese Archipelago, (2) that the relation is closest with the mainland, and (3) that the relation is closest with the Philippines.

The first, made by Horikawa (*9*), is based on the distribution of the Bryophytes. As this is not supported by similar studies of higher plants, it will not be discussed further.

The third, as advocated by Christ (1), is based on the studies of the Pteridophytes. Engler (2) similarly proposes the inclusion of Taiwan and Philippine in one region. After Merrill's decisive study (*25*) on the difference between the two floras, Engler (*3*), modifies somewhat his original opinion but insists that the flora of Taiwan below 1800 m. should, together with Philippine and Malaysia, belong to the "Monsungebiet."

Most authors, such as Henry (*8*), Hayata (*5*, *6*, *7*), Wilson (*34*), Merrill (*26*), Sasaki (*30*), Kudo (*17*), Handel-Mazzetti (*4*), Masamune (*19*, *20*, *21*),

and Yamamoto (*35*) maintain the second opinion, that is, the floristic relationship of Taiwan is closest with China, especially with its southern flora. Their illustrations and proofs, based largely on the distribution of Spermatophytes, are more numerous and inclusive. Thus this opinion is the most reliable. But aside from the relations with southern China, widely different and controversial opinions are found in the relation with the Philippines. This may be illustrated by the contracdictory conclusions of Sasaki (*30*) and Masamune (*20*).

Sasaki's statistics shows that out of 3658 species and 79 varieties of Taiwan plants 42.9 % are endemic, 22.6 % southern Chinese, 18.0 % Malayan, 17.5 % Indian, and others. Philippine elements, when combined with Malayan ones, constitute only 18.0% and are thus of relatively less importance.

Masamune, on the other hand, reaches exactly the reverse conclusion. He tabulates the distribution of the genera of vascular plants (Pteridophytes & Spermatophytes) and finds that Philippine elements in Taiwan rank second in importance and are only slightly fewer than Chinese mainland elements. For instance, in the 78 genera of Pteridophytes, 92 % of them are found also in China and 90% in Philippines. This very high percentage of Philippine elements as found by Masamune is apparently due to his inclusion of many Indian & Malayan genera in his category of Philippine plants, as well as due to the larger size and more widely distributed nature of many tropical families and genena.

The flora of the island of Taiwan, after excluding Hunchuen Peninsula and the two small isalnds, Ho-shao-tau and Botel Tobago, is apparently more closely allied to the mainland of China in the west and the Liukiu Archipelago in the east than any other region. The relationship with China has been considered by many authors as cited above. The relationship with Liukiu is especially noted by Nakai (28) and Masamune (22). To illustrate, the ranges of distribution of *Taiwania* and *Tutcheria* are shown in Fig. 6 and Fig. 7 respectively. Merrill (*26*) states that the majority of the Malayan and Indian elements may enter Taiwan through continental China before their separation. The floristic relationships of Taiwan proper with Japan (*13*) and Philippine (26, 30) are comparatively weak.

In the region embodying Hunchuen, Ho-shao-tau and Botel Tobago, Chinese mainland and Philippine elements are present nearly in equilibrium. For example, in Botel Tobago (*31*), out of a total of 674 plants, 320 or 47.5 % are of Chinese relation and 318 or 47.2% are of Philippine relation. Hunchuen Peninsula, therefore, appears as an intermediate zone where floras of two regions come into contact and commingle with each other. Before the geological

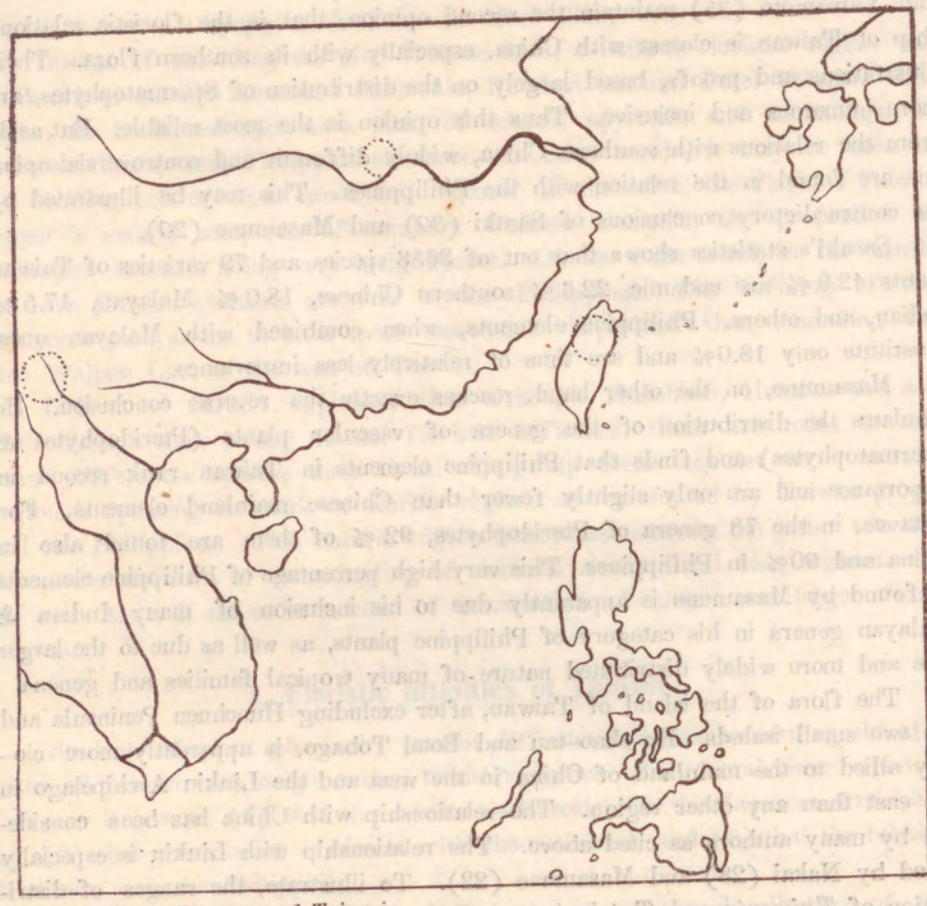


Fig. 6. The range of *Taiwania*

history is fully known, it is difficult to surmise whether Hunchuen has once been a separate island detached from Taiwan proper and whether it has been directly connected with Ho-shao-tau, Botel Tobago, and even the Philippines. However, it is safe to infer that (a) as Hunchuen is contiguous to Taiwan proper, the manifest distinction in their floras is evidently not simply due to latitudinal difference, and (b) as Hunchuen, Ho-shao-tau, Botel Tebago and Philippine are geographically isolated from each other, their many common species are not simply brought about by factors of dispersion such as ocean current, wind and animals.

The real demarcation of Hunchuen Peninsula from Taiwan proper requires

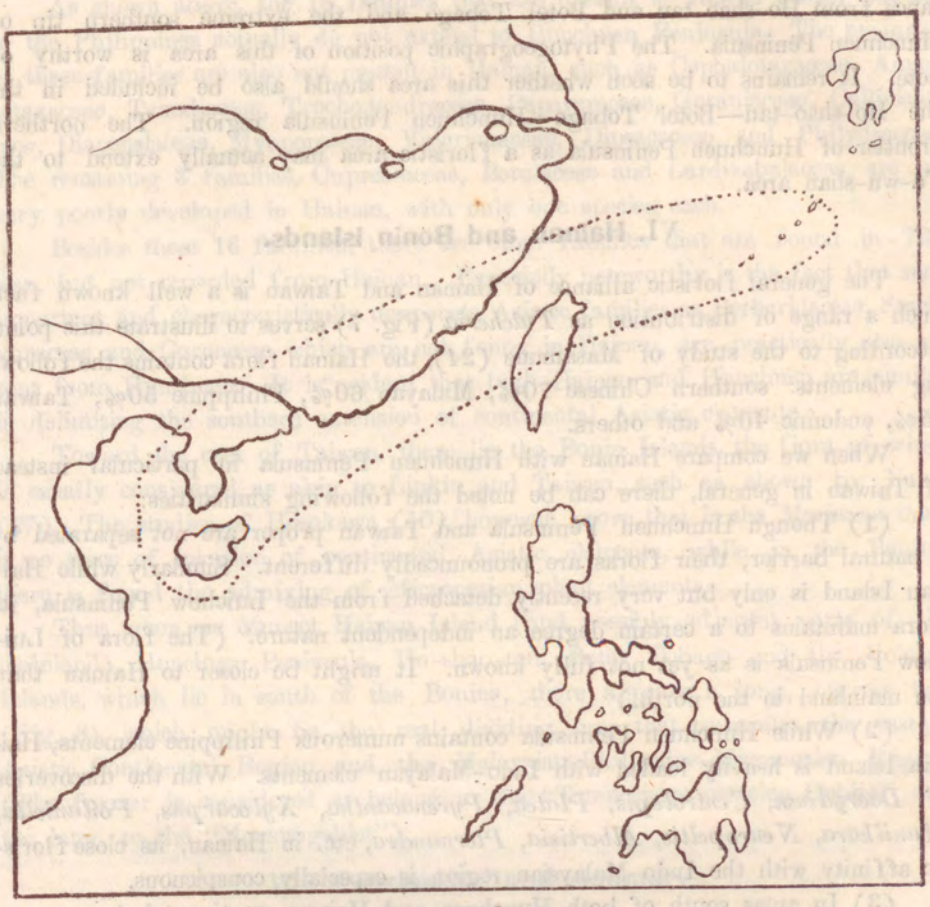


Fig. 7. The range of *Tutcheria*

further investigation. Many continental plants have their southern limit of extension to Ta-wu-shan mountains (Daibusan). From Feng-kong-chi (Hûkûkei), the tentative northern boundary of Hunchuen Peninsula, to Ta-wu-shan, the district in between contains many elements common to Hunchuen. The relationship is especially conspicuous in the area around Chin-sui-in (Shinsuiei) in the east. In the genus *Castanopsis*, for instance, out of a total of 10–11 species of the whole island of Taiwan, 3 of them, *i. e.*, C. *brevistella* Hay. & Kaneh., *C. sinsuiensis* Kaneh. and *C. subacuminata* Hay., are endemic to Hunchuen Peninsula and Chin-sui-in. The area around Chin-sui-in is of nearly equal dis-

tance from Ho-shao-tau and Botel Tobago and the extreme southern tip of Hunchuen Peninsula. The Phytogeographic position of this area is worthy of note. It remains to be seen whether this area should also be included in the the Ho-shao-tau—Botel Tobago—Hunchuen Peninsula region. The northern frontier of Hunchuen Peninsula as a floristic area may actually extend to the Ta-wu-shan area.

VI. Hainan and Bonin islands.

The general floristic alliance of Hainan and Taiwan is a well known fact. Such a range of distribution as *Tutcheria* (Fig. 7) serves to illustrate this point. According to the study of Masamune (*24*), the Hainan flora contains the following elements: southern Chinese 70%, Malayan 60%, Philippine 50%, Taiwan 45%, endemic 40% and others.

When we compare Hainan with Hunchuen Peninsula in particular instead of Taiwan in general, there can be noted the following similarities:

(1) Though Hunchuen Peninsula and Taiwan proper are not separated by a natural barrier, their floras are pronouncedly different. Similarly while Hainan Island is only but very recently detached from the Luichow Peninsula, its flora maintains to a certain degree an independent nature. (The flora of Luichow Peninsula is as yet not fully known. It might be closer to Hainan than the mainland in the north.)

(2) While Hunchuen Peninsula contains numerous Philippine elements, Hainan Island is heavily loaded with Indo-Malayan elements. With the discoveries of *Dacrydium*, *Centrolepis*, *Platea*, *Pyrenacantha*, *Xylocarpus*, *Poilaniella*, *Manilkara*, *Neuropeltis*, *Albertisia*, *Pternandra*, etc. in Hainan, its close floristic affinity with the Indo-Malaysian region is especially conspicuous.

(3) In areas south of both Hunchuen and Hainan, continental elements are but poorly represented. An interesting fact is the close relationship of areas north of these two regions. Taiwan proper, a region north of Hunchuen, is of close floristic relationship with the Mid-Mekong Region (*18*), a region northwest of Hainan. (see Fig. 6).

(4) The southern limit of many northern families lies in these two regions. Tanaka and Odashima (*33*) notes, for instance, the nearly total absence of the Cruciferae in Hainan. Only one widely distributed species, *Nasturtium indicum* (L.) DC. is indigenous. Similarly, although some 14 species (and varieties) are indigenous to Taiwan proper, only 2 extend to Hunchuen, 2 others are found in Ho-shao-tau, while none is found in Botel Tobago.

As shown above, the 16 families that are present in Taiwan proper but not in the Philippines actually do not extend to Hunchuen Peninsula. The majority of these families are also not present in Hainan, such as Cephalotaxaceae, Amentotaxaceae, Taxodiaceae, Trochodendraceae, Papaveraceae, Geraniaceae, Callirichaceae, Diapensiaceae, Myoporaceae, Valerianaceae, Dipsacaceae and Philydraceae. The remaining 3 families, Cupressaceae, Betulaceae and Lardizabalaceae, are all very poorly developed in Hainan, with only one species each.

Besides these 16 families, there are other families that are found in Taiwan, but not recorded from Hainan. Especially noteworthy is the fact that such important and characteristically temperate Asiatic families as Berberidaceae, Stachyuraceae and Cornaceae which are not found in Hainan, are practically also absent from Hunchuen. It is evident that both Hainan and Hunchuen are similar in delimiting the southern extension of continental Asiatic elements.

Toward the east of Taiwan, there lie the Bonin Islands, the flora of which is usually considered as akin to Liukiu and Taiwan, such as shown by Nakai (27). The studies of Hosokawa (10), however, prove that in the Marianas there is no trace of invasion of continental Asiatic elements, while in the Bonins, there is found the admixing of Micronesian plant elements.

Thus when we connect Hainan Island (and possibly adjacent parts of the mainland), Hunchuen Peninsula, Ho-shao-tau, Botel Tobago and the Volcano Islands, which lie in south of the Bonins, there appears a long, narrow belt (Fig. 8) which might be the real dividing area that separates the eastern Asiatic Continental Region and the Malaysian-Philippine-Micronesian Region. (The former is considered as belong to the "Temperierte ostasien Gebiet", and the later, to the "Monsungebiet").

VII. Conclusions and summary

(i) Although there is no physiographic barrier between Taiwan proper and Hunchuen Peninsula, their floras are notably different. This discrepancy is apparently not simply due to latitudinal variation. As suggested by Kudo (*17*), Hunchuen Peninsula should be considered as an independent small region, seggregated from Taiwan proper. In a sense, it can be regarded as a "phytogeographical island".

(ii) There is close and manifest floristic relationship existed between Hunchuen Peninsula, Ho-shao-tau and Botel Tobago. Instead of extending the Neo-Wallace Line as suggested by Kano, it is more logical to treat Hunchuen Peninsula together with these two small islands as constituting an independent

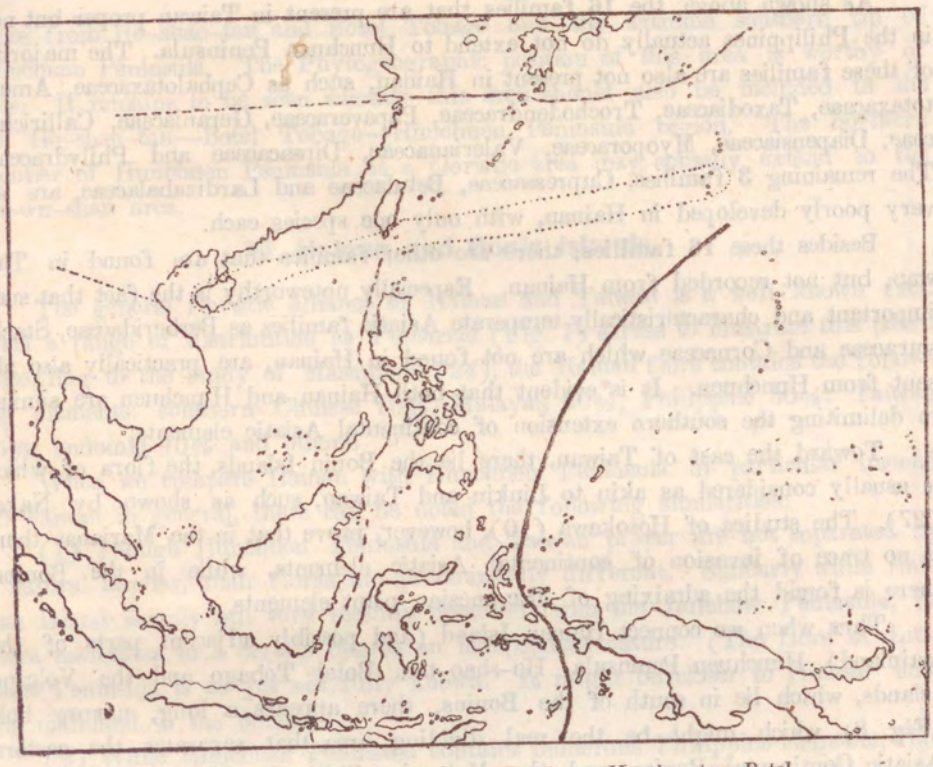


Fig. 8. A floral belt connecting Hainan, Hunchuen, Ho-shao-tau, Botel Tobago, and the Volcano Islands

floral region. This region is an area where continental southeastern Asiatic elements blend and commingle with Malaysian-Philippine elements.

(iii) The phytogeographical positions of Hainan Island and the Volcano Islands are approximately the same as that of Hunchuen Peninsula. When connecting these different parts, thisnarrow strip of the earth's surface might be an important divisional belt in phytogeography. In the dynamic field of phytogeography, unless because of pronounced physiographic and geologic factors, generally a separating belt is more reasonable and plausible than a sharp dividing line in delimiting two different floristic regions.

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Appendix

A table showing the geographical distribution of the woody plants in the primeval forest of the extreme southern tip of Hunchuen Peninsula. (After S. Sasaki, emended.)

	Philippine	Chinese	Malaysian	Liukiu	Indian	Australian	Pantropic	Endemic	Japanese
Pandanus tectorius Sol.	×	×	×	×		×	×		
Arenga Engleri Becc.				×					
Phoenix Hanceana Naudin								×	
Celtis nervosa Hemsl.		×							
Cudrania cochinchinensis var. gerontogea		×							×
Ficus cuspidato-caudata Hay.	×							×	
Ficus retusa L		×	×	×	×				×
Ficus septica Burm. f.			×	×					
Ficus Swinhoei King								×	
Ficus vasculosa Wall.		×	×						
Ficus superba Miq.		×		×					×
Malasia scandens Planch.	×	×	×						
Laportea subglabra Hay.								×	
Champereia Cumingiana Merr.	×								
Pisonia aculeata L.	×	×	×	×	×	×	×		
Pisonia umbellifera Seem.	×		×			×			
Actinodaphne pedicellata Hay.								×	
Cinnamomum reticulatum Hay.								×	
Hernandia ovigera L.	×		×	×	×		×		
Capparis formosana Hemsl.								×	
Crataeva religiosa Frost. f.	×	×	×	×	×	×			×
Pittosporum formosanum Hay.								×	
Eriobotrya deflexa var. koshunensis								×	
Caesalpinia Nuga Ait.	×		×	×			×		
Erythrina variegata var. orientalis	×		×	×	×		×		
Indigofera Zollingeriana Miq.	×	×	×	×		×			
Pongamia pinnata Merr.	×	×	×	×		×	×		
Sophora tomentos L.	×	×	×	×	×	×	×		
Severina monophllya Tanaka		×							
Clausena lunulata Hay.								×	

	Philippine	Chinese	Malaysian	Liukiu	Indian	Australian	Pantropic	Endemic	Japanese
Evodia pteleatefolia Merr.		×	×						
Fagara nitida Roxb.		×							
Murraya paniculata Jack.	×	×	×	×	×	×	×		
Toddalia asiatica Lam.	×	×		×	×				
Aglaia formosana Hay.	×								
Melia Azedarach L.	×	×		×	×				×
Hiptage bengalensis Kurz.			×		×				
Tristellateia australasiae A. Rich.	×		×			×	×		
Antidesma pentandrum Merr.	×			×					
Bischoffia javanica Blume	×		×	×	×	×			
Breynia acrescens Hay.								×	
Breynia officinalis Hemsl.								×	
Bridelia Balansae Tutcher		×	×	×	×				
Croton Cumingii Muell.-Arg.	×		×	×					
Drypetes Ysmadai K. & S.								×	
Excoecaria Agallocha L.	×		×	×	×	×			
Gelonium aequoreum Hance	×	×	×		×	×			
Glochidion philippicum Robinson								×	
Glochidion Fortunei Hance	×	×	×						
Macaranga Tanarius Muell.-Arg.		×							
Mallotus repandus Muell.-Arg.	×	×	×	×	×	×			
Melanolepis multiglandulosa Reich. f. Zoll.	×	×	×		×	×			
Phyllathus takaoensis Hay.	×		×		×				
Securinega ramiflora Muell.-Arg.								×	
Securinega virosa Pax & Hoffm.	×	×	×			×			
Pistacia chinensis Bunge	×	×							
Ilex Asperella Champ.	×	×							
Gymnosporia diversifolia Maxim.	×	×		×					
Allophylus timorensis Blume.	×		×						
Sapindus Mukorossi Gaertn.		×		×	×				×
Rhamus formosana Matsm.								×	
Ampelopsis heterophylla S. & Z.	×	×		×					×
Leea manilensis Walp.	×								
Vitis lanata Roxb.				×					×
Hibiscus mutabilis L.		×							
Hibiscus tiliaceus L.		×				×			

	Philippine	Chinese	Malaysian	Liukiu	Indian	Austral'an	Pantropic	Endemic	Japanese
Thespesia populnea Sol.	×	×	×	×	×	×	×		
Heritiera littoralis Dryand.	×	×	×	×	×	×	×		
Kleinhovia Hospita L.	×		×		×				
Calophyllum inophyllum L.	×	×	×		×	×	×		
Scolopia Oldhami Hance	×								
Lagerstroemia subcostata Koehne		×		×					
Pemphis acidula Forst.	×	×	×	×	×	×	×		
Barringtonia asiatica Kurz	×	×	×	×	×	×	×		
Terminalia Catappa L.	×	×	×	×	×	×	×		
Decaspermum fruticosum Forst.	×	×	×		×	×			
Psidium Guajava L.	×	×	×	×	×	×	×		×
Schefflera arboricola Hay.		×							
Palaquium formosanum Hay.	×								
Sideroxylon ferrugineum Hook. & Arn.	×	×	×	×					
Diospyros utilis Hemsl.								×	
Maba buxifolia Pers	×		×	×	×	×			
Jasminum subtrinervum Blume		×	×		×				
Cerbera Manghas L.	×	×	×	×	×		×		
Rauwolfia verticillata Baillon		×							
Tabernaemontana dichotoma Roxb.					×				
Cordia Kanehirai Hay.								×	
Ehretia Dicksonii Hance				×					
Ehretia resinosa Hance								×	
Ehretia macrophylla Lam.	×	×	×	×	×				
Ehretia taiwaniana Nakai		×		×					
Tournefortia argentetea L. f.	×	×	×	×	×	×	×		
Callicarpa formosana Rolfe	×								
Clerodendron inerme Gaertn.	×	×	×	×	×	×			
Clerodendron trichotomum Thunb. var Fargesii		×							
Premna japonica Meq.									×
Premna odorata Blanco	×								
Vitex rotundifolia L. f.	×	×	×	×	×		×		
Vitex Negundo L.	×	×	×	×	×				×
Sterospermum sinicum Hance		×							
Guettarda speciosa L.	×		×	×	×				
Morinda citrifolia L.	×	×	×	×	×	×	×		

	Philippine	Chinese	Malaysian	Liukiu	Indian	Austrlian	Pantropic	Endemic	Japanese
Morinda umbellata L.	×	×	×	×	×				
Mussaenda parviflora Miq.				×					
Viburnum odoratissimim Ker.	×	×	×		×				
Scaevola frutescens Krause	×	×	×	×	×	×	×		
Total number	61	58	52	48	41	34	26	19	14
Percentage	57.5%	54.7%	49.0%	46.1%	38.7%	32.0%	24.5%	17.9%	13.4%