PRELIMINARY PLANT-GEOGRAPHICAL ANALYSIS OF THE PACIFIC

as based on the distribution of Phanerogam genera

by

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I. INTRODUCTION

This analysis has been made to find out where the demarcation is situated in the Pacific between the flora of the Old and the New Worlds, and whether this is a sharp line.

Further, it has been tried to subdivide the flora of the Pacific into provinces and districts, and to establish the hierarchy of these subdivisions.

Compare the map at the end of the paper.

The Pacific is defined for this purpose as comprising all islands except Malaysia (in the strict sense of the Flora Malesiana), Hainan, Formosa, the Riukius, Japan, the Kuriles and Aleutians; and, in the south, Tasmania which has been accepted as a part of the Australian Flora. On closer examination it was deemed worthwhile to verify this and add a concise analysis of the Tasmanian flora.

The floristic status of the Bismarck Archipelago, although generally treated as a part of New Guinea, hence of Malaysia, has not yet been properly analysed. For that reason it is included separately in the present work.

On the American side of the Pacific there are a number of islands of which only the Galapagos, San Ambrosio, and Juan Fernandez have been treated as Pacific.

The principles which have been used for the analysis are the same which have been set up by Van Steenis for Malaysia (1950). They are:

(1) The distributional area of the genus or of a significant subdivision (subgenus, section) is the unit of the analysis.

(2) Demarcations between floras are those places where the greatest number of generic areas coincide ('demarcation knots'). They represent critical boundaries where the flora more or less abruptly changes its floristical composition.

(3) The hierarchy of the provinces, districts, subdistricts, etc. is defined in proportion to the number of genera concerned in the demarcation knots.

(4) The genera are classified in a number of categories according to their main centre of development and their distributional area as a whole. In this way a differentiated survey is obtained of each separate area, for which Van Steenis has proposed the term "floristic generic spectrum".

To give an example of point four I mention the genus *Hibbertia* Dill. *) This contains c. 100 species in Australia and Tasmania, further c. 20 in New Caledonia, 2 in New Guinea and the S. Moluccas (both also in Australia), 1 in Fiji, and 1 in Madagascar. I have considered this to be an 'Australian genus' (type 6) and in a flora outside Australia to represent the 'Australian element'.

Crossostylis Rhiz. is only known from the Pacific islands and has been referred to 'Pacific' genera (type 8). A genus such as *Degeneria* Deg., which occurs only in Fiji, has been classified as 'endemic-Pacific' (type 8a).

In the genus *Cyrtandra* Gesn., of which hundreds of species have been described from Malaysia, only 1 occurs in tropical continental Asia, 1 in North Queensland; it is further distributed over the Pacific islands as far as Hawaii and the Marquesas and has been classified as belonging to the Malaysian type (type 5a).

Other genera are distributed much farther in the Old World, as for example *Diospyros* Eben. These have been classified as a separate category (type 4).

Though not all genera can be as easily fitted into a coherent category, the classification of the genera into 15 types has generally not met with great difficulties.

A number of genera were formerly accepted to belong to other categories than accepted here. Their original 'label' was merely due to what I call "priority of description". *Vavaea* Meliac., for example, was originally described from the Pacific islands, but later exploration, identification, and description has proved that this first description was purely accidental and from the margin of the generic area. *Vavaea* has a distinct centre of speciation in Malaysia, and not in the Pacific. Other similar cases are those of *Trimenia* Monim., *Inocarpus* Leg., *Clitandropsis* Apoc., and *Merrilliodendron* Icac. On the other hand I have still accepted *Ascarina* Chlor. as Pacific, although several species are now known as far as New Guinea, the Philippines, and Borneo.

Another case comes up when genera do not show one very clear centre of development, for example *Pittosporum* Pitt.: Africa 19 spp., continental Asia 53, Malaysia 13, Australia 10, New Caledonia 46, New Zealand 20, Hawaii 12. Though the Australasian area is indubitably the focus of the family it would not appear justified to call the genus *Pittosporum* an

*) To facilitate orientation of the generic names mentioned in this study I have added for convenience' sake the name of the family of the genus in abbreviated form after the generic name.

Australian genus. It has been assigned to type 4, Old World (Palaeotropical) genera.

Nepenthes Nep. is mainly developed in Malaysia, but on the other hand it shows such a wide distribution from Madagascar, Ceylon, and Assam to New Caledonia, that this has been assigned to type 4, palaeotropical genera.

Myoporum Myop. has 30 species in Australia, and though it is true that one species is distributed far outside Australia as far as the Seychelles, SE. Asia, Bonin, and Hawaii, it has been classified among Australian genera (type 6).

However, genera which are richly represented in Australia, but have a significant number of species outside it to remote areas, have been assigned to other groups, for example *Schoenus* Cyp. to type 1, *Mitrasacme* Logan. to type 5b, *Haloragis* Halor. to type 7.

Though I realize that the census of genera on which this study has been based will prove to be incomplete, and that some genera may have to be classified in other types than I have them, it is assumed that the general outcome will be right in the principal points. There is a good indication for this perspective in that, after I had made the first draft, a newly published list of Tonga plants came at hand and a copy of an unpublished Flora of the Bismarcks by Father G. Peekel. In both cases the number of genera for these groups was distinctly enlarged, but the nature of the spectrum and its percentages remained almost exactly as they were before.

For this kind of generic analysis there are advantages and disadvantages.

The disadvantages would be far greater if an analysis would be made on the basis of species; this could properly only be performed when a complete critical Flora of the Pacific was available. Besides, species are far more liable to difference of opinion as to their delimitation than genera. Further it would be extremely difficult to classify the 'affinities' of the species, even if well known. In the present state of our knowledge such an endeavour is impossible.

Disadvantages inherent to the generic method are firstly that all genera, large or small, are treated on the same level; secondly, they are not uniformly known, some have been revised, others not.

Further a present species centre may be secondary in nature and the old centre may have now an obsolete importance, being largely extinct. This is specially significant for ancient genera (*Araucaria, Nothofagus,* etc.).

This study is of course not one which can immediately be used for the genesis of the Pacific flora; it offers the floristic raw material and features as they are today.

Besides, a rather large number of genera have been referred to type 1, the worldwide genera; among these there will be a number which could be useful if the affinities of their representatives in the Pacific could be more closely defined. I have refrained from doing this; it would require an intense taxonomical study.

Advantages of the methodology applied here are in the first place that the delimitation and distribution of the genera is far better known and therefore more reliable than that of separate species.

Further, as alluded to above, it would be very difficult to classify species in categories which we need; what is to be done with a species which occurs far apart from the centre of the genus? Would *Stylidium kunthii* Wall. ex DC., which occurs widely in SE. Asia, be considered as representing the 'Asiatic element'?

Genera mostly show a rather coherent generic area of distribution. In the Pacific there are a few, however, which display a remarkably disjunct area, to wit *Chroniochilus* Orch. (1 species, Java & Fiji), *Cossignia* Sapind. (Fiji, New Caledonia, and Mascarenes), *Koelreuteria* Sapind. (E. China, Formosa, and Fiji), *Nesogenes* Verb. (Hawaii & Tuamotu, Rodriguez, Madagascar, and Africa).

Calyptosepalum Sant. (S. Sumatra, Fiji) has been discarded as Van Steenis has just found this to be congeneric with *Drypetes* Euph.

The case for *Chroniochilus* Och. seems not to be a strong one as Holttum, in his work on Malayan orchids, finds this not distinct from *Sarcochilus* which has a much wider distribution.

There are naturally some others which show remote affinity within the Pacific basin; these remain here unmentioned.

With this kind of analysis, which cannot rest upon a critical revision of all genera and species of such a colossal area, certain details must be disposed of, for example those which are connected with a number of ancient, cultivated plants. *Colocasia* Arac., *Cocos* Palm., *Aleurites* Euph., etc. are known to have been cultivated from times immemorial and it is practically impossible to establish, or even estimate, the native area of distribution. Hillebrand (1888) and others assume that in Hawaii certain plants have been introduced by men in prehistoric time, viz *Thespesia* Malv., *Hibiscus tiliaceus* Malv., and *Calophyllum* Gutt. To avoid any uncertainties in the calculations, all these genera which might give rise to some doubt have been omitted in the surveys.

The same holds for those plants which have obviously or probably been imported into the Pacific islands as weeds or aliens or which are cultivated and have naturalized.

In certain cases one genus may have both native species and species which have been introduced, for example in *Apium* Umb., *Chenopodium* Chen., *Eragrostis* Gram., etc. The area accepted for these genera refers only to those places where they are distinctly native, and if there was uncertainty the localities have been omitted, in order to keep the raw material on which this analysis is based as clean as possible.

Unfortunately the synonymy of the genera in the Pacific has never been correlated and integrated in one critical whole. As far as possible I have traced the synonymy, but it is inevitable that more genera will have to be reduced, and others added as critical work on the Pacific flora proceeds. This will also occur with endemic genera, as some will be

added, but others will have to be removed from the list of endemics.

The total number of genera found valid for the present purpose of phytogeographical analysis is 1511, which seems a reasonable basis for statistical purpose.

The survey is naturally not a particularly balanced one, as certain islands have been much better investigated than others and, besides, the amount of published matter varies to a high degree. For instance, Samoa is far less well known as to published records than Fiji, but is better known than the New Hebrides which represent botanically a most undesirable semi-vacuum. The Solomons, which are a most promising country botanically, have mainly been explored for forestry purposes and have never been the subject of an overall botanical exploration.

By presenting in this publication the preliminary concise result of a rather laborious task, it has not been possible to add to it the entire body of factual data on which it was based and the references to the mass of literature from which these data were derived.

If circumstances permit I envisage to embody in a future, larger work a digest of the floristical theories on the affinities of the Pacific flora, an endeavour to correlate a polished version of the present outcome with geographical, geological, and other data, an enumeration of Pacific genera with their detailed distribution, and a complete bibliography.

In addition to the digest of literature I have much profited from the expert help of the following botanists of the Rijksherbarium, Leyden, and of the Foundation Flora Malesiana, who generously provided information: R. C. Bakhuizen van den Brink on *Rubiaceae* and *Apocynaceae*, Ding Hou on *Celastraceae* and *Rhizophoraceae*, J. H. Kern on *Cyperaceae*, P. W. Leenhouts on *Burseraceae*, *Loganiaceae*, and *Goodeniaceae*, S. J. van Ooststroom on *Convolvulaceae*, P. van Royen on *Sapotaceae*, and H. Sleumer on *Ericaceae*, *Proteaceae*, *Epacridaceae*, and *Flacourtiaceae*. Besides, R. D. Hoogland, Canberra, kindly provided data on *Cunoniaceae* and *Saxifragaceae*.

I feel highly honoured and indebted for this kind and loyal assistance.

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II. THE DISTRIBUTIONAL TYPES OF PACIFIC PHANEROGAM GENERA

The nine distributional types, with 6 additional subtypes, used in this analysis are the following:

Type 1. Worldwides. Genera of this type do not provide data for delimitation of provinces in the Pacific by their occurrence both in the Old and New World. Examples are *Cyperus* Cyp., *Carex* Cyp., *Drosera* Dros., *Tournefortia* Borr., *Commelina* Comm., *Ipomoea* Conv., etc. It is quite well feasible that areas of certain species of these genera could be used, but this falls beyond the project as defined in the present study.

A few genera which are widely distributed in the southern hemisphere have been included in type 1, for example *Pisonia* Nyct., *Pratia* Camp., *Weinmannia* Cun., *Machaerina* Cyp. The circum-Pacific genus *Libocedrus* Conif. has also been placed in type 1.

Type 1a. Temperate worldwides. Genera distributed over the major part of the temperate regions of both hemispheres in the Old and New World, and ascending in the tropics on the mountains; for example *Luzula* Junc., *Coriaria* Cor., *Geum* Ros., *Gentiana* Gent., etc. If in such cases the genus is more distinctly pronounced in either the northern hemisphere (as e. g. *Euphrasia* Scroph. and *Erigeron* Comp.) or the southern one (e. g. *Tetragonia* Aizoac. and *Wahlenbergia* Camp.), they have been classified under group 2 and 7 respectively.

Type 2. Northern temperate type. This category comprises the genera which are principally developed in the northern hemisphere and are typical for temperate Eurasia, often extending over North America, but are not or hardly represented in the southern hemisphere; for example *Crepis* Comp., *Vaccinium, Rhododendron* Eric., *Epilobium* Onagr., etc.

Type 3. Continental East Asian and Japanese genera. This type is centred in China and Japan, being temperate to subtropical. In the Pacific it is almost only represented in the Bonin Islands and has obviously had no opportunity to penetrate further. An example is *Bothriospermum* Borr.

A number of such genera, however, have escaped from the East Asian site through the tropics of Malaysia, where they have reached an appreciable development and have from Malaysia spread towards the Pacific. These are arranged here in type 5.

Type 4. Palaeotropical genera. Under this category I understand the genera which range through the tropics and subtropics of the Old World (Africa, Asia, Australia), but do not occur in the New World. They may be absent in Africa. Examples are *Diospyros* Eben. (for the whole range), *Elaeocarpus* Elaeoc. (not in Africa, but in Madagascar), and *Boea* Gesn. (neither in Africa nor in Madagascar). Although *Elaeocarpus* is qua species best developed in Malaysia its area is so large that it should range with type 4.

Type 5. Asiatic-Malaysian genera not represented in Australia, whether or not also in Africa. Some of these may even be abundantly developed in Africa, as for example *Mussaenda* Rub. Further examples are *Globba* Zing., and *Melastoma* Melast.

Type 5a. Malaysian genera. In this group the genera have a pronounced centre in Malaysia; if they occur also in Asia and Australia it is merely with a few outliers or stray species. Examples are *Cyrtandra* Gesn. and *Gonystylus* Thym.

Type 5b. Australian-Malaysian genera. These genera have, in Malaysia, mostly the largest development in its Eastern province, focussed frequently in New Guinea and Northern to Eastern Australia. None of them is represented in continental Asia. Typical examples are *Pandorea* Bign., *Agathis* Con., *Aceratium* Elaeoc., *Deplanchea* Bign., *Homalanthus* Euph.

Type 6. Australian genera. Under this category fall genera which are overwhelmingly developed in Australia though they may have some stray representatives or specimens in far flung localities from that continent. A typical example is *Hibbertia* Dill., with over 100 species in Australia, 20 in New Caledonia, 2 in New Guinea and the S. Moluccas (both known also from Australia), 1 in Fiji, and 1 in Madagascar. Another example is *Styphelia* Epacr.

Type 7. Subantarctic-Pacific genera. This group comprises the genera which find their main distribution over the temperate part of the South Pacific in the southern hemisphere: SE. Australia, Tasmania, New Zealand, the subantarctic islands, and temperate South America. Some genera range throughout that area, for example *Nothofagus* Fag.; others are of more limited distribution, for example *Corokia* Sax.

Type 7a. Subantarctic-Indian Ocean genera. This is a small subsection of type 7 comprising those genera which fail to occur in South America, but are found from New Zealand westward via Tasmania or South Australia to South Africa. This interesting group is only very small and as far as I know contains only 8 genera, viz *Cassinia, Helichrysum* Comp., *Lobelia* sect. *Mezliera* Camp., *Sebaea* Gent., *Pelargonium* Geran., *Moraea* Irid., *Bulbinella* Lil., and *Australina* Urt.

Type 7b. Pan-Subantarctic genera. This is an equally small group of genera, as interesting as the preceding one, containing genera which have a still much wider distribution throughout the antarctic region, and which occur in or on islands near all three continents of the New and Old Worlds. Sometimes a single species has reached or even overstepped the equator (via the mountain ranges) and has reached continental Asia or Malaysia (*Nertera* Rub., *Leptocarpus* Rest., *Acaena* Ros., *Wahlenbergia* Camp.). They are the following: *Mesembryanthemum, Tetragonia* Aizoac., *Brachycome* Comp., *Carpha* Cyp., *Sophora* sect. *Edwardsia* Leg., *Leptocarpus* Rest., *Acaena* Ros., *Nertera* Rub., *Azorella* Umb., and *Wahlenbergia* Camp.

Type 8. Pacific genera. These are genera which distinctly center in the Pacific, including naturally also New Caledonia and New Zealand. Sometimes the Pacific origin is beyond doubt, as for example in *Crossostylis* Rhiz. and *Kermadecia* Prot., which do not occur beyond Pacific borders. Their number has been marked with an asterisk * in the survey (p. 392). In some other cases Pacific genera have got that name because they were known only from the Pacific for a very long time, but have

more recently also been found to occur in Malaysia or Queensland as for example *Trimenia* Monim., *Vavaea* Meliac., *Couthovia* Logan., and in some cases there is now even a slight majority of species found in Malaysia as compared with the Pacific.

Type 8a. Endemic Pacific genera. Some of these are local endemic genera known from a single island only, as in the outstanding example of *Degeneria* Deg. in Fiji. But to this category I have also reckoned a number of genera which are confined to a limited group of islands situated close together, as for example New Caledonia and Loyalty Is., the Samoa group, the Fiji group, the Hawaiian group, etc. Of these genera I have tried to find data on their affinity, for example that of *Charpentiera* Amarant. from Hawaii is American, that of *Robinsonia* Comp. from Juan Fernandez is Papuan, that of *Entelea* Til. fom New Zealand is African!

Type 9. Tropical or subtropical American genera. This group is small and its occurrence in the Pacific is almost confined to the Galapagos Is., as for example *Laguncularia* Combr. (which also occurs in West Africa). There are, however, some which show a distinct crossing over the entire Pacific, beyond the temperate to cold Subantarctic, as for example *Nicotiana* Sol.

III. SURVEY OF ALL THE GENERA SEGREGATED INTO TYPES

Types	Number of genera		Percentage	
Type 1	334		22.1 %	
Type 1a	40		2.7 %	
Type 2	46		3.0 %	
Type 3	10		0.7 %	
Type 4	244		16.1 %	
Type 5	118		7.8 %	
Type 5a	96	256	6.4 %	17 %
Type 5b	42		2.8 %	
Type 6	97		6.5 %	
Type 7	51		3.4 %	
Type 7a	8		0.5 %	
Type 7b	10		0.7 %	
Type 8	88		5.8 %	
(8*)	(53)			
Type 8a	233		15.4 %	
Type 9	94		6.2 %	
Total	1511		100.1 %	

IV. FLORISTIC SPECTRA FOR THE PACIFIC ISLAND GROUPS AND DISCUSSION OF THEIR STATUS

In the following local surveys of the island groups the sequence chosen is from West to East in two major series, one from Bonin across Micronesia and Melanesia to Hawaii, and the second from New Caledonia and New Zealand via Juan Fernandez to Galapagos.

In order to give an approximate idea of the position on the globe and the size and nature of the islands, the latitude, longitude, area in sq.km, and approximate highest altitude in metres have been given.

1. Bonin Islands

25—28° N, 140—143° E; surface 80 sq.km; altitude 320 m

Types	Number of genera		Percentage	
Type 1	91		51.7 %	
Type 1a	5		2.9 %	
Type 2	25		14.3 %	
Type 3	8		4.6 %	
Type 4	31		17.8 %	
Type 5	5		2.9 %	
Type 5a	1	8	0.6 %	4.7 %
Type 5b	2		1.2 %	
Type 6	1		0.6 %	
Type 7	—		—	
Type 7a	—		—	
Type 7b	1		0.6 %	
Type 8	2		1.2 %	
Type 8a	3		1.7 %	
Type 9	—		—	
Total	175		100.1 %	

Discussion: In this spectrum types 2 and 3 are proportionally abundantly represented, far more than in any other island group to follow. This shows the great affinity with the East Asian mainland of China, Siberia, and Japan, and the sharp demarcation against the true Pacific islands. The spectrum of the flora is more boreal and East Asian than in any other group.

Types 4 and 5 show, furthermore, a rather large number of tropical genera, but the percentage of Malaysian elements is not particularly large. One genus (type 5a), viz *Paralstonia* Apoc., is confined to Bonin and the Philippines.

The Pacific element (type 8) is very small.

The three endemic genera (*Dendrocacalia* Comp., *Platypholis* Orob., *Boninia* Rub.) show a (rather feeble) indication of individuality. Only seven genera (incl. the three endemics), or 4 %, are not found in Asia or Japan.

The conclusion is that the Bonin Islands should not be considered a province of the Pacific flora but undoubtedly make part of the East Asian flora.

Comparison with the flora of the Marianas. The spectrum differs markedly from that of the Marianas, especially if we take into consideration the relatively small distance between these two groups which form superficially one arc. In comparing the spectra it appears that the difference lies in the types 1a, 2, and 3 (East Asian and temperate northern), amounting to 37 genera or ± 21 % in the Bonins against 1 or 0.5 % in the Marianas, a most significant proportion.

Comparing the Bonins and Marianas we find that Bonin has 175 genera (incl. 3 endemics) and the Marianas 217 genera (incl. 1 endemic).

Common to both groups are 86 genera; in Bonin occur 89 genera not known from the Marianas. Conversely 131 genera of the Marianas are not found in the Bonins. The demarcation thus amounts to 89 + 131 = 220 genera, i. e. 72 % of the total number of genera (306) found in both groups together.

A curious case is *Santalum* Sant. which occurs throughout the Pacific, but has never been found in the Marianas and Carolines!

2. Marianas

13—20° N, 144—146° E; surface 640 sq.km; altitude 400 m

Types	Number of genera		Percentage	
Type 1	134		61.1 %	
Type 1a	1		0.5 %	
Type 2	—		—	
Type 3	—		—	
Type 4	54		25.4 %	
Type 5	13		6.0 %	
Type 5a	6	20	2.7 %	9.2 %
Type 5b	1		0.5 %	
Type 6	3		1.4 %	
Type 7	—		—	
Type 7a	—		—	
Type 7b	—		—	
Type 8	4		1.9 %	
Type 8a	1		0.5 %	
Type 9	—		—	
Total	217		100.0 %	

Discussion: As can be observed from the figures under types 1a, 2, and 3 the affinity with East Asia is extremely small.

In contrast the affinity with Malaysian tropics is larger (groups 5—5b) and there is a distinct increase in Palaeotropical elements (group 4).

The genera of the Marianas are all found in Malaysia except the one endemic genus *Guamia* Ann.

On the other hand the Marianas have 14 genera (6.5 %) which are not found in continental Asia; of these 6 belong to type 5a, 1 to type 5b, 2 to type 6, 4 to type 8, and 1 to type 8a.

The demarcation between Bonin and Marianas. In comparing the genera from both groups we can oppose the Northern and Western genera which end their distribution in the Bonins to the Eastern and Southern genera which end their distribution area in the Marianas. In doing this we get the following figures:

For Bonin:	in types 1a and 2	28 genera
	in type 3	8 genera
	in types 4, 5, and 5a	6 genera
	endemic	3 genera
	Totaal	45 genera
For the Marianas:	in types 4 and 5	46 genera
	in types 5a and 5b	6 genera
	in types 6 and 8a	6 genera
	endemic	1 genus
	Totaal	59 genera

As we have seen in the section on the Bonin Islands there is a marked gap of 220 genera, i. e. 72 % of the total number of genera, between Bonin and the Marianas.

Conclusion: The Marianas distinctly belong to the Malaysian floral district.

In order to find out their closest affinity I have tried to find out how many genera the Marianas share with the Philippines, but not found in New Guinea, and those shared by Marianas and New Guinea that do not occur in the Philippines.

The Marianas share 6 genera with New Guinea which are not found in the Philippines. They are: *Bleekeria* Apoc., *Fenzlia* Myrt., *Merrilliodendron* Icac., *Meryta* Aral., *Pachygone* Menisp., and *Sacciolepis* Gram.

There are 2 genera shared by the Marianas and the Philippines which are not recorded for New Guinea, viz *Cantharospermum* and *Teramnus* Leg. Both are wide-spread plants of ± anthropogenous country.

This appears to be a slight discrepancy only, but still induces me to include the Marianas in a subdistrict of East Malaysia.

3a. West Carolines and Palau 7—10° N, 132—145° E; surface 600 sq.km; altitude 240 m				3b. East Carolines 5—9° N, 145—163° E; surface 700 sq.km; altitude 790 m			
Types	Number of genera	Percentage		Number of genera	Percentage		
Type 1	151	42.9 %		113	47.5 %		
Type 1a	—	—		—	—		
Type 2	—	—		—	—		
Type 3	1	0.3 %		1	0.4 %		
Type 4	99	29.1 %		65	28.4 %		
Type 5	47	13.8 %		24	10.2 %		
Type 5a	26	7.7 %	23.6 %	18	7.6 %	19.1 %	
Type 5b	7	2.1 %		3	1.3 %		
	80			45			
Type 6	2	0.6 %		1	0.4 %		
Type 7	1	0.3 %		—	—		
Type 7a	—	—		—	—		
Type 7b	—	—		—	—		
Type 8	10	2.9 %		9	3.8 %		
Type 8a	1	0.3 %		1	0.4 %		
Type 9	—	—		—	—		
Total	345	100.0 %		235	100.0 %		

Discussion: Although from the above contrasted tables it appears that both groups are distinctly similar in character of the spectrum, it appears that the West Carolines, notwithstanding their lower altitude, harbour many more genera. This is mainly to be ascribed to the relative richness of Palau which has, for its small size, a surprisingly varied flora.

(a) *West Carolines.* All genera represented in the West Carolines also occur in Malaysia, 3 excepted, among which is the endemic *Palaoea* Sapind. Further 40 (= 11.8 %) of its genera do not reach the East or Southeast Asiatic mainland.

Pacific elements (type 8) are represented by only 10 genera, of which 8 also occur in Malaysia.

(b) *East Carolines.* The generic relationship between the East Carolines and Malaysia is about equally strong as that of the West Carolines, but the Pacific influence (type 8) is slightly larger. Four genera of the East Carolines do not occur in Malaysia, viz 3 Pacific genera and the endemic genus *Trukia,* Rub. Furthermore, 28 (= 11.9 %) of its genera have not been recorded for the Asiatic mainland.

(c) *Difference and similarity between the West and East Carolines.* The West and East Carolines have together 379 genera, of which they have in common 198 genera = 52.5 %.

The East Carolines have 38 genera not occurring in the West Caro-

lines, and conversely the West Carolines have 142 genera not occurring in the East Carolines; demarcation knot: 47.5 %.

(d) *Demarcation between West Carolines and Marianas.* The demarcation between the West Carolines and the Marianas is more distinct than between the West and East Carolines. The situation is as follows: of the 217 Marianas genera 54 are not found in the West Carolines and conversely from the 345 West Carolines genera 182 do not occur in the Marianas, the total demarcation being 236 genera out of a total of 399, that is 59.1 %.

The number of genera which terminate their distribution in the West Carolines and do not occur in the Marianas or East Carolines is 72, which belong to types 4 and 5—5b, with of course the endemic *Palaoea.*

The conclusion is that there are distinct demarcations both between the West Carolines and the Marianas and between the West and East Carolines; they are of about equal magnitude.

(e) *The relation between the Carolines and the Philippines and New Guinea.* For this aim it seems convenient to combine the entire flora of the West and East Carolines in one survey:

Carolines

Types	Number of genera	Percentage
Type 1	159	42.0 %
Type 1a	—	—
Type 2	—	—
Type 3	1	0.3 %
Type 4	113	29.8 %
Type 5	49	12.9 %
Type 5a	30	7.9 %
Type 5b	9	2.4 %
Type 6	2	0.5 %
Type 7	1	0.3 %
Type 7a	—	—
Type 7b	—	—
Type 8	12	3.2 %
Type 8a	3	0.8 %
Type 9	—	—
Total	379	100.1 %

The relation can be tested by the number of genera that do not occur in both Philippines and New Guinea, but only in one of these two districts. In doing this it appears that there are 2 genera which the Carolines have in common with the Philippines which do not occur in New Guinea. These are: *Scirpodendron* Cyp. and *Symplocos § Bobua*

Sympl. Conversely there are 18 genera which are shared by the Carolines and New Guinea and do not occur in the Philippines, viz:

Aglossorrhyncha Orch.
Campnosperma Anac.
Clitandropsis Apoc.
Fenzlia Myrt.
Finschia Prot.
Gulubia Palm.
Gymnosiphon sect. Gymnosiphon Burm.
Haplolobus Burs.
Loeseneriella Hippoc.
Lophopyxis Euph.
Mediocalcar Orch.
Merrilliodendron Icac.
Meryta Aral.
Pentaphalangium Gutt.
Pseuderia Orch.
Sacciolepis Gram.
Salacicratea Hippoc.
Soulamea Simaroub.

It appears, therefore, that the Carolines should be joined to the East Malaysian Province, and not to the Philippines (West Malaysian Prov.).

4. Marshall, Gilbert, and Ellice Isands, including also Line, Phoenix, and Tokelau Islands

10° S—20° N, 175° E—150° W; surface 1000 sq.km; highest altitude 5 m

	Marshall, Gilbert, Ellice		Line, Phoenix, Tokelau	
Types	Number of genera	Percentage	Number of genera	Percentage
Type 1	43	68.3 %	31	86.1 %
Type 1a	—	—	—	—
Type 2	—	—	—	—
Type 3	—	—	—	—
Type 4	15	23.8 %	3	8.3 %
Type 5	2	3.2 %	1	2.8 %
Type 5a	—	—	—	—
Type 5b	—	—	—	—
Type 6	—	—	—	—
Type 7	—	—	—	—
Type 7a	—	—	—	—
Type 7b	—	—	—	—
Type 8	3	4.7 %	1	2.8 %
Type 8a	—	—	—	—
Type 9	—	—	—	—
Total	63	100.0 %	36	100.0 %

Central Pacific (combined)

Types	Number of genera	Percentage
Type 1	49	71.0 %
Type 1a	—	—
Type 2	—	—
Type 3	—	—
Type 4	15	21.7 %
Type 5	2	3.0 %
Type 5a	—	—
Type 5b	—	—
Type 6	—	—
Type 7	—	—
Type 7a	—	—
Type 7b	—	—
Type 8	3	4.3 %
Type 8a	—	—
Type 9	—	—
Total	69	100.0 %

Discussion: The reason for taking these widely diffused islands together is because they have practically no significance from the plant-geographical point of view and share the general features of low coral flats and atolls. Their flora mainly consists of wide-spread tropical shore plants of the pescaprae and Barringtonia formations. Though from their situation in the middle of the Pacific one would expect a high percentage of the Pacific type 8, this appears hardly represented.

Conclusion: The group belongs certainly to the Old World tropics, but it cannot be defined as a separate province by lack of character.

5. Bismarck Archipelago

Discussion: Though situated in the immediate vicinity of New Guinea, it appeared worthwhile to establish the percentages, especially in relation with the Solomons, which form superficially an elongation of New Ireland.

Unfortunately the Bismarcks are not a particularly well explored area and publications on it are relatively scarce. At Berlin the Herbarium formerly started a series of publications on this group and Micronesia, but this was soon abandoned. In other publications authors frequently merge the Bismarck records with those of New Guinea and omit to mention any separate records.

As far as I could trace 525 genera have been recorded in literature; from this figure I have deleted 11 in which it is not quite certain that

1—6°S, 146—153° W; surface 50.000 sq.km; altitude 2400 m

Types	Number of genera		Percentage	
Type 1	194		37.8 %	
Type 1a	1		0.2 %	
Type 2	1		0.2 %	
Type 3	—		—	
Type 4	152		29.6 %	
Type 5	71		13.8 %	
Type 5a	52	146	10.2 %	28.5 %
Type 5b	23		4.5 %	
Type 6	7		1.4 %	
Type 7	1		0.2 %	
Type 7a	—		—	
Type 7b	—		—	
Type 8	11		2.0 %	
Type 8a	1		0.2 %	
Type 9	—		—	
Total	514		100.0 %	

they are indigenous, as for example *Melia* Meliac., *Aleurites* Euph., etc. This leaves a clean total of 514.

Among these only 3 genera have not yet been recorded for Malaysia, viz *Maytenus* Celastr., *Nasturtium sect. Ceriosperma* Cruc., and *Clymenia* Rut.

The affinity is largest with New Guinea, with which they share not less than 508 genera (98.5 %).

Besides, the Bismarks share with New Guinea 4 genera which have never been recorded from elsewhere, viz *Calycacanthus* Acanth., *Tripetalum* Gutt., *Antiaropsis* Morac., and *Peekelia* Leg., whereas quite a few genera are found outside New Guinea and the Bismarcks only in the Moluccas or the Solomons. The only endemic genus is: *Clymenia* Rut.

Among the 11 Pacific genera of type 8 there are none which are absent from Malaysia.

Many palaeotropical genera end their distribution in the Bismarcks, though their number is smaller than has been found for the Solomons. They are distributed over the types as follows:

Genera which terminate their distribution in the Bismarcks:

Type 1	8 genera	Type 5a.....	13 genera
Type 4	12 genera	Type 5b.....	6 genera
Type 5	22 genera	Type 6	2 genera
		Total	63 genera

Concerning the relation with other adjacent island groups it appears that there is a much stronger affinity with the Solomons than with the Carolines. Of the 514 Bismarck genera 242 do not occur in the Carolines, and conversely of the 379 Carolines genera 107 do not occur in the Bismarcks; the demarcation being in all 349 genera, or 53 % of the total number of genera in both groups.

In applying the same considerations to the Solomons the figures are as follows: of the 514 Bismarck genera 179 do not occur in the Solomons, and conversely of the 431 Solomon genera 87 do not occur in the Bismarcks; together amounting to a demarcation of 266 genera or 44 % of the total number of genera in both groups.

Conclusion: In conclusion the situation induces us to subordinate the Bismarcks to the East Malaysian Province without possibility of defining it as a separate district, but joining it immediately to Papuasia.

6. Solomon Islands

5—11° S, 154—162° E; surface 42.500 sq.km; altitude 2700 m

Types	Number of genera		Percentages	
Type 1	150		34.8 %	
Type 1a	—		—	
Type 2	3		0.7 %	
Type 3	—		—	
Type 4	122		28.3 %	
Type 5	44		10.2 %	
Type 5a	56	119	13.0 %	27.6 %
Type 5b	19		4.4 %	
Type 6	6		1.4 %	
Type 7	3		0.7 %	
Type 7a	—		—	
Type 7b	—		—	
Type 8	23		5.3 %	
Type 8a	3		0.7 %	
Type 9	2		0.5 %	
Total	431		100.0 %	

Discussion: The state of exploration and publication is no better for the Solomons than it is for the Bismarcks. The exploration has been done largely for purposes of forestry and proportionally little attention has been paid to the herbaceous flora.

From the figures above it appears clearly that the flora of the Solomons is closest allied to that of Malaysia and very remote from that of Australia, the percentages of types 5—5b being 27.6 % against that of type 6 being only 1.4 %.

The Pacific element is somewhat better represented in the Solomons than in the Bismarcks, which appears from the following comparison. The Bismarcks have 11 Pacific genera (2.7 %) all of which are also found in Malaysia. The Solomons, however, have 23 (5.3 %), 10 of which do not reach Malaysia.

Besides, the Solomons have somewhat more individuality due to the presence of three endemic genera, all palms, viz *Paragulubia, Pritchardiopsis,* and *Rehderophoenix.*

The demarcation between the Solomons and New Hebrides is more distinct than many other demarcations in the Pacific. A considerable number of paleotropical, especially Malaysian genera, terminate their distribution in the Solomons. Besides, a number of genera from other types also find the limit of their distribution in the Solomons. Their spectrum is as follows:

Genera penetrating into the Pacific as far as and including the Solomons:

Type 1	10 genera	Type 5a.....	31 genera
Type 2	2 genera	Type 5b.....	4 genera
Type 4	24 genera	Type 6	1 genus
Type 5	22 genera	Type 8a.....	3 genera
		Total	97 genera

The 10 genera of type 1, though world-wide in distribution, are known in the Pacific only as far east as the Solomons and so virtually terminate their distribution in this island group. Conversely there is a significant number of Pacific and other southern and eastern genera which occur in the New Hebrides but have not been found in the Solomons. Their spectrum is:

Genera terminating their area in the New Hebrides with relation to the Solomon Islands:

Type 1a	2 genera
Type 6	8 genera
Type 7	2 genera
Type 8	22 genera
Type 8a	2 genera
Total	36 genera

The complete demarcation knot between the Bismarcks, Solomons, and New Hebrides are as follows: 179 Bismarck genera do not occur in the Solomons, 87 Solomon Is. genera do not occur in the Bismarcks, demarcation knot 266 genera on a total of 601 = 44.2 %.

Furthermore 201 Solomon Is. genera do not occur in the New Hebrides, 141 New Hebrides genera are not recorded from the Solomons, demarcation knot 342 genera on a total of 572 = 60.0 %. Probably the latter figure

is too high because a number of the New Hebrides genera are known in the Bismarcks, which points to an under-exploration or publication of the Solomon Is. flora. The demarcation between Solomons and New Hebrides is further accentuated by the percentage of Pacific genera (type 8) amounting to 5.3 % and 10.5 % respectively. Also many genera are known from the Solomons and Fiji which have not yet been recorded from the New Hebrides. I expect that the demarcation percentages will decrease with intensified exploration and publication.

It is remarkable that neither in the Solomons nor in the Bismarcks representatives have been recorded of the *Dipterocarpaceae* though they are still represented with 3 genera in the most eastern islands of the Louisiades. This is also valid for *Quercus* sens. lat. and *Castanopsis* Fag., *Ericaceae, Melastomataceae,* etc. which are almost absent east of New Guinea.

Conclusion: The Solomon Islands form a distinct part of the East Malaysian flora. However, there is a distinct demarcation in the west against New Guinea and the Bismarcks, and a still more significant demarcation against the New Hebrides flora in the east. Therefore, the Solomon Islands flora deserves a separate status as a district.

7. New Hebrides

12—20° S, 166—170° E; surface 15.000 sq.km; altitude 1800 m

Types	Number of genera		Percentage	
Type 1	135		36.4 %	
Type 1a	2		0.5 %	
Type 2	2		0.5 %	
Type 3	—		—	
Type 4	107		28.8 %	
Type 5	33	69	8.9 %	18.6 %
Type 5a	24		6.5 %	
Type 5b	12		3.2 %	
Type 6	12		3.2 %	
Type 7	2		0.5 %	
Type 7a	—		—	
Type 7b	—		—	
Type 8	39		10.5 %	
Type 8a	2		0.5 %	
Type 9	1		0.3 %	
Total	371		99.9 %	

Discussion: Unfortunately the New Hebrides [1]) have been very inade-

[1]) The Santa Cruz Islands have been included here in the New Hebrides. They may turn out to be closer allied to the Solomons, but their flora is at present too poorly known.

quately explored, which is the more regrettable as they are situated in a crucial area of plant distribution in the Pacific; from their area and altitude one may expect a much richer flora than is known at the present time. The number of Pacific genera which terminate their distribution in the New Hebrides may be larger and possibly also the number of genera which we know only from New Caledonia, as some endemic New Caledonian genera have later been found also in the New Hebrides.

As to Malaysian and other western genera, the New Hebrides are not such a marked "end-station" as compared with the Solomons, Fiji, or Samoa; if western genera are known from the New Hebrides, they usually also occur in Fiji and/or Samoa/Tonga.

There is in types 5 and 5a, amounting to 33 and 24 genera, a considerable number of orchid genera, viz 14 and 4 genera respectively; this is probably out of proportion as obviously for some reason the intensity of orchid collecting and publication has been more thorough than for other groups.

The two endemic genera known from the New Hebrides are *Trichochilus* Orch. and *Physokentia* Palm.

As an "end-station" for various floristical types the figures for the New Hebrides are: for type 4: 10 genera, for types 5—5a: 10 genera, for types 6 and 8 (Australian and New Caledonian genera): 16 genera, and for "pure" Pacific genera, type 8: 7 genera.

The New Hebrides have one genus in common with Australia, viz *Lysiana* Loranth. and they share 5 genera with New Caledonia which do not occur elsewhere, viz *Alphandia* Euph., *Chambeyronia* Palm., *Cyclophyllum* Rub., *Dizygotheca* and *Strobilopanax* Aral.

There are no purely Malaysian genera which Malaysia and the Solomons share with the New Hebrides. This is in agreement with the fact that the New Hebrides do not represent, as alluded to above, a terminus for typical Malaysian genera.

If we consider the complete survey of the demarcation knots we get the following picture:

(1) Against the Solomons: The New Hebrides have 141 out of 371 genera not occurring in the Solomons, conversely the Solomons have 201 genera out of 431 not occurring in the New Hebrides; demarcation knot consequently 342 genera on a total of 572 = 60.0 %.

(2) Against New Caledonia: The New Hebrides have 88 genera out of 371 not occurring in New Caledonia, conversely New Caledonia has 379 genera out of 662 not occurring in the New Hebrides; demarcation knot consequently 467 on a total of 750 = 62.3 %.

(3) Against Fiji: The New Hebrides have 102 genera out of 371 which do not occur in Fiji, conversely Fiji has 178 genera out of 447 which do not occur in the New Hebrides; demarcation knot consequently 280 genera out of a total of 549 = 51.0 %.

Conclusion: The New Hebrides are in proportion to floristic affinity allied to the surrounding island groups in the sequence Fiji, Solomons, New Caledonia.

8. Fiji Islands

15—10° S, 177° E to 179° W; surface 18.500 sq.km; altitude 1300 m

Types	Number of genera		Percentage	
Type 1	174		38.8 %	
Type 1a	3		0.7 %	
Type 2	1		0.2 %	
Type 3	1		0.2 %	
Type 4	117		25.0 %	
Type 5	42		9.4 %	
Type 5a	30	86	6.7 %	20.2 %
Type 5b	14		3.1 %	
Type 6	8		1.8 %	
Type 7	3		0.7 %	
Type 7a	—		—	
Type 7b	—		—	
Type 8	41		9.2 %	
Type 8a	12		2.7 %	
Type 9	3		0.7 %	
Total	449		100.0 %	

Discussion: The ratios in the spectrum of the Fiji flora resemble those of the New Hebrides to a most remarkable extent, with the exception of the much more numerous endemic genera (type 8a) in Fiji, the much smaller Australian element (type 6), and a surprisingly larger number of Malaysian genera (types 5—5b), although the distance from Malaysia and from Australia has equally been increased with reference to the New Hebrides. This seems to be a most significant feature.

The 12 endemic genera are the following: *Degeneria* Deg., *Goniocladus*, *Goniosperma*, *Neoveitchia*, *Taveunia* Palm., *Gillespiea*, *Hedstromia*, *Readia*, *Squamellaria*, *Sukunia* Rub., *Amaroria* Simaroub., and *Pimia* Sterc. The monotypic primitive *Degeneria* forms a separate family.

Comparable with the Solomons, Fiji represents a distinct "end-station" of many palaeotropical and Malaysian genera, as has already been emphasized by A. C. Smith (1955). It will appear, however, in the spectral survey of Samoa and Tonga, that a higher percentage of genera find their terminus in these islands, although they are situated beyond the so-called 'andesite line', which has been accepted as the ancient continental border. From East Malaysia the number of Malaysian and palaeotropical genera fades away rather gradually as we proceed eastwards; the gradation shows several minor abrupt discrepancies, namely a feeble one West of the Solomons, a more pronounced one East of the Solomons, a very feeble one between the New Hebrides and Fiji, a rather feeble one between Fiji and Samoa, and a more pronounced one East of Samoa-Tonga.

In all there are 77 western genera that end their distribution in Fiji, which is 17 % of all the Fijian genera. These are distributed over the types as follows: type 3: 1 genus, type 4: 27 genera, type 5: 14 genera, type 5a: 11 genera, type 5b: 5 genera, type 6: 4 genera, and type 8: 15 genera.

Conversely there are only 5 eastern Pacific genera which find their most western station in Fiji.

The relations with the four surrounding island groups for finding the demarcation knots are as follows:

(1) Against the New Hebrides: Fiji has 180 genera out of 449 which do not occur in the New Hebrides, conversely the New Hebrides have 102 genera out of 371 not occurring in Fiji; demarcation knot consequently 282 genera on a total of 551 = 51 %.

(2) Against New Caledonia: Fiji has 146 genera out of 449 which do not occur in New Caledonia, conversely New Caledonia has 357 genera out of 662 not occurring in Fiji; demarcation knot consequently 503 genera in a total of 808 genera = 62 %.

(3) Against Tonga: Fiji has 239 genera out of 449 not recorded from Tonga, conversely Tonga has only 39 out of 249 genera not occurring in Fiji; demarcation knot consequently 278 out of 488 genera = 57 %.

(4) Against Samoa: Fiji has 189 genera out of 449 not occurring in Samoa, conversely Samoa has only 43 genera out of 302 not occurring in Fiji; demarcation knot consequently 232 genera out of a total of 491 = 48.5 %.

These figures naturally have only a relative value as the island groups considered are not at all comparable as to size and richness. The number of genera in Samoa and Tonga, which are absent in Fiji, is very low, viz 43 and 39 respectively. In the New Hebrides it is somewhat larger, viz 102, and in New Caledonia it is very much larger, viz 357.

The sizes and altitudes of Samoa, Tonga, New Hebrides, and New Caledonia are: 3600 sq.km/1820 m — 900 sq.km/1000 m — 15000 sq.km/1800 m — 24500 sq.km/1600 m respectively.

Conclusion: Fiji undoubtedly forms an extension towards the Pacific of the Malaysian Province, though to a much lesser extent than for example the Solomons. The closest affinity is with the New Hebrides and as we shall see in the next section a similar relationship exists with Samoa and Tonga; the four will be taken together in one district of the Malaysian Province.

9. Samoa group

13—14° S, 169—174° W; surface 3600 sq.km; altitude 1820 m

Types	Number of genera		Percentage	
Type 1	130		43.0 %	
Type 1a	1		0.3 %	
Type 2	1		0.3 %	
Type 3	—		—	
Type 4	80		26.5 %	
Type 5	24		8.0 %	
Type 5a	23	57	7.6 %	18.9 %
Type 5b	10		3.3 %	
Type 6	3		1.0 %	
Type 7	2		0.7 %	
Type 7a	—		—	
Type 7b	1		0.3 %	
Type 8	24		8.0 %	
Type 8a	2		0.7 %	
Type 9	1		0.3 %	
Total	302		100.0 %	

Discussion: If we compare the spectrum of Samoa with that of Fiji we find a striking resemblance in the composition in all types, with the exception of type 8a, the endemic genera, of which there are only two in Samoa, viz *Coralliokyphos* Orch. and *Sarcopygme* Rub., against twelve in Fiji.

Genera with their distribution ending in Samoa are treated in the next section on Tonga.

10. Tonga group, including Niue

18—22 °, 174—175° W; surface 900 sq.km; altitude 1000 m

Types	Number of genera		Percentage	
Type 1	124		50.0 %	
Type 1a	—		—	
Type 2	—		—	
Type 3	—		—	
Type 4	72		29.0 %	
Type 5	13		5.2 %	
Type 5a	7	29	2.8 %	11.6 %
Type 5b	9		3.6 %	
Type 6	3		1.2 %	
Type 7	—		—	
Type 7a	—		—	
Type 7b	2		0.8 %	
Type 8	16		6.4 %	
Type 8a	—		—	
Type 9	3		1.2 %	
Total	249		100.2 %	

Discussion: As can be observed from the figures above the spectrum is again to a surprisingly high degree comparable to those of Fiji and Samoa, especially with the latter, as there are no endemic genera. The Tonga group can botanically be considered as a depauperated version of Fiji. This is not unexpected if one takes into consideration the small surface covered by the group.

In comparing type 1 in Fiji, Samoa, and Tonga respectively, it can be observed that the percentage of type 1 (world-wide genera) obviously increases inversely proportional to the size of the islands.

Samoa and Tonga as an "end-station" of western genera. — The number of genera occurring in both groups together is 357 of which 101 genera = 28.1 % find their easternmost station in the Pacific in these islands. They are distributed over the types as follows:

Type 4	39 genera	Type 5b.....	10 genera
Type 5	20 genera	Type 6	3 genera
Type 5a.....	14 genera	Type 8	15 genera
		Total	101 genera

Demarcation between Samoa and Tonga. — Samoa possesses 108 genera which do not occur in Tonga, conversely Tonga has 54 genera which are not recorded from Samoa, which makes a total demarcation of 162 genera out of 357 occurring in both groups together = 45.5 %. This figure is still less than we have found as demarcation between Samoa and Fiji.

The combined generic spectre of Samoa and Tonga is the following:

Types	Number of genera	Percentage
Type 1	155	43.4 %
Type 1a	1	0.3 %
Type 2	1	0.3 %
Type 3	—	—
Type 4	89	24.9 %
Type 5	28	7.8 %
Type 5a	25	7.0 %
Type 5b	12	3.3 %
Type 6	4	1.1 %
Type 7	2	0.6 %
Type 7a	—	—
Type 7b	3	0.9 %
Type 8	31	8.7 %
Type 8a	2	0.6 %
Type 9	4	1.1 %
Total	357	100.0 %

Conclusion on New Hebrides, Fiji, Samoa and Tonga groups: The affinity between the Samoa and Tonga groups is so strong that they should be merged.

Furthermore the spectra of the three groups, New Hebrides, Fiji, and Samoa/Tonga, are so similar that they should form together one separate District of the Malaysian flora.

11. Southeast Polynesian islands

Before venturing on the large archipelagos of the small islands of SE. Polynesia, a few general remarks should be made.

They consist of the Cook Islands, Society Islands, Tubuai including also Rapa, Tuamotu, and Marquesas Islands.

Their flora is generally poor in genera and rather uniform in character. It has only appeared during the analysis that Rapa obviously occupies a position of its own.

The evaluation of the literature appeared far from easy, as some authors cite localities as "Society Is." in a very loose way, as it sometimes appeared that their records really were only from Tuamotu, Cook, or other islands.

I have treated below each island group separately and have finally combined them, with the exception of Rapa.

11a. Cook Islands

19—22° S, 157—160° W; surface 250 sq.km; altitude 650 m

Types	Number of genera		Percentage	
Type 1	85		61.6 %	
Type 1a	—		—	
Type 2	1		0.7 %	
Type 3	—		—	
Type 4	30		21.7 %	
Type 5	4		3.0 %	
Type 5a	4	9	3.0 %	6.7 %
Type 5b	1		0.7 %	
Type 6	2		1.4 %	
Type 7	1		0.7 %	
Type 7a	—		—	
Type 7b	—		—	
Type 8	9		6.5 %	
Type 8a	—		—	
Type 9	1		0.7 %	
Total	138		100.0 %	

Discussion: Between Samoa and Tonga on one side, and Cook and other SE. Polynesian islands on the other, there is obviously a pronounced demarcation. This can for example be demonstrated by the number of western genera occurring on these island groups (and their % of the local number of genera):

Types	Samoa	Tonga	Cook	Society
Type 4	80	72	30	43
Type 5—5b	57	29	9	19
Type 6	3	3	2	2
Total	140	104	41	64
	(= 46.4 %)	(= 41.7 %)	(= 29.8 %)	(= 34.5 %)

East of Samoa/Tonga there is hence a very distinct decrease of western genera.

On the other hand there is no increase of American genera whatsoever (type 9) which would counterbalance the western decrease, nor is there an increase of Pacific elements (type 8).

If we would characterize Cook Is. the definition would be: a distinct part of the palaeotropics, with special affinity to Malaysia, and hardly any individuality by the absence of endemic genera (type 8a) and by a high percentage in type 1.

11b. Society Group

12—16° S, 148—155° W; surface 1700 sq.km; altitude 2200 m

Types	Number of genera		Percentage	
Type 1	95		51.1 %	
Type 1a	1		0.5 %	
Type 2	1		0.5 %	
Type 3	—		—	
Type 4	43		23.1 %	
Type 5	10	19	5.4 %	10.3 %
Type 5a	7		3.8 %	
Type 5b	2		1.1 %	
Type 6	2		1.1 %	
Type 7	3		1.6 %	
Type 7a	—		—	
Type 7b	1		0.5 %	
Type 8	19		10.2 %	
Type 8a	1		0.5 %	
Type 9	1		0.5 %	
Total	186		99.9 %	

Discussion: The surface and altitude of the Society Islands are larger than those in Tuamotu Is. which accounts for a richer flora (see 11c.).

A significant character is the still large percentage of palaeotropical genera and a considerable number of Malaysian genera with no increase in American genera and a slight increase of Pacific genera. There is also one endemic genus, *Tahitia* Til. which is said to be closely allied to Malaysian genera.

There is further one American genus, *Fuchsia* Onagr. which also occurs in New Zealand and hence could be placed in type 7 as well.

Among the types 4 and 5, palaeotropical and Malaysian, the number of genera represented by shore plants is playing a preponderant role, such as *Barringtonia* Lec., *Terminalia* Combr., *Pandanus* Pand., etc.. Also orchidaceous genera are common in these two types.

Concluding it may be said with confidence that the flora of the Society Islands is still a distinctly palaeotropical one.

11c. Tuamotu Islands

11—25 ° S, 125—148° W; surface 940 sq.km; altitude 400 m

Types	Number of genera		Percentage	
Type 1	64		68.1 %	
Type 1a	—		—	
Type 2	—		—	
Type 3	—		—	
Type 4	17		18.0 %	
Type 5	2	3	2.1 %	3.3 %
Type 5a	—		—	
Type 5b	1		1.1 %	
Type 6	1		1.1 %	
Type 7	1		1.1 %	
Type 7a	—		—	
Type 7b	—		—	
Type 8	8		8.5 %	
Type 8a	—		—	
Type 9	—		—	
Total	92		100.0 %	

Discussion: The surface of the archipelago is very large, but the actual amount of land is very small with distant islets. A large number of these islands consist of low coral islets and atolls generally with a very poor litoral flora. Only the most southern islands show any character with elevations up to 400 m, such as Mangareva, Pitcairn, Henderson I., etc. They form one continuous series with the Cook and Tubuai islands group.

Although the Malaysian type (type 5—5b) has dwindled to a very

low percentage, the character is still distinctly palaeotropical through the high percentage in type 4 and the absence of type 9. Generic endemism is also absent.

The conclusion is that there is no appreciable difference in floristic spectrum between the Cooks and Tuamotus.

11d. Marquesas

10° S, 140—139° W; surface 1300 sq.km; altitude c. 1400 m

Types	Number of genera		Percentage	
Type 1	68		58.6 %	
Type 1a	1		0.9 %	
Type 2	1		0.9 %	
Type 3	—		—	
Type 4	20		17.2 %	
Type 5	1		0.9 %	
Type 5a	3	4	2.6 %	3.5 %
Type 5b	—		—	
Type 6	2		1.7 %	
Type 7	—		—	
Type 7a	—		—	
Type 7b	—		—	
Type 8	17		14.7 %	
Type 8a	1		0.9 %	
Type 9	2		1.7 %	
Total	121		100.1 %	

Discussion: All that can be said is that the Marquesas have a larger percentage of Pacific genera, but furthermore that the spectrum is very similar to those of the Society and Tuamotu Islands.

There are two American genera represented, viz *Nicotiana* Sol. and *Dianella sect. Archidiana* Lil.; the former is also represented westward to Australia. *Dianella* is a large genus from both the Old and New World tropics. Furthermore there is a rather doubtful record of an American genus, *Diplothemium* Palm.

The subendemic genus *Pelagodoxa* Palm. (also found in Tubuai), said to be allied to American genera, is doubtfully recorded for New Caledonia.

There is one endemic genus, *Cyrtandroidea* Camp. which is allied to Hawaiian genera.

11e. Tubuai, including Rapa

22—28° S, 143—155° W; surface c. 300 sq.km; altitude 660 m

Types	Number of genera		Percentage	
Type 1	65		52.9 %	
Type 1a	5		4.0 %	
Type 2	2		1.6 %	
Type 3	—		—	
Type 4	24		19.5 %	
Type 5	1		0.8 %	
Type 5a	2	4	1.6 %	3.2 %
Type 5b	1		0.8 %	
Type 6	4		3.2 %	
Type 7	6		4.9 %	8.1 %
Type 7a	—		—	
Type 7b	2		1.6 %	
Type 8	10		8.1 %	
Type 8a	1		0.8 %	
Type 9	—		—	
Total	123		100.0 %	

Discussion: There is no doubt that these islands still belong to the Old World part of the Pacific with no less percentages in types 4 and 5 than in the Marquesas, though less than in Cook and Society Islands. The American type (9) is absent.

Australian genera (type 6) are equal in number to Malaysian ones (*Inocarpus, Serianthes* Leg., *Procris* Urt., *Homalanthus* Euph.), two of which are shore plants. Among the 4 Australian genera none is of the shore (*Metrosideros* Myrt., *Olearia* Comp., *Styphelia* Epacr., *Myoporum* Myop.).

The list shows much more 'individuality' or 'character' than the hitherto treated island groups of SE. Polynesia. This also appears from the genera of types 1, 1a, and 2, several of which are not found anywhere else in SE. Polynesia, as for example *Senecio* Comp. (affinity in S. America), *Eurya* Theac., *Plantago sect. Palaeopsyllium* Plant. (subantarctic affinity), and *Erigeron* Comp. (probably the same species as in Juan Fernandez). The same is found in type 7, which includes for example *Haloragis* Halor. and *Corokia* Sax.

All these remarkable finds come from the isolated island of Rapa and not from Tubuai. The number of genera restricted to Rapa amounts to not less than 21 = 17 %.

The generic spectrum of Rapa reminds one of that of Norfolk Island (see 16b). It makes the impression of an isolated focus in the S. Pacific showing a southern and Australian affinity because, though the number of

genera of type 6 is not particularly high, several genera of types 1 and 7 show Australian—New Zealand affinity.

The individuality of Rapa appears also in the very high specific endemism which amounts to c. 60 % according to F. B. H. Brown (1935). The only endemic genus is *Metatrophis* Morac.

There is also a rather marked Hawaiian influence, often with representatives also in the intervening Society and Marquesas Islands, for example *Lycium* Sol. (even the same species), *Apium* Umb., *Hedyotis sect. Oceanica* Rub., *Nesoluma* Sapot., *Astelia sect. Asteliopsis* Lil.

Generic spectra of Tubuai and Rapa contrasted

Types	**Tubuai** (Austral Is.) surface c. 260 sq.km		**Rapa** surface c. 40 sq.km	
	Number of genera	Percentage	Number of genera	Percentage
Type 1	52	61.2 %	49	51.6 %
Type 1a	—	—	5	5.3 %
Type 2	—	—	2	2.1 %
Type 3	—	—	—	—
Type 4	20	23.5 %	15	15.8 %
Type 5	1	1.2 %	—	—
Type 5a	2	2.3 %	—	—
Type 5b	—	—	2	2.1 %
Type 6	2	2.3 %	4	4.2 %
Type 7	1	1.2 %	6	6.3 %
Type 7a	—	—	—	—
Type 7b	2	2.3 %	2	2.1 %
Type 8	5	6.0 %	9	9.5 %
Type 8a	—	—	1	1.0 %
Type 9	—	—	—	—
Total	85	100.0 %	95	100.0 %

Conclusion: It seems, firstly, that both Rapa and Tubuai must be assigned to the Old World flora; secondly, that Tubuai and Rapa must be separated; thirdly, that with the low percentage of Malaysian genera and the relatively high percentages of Australian and Subantarctic affinity Rapa must be subordinated to the Australian—New Zealand flora.

The status of SE. Polynesia, including the Cook, Society, Marquesas, Tuamotu, and Tubuai Islands (minus Rapa), which are of similar character and should be treated as a whole, must be concluded from the survey on the next page.

From its spectrum it appears that the flora of the SE. Polynesian district is palaeotropical, depauperated Malaysian, sparsely sprinkled with the original Pacific element (types 8—8a), and with a negligible American element. Endemic genera in this district are: *Tahitia* Til. (Society Is.), *Cyrtandroidea*

Southeast Polynesia

Types	Number of genera		Percentage	
Type 1	120		50.4 %	
Type 1a	2		0.8 %	
Type 2	1		0.4 %	
Type 3	—		—	
Type 4	49		20.6 %	
Type 5	13		5.5 %	
Type 5a	11	27	4.7 %	11.5 %
Type 5b	3		1.3 %	
Type 6	3		1.3 %	
Type 7	2		0.8 %	
Type 7a	—		—	
Type 7b	2		0.8 %	
Type 8	24		10.0 %	
Type 8a	5		2.1 %	
Type 9	4		1.7 %	
Total	238		100.0 %	

Camp. (Marquesas), *Apetahia* Camp., *Sclerotheca* Camp., and *Fitchia* Comp. (in more than one group).

Brown (1935) came to the conclusion that the SE. Polynesian islands have a flora with a predominantly American facies, but I cannot agree with his argumentation.

12. Hawaiian Islands and some islets westward

155—180° W, 19—28° N; surface 15.000 sq.km; altitude 4100 m

Types	Number of genera		Percentage	
Type 1	111		46.7 %	
Type 1a	8		3.4 %	
Type 2	8		3.4 %	
Type 3	—		—	
Type 4	25		10.5 %	
Type 5	2		0.8 %	
Type 5a	2	32	0.8 %	13.3 %
Type 5b	—		—	
Type 6	3		1.2 %	
Type 7	5		2.1 %	
Type 7a	—	10	—	4.2 %
Type 7b	5		2.1 %	
Type 8	19		8.0 %	
Type 8a	43		18.1 %	
Type 9	7		3.0 %	
Total	238		100.1 %	

Discussion: Compared with island groups of similar size, for instance Fiji, the number of genera is rather small. But the number of endemic genera (type 8a) is exceptionally high, being 43 (Fiji 12).

Furthermore there are a number of genera which are very highly developed in Hawaii and are confined to the Central Pacific, sometimes reaching Melanesia.

Also the number of endemic species is extremely high; besides, the number of species per endemic genus is sometimes very high, up to c. 60 as e. g. in *Cyanea* Camp.

The affinity of the endemic genera is often obscure. Of the others it points to various directions, for example *Charpentiera* Amaranth. is with American affinity, *Brighamia* Camp. has Australian affinity, and *Haplostachys* Lab. has Asiatic-Malaysian affinity.

Some families or tribes are better developed in Hawaii than in any other similarly small part of the world, for example *Campanulaceae.*

In comparing the Old World (types 4—6) and the New World percentages (type 9) it is clear that the Old World element is preponderant, showing a proportion of 13.3 : 3.

Of the Pacific genera (type 8) 6 reach Malaysia in the west; among these 6 there are 2 which are confined to Malaysia and Hawaii, viz *Tetraplasandra* Aral. and *Tetramolopium* Comp.

There are also 6 Pacific genera reaching as fas as Australia; there is one genus confined to New Zealand and Hawaii, viz *Suttonia* Myrs.

Other Pacific genera reach westward only as far as Melanesia, for example *Lipochaeta* Comp. (New Hebrides and Loyalty Is.), *Pritchardia* Palm. (Fiji).

Only 2 Pacific genera reach America, viz *Pritchardia* Palm. and *Astelia sect. Asteliopsis* Lil. (Tierra del Fuego).

About 9 Pacific genera centering in Hawaii have a southward area to SE. Polynesia, for example *Nesoluma* Sapot. and *Bidens sect. Campylotheca* Comp.

For a group so far north, nearing the tropic of Cancer, the percentage of the subantarctic element (types 7—7b) amounting to 10 genera = 4.2 % is proportionally extremely high. We must bear in mind, of course, that most subantarctic genera are microtherm and that the greatest altitude in the Pacific is found in Hawaii. If the peaks in Fiji or Samoa would have been more lofty at present they would doubtless have harboured a much better representation of subantarctic genera. Therefore, the subantarctic type in Hawaii is to be considered as a relic of an element which was formerly more widely distributed over the Central Pacific islands. Such a condition is at present still found in New Guinea where the colossal highland area possesses a marked subantarctic element.

Conclusion: I consider Hawaii botanically making part of the palaeotropics. It deserves a high status, because of the large number and percentage of endemic genera, and the rather remarkably low percentage of American genera, which gives it a pronounced individuality, probably due to very ancient isolation.

	13. New Caledonia 19—23° S, 163—168° E; surface 23.200 sq.km; altitude 1600 m		Loyalty Islands 20—23° S, 169—170° E; surface 1300 sq.km; altitude 75 m	
Types	Number of genera	Percentage	Number of genera	Percentage
Type 1	223	33.8 %	122	47.5 %
Type 1a	8	1.2 %	4	1.5 %
Type 2	3	0.5 %	—	—
Type 3	—	—	—	—
Type 4	138	20.9 %	74	28.9 %
Type 5	26	4.0 %	7	2.7 %
Type 5a	14	2.1 %	2	0.8 %
Type 5b	18	2.7 %	4	1.5 %
Type 6	56	8.5 %	13	5.0 %
Type 7	9	1.3 %	4	1.5 %
Type 7a	1	0.2 %	1	0.4 %
Type 7b	3	0.5 %	2	0.8 %
Type 8	58	8.8 %	21	8.2 %
Type 8a	97	14.7 %	—	—
Type 9	6	0.9 %	3	1.2 %
Total	660	100.0 %	259	100.0 %

Discussion: In the above surveys I have contrasted the figures for New Caledonia and the adjacent Loyalty Islands. The list is undoubtedly incomplete for the Loyalties as no separate enumeration has been published for this group such as we possess for New Caledonia by Guillaumin (1948). Type 1 is better represented in the Loyalties, but this is always a larger figure conversely proportional to the size of the islands. The only significant difference is the slightly larger percentage of type 6 (Australia) in New Caledonia, type 4 (Old World) slightly higher in the Loyalties, and absence of endemic genera in the Loyalty Islands. The latter difference points to the desirability to subordinate the Loyalties to New Caledonia.

This is also emphasized by the fact that there are only 2 genera known from the Loyalty Islands, which do not occur in New Caledonia (*Lipochaeta* Comp. of Hawaii, and *Chariessa* Icac.).

Five genera are entirely restricted to New Caledonia and the Loyalties, viz *Phelline* Aquif., *Anisomallon* Icac., *Cyphokentia* Palm., *Cupaniopsis sect. Mizopetalum* Sapind., and *Oxera* Verb.

Further there are 5 other subendemic genera restricted to New Caledonia and New Hebrides, viz *Chambeyronia* Palm., *Cyclophyllum* Rub., *Alphandia* Euph., *Dizygotheca* Aral., and *Strobilopanax* Aral. (the latter two also in the Loyalties).

Conclusion: From the spectra and this discussion I feel that New

Caledonia and the Loyalty Islands cannot be separated and should be joined, as has been suggested in the past. In doing this we get the following combined survey:

13. New Caledonia, Isle of Pines, and Loyalty Islands

19—23° S, 163—170° E; surface 24.500 sq.km; altitude 1600 m

Types	Number of genera		Percentage	
Type 1	223		33.8 %	
Type 1a	8		1.2 %	
Type 2	3		0.5 %	
Type 3	—		—	
Type 4	138		20.8 %	
Type 5	26		3.9 %	
Type 5a	14	59	2.1 %	8.9 %
Type 5b	19		2.9 %	
Type 6	56		8.5 %	
Type 7	9		1.4 %	
Type 7a	1		0.2 %	
Type 7b	3		0.5 %	
Type 8	54		8.2 %	
Type 8a	102		15.4 %	
Type 9	6		0.9 %	
Total	662		100.2 %	

Discussion: In the first place it appears from types 4, 5—5b, and 6 that nearly 40 % of the flora is definitely Old World and only 0.9 % New World *).

But the plant-geographical subordination within the Old World is a difficult question as the Malaysian element (type 5—5b) of 8.9 % is only slightly larger than the Australian element (type 6) of 8.5 %.

If we approach this problem by calculating how many genera New Caledonia shares with Malaysia which do not or hardly occur in Australia against genera shared by New Caledonia and Australia which are not or hardly known from Malaysia, the figures are exactly equal, viz 58.

If we compare the number of genera strictly confined to New Caledonia and Australia with the number of genera strictly confined to New Caledonia and Malaysia, it appears that the former category is the larger one.

*) Even this small percentage, caused by 6 genera, contains most interesting records, viz *Desmanthus* Leg. (Central & South America, Galapagos, New Caledonia), *Leucaena*, Leg. (tropical America further from Tonga to New Caledonia and Solomons), *Epistephium* Orch. (S. America, New Caledonia), *Licania* Ros. (S. America, Loyalty, New Caledonia), *Lindenia* Rub. (Central America, Fiji, New Caledonia), and finally *Nicotiana* (Americas, Juan Fernandez, Marquesas, Tonga, New Caledonia, Loyalties, Lord Howe I., and Australia).

It is therefore impossible to include New Caledonia c. a. either in the Malaysian or in the Australian Province, and we conclude from this comparison that it should range as a province of its own.

This is in full agreement with the enormous development of endemic genera which is most surprising for the size of the island group, viz 102 = 15.4 %.

This is of the same order as has been found in East Malaysia and in West Malaysia, but both these areas have an immensely larger surface and reach much higher altitudes.

It is still more surprising that the endemic genera are partly not at all monotypic, but often have large numbers of species, sometimes up to 50.

Others are of a very distinct relict type or of remote affinity, as for example *Canacomyrica* Myric., *Oceanopapaver* Papav., etc.

As to degree of endemic development only Hawaii and Juan Fernandez are more or less comparable.

There are distinct relationships with New Guinea as shown for example by *Dubouzetia, Antholoma* Elaeoc., *Mooria* Myrt., and the taxonomically isolated *Sphenostemon* Aquif., but it should be added immediately that the latter genus has recently also been recorded from Queensland.

Similar relationships exist between New Caledonia and Australia, as shown for example by the distribution of *Canarium sect. Canariellum* Burs., *Callitris* Conif., *Argyrophyllum* Sax., and *Microsemma* Thym., which are confined to Australia and New Caledonia.

An interesting case is that of *Nothofagus subsect. Bipartitae* of which the living species are restricted to New Caledonia and New Guinea, but which is found (as Tertiary pollen) all over Australia.

There are a fair number of Pacific genera which are best developed in New Caledonia and the 8.2 % of Pacific genera is as high as that for Australia and for Malaysia; 17 of them are not found in either Australia or Malaysia.

Further there are an astonishing number of genera which have a rich autochthonous speciation; they belong to several types, to mention a few examples: *Psychotria* Rub., *Phyllanthus* Euph., *Chrysophyllum* Sapot. of type 1, *Styphelia* Epacr. of type 6, *Bubbia* Wint. of type 5b, *Pittosporum* Pitt. of type 4.

Conclusion: All these aspects lead to one conclusion, viz that New Caledonia is a focus of specific and generic development deserving a status of its own in the West Pacific, with strong affinities to Australia, Malaysia, and the Pacific, that is, in all directions.

14. Tasmania

No generic spectrum of this island has been made, but I want to verify roughly in how far it is true that it should be included in the Australian floral province.

There are at least 367 autochthonous genera, according to the Flora by Rodway (1903) of which 342 also occur in Australia = 93.2 %. The

endemism is still rather high, viz at least 13 genera = 3.5 %. A large number of genera are restricted to Tasmania and Australia.

I conclude therefore that Tasmania belongs to the Australian Province as a distinct subdivision.

15. New Zealand

34—47° S, 166—178° E; surface 265.000 sq.km; altitude 3750 m

Types	Number of genera		Percentage	
Type 1	90		26.8 %	
Type 1a	32		9.6 %	
Type 2	12		3.6 %	
Type 3	—		—	
Type 4	21		6.2 %	
Type 5	2	7	0.6 %	2.1 %
Type 5a	—		—	
Type 5b	5		1.5 %	
Type 6	50		14.9 %	
Type 7	49		14.6 %	
Type 7a	7		2.1 %	
Type 7b	9		2.7 %	
Type 8	23		6.8 %	
Type 8a	31		9.2 %	
Type 9	5		1.5 %	
Total	336		100.1 %	

Discussion: Although New Zealand is often not included in the Pacific Islands it must be taken up in this survey in order to fix its status.

Its generic spectrum shows a marked decrease in tropical genera which is in accordance with its latitude. Conversely there are a large number of temperate ones from types 1a, 2, 7—7b, in all 108 genera or 32.2 % of the total flora.

A remarkable feature is the occurrence of northern temperate genera which in the southern hemisphere are confined to New Zealand (some of these also in Australia). It is most likely that these genera have reached New Zealand through Malaysia-Australia — or have wandered vice versa — for example *Euphrasia* Scroph. (the area of which extends further to Tierra del Fuego and Juan Fernandez). Other examples are *Epilobium* Onagr. and *Potentilla* Ros., which are of the same type. The presence of some of these genera in the high mountains of Malaysia point in this direction.

In contrast to the hitherto considered island groups the Malaysian element is weak, viz 2.1 %. There are several genera which Malaysia has in common with New Zealand (in types 7 and 8), but most of these are foreign elements in Malaysia and of southern origin.

It is clear that the main affinity of the New Zealand genera is with Australia and Tasmania (type 6), c. 15 %.

New Zealand shares 271 genera or 80 % of the total with Australia and Tasmania. Of these 27 are restricted to Australia and/or Tasmania and New Zealand.

The next closest affinity is with temperate South America with which it has in common 176 genera = 52 %. In addition 8 genera are restricted to New Zealand and South America and do not occur in the Old World (mainly Australia and Tasmania).

A remarkable feature is the occurrence in New Zealand of some genera which are otherwise known mainly from South Africa (type 7a) and sometimes also from Australia, viz *Lobelia sect. Mezliera* Camp., *Sebaea* Gent., *Pelargonium* Geran., *Bulbinella* Lil., *Australina* Urtic., and *Cassinia, Helichysum* Comp. The endemic genus *Entelea* Til. belongs in this group as its closest allies are South African.

The number of endemic genera is fairly large, 31 genera = 9.2 %.

Conclusion: It may be stated that the generic spectrum and further considerations lead inevitably to refer the New Zealand flora to the Old World flora as a distinct Subprovince of the Australian Region.

15a. The subantarctic islands south of New Zealand

Incidentally a short survey is inserted on these islands in the New Zealand area. They show the following generic spectrum:

Auckland, Macquaries, Bounty, Antipodes, Campbell, and Chatham I.

43—55° S, 159° E to 176° W; surface 2300 sq.km; altitude 550 m

Types	Number of genera	Percentage
Type 1	23	22.8 %
Type 1a	19	18.8 %
Type 2	5	5.0 %
Type 3	—	—
Type 4	—	—
Type 5	—	—
Type 5a	—	—
Type 5b	1	1.0 %
Type 6	15	14.8 %
Type 7	23	22.8 %
Type 7a	3	3.0 %
Type 7b	7	6.9 %
Type 8	2	2.0 %
Type 8a	3	3.0 %
Type 9	—	—
Total	101	100.1 %

Discussion: As might be expected from their latitude the percentage of the subantarctic element (types 7—7b) is very high. The Malaysian element (type 5b) is only represented by *Corybas* Orch.

The endemic genera are *Myosotidium* Borr., *Pleurophyllum* Comp., and *Stilbocarpa* Aral.

Although most of the genera are also known from New Zealand the presence of three endemic genera induces us to give it the status of a District of the New Zealand Subprovince.

16. Lord Howe, Norfolk, and Kermadec Islands

16a. Lord Howe I.	16b. Norfolk I.	16c. Kermadec Group
32° S, 159° E; surface 13 sq.km; altitude 750 m	20° S, 168° E; surface 40 sq.km; altitude 310 m	29—32° S, 179° W; surface 34 sq.km; altitude 520 m

Types	Number of genera	Percentage	Number of genera	Percentage	Number of genera	Percentage
Type 1	54	43.0 %	40	38.5 %	30	47.7 %
Type 1a	5	4.0 %	5	4.8 %	6	9.5 %
Type 2	—	—	3	2.9 %	—	—
Type 3	—	—	—	—	—	—
Type 4	24	19.0 %	21	20.2 %	3	4.7 %
Type 5	—	—	2	1.9 %	—	—
Type 5a	—	—	—	—	—	—
Type 5b	4	3.2 %	3	2.9 %	1	1.6 %
Type 6	14	11.1 %	10	9.6 %	8	12.7 %
Type 7	7	5.5 %	7	6.7 %	6	9.5 %
Type 7a	1	0.8 %	—	—	—	—
Type 7b	5	4.0 %	3	2.9 %	5	7.9 %
Type 8	6	4.8 %	8	7.7 %	3	4.8 %
Type 8a	4	3.2 %	1	1.0 %	—	—
Type 9	2	1.6 %	1	1.0 %	1	1.6 %
Total	126	100.0 %	104	99.9 %	63	100.0 %

Discussion: The number of genera of these islands is of course small, but the percentages in the spectra agree rather well with those of New Zealand although the palaeotropical element (type 4) is stronger, except in Kermadec. The latter island group had better be subordinated under New Zealand; it has only 3 genera which do not occur in New Zealand and there are no endemic genera. The islands must all be assigned to the Australian Region on account of their large number of genera of type 6.

Pacific genera (type 8) are very few and are all of New Zealand origin.

Among the three groups *Lord Howe* has the best expressed individuality; though it is nearest to Australia (500 km), and is the smallest of the

three, it possesses 4 endemic genera (3 palms: *Howea, Hedyscepe,* and *Lepidorachis,* and *Negria* Gesn.). One genus is restricted to Lord Howe I. and New Zealand, viz *Carmichaelia* Leg. and further the endemic genus *Negria* Gesn. is allied to the New Zealand genus *Rhabdothamnus.*

Lord Howe shares with Australia the genus *Westringia* Lab. and a section of *Dianella,* viz the group *Caerulea* Lil. Taking into consideration the much larger distance between Lord Howe and New Zealand than between it and Australia with its immensely rich stock of plants, the affinities with New Zealand become significant.

A peculiar phenomenon is the occurrence of *Moraea* Irid. which is otherwise only known from South Africa. A similar representation of the S. African element (type 7a) has been found in New Zealand.

Norfolk I. has far less individuality than Lord Howe I. and also less genera, but there is still one endemic genus, *Streblorrhiza* Leg. The spectrum of the types shows a great similarity to that of Rapa. See Survey 11e.

Kermadec is closely related to New Zealand; it has no endemic genera.

Conclusion: We may say that all three groups, and also Rapa, belong to the Australian Region, within which they show the greatest affinity to the New Zealand District. Kermadec belongs to the New Zealand Subdistrict, whereas Norfolk, Lord Howe, and Rapa form Subdistricts of their own.

17. Easter Island

27° S, 109° W; surface 117 sq.km; altitude 600 m

Types	Number of genera	Percentage
Type 1	16	61.5 %
Type 1a	6	23.0 %
Type 2	—	—
Type 3	—	—
Type 4	—	—
Type 5	—	—
Type 5a	—	—
Type 5b	—	—
Type 6	1	3.8 %
Type 7	—	—
Type 7a	—	—
Type 7b	2	7.7 %
Type 8	—	—
Type 8a	—	—
Type 9	1	3.8 %
Total	26	99.9 %

Discussion: The flora of Easter I. is so poor that its character is difficult to define. Probably the flora has been depauperated through the action of ancient inhabitants, and has in historic time still more been devastated by herbivores.

Against one American genus (*Axonopus* Gram.) also one Australian genus (*Dichelachne* Gram.) is found.

In order to make a more detailed analysis I have compared the affinities of the species within the genera. Of a number of these species nothing can be said in this respect, but of those which are positive the proportion is 10 allied to Asiatic or (mostly) Australian species and 4 to American species.

Conclusion: If it should be subordinated it should form an appendix to the Australian Province, classified here as a Subdistrict.

18. Juan Fernandez group

34° S, 79—81° W; surface 140 sq.km; altitude 1600 m

Types	Number of genera		Percentage	
Type 1	25		27.8 %	
Type 1a	13		14.4 %	
Type 2	3		3.3 %	
Type 3	—		—	
Type 4	—		—	
Type 5	—		—	
Type 5a	—		—	
Type 5b	—		—	
Type 6	—		—	
Type 7	10		11.1 %	
Type 7a	—	15	—	16.7 %
Type 7b	5		5.6 %	
Type 8	1		1.1 %	
Type 8a	17		18.9 %	
Type 9	16		17.8 %	
Total	90		100.0 %	

Discussion: The number of genera is not particularly large but of distinct interest owing to the extremely high percentage of endemic genera which give it a prominent degree of individuality.

Taxonomically these belong to the following families: *Borraginaceae* 1,

Bromeliaceae 1, *Compositae* 9, *Gramineae* 2, *Labiatae* 1, *Lactoridaceae* 1, *Myrtaceae* 1, *Palmae* 1. The family *Lactoridaceae,* consisting of a single species, is confined to this group.

Among the endemic genera there are 2 *Compositae,* viz *Robinsonia* and *Rhetinodendron,* which are closest allied to the Papuan genus *Brachionostylum.*

The strongest affinity is with South America, especially ifs antarctic portion.

There is a large proportion of subantarctic genera (types 7—7b), viz 16.7 %, all of which are also found in New Zealand. Among these, two genera do not occur in South America, viz *Haloragis* Halor. and *Coprosma* Rub., although the distance between the group and the mainland of America is only 600 km.

The single representative of group 8 is *Santalum* Sant., which does not occur in South America. This genus is particularly well developed in Hawaii.

It seems that the Juan Fernandez group is an old marginal refuge or exile of an ancient South Pacific flora, showing scattered remains of remote affinity. Through the generic spectrum it should floristically be subordinated to the South American Region.

19. San Ambrosio and San Felix (Desventuradas)

26° S, 80° W; surface 5 sq.km; altitude 400 m

Types	Number of genera	Percentage
Type 1	8	47.0 %
Type 1a	2	11.8 %
Type 2	—	—
Type 3	—	—
Type 4	—	—
Type 5	—	—
Type 5a	—	—
Type 5b	—	—
Type 6	—	—
Type 7	—	—
Type 7a	—	—
Type 7b	1	5.8 %
Type 8	—	—
Type 8a	3	17.7 %
Type 9	3	17.7 %
Total	17	100.0 %

Discussion: Against the situation found in Easter Island there are here 3 American genera (*Sicyos* Cuc., *Cristaria* Malv., *Plantago sect. Novorbis* Plant.) and no Pacific or Old World genera represented.

There are 3 endemic genera, which is quite surprising for such small islands, viz *Nesocaryum* Borr. (affinity pointing to tropical America), *Lycapsus* Comp. (no direct affinity), and *Thamnoseris* Comp. (probable affinity with *Dendroseris* of Juan Fernandez).

There are no wider dispersed Pacific genera represented (type 8).

Conclusion: Though small and poor, the flora of San Ambrosio should be subordinated to that of the South American Region. Its character approaches that of Juan Fernandez with which it could form one district.

20. Galápagos Islands

1° N—2° S, 89—93° W;
surface 5400 sq.km; altitude 1400 m

Types	Number of genera	Percentage	
Type 1	98	54.9 %	
Type 1a	2	1.1 %	*Apium* Umb., *Lycium* Sol.
Type 2	1	0.6 %	*Erigeron* Comp.
Type 3	—	—	
Type 4	1	0.6 %	*Chrysanthellum* Comp.
Type 5	1	0.6 %	*Odontochilus* Orch.
Type 5a	—	—	
Type 5b	—	—	
Type 6	—	—	
Type 7	1	0.6 %	*Pernettya* Eric.
Type 7a	—	—	
Type 7b	—	—	
Type 8	1	0.6 %	*Lipochaeta* Comp.
Type 8a	2	1.1 %	
Type 9	71	40.0 %	
Total	178	100.1 %	

Discussion: Though the Galápagos Islands are over 1000 km off the American coast the floristic spectrum indicates an extremely strong American element in their flora (type 9) amounting to 40 % of all the genera represented.

On the other hand the number of endemic genera is surprisingly low, namely only 2: *Scalesia* and *Lecocarpus*, both Comp.

In remarkable contrast with this stands the enormous number of endemic species of certain widely dispersed genera, for instance in the *Amaranthaceae*.

It is also remarkable that 5 types are not represented and five others only by one genus; the names of the genera have been mentioned in the spectrum.

Relations with the other Pacific islands are very weak, being only expressed in the occurrence of *Lipochaeta* Comp., which is obviously representative of the Hawaiian element in the flora.

Further there are a great number of the genera of type 1 which in the Pacific only occur in the Galápagos Islands.

There is a very sharp contrast between Galápagos on one side and all other Pacific islands on the other by the predominant tropical-American element. The only other island group where a high percentage of the American element is found is Juan Fernandez, but in the latter group this goes together with some other affinities (Subantarctic, Papuan, Pacific, etc.), which is not the case in the Galápagos.

Conclusion: The only conclusion can be that the flora of Galápagos is part of that of the Neotropical Region.

Summary

(1) The accompanying map illustrates the hierarchy of the floristic subdivision of the Malaysian-Pacific area and its demarcation against the New World flora. The way of linking it with the mainland of Eastern Asia has not been worked out. Further it has not been attempted to subdivide the Australian flora including Tasmania.

The following names are proposed:

Region	Province	Subprovince	District	Subdistrict
Indo-Malaysian	E. Asiatic			
	SE. Asiatic			
	Malaysian	W. Malaysian		
		S. Malaysian		
		E. Malaysian.....		E. Malaysian s.str. (incl. also Bismarcks)
				W. Carolines & Palau
				E. Carolines
				Marianas
				Solomons
		SW. Pacific		New Hebrides
				Fiji
				Samoa & Tonga
		.....		Central Pacific
		.....		SE. Polynesia
	Hawaiian			
New Caledonian		Australia & Tasmania		
Australian				New Zealand, incl. also Kermadec
		New Zealand c.a.		Chatham, Auckland, Antipodes, Campbell, Bounty and Macquaries
				Lord Howe I.
				Norfolk I.
				Rapa
				..... Easter I.

(2) As has appeared from the surveys the number of endemic genera pro subdivision cannot be placed in any proportion to the surface of that subdivision; this appears for example from the following figures:

Name of area	maximum altitude in m	surface in sq.km	number of genera	endemic genera	percentage
Malaysia s.str.	5050	3.013.000	2178	c. 500	c. 23.0 %
Bonin	320	80	175	3	1.7 %
Marianas	400	640	217	1	0.5 %
West Carolines	240	600	345	1	0.3 %
East Carolines	790	700	235	1	0.4 %
Bismarcks	2400	50.000	514	1	0.2 %
Solomons	2700	42.500	431	3	0.7 %
New Hebrides	1800	15.000	371	2	0.5 %
Fiji	1300	18.500	449	12	2.7 %
Samoa & Tonga	1820	4.500	357	2	0.6 %
Central Pacific	5	1.000	69	—	—
Southeast Polynesia	2200	c. 4.500	238	5	2.1 %
Hawaii	4100	15.000	238	43	18.1 %
New Caledonia & the Loyalties	1600	24.500	662	102	15.4 %
New Zealand & Kermadec I.	3750	265.000	339	31	9.1 %
Chatham, Auckland, Antipodes, Campbell, Bounty & Macqaries	550	2.300	101	3	3.0 %
Lord Howe I.	750	13	126	4	3.2 %
Norfolk I.	310	40	104	1	1.0 %
Rapa	660	40	95	1	1.0 %
Easter I.	600	117	26	—	—
San Ambrosio	400	5	17	3	17.7 %
Juan Fernandez	1600	140	90	17	18.9 %
Galapagos	1400	5.400	178	2	1.1 %

(3) If two islands are comparable ecologically (latitude, altitude, climate, soils) and are at comparable distance from a continental flora or other big plant source, the island with the smallest surface has the largest percentage of world-wide genera (type 1). This appears from a comparison of Samoa (43 %) with Tonga (50 %), and Tonga with Cook I. (61.6 %).

(4) The highest percentage of worldwides is found in the coral islets and atolls.

(5) For ecologically more or less comparable islands the rule seems to be that the distance to a continental flora or other rich plant source and the total number of genera are inversely proportional. For example

Lord Howe I. (surface 13 sq.km) at a distance of 500 km from Australia has 126 genera and Norfolk I. (surface 40 sq.km) at a distance of 1600 km from Australia has only 103 genera, even though it is thrice as large as Lord Howe I.

(6) Generic endemism and specific endemism often do not go parallel. The Galápagos, Marquesas, New Hebrides, and Rapa I. have a high specific endemism, but possess very few endemic genera.

(7) *a.* In the Pacific the Malaysian influence reaches in general wide and far.

b. The Australian influence in the Pacific is proportionally small and affects mostly the southern Pacific.

c. The influence of the American flora is surprisingly small, even in islands which are situated relatively very close to the New World if compared with their distance to the Old World, for example the Marquesas, Easter I., etc.

d. If the South American element is found far in the Pacific it is almost restricted to the subantarctic part of it.

(8) The method of the demarcation knots is only useful if islands or island groups are contrasted which have a comparably rich flora, containing a number of genera of about the same order, for example Formosa and the Philippines, Malaysia and Australia, the Solomons and the New Hebrides (the latter with respectively 431 and 371 genera : demarcation 60 %).

If the areas are very dissimilar in number of genera the method of demarcation knots will result in a wrong picture of the situation.

In the latter case the approach for the estimate should be made in another way, for example by focussing attention to the number of genera which occur in the poorest of the pair and not in the richest.

An illustrative example of this is a comparison between New Caledonia and the Loyalty Islands, where the demarcation knot would be 61 % on account of the very high number of New Caledonian genera which do not occur in the Loyalties. Actually, only 2 genera occur in the Loyalties which have not been recorded from New Caledonia, showing that the Loyalty Islands flora is merely a depauperated New Caledonian one.

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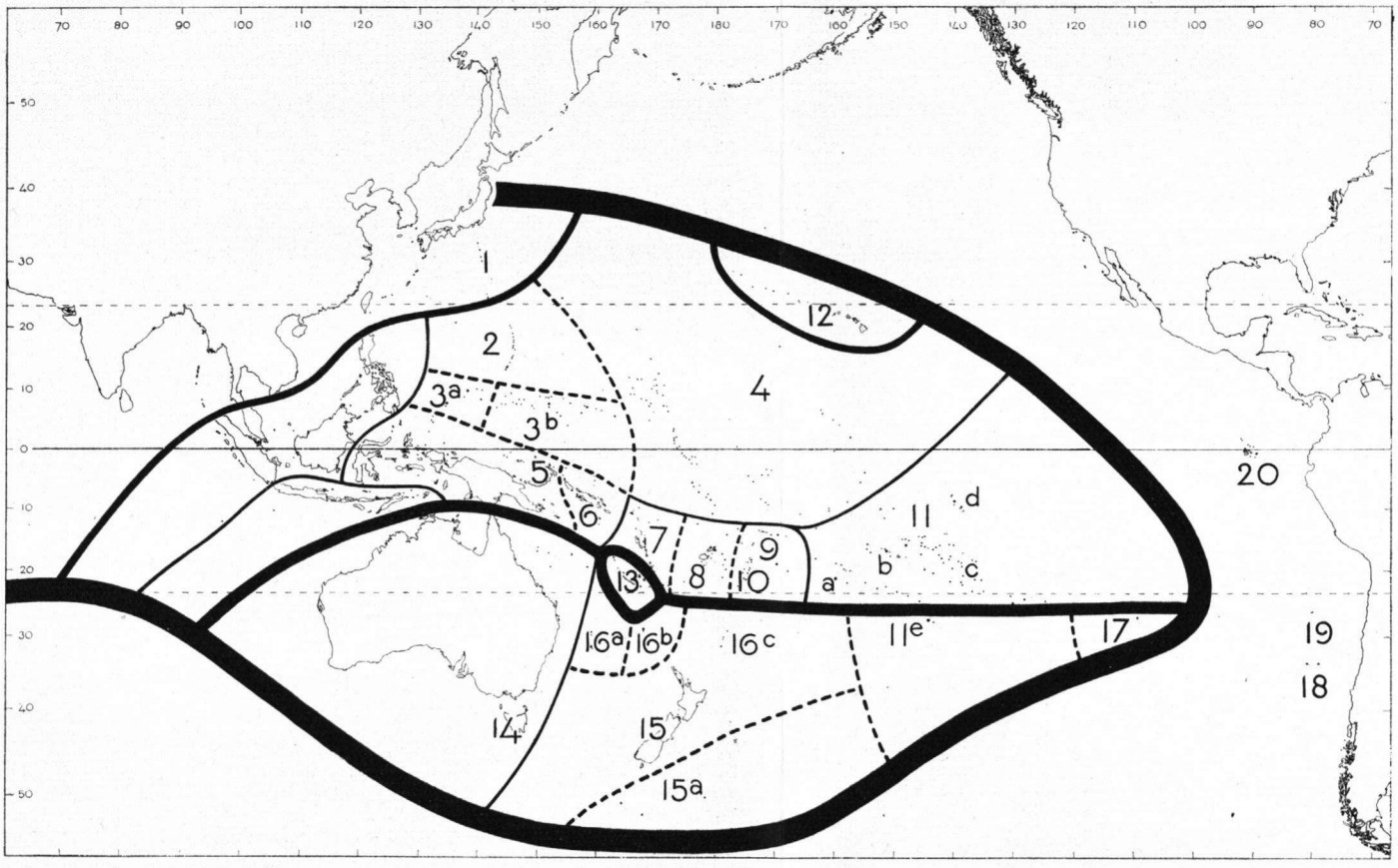

Map 1. Delimitation and subdivisions of the Eastern Old World flora. The numbers (and subordinated letters) merely refer to the sequence of the areas and subareas as treated in the text.

The relative thickness of the lines refers to the floristic, plant-geographic hierarchy of the Regions, Provinces, Subprovinces, and Districts, in that sequence, as distinguished and tabulated in the summary.