NOTES ON THE HISTORICAL PHYTOGEOGRAPHY OF CELEBES

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CONTENTS

1. INTRODUCTORY REMARKS.

In one of his papers on Malaysian Orchids R. Schlechter (1911) expresses his surprise that the flora of Celebes, though promising so much from a phytogeographical point of view, is very little known in comparison with that of the Philippines and Java and even with that of Borneo. In 1926 E. D. Merrill repeated this assumption with little less emphasis, and it is, indeed, still holding good even nowadays. I am not able to tell the reason why Celebes has been so much neglected in this respect, though it has been given ample attention by zoogeographers.

Yet, botanical exploration has been carried out ever since the French scientific world cruises of the "Astrolabe" (1828) and the "Astrolabe" and the "Zélée" (1839). The more important collections have been enumerated in the "Appendix" to the present paper and among these the most outstanding ones are those made by the Neth.-Indian Forestry Service and by such individual collectors as Forsten (1840, N), Zollinger (1847, SW and Salajar), Teysmann and De Vriese (1860, N), Teysmann (1877, SW and Salajar), Warburg (1888, SW), Koorders (1894—'95, N), P. and F. Sarasin (1893—'96 and 1902—'03, all parts), Elbert (1909, SE), Schlechter (1910, N), Van Vuuren (1912—'14, SW, C, SE), Docters van Leeuwen (1913, Salajar, etc.), Kaudern (1917—'20, SE, C, E, N), Bünnemeijer (1921, SW), Lam (1926, Talaud), Kjellberg (1929—'30, SW, SE), Eyma (1938, C, E) and Monod de Froideville (1937—'39, SW, C, SE).

Of these collections only two or three were actually intended to contribute materials towards our phytogeographical knowledge of the island. Two of the explorations, viz. those made by Elbert and Van Vuuren were carried out in order to check parts of Wallace's Line; a third (Lam) intended to check the Philippines-Moluccas-New Guinea migration track.

How important an island Celebes is to the phytogeography of Malaysia is, for one thing, shown by the instructive map of the three main migration

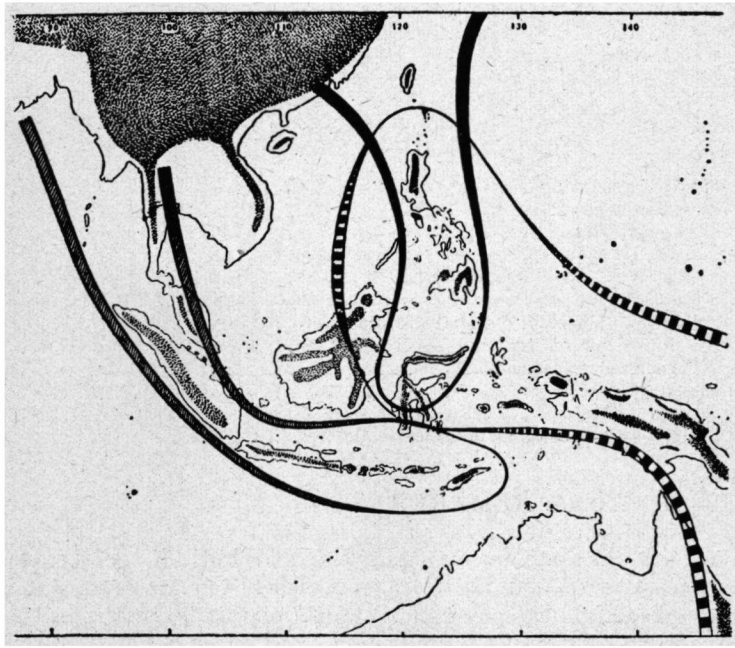

Fig. 1 — Three main migration tracks for mountain plants as conceived by Van Steenis (1934), the western part of the New Guinea track modified according to the paper of 1935. In 1938 another correction was added, by which the Philippine track was extended southward so as to include the whole of S.W. Celebes.

tracks for mountain plants (*Fig. 1*), published by Van Steenis (1934[1])). It is also evidenced by the situation of the island relative to Wallace's Line. In fact, the most trustworthy, or should we rather say, the least dubious part of that historically famous line of demarcation is the Straits of Macassar between Celebes and Borneo, and until recently most biogeographers — and geologists — considered it an almost absolute or at least

[1]) Cf. also Van Steenis 1938 (p. 732) where a correction is given to the New Guinea track so as to include N. Sumatra. This is, however, irrelevant to our present problem; neither is this likely to be the ultimate correction. The Philippine track has been extended southward so as to include the whole of the SW. Peninsula. This agrees, as will be shown underneath, with our results.

a most paramount barrier to migrations of plants and animals between the West and the East since early Tertiary times. However, it has been shown by the Sarasin's, Merrill, Hallier, Rensch, Lam and others that this barrier must have been outflanked both in the North (Borneo-Philippines-N. Celebes connection) and in the South (Java- and Flores-bridges).

In fact, one of the primary results of the extensive explorations of the Sarasin's was the assumption of four land-connections. The materials collected by them of Molluscs, Amphibians, Reptilians and Birds could be arranged into five area-categories, one containing the large or concentric areas as well as the doubtful cases, and four which were also checked geologically, suggesting migration tracks to Celebes each from a different direction. Their procentual proportions were:

a.	large areas and doubtful cases	25.6 %
b.	Java-bridge (Madoera-Kangean-SW. Celebes)	28.3 %
c.	Philippine-bridge (Mindanao-Sangihe-N. Celebes)	21.9 %
d.	Flores-bridge (Kalao-Djampea-Salajar-SW. Celebes)	15.3 %
e.	Moluccan bridge (Boeroe-Soela-E. Celebes)	8.9 %
		100 %

The proportion West ($b + c + > \frac{1}{2} a$) : East ($d + e + < \frac{1}{2} a$) is therefore at least 50.2 : 24.2 or 67.5 % : 32.5 %.

The conclusion was that Celebes possesses an old and more or less impoverished fauna (a statement already made in 1894 by Max Weber on account of his study on Fishes), subsequently enriched by younger infiltrations from different sources and directions. According to the Sarasin's Borneo and Celebes should never have been connected directly: no single species was known from Borneo and Celebes only.

These views were, in general, supported by the subsequent geological investigations by Abendanon who, however, accepts a direct Borneo-Celebes connection in the Oligocene period. According to him Celebes consisted during most of the Tertiary of a large northern island and a small southern one (SW. Celebes). Sarasin's Java-, Flores- and Philippine-bridges are, geologically speaking, not impossible but the latter is decidedly younger than the Sarasin's conceived, viz. of Plio-Plistocene age. The connection of SW. and C. Celebes is extremely recent (youngest Plistocene) and was only established after the Java- and Flores-bridges had been cut. As to the Moluccan bridge, this is considered doubtful since the connection E. Celebes-Banggaai was already interrupted in the Miocene period. However, it must be added here, that the bathymetrical chart (cf. *Fig. 2*) made by the "Snellius Expedition" of 1929—'30 (Vol. II, Part. 2, Chapter II, P. M. van Riel, The bottom configuration, etc., 1934) shows a continuous submarine ridge connecting E. Celebes with New Guinea, which, except in one place (between Mangoli and Obimajor, less than 2000 m) is less than 1000 m below sea level. This suggests a possible former connection and, as will be shown underneath, this is also more in accordance with our present phytogeographical views.

In his book on the (zoogeographical) history of the Sunda Arch, Rensch (l. c., p. 252) calculated that the Celebes fauna as far as con-

sidered by him consists of 75 % western genera, 25 non-western (viz. 13 % "Wallacean[1])" and 12 % eastern). The same author (p. 268) accepts a SW. Celebes-E. Java connection and, after this had been severed, a SW. Celebes-Lombok connection. The first-named connection should also geologically be justified (Van Es and Umbgrove in Rensch, l. c., p. 278).

Phytogeographical studies generally supported the results obtained by the Sarasin's and Rensch for the fauna, though the state of our knowledge of the flora as well as the different nature of the material does not allow so far-reaching and detailed conclusions as the fauna was able to procure.

While Hallier and Warburg stipulated the SW. Celebes connections on account of plant areas (SE. Celebes is a "cul de sac"), Merrill did the same concerning the northern part. In his important study of 1923 he calculated that the Philippines harbour more eastern species than Borneo and more western ones than Celebes, further that of 365 Sundaland genera which are not known east of Wallace's Line, 218 or 61 % are found in the Philippines and that the reciprocal figures for eastern genera are 225, 56 and 25 %. These are the principal reasons why Lam (1938) suggested that the migration track between the Sundaland and the East runs through N. Borneo, Mindanao and N. Celebes to E. Celebes and the Moluccas. In addition, Holthuis and Lam showed in 1942 the importance of the Philippine-Talaud-Moluccas-New Guinea track (following the so-called "Snellius ridge", discovered by the Snellius Expedition) in which N. Celebes in many instances seems to have participated. They stated that of 160 Talaud species which are of some value in this respect, 110 or almost 69 % possess an area along this track.

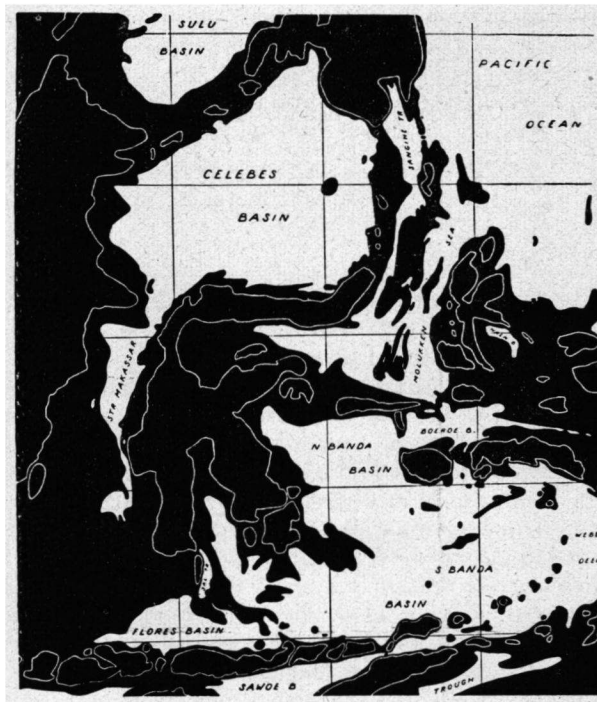

Fig. 2 — Bottom configuration at a depth of 2000 m (according to Van Riel, Snellius Expedition).

[1]) "Wallacea" is the name of the unstable part of Malaysia between the Sunda- and the Sahul-sholves (cf. Merrill, 1923).

Several authors, e.g. the Sarasin's, have alluded to the fact that certain parts of the island show a fauna and flora different from those of others. More particularly a difference was stated between N. and SW. Celebes. It is true that separate families may lead to quite different results — the Orchids, for instance, show little regional differentiation — but we can avoid an undesirable one-sidedness by basing our conclusions upon an impartial selection from the flora, collecting our data from as many natural orders as possible. If this is done, there is undoubtedly a marked floristic difference, notably between N and SW. This may be partly due to a former disconnection between SW. Celebes and the rest of the island, partly to former infiltrations along the various bridges mentioned.

In how far these relations may be interpreted statistically will be discussed underneath, together with some other current problems, such as a possible direct connection between Borneo and Celebes and another between the Moluccas and Talaud, and Celebes.

2. OWN INVESTIGATIONS.

A. THE MATERIAL.

The immediate inducement to the following considerations was twofold: firstly the elaboration of the collection made by Mr. Monod de Froideville and presented to the "Rijksherbarium" in 1943 (v. Blumea V, n. 3, 1945, p. 554—599) and secondly the preparation of a paper on the vegetation and the flora of Celebes on behalf of a monograph of the island to be edited by the "Indisch Instituut" at Amsterdam.

On behalf of this work I prepared lists of carefully checked species and other groups with their distribution. These were borrowed from various sources. As far as the Orchids were concerned, I had the great privilege to obtain the collaboration of Dr J. J. Smith, who checked the areas of all Celebes species known at present (401 in all) and kindly put the results at my disposal. Pteridophytes were partly taken from Posthumus's paper on the Pteridophyta of the Elbert expedition (cf. Literature). The other plants were mostly borrowed from the numerous local monographs, published in the last twenty or twenty-five years in the "Bulletin du Jardin botanique de Buitenzorg" and in "Blumea". Others were taken from other sources but the utmost care was given to secure trustworthy data both systematically and geographically.

Only adequate areas were selected, in this sense that areas which, relative to Celebes, are either wide or concentric or endemic with unknown or concentric relationship, were ignored, with the result that of an original number of more than 1000 only 734, perhaps about one tenth of the actual number of higher plants, were left. Of these 31 were Pteridophytes and 263 Orchids, the other 440 are miscellaneous Phanerogams. The reason why Pteridophytes and Orchids were kept apart from other Phanerogams was that both of the two first-named groups are dispersed by wind; moreover, the Orchids possess the peculiar root fungus symbiosis which can hardly fail to have some bearing upon the dispersal of the species.

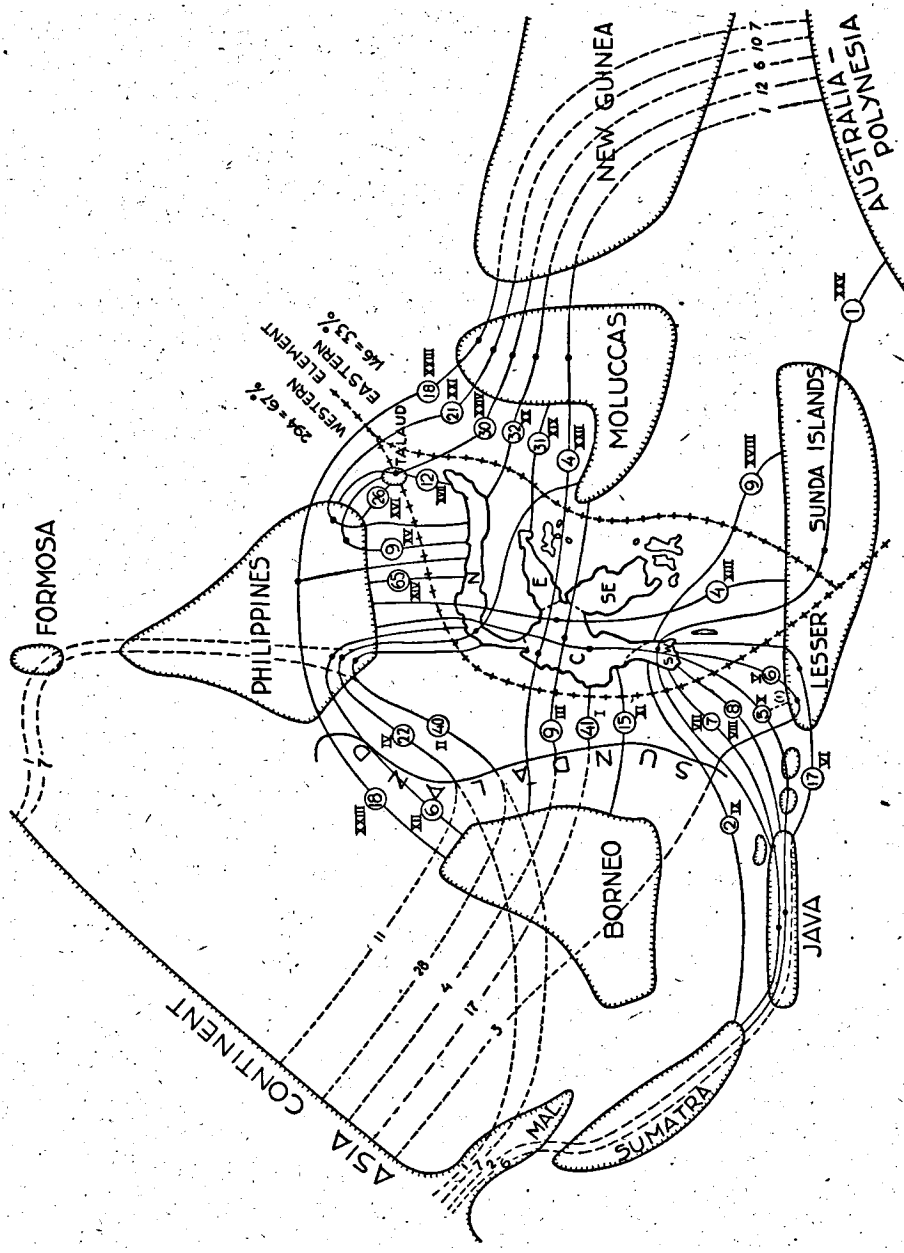

Fig. 3 — Phytogeographical map of Celebes and surrounding islands, based on the areas of 440 Phanerogams. I—XXV, Area categories of Table I (see there). Numbers in circles: numbers of species belonging to the area category, indicated by a continuous line. Connections and black dots always represent the whole island or region, not the part only in which they happen to be placed on the map.

B. AREA CATEGORIES.

On behalf of a phytogeographical subdivision of this material, 25 area categories were accepted, in which the species of the three groups participate as is shown in *Table I*. These categories, which are further illustrated by *Fig. 3*, are based upon actual areas or, in the case of endemics, on relationships.

TABLE I (cf. *Fig. 3*)

A. Western centre (→ also occurring in continental Asia; ⇉ one connection Philippines – N. Celebes, another E. Java – S.W. Celebes; Sundaland = Brit. Malaya + Sumatra + Java + Borneo + Palawan, or the greater part of it).

	Pteridoph.	Orchids	Other Phanerog	Total
I (→) Sundaland–Celebes	4	43 (4 →)	41 (17 →)	88 (21 →)
II (→) Sundaland–Philippines–Celebes	6	10 (6 →)	40 (21 → 7 ⇉)	56 (27 → 7 ⇉)
III (→) Sundaland–Celebes–Moluccas	—	4 (1 →)	9 (4 →)	13 (5 →)
IV (→) Sundaland–Philippines–Celebes–Moluccas	4	2	22 (11 → 1 ⇉)	28 (11 → 1 ⇉)
V (→) Sundaland–Lesser Sunda Islands–Celebes [1]) 1 also in Moluccas	2 [1])	3	6 (3 →)	10 (3 →)
VI (→) Java–Lesser Sunda Islands–Celebes	—	2	17 (6 →)	19 (6 →)
VII (→) Sumatra–Java–Celebes	2	32 (16 →)	7	41 (16 →)
VIII Java–Celebes	2	27	8	37
IX (→) Sumatra–Celebes	—	7 (1 →)	2	9 (1 →)
X (→) Sumatra–Java–Celebes–Philippines * — Lesser Sunda Islands)	1 (1*)	2 (1*)	5 (2 →) (1*)	8 (2 →) (3*)
XI Borneo–Celebes	—	8	15	23

	Pteridoph.	Orchids	Other Phanerog.	Total
XII Borneo–Philippines–Celebes	1	—	6	8
Totals A	22	140 (28 →)	178 (64 →, 8 ⇉)	340 (92 →, 8 ⇉)
B. Northern Centre.				
XIII Philippines–Celebes–Lesser Sunda Islands	—	—	4	4
XIV Philippines–Celebes	1	21	65	87
XV Philippines–Talaud and Celebes	—	—	9	9
XVI Philippines–Talaud	1	—	26	27
XVII Talaud–Celebes	—	1	12	13
Totals B	2	22	116	140
C. Eastern Centre (← also in Australia and/or Polynesia).				
XVIII Lesser Sunda Islands–Celebes [1]) also in Polynesia	1 [1])	4	9	14
XIX Moluccas–Celebes [1]) 1 also in Borneo	—	28 [1])	31	59
XX New Guinea–(Moluccas–)Celebes (←)	1	58 (1 ←)	32 (12 ←)	91 (13 ←)
XXI New Guinea–Moluccas–Philippines–Celebes (←)	—	2	21 (10 ←)	23 (10 ←)
XXII New Guinea–Moluccas–Celebes–Borneo (←) [1]) 1 in Java instead of Borneo	1	—	4 [1]) (1 ←)	5 (1 ←)
XXIII New Guinea–Moluccas–Philippines–Celebes and Borneo) (←)	—	1 (1 ←)	18 (7 ←)	19 (8 ←)
XXIV New Guinea–Moluccas–Talaud (Philippines) (←)	4 (1 ←)	8 (1 ←)	30 (6 ←)	42 (8 ←)

	Pteridoph.	Orchids	Other Phanerog.	Total
XXV Lesser Sunda Islands–Celebes–Java (←)	—	—	1 (1 ←)	1 (1 ←)
Totals C	7 (1 ←)	101 (3 ←)	146 (37 ←)	254 (41 ←)
Grand-Totals	31 (1 ←)	263 (28 →, 3 ←)	440 (64 →, 8 ⇄, 37 ←)	734 (92 →, 8 ⇄, 41 ←)

C. THE WEST–EAST PROPORTION.

If group B may be considered to represent the western element (cf. Lam in Blumea III[1], 1938, 142—147), an assumption which is, by the way, only partly justified regarding the categories XIII and XVI (31 species in all), the proportion of the western (A + B) and the eastern (C) element is the following, in which because of the said categories XIII and XVI the figures for West are maxima, those for East minima:

for the Pteridophytes only	24 : 7 or 77 %	West, 23 %	East
„ „ Orchids only	162 : 101 or 62 %	„ , 38 %	„
„ „ other Phanerogams	294 : 146 or 67 %	„ , 33 %	„
„ all plants considered	480 : 254 or 65 %	„ , 35 %	„ .

It may be stated here that the proportion West/East, as calculated by the Sarasin's for the fauna, is almost exactly the same as that obtained by us for the Phanerogams except the Orchids, viz. 67 % : 33 %. Again exactly the same proportion was found by Holthuis and Lam for Talaud (1942). This confirms the opinion that the Celebes flora is preponderantly Asiatic. We deem it unlikely that statistics based upon larger numbers of species will fundamentally alter the proportion W : E = 2 : 1. The number of Pteridophytes is, of course, too low to guarantee for them alone any trustworthy results in this matter.

D. ENUMERATION OF THE SPECIES ("OTHER PHANEROGAMS" ONLY).

In order to give an idea of the species concerned, it seems worth while to enumerate those of the general group. In the following list an asterisk (*) denotes endemic species. Behind each name the regions are indicated — as far as they could be traced — in which the species has been collected: SW, SE, C, E and N; "all" means that the species in question actually is known or readily may be expected to occur in all of the five parts; it is accepted that this condition is extant as soon

as a species occurs both in SW and in N. The boundaries between the central part and the N, E and SE peninsulae have been drawn at the spot where these arms are connected with the "main body" of the island, viz. between C and N along the line Paloe—south of Parigi, between C and E along the line Oeë Koeli—Tambajoli Bay, and between C and SE along the line Kolonodale—Malili. Regarding the SW arm, however, this procedure could not be followed, since the "Tempe depression" (along the line Pinrang—Pampanoea), which is only 12 m above sea-level, affords a much more natural boundary between C and SW than the line Boengin—Palopo, which has been adopted as a boundary by the Sarasin's. Furthermore, the following abbreviations have been used in the list: r = connection on account of relation; Amb. = Amboina; And. = Andamans; Austr. = Australia; Boet. = Boeton; BNB = Brit. North Borneo; Flor. = Flores; Form. = Formosa; Kab. = Kabaena; Kngn. = Kangean; LSI = Lesser Sunda Islands; Lomb. = Lombok; Luz. = Luzon; Mar. = Marianas; Mind. = Mindanao; Mol. = Moluccas; Mor. = Morotai; NG = New Guinea; Pal. = Palawan; Sal. = Salajar; SEB = S.E. Borneo; Sum. = Sumatra; Tan. = Tanimbar; T.B. = Toekang Besi; Tim. = Timor; Tl. = Talaud.

Area Categories of 440 Celebes Phanerogams.

I. (→) *Sundaland–Celebes.*

1.* → Aeginetia selebica Bakh. (r, SW, C)
2.* Alangium maliliense Bloemb. (r, C)
3. Baccaurea javanica (Bl.) M.A. (N, Tl)
4. → Blastus Cogniauxii Stapf (SE)
5. Canarium littorale Bl. (C)
6. → Cerastium indicum Wall. (SW)
7.* Cinnamomum Koordersi Cammerl. (r, N)
8.* „ pilosum Cammerl. (r, SW)
9. Cissus nodosa Bl. (N, Tl)
10. Conocephalus suaveolens Bl. (N)
11. → Cynoglossum javanicum (Thunb.) DC. (SW)
12. → „ micranthum Desf. (C)
13.* Dendrophthoë locellata Dans. (r, SW)
14.* „ pauciflora Dans. (r, E, N)
15. → Diospyros frutescens Bl. (N)
16. Dysoxylum acutangulum Miq. (N)
17. „ densiflorum Miq. (N)
18. Fagraea fragrans Roxb. (SW, SE, C)
19*. → Gentiana lateriflora Hemsl. (r, SW)
20. → Helixanthera cylindrica (Jack) Dans. (SW, C)
21. → Lysimachia japonica Thunb. (SW)
22.* Medinilla celebica Bakh.f. (r, N)
23. Nepenthes gracilis Korth. (C)
24. Oldenlandia subulata Korth. (SW)
25. → Otanthera celebica Bl. (N, And.)
26. → Pachycentria constricta (Bl.) Bl. (C?, N)

27.* Palaquium multiflorum Pierre (r, C)
28. „ obovatum (Griff.) Engl., var. α occidentale H. J. Lam (C)
29. → Pericopsis (genus) (?)
30.* → Poliothyrsis Stapfii Koord. (r, N)
31. Pouteria malaccensis (Clarke) Baehni (C)
32. → Ranunculus diffusus DC. (SW)
33.* → „ Frigidurbis H. J. Lam (r, SW)
34.* Rhododendron celebicum DC. (r, SW, N)
35. Santiria laevigata Bl. (C)
36. → Sloetia (genus) (C, N)
37.* Sonerila celebica Bakh.f. (r, C)
38. Sterculia macrophylla Vent. (Boet., C)
39. → Themeda villosa (Poir.) Hack. (SW)
40. Trichosporum radicans (Jack) Nees (N, Tl)
41.* Vaccinium dubiosum J. J. S. (r, C)

II. (→) *Sundaland–Philippines–Celebes* (eventually also in *Lesser Sunda Islands*)

1. → Alangium salvifolium (L.f.) Wang. (SW, C; Balabac, LSI)
2.* Amorphophallus plicatus M. B. Bok & H. J. Lam (r, N; Coch. Ch.)
3. → Buchanania arborescens Bl. (N, Tl; Soemba)
4. → Chamabainia cuspidata Wight (SW)
5. → Cinnamomum iners Reinw. (SW)
6. → Cissus hastata (Miq.) Planch. (N, Tl)
7. Cyclostemon Minahassae Boerl. & Koord. (N, Tl)
8. → Dacryodes rostrata (Bl.) H. J. Lam (N)
9. Diospyros Korthalsiana Hiern (SE)
10. „ macrophylla Bl. (C; S. Phil.)
11. ⇉ „ montana Roxb. (SW, SE, C; LSI, Luz.)
12. ⇉ Flacourtia indica (Burm.f.) Merr. (SW; Leti)
13. → Garuga (genus) (all)
14. → Gleditschia (genus) (N)
15. Glochidion rubrum Bl. (Tl)
16.* Homalium celebicum Koord. (r, all)
17.* Lepeostegeres alveolatus (v. Tiegh.) Dans. (r, SE, C)
18. → Limnophila chinensis (Osb.) Merr. (C)
19. → Lindernia cordifolia (Colsm.) Merr. (C)
20. Macaranga triloba (Bl.) M. A. (Tl, Pal.)
21. → Macrosolen cochinchinensis (Lour.) v. Tiegh. (N)
22. Medinilla crassifolia (Reinw.) Bl. (C, N)
23. → Memecylon laevigatum Bl. (SW)
24. → Merremia vitifolia (Burm.f.) Hall.f. (all; LSI)
25. → Morinda celebica Miq. (SW)
26. Neodissochaeta celebica (Bl.) Bakh.f. (C?, N)
27. → Oroxylum indicum (S.) Vent. (all; Tim.)
28. → Parkia javanica (Lamk.) Merr. (N; Tim.)

29. Piper abbreviatum Opiz (all; Bali, Lomb.)
30. ⇉ Polygonum caespitosum Bl. (SW)
31. ⇉ „ perfoliatum L. (C; NG)
32. ⇉ „ pulchrum Bl. (SW; N. Phil.)
33. → Pratia nummularia (Lamk.) Kurz (C)
34.* Rhododendron Vanvuurenii J. J. S. (C)
35. → Schima (genus) (?; Pal.)
36. ⇉ Scolopia crenata Clos (SW, SE)
37. → Scurrula ferruginea (Jack) Dans. (E; Tl)
38. → Strophioblachia fimbricalyx Boerl. (Sal.; Coch.Ch.)
39. ⇉ Taxus baccata L. var. Wallichiana Pilg. (SW, C; N. Phil.)
40. → Viola arcuata Bl. (C)

III. (→) *Sundaland–Celebes–Moluccas*

1. → Alangium Griffithii (Clarke) Harms (C)
2. „ javanicum (Bl.) Wang. (C, N)
3. Astronia macrophylla Bl. (N, Tl)
4. → Balanostreblus ilicifolia Kurz (N)
5. → Dendrophthoe falcata (L.f.) Ettingsh. (SW)
6. Gnetum cuspidatum Bl. (Tl)
7. → Intsia retusa (Kurz) O. Ktze (SE, C)
8. Polyalthia lateriflora (Bl.) Kurz (N)
9. Terminalia belerica Roxb. (N)

IV. (→) *Sundaland–Philippines–Celebes–Moluccas*

1. → Adenosma bilabiatum (Roxb.) Merr. (SW)
2. → Ajuga bracteosa Benth. (E, Tl)
3. → Bonamia semidigyna (Roxb.) Hall.f. (SW)
4. → Combretum acuminatum Roxb. (SW; Soela)
5. → Diospyros cauliflora Bl. (C, N)
6. „ pilosanthera Blanco (SE, N)
7. → Eragrostis unioloides Nees (all)
8. → Garcinia cornea L. (all)
9. Ginalloa Arnottiana Korth. (all)
10. → Lepistemon binectariferum (Wall.) O.K. (C?, N)
11. Memecylon costatum Miq. (N, Tl)
12. Microstegium fasciculatum (L.) Henr. (N)
13. Nothaphoebe umbelliflora Bl. (C, N, Tl)
14. Pangium edule Reinw. (SE, N)
15. → Porana volubilis Burm.f. (SW)
16. Rhododendron malayanum Jack (C; to Mind.; + Flor.)
17. → Rhynchoglossum obliquum Bl. (SW)
18. Santiria apiculata Benn. (SW, C)
19. Scurrula fusca (Bl.) G. Don (all)
20. ⇉ Shorea (genus) (SE, N; not in Java)
21. Terminalia edulis Blanco (all)
22. → Turpinia pomifera (Roxb.) DC. (C, N, Tl; Form.)

V. (→) *Sundaland–(SW)Celebes–Lesser Sunda Islands* (ev. *Moluccas)*

1. → Adenostemma macrophyllum (Bl.) DC. (SW; Ceram)
2. Cinnamomum Burmanni Bl. (SW; Soemba)
3. → Combretum latifolium Bl. (SW, SE; Flor.)
4. → Intsia palembanica Miq. (SW, C)
5. Planchonia valida Bl. (all; Aroe)
6. Randia oppositifolia Koord. (all)

VI. (→) *Java–Celebes–Lesser Sunda Islands*

1. Astronia spectabilis Bl. (SW)
2.* Diospyros eburnea Bakh. (r, all)
3.* „ Greshoffiana Koord. (r, N)
4. → „ malabarica (Desr.) Kostel. (all)
5.* „ venenosa Bakh. (r, SW, SE, C)
6. Hypericum Hookerianum W. et A. (SW; Lomb.)
7. Ipomoea Decaisnei v. Ooststr. (SW, Boet.)
8. → „ maxima (L.f.) Don (SW)
9. „ trichosperma Bl. (Sal., Boet.)
10. Ixora timorensis Decne. (SW, SE; + Kai)
11. → Osbeckia dolichophylla Naud. (SW)
12. → Porana racemosa Roxb. (SW)
13. Rhododendron Zollingeri J. J. S. (C; Bali, Lomb.)
14. → Schleichera trijuga Willd. (= oleosa Merr.) (Kab., Moena, Boet.; Banda, Amb.)
15. Tabernaemontana sphaerocarpa Bl. (Moena, N)
16. Vernonia erigeroides DC. (Sal.)
17. → Viola serpens Wall. (SW)

VII. (→) *Sumatra–Java–Celebes*

1. Calamagrostis australis Buse (SW; Bali)
2. Carex longebracteata Steud. (SW; Bali)
3. Geranium ardjunense Z. et M. (SW)
4. Medinilla laurifolia (Bl.) Bl. (all)
5.* Radermachera elegans v. Steen. (r, N)
6. Tetrameles nudiflora R. Br. (all; Kngn, Lomb.)
7.* Vernonia Reinwardtiana De Vriese (r, N)

VIII. *Java–Celebes.*

1. Cladopus Nymani H. Möll. (SW)
2. Dicymanthes breviflora Dans. (N)
3.* Diflugossa Everettii (Rolfe) Brem. (r, SW)
4.* Diplycosia hirsuta Sleum. (r, C)
5. Phaleria urens (Reinw.) Koord. (N, Tl)
6. Plectranthus Teysmanni Miq. (SW)
7.* Rhaphidospora celebica Brem. (r, C)
8.* Vernonia subtilis Kost. (r, SW)

IX. *Sumatra–Celebes*

1.* Diplycosia aperta J. J. S. (r, C)
2.* „ retusa Sleum. (r, C)

X. (→) *Sumatra–Java–Celebes–Philippines (*ev. *Lesser Sunda Islands)*

1. → Acer niveum Hassk. (N)
2. → Festuca leptopogon Stapf (SW)
3. Podocarpus amara Bl. (SW, C; LSI)
4. Taraktogenos heterophylla (Bl.) v. Sl. (N)
5.* Vaccinium lucidum Miq. (r, SW, C)

XI. *Borneo (Palawan)–Celebes*

1.* Argyreia cinerea v. Ooststr. (r, N)
2.* Boea leporina H. J. Lam (r, C)
3. Brownlowia Beccarii (Mast.) Pierre (?, Tl)
4. Dendrophthoë constricta (Korth.) Dans. (C, N)
5. Diospyros Beccarii Hiern (N)
6.* Driessenia ferox Bakh.f. (r, BNB) (C)
7. Fagraea bracteosa Camm. (C?, Pal.)
8.* Gentiana uncifolia H. J. Lam (r, BNB) (C)
9. Helixanthera xestophylla (Miq.) Dans. (C)
10. Litsea accedens (Meissn.) Boerl. (N, Tl)
11. Mastixia parvifolia Hall. (SE)
12. Melastoma nitidum Korth. (SE [Kab.])
13. Nepenthes tentaculata Hook.f. (C)
14. Pratia borneensis Hemsl. (BNB) (C)
15.* Vaccinium Henrici Sleum. (r, BNB) (SW)

XII. *Borneo–Philippines–Celebes*

1. Camptostemon philippense (Vid.) Becc. (mangrove) (SEB; all)
2. Hydnocarpus Hutchinsonii Merr. (BNB, N)
3. Ixora philippensis Merr. (BNB; N; Soela)
4. Madhuca betis (Merr.) Macbr. (N)
5. Phyllocladus hypophyllus Hook.f. (BNB; C)
6. Styphelia suaveolens (Hook.f.) Koord. (SW)

XIII. *Philippines–Celebes–Lesser Sunda Islands (*ev. *Moluccas)*

1. Astenochloa tenera Buse (Sal.; E. Java)
2. Buchnera urticifolia R. Br., var. glaberrima H. J. Lam (SW, C)
3. Pycnarrhena celebica (Boerl.) Diels (all; Kngn, Soemba)
4. Rubus fraxinifolius Poir. ssp. celebicus Bl. (all; Mol.)

XIV. *Philippines (M = Mindanao only)–Celebes*

1. Acanthophora scandens Merr. (N)
2. Agathis philippinensis Warb. (C, N)

3. Aglaonema Haenkei (Presl) Schott (N)
4. Alocasia heterophylla (Presl) Merr. (N)
5. Argostemma solaniflorum Elm. (C)
6.* Argyreia celebica v. Ooststr. (r, N)
7. Begonia pseudolateralis Warb. (N)
8. Calamus symphisipus Mart. (N)
9. Canarium Vrieseanum Engl. (C, N)
10. Casearia densifolia Elm. (SW)
11. Casuarina Rumphiana Miq. (SE, C, N)
12. Cratoxylon celebicum Bl. (C, N)
13. Dalbergia mimosella (Blanco) Prain (N)
14. Dillenia ochreata T. & B. (N)
15. Diospyros philippinensis A. DC. (N; M)
16.* Diplycosia caryophylloides J. J. S. (r, SE)
17.* „ celebensis J. J. S. (r, C)
18.* „ Kjellbergii J. J. S. (r, SE)
19.* „ sagittanthera J. J. S. (r, SE)
20. Elaeocarpus Cumingii Turcz. (N)
21. Euphorianthus obtusatus Radlk. (all)
22. Elatostema delicatulum Wedd. (SW)
23. Fagraea plumeriifolia A. DC. (N)
24.* Gaultheria celebica J. J. S. (r, C)
25. Gleditschia Rolfei Vid. (N)
26. Glochidion album (Blanco) Boerl. (N; to Form.)
27. Hedyotis benguetensis (Elm.) Elm. (SW)
28.* „ coryphoecetes Brem. (r, SW)
29.* Hemigraphis celebica Brem. ined. (r, C)
30.* „ mandarensis Brem. ined. (r, C)
31. Hoya subg. (H. gracilis Schlecht. + H. imbricata Decne. + H. pseudomaxima Koord.) (N)
32. Ixora Bartlingii Elm. (N)
33. „ filipes Val. (N)
34. Kibara obtusa Bl. (N)
35. Lobelia philippinensis Skottsb. (SW)
36. Madhuca philippinensis Merr. (SE)
37.* Medinilla malaboensis Bakh.f. (r, SW)
38. „ Cumingii Naud. (N)
39.* Myriactis spec. (C)
40. Neotrewia Cumingiana (M. A.) Pax & Hoffm. (N)
41. Nepenthes Merrilliana Macf. (N; M)
42. Osmelia celebica Koord. (N)
43. Pithecellobium subacutum Benth. (N)
44. Pleomele multiflora (Warb.) Merr. (N)
45. Pouteria fragrans (Elm.) H. J. L. (SW)
46. Premna Cumingiana Schau. (N)
47. Quercus Minahassae Koord. (N; M)
48. Radermachera Fenicis Merr. (SW)
49. „ pinnata (Blanco) Seem. (SW, SE)
50. Reinwardtiodendron celebicum Koord. (N)

51. Scaevola Minahassae Koord. (N; M)
52. Scindapsus falcifolius Engl. (N)
53.* Shorea Koordersii Brand. (r, N)
54. Sonerila brachyandra Naud. (SW)
55. Spiraeopsis celebica (Bl.) Miq. (C, N)
56. Tabernaemontana mucronata Merr. (N)
57. Tarrietia sylvatica (Vid.) Merr. (SW, N)
58. Ternstroemia toquian F.-Vill. (N)
59. Tetraplasandra (genus) (N, Tl; Pal.)
60. Teysmanniodendron longifolium (Merr.) H. J. Lam (Mind.) (SW)
61.* Vaccinium Kjellbergii J. J. S. (r, C)
62. Vernonia Elmeri Merr. (all)
63. Wallaceodendron celebicum Koord. (SE, N)
64. Weinmannia urdanetensis Elm. (C)
65. Wendlandia luzoniensis DC. (SW, C)

XV. *Talaud–Philippines–Celebes*

1. Amyema celebica (v. Tiegh.) Dans. (SE, N, Tl)
2. Couthovia celebica Koord. (N, Tl)
3. Elaeocarpus multiflorus (Turcz.) F.-Vill. (N, Tl)
4. Elmerrillia ovalis Dandy (C, N, Tl)
5. Ficus Minahassae (T. & De Vr.) Miq. (N, Tl)
6. Garcinia tetrandra Pierre (all)
7. Hemigraphis lanceolata Merr. (N, Tl)
8. Palaquium bataanense Merr. (C, N, Tl)
9. „ luzoniense (F. Vill.) Vid. (C, N, Tl)

XVI. *Philippines–Talaud*

1. Antidesma Cumingii M.-A.
2. Antirrhoea microphylla (Bartl.) Merr.
3. Blumeodendron paucinervium (Elm.) Merr.
4. Boerlageodendron serratifolium Elm.
5. Cladium philippinense Merr.
6. Cyathocalyx acuminatus C. B. Rob.
7. Cyclostemon littoralis C. B. Rob.
8. Decaspermum Blancoi Vid.
9. Dischidia Copelandii Schlecht.
10. Eugenia calubcob C. B. Rob.
11. „ Everettii C. B. Rob.
12. „ panduriformis Elm.
13. Garcinia rhizophoroides Elm.
14.* Gynochthodes nov. spec. (r)
15. Iaera lanaensis (Merr.) Copel.
16. Ilex paucinervia Merr.
17. Melicope triphylla (Lamk.) Merr.
18. Mussaenda philippica A. Rich.
19.* Psychotria spec. n. (r)

20. Scaevola micrantha Presl.
21. Schefflera ovoidea Merr.
22. Strombosia philippinensis (Baill.) Rolfe
23. Terminalia Copelandi Elm.
24. Trichospermum eriopodum (Turcz.) Merr.
25. Tylophora Perrottetiana Decne.
26. Vaccinium Vidalii Merr. & Rolfe.

XVII. *Talaud–Celebes*

1. Alpinia pectinata "Ridl." (N?)
2. Cinnamomum celebicum Miq. (N)
3. Evodia Minahassae (Miq.) T. & B. (N)
4. Ficus botryocarpa Miq. (N)
5. Geniostoma celebicum Val. (all)
6.* Jasminum suberosum Holth. (r, N)
7. Myristica celebica Miq. (N)
8. Ophiorrhiza parviflora Reinw. (all)
9. Polyalthia celebica Miq. (N)
10. Pterospermum celebica Miq. (all)
11. Stephania cauliflora Becc. (SE, C)
12. Timonius celebicus Koord. (N)

XVIII. *Lesser Sunda Islands–Celebes (*ev. *Amboina)*

1.* Amyema anisomeres Dans. (r, C; Tim.)
2. Amylotheca stenopetala (Oliv.) Dans. (all; Flor.)
3.* Ipomoea stibaropoda v. Ooststr. (r; Djampea, Tim.)
4. Quisqualis sulcata v. Sl. (Kal. Toea, Wetar)
5. Stictocardia neglecta v. Ooststr. (SW; Sal.)
6. Trachymene acerifolia Norm. (SE, C).
7. Vernonia actaea Kost. (Sal., Moena, T. B., Tan.)
8. „ moluccensis (Bl.) Miq. (SW; Bali to Amb.)
9. Xylosma amara (Span.) Koord. (SE; Tim.)

XIX. *Moluccas–Celebes*

1. Adina fagifolia (T. & B.) Val. (C, N)
2. Albizzia Minahassae Koord. (N)
3. Amomum roseum (T. & B.) Benth. & Hook. (N, Tl)
4. Amylotheca Zollingeri (Engl.) v. Tiegh. (SW; to Kngn)
5. Artocarpus reticulata Miq. (N, Tl, Boet.)
6. Buchanania amboinensis Miq. (N)
7. Canarium balsamiferum Willd. (all)
8. „ commune L. (all; to Kngn)
9. „ multijugum H. J. Lam (C)
10. Colona scabra (Sm.) Burrett (SE; Tl)
11. Diospyros Minahasae Bakh. (C, N)
12. „ Rumphii Bakh. (N, Tl)
13. Elatostema polioneurum Hall.f. (N, Tl)
14. Ficus adenosperma Miq. (N)

15. Haplolobus celebicus H. J. Lam (C, N?)
16. Hemigraphis stenophylla Hall.f. (N; Mor.)
17. Homalium minahassae Koord. (N)
18. Itoa Stapfii (Koord.) Sleum. (N)
19. Ixora subg. Eu-Ixora Brem., sect. Ixorastrum Brem., ser. Macrothyrsae + I. inexpecta Brem. (SE, C, N)
20. Litsea Forstenii (Bl.) Boerl. (all)
21. Mastersia Bakeri (Koord.) Back. (N; N. Mol.)
22. Medinilla crispata (L.) Bl. (N)
23. „ ternatensis Miq. (N)
24. Mischophloeus paniculatus (Scheff.) Scheff. (N, Tl)
25. Polyscias Rumphiana Harms (N, Tl; Tim.)
26.* Rhododendron impositum J. J. S. (r, C)
27.* „ Kjellbergii J. J. S. (r, C)
28.* „ lagunculicarpum J. J. S. (r, C)
29.* „ poremense J. J. S. (r, SE)
30. Schuurmansia elegans Bl. (N)
31. Sterculia comosa Wall. (Tl)

XX. *New Guinea–(Moluccas–)Celebes* (ev. *Lesser Sunda Islands)* (←)

1.* Amylotheca celebica (Hemsl.) Dans. (r, SW)
2. Canarium acutifolium (DC.) Merr. (C)
3. „ maluense Laut. (C; NG)
4. „ oleosum Engl. (N; + Tim.)
5. Clematis aristata R. Br. (N, Tl; LSI) ←
6.* Diospyros celebica Bakh. (r, C, N; NG)
7. „ ellipticifolia (Stok.) Bakh. (SW, C) ←
8. Gmelina palawensis H. J. Lam (C; Palau) ←
9. Gnetum gnemon L., var. silvestre (Brongn.) Parl. (N, Tl) ←
10. Gomphandra australiana F. Muell. (N, Tl) ←
11. Grevillea (genus) (C; NG, Austr.) ←
12. Ixora subg. Eu-Ixora Brem., sect. Otobactrum Brem., ser. Cauliflorae (SE)
13. Lepistemon urceolatum (R. Br.) F. Muell. (all) ←
14. Litsea aff. calophyllantha K. Schum. (C; NG)
15. Macadamia (genus) (C; Austr.) ←
16. Medinilla crassinervia Bl. (N)
17. „ rosea Gaud. (N; Mar.) ←
18. Neuburgia tubiflora Bl. (C)
19. Palaquium amboinense Burck (E)
20.* Podocarpus dacrydiifolia Wassch. (r, C, NG)
21. Potentilla papuana Focke (SW)
22. Pouteria moluccana (Burck) Baehni (C; Flor.)
23. „ obovoidea (H. J. L.) Baehni (SE; + Tim.
24. Premna sessilifolia H. J. Lam (C; NG)
25.* Trachymene acrotricha Buw. (r, C; NG)
26. „ arfakensis (Gibbs) Buw. (C?; NG)
27.* „ erodioides Buw. (r, C; NG)
28.* Trochocarpa celebica (J. J. S.) H. J. Lam (C) ←

29. Tylecarpus papuanus (Becc.) Engl. (C)
30.* Vaccinium pilosilobum J. J. S. (r, C)
31.* „ tomicipes J. J. S. (r, C)
32. Vernonia lanceolata (Warb.) Mattf. (N, Tl) ←

XXI. *New Guinea–Moluccas–Philippines–Celebes* (←)

1. Aneilema vitiense Seem. (N, Tl, Tim.) ←
2. Anomopanax (genus) (all)
3. Couthovia (genus) (N)
4. Diospyros hebecarpa Cunn. (all) ←
5. Elmerrillia (genus) (N)
6. Eucalyptus (genus) (all; Mind., Tim. c.a.) ←
7. Euphorianthus (genus) (all)
8. Ixora subg. Pavettoides Brem., sect. Pavettopsis Brem., ser. Orientalis (all) ←
9. Macaranga hispida (Bl.) M. A. (all)
10. „ Mappa (L.) M. A. (N, Tl)
11. Ormosia calavensis Az. (N, Tl) ←
12. Podocarpus Pilgeri Foxw. (SW, C) ←
13. Pothos Rumphii Schott (N, Tl)
14. Pueraria pulcherrima (Koord.) Merr. (N, Tl)
15. Scaevola, Sect. Enantiophyllum (SW; Mol.) ←
16. Schuurmansia (genus) (N) ←
17. Scutellaria luzonica Rolfe (C, N)
18. Spiraeopsis (genus) (C, N)
19. Stylidium alsinoides R. Br. (SW) ←
20.* Terminalia Supitiana Koord. (r, N)
21.* Xanthostemon celebicus Koord. (r, SE, C, N) ←

XXII. *New Guinea–Moluccas–Celebes–Borneo* (←)

1. Codiaeum variegatum (L.) Bl., var. moluccanum (Decne.) M. A. (N, Tl; LSI, Java, not in Borneo) ←
2. Homalium foetidum (Roxb.) Benth. (C, SE)
3. Nepenthes maxima Nees (C, N)
4. Piper amboinense (Miq.) C. DC. (all; BNB)

XXIII. *New Guinea–Moluccas–Philippines–Celebes–Borneo* (←)

1. Agathis (genus) (all; Sum., Indo-Ch.) ←
2. Aglaia luzoniensis Merr. & Rolfe (N; BNB)
3. Alphitonia sizyphoides (Spr.) A. Gray (C, Tl) ←
4. Boerlageodendron (genus) (N, Tl)
5. Camptostemon (genus) (all) (N. Austr.) ←
6. Canarium asperum Benth. (all; BNB)
7. Dioscorea nummularia Lamk. (all; BNB)

8. Drimys piperita Hook.f. (SW)
9. Gnetum gnemon L., var. domesticum (Rumph.) Markgr. (SE, N, Tl) ←
10. Koordersiodendron pinnatum (Blanco) Merr. (all; E. Born.)
11. Paratrophis (genus) (G; BNB) ←
12. Phyllocladus (genus) (C; BNB) ←
13. Podocarpus Rumphii Bl. (all; BNB, Soemba, Tim.)
14. Polygonum minus Huds., ssp. procerum Dans. (all; S. Phil.)
15. Rhododendron quadrasianum Vid. (C)
16.* Tetraplasandra (genus) (T. Koordersii Harms) (r, N, Tl; Pal.) ←
17.* Trachymene celebica Hemsl. (r, SW)
18.* „ Sarasinorum (Wolff) Buw. (r, SW)

XXIV. *New Guinea–Moluccas–Talaud* (ev. *Philippines)* (←)

1. Adenia pandurata Hall.f.
2. Alpinia pubiflora (Benth.) K. Schum. ←
3. Amyema rigidiflora (Krause) Dans.
4. Anthocephalus macrophyllus (Roxb.) Havil.
5. Artocarpus communis Forst. ←
6. Boerlageodendron barbatum (Becc.) Harms
7.* Canthium nov. spec. (r)
8. Cyrtandra capitellata Clarke
9. Dianella coerulea Sims ←
10. Dolicholobium (genus) ←
11. Elaeocarpus dolichostylus Schlecht.
12. Fagraea ternatana Miq.
13. Hemigraphis ceramensis Brem.
14. „ Rumphii Brem.
15. Horsfieldia novo-guineensis Warb.
16. Hoya sussuela (Roxb.) Merr.
17. Hydnophytum amboinense Becc.
18. „ inerme (Gaud.) Brem.
19. Lepidagathis Robinsonii Merr.
20. Macropsychanthus (genus) ←
21. Myrtella Beccarii F. Muell.
22. Myxopyrum ovatum A. W. Hill
23. Osmelia philippina (Turcz.) F.-Vill. ←
24. Pandanus latissimus Bl.
25. Pimeleodendron amboinicum (Miq.) Hassk.
26. Rapanea densiflora (Scheff.) Mez
27. Riedelia curviflora Oliv.
28. Schuurmansia Theophrasta Hall.f.
29. Sterculia Treubii Hochr.
30. Styphelia moluccana (Scheff.) J. J. S.

XXV. *Australia (New Zealand)–Lesser Sunda Islands–Celebes and Java*

1. Gnaphalium involucratum Forst. (SW).

E. RELATION BETWEEN REGIONAL FLORULAE AND ORIGIN.

As has been remarked above, the different parts of Celebes possess a more or less distinct floristic character. Now, it may be asked whether the regional distribution of the species in the island itself can give rise to any conclusions regarding their geographical origin. Are we able to give any definite percentages of plant species relative to the supposed land-bridges, as was done by the Sarasin's regarding the fauna?

Unfortunately, the answer is in the negative. First of all this is due to the difference inherent to the materials of phyto- and zoogeography. Of a great number of plants, the mode of dispersal is unknown or doubtful and even if a definite mode is suggested by the nature of the diaspores, we are often not certain that other possibilities are excluded. Many old oceanic islands must have been populated by ocean-crossing transport of diaspores but in many cases we fail to understand how it may have been brought about. In botany we unfortunately miss such reliable groups as the great mammals, freshwater-fishes and molluscs, and earth-worms and accordingly our results have to be based upon statistics rather than upon single groups. The matter is still further entangled by the fact that even some easily dispersed groups, such as *Fungi*, Pteridophytes, Orchids, *Rhododendron*, some mangrove-species, etc. may occupy very limited areas. This phenomenon is also well-known in animals (e.g. birds) and is presumably partly due to historical, partly to ecological factors.

In the present case, however, another important point is the differences in the intensity with which botanical explorations have been carried out in the various parts of the island. As may be inferred from the list of collectors (cf. Appendix) by far the best known part is the eastern tip of the northern peninsula, the so-called Minahasa. Comparatively well-known is also SW. Celebes; but, of course, it is a general rule that the best accessable parts have the largest population and in these parts the original flora is usually most badly damaged.

Of the remaining parts, C. Celebes is the least unknown. It has recently been incidentally explored and what small collections have reached us, both from the high mountain ranges (Mt. Latimodjong, Mt. Mamboeliling, etc.) and from the plains near Malili is most promising from a phytogeographical point of view indeed.

Little known is SE. Celebes, except the islands of Boeton, Moena and Kabaena, but there, as in SW. Celebes the climate is considerably drier than in C. and N. Celebes and much of the vegetation has fallen a victim to fires.

Least known of all are E. Celebes (as long as the late Dr Eyma's collection of 1938 remains unelaborated) and the greater part of the northern Peninsula.

The following statement (*Table II*), relative to the numbers of Celebes Orchids known in 1925 and 1945 respectively, more or less truly reflects the state of our knowledge of the flora and its progress in the last twenty years.

These figures show, beside a natural decrease of the specific endemism, that, though the percentage for N has decreased and that for the other

TABLE II.

Orchidaceae	1925 (R. Schlechter)	1945 (J. J. Smith)
Number of genera	82	89
„ „ species	321	401
Of which endemic	253 (78.8 %)	286 (71.3 %)
Number of species known		
from N. Celebes (Minahasa)	251 (78.2 %)	269 (67.1 %)
E. Celebes	— (0 %)	13 (3.2 %)
C. Celebes	19 (5.9 %)	94 (23.4 %)
SE. Celebes	16 (5.0 %)	78 (19.4 %)
SW. Celebes	36 (11.3 %)	73 (18.2 %)

parts increased since 1925, we are far from having reached a probable equilibrium. Neither could be inferred from them that N has a richer Orchid flora than, say C, or — as it probably has on account of the climate — than SW. The percentage of 67.1 for N is doubtless still largely due to our better knowledge of the Minahasa flora and it is impossible to predict to which figure this percentage will fall or which figures each of the five parts will ultimately show, when they will be equally well known to us.

In the following tables, one for the Orchids (*Table III*) and one for the "other Phanerogams" (*Table IV*), it has been indicated in which way, according to our present knowledge, the five geographical parts of the island participate in the number of species in either group. The figures in brackets ( ) indicate the number of species o n l y found in the region in question, the others are also known from other parts. Moreover, there is a column "all", including those species which actually have been found or may readily be expected to occur in all of the five parts. This has again been supposed to be the case when the area comprises at least SW and N. This category has been kept apart and has not been distributed to the columns for the five parts, first of all since these species have no significance to the problem of the geographical origin of the species, and also since its distribution would provide such very poorly known parts as E with relatively too high a figure (Tables III and IV.).

It appears from these figures that the domination of N may be very strong, even in SW area categories. For instance, out of the 59 species of such typically south-western area categories as VII and VIII of Table III, no less than 37 are known from N (and 29 only from N!), and only 10 from SW. On the other hand, the fact that out of the 65 species of category XIV of Table IV (Philippines–Celebes), 24 are unknown from N. Celebes and 22 are even only known from SW, SE or C., suggests a very imperfect knowledge of the distribution of the species in the island itself.

TABLE III

	ORCHIDS	Number of species	Known from					
			SW	SE	C	E	N	all
A.	I. Sundaland–Celebes	43	10 (7)	5 (2)	7 (4)	—	26 (23)	1
	II. Sundal.–Phil.–Cel.	10	3 (2)	2 (1)	—	1 (—)	6 (6)	—
	III. Sundal.–Cel.–Mol.	4	2 (1)	1 (—)	—	—	2 (2)	—
	IV. Sundal.–Phil.–Cel.–Mol.	2	—	—	—	—	1 (1)	1
	V. Sundal.–L.S.I.–Cel.	3	—	—	2 (2)	—	1 (1)	—
	VI. Java–L.S.I.–Cel.	2	—	—	1 (—)	—	2 (1)	—
	VII. Sum.–Java–Cel.	32	5 (3)	6 (2)	8 (6)	—	19 (15)	—
	VIII. Java–Celebes	27	5 (4)	6 (2)	5 (2)	—	18 (14)	—
	IX. Sumatra–Celebes	7	1 (1)	2 (2)	2 (—)	—	3 (1)	1
	X. Sum.–Java–Cel.–Phil. (–L.S.I.)	2	1 (—)	1 (—)	1 (1)	—	—	—
	XI. Borneo–Celebes	8	—	3 (3)	4 (1)	—	3 (2)	1
	XII. Borneo–Phil.–Cel.	—	—	—	—	—	—	—
	Totals Western Group	140	27 (18)	26 (12)	30 (16)	1 (—)	81 (66)	4
B.	XIII. Phil.–Cel.–L.S.I.	—	—	—	—	—	—	—
	XIV. Philippines–Cel.	21	2 (1)	3 (1)	4 (4)	—	14 (13)	—
	XV. Phil.–Tal. and Cel.	—	—	—	—	—	—	—
	XVI. Phil.–Talaud	—	—	—	—	—	—	—
	XVII. Talaud–Celebes	1	—	—	—	—	1 (1)	—
	Totals Northern Group	22	2 (1)	3 (1)	4 (4)	—	15 (14)	—

	ORCHIDS	Number of species	Known from					
			SW	SE	C	E	N	all
C.	XVIII. L.S.I.–Celebes	4	2 (2)	2 (1)	—	—	—	—
	XIX. Moluccas–Celebes	28	4 (3)	9 (3)	3 (1)	—	19 (12)	1
	XX. NG.–Mol.–Celebes	58	5 (4)	5 (3)	11 (9)	—	40 (37)	1
	XXI. NG.–Mol.–Phil.–Cel.	2	—	1 (—)	2 (1)	—	1 (—)	—
	XXII. NG.–Mol.–Cel.–Born.	—	—	—	—	—	—	—
	XXIII. NG.–Mol.–Phil.–Cel. and Borneo	1	—	1 (—)	—	1 (—)	1 (—)	—
	XXIV. NG.–Mol.–Talaud–(–Phil.)	8	—	—	—	—	8 (8)	—
	XXV. Austr.–L.S.I.–Cel. and Java	—	—	—	—	—	—	—
	Totals Eastern Group	101	11 (9)	18 (7)	16 (11)	1 (—)	69 (57)	2
	Grand-totals	263	40 (28)	47 (20)	50 (31)	2 (—)	165 (137)	6

TABLE IV

	OTHER PHANEROGAMS	Number of species	Known from					
			SW	SE	C	E	N	all
A.	I. Sundaland–Celebes	41	14 (10)	3 (1)	16 (10)	1 (—)	15 (11)	—
	II. Sundal.–Phil.–Cel.	40	12 (8)	5 (1)	12 (7)	1 (—)	13 (10)	5
	III. Sundal.–Cel.–Mol.	9	1 (1)	1 (—)	3 (1)	—	6 (5)	—
	IV. Sundal.–Phil.–Cel.–Mol.	22	5 (4)	3 (—)	6 (1)	1 (—)	10 (2)	5

	OTHER PHANEROGAMS	Number of species	Known from					
			SW	SE	C	E	N	all
A.	V. Sundal.–L.S.I.–Cel.	6	4 (2)	1 (—)	1 (—)	—	—	2
	VI. Java–L.S.I.–Cel.	17	11 (7)	6 (1)	2 (1)	—	2 (1)	2
	VII. Sum.–Java–Cel.	7	3 (3)	—	—	—	2 (2)	2
	VIII. Java–Celebes	8	4 (4)	—	2 (2)	—	2 (2)	—
	IX. Sumatra–Celebes	2	—	—	2 (2)	—	—	—
	X. Sum.–Java–Cel.–Phil. (–L.S.I.)	5	3 (1)	—	2 (—)	—	2 (2)	—
	XI. Borneo–Celebes	15	1 (1)	2 (2)	8 (7)	—	5 (4)	—
	XII. Borneo–Phil.–Cel.	6	1 (1)	—	1 (1)	—	3 (3)	1
	Totals Western Group	178	59 (42)	21 (5)	55 (32)	3 (–)	60 (42)	17
B.	XIII. Phil.–Cel.–L.S.I.	4	2 (1)	—	1 (—)	—	—	2
	XIV. Philippines–Cel.	65	13 (10)	7 (4)	14 (8)	—	38 (32)	2
	XV. Phil.–Tal. and Cel.	9	—	1 (—)	3 (—)	—	8 (4)	1
	XVI. Phil.–Talaud	26	—	—	—	—	26 (26)	—
	XVII. Talaud–Celebes	12	—	1 (—)	1 (—)	—	8 (8)	3
	Totals Northern Group	116	15 (11)	9 (4)	19 (8)	—	80 (70)	8

	OTHER PHANEROGAMS	Number of species	Known from					
			SW	SE	C	E	N	all
C.	XVIII. L.S.I.–Celebes	9	3 (2)	5 (3)	2 (1)	—	—	1
	XIX. Moluccas–Celebes	31	1 (1)	3 (1)	8 (4)	—	22 (16)	3
	XX. NG.–Mol.–Celebes	32	3 (2)	2 (2)	19 (17)	1 (1)	8 (7)	1
	XXI. NG.–Mol.–Phil.–Cel.	21	3 (2)	1 (—)	4 (—)	—	12 (9)	6
	XXII. NG.–Mol.–Cel.–Born.	4	—	1 (—)	2 (—)	—	2 (1)	1
	XXIII. NG.–Mol.–Phil.–Cel. and Borneo	18	3 (3)	1 (—)	4 (3)	—	5 (3)	7
	XXIV. NG.–Mol.–Talaud–(–Phil.)	30	—	—	—	—	30 (30)	—
	XXV. Austr.–L.S.I.–Cel. and Java	1	1 (1)	—	—	—	—	—
	Totals Eastern Group	146	14 (11)	13 (6)	39 (25)	1 (1)	79 (66)	19
	Grand-totals	440	88 (64)	43 (15)	113 (65)	4 (1)	219 (178)	44

F. APPLICATION OF REGIONAL COEFFICIENTS.

However this may be, both tables show that, in the totals of each of the three main area-groups, N has absolute preponderance. Only in the western group (A) of Table IV it is almost equal to SW. The question arises, is there any possibility of neutralizing the effect of the greater numbers in the better known districts so as to render the figures for the five parts of the island more or less equivalent?

As far as I can see there are two solutions to this problem. In both, the figures for N, as the best known district, have to be considered the nearest approach to stability and therefore as a basis regarding those for the other parts.

Now, in order to make the numbers for all parts equivalent, two ways can be followed; either the grand-totals for N in the Tables III and IV are to be accepted as a basis for a proportional regional coefficient or the percentage of the Orchids in N. Celebes as shown in Table II. A draw-

back of the first method is that the material is biased insofar as only phytogeographically important areas are involved. Furthermore, the proportional coefficient thus obtained for the E. peninsula would become so large as to greatly overvalue its figure. A drawback of the Orchid method is that the material is biased insofar as only one natural group is involved. Advantages, however, are that the Orchids probably show little regional differentiation and that the figures for E are much less exaggerated.

We have, therefore, given preference to the last-named procedure, by which the four regional coefficients may be calculated as follows (N = 1):

SW — 67.1 : 18.2 = 3.7
SE — 67.1 : 19.4 = 3.5
C — 67.1 : 23.4 = 2.9
E — 67.1 : 3.2 = 21.

(Tables V and VI).

Applying these coefficients to the totals of Tables III and IV (repeated underneath in *Table V*) we obtain the following results (*Table VI*).

Although it is obvious that this method is far from perfect — e.g. in group A of Table VI (other Phanerogams) the number of species thus obtained (218) is considerably higher than the actual one (178) — it is striking that in the western group the domination evidently lies in SW and C, in the northern group it remains in N, and in the eastern group it convincingly comes to C (standing for the unknown E. peninsula).

This seems to agree with the Sarasin's conclusion of a Java-bridge, a Philippine bridge and a Moluccan bridge. We may add to this that even in Table IV the preponderance of SW in the categories V—VIII (Southern Sundaland, Less. S. Isl. and Celebes) is striking and also that of N in category XIX (Mol.-Cel.) and of C in category XX (New Guinea-Cel.). A most striking evidence is also given by the northern group, particularly by the categories XIV—XVII, in which N very strongly prevails.

Regarding the Orchids the proportions are somewhat different. Of the western group SW still leads, but it is remarkably little ahead of SE, C and N. Particularly striking in Table III are the figures for the western categories VII and VIII, in which N is strongly dominating. This may be partly due to our better knowledge of that region, partly, however, it may be an illustration of an assumption, uttered by Schlechter, that, as far as the Orchids are concerned, Celebes has to be considered a phytogeographical unity. This might be due to the relative independence of Orchids from land connections.

In the northern group N leads normally, but of the eastern group the preponderance lies with N, instead of C. This gives some support to Schlechter's statement that the relations of the N. Celebes Orchids mainly point eastward and particularly to New Guinea. However, his assertion that the Orchid flora of Celebes should be of a mixed nature "in dem aber die papuasischen Typen vorherrschen", is not confirmed by our knowledge of today and is to be considered the expression of an ever returning psychological mistake of botanists who, accustomed to a Western-Malaysian flora, on a slight eastward move expect (and hope) to find that much discussed and not easily attainable eastern element suddenly dominating.

TABLE V.

Totals of Tables III and IV.

Orchids							Other Phanerogams						
Geogr. group	Numb. of spec.	SW	SE	C	E	N	Geogr. group	Numb. of spec.	SW	SE	C	E	N
A. West	140	27	26	30	1	**81**	A. West	178	59	21	55	3	**60**
B. North	22	2	3	4	—	**15**	B. North	116	15	9	19	—	**80**
C. East	101	11	18	16	1	**69**	C. East	146	14	13	39	1	**79**
Total	263						Total	440					

TABLE VI.

Figures of Table V after application of the regional coefficients.

Orchids							Other Phanerogams						
Geogr. group	Numb. of spec.	SW	SE	C	E	N	Geogr. group	Numb. of spec.	SW	SE	C	E	N
A. West	140	**100**	91	87	21	81	A. West	178	**218**	74	160	63	60
B. North	22	7	11	12	—	**15**	B. North	116	56	32	55	—	**80**
C. East	101	41	**63**	46	21	**69**	C. East	146	52	46	**113**	21	79
Total	263						Total	440					

To try and extract more detailed conclusions from our data would in our opinion, be preposterous and presumptuous. It seems impossible at the time being, to give any procentual figures for the shares contributed to the Celebes flora by each of the bridges, as was done by the Sarasin's regarding the fauna, let alone to state the percentage of an eventual "old Asiatic element".

G. "ANOMALOUS" AREAS.

As has been stated above, most of the older investigators considered the Macassar Straits a very strong or even an absolute barrier to W.–E. or E.–W. migrations. The numerous plants connecting Celebes and the Sundaland were, in most cases, also found either in the Philippines or in the Lesser Sunda Islands or in both regions and it was therefore generally accepted that the above assumption was holding good for the Macassar Straits proper and that the migrations had passed Wallace's Line either north or south of it, or both.

However, in 1932 Van Steenis pointed out that there are a rather considerable number of groups which defy what was once considered a rule of general validity. He enumerates 16 genera, both of eastern and of western origin, belonging to 10 different families and each elucidated by an area map, which cross the Straits of Macassar without being known either from the Lesser Sunda Islands or from the Philippines. Van Steenis's attention was drawn to this "anomalous" category of areas by his study of the Malaysian *Styracaceae*, a typically continental family of which 6 species have penetrated into the Malay Peninsula and Sumatra (and 1 also into West-Java) and two are extending as far as New Guinea. These two, *Styrax agrestis* G. Don and *Bruinsmia styracoides* Boerl. & Koord. are known from Annam to New Guinea and from Sumatra to New Guinea respectively, being unknown from the Philippines (sometimes excluding Palawan) and the Lesser Sunda Islands. The mode of dispersal is not self-evident (animals ?), but it is probably slow.

Next to these two Van Steenis enumerates the following cases:
Soulamea (*Simarubaceae*), woody, monotypic. Borneo to Solomon Islands (lowlands). Of eastern origin. Mode of dispersal unknown.
Bromheadia (*Orchidaceae*), herb. Indo China to New Guinea (lowlands). Of western origin. Wind dispersal.
Schima (*Ternstroemiaceae*), woody. In Malaysia one or some few closely related species. Asia and Formosa to Palawan, Borneo, Celebes and West-Java (mountains). Of western origin. Mode of dispersal unknown.
Rhodamnia (*Myrtaceae*), woody. In Malaysia one species from Asia to Australia (lowlands to 1000 m). Of eastern origin. Wind dispersal.
Prainea (*Moraceae*), woody. Malay Peninsula, Sumatra, Borneo, Halmahera. Origin and mode of dispersal unknown. Perhaps not generically different from *Artocarpus*.
Deplanchea (*Bignoniaceae*), woody. Malay Peninsula and Sumatra to N.E. Australia. Of eastern origin, two species in the Sundaland. Wind dispersal.
Mastersia (*Leguminosae*), liana. India to New Guinea (one species). Of western origin. Mode of dispersal unknown.

Baeckea frutescens L. (*Myrtaceae*), woody. Australia to Asia. Of eastern origin. Wind dispersal.
Melaleuca (*Myrtaceae*), woody. One species from Australia to Malay Peninsula. Of eastern origin. Mode of dispersal unknown.
Pericopsis (*Leguminosae*), woody. Ceylon to Moluccas and Talaud. Of western origin. Mode of dispersal unknown.
Barclaya (*Nymphaeaceae*), aquatic plant. Asia to Malay Peninsula, Sumatra and Borneo, also in New Guinea. Origin and mode of dispersal unknown.
Sloetia (*Moraceae*), woody. India to Celebes. Of western origin. Dispersal by animals.
Lepironia (*Cyperaceae*), herb. One species from Madagascar to Fiji from sealevel to about 1100 m alt. Origin and mode of dispersal unknown.
Claderia (*Orchidaceae*), herb. Sumatra to New Guinea. Origin unknown. Wind dispersal.

It is obvious that these instances are of very different phytogeographical value. They have very little in common but that none of them is known from the Philippines proper (Palawan sometimes excluded), from the Lesser Sunda Islands (except *Melaleuca* in Timor) and from C. and E. Java. Only in 4 out of the 16 cases mentioned the area includes a small portion of W. Java, a region which is considered to belong phytogeographically to Sumatra rather than to Java proper.

In connection with the results of the present paper, we may add to Van Steenis's list the following data:

1. Our area-category XI (Borneo-Celebes) with 23 species (12 endemic). The 8 Orchids not mentioned above are:
   1. **Adenoncos celebicus* Schlecht. (r; N)
   2. * „ *macranthus* Schlecht. (r; C)
   3. **Apostasia celebica* J. J. S. (r; SE)
   4. **Arachnis celebica* (Schlecht.) J. J. S. (r; all)
   5. **Cystorchis celebica* Schlecht. (r; C, N)
   6. **Dipodium Ferrellii* J. J. S. (r; SE)
   7. *Habenaria damaiensis* J. J. S. (N)
   8. **Nephelaphyllum laciniatum* J. J. S. (r; SE)
2. Our area category III (Sundaland-Celebes-Moluccas) with 13 spceies (2 endemic).
   The 4 Orchids not mentioned above are:
   1. *Bulbophyllum odoratum* Lindl. (Malay Peninsula, Borneo, Java, Celebes, Amboina, Boeroe).
   2. * „ *Steffensii* Schlecht. (r)
   3. * „ *tylophorum* Schlecht. (r)
   4. *Sarcanthus subulatus* (Bl.) Reichenb. f. (India and Indo China, Malay Peninsula, Batoe, Sumatra, Borneo, Java, Celebes, Amboina, Boeroe, Ceram).
3. Our area category XXII (New Guinea-Moluccas-Celebes-Borneo) with 5 species.
   The Pteridophyte not mentioned above is:
   1. *Tapeinidium moluccanum* (Bl.) C. Chr.

4. Six species of our area category I (Sundaland-Celebes) which do not occur in Java and have therefore probably not reached Celebes by means of the Java-bridge. They are:
   1. *Blastus Cogniauxii* Stapf
   2. *Nepenthes gracilis* Korth.
   3. *Otanthera celebica* Bl.
   4. *Palaquium obovatum* (Griff.) Engl.
   5. *Pouteria malaccensis* (Clarke) Baehni
   6. *Santiria laevigata* Bl.
5. The following species mentioned by Van Steenis and not inserted in one of our lists:
   1. *Dendrobium Lobbii* T. et B. (syn. *D. calcaratum* Lindl., *D. conostalix* Reichenb. f., *D. Teysmannii* Miq.) (Siam, Singapore, Sumatra, Bangka, ? Borneo, Celebes, closely related to other species from these regions and from New Guinea).
   2. *Gnetum macrostachyum* Hook. f. (Malay Peninsula, Sumatra, W. Java, Borneo, New Guinea).
   3. *Nepenthes ampullaria* Jack (Malay Peninsula, Sumatra, Borneo, New Guinea)
6. One Orchid of our area category XIX (Moluccas-Celebes):
   1. *Trichoglottis geminata* (T. et B) J. J. S. (also in Borneo).
   More or less to the same group belong:
7. One Orchid species of our area category XXIV (New Guinea-Moluccas-Talaud):
   **Microstylis talaudensis* J. J. S. (r; also related to N. Celebes species).
8. Our area category XVII (Talaud-Celebes) with 13 species (1 endemic). The Orchid not mentioned above is:
   Microstylis trigonopetala J. J. S.
9. Certain species of our area categories XIX (Moluccas-Celebes) and XX (New Guinea[-Moluccas]-Celebes), viz. inasfar as they have probably not reached Celebes by means of the Moluccan bridge. Notably this might be assumed for such species as are only occurring in (known from) N. Celebes (38 endemic).

Cat. XIX. Orchids:
1. *Bulbophyllum amplebracteatum* T. et B.
2. „ *klabatense* Schlecht.
3. *Dendrobium concavum* J. J. S.
4. * „ *mirandum* Schlecht. (r)
5. „ *Rumphianum* T. et B.
6. **Luisia celebica* Schlecht. (r)
7. *Pomatocalpa Koordersii* (Rolfe) J. J. S.
8. *Saccolabium Rumphii* J. J. S.
9. *Trichoglottis Koordersii* Rolfe (but related to Philippine species)
10. **Vanda celebica* Rolfe (r)
11. **Zeuxine viridiflora* J. J. S. (r)

Other Phanerogams:
1. *Albizzia Minahassae* Koord.
2. *Amomum roseum* (T. et B.) Benth. & Hook.[1])

([1]) also in Talaud)

3. *Buchanania amboinensis* Miq.
4. *Diospyros Rumphii* Bakh. [1])
5. *Elatostema polioneurum* Hall. f. [1])
6. *Ficus adenosperma* Miq.
7. *Hemigraphis stenophylla* Hall. f.
8. *Homalium minahasae* Koord.
9. *Itoa Stapfii* (Koord.) Sleum.
10. *Medinilla crispata* (L.) Bl.
11. „ *ternatensis* Miq.
12. *Mischophloeus paniculatus* (Scheff.) Scheff. [1])
13. *Polyscias Rumphiana* Harms (also in Timor) [1])
14. *Schuurmansia elegans* Bl.

Cat. XX. Pterid.: 1. *Dipteris novo-guineensis* Posth.

Orchids:
1. **Agrostophyllum simile* Schlecht. (r)
2. **Bulbophyllum aberrans* Schlecht. (r)
3. * „ *codonanthum* Schlecht. (r)
4. * „ *subuliferum* Schlecht. (r)
5. **Cheirostylis quadrilobata* Schlecht. (r)
6. **Dendrobium amblyogenium* Schlecht. (r)
7. „ *confusum* Schlecht.
8. * „ *cultratum* Schlecht. (r)
9. * „ *Eickhardtioides* Schlecht. (r)
10. * „ *masarangense* Schlecht. (r)
11. * „ *parvulum* Rolfe (r)
12. „ *rhipidolobum* Schlecht.
13. * „ *sororium* Schlecht. (r)
14. * „ *speculigerum* Schlecht. (r)
15. * „ *stenophyton* Schlecht. (r)
16. * „ *suaveolens* Schlecht. (r)
17. **Dipodium gracile* Schlecht. (r)
18. **Epiblastus masarangicus* (Kraenzl.) Schlecht. (r)
19. **Eria oreogana* Schlecht. (r)
20. * „ *rhizophoreti* Schlecht. (r)
21. **Glomera celebica* (Schlecht.) J. J. S. (r)
22. **Malleola Steffensii* J. J. S. et Schlecht. (r)
23. **Microstylis klabatensis* Schlecht. (r)
24. * „ *mambulilingensis* J. J. S. (r)
25. * „ *trichopoda* Schlecht. (r)
26. * „ *umbraticola* Schlecht. (r)
27. **Oberonia celebica* Schlecht. (r)
28. **Pholidota celebica* Schlecht. (r)
29. **Phreatia klabatensis* Schlecht. (r)
30. **Podochilus Minahassae* Schlecht. (r)
31. * „ *truncatus* J. J. S. (r)
32. *Sarcochilus platyphyllus* F. v. M.
33. **Taeniophyllum ficicola* Schlecht. (r)
34. *Thrixspermum Loogemanianum* Schlecht.
35. * „ *tylophorum* Schlecht. (r)

36. **Vanilla platyphylla* Schlecht. (r)
37. **Vrydagzynea celebica* Schlecht. (r)
38. **Zeuxine Minahassae* Schlecht. (r)

Other Phanerogams: 1. *Canarium oleosum* Engl. (also in Timor)
2. *Gnetum gnemon* L., var. *silvestre* (Brongn.) Parl.[1])
([1]) also in Talaud) 3. *Gomphandra australiana* F. Muell. [1])
4. *Medinilla crassinervia* Bl.
5. „ *rosea* Gaud. (also in Marianas)
6. *Vernonia lanceolata* (Warb.) Mattf. [1])

Altogether the "anomalous" group comprises some 16 genera (many of which, however, represented by only one or by a few species) and moreover 135 species (of which 2 Pteridophyta and 65 Orchids), with areas which are not in accordance with our current views on migration tracks on account of geologically justified connections. Of these 135 species, however, 54 (of which 48 Orchids) are endemics whose insertion in a certain area category is based upon relationship. If these are left out there are, beside Van Steenis's 16 genera, 81 species (of which 2 Ferns and 17 Orchids), say about 100 species. This seems a group too numerous to be ignored. Yet, much of its importance is lost on considering its heterogeneity. Unless we know much more about the species concerned we are utterly unable to produce any satisfactory theory towards the explanation of these anomalous areas. What we have to do to this purpose is to to investigate for each individual species its probable mode of dispersal and as much of its taxonomical and geographical history as possible. We have merely mentioned the above species as an extension to Van Steenis's list and in order to draw the attention of future investigators to these interesting areas. Van Steenis failed to discover any common element to his 16 genera and though unable to offer any explanation, seems inclined to look for a possible common feature in the mode of dispersal. To us, however, it seems, provisionally, that there are a great many possibilities such as:

1. A species may belong to an ancient, e. g. Tertiary flora and it (or its direct ancestors) may have reached the island in times when the land and sea configuration may have been entirely different compared with the present one. This possibility seems not to have occurred to Van Steenis. Still it means that a species belongs to what is often called an "old invasion". Curiously enough, this term is always thought of in connection with Asia. Never, or very rarely, it is applied to the eastern element and though this is undoubtedly much poorer and probably also provided with less favourable communications than the western one, it should not be entirely neglected. Accordingly, every species of this group, and possibly many others, are to be checked as to whether or not they may belong to an ancient family, the distribution of which may be naturally incoherent with present conditions.
2. It is possible that a species has disappeared from a region which nowadays is considered a former land connection. For instance, it might be suggested that some species which are now lacking in Java or are found only in West-Java, have vanished, as, in fact, has been

proved by certain fossils (*Dryobalanops* and *Shorea* in West-Java. Such an event may have been caused by geological actions as well as by the activities of man.

3. An "anomalous" area may have been brought about by
   a. polytopic origin,
   b. chance dispersal.
4. An "anomalous" area may merely be an incompletely known one, which on account of subsequent discoveries will appear to become a perfectly "normal" one.

These considerations seem sufficient to prevent any premature and far-reaching conclusions. We therefore leave this matter to future investigators and will summarize our views on the phytogeography of Celebes in the following conclusions.

3. CONCLUSIONS (cf. *Fig. 4*).

From earlier as well as from the present investigations the following conclusions may be drawn:

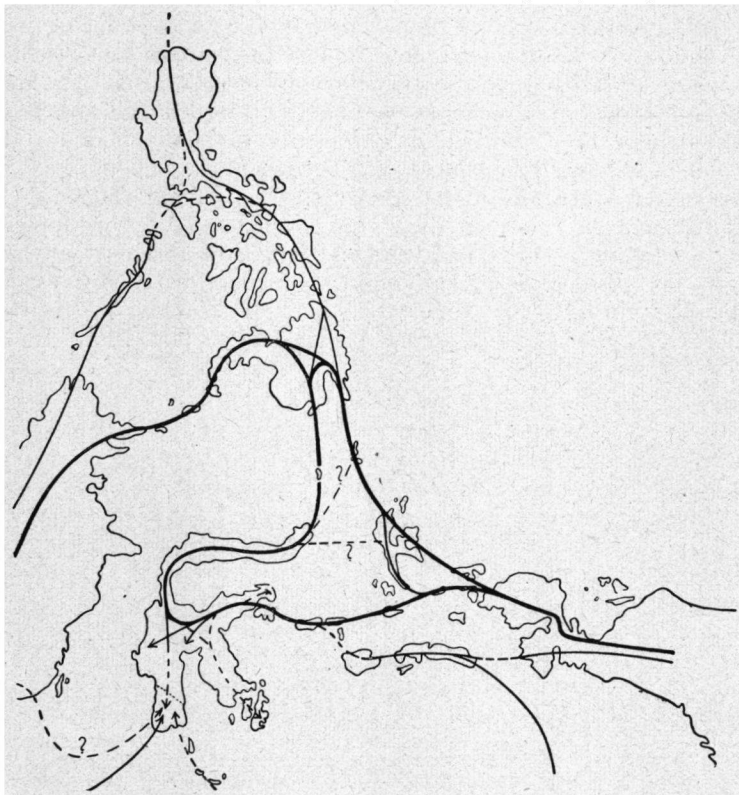

Fig. 4 — Principal migration tracks in and around Celebes; the weaker ones have been indicated by broken lines, doubtful ones by an additional interrogation mark, main tracks somewhat heavier than secondary ones.

1. Phytogeography differs greatly from Zoogeography both in methods and results. Owing to our lack of knowledge concerning the modes of dispersal and the apparent want of certain species being restricted to definite modes of dispersal, the results of Historical Phytogeography are often much less reliable than those of Zoogeography. They have often to be obtained by statistical rather than by direct methods. Before really trustworthy conclusions may be expected, great numbers of species will have to be checked relative to their possible taxonomical and geographical history. Special attention should be given as to whether or not land-connections are probably essential regarding the dispersal. Mountain (alpine) species should be considered separately, as they are probably more independent of former landbridges than low-land species are.
2. Ancient invasions of plants into Celebes, either from the West or from the East, as have been assumed for the fauna, may have taken place, but are as yet unproved. Species with "anomalous" areas (cf. point 10) as well as many others should be checked as to their possible belonging to any of these ancient flora stocks.
3. Of the supposed "younger" infiltrations — whose age, for lack of paleobotanic research, is by no means proved either —, several may be well in accordance with the Sarasin's land-bridges, though the nature of the material does not allow such (apparently) well-founded procentual proportions as have been given regarding the fauna.
4. As has been illustrated by *Fig. 4* the main outside connections of the Celebes flora are a number of migration tracks which have been constructed on account of plant areas and checked with the results of geological research.
5. Most distinct is the Philippine track. Representatives of this element have probably entered through the Sangihe Islands chain, albeit possibly in a different configuration. This is suggested by geological research but phytogeographically it cannot be proved on account of the fact that the flora of these young-volcanic islands is very strongly influenced by the dense population, and that its vestiges have never been thoroughly investigated.

   Although there are a number of species (cf. point 10) which are only known from Talaud and N. Celebes, it is, on geologic grounds, not probable that a direct migration track from Mindanao to Celebes has run through these islands. A strong track, however, runs from New Guinea and the Northern Moluccas via Talaud to the Philippines v.v. (cf. Holthuis and Lam, l. c.) and it may be assumed that many of its species have reached Celebes through Sangihe, though they meanwhile may have disappeared — e.g. by recent volcanic, tectonic or human action — or have not yet been discovered there.

   Representatives of the Philippine element have penetrated very far down south. Many species have even reached C. or SW. Celebes (25 and 13 out of 65 species of our area category XIV respectively), which may mean either that — inasfar as land-connections were essential for them — they have very recently arrived, or that a land-

connection between SW. and C. has existed during a longer period or for more numerous times than has thusfar been assumed by geologists.

6. Another fairly distinct track is that between Java and SW. Celebes, though its influence up north is distinctly weaker (8 out of 45 species of our area categories V—X reached N. Celebes) than that of the Philippine element in the south. Again its course is difficult to reconstruct owing to the lack of our knowledge of the original forest flora of Salajar c.a., which moreover is apparently of a recent date and partly strongly influenced by man (cf. Docters van Leeuwen, l. c.). Geological research suggests that it runs through the Salajar archipelago and Kangean and as far as the flora of the latter islands is concerned this is phytogeographically supported (*Canarium commune* L., Moluccas to Kangean!).

   Although the present study does not deal particularly with mountain plants — whose dispersal is, as a rule, less dependent from land-connections than that of lowland plants — it should be reminded here that Van Steenis (1936) has clearly shown the importance of the Java-track for SW. Celebes. The flora of this region — particularly the Peak of Bonthain flora — is "less markedly Asiatic than (that of) the Lesser Sunda Islands"; out of 44 temperate species, "clearly belonging to some track", 59 % belonged to the Java track, 23 % to the Philippine track and 18 % to the Moluccan (New Guinea) track. The representatives of the northern and the eastern elements increase rapidly — perhaps even suddenly — in number as one moves northward and this marks the floristic boundary between SW en C. Celebes, also alluded to in the present study. It is possibly though by no means proved as yet that this boundary coincides with the so-called Tempe-depression. In 1938 (p. 732) Van Steenis rightly produced the Philippine track southward so as to include the whole of SW. Celebes.

   At present it seems impossible to discriminate between eventual representatives of a Java track and a Flores track. Much more detailed research is needed to enable such a subtle conclusion.

7. The relations to the Moluccas are much more confused. This is mainly due to our very scanty knowledge of the flora of the Banggaai Archipelago and of E. Celebes. As it is, the Moluccan and Papuan elements (area categories XIX and XX) seem to be manifestating themselves mainly in two districts, C. and in N. Celebes. Whilst the former district, in view of our very imperfect knowledge of the E. Celebes flora, may be supposed to represent the outcome of a Central Moluccan track, the Moluccan and Papuan relations of N. Celebes (without intermediary of the Philippines) are still insufficiently explained (cf. points 5 and 10). A thorough investigation of C. and E. Celebes is urgently needed and we may look forward with high expectations to the results of the late Dr Eyma's exploration of 1938.

8. As has already been pointed out by Hallier, there are so far no phytogeographical indications that SE. Celebes has ever been inhabited from the Lesser Sunda Islands. This is in accordance with the results of geological research. It looks as if the flora of this peninsula is entirely

hailing from C. Celebes, through which it may have got its representatives of the western, northern and eastern elements.

9. The main connection between Borneo and Celebes seems to have run through the Philippines. As has been pointed out by Merrill, the islands of Palawan, Culian and Busuanga belong to the Sunda-shelf rather than to the Philippines proper and this land-bridge seems to have been interrupted at an early date between the last-named island and Mindoro. The main track probably runs via the Sulu-bridge and Mindanao, where it joins the Philippine track. Another possible but as yet obscure connection might be supposed in the extreme south, where it, some time, may — or may not — have joined the Java track. This suggestion is to a certain degree supported by the submarine configuration (cf. *Fig. 2*); for the time being, it cannot be proved phytogeographically.

10. A not inconsiderable number of areas do not comply with the above rules, based upon geologically justified area categories. They are mainly referring to two connections, for which no geological basis has been found, viz. that between Borneo and Celebes without an intermediary of the Philippine- or the Java-bridge, and that between the Moluccas (and Talaud) and Celebes without an intermediary of the Philippines or the Lesser Sunda Islands. This group of areas, however, is too heterogeneous to suggest a general cause or to necessitate a fundamental change in the above rules. A thorough investigation as to the individual taxonomical and geographical histories of the species involved is needed before the importance of this group as such can be judged. More particularly their eventual belonging to one of the "ancient invasions" (cf. point 2) should be considered.

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APPENDIX.

List of the principal botanical collectors in Celebes.

(pro = on behalf of)

Southwest-Celebes.

H. A. B. BÜNNEMEIJER — Bonthain c.a. (III—VI. 1921).
W. M. DOCTERS VAN LEEUWEN — Makasar, Salajar, Djampea, Bonerate, Kajoeado, Kalaotoa (V. 1913).
FORESTRY EXPERIMENT STATION (pro) — Bonthain, Salajar.
C. MONOD DE FROIDEVILLE (XII. 1937—IV. 1939)
NOERKAS and RACHMAT (pro L. VAN VUUREN) — Makasar, Bone, Balangnipa, Lake Tempe, Takalar (IV. 1912—VII. 1913).
P. and F. SARASIN — Peak of Maros (VI—VII. 1895), Lompobatang (IX—XI. 1895), div. loc. (IV—VII. 1902; XII. 1902—II. 1903).
J. E. TEYSMANN, 1877 — Pare-pare (VII), Pangkadjene (VII—VIII), Balehangin near Maros (IX), Maros and Boeloe-boeloe (IX), Bonthain (X), Salajar (XI—XII).
L. VAN VUUREN, see under NOERKAS and RACHMAT.
O. WARBURG — Peak of Bonthain c.a. (Balangnipa [1]), Bikeroe, Tasoso, Manipi, Tjamba, Maros) (XI—XII. 1888).
H. ZOLLINGER — Makasar c.a., Salajar (VII. 1847).

Other collectors in this region are:

BARCLAY (Makasar); O. BECCARI (Makasar—XII. 1873—I. 1874); Mrs. A. BOUMAN—HOUTMAN (Makasar, Djeneponto, c.a.); BRÄUTIGAM (Bone; pro HEYNE?); F. B. DUTRIEUX (Makasar; 1937); A. H. EVERETT (Peak of Bonthain); P. J. EYMA (Malino; 1939?); (pro) K. HEYNE; J. B. HOMBRON (Makasar; V. 1839); G. K. KJELLBERG (Makasar,

[1]) Balanipa, according to W. in "Monsunia" I, 1900, p. VII. According to Van Vuuren's map, the orthography should be Balangnipa, unless the Balanipa District in Mandar-Madjene is meant instead of, as I think is the case, the coastal village in Bonthain-Sindjai.

Bonthain; III and VI. 1929; I. 1930); J. A. LÖRZING (Malino); M. PICICELLI (III. 1914); O. POSTHUMUS, 1930, 1932 (i.a. Malino); A. RANT (Makasar, Malino; X. 1931); (pro) G. E. RUMPHIUS (Makasar, end 17th century); SCHAEPMAN (Peak of Bonthain); R. SCHLECHTER (Makasar; XI. 1909 and II. 1910); TENGWALL (Pinrang and Saädang Valley; IX. 1924); TOLSON (Gowa); A. R. WALLACE (1856, 1857); MAX WEBER (1889); J. VAN ZIJLL DE JONG (1933).

Southeast-Celebes.

O. BECCARI — Kendari (II—VIII. 1874).
J. ELBERT, 1909 — Toekang Besi (VII), Moena (VII—VIII), Kolaka (G. Mengkoka) and Roembia (IX), Kabaëna (X), Boeton (VIII, IX and XI).
FORESTRY EXPERIMENT STATION (pro) — Boeton, Moena, Kabaëna, Saloeang.
C. GRÜNDLER (pro J. ELBERT) — Kabaëna (X. 1909).
HAM — Moena.
HEINRICH — G. Mengkoka (Kolaka).
W. A. KAUDERN — Kolaka (VI. 1919).
G. K. KJELLBERG, 1929 — Boeton and Moena (II), Kendari, Kolaka, Watoewila (II—IV).
C. MONOD DE FROIDEVILLE (XII. 1937—IV. 1939).
NOERKAS and RACHMAT (pro L. VAN VUUREN) (VIII. 1912—I. 1914).
P. and F. SARASIN — Moena, Kendari, Mengkoka (II—III. 1903).
L. VAN VUUREN, see under NOERKAS and RACHMAT.

Central-Celebes.

S. BLOEMBERGEN — Lindoe-lake and G. Ngilalaki (Paloe) (VII. 1939).
P. J. EYMA and C. G. G. J. VAN STEENIS — G. Latimodjong c.a. (1937).
P. J. EYMA — Lake Matano and L. Poso c.a. (1938).
FORESTRY EXPERIMENT STATION (pro) — Malili, Oesoe, Parigi, Paloe, Donggala.
W. A. KAUDERN, 1918 — Paloe, Koelawi, Koro, Kantewoe (IX), Bada, Poso, Mori.
G. K. KJELLBERG, 1929 — Enrekang c.a. (V), Palopo (VI—VII), Todjamboe (VII), Malili and Towoeti-lake c.a. (VIII—XII).
C. MONOD DE FROIDEVILLE (XII. 1937—IV. 1939).
NOERKAS and RACHMAT (pro L. VAN VUUREN) — Madjene, Enrekang, Mamoedjoe, Mandar (Polewali), Loewoe (Belandai), Palopo, Tomori (VI. 1912—XI. 1913).
P. and F. SARASIN — Palopo to Poso (I—III. 1895, Oesoe to Tomori (II—III. 1896), Paloe to Palopo (VII—XI. 1902), Enrekang c.a. (VII—VIII. 1895).
C. G. G. J. VAN STEENIS, see under P. J. EYMA.
F. K. M. STEUP (pro FORESTRY EXPERIMENT STATION) — Paloe, Poso (1929—1933).
L. VAN VUUREN, see under NOERKAS and RACHMAT.

Other collectors in this region are:

E. C. ABENDANON (1910—1911); LE COCQ D'ARMANDVILLE (Malili); GÄUMANN (Palopo, X. 1921); pro K. HEYNE (Loewoe, Poso); PESIK (Paloe, XI. 1928); O. POSTHUMUS (Paloe, Lindoe-lake, XI. 1930); R. SCHLECHTER (Donggala; XI. 1909 and II. 1910); C. G. G. J. VAN STEENIS (Saadang-valley, VI. 1937).

East-Celebes.

W. A. KAUDERN — Loewoek, Banggaai Isl. [(1917?—)1920].
P. J. EYMA — G. Loemoet, Loewoek, Wana distr. (1938).

North-Celebes.

FORESTRY EXPERIMENT STATION (pro) — Minahasa, Kwandang, Boalemo, Gorontalo.
E. A. FORSTEN — Minahasa (V—IX, 1840).
C. HOSE — Minahasa (1894—1895).
W. A. KAUDERN — Bolaang Mongondow, Minahasa: Goeroepahi (III—XII. 1917; I. 1919; II. 1920).
S. H. KOORDERS — Minahasa (XII. 1894—V. 1895).

H. J. LAM, 1926 — Minahasa (IV), Talaud Isl. (V—VI).
C. G. C. REINWARDT — Minahasa (Amoerang, G. Klabat, G. Lokon) and Gorontalo (IX—XI, 1821).
J. G. F. RIEDEL — Minahasa, Gorontalo (1864—1875 → ?).
R. SCHLECHTER — Minahasa, Toli-toli, Paleleh, Bolaang Itang, Sangkoep (XI. 1909—II. 1910).
F. C. and H. F. STEFFENS (pro —, pro R. SCHLECHTER) — Minahasa (1909—1911).
F. K. M. STEUP (pro FORESTRY EXPERIMENT-STATION) — Minahasa, Bolaang Mongondow, Boalemo (1931—1936).
P. and F. SARASIN — Minahasa (VI—XI. 1893; I—VIII. 1894; IX—XI. 1894; III—V. 1895), Gorontalo (XI. 1893—I. 1894; III. 1895), Boeol to Marissa (VIII—IX. 1894).
J. E. TEYSMANN and W. H. DE VRIESE — Minahasa (beginning 1860).
O. WARBURG — Minahasa (VIII. 1888).

Other collectors in this region are:

Asst. Vet.-Surgeon of Gorontalo (Gorontalo, 1928); W. J. D. VAN ANDEL (Boeol); BEHAGEL (Gorontalo); HEES (Gorontalo, 1900); H. A. GUSDORF pro K. HEYNE; E. J. JELLESMA (1892—1903); G. KARSTEN (1889); T. S. A. KNIJFF (Minahasa); KRUYFF (Minahasa); P. A. LESSON (Minahasa; VII—VIII. 1828); WL. ROTHERT (Gorontalo, V. 1909); E. DE LA SAVINIERRE (Minahasa, ± 1877); J. J. SMITH (Minahasa, 1900); General DE VOOGT (Paleleh); VORDERMAN (VI. 1897); A. R. WALLACE (VI—IX. 1859); WISSE.