The Origin and Introduction of the Basic Food Crops of the New Guinea People.

G. P. KELENY.

Plant Introduction Officer, D.A.S.F., Port Moresby.

This Paper was presented at the UNESCO Symposium on the Vegetation of the Humid Tropics, Goroka, September, 1960. Also published in the Proceedings of the Symposium. Now slightly revised.

Introduction.

IN this section of the Symposium we are considering the influence of plant introduction on the food habits of early man. One might be inclined to assume that relatively primitive communities, living under fairly isolated conditions and practising subsistence agriculture are likely to be utilizing mainly locally occurring, endemic species of food plants. This, however, is not so. Even a cursory glance will reveal broad patterns of food utilization over a wide area of South-East Asia and the Pacific, indicating a considerable dispersal or exchange of the basic subsistence crops.

Phytogeographical Regions.

On examining the geographical distribution of plants in this part of the world one notices the strategic position and special importance of the Malay Archipelago in acting as a land bridge between various phytogeographical regions, and also as a focus for the dissemination of plants. To the north of the Archipelago lies the Continental South East Asiatic Region, comprising Southern Burma, tropical South China, Formosa, Thailand, Annam and the Malay Peninsula. The endemic genera of this area are estimated at over two hundred but its flora is essentially part of the Malay Archipelago. Many cultivated economic crops, rice, tea, some members of the Genus *Citrus* and *Cinnamonum* probably originate from this region.

Van Steenis in his work on the montane florae of the Malay Archipelago traces two distinct routes for the distribution of species between the Asiatic mainland and the Archipelago, one via India, Malay Peninsula, Indo-China, Java and Sumatra and the other by way of China, Japan, Formosa, the Philippines and North Celebes. But there is also a third element contributing to the richness of the flora; from Australia by way of New Guinea, Celebes, Borneo and the Philippines. Geographical proximity has not always resulted in a similar flora, e.g., Java is much closer to the Australian continent, yet has very few Australian types in its flora compared with the Philippines where numerous Australian genera are found fairly well distributed even to Northern Luzon.

Geographically, the Malay Archipelago has three zones, Asiatic in the west, Australian in the east and an intermediate zone. It is also evident that the flora and fauna show similar divisions. Generally speaking, in the island region, the Asiatic and continental types become less dominant as one proceeds to the south and east, and at the same time Australian species which are strongly represented in New Guinea become less dominant as one progresses north and west.

The vegetation of the Malay Archipelago is probably the richest and most luxuriant in the world. Growing conditions favour plant growth and contributions were received from many sources on the Asiatic continent, yet the number of endemic genera is very large, probably in excess of five hundred. The degree of endemism varies from island to island. New Guinea has the highest, it is variously estimated at 150 genera or 85 per cent. of the total; Borneo and the Philippines are considered to have approximately 100 genera each or approximately 50 per cent. followed by Java and Sumatra, the latter having only about 20 genera. Some of the more important species originating from this region are *Areca Catechu, Arenga saccharifera, Artocarpus integer, Artocarpus incisa, Boehmeria nivea, Calamus* sp., *Canarium Luzonicum, Colocasia esculenta, Curcuma* sp., *Durio zibethinus, Eugenia* spp., *Garcinia mangostana, Mangifera indica, Metroxylon Rumphii, Musa textilis, Myristica fragrans, Nephelium lappaceum, Piper betle, Piper cubeba, Zingiber officinale.*

In contrast to the above regions, Melanesia, Polynesia and Micronesia, except for Hawaii and New Caledonia, have essentially a flora derived almost entirely from the Malaysian and Australian zones. Even in Hawaii the majority of indigenous genera are of Malaysian origin, although most of the species in these genera are different from those that occur in the Western Pacific region. Micronesia has six endemic genera listed, while twenty-three were recorded for Polynesia. Fiji has perhaps 50 per cent. of endemism, Tahiti 35 per cent. and Samoa rather less.

Considering the high degree of endemism of the flora of New Guinea and the supposed isolation of its people, who, prior to the arrival of Europeans, lived in a state of constant warfare with each other, one would expect that the majority of the basic subsistence food plants would be indigenous to the area. However, of the major basic foodcrops of the New Guinea peoples only the *Musa* spp., *Saccharum* spp. and sago *Metroxylon* spp. could be regarded as originating there. All the others : taro *Alocasia* spp., *Colocasia* spp., yam *Dioscorea* spp. and the sweet potato *Ipomoea batatas*, must be considered to have been introduced at one stage or another. Moreover, human agency is the most likely means by which they were distributed. Who were the people and where did they come from ?

Origin of the New Guinea People.

There is no certainty of the origin of the peoples of the island of New Guinea, who are extremely diverse in their physical type and language. At the time of the arrival of the first Europeans they were using only stone, wood or bone implements but no metal of any kind. Several hypotheses were advanced, yet the views of Strong (1920) though written forty years ago, still seem to be valid. It is generally held that there are three main constituents in the native population of Papua and New Guinea. The original inhabitants called Negritoes—allied to the Negritoes of the Andamanese Islands and the Malay Peninsula—are short or dwarfish, live in isolated communities towards the centre of the island, e.g., the Jimmi River, the Kuku-Kuku, and around Mount Yule. Although taller, the aboriginal population of Tasmania is supposed to have been related to the Negritoes.

It is supposed that after the Negrito, came a race spoken of as " Papuans ". They are a medium tall, fairly dark race. Allied races can be found in some of the Malayan Islands. In some far off prehistoric time the primitive " Papuan " drove the still more primitive Negrito to the central mountains. The result is that the mountains are populated by people tending towards the Negrito type, whilst at lower levels the population is tending toward the " Papuan " type.

The " Papuans " were followed by at least one major invasion—the Melanesians. They have settled along the coast and are now so mixed with the " Papuans " that it would be difficult to distinguish them, but for the fact that they have retained their own type of language. The Melanesians are found in many areas along the coast of Papua and New Guinea and the adjacent islands extending to the Solomons, New Caledonia and Fiji. The immigrants or invaders have, in many cases, imposed their language and probably their culture on the " Papuan ", but their numbers were comparatively small and they have inter-married with the " Papuans " to such an extent that, physically they have approximated the " Papuans ". Nevertheless, they tend to be lighter in colour. The original Melanesian was probably straight-haired and relatively light-coloured, more comparable with the present day Malay or Polynesian.

The original home of the Melanesians is placed somewhere in Southern Asia. From there they have spread both east and west and their descendants can be traced in the languages from Madagascar to the Malay Peninsula and Archipelago right to Polynesia. The early Melanesians were probably the first seamen of the Pacific, travelling in outrigger canoes, which are typical of the area of their influence. The migration of Melanesians or Malays has continued until comparatively recent times, e.g., the culture hero of the Motu people living at Port Moresby is Hedai Siabo, a Malayan, who taught them the building of the large trading canoe and organized the annual trade journey, the Hiri, towards the west to obtain sago. Similarly, the Hula people, living about seventy miles east of Port Moresby show distinct signs of their Malay ancestry, being light-skinned, straight-haired and having the characteristic eye-fold.

The Negritoes are still mainly hunters and gatherers of roots, leaves, nuts, berries of the forest. Agriculture plays only a small part in

their economy, so it is unlikely that they were responsible for the introduction of food plants into New Guinea. Therefore the "Papuans" and Melanesians are probably the people who brought in most of the basic food plants used today.

Origin and Distribution of the Basic Foods.

Starchy foods form the basic subsistence diet of the people of New Guinea and the plant supplying it varies from district to district. It may be taro *Alocasia* and *Colocasia* spp, yam *Dioscorea* spp., banana *Musa* spp., sago *Metroxylon* spp., or sweet potato *Ipomoea batatas*. One or more of the above might be present in the same area, but the dominant subsistence crop is invariably well defined.

Degener (1946) gives India as the type habitat of *Dioscorea* sp. while *Alocasia* and *Colocasia* originate probably from Malaysia, thus their introduction into New Guinea may be explained through the migration of the people. The name of a crop throughout a region is often a good indication of its origin and dispersion, e.g., throughout the Malay archipelago to the Philippines and New Guinea the yam *Dioscorea* sp. is called by names such as ubi, uebi, uwi huwi, while in Polynesia as far east as Hawaii and the Marquesas, the same name appears as ui, ufi, uhi, pahui. For taro *Colocasia esculenta* we find throughout Indonesia names such as: tale, talo, talas, taleh talos, taleus, gelo, tales, talak, which are comparable with dalo used in Fiji.

The bread fruit *Artocarpus* sp., is not as important as a food crop in New Guinea as it is in Polynesia, but being a plant of the Malay Archipelago its introduction follows the same pattern. Similarly, the coconut, *Cocos nucifera* is seldom the principal item of the diet, as it is on many atolls in Polynesia, but is mentioned because it is regarded as one of the most characteristic plants and crops of the Pacific. It is a Pan-Pacific species with its origin probably along the shores of the Indian Ocean. Man is considered the agent of its distribution, reaching Madagascar on the one hand and Hawaii on the other. The name for the coconut throughout the Malay Archipelago and Polynesia comes within the niu, -nia, -niue, -niog series of names, demonstrating how the name was transmitted by man along with the plant throughout his travels. This view is supported by de Candolle (1882) who comments that "the uniformity of nomenclature in the archipelago as far as Tahiti and Madagascar indicates a transport by human agency since the existence of known languages". Incidentally both Dampier and Moresby recorded the palm as growing in abundance along the shores of New Guinea and on the Islands of Torres Strait. In the Western Hemisphere, in tropical America, the name of the palm is based on "coco"—its Portugese name, demonstrating that they were probably the human agents introducing it to that part of the world.

Ridley (1930) advances the theory that the original home of the coconut must have been in Costa Rica and Panama. He is relying mainly on an account by the Spanish traveller Oviedo who visited Panama in 1515 and claims to have seen the coconut there. Peter Martyn in *Hakluyt's Voyages* 1520 describes the coconut from both the Moluccas and in Panama. A much earlier record is that of Marco Polo who mentions the occurrence of the coconut in Sumatra, Nicobar, Andamans and in Madras and Malabar in 1280. Coconut palms are represented in the carvings of both Angkor-Wat in Cambodia and the Borobodur in Central Java, dating from the Tenth to Twelfth Centuries. Ridley (1930) considers that the coconut must have reached Polynesia from America through nuts carried by ocean currents, and has spread from there to Malaysia and the Asiatic mainland by both sea-drift and human agency some thousands of years ago. However, he seems to overlook that most of the migration of the people was from the Asiatic mainland towards the islands of the Pacific and not vice versa, and that the American flora is barely represented in Polynesia, whereas those of Malayan origin are predominating. Ridley's hypothesis, though interesting, represents an earlier view, which is largely superseded.

The distribution of the sweet potato *Ipomoea batatas* which is the basic foodcrop of the people of the New Guinea Highlands presents an interesting problem in plant geography. In the whole of the island, population densities reached their highest level in the Highlands—and this is attributed to the presence of the culture of the sweet potato—in other words, there is a symbiotic relationship between man and the sweet potato. The question is when and how was the sweet potato—a species of the new world—introduced into the Highlands

of New Guinea ? If it is only a recent introduction, following European contact with Malaysia, then the population in their present densities must have developed only recently. It is interesting to note that throughout New Guinea, and particularly in the Highlands, stone pestles and mortars are unearthed from time to time. These stone implements are not part of the culture of the present population and they know nothing of them, neither do they utilize them in their everyday life. These stone mortars must be a relic of a previous population or perhaps the ancestors of the present people used them before the introduction of the sweet potato, following which their use was no longer necessary and was forgotten. These mortars are of various sizes with a diameter of a few inches to about three feet, rather indicating a culture which used them extensively for a variety of purposes, not just, say, for the pounding of the basic item of the diet. It is obvious that before the advent of the sweet potato, the Highland people must have subsisted on a diet of various wild roots, berries, nuts, etc., just as some of the still nomadic Negrito tribes exist, even today, in the region between the highland mass of people and the coastal inhabitants. A possible pre-sweet potato " staple " is the mountain *Pandanus* sp., whose nuts are still highly favoured.

Massal and Barrau (1956) state that the sweet potato was brought to Europe in 1495 and was taken from there to India, the Philippines, China and Japan. Candolle (1882) quotes Dr. Breitschneider that according to Chinese sources the sweet potato is of foreign origin to China and introduction took place between 1573 and 1620. This points to the American origin of the species. It is listed by Rumphius in his " Herbarium Amboinense " indicating that it reached the borders of Melanesia by 1650. He says positively that according to general opinion, sweet potatoes were brought by the Spanish to Manila and the Moluccas, whence the Portugese diffused it throughout the Malay Archipelago. It is noteworthy that in many parts of East Indonesia, e.g., Menado, Gorontalo and other parts of North Celebes, also in Timor, Lombok, West Sumbawa and Ambon the local name for the sweet potato is similar to its botanical name, e.g., batata, batatas, potatas, watata, indicating a possible distribution from the Eastern regions, probably from the Philippines. The Spaniards also introduced it into Micronesia. From the Moluccas or Ambon it is easy to picture the introduction of the crop into New Guinea through well developed trading routes. For example cowrie and gold lip pearl shells from Thursday Island in the Torres Strait are still used as currency and means of personal adornment throughout the Highlands and the sweet potato could have been brought in by the same route.

The above description might explain the introduction of the sweet potato into New Guinea, but it does not explain its presence in Polynesia. If the crop had not reached Malaysia until 16th Century it could not have been taken by the Polynesians on their journey eastward across the Pacific. It might be also remarked that of the Polynesian communities on islands close to New Guinea, the Trobriand Islanders have a staple diet of yams and those at the Mortlocks eat taro. Massal and Barrau (1956) state that when the first Europeans reached Polynesia they already found the sweet potato growing there. This suggests a pre-European contact between the people on the West coast of South America and Polynesians. It could be, as Peter Buck suggested, that Polynesians visited America and brought some tubers with them, or that some American Indians travelled across the Pacific, from the West towards the East, the feasibility of which was proved by Heyerdahl. The name of the sweet potato in Polynesia, Kumara, or Kumala, also suggests contact with Peru., Colombia or Ecuador where similar names are used. Whatever the means of introduction, the sweet potato has spread throughout Polynesia, reaching Hawaii in the North and New Zealand in the South, becoming the staple food of the Maoris.

Candolle (1882) suggests two additional hypotheses for the distribution of *Ipomoea batatas*. One assumes a prehistoric communication between Asia and America. The other considers that, in view of the wide distribution of Convolvulaceae, the species may well have existed further north before the extension of glaciers and prehistoric men may have transported it southward when the climatic conditions altered. These hypotheses would certainly help to explain the presence of the sweet potato in Polynesia.

Two other new-world plants, maize *Zea mays* and tobacco *Nicotiana tabacum* were also widely distributed in New Guinea including the

Highlands, prior to the exploration of the island during the last century. It seems that the Philippines and Ambon might have been important centres for the distribution of American species in Malaysia and Melanesia. Rumphius records maize in his Herbarium and notes that it was cultivated in the Philippines. My own view is that maize could have been introduced by shipwrecked Portugese or Spanish sailors who are known to have frequented the New Guinea shores in the 16th and 17th Centuries. Later, with additional European contact, fresh strains and varieties were introduced. Massal and Barrau (1956) state that it was grown by Quiros on Santa Cruz and the Marquesas as early as the 15th Century and later cultivated on Guam. According to Yen (1959), the earliest recorded introduction into New Zealand is in 1772, (a little after the introduction of potatoes *Solanum tuberosum* attributed to De Surville in 1769).

Gilmour (1931) studied the forms of tobacco occurring in New Guinea and concluded that they are all *N. tabacum,* disproving an earlier claim by Maiden that New Guinea tobacco might have been derived from *N. suaveolens* which is indigenous to Australia. According to Comes (quoted by Gilmour) the Spaniards cultivated tobacco in the Philippines in 1600. In 1601 the Dutch imported tobacco into Java and introduced it into Timor in 1613. By 1615 it was recorded as being cultivated in a number of islands north of New Guinea. Merrill (1946) in his paper "Tobacco in New Guinea" supports this view. He points out that Amboina was first visited by the Portugese in 1511 and was definitely colonized by them in 1521 and that this island was the first important centre in Malaysia for the introduction and dissemination of American plants. The Portugese were soon followed by the Spaniards operating through the Philippines. *Nicotiana tabacum* is also clearly described in Rumphius' Herbarium Amboinense, so it seems that the first introduction of tobacco into New Guinea might have been from Amboina, followed by other introductions along trade routes on the north shore of the island from the Philippines and the Moluccas.

Merrill (1946) draws attention to the use of place names in indicating possible sources of distribution for the new-world plants, "Manila" in particular seems to occur frequently, e.g., *Pithecolobium dulce,* a plant of Mexican origin, is called Manila tamarind in India, the tree having been introduced there from the Philippines shortly after the middle of the 18th Century. In Java the American sapodilla *Achras sapota* originating in Central America is claimed to be known as sawo manila, the peanut *Arachis hypogaea* as Katiang manila, the soursop *Anona muricata* as langka manila. In the Philippines *Cassia alata* is known as Kapurko or Akapulko, having been introduced from Acapulco in Mexico, while in Java it is known as Ki manila.

Discussion.

Our survey of the pre-European introductions of basic food plants into New Guinea poses several questions. First, why were these plants introduced—were they the diet of the people concerned who brought their food plants with them as they migrated to new lands or were the crops introduced subsequently through trade routes and through contact of the people with their neighbours? Or perhaps were the food plants already growing in the new environment and subsequently utilized by the immigrants? All people, whatever the state of their civilization or culture, are conservative in their food habits and it is reasonable to expect that they prefer the foods they are used to consuming. Conversely they could be expected to take with them the basic items of their diet. This might apply to the old world plants, but it is obvious that food crops originating in the Western Hemisphere must have been imported, subsequent to the arrival of the people, the sweet potato and maize changing the agriculture of Malayans and Melanesians, just as the potato and maize revolutionized the agriculture of Europe.

The second pertinent question is: if the Malay Archipelago and Ambon in particular, played such an important part as the source of plant material for New Guinea, why were some crops introduced, or why some found their way into a new country, and not others? The most important exception being rice *Oryza sativa,* even though some wild forms, e.g., *O. schlechteri; O. perennis, O. minima,* are known to occur in various parts of the Territory such as Ramu and Sepik River valleys. Surely rice, being an easily storable product would have appealed to travellers. This question is not easy to answer. There is evidence in the pattern of land settlement in various parts of Indonesia that rice culture is the result of Malayan influence

and that the intensive system seen today is only a relatively recent development due to pressure of population growth. Further, that rice tended to displace an older system, based on root crops which might have been the only standard food crops the Melanesians knew at the time of their migration.

The second possible reason why rice has not found its way to New Guiena is that most contacts were with the Eastern part of Indonesia where rice is barely grown, even today. Sago is the basic food crop in Ambon and the Moluccas, while approximately from Lombok eastward, maize and cassava are the principal foods grown. Thus there was no direct contact with rice eaters and rice growers.

The first rice grown in Papua was by members of the Sacred Heart Mission at Yule Island at the turn of the 20th century ; Brother Kala from the Philippines was responsible for the first planting. (Private communication from Bishop A. Sorin, March, 1951.) It is also rather peculiar that examples of the very rich tropical fruit flora of the Malay Archipelago were not gradually introduced into these islands. Mangoes *Mangifera indica* are an introduction by Europeans, while other delicious fruits such as the mangosteen *Garcinia mangostana*, rambutan *Nephelium lappaceum*, durian *Durio zibethinus*, etc., are practically unknown and non-existent even today. As against this, the papaw *Carica papaya*, which is of American origin, is ubiquitous. If it is correct that some of the important basic food crops such as the sweet potato and maize are the result of contact, subsequent to the advent of Europeans to the Eastern portion of the Malay Archipelago, it seems remarkable that the main objective and interest of the presence of Europeans in those days, namely the spices, were not imported as well. None of these spices sought after by the European traders, and the subject of wars between the Portugese, Spaniards and Dutch, pepper *Piper nigrum*, nutmeg *Myristica fragrans*, cinnamon *Cinamomun zeylanicum*, cloves *Eugenia aromatica* are present in New Guinea, even though other members of the genera have a widespread occurrence.

Recent Introductions.

Of the more recent introductions cassava or tapioca *Manihot utilissima*, is of major importance. It is native of tropical America, Mexico, Brazil and Peru, and was grown there as a food plant before the arrival of the Europeans. Massal and Barrau (1956) report that it was taken to Africa by the Portugese whence it spread to Madagascar and the Asiatic continent. It was introduced into Polynesia in the fist half of the last century, reaching New Caledonia from Samoa or Tonga in 1852. According to Terra (1958) cassava became established in the Gunung Kidul region of Central Java only during the Governor-Generalship of Daendels during the Napoleonic Wars. Since then it has become wide-spread throughout Indonesia and is one of the most important food crops in areas having a pronounced dry season. In New Guinea it is planted in mixed food gardens in many parts of the island, but is only a subsidiary, if important, food crop even in the drier regions.

Another more recent introduction, originating in America is *Xanthosoma* spp. It was probably brought to the Pacific in the 19th Century. In New Guinea it is called Kong-Kong (Chinese) taro, in New Caledonia " New Hebrides taro " in the New Hebrides " Fiji taro " giving some indication of its dissemination or supposed distribution. In New Guinea it is becoming of ever increasing importance as a standby food reserve for droughts and supplementing the diet in areas having a taro staple crop.

Of the introductions made during the past fifty years, peanuts *Archis hypogaea* and potatoes *Solanum tuberosum* are of the greatest importance. Both reached this popularity only after the second world war and are being accepted into the dietary of the indigenes. Peanuts are one of the many pulses and legumes introduced in an effort to increase the protein component of the diet. They seem to be fairly readily consumed though the high fat content can cause a stomach upset. Although the average food garden, particularly of the Highland people, contains a wide variety of pulse crops, e.g., *Psophocarpus tetragonolobus, Phaseolus lunatus, Dolichos lablab, Vigna sesquipedalis,* (the Chimbu people are said to use more than 100 types of various greens) more recent introductions such as *Vigna sinensis, Phaseolus mungo, Phaseolus calcaratus, Canavalia ensiformis, Cajanus cajan* have not been readily accepted so far. Perhaps more time and more intensive effort at popularizing them is needed.

The potato *Solanum tuberosum* is rapidly gaining importance in high altitude areas where sweet potato crops are killed by periodic frosts.

Due to a rapidly increasing population, the people are becoming increasingly dependent on crops from areas subject to frosts. In these areas potatoes, particularly short-day varieties or those tolerant of short-day conditions, can be expected to supplement or even gradually displace sweet potatoes. Since the advent of European missionaries and government officials, a wide range of vegetables was introduced to New Guinea including beans, tomatoes, cabbage, chinese cabbage, lettuce, etc. Some of these, particularly beans *Phaseolus vulgaris*, tomatoes *Lycopersicum esculentum*, chinese cabbage *Brassica chinensis* and pumpkin *Cucurbita maxima* have been readily accepted into the diet and gardening practices.

Conclusion.

We have seen that although New Guinea has a very large endemic flora, the majority of the basic food plants, forming the subsistence diet of the inhabitants were introduced at varying times in history. The dependence of the people on introduced species and the success of the plants in their new environment would suggest a considerable scope for future systematic plant introduction. It is unlikely, however, that new food crops could be imported which would displace the existing major basic subsistence foods. Perhaps a major change would come with the acceptance by the people of grain crops such as rice and sorghum. Rice is already widely consumed, but post-war efforts at encouraging its culture have not been too successful. Perhaps eventually population pressure will demand a more intensive system of food production to replace shifting agriculture. Similarly, sorghum might prove to be the ideal crop for the drier regions, if methods of consumption could be developed and popularized, but both rice and sorghum are already grown in the Territory so would no longer be initial introductions. There is, however, still a fairly wide field for introducing and disseminating further subsidiary crops rich in proteins or protective foods for the improvement and diversification of the diet.

The stage is being rapidly passed when much success could be expected from introducing a few seeds or plants from here and there. The future role of plant introduction will be more to provide the basic collections for specialists working on crop improvement, e.g., sweet potatoes from the Andes which migh possess frost resistance ; short-day potato and soy-bean varieties ; collection of *Colocasia* for breeding resistance to *Phytophtora colocasiae*. In other words, plant introduction is no longer the pastime of the naturalist, but the field for systematic research to find the type of material most suited for the new environment or required for research projects.

REFERENCES.

DE CANDOLLE A. (1882). (Reprinted 1959) *Origin of Cultivated Plants*. Hafner Publishing Co., New York.

DEGENER, O. (1946). *Flora Hawaiiensis Books* 1-4.

GILMOUR, J. S. L. (1931). *The species of tobacco grown in New Guinea*. Anthropology Report No. 11, Territory of Papua.

GOODE, R. (1947). *The geography of flowering plants*. Longman's, Green & Co., London.

HEYNE, K. (1950). *De Nuttige Planten van Indonesie*. W. van Hoeve, S-Gravenhage.

MASSAL, E., & BARRAU, J. (1956). *Food Plants of the South Sea Islands*. Technical Paper No. 94. South Pacific Commission, Noumea.

MERRIL, E. D. (1946). *Plant Life of the Pacific World*. Macmillan Co., New York.

RIDLEY, H. N. (1930). *The Dispersal of Plants throughout the World*. L. Reeve & Co., Ltd., Ashford, Kent.

STRONG, W. M. (1920-21). First Annual Report by Anthropologist. *Annual Report* 1920-21. Territory of Papua, p. 31.

TERRA, G. J. A. (1952-53). Some Sociological Aspects of Agriculture in South-East Asia. *Indonesie*. Vol. VI, No. 4 and 5, 297-316, and 439-455.

YEN, D. F. (1959). The use of Maize by New Zealand Maoris. *Economic Botany*. Vol. 13, No. 4.