PLANTS OF TONGA

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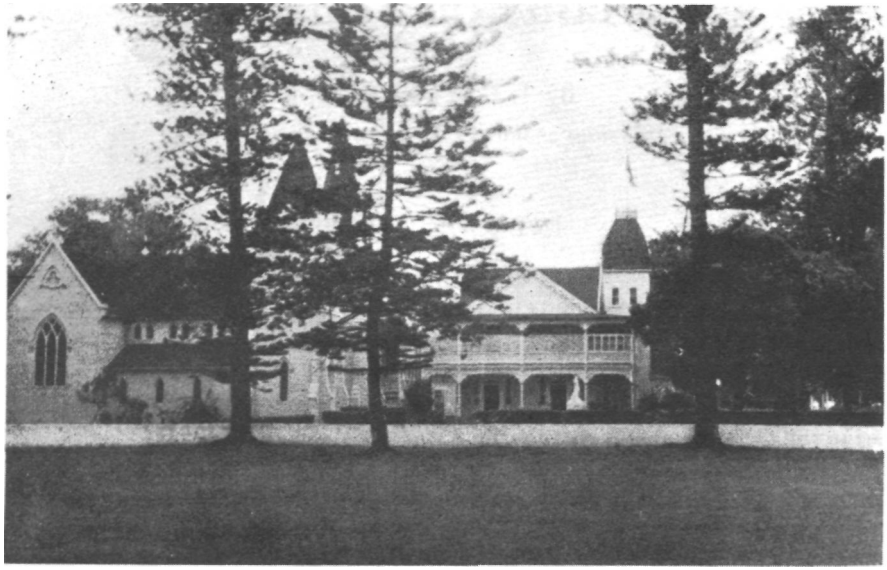
INTRODUCTION

The Tongan archipelago is a group of 150 or more islands and islets of volcanic and coral formation. Of these, only a relatively small number are sufficiently large or topographically suitable for plantations adequate to support populations of any size. Most of the islands are arranged in three main, roughly circumscribed, areas situated in the southern, central, and northern parts of the archipelago known as the Tongatapu, Ha'apai, and Vava'u groups respectively. The islands of these three groups are arranged in two roughly parallel lines from slightly southwest to northeast in the south Pacific Ocean between 15° and 23° south latitude and 173° and 177° west longitude. To the north, and somewhat remote from the northern Vava'u group, lie the volcanic islands of Niuafo'ou, Tafahi, and Niuatoputapu (Keppel). The islands of the eastern line are the more numerous and are of coral origin. For the most part, they are low, flat, and topographically uninteresting. The western line, extending from the extreme southern, and at present uninhabited island of 'Ata to Niuafo'ou on the north, is of volcanic origin. It includes the island of Kao in the Ha'apai group which rises to a height of about 1,000 meters, the highest of the Tongan islands. Some of the islands—for example, Tofua, Fonualei, and Niuafo'ou—are still volcanically active. Tongatapu, the largest of the coral islands, with an area of nearly 100 square miles, is very flat and reaches an altitude of scarcely 90 meters at its highest point. On it is located Nuku'alofa, which is the largest town in Tonga and the seat of government (fig. 1, a).

A few miles to the east of Tongatapu lies the island of 'Eua, about 35 square miles in area and composed of a volcanic base overlaid for the most part with limestone. It has been built up to a height of approximately 300 meters at its highest point. An elevated ridge runs along the eastern side of the island, rendering that coast rugged and very picturesque (fig. 1, *b).* The seaward face of this ridge is precipitous in places, and some parts are reached only with great difficulty. A much lower ridge, with a maximum height of about 100 meters, lies toward the western side. The ridges and slopes, especially those on the eastern side, are well covered with native vegetation. Here, one finds some of the largest trees and densest forests in all Tonga. Specimens of

1 The opportunity to visit the Tongan Islands and collect the data upon which this study is based was made possible by a John Simon Guggenheim Memorial Foundation Fellowship and a grant from the National Science Foundation. The manuscript was completed in 1955 and submitted to Bishop Museum for publication.



b

FIGURE 1.—a, Royal Palace, Nuku'alofa, with introduced specimens of *Araucaria excelsa* in foreground; b, near summit of eastern ridge on 'Eua island at an altitude of 300 meters, showing erosion scars in foreground.

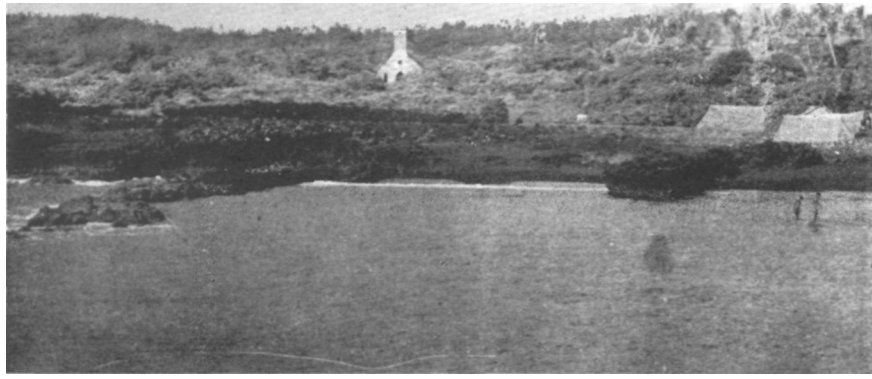
Laportea harveyi, Rhus taitensis, Alphitonia zisyphoides, Dysoxylum spp., and other trees may reach considerable size. Tongatapu and 'Eua are the only permanently inhabited islands of the Tongatapu group.

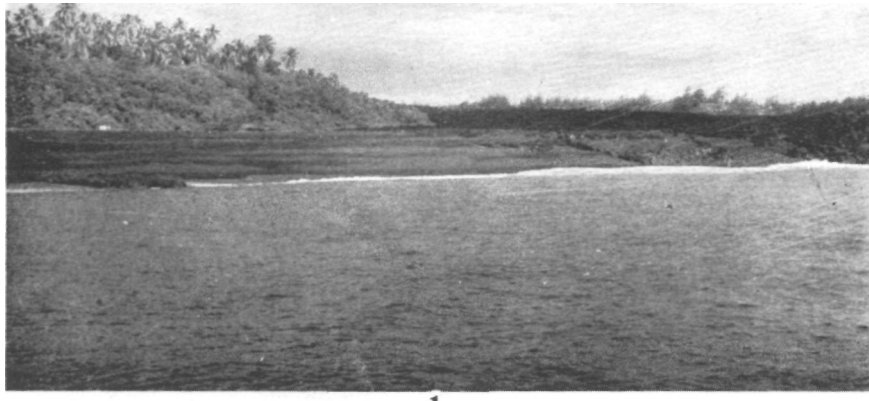
The central, or Ha'apai, group is about 90 miles from Tongatapu. It includes the main islands of Lifuka, the former capital and site of the Chief's Palace; Nomuka; Kao; Tofua; and a large number of smaller islands, many of which now support no permanent inhabitants.

Vava'u, the largest and principal island of the Vava'u group, has an area of approximately 35 square miles and reaches an altitude of about 150 meters along the precipitous northern coast. Its surface is uneven and the southern, very irregularly and deeply indented coastline provides a beautiful and completely land-locked harbor, where the principal town of Neiafu is situated. At the northwestern part of the island is a lake of brackish water and nearby is a rather large swamp of marshy area unique in the islands. Another, a large central lake connected at one point with the sea during high water, is found on the island of Nomuka in the Ha'apai group. Large crater lakes also occur on Tofua and on Niuafo'ou. Ocean-going steamers are able to dock at Neiafu in Vava'u and at Nuku'alofa on Tongatapu. Cutters and interisland boats can reach a jetty at the village of Pangai on Lifuka Island in the Ha'apai group, and it is possible for very small boats to make a landing at a makeshift dock on 'Eua. And it is usually possible, in moderate seas, to get ashore from canoes or other small boats on the other low coral islands. It is much more difficult, however, to land on the volcanic islands of Tofua, Kao, Late, Niuafo'ou, or Tafahi where most of the coast is steep and abrupt and where protecting reefs are lacking or do not break the often strong wave action. These islands can be reached only by canoe or small boat and under most favorable weather conditions, or by swimming from larger boats which must stand well off shore for safety.

The population of Tonga is nearly 50,000. It is heavily concentrated on the islands of 'Eua, Tongatapu, Nomuka, Lifuka, and Vava'u and some of the smaller adjacent islands. The volcanic islands of 'Ata, Tofua, Kao, Late, and Niuafo'ou have few or no permanent inhabitants at the present time. The former population of about 1,300 on Niuafo'ou was evacuated after the disastrous volcanic eruption in 1946, and at present makes up a large part of the population on 'Eua. (See figure 2.)

The more heavily populated islands show a high percentage of land utilization, the indigenous plant species surviving only in occasional uncultivatable areas, usually near the sea. Everywhere grows a number of species of greater or lesser usefulness presumably brought to the islands by the aborigines as they arrived in Tonga from other islands. These species predominantly show Asiatic, African, or Malaysian origin. A possible exception is the sweet potato, and there is considerable question as to how it reached Polynesia. **In this group** one may include that most useful of all plants for island peoples, the coconut.





b

FIGURE 2.—a, remains of church in village on Niuafo'ou Island destroyed by 1946 eruption (note lava flow which reached sea) ; vegetation is rapidly pioneering on older flows. Houses on right are used by temporary visitors who come to cut copra, b, lava flow on island of Niuafo'ou, where an extensive beach of "black sand" has been formed. Background trees at right form large grove of *Casuarina equisetifolia.*

Presumably, the unintentional introduction of certain weedy species occurred at the same time, A good many cultivated species, together with many weeds, owe their presence to the visits of European ships, starting early in the seventeenth century and continuing with increasing frequency to the present time. Some of these alien species find optimum conditions for growth and multiplication, and have undoubtedly played a part in limiting or even exterminating some endemics or indigenous species through aggressiveness. A high percentage of the usual strand and weed species includes those frequently found on other Pacific islands and elsewhere in tropical countries.

There is little fresh water available other than that impounded in tanks from rainfall. Aside from occasional small localized areas, the low coral islands present a monotonous repetition of plantation weeds and fallow-resting plantations of second-growth "bush." The dominant crop is coconuts, and large areas have been cleared for the extensive plantations found on most of the islands. At present, the high market value of copra makes it the most important source of income for the islanders. The second most important export crop is bananas, of which 50,000 or more cases are shipped annually to New Zealand. The more rugged topography of 'Eua, and to a somewhat lesser extent of Vava'u, prevents the cultivation of some parts of the islands. As a consequence, there are more opportunities on these islands for the survival of native species. Some of the islands, especially 'Eua and Kao, still have significant timbered areas with some of the tree species reaching a diameter of more than a meter and offering a source of timber. Lumbering operations are being developed by the government on 'Eua which, together with, the fact that more and more of the forested land is being cleared for new plantations, threaten to reduce or eliminate many of the native species. Too, this has caused a soil erosion problem on some of the slopes. Lumbering operations on the volcanic islands of Late, Tofua, Kao, and Tafahi, because of the present lack of harbor facilities, are all but impossible. It seems improbable, therefore, that much timber will be cut on those islands in the immediate future, and it is on those islands that many of the native species will have the best chance of survival. However, with any marked increase in population, it will eventually become necessary to colonize and develop such islands.

The climate of Tonga is pleasant during most of the year. The annual temperature ranges from a low of around 75° F. in July and August to a high of 85° to 90° F. from January to March. Slightly higher or lower temperatures are not infrequent. The humidity is comparatively high, ranging from about 88° in the warmer months to a low of around *72*° in the winter period. The average mean rainfall is about 80 to 90 inches, with the wettest season during the first six months of the year.

The collections upon which this report is based were made on the islands of Tongatapu, 'Eua, Nomuka, Lifuka, Kao, Vava'u and Niuafo'ou between February and June 1953. Projected visits to 'Ata, Tofua, and Late were aban-

doned because of a combination of unfavorable weather and lack of transportation. But I predict that collections made on those islands, so far little-known botanically, where land utilization has been slight will increase to some extent the list of species known to grow in Tonga.

A number of botanists have visited Tonga in the past and made collections ranging from a few numbers to several hundred. Among the first collectors known to have reached the islands were Banks, Solander, the Forsters, and Nelson who accompanied Captain Cook on his voyages in the latter part of the eighteenth century. Among others who have collected there subsequently may be mentioned George Barclay, James Macrae, Captain W. F. Beechey, Alexander Mathews, Sir Edward Home, W. H. Harvey, Dr. E. Graeffe, J. N. Moseley, Charles Wilkes of the United States Exploring Expedition, T. B. Cartwright, J. J. Lister, and C. S. Crosby. With the exception of the collections made by Moseley on Tongatapu, Lister on 'Eua, and Crosby on Vava'u, most were relatively small and most were obtained during the nineteenth century. In 1926, H. E. Parks and W. A. Setchell collected on Tongatapu and 'Eua, and in 1951 Dr. Hans Hiirlimann spent several weeks making collections, principally on Tongatapu, 'Eua, Tafahi, and Niuatoputapu.

Two comprehensive reports have been made on the flora of Tonga : (1) The flora of the Tonga or Friendly Islands, . . ., by W. B. Hemsley in the Journal of the Linnaean Society (Botany 30:158-217, 1894), which also included some species from islands outside the Tongan group, and (2) The flora of Vava'u, one of the Tonga Islands, by I. H. Burkill in the Journal of the Linnaean Society (Botany 35 : 20-65, 1901). In addition, occasional references to Tongan species are found in reports on the flora of nearby islands or on the Pacific area in general.

The collections cited by Hemsley and by Burkill in their reports, unless for some reason questioned, have been included in the list of citations for the different species. These specimens have not been studied and are only provisionally included. The Hemsley and Burkill publications when referred to with respect to synonymy are indicated as Hemsley's and as Burkill's lists. The specimens collected by Dr. Hiirlimann which have been examined are also cited. Altitudes given in connection with the citation of some of the collections were estimated or obtained from map records.

I made no attempt to procure extensive collections of the lower plants, and only the most conspicuous and abundant species were taken. The small representation of the lower groups should, therefore, not be interpreted as an indication of their scarcity. Fleshy fungi, especially, appeared to be quite abundant in the moist forested areas. Parasitic fungi such as leafspots and rusts, on the contrary, were very scarce. In none of the regions visited were bryophytes conspicuously abundant, as is frequently true in tropical rain-forest areas. Such collections of the lower cryptogams as were made are included in this report as a matter of record.

The conspicuous and apparently well-established cultigens, as well as introduced weedy species, were either collected or noted and are, for the most part, included, as I believe that such information is of value in helping formulate a proper concept of the flora of any region. So far as I know, many of these introduced or migrant species are covered in no previous report on the Tongan flora.

In this work, 49 lower cryptogams, 71 pteridophytes, and 630 spermatophytes are recognized, making a total of 750 species and varieties.

The late Sir Peter Buck, then Director of Bishop Museum, originally suggested the desirability of a botanical survey of Tonga and assisted in the preliminary plans. The government of Tonga was interested in the project and, through Prince Tungi, rendered aid in every way possible. Mr. Willy Straatmans, Director of the Department of Agriculture, was most helpful in arranging for transportation between the islands, for living quarters in government rest houses, and for local transportation by land-rover on the islands of Tongatapu and Vava'u.

I was fortunate in obtaining the assistance of W. Toluta'u Ha'angana, a member of the Tongan department of agriculture staff, who served as chief assistant for the entire period of the work. "Tolu" proved to be a most intelligent and cooperative assistant at all times, and his knowledge of Tongan plants was considerable. Most of the local names given in this report were supplied by him, as well as the information about the uses made of the plants by the Tongan people. On many occasions his explanation for our presence on plantations or other private property of suspicious owners unable to understand English smoothed the way and avoided trouble. His agility in procuring drinking coconuts was likewise much appreciated.

Tongans do not always distinguish between closely related plants and sometimes apply the same name to more than one species. Also, occasionally the same name is given to widely different species, leading one to suspect that some names are erroneous. Such presumed errors were checked as far as possible and, if obviously wrong, eliminated. Where two or more names have been supplied for a given species, the one believed to be more commonly used is listed first.

In the identification of the collections I am greatly indebted to a number of specialists. The fleshy fungi were identified by Dr. J. A. Stevenson; the liverworts, by Dr. Margaret Fulford; the lichens, by Dr. Carroll W. Dodge; the mosses, by Mr. E. B. Bartram, who also furnished the description of the new species; the description of the new *Podocarpus,* by Mrs. Netta Gray; the pteridophytes (excepting *Sclaginella),* by Mr. C. V. Morton; *Selaginella,* by Mr. A. H. G. Alston; the grasses, by Dr. J. R. Swallen; the orchids, by Mr. Charles Schweinfurth; *Ficus,* by Mr. W. J. H. Corner; *Pipturus* and *Santalum,* by Dr. Carl Skottsberg; certain members of the Apocynaceae, by

Dr. R. E. Woodson, Jr.; the Verbenaceae, by Dr. H. N. Moldenke; *Bidens,* by Dr. Earl E. Sherff; and *Nicotiana,* by Dr. T. H. Goodspeed.

Dr. A. C. Smith of the Smithsonian Institution, a student of the flora of the Pacific, in particular that of Fiji, has named a large number of the more difficult and often sterile specimens of the flowering plants. He has prepared the description of the new species and has contributed numerous comments relative to distribution and other pertinent information. For this most valuable assistance I am deeply grateful.

My wife, Ethel Yuncker, who accompanied me, took charge of the drying and care of the specimens as they were brought from the field. Her assuming responsibility for this tedious and monotonous work greatly reduced the task of preparing the specimens for shipment.

Dr. H. L. Mason, Director of the Herbarium at the University of California, lent me the unpublished manuscript list of collections made in 1926 by Setchell and Parks and also a number of herbarium specimens of questionable or critical species. These loans were most useful, and are appreciated.

Many other persons have assisted in various ways, including Tongan and European residents in the islands. To all who have aided in any way, I express my thanks.

The following symbols indicate herbaria where the collections are stored: BISHOP (Bernice P. Bishop Museum), BM (British Museum, Natural History), DPU (DePauw University), F (Chicago Natural History Museum), GH (Gray Herbarium), MO (Missouri Botanical Garden), UC (University of California, Berkeley), and US (United States National Museum).

FUNGI

Identifications of the following fungi are by J. A. Stevenson.

FAMILY THELEPHORACEAE

Genus **Stereum** S. F. Gray

Stereum caperatum (Berkeley and Montague) Massee, Linn. Soc. Bot., Jour. 27:161,1890.

'Eua: on rotten log in forest above Fuai, near center of island, Apr. 5, 1953, *Yuncker 15646.*

FAMILY POLYPORACEAE

Genus **Daedalea** Persoon ex Fries

Daedalea elegans Sprengel, ex Fries, Syst. Myc. 1: 335, 1821.

'Eua: on rotten log in thicket near Fuai, near center of island, Apr. 7, 1953, *Yuncker 15661.*