

ATOLL RESEARCH BULLETIN

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No. 97

The flora and vegetation of Laysan Island

by

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Issued by

THE PACIFIC SCIENCE BOARD

National Academy of Sciences--National Research Council

Washington, D. C.

November 15, 1963

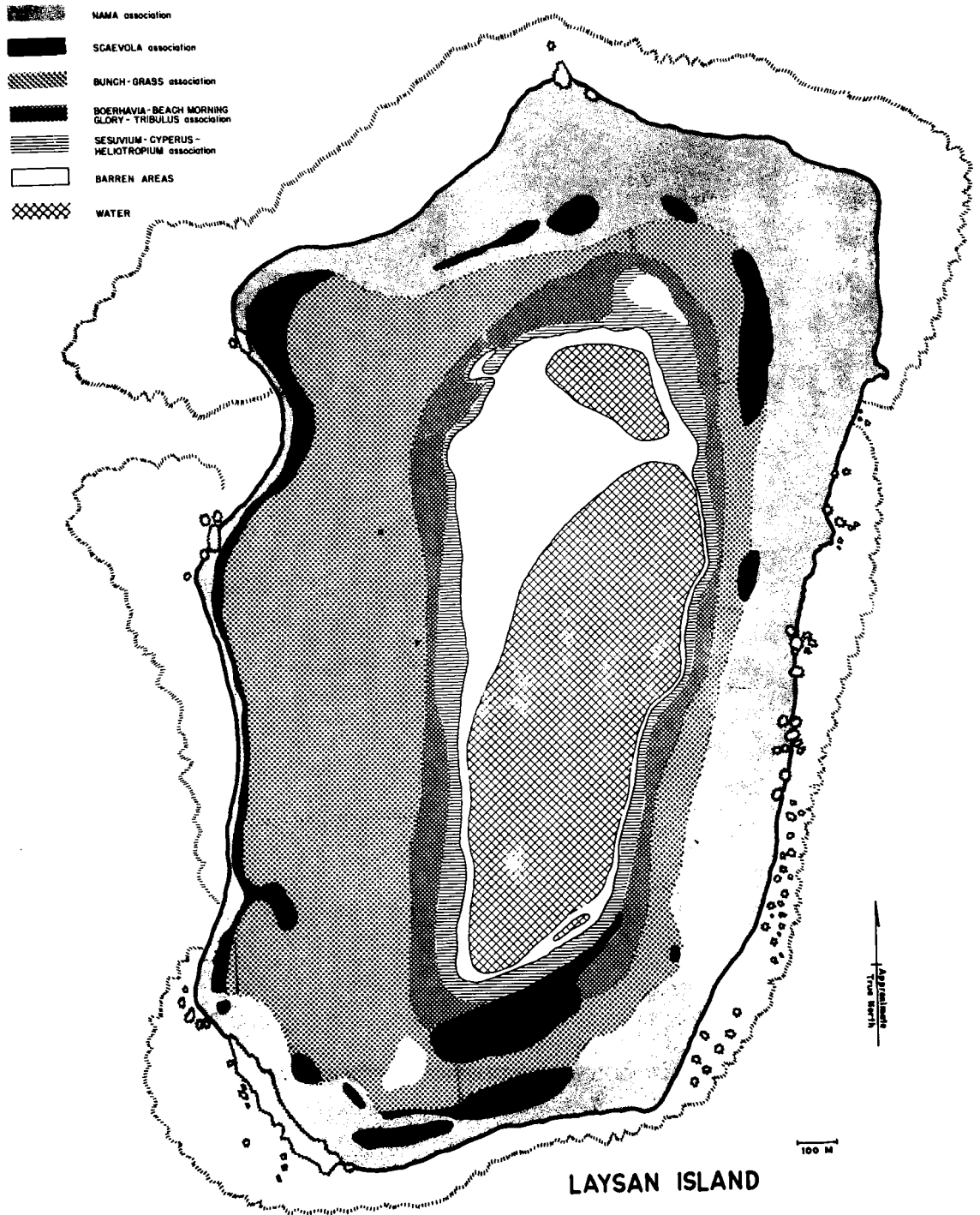


Fig. 1. Vegetation map of Laysan Island, based primarily on data collected in September 1961. The water level in the lake is known to vary somewhat, and at times the large "barren area" in the center of the island is completely under water.

# The flora and vegetation of Laysan Island

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Charles H. Lamoureux \*

Laysan Island, one of the Leeward Hawaiian Islands, is located about 790 nautical miles northwest of Honolulu at 25° 42' 14" North latitude, 171° 44' 6" West longitude. The island is about one and three-quarters miles in length and one mile wide. It is a low coral island. Most of its surface is composed of coral sand, with patches of coral reef and beachrock near the shore. The island is used as a nesting area by various sea birds, and there were formerly large deposits of guano present. The center of the island is occupied by a salt-water lake. The west, north, and ~~east~~ south rims of the island reach heights of 30 to 40 feet before sloping downward toward the central lake, but the south rim is only about 10 feet above sea level.

Laysan has long been known to naturalists, not only as a major breeding ground for sea birds, but also as the home of ~~five~~ endemic land birds and ~~five~~ endemic plants. The history of Laysan has been described at length in several other publications (Christophersen and Caum, 1931; Bryan, 1942; Bailey, 1956) and will only be summarized briefly here.

The first recorded discovery of the island was made in 1828 by Captain Stanikowitch of the Moller. In 1857 Laysan was annexed to the Kingdom of Hawaii (it is now part of the State of Hawaii and the City and County of Honolulu). In 1892 guano digging operations began on Laysan. In 1903, just before guano digging ceased, rabbits were introduced to Laysan. The rabbits were typically prolific, and by the time the Tanager expedition visited Laysan in 1923 most of the plants and many of the birds had disappeared. With the disappearance of the plants the rabbit population became depleted by starvation. The Tanager expedition killed the remaining rabbits and planted seeds and cuttings of many plant species, and additional plantings were made by G. P. Wilder in 1930. There have been no published reports on the recovery of the vegetation since the removal of the rabbits and the replanting of the island.

Through the courtesy of Dr. Harold J. Coolidge and the United States Coast Guard I was able to visit Laysan on September 4-10, 1961. Thanks are also due George Butler, M.D.F. Udvardy, Richard Warner, and David Woodside, all of whom had previously visited the island and were able to provide me with useful information about it.

## FLORA

The flora of Laysan, like that of most low oceanic islands, contains relatively few species. A total of 38 species of vascular plants, of which not more than 27 were native, have been recorded at

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various times from the island. In 1961 there were 24 species growing on Laysan of which not more than 16 were native.

Early visitors to the island, Isenbeck in 1828 and Paty in 1857, provided little specific information on the flora other than noting the presence of a small species of fan palm (Pritchardia sp.). Captain N. C. Brooks of the Gambia collected "25 varieties of plants, some of them splendid flowering shrubs" in 1859. Unfortunately his collections have disappeared, and the identifications, if made, were never published. In 1891 George C. Munro spent 10 days on Laysan. His notes (1942) provide descriptions sufficiently detailed that a few plants can be recognized: Eragrostis variabilis, Sesuvium portulacastrum, Sicyos sp., Capparis sandwichiana, Tribulus cistoides, Ipomoea pes-caprae, and Pritchardia sp. Munro noted two palms still standing and the stumps of several more. When Schauinsland visited Laysan in 1896-97 the palm had become extinct. Schauinsland made the first collection of Laysan plants which is available to science. Part of his collection is preserved in the Bernice P. Bishop Museum. W. K. Fisher's collections, made in May 1902, were determined by W. E. Safford and published by Fisher (1903a). Later collections, all at the Bishop Museum, were made by W. A. Bryan in April 1903 and April 1911, E. L. Caum in April 1923, G. P. Wilder in August 1930, G. D. Butler, Jr. in April and July 1959, C. W. Daniel in July 1959, and C. H. Lamoureux in September 1961.

Although detailed treatments of the flora of Laysan have been presented by Bitter (1900) and Christophersen and Caum (1931), there have been significant changes in the composition of the flora in recent years. Thus, it seems advisable to present a list of the species which have been recorded from Laysan, to include in parentheses the synonyms which have been used in other treatments of the Laysan flora, and to indicate the dates at which each species was observed or collected. Species growing on Laysan in September 1961 are preceded by an asterisk.

GRAMINEAE -- Grass family

Cenchrus agrimonioides var. laysanensis F. Br. (Cenchrus calyculatus Cav.).

This unusual sand-bur was collected on Laysan between 1896 and 1911, but became extinct there by 1923. It still survives on Kure in limited numbers.

\* Cynodon dactylon (L.) Pers. Bermuda grass was collected first in 1903, and was probably introduced during the guano digging operations. It was not found in 1911 or 1923, but is present in 1930, 1959, and 1961 collections. It may have been replanted in 1923.

\* Eragrostis variabilis (Gaud.). Steud. (Eragrostis hawaiiensis Hillebr.). This bunch grass, noted by Munro in 1891, was described by Schauinsland as the most common plant on the island in 1896. It was present in all collections until 1923, at which time no living plants were observed. Rhizomes and seeds were planted in 1923, and the species has been represented in all later collections. In 1961 this grass was again abundant.

Lepturus repens (Forst.) R. Br. This grass, characteristic of strand areas throughout much of the tropical Pacific, was collected on Laysan only in 1896 and 1903.

Sporobolus virginicus (L.) Kunth. Another beach grass, collected only in 1896 and 1903.

CYPERACEAE -- Sedge family

\* Cyperus pennatifolius var. bryanii Kükenthal (Cyperus canescens Vahl). A striking sedge, endemic to Laysan, was collected between 1896 and 1911. Although not observed in 1923, it was present in all collections since 1930.

\* Fimbristylis cymosa R. Br. First collected in 1930, this sedge was apparently planted on Laysan by the Tanager expedition in 1923. In 1961 it was distributed widely over the island.

PALMAE -- Palm family.

\* Cocos nucifera L. Coconuts were first planted on Laysan by the guano workers. Some trees survived at least until 1923 but died before 1959. Several young trees, planted in 1959, appeared to be thriving in 1961.

Pritchardia sp. Specimens of a small fan palm, probably Pritchardia, were seen on Laysan by Isenbeck in 1828, and were also observed by Paty in 1857, Brooke and Brooks in 1859, and Munro in 1891. The palm had become extinct by 1896, at which time Schauinsland found only dead stumps. No specimens of this palm are known to exist in any herbaria. The only permanent record is a photograph taken at some time between 1891 and 1896 by an unknown photographer, which shows two living trees and the stumps of others. This photograph, which was reproduced by Christophersen and Caum (1931), does not reveal sufficient detail to permit identification. It is generally agreed that the palm was a Pritchardia, of which one species, P. remota, occurs on Nihoa. The Hawaiian species of Pritchardia are of extremely local distribution, no species being found on more than one island. Although Rock (Beccari and Rock, 1921) suggests that the Laysan plant was also P. remota, George C. Munro (personal communication, 1961), who observed both the Nihoa and Laysan palms, is of the opinion that they were of different species, a conclusion also reached by Christophersen and Caum (1931).

CASUARINACEAE -- Ironwood family.

\* Casuarina equisetifolia L. One ironwood tree was growing on the island in 1923 and showed signs of rabbit damage (Wetmore, 1925). The single tree still on Laysan in 1961 is probably the same tree.

SANTALACEAE -- Sandalwood family

Santalum cuneatum var. laysanicum Rock (S. freycinetianum Gaud.).

The Laysan sandalwood, first collected in 1896, was still living in 1923 when "many of the stumps were seen to be alive and trying to sprout, in spite of their being kept trimmed clean by the rabbits" (Christophersen and Caum, 1931). Since 1923, however, the sandalwood has not been collected.

CENOPODIACEAE -- Goosefoot family

Chenopodium oahuense (Meyen) Aellen (C. sandwichicum Moq.). The aweoweo, which in 1896 was exceeded in abundance only by Eragrostis, disappeared from Laysan between 1903 and 1911.

AMARANTHACEAE -- Pigweed family

Amaranthus viridis L. (Euxolus viridis (L.) Moq.). This species was probably introduced to Laysan by the guano workers, and was collected between 1896 and 1903.

Achyranthes splendens var. reflexa Hillebr. A native shrub first collected in 1896 which apparently became extinct between 1903 and 1911.

NYCTAGINACEAE -- Four o'clock family

\* Boerhavia diffusa L. (B. tetrandra Forst.). Present in all collections of plants from Laysan (except 1923, when all plants observed appeared to be dead), Boerhavia formed one of the major elements of the vegetation in 1961.

AIZOACEAE -- Mesembryanthemum family

\* Sesuvium portulacastrum L. The akulikuli was the only plant native to Laysan that was at all abundant in 1923. Although not collected in 1930, it must have been present then, and was found to be growing well in 1959 and 1961.

PORTULACACEAE -- Purslane family

\* Portulaca lutea Sol. (P. oleracea L.). Present in all collections except 1930.

\* Portulaca oleracea L. Collected only in 1959 and 1961, this species is apparently a recent introduction to Laysan. Schauinsland's specimens, called P. oleracea by Bitter (1900), are actually P. lutea.

CRUCIFERAE -- Mustard family

Lepidium o-waihiense C. & S. Collected only by Schauinsland in 1896, who observed only a single plant.

CAPPARIDACEAE --- Caper family

\* Capparis sandwichiana DC. The puapilo was probably one of the "splendid flowering shrubs" noted by Captain Brooks in 1859. It was also observed by Munro in 1891, and was represented in collections between 1896 and 1903. It had disappeared by 1911 and was not found in 1923, but was collected again in 1930, 1959, and 1961.

ZYGOPHYLLACEAE --- Caltrop family

\* Tribulus cistoides L. Represented in all collections from 1896 to 1961.

MALVACEAE -- Mallow family

Hibiscus tiliaceus L. The hau was evidently planted on Laysan by the guano workers, and three trees were observed in 1923 growing near the old buildings. It has not been found since 1923.

CONVOLVULACEAE -- Morning glory family

\* Ipomoea indica (Burm.) Merr. (I. insularis Steud.). This morning glory was collected between 1896 and 1903, and then not again until 1959 and 1961.

\* Ipomoea pes-caprae (L.) Sw. The beach morning glory, first noted by Munro in 1891, was also not collected between 1903 and 1959.

HYDROPHYLLACEAE -- Waterleaf family

\* Nama sandwicensis var. laysanicum Brand. Nama has been represented in all Laysan collections except that of 1923.

BORAGINACEAE -- Borage family

\* Heliotropium curassavicum L. The seaside heliotrope apparently disappeared from Laysan between 1903 and 1911, but was present again in 1930, 1959, and 1961.

\* Messerschmidia argentea (L. f.) Johnston. The tree heliotrope was collected on Laysan for the first time in 1961 when only a single plant was found.

LABIATAE -- Mint family

Phyllostegia variabilis Bitter. This species became extinct on Laysan between 1903 and 1911. It may still survive on Kure.

SOLANACEAE -- Nightshade family

\* Nicotiana tabacum L. Tobacco was probably introduced by the guano workers, and is present in all collections from 1911 to 1961. In 1923 it appeared to be thriving although most other plants had disappeared, probably because it was not palatable to the rabbits.

Solanum nelsoni Dunal (S. laysanense Bitter). This small native Solanum disappeared from Laysan between 1903 and 1911.

Solanum nodiflorum Jacq. The black nightshade was found on Laysan only in 1930.

CUCURBITACEAE -- Squash family

\* Sicyos hispidus Hillebr. Collected from 1896 to 1911 and again from 1930 to 1961.

\* Sicyos microcarpus Mann. Collected in 1896, 1959, and 1961 only.

\* Sicyos sp. Collected in 1903, 1911, and 1961 only.

GOODENIACEAE -- Goodenia family

\* Scaevola taccada (Gaertn.) Roxb. (S. koenigii Vahl, S. lobelia L., S. frutescens (Miller) Krause). Represented in all collections from Laysan.

COMPOSITAE -- Composite family

Lipochaeta integrifolia (Nutt.) Gray. The nehe was collected in 1896 and 1903, but has not since been found on Laysan.

\* Pluchea indica (L.) Less. A recent introduction, collected only in 1959 and 1961.

In addition to the plants listed above, which are known to have grown on Laysan, other species have been planted there. In 1923 and again in 1930 G. P. Wilder planted seeds and cuttings of various species in an attempt to revegetate Laysan after its devastation by rabbits. Although complete records are not available, it is known that Casuarina equisetifolia, Calophyllum inophyllum, Pritchardia sp., Coccoloba uvifera, Thespesia populnea, Hematoxylon campechianum, Cocos nucifera, various Hawaiian lobelias, Scaevola taccada, Eragrostis variabilis, and Lepturus repens were planted (Gregory, 1924, 1931; Christophersen and Caum, 1931). Of these only Scaevola and Eragrostis were successful - it is not even certain that these were, since both plants were already on the island



and viable seeds of both species were probably already in the soil. It is quite probable, however, that in 1923 seeds of Fimbristylis cymosa were planted, and this introduction was successful.

Seeds of several species have been found on Laysan beaches although the plants do not grow on the island. These seeds have probably drifted ashore and are either inviable because of long exposure to sea water or have not met proper conditions for germination. Species known only from seeds are Aleurites moluccana, the candlenut, and four species of leguminous vines: Entada scandens, Mucuna gigantea, Dioclea altissima, and Caesalpinia crista (Christophersen and Caum, 1931).

Heller (1897) seems to have been mistaken when he indicated that Gossypium tomentosum, the Hawaiian cotton, was to be found on Laysan. There are no records of the occurrence of this plant on Laysan, and Heller apparently never visited the island.

Of the 38 species that have grown on Laysan, 10 have evidently been introduced by man, either intentionally or otherwise. These are:

Cynodon dactylon  
Cocos nucifera  
Casuarina equisetifolia  
Amaranthus viridis  
Portulaca oleracea  
Hibiscus tiliaceus  
Messerschmidia argentea  
Nicotiana tabacum  
Solanum nodiflorum  
Pluchea indica

It is highly probable that another species, Fimbristylis cymosa, which is native to the main Hawaiian Islands, was also introduced intentionally in 1923.

Among the 27 remaining species are 11 which have a rather wide distribution on the islands of the Pacific. These are:

Lepturus repens  
Sporobolus virginicus  
Cyperus laevigatus  
Boerhavia diffusa  
Sesuvium portulacastrum  
Portulaca lutea  
Tribulus cistoides  
Ipomoea indica  
Ipomoea pes-caprae  
Heliotropium curassavicum  
Scaevola taccada

Nine species are endemic to the Hawaiian Islands, but are found on both the main islands and the leeward islands:

Eragrostis variabilis  
Chenopodium oahuense  
Achyranthes splendens var. reflexa  
Lepidium o-waihiense  
Capparis sandwichiana  
Solanum nelsoni  
Sicyos hispidus  
Sicyos microcarpus  
Lipochaeta integrifolia

Three species or varieties are restricted to the leeward islands:

Cenchrus agrimonioides var. laysanensis  
Nama sandwicense var. laysanicum  
Phyllostegia variabilis

Four species or varieties occur only on Laysan:

Cyperus pennatifolius var. bryanii  
Pritchardia sp.  
Santalum cuneatum var. laysanicum  
Sicyos sp.

The flora of Laysan has a distinctly Hawaiian character. Of the 27 species or varieties native to the island, 16 or 59% are endemic to the Hawaiian Islands; of these 16, nine are distributed throughout the chain, three are restricted to the leeward islands but are found on more than one island, and four are restricted to Laysan. The 24 species found on Laysan in 1961 represent eight introduced species, nine species of wide distribution in the Pacific, four species endemic to the entire Hawaiian Islands, one species restricted to the leeward islands, and two species restricted to Laysan.

## VEGETATION

Early visitors to Laysan described the rather dense vegetation covering the island (cf. Christophersen and Caum, 1931; Bryan, 1942). Isenbeck in 1828 noted that most of the island was covered with a bushy grass (Eragrostis). In places were short shrubs (probably Chenopodium and Scaevola), between which were a few dwarfed fan palms (Pritchardia).

Paty described the island in 1857 as covered with "beach grass" (presumably Eragrostis) and having half a dozen palm trees. Brooks in 1859 noted "a luxuriant growth of shrubs" and five palm trees. Munro in 1891 found the island "to be covered a good deal by vegetation" (personal communication, 1961) consisting of a tussock grass (Eragrostis) and some tangled scrub (probably Chenopodium and Scaevola). The scrub was more abundant at the north end of the island. He found the beds of guano covered with a carpet of "iceplant" (probably Sesuvium), and a

carpet of "iceplant and other creepers" fringing the lake. Munro also noted two Pritchardia trees and the stumps of several more.

Schauinsland (1899) provided a detailed description of the vegetation as it was in 1896. Although the Pritchardia had become extinct by this time (Schauinsland found only dead stumps, but estimated the former number of trees at several hundred), Laysan had just begun to feel the influence of man and was still in a relatively unspoiled state. Only one (Amaranthus viridis) of the 26 plant species Schauinsland found was introduced by man. On the higher parts of the beaches he noted that Lepturus and Sporobolus were abundant. In this region also were plants of Phyllostegia, Nama, Portulaca, and Santalum. At the northwest end of the island Santalum was especially abundant.

Just above the beach, on the seaward slope, was a region of Scaevola shrubs, among which were growing Solanum and both species of Ipomoea. In this region, on the west side of the island, were several shrubs of Capparis, and at one place on the northwest side of the island was a stand of Achyranthes about 100 meters in diameter.

Inland of the Scaevola was a zone dominated by Eragrostis which covered most of the island. The Eragrostis formed clumps among which were found plants of Cenchrus, Tribulus, Boerhavia, and Ipomoea indica. The shrubby Chenopodium was widely distributed throughout this zone and was apparently especially well developed on the lower, inner slopes. Toward the inner part of this zone Cyperus pennatifolius was occasionally found. In the transition region between Eragrostis and the Sesuvium association around the lake, Lipochaeta was present.

The band around the lake was composed predominantly of Sesuvium, Heliotropium, and Cyperus laevigatus. Mixed with these were Sicyos spp., Cyperus pennatifolius, and Amaranthus.

Schauinsland further noted that the vegetation of the western half of the island was more luxuriant and was composed of more species than that of the eastern half.

In 1902 Fisher (1903a,b) noted essentially the same zonation of vegetation described by Schauinsland, but added that the band around the lake also contained large numbers of Portulaca lutea plants. Conditions must have been similar at the time of W. A. Bryan's visit in 1903. He collected all but two of the species found by Schauinsland (Lepidium and Sicyos microcarpus), and added only two new species (Cynodon and Sicyos sp.). At about this time, however, rabbits were introduced to Laysan and extensive changes in the vegetation began. When Bryan made his next visit to the island, in 1911, 13 of the 26 species that he collected in 1903 had disappeared. Bryan predicted at this time (Dill and Bryan, 1912) that even more species would disappear unless drastic measures were taken.

Unfortunately Bryan's advice was not accepted, and when the members of the Tanager Expedition visited Laysan in 1923, they found a veritable wasteland. Only four native plant species were still growing (Sesuvium, Portulaca lutea, Tribulus, and Scaevola). Living stumps of Santalum

were observed (Christophersen and Caum, 1931), but they evidently died soon thereafter. Only dead plants of Boerhavia could be found. Four introduced species had survived -- one ironwood, two coconuts, and three hau trees, in addition to several tobacco plants which were apparently so unpalatable that their number was increasing. The members of the Tanager expedition exterminated the rabbits and planted seeds and cuttings of many species in an attempt to revegetate the island.

With the disappearance of the rabbits, the vegetation started to return to Laysan. In 1930 G. P. Wilder collected 13 species, 9 of which were native. The Templeton Crocker expedition visited the island in December 1936 and "reported that conditions, while not yet back to pre-poacher and pre-rabbit optimum, were greatly improved" (Bryan, 1942). Aerial photographs made in May 1949 (Bailey, 1956) reveal a dense cover of vegetation over much of the island and are quite similar to aerial photographs made in July 1961.

In 1959 a preliminary study of the vegetation was made along two transects from the sea to the lake by Dr. M. D. F. Udvardy. In 1961 this study was extended when ten additional sea to lake transects were made by the author. The data obtained from these 12 transects form the major body of evidence on which the vegetation map (Fig. 1) and the following descriptions of vegetation associations are based.

The 24 species of vascular plants growing on Laysan in 1961 formed five distinct associations. These are:

1. The Nama association.

The plant which characterizes this association is Nama sandwicensis var. laysanicum, an herb which forms small rounded mounds up to 10 cm high and 40 cm in diameter. The association occurs on the beaches and seaward slopes of the island, beginning at some places within two meters of the high tide line. It reaches its best development on the north and east sides of the island, where there are large open sandy areas. Here the association extends inland for 300 to 400 meters, and is found on the crest of the island and the upper part of the inner slopes. Throughout most of the area Nama occurs alone, but in some spots scattered plants of Portulaca spp., Ipomoea pes-caprae, Boerhavia, Heliotropium, and Eragrostis can be found. In September 1961 Nama was most abundant on the north and east sides of the island where the plants were growing very thickly and were reproducing well, as indicated by the large numbers of seedlings (Fig. 2, 3). On the south and west sides of the island the individual plants tended to be more widely scattered. In July 1959, and as late as March 1961 much of the area on the north and east sides of the island was barren. Nama was present only as widely scattered individuals. The abundant development evident in September 1961 thus apparently occurred quite rapidly. This may reflect normal seasonal variation, but more likely indicated that 1961 was a year of relatively heavy rainfall. Since rainfall data are not available, this hypothesis cannot be substantiated.

It is possible that the development of a good cover of Nama can represent an early stage of vegetational succession, in which soil stabilization resulting from the presence of Nama enables seedlings of other species to become established. In places where this association comes into contact with the bunch-grass association (Fig. 5), small grass seedlings were growing among the Nama. In other places prostrate stems of the beach morning glory, some as much as 20 meters long, extended across areas covered by Nama, further stabilizing the loose sandy soil (Fig. 4). Continued observation of these areas over a period of years should provide the answer to this question.

## 2. The Scaevola association.

This association is characterized by Scaevola taccada, which forms a dense, highly branched shrub up to 1.5 meters in height. It typically occurs just inland of the Nama association. On the west side of the island it forms a nearly continuous strip from five to 100 meters in width. On the north, east, and south sides of the island it occurs in scattered patches, and may form "islands" within the Nama. Where the Nama association extends far inland, the Scaevola association may be present on the inner slopes. At the south end of the lake and in a few places on the west side, scattered plants of Scaevola, and occasionally a well-developed Scaevola association, appear on the lower part of the inner slopes.

The Scaevola bushes occur either singly or in groups, between which other species are often found. Toward the seaward edge of the association Nama is sometimes present. Other species in the association include Ipomoea pes-caprae, Boerhavia, Tribulus, Eragrostis, and occasionally Fimbristylis. Capparis is found in this association and occurs only as a few shrubs mixed with Scaevola on the west side of the island. At one place on the north end of the island, Sicyos hispidus was observed climbing over the Scaevola bushes.

## 3. The bunch-grass association.

Eragrostis variabilis, a bunch grass about one meter high, is the plant characteristic of this association, which occupies a majority of the land area on Laysan. On the west, southwest, and northwest portions of the island, the bunch-grass association occurs in a well-defined band, in places more than 500 meters wide. On the eastern part of the island the association can also be recognized although it is less well-defined and intergrades with the Boerhavia - beach morning glory - Tribulus association. The bunches of Eragrostis are spaced at intervals of one meter or more. The areas between bunches in some places contain only bare sand honeycombed with shearwater burrows, while in other places the sand is covered with Boerhavia (Fig. 6), Ipomoea pes-caprae (Fig. 7), Tribulus (Fig. 8), Nicotiana (Fig. 9), and Fimbristylis. At the north end of the island, near the inner edge of the association, vines of Sicyos spp. are found growing over the Eragrostis (Fig. 10). In some of the more open areas, Nama can be found.

Aerial photographs made in 1949 and 1961 reveal the presence of two rather distinct, more or less parallel, bands of less dense vegetation in the bunch-grass association. These bands extend throughout most of the length of the west side of the island, and alternate with three bands of denser vegetation. A survey from the ground indicates that within the less dense areas the bunches of Eragrostis are more widely spaced, and there are fewer other plants growing between the bunches. The factors responsible for this phenomenon are not yet known.

4. The Boerhavia - beach morning glory - Tribulus association.

The species which characterize this association are Boerhavia diffusa, Ipomoea pes-caprae, and Tribulus cistoides, all of which are low, creeping plants. The association occurs on the lower, inner slopes of the island, and occupies a zone from 20 to 200 meters in width, which is more or less continuous around the lake. At places within this zone each of the three characteristic species may form more or less pure stands, but they often occur intermixed. Also present in this association are widely scattered plants of Eragrostis. In the northeast part of the island the introduced shrub Pluchea indica (Fig. 11) has become established. In a few areas within the association are patches of Cynodon and Ipomoea indica. At the south end of the lake, near the inner border of this association, were found the only plants of Cyperus pennatifolius on the island.

5. The Sesuvium - Cyperus - Heliotropium association.

The association is characterized by Sesuvium portulacastrum, Cyperus laevigatus, and Heliotropium curassavicum. Sesuvium is a creeping plant with succulent leaves which forms a dense mat only a few centimeters high. Cyperus laevigatus looks superficially like a rush, grows in dense masses, and may reach a meter in height. The association occurs in a band from 10 to 100 meters in width completely around the shore of the lake. Near the lake shore Sesuvium and Cyperus laevigatus appear in pure stands; further from the shore both species occur together, mixed with Heliotropium (Fig. 12). Ipomoea pes-caprae appears frequently in this association (Fig. 13). Less commonly Tribulus and Portulaca lutea are found here. Fimbristylis occurs in two forms in this association, a larger form up to 40 centimeters high which appears identical with that which is found in the bunch-grass association, and a smaller form, about 10 centimeters high which occurs only near the lake shore.

The plants which do not participate in the formation of distinct associations are Cocos nucifera, Casuarina equisetifolia, and Messerschmidia argentea. Cocos occurs in two small groves, at the north and south ends of the lake. The Casuarina tree grows on the northwest end of the island, above the landing beach, in the transition between the Scaevola and bunch-grass associations. The single plant of Messerschmidia grows at the northwest end of the island, at the top of the beach, on the boundary between the Nama and Scaevola associations.

The only extensive barren areas on Laysan in September 1961 were an area at the south end of the island which was the site where guano was mined, the shallow bottom of the lake which becomes exposed when the

water level drops by a few inches, and an area about 50 meters north of the north end of the lake which is also apparently underwater when the level of the lake is high.

The observations presented above indicate that the vegetation has made an impressive recovery. Not only are many of the original species still present, but the structure of the vegetation appears similar to that described before the island was devastated by rabbits. The major difference evident today is the absence of three shrubs which formerly composed a significant element of the vegetation: Chenopodium, Achyranthes, and Santalum. Although the shrubby Pluchea indica could play a similar role in the formation of the vegetation, it would seem more desirable to attempt to remove the Pluchea and to re-establish Chenopodium and Achyranthes on Laysan, thus creating a more natural habitat.

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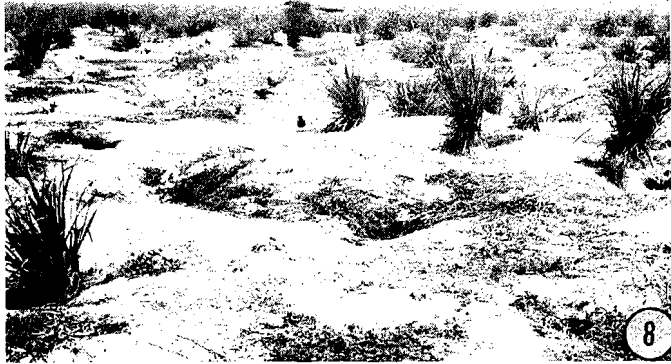




Photographs used for figures 2-13 were taken on Laysan Island in September 1961.

- Fig. 2. The Nama association at the north end of the island. In the foreground is a single clump of Eragrostis variabilis. The prostrate plants are Nama sandwicensis var. laysanicum, of which individuals of several ages are present.
- Fig. 3. The Nama association at the north end of the island. The prostrate plants in the foreground are Nama sandwicensis var. laysanicum, and the bunch-grass in the background is Eragrostis variabilis.
- Fig. 4. The Nama association at the north end of the island. In the foreground are vines of Ipomoea pes-caprae, with Nama in the middle distance and background. At the left is a large clump of Scaevola taccada.
- Fig. 5. View from north rim of island looking southeast across the central depression, showing the boundary between the Nama association and the bunch-grass association. In the middle distance is a grove of coconuts planted in 1959.
- Fig. 6. The bunch-grass association. The ground between the clumps of Eragrostis variabilis is covered with Boerhavia diffusa.
- Fig. 7. The bunch-grass association. The ground between clumps of Eragrostis variabilis is covered with Ipomoea pes-caprae and Boerhavia diffusa.





- Fig. 8. The bunch-grass association. The clumps of Eragrostis variabilis are rather widely spaced, and the ground cover is mainly Tribulus cistoides. Note the uneven ground surface, caused by the presence of many wedge-tailed shearwater burrows.
- Fig. 9. The bunch-grass association. Note the Nicotiana tabacum in the center of the photograph, and Boerhavia diffusa in the right foreground.
- Fig. 10. The bunch-grass association. Vines of Sicyos spp. growing among and over clumps of Eragrostis variabilis.
- Fig. 11. Transition between the Boerhavia-beach morning glory-Tribulus association and the Sesuvium-Cyperus-Heliotropium association at the northeast end of the lake. In the foreground are several plants of Heliotropium curassavicum, and at the left a large shrub of Pluchea indica.
- Fig. 12. The Sesuvium-Cyperus-Heliotropium association at the northeast end of the lake. The light-colored plants in the foreground are Heliotropium curassavicum, and in the background is a mat of Sesuvium portulacastrum with scattered plants of Fimbristylis cymosa.
- Fig. 13. The Sesuvium-Cyperus-Heliotropium association. In the foreground are Ipomoea pes-caprae and Heliotropium curassavicum, behind which is a large stand of Cyperus laevigatus.

