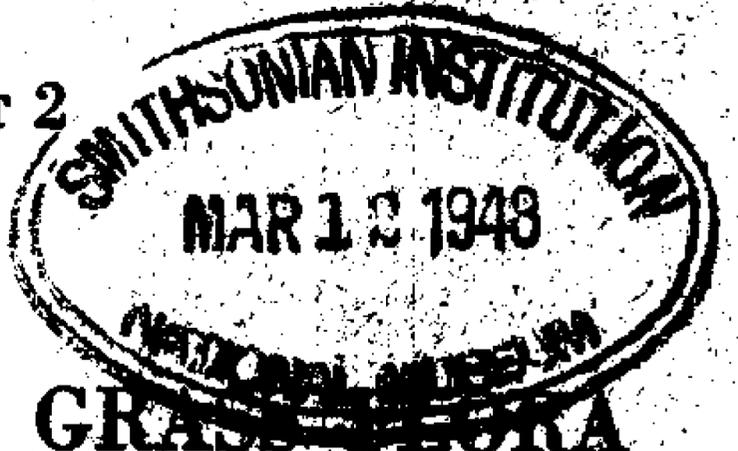


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**CONTRIBUTIONS
FROM THE
UNITED STATES NATIONAL HERBARIUM**

VOLUME 30, PART 2



**OBSERVATIONS ON THE GRASS FLORA
OF CERTAIN PACIFIC ISLANDS**

By L. T. BURCHAM



**SMITHSONIAN INSTITUTION
UNITED STATES NATIONAL MUSEUM
WASHINGTON, D. C.**

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OBSERVATIONS ON THE GRASS FLORA OF CERTAIN PACIFIC ISLANDS

By L. T. BURCHAM

INTRODUCTION

THE grasses discussed in this paper were collected on islands of the South and Western Pacific between November 1942 and July 1945, while I was on duty with the United States Marine Corps. Areas represented include Guadalcanal, British Solomon Islands; Goodenough Island, Territory of Papua; New Britain, Bismarck Archipelago; Pavuvu Island, Russell Islands; Peleliu Island, Palau Islands; Okinawa Shima, Ryukyu Archipelago; and two species from New Caledonia. Although a reasonable attempt was made to obtain a complete representation of grasses from each locality, collecting was done during periods when active combat operations were in progress, except for Goodenough and Pavuvu Islands. This handicap, together with the difficulty of obtaining driers and caring for specimens at such times, at least partly explains why the collections from some areas were not more extensive.

This collection of 104 numbers includes representatives of 9 tribes, 45 genera, and 72 species. The species were identified by Mrs. Agnes Chase, research associate, division of grasses, U. S. National Herbarium, whose suggestions and assistance in the preparation of this paper are gratefully acknowledged. A complete set of the specimens is deposited in the National Herbarium. Isotypes of the new species are in the herbarium of the University of California.

All localities and altitudes were determined, on the ground, from the best military topographic maps available; local place names used are as given on those maps. The areas of occurrence are condensations of the "known range" as determined from specimens in the National Herbarium, supplemented in a few instances by statements of qualified authorities.

GUADALCANAL, BRITISH SOLOMON ISLANDS

The island of Guadalcanal, located in latitude 10° S., longitude 160° E., is the second largest of the British Solomon Islands. The name Guadalcanal is a corruption of the original Guadalcanar, meaning "a dry river bed," from the city of that name in Spain, for which the island was named.

The Kavo Range, with the highest peak just over 8,000 feet, forms a mountainous backbone dominating the southern half of the island; from this range the land slopes abruptly toward the south and more gently toward the north, here forming a relatively broad coastal plain. Generally, the topography is steep, and coral outcrops along much of the northern shoreline indicate a relatively recent rise above sea level.

The climate is that typical of the hot, humid tropics—an average annual temperature of 82° F., and annual rainfall ranging between 94 and 180 inches. Although the period between January and March is considered the rainy season, and from June through August the dry season, there is really but little difference between monthly rainfall records of these periods on much of the island.¹

Soils personally examined were mostly in coastal areas, over coral outcrops; they were shallow and texture varied from sand to adobe clay, and in several instances clayey soils had an appreciable amount of peaty material in the upper 3 or 4 inches. There was no opportunity to investigate soils farther than about 5 miles inland.

The original vegetation of this island consisted of tropical rain-forest on the uplands, extending down to the seacoast in most of the ravines, particularly on south and west slopes of ridges. These forests contain several varieties of teak, two or three so-called "mahoganies," and a species of ebony, which are of some commercial importance.¹ There are some swamps along the coasts where mangrove (*Rhizophora* sp.) is dominant. In recent years much of the coastal plain has been cleared for coconut plantations.

In all I spent 11 days on Guadalcanal in 1942, during which time the collection was made, but combat conditions then prohibited an extensive examination of terrain and vegetation. During 1944 and 1945 I spent about 15 additional days on the island and was able to make more extensive observations, but no further collections. A considerable portion of the northwest coast I observed from a plane at low altitude.

GRASSES COLLECTED

Eleusine indica (L.) Gaertn. Fruct. et Sem. 1: 8. 1788.

Cynosurus indicus L. Sp. Pl. 72. 1753. India.

Common throughout tropics and subtropics of both hemispheres. East bank Lunga River, about half a mile from mouth; altitude 5 to 10 feet; *Burcham* 73, December 8, 1942. In silty river overwash. Annual, in open clumps; associated with *Echinochloa colonum*, *Paspalum conjugatum*, and other grasses. Occasional in this vicinity.

¹ Personal conversation with Maj. Martin Clemens, A. I. F., formerly assistant district officer at Aola, Guadalcanal.

Paspalum conjugatum Berg. Act. Helv. Phys. Math. 7: 129. pl. 8. 1762. Surinam.

Warm regions of America; introduced in Eastern Hemisphere; common in East Indies, Philippines, and Pacific Islands.

East bank Lunga River, about half a mile from mouth; altitude 5 to 10 feet; *Burcham* 72, December 8, 1942. In silty river overwash. Stoloniferous perennial; flowering culms suberect, to 2 feet tall; associated with *Echinochloa colonum*, *Eleusine indica*, and other grasses. Occasional to common; economic value uncertain, apparently grazed to some extent locally by plantation cattle.

Panicum cambogiense Balansa, Journ. de Bot. 4: 142. 1890. Cambodia.

Panicum reticulatum Thwaites, in Trimen, Journ. Bot. 23: 271. 1885. Not *P. reticulatum* Torr. 1852 or Griseb. 1857. Ceylon.

Panicum cruciabile Chase, Journ. Arnold Arb. 20: 309. 1939. Based on *P. reticulatum* Thwaites.

Ceylon, Burma, Cambodia, Philippines, and New Guinea.

South side Henderson Field; altitude 20 feet; *Burcham* 74, December 8, 1942. Margin of rain-forest, one-fourth mile east of Lunga River; east slope, adobe-clay soil underlain with coral at shallow depths. Coarse, erect perennial, to 6 feet tall; culms and sheaths hirsute with coarse white hairs, irritating to the skin, associated with bamboos, Convolvulaceae, and trailing herbs. Rare to occasional.

Echinochloa colonum (L.) Link, Hort. Berol. 2: 209. 1833.

Panicum colonum L. Syst. Nat. ed. 10. 2: 870. 1759. Jamaica.

Tropics and subtropics of both hemispheres.

East bank Lunga River, about half a mile from the mouth; altitude 5 to 10 feet; *Burcham* 71, December 8, 1942. Decumbent annual, growing with *Paspalum conjugatum*, *Eleusine indica*, and other grasses, along banks of river, in silty river overwash. Common; apparently grazed by plantation cattle.

Imperata exaltata (Roxb.) Brongn. in Duperrey, Bot. Voy. Coquille 2 (2): 101. 1831.

Saccharum exaltatum Roxb. Fl. Ind. 1: 249. 1820. India.

India, Malay Peninsula, Philippines, Borneo, New Guinea.

South side Henderson Field; altitude 25 feet; *Burcham* 69, December 8,⁵ 1942. Grassland, one-fourth mile east of Lunga River; on moist, peaty clay, underlain with coral fragments at 10 to 12 inches. Robust, erect perennial with stout, scaly rhizomes; leaves mostly in a basal tuft; appears to reproduce primarily by vegetative means. Associated with *Themeda australis* and trailing herbaceous plants. Moderately abundant and widespread, this and the following being the two dominant species throughout the majority of grasslands at low elevations. Economic use here not known.

Themeda australis (R. Br.) Stapf, in Prain, Fl. Trop. Afr. 9: 420. 1919.

Anthistiria australis R. Br. Prodr. Fl. Nov. Holl. 1: 200. 1810. Australia.

Australia; New Guinea.

South side Henderson Field; altitude 25 feet; *Burcham* 68, December 7, 1942. Grassland, one-fourth mile east of Lunga River; clay loam, underlain with coral at 4 to 6 inches. Perennial, in clumps to 5 feet tall; associated with *Imperata exaltata*, trailing herbs, and sometimes with small shrubs or in borders of rain forests. Widely distributed and abundant in low-elevation grasslands, growing under a wide variety of soil and moisture conditions.

Polytoca macrophylla Benth. Journ. Linn. Soc. Bot. 19: 52. 1881. Louisiade Archipelago.

New Guinea and adjacent islands; introduced in Hawaii.

South side Henderson Field; altitude 30 feet; *Burcham* 70, December 8, 1942. Margin of rain-forest, one-fourth mile east of Lunga River; peaty clay underlain with coral at 6 to 8 inches. Coarse, erect perennial, in clumps to 6 feet tall; with *Themeda australis*, bamboos, and trailing herbs. Occasional, in margins of rain-forest in part shade.

Although this collection comprises only a portion of the grass flora of Guadalcanal, it does include representative species of two characteristic habitats.

Open spots along river margins are characterized by such grasses as *Echinochloa colonum* and *Eleusine indica* and by such moisture-loving species as *Paspalum conjugatum*, which are presumably accidental introductions since the advent of white men there. Though not represented in the collection, *Dactyloctenium aegyptium* (L.) Beauv. was also observed along streams, as well as in several other areas where it formed almost pure stands on sandy soils, particularly near the coast.

Dominant species of low-altitude grasslands are *Themeda australis* and *Imperata exaltata*, in varying proportions. On exposed, stony, and well-drained slopes, where soils are generally of coarser texture, *Themeda australis* tends to form almost pure stands; in flatter areas, where soils are less well-drained and more clayey, *Imperata exaltata* is the dominant species, with *Themeda australis* definitely a subordinate. *Panicum cambogiense* and *Polytoca macrophylla* represent species observed associated with these grassland dominants along borders of the rain forest, where they appear restricted to habitats of part shade. A species of *Stenotaphrum* was observed but not collected; it was locally abundant in rain-forest margins, in vicinity of the coast just east of Cape Esperance.

Grasslands tend to be restricted to north and east slopes of ridges, here in the Southern Hemisphere the slopes of higher insolation; to



EAST COAST OF GOODENOUGH ISLAND

The mountain summits are clothed with "moss" forest above the line of cloud formation. Below are rain forests extending down to the seacoast along many of the stream valleys; on exposed slopes these give way to savanna or grassland. (Official U. S. Marine Corps photo.)



HAWAII VILLAGE, GOODENOUGH ISLAND

Native houses are thatched with grasses from the immediate vicinity, principally *Manisuris rattboelliioides*. Natives were evacuated from areas occupied by troops. Many of the specimens obtained on Goodenough Island were collected in this locality. (Official U. S. Marine Corps photo.)



NATIVE LABORERS, GOODENOUGH ISLAND

The dominant grasses are *Manisuris ruficollisoides*, *Imperata* sp., and *Themeda* sp. The white-barked, sparse-foliaged leguminous trees occur invariably in the savanna type, giving its characteristic aspect. Here native laborers are cutting grass for thatching huts to be used as offices by the United States Marines. (Official U. S. Marine Corps photo.)



SAVANNA, GOODENOUGH ISLAND

Areas in which grasses are dominant are invariably habitats of full sun, for the most part well drained. Here *Themeda* sp. is the dominant one, with lesser proportions of *Manisuris rotboellioides* and *Imperata* sp. The white-barked, sparse-foliaged trees are characteristic of the savanna. (Official U. S. Marine Corps photo.)

flatter areas which are the seaward extensions of ridges; and to rocky, well-drained slopes. Soils of grassland areas are much shallower than under rain-forests. These factors of soil, insolation, and drainage appear to be the principal determinants between rain-forest and grassland in any given area.

GOODENOUGH ISLAND, TERRITORY OF PAPUA

The Territory of Papua comprises the southeastern part of the island of New Guinea together with the adjacent offshore island groups. Goodenough Island is one of three principal islands of the D'Entrecasteaux group, located off the northeast coast of the mainland of New Guinea and separated from it by Ward Hunt Strait; it lies about 20 miles northeast of Cape Vogel, in approximately latitude $9^{\circ}15''$ S. and longitude $150^{\circ}15''$ E. Goodenough is also known as Morata Island.

The island is of volcanic origin with high mountains located about two-thirds of the distance from northeast to southwest. The tallest peak, Mount Whyalla, has an elevation of 8,419 feet; this is also the highest island mountain in the Territory of New Guinea. Mount Nimadao, Mount Stella, and at least five other peaks in this backbone reach above 7,000 feet. From this rugged chain the terrain falls off sharply to the coastline on the north, west, and south sides. On the northeast an undulating, well-drained plain extends 4 to 5 miles from the base of the mountains to the coast. Mountain canyons are geologically rather young, being very narrow and V-shaped as well as having steep gradients. As soon as streams reach the coastal plain they tend to meander to a considerable extent; some of them have made marked changes of course in the recent past. Heavy rains in the hills, which are practically of daily occurrence, often manifest themselves in abrupt rises in the streams—the north branch of Malauna Creek was observed to rise 2 feet in less than 15 minutes at a point approximately 3 miles from its source in the hills.

The climate is humid-tropical, characterized by average annual temperatures of about 80° F. and by an annual rainfall of 100 to 150 inches. December to April are the rainiest months, but high mountains and the small size of the island minimize usual "wet" and "dry" season distinctions.

Virtually all the area of the northeast coastal plain is covered with boulders of all sizes, up to many tons. These rocks are chiefly basaltic, with considerable amounts of quartz intruded—and the whole strongly metamorphosed. Soils weathered from these are almost invariably shallow, sandy to loamy in texture, and with much organic matter in the first few inches; in some grasslands the surface layer is almost peaty.

The vegetation pattern is very similar to that found on other tropical islands throughout the Southwest Pacific. Mountain summits are clothed with "moss" forest above the line of cloud formation. Below are rain-forests extending down to the seacoast along many stream valleys (pl. 1). On much of the coastal plain, and on exposed north and east slopes to about 3,000 feet elevation, these forests give way to savanna or grassland. Much of the coastline has a narrow fringe of mangrove (*Rhizophora* sp.). A relatively insignificant area in vicinity of the coast has been cleared for coconut plantations, but for the most part this island had been scarcely touched by white men before the war.

I was on Goodenough Island from October 21 to December 15, 1943, and during this time explored much of the northeast portion of the island on foot.

GRASSES COLLECTED

Eragrostis distans Hack. [Publ.] Bur. Gov. Lab. Philippine Islands 35: 81. 1906.
Luzon, Philippine Islands.

Okinawa and Philippine Islands to New Guinea.

Haiwali village; altitude 100 feet; *Burcham* 123, November 14, 1943. Grassland, 2 miles inland on coastal plain; well-drained sandy loam, with much organic matter. Tufted annual with shallow roots, to 2 feet tall, associated with *Digitaria microbachne*, *Paspalum scrobiculatum* var. *bispicatum*, *Apluda mutica*, *Manisuris rottboellioides*, *Sorghum nitidum*, *Imperata* sp., *Themeda* sp., and other grasses. Occasional in this locality.

Centotheca latifolia (Osbeck) Trin. Fund. Agrost. 141. 1820. Presumably based on *Holcus latifolius* Osbeck; *Cenchrus lappaceus* L. cited as synonym.

Holcus latifolius Osbeck, Dagbok 247. 1757. China.

Cenchrus lappaceus L. Sp. Pl. ed. 2. 1488. 1762. India.

Centotheca lappacea Desv. Journ. de Bot. Desv. 1: 71. 1813.

Tropical Asia, East Indies, South Pacific Islands; Queensland, Australia; west tropical Africa.

Near Haiwali village; altitude 100 feet; *Burcham* 118, November 12, 1943. Margin of tropical rain-forest, 2 miles inland on coastal plain; among metamorphic boulders, on thin soil containing much leaf mold. An erect, broad-leaved perennial, to 3 feet tall; occasional, in forest glades and along forest margins.

Garnotia mezii Janowski in Mez, Repert. Sp. Nov. Fedde 17: 86. 1921; 18: 27. 1922. Kaiser Wilhelmsland, New Guinea.

Previously known only from the mainland of New Guinea.

Malauna Creek; altitude 100 feet; *Burcham* 127, November 27, 1943. Between boulders and bordering banks of creek, 2 miles inland; soil shallow, sandy, moist to wet. An erect, tufted perennial

with slender culms, simple or branching from the lower nodes, to 30 inches tall; associated with *Paspalum cartilagineum*, *P. orbiculare*, *Panicum nodosum*, and *Alloteropsis semialata*. Occurs sparingly.

Arundinella lasiostoma Schum. in Schum. & Lauterb. Fl. Deutsch. Schutzgeb. Südsee 174. 1901. New Guinea.

New Guinea; Bismarck Archipelago.

Near Nubuali village; altitude 80 feet; *Burcham* 132, December 5, 1943. Savanna; light sandy soil with much organic matter in the first 4 inches, underlain with sand and gravel somewhat stratified by water deposition. A coarse, tufted perennial without rhizomes, arising from a woody rootstock; erect, to 5 feet tall; associated with *Manisuris rottboellioides*, *Sorghum nitidum*, *Imperata* sp., *Themeda* sp., trailing herbs, and occasional trees—these being typical savanna plants in this area. Fairly common.

Digitaria microbachne (Presl) Henr. Med. Rijks Herb. Leiden 61: 13. 1930.

Panicum microbachne Presl, Rel. Haenk. 1: 298. 1830. Source unknown, probably Philippines.

India and Malay Peninsula to China, Japan, Philippines, and Melanesia.

Haiwali village; altitude 100 feet; *Burcham* 120, November 14, 1943. Grassland, 2 miles inland on coastal plain; well-drained sandy loam. Perennial, in spreading clumps to 2½ feet tall, or creeping and rooting at the nodes. For associated grasses see *Eragrostis distans*, above; occurs occasionally in clearings and grasslands.

Paspalum cartilagineum Presl, Rel. Haenk. 1: 216. 1830. Luzon, Philippines.

India and Malay peninsula to Philippines, Guam, New Guinea, Samoa, and Tahiti.

Malauna Creek; altitude 100 feet; *Burcham* 129, November 27, 1943. Between boulders and along stream banks, 2 miles inland; soil scanty, sandy, moist to wet. An erect, robust perennial; culms few or solitary, to 5 feet tall. Associated with *Garnotia mezii*, *Paspalum orbiculare*, *Panicum nodosum*, and *Alloteropsis semialata*. Occasional along stream beds and banks; economic value unknown.

Paspalum orbiculare G. Forst. Fl. Ins. Austr. Prodr. 7. 1786. Society Islands.

Paspalum scrobiculatum var. *orbiculare* Hack. Bot. Jahrb. Engler 6: 233. 1885.

Malay Peninsula and China to Formosa, East Indies, New Guinea, New Caledonia, and Polynesia.

Malauna Creek; altitude 100 feet; *Burcham* 130, November 27, 1943. Stream bed and banks. Robust perennial, in compact bunches; leaves mostly basal, ascending. Occasional, in grasslands and in forest along streams; economic value not known.

Paspalum paniculatum L. Syst. Nat. ed. 10. 2: 855. 1759. Jamaica.

American tropics; widely introduced in Old World tropics.

Two miles west of Haiwali village; altitude 700 feet; *Burcham* 134, December 11, 1943. Scanty soil among boulders in dense secondary growth near village; occasional. Coarse perennial with hirsute sheaths, rather broad flat blades, and a many-flowered panicle with minute spikelets.

Paspalum scrobiculatum L. var. *bispicatum* Hack. in Merrill, Publ. Bur. Sci. Manila No. 5: 86. 1912. Luzon, Philippines.

New Guinea and Goodenough Island.

Haiwali village; altitude 100 feet; *Burcham* 122, November 14, 1943. Grassland, 2 miles inland on coastal plain. Rather slender tufted perennial, about 15 inches tall, with two racemes of brownish spikelets.

Panicum nodosum Kunth, Rev. Gram. 1: Suppl. IX. 1830.

Panicum multinode Presl, Rel. Haenk. 1: 303. 1830. Not *P. multinode* Lam. 1798. Luzon, Philippines.

Hemigymnia multinodis Stapf, in Prain, Fl. Trop. Afr. 9: 742. 1920. Based on *P. multinode* Presl.

Ottochloa nodosa Dandy, Journ. Bot. 69: 55. 1931. Based on *Panicum nodosum* Kunth.

India to southern China, Philippines, East Indies, and New Guinea.

Malauna Creek; altitude 100 feet; *Burcham* 128, November 27, 1943. Shallow sandy soil between boulders along banks of stream, 2 miles inland. Creeping perennial, rooting at nodes; culms slender, mostly simple; inflorescence a spreading terminal panicle. Associated with *Garnotia mezii*, *Paspalum cartilagineum*, *P. orbiculare*, and *Alloteropsis semialata*. Occasional.

Cyrtococcum patens (L.) A. Camus, Bull. Mus. Hist. Nat. (Paris) 27: 118. 1921.

Panicum patens L. Sp. Pl. 58. 1753. India.

Panicum radicans Retz. Obs. Bot. 4: 18. 1786. Canton, China.

Panicum carinatum Presl, Rel. Haenk 1: 309. 1830. Luzon, Philippines.

Throughout tropical Asia, East Indies, Philippines, and New Guinea.

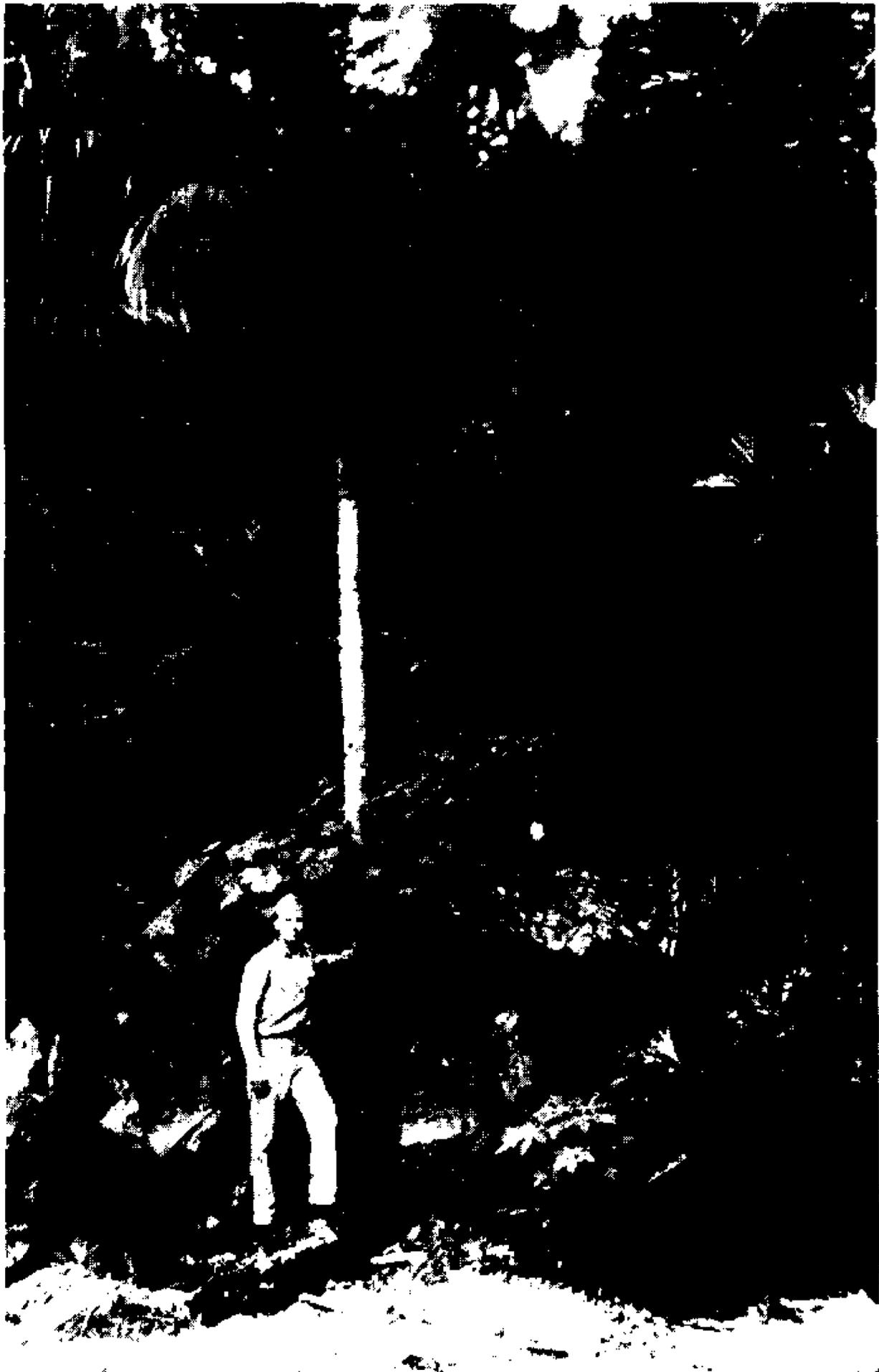
Dense secondary growth, 2 miles west of Haiwali village; altitude 700 feet; *Burcham* 135, December 11, 1943. Trailing perennial, rooting at nodes; here associated with *Paspalum paniculatum*, *Rhaphis aciculata*, and shrubby species of secondary growth, in shallow soil among boulders. Occasional.

Alloteropsis semialata (R. Br.) Hitchc. Contr. U. S. Nat. Herb. 12: 210. 1909.

Panicum semialatum R. Br. Prodr. Fl. Nov. Holl. 192. 1810. Australia.

Alloteropsis distachya Presl, Rel. Haenk. 1: 344. pl. 47. 1830. Luzon, Philippines, but source erroneously given as California.

Tropical regions of the Eastern Hemisphere.



HETEROSPATHE ELATA SCHEFF.

Photograph taken on Guam in 1945 by Albert Vatter.



TRISTIOPSIS OBTUSANGULA RADLK.

Fruits (above) and habit (below). Photographs taken on Guam in 1945 by
Russell L. Steere.

Malauna Creek; altitude 100 feet; *Burcham* 131, November 27, 1943. Two miles inland, among boulders in stream bed and along the banks; scant, sandy soil, moist to wet. Coarse perennial, culms a few together, erect, to 4 feet tall; with *Garnotia mezii*, *Paspalum cartilagineum*, *P. orbiculare*, and *Panicum nodosum*. Occasional; economic value not known.

Setaria pallidifusca (Schumach.) Stapf & Hubb. Kew Bull. Misc. Inf. 1930: 259. 1930.

Panicum pallide-fuscum Schumach. Beskr. Guin. Pl. 78. 1827. Guinea, Africa.

Africa; India, Java, Sumatra, and New Guinea (probably introduced in Asia and Pacific islands).

Haiwali village; altitude 100 feet; *Burcham* 125, November 22, 1943. Two miles inland on coastal plain; well-drained sandy loam. Weedy annual, to 4 feet tall; occasional about buildings of native village and into surrounding grassland; probably introduced.

Setaria palmifolia (Koen.) Stapf, Journ. Linn. Soc. Bot. 42: 186. 1914.

Panicum palmifolium Koen. Naturforscher 23: 208. 1788.

Panicum plicatum Willd. Enum. Pl. 1033. 1809. Not *P. plicatum* Lam. 1791. Asia.

Tropical Asia through Pacific islands to Polynesia.

Malauna Creek; altitude 150 feet; *Burcham* 133, December 11, 1943. One mile west of Haiwali village; shallow soil among boulders along stream banks. Observed also in old clearings, about native villages, and along borders of rain forest. Coarse, erect perennial; culms few together or in small tufts, 2 to 6 feet tall; blades broad, lanceolate, very finely plicate. Occurs sparingly; young shoots are sometimes used as food by the natives.

Apluda mutica L. Sp. Pl. 82. 1753. India.

Apluda varia Hack. subsp. *mutica* Hack. in DC. Monogr. Phan. 6: 198. 1889.

India to Japan, Philippines, New Guinea, and New Caledonia.

Haiwali village; altitude 100 feet; *Burcham* 119, November 14, 1943. Grassland, 2 miles inland on coastal plain; well-drained sandy loam, with much organic matter in surface layer. Trailing perennial, rooting and branching freely at nodes, the slender culms intertwined among the tall grassland species; spikelets pale green, with a whitish bloom when young. Associated here with *Eragrostis distans*, *Digitaria microbachne*, *Paspalum scrobiculatum* var. *bispicatum*, *Setaria pallidifusca*, *Manisuris rottboellioides*, *Sorghum nitidum*, *Themeda* sp., and *Imperata* sp.

Manisuris rottboellioides (R. Br.) Kuntze, Rev. Gen. Pl. 2: 779. 1891.

Ischaemum rottboellioides R. Br. Prodr. Fl. Nov. Holl. 205. 1810. Tropical Australia.

Rottboellia ophiuroides Benth. Fl. Austral. 7: 514. 1878. Based on *Ischaemum rottboellioides* R. Br.

Philippines, New Guinea, Australia.

Haiwali village; altitude 100 feet; *Burcham* 124, November 14, 1943. Grassland, 2 miles inland on coastal plain; well-drained sandy loam soil, with much organic matter in the surface layer. An erect, robust perennial to 8 feet tall; associated with same grasses as the preceding. This species is the dominant grass throughout the savanna type, and in much of the grassland on this island. Widely used by natives for thatching houses, in common with other savanna and grassland species. (Pls. 2, 3.)

Sorghum nitidum (Vahl) Pers. Syn. Pl. 1: 101. 1805.

Andropogon serratus Thunb. Fl. Japon. 41. 1784. Japan.

Holcus nitidus Vahl, Symb. Bot. 2: 102. 1791.

Southeast Asia to Japan, Melanesia, and Australia.

Haiwali village; altitude 100 feet; *Burcham* 121, November 14, 1943. Grassland, 2 miles inland on coastal plain; well-drained sandy loam soil, with much organic matter in the surface layer. Coarse, erect perennial, to 6 feet tall; occasional throughout the savanna type.

Rhaphis aciculata (Retz.) Desv. Opusc. 69. 1831.

Andropogon aciculatum Retz. Obs. Bot. 5: 22. 1789. Amboina.

Chrysopogon aciculatus Trin. Fund. Agrost. 188. 1820.

Widespread in tropical Asia, Philippines, Micronesia, Melanesia, Polynesia, and Australia.

Abandoned native village, 2 miles west of Haiwali; altitude 700 feet; *Burcham* 136, December 11, 1943. Shallow soil among boulders, mostly about bases of coconut palms scattered through encroaching secondary growth. Sod-forming perennial with erect, slender flowering culms to 2 feet tall; fairly common on suitable sites.

Polytoca macrophylla Benth. Journ. Linn. Soc. Bot. 19: 52. 1881. (See page 408.)

Haiwali village; altitude 100 feet; *Burcham* 126, November 22, 1943. Margin of rain forest, 2 miles inland on coastal plain; among large boulders, on thin soil containing much leaf mold. Common to abundant along borders of the rain forest, in part shade. This grass was commonly mistaken for some variety of Indian corn (*Zea mays* L.) by our troops.

This collection includes all species of grasses encountered on Goodenough Island, except the following: *Eleusine indica* (L.) Gaertn., observed about native villages and other inhabited places; *Imperata* sp. and *Themeda* sp., abundant in low altitude grassland and savanna types; and a tufted bunchgrass, of which only vegetative parts were in evidence, which was the dominant species of grasslands above some 1,500 to 2,000 feet elevation. No native bamboos were observed on the portion of the island investigated.

Five habitats are represented by these grasses. It is remarkable how few species are common to two or more habitats.

Within the environs of native villages (pl. 2) and about plantation buildings one finds mostly *Rhaphis aciculata* and *Eleusine indica*, which throughout the Pacific islands seem to be associated with activities of man. To a lesser extent occurs *Setaria pallidifusca*, which appears to be a recent introduction that is spreading into surrounding grasslands to a limited degree; and *Setaria palmifolia*, a native grass that is occasionally used for food.

Areas of secondary growth are characterized by well-drained, shallow to moderately deep soils and by dense shade. These areas have been cleared from mature rain-forest by the natives for gardens; after a few years' use they are permitted to revert to forest again and during the intervening years are exceptionally dense tangles of shrubs, small to medium-sized trees, and intertwining vines. In such habitats *Rhaphis aciculata* was occasional to common; *Paspalum paniculatum*, *Cyrtococcum patens*, and *Setaria palmifolia* were found occasionally. These grasses are manifestly losing out in competition with woody species which will eventually return such areas to rain forest, if not further disturbed by man.

The banks and beds of streams running through the rain-forest provide habitats varying from moist to wet and from part to full shade. Soils are sandy, mostly very shallow, and with but little humus. Here are found such moisture- and shade-loving species as *Garnotia mezii*, *Paspalum cartilagineum*, *P. orbiculare*, *Panicum nodosum*, *Alloteropsis semialata*, and *Setaria palmifolia*. These grasses were all occasional to rare in areas investigated.

Margins of the rain-forest, and small glades within it, are characteristically well drained, in part shade, and with shallow to moderately deep soils. *Centotheca latifolia* and *Setaria palmifolia* are occasional but widespread in these habitats; *Polytoca macrophylla* is occasional to abundant but on this island is restricted to margins of the forest.

In a number of instances *Polytoca macrophylla* and *Manisuris rottboellioides* were found in juxtaposition along margins of the rain forest; the division between their habitats appeared always to be at a point where *M. rottboellioides* would remain in full sunshine and where *P. macrophylla* would be in part shade.

Areas in which grasses are dominant are invariably habitats of full sun, with major slope orientations to the north and east, and for the most part well drained (pls. 3, 4); soils vary from quite shallow to about 30 inches in depth—on the coastal plain, frequently with alternating layers of sand and gravel from water deposition; on the ridges, with outcrops of metamorphic or volcanic rock.

Much of the coastal plain is savanna (pl. 4). The dominant grasses

are *Manisuris rottboellioides*, *Imperata* sp., and *Themeda* sp., in that order of abundance. Together these three would account for 90 to 95 percent of the vegetation. Minor species collected from savanna areas were *Arundinella lasiostoma* and *Apluda mutica*, both relatively common; *Eragrostis distans*, *Digitaria microbachne*, *Paspalum orbiculare*, and *Sorghum nitidum* occur as occasional but widely distributed species. A few trailing herbs, chiefly Leguminosae and Convolvulaceae, are found among these grasses. The principal tree is a species of white-barked, sparse-foliaged legume—the trees invariably scattered through the savanna type, giving it its characteristic aspect, but not observed to grow in rain forest.

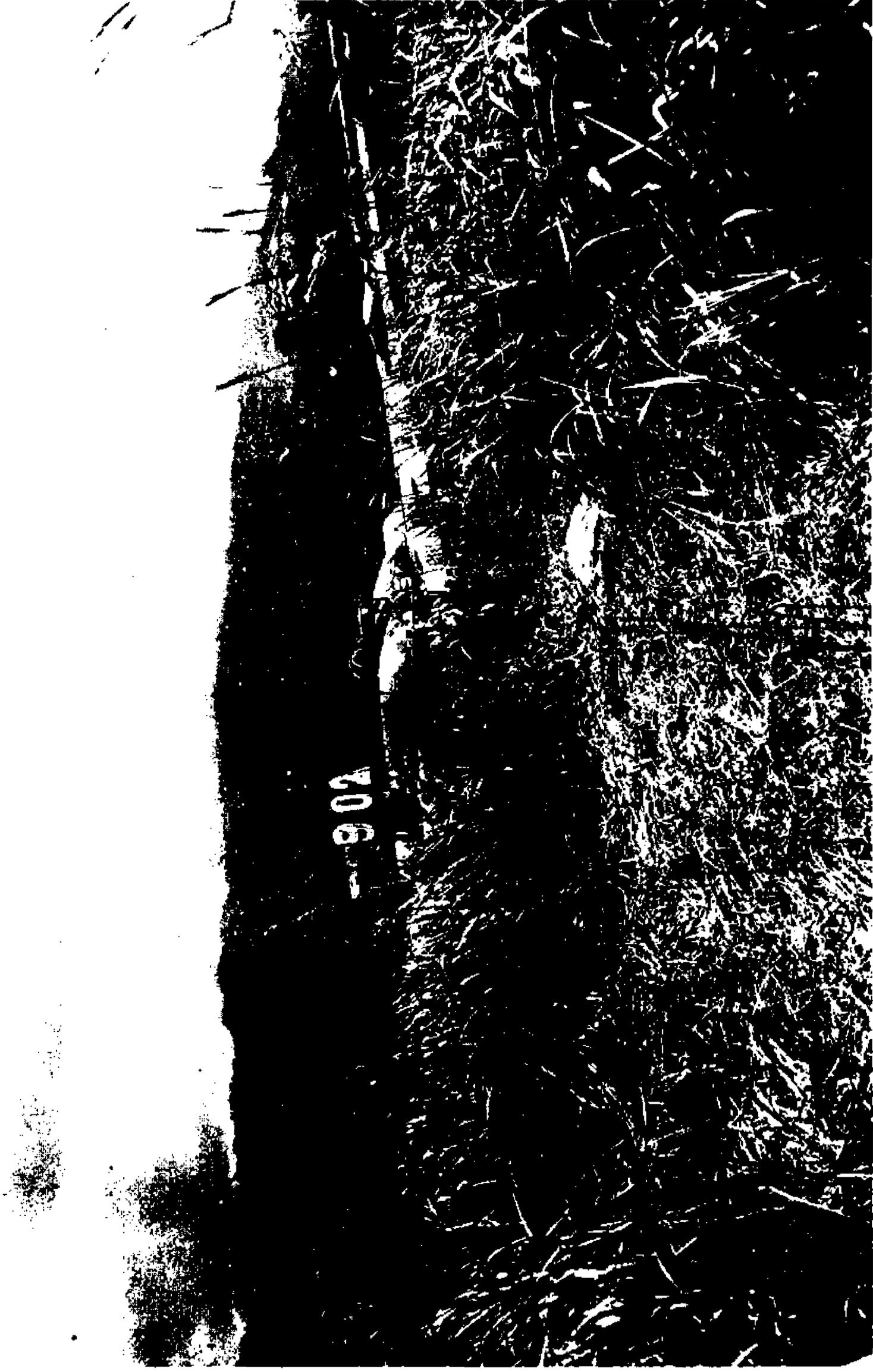
Apart from the savanna, which is here confined to the coastal plain, there are considerable areas of grassland, both on the coastal plain and on mountain slopes. In lowland areas the species composition is essentially the same as in savanna: *Manisuris rottboellioides*, *Imperata* sp., and *Themeda* sp. are generally in that order of abundance—sometimes they are in approximately equal proportions; again with a preponderance of *Imperata* sp. or of *Themeda* sp. On clayey and poorly drained soils there is a tendency toward more *Imperata* sp.; on exposed, rocky ridges *Themeda* sp. becomes dominant. Of associated species *Eragrostis distans*, *Arundinella lasiostoma*, *Digitaria microbachne*, *Paspalum orbiculare*, *Apluda mutica* and *Sorghum nitidum* were found to vary from occasional to common, and to be relatively widespread throughout the type; *Setaria pallidifusca* was observed occasionally in vicinity of native villages.

In mountain areas it was observed that, as one ascends, first the *Imperata* sp. disappears from the grassland type at elevations of about 1,000 feet; then the *Themeda* sp. at elevations between 1,500 and 2,000 feet, leaving as dominant a tufted bunchgrass, of which only vegetative parts were in evidence at this time.

NEW BRITAIN, BISMARCK ARCHIPELAGO

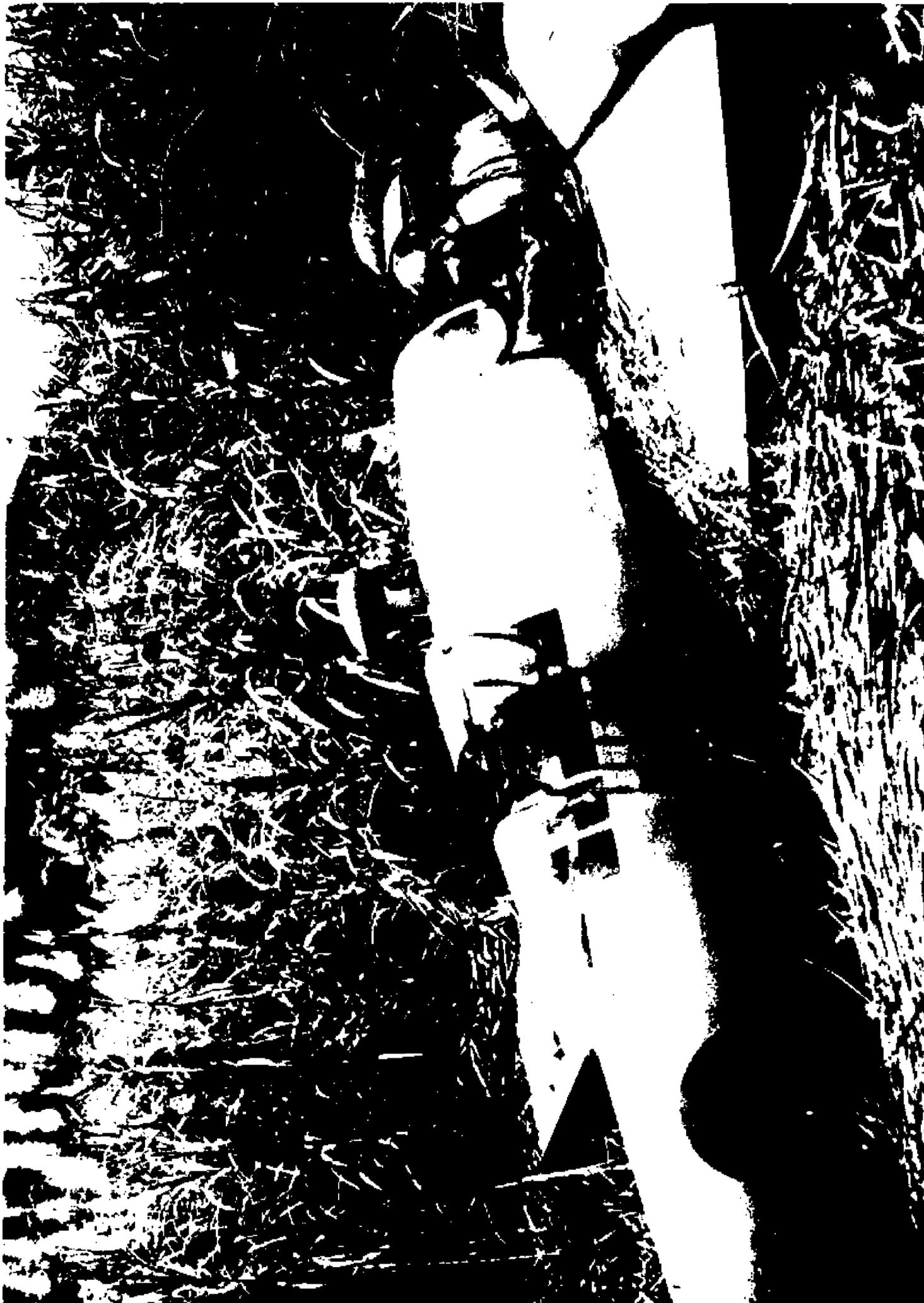
New Britain, the principal island of the Bismarck Archipelago, is a narrow, crescent-shaped body of land located in latitude 4°15'' to 6°15'' S. and between longitude 148°15'' and 152°15'' E. The Germans, who occupied New Britain prior to 1914, called this island Neu-Pommern (New Pomerania), and it is so labeled on maps dated prior to the early 1920's.

The island is about 370 miles in length, and the greatest width is about 60 miles; the land area has been estimated at 13,000 square miles. Topography is mountainous, with a range of high, rugged peaks running its entire length; the highest have been estimated at around 7,500 feet. Volcanos are common throughout the island, and evidences of their recent activity are plentiful. From the interior



GRASSLAND, CAPE GLOUCESTER, NEW BRITAIN

Much of the grassland in the vicinity of Cape Gloucester is very similar to that on Goodenough Island. The dominant species, *Manisuris rotboelliioides*, forms an almost pure stand here. This is the northwest corner of Cape Gloucester's famous No. 2 Airstrip. (Official U. S. Marine Corps photo.)



SACCHARUM SPONTANEUM ON CAPE GLOUCESTER, NEW BRITAIN

In some places this grass occurred as pure stands over considerable areas, with thick, reedlike culms, and to 15 feet tall. This was the "kunai grass" encountered by American troops on Cape Gloucester.

mountains the terrain slopes steeply toward the coast; short, swift rivers, in narrow canyons with steep gradients, further accentuate the ruggedness of the terrain.

There is no essential difference between the climate of New Britain and that of New Guinea or the Solomons. Wet and dry seasons are somewhat more sharply defined, however, and the central mountain chain results in seasons on the opposite coasts being reversed—north and west coasts having a rainy season during the northwest monsoon, from about September to March, while on the south and east coasts the rainy season is during the southeast monsoon, between March and September. Further, it is reported that rainfall on the south coast is considerably heavier than on the north: Arawe, on the south coast, has received as much as 300 inches of rain annually, while at Cape Gloucester, on the north coast, annual rainfall was 150 to 200 inches.¹ Annual temperatures, averaging about 80° F., are lower than for some of the neighboring islands, but relative humidity is generally high, resulting in a less agreeable climate.

Soils personally examined on New Britain varied from sandy loams to clay; mostly they were moderately deep, with a surface layer heavily humified to a depth of 1 foot or more. Bedrock is mostly basaltic; much of the Willaumez Peninsula in vicinity of Talasca is underlain with black obsidian.

This combination of deep, fertile soils and a warm, humid climate has produced a luxuriant vegetation. The major portion of New Britain is forested with a very complex array of tree species, with some stands of hardwoods of commercial importance.

“Moss” forests occur on the mountains, extending down to about 2,500 feet elevation in some places (e. g., the saddle between Mount Talawe and Mount Tangi in western New Britain). The lower fringe of moss forest coincides roughly with the lower limits of cloud formation; it is indicated by a great many lichens and epiphytic mosses on tree trunks and limbs and by a marked increase in ferns and mosses on the forest floor. The moss forest proper typically has a thick ground cover of mosses and decayed vegetation, partially concealing the trunks and branches of many fallen trees. Footing is very uncertain, reminiscent of northern sphagnum bogs. Trees persisting from the rain-forest are heavily overgrown with mosses, lichens, and other epiphytes. Condensation of moisture from the clouds is practically continuous; chilling winds are frequent; the gloomy, depressing surroundings are further accentuated by silence, for mammals, birds, and insects are virtually absent. The wide diversity of plant species and forms makes this a most interesting formation.

¹ Conversations with Lt. W. G. Wiedemann, RANVR, formerly missionary at Arawe and Sag Sag, New Britain, for a period of 8 years.

Much of the coastline is bordered with swamps of mangrove (*Rhizophora* sp. and *Bruguiera* sp.), and nipa palm (*Nipa fruticans*) occurs limitedly near the mouths of some rivers. Small areas of grassland are scattered throughout the coastal region, the largest being in the vicinity of Cape Gloucester. Coconut plantations are frequent along the coast, occupying a considerable area near Rabaul; there are some plantations of coffee and cacao, these being recent introductions that have been comparatively successful. Most plantations are planted to grass, or a species of legume, as a cover crop; cattle are grazed to keep the cover crop under control. As a whole, these cultivated areas comprise only an insignificant portion of the island; the vegetative cover can be considered as basically untouched by activities of men.

I was on this island between December 26, 1943, and May 4, 1944. Though I had opportunity to examine thoroughly the entire western end of the island and the north coast as far eastward as Talasea, combat conditions prevented the collection and preservation of any but a few botanical specimens.

GRASSES COLLECTED

Cyrtococcum oxyphyllum (Hochst.) Stapf in Hook. Icon. Pl. 31: 3096. 1922.

Panicum oxyphyllum Hochst. ex Steud. Syn. Pl. Glum. 1: 65. 1854. East Indies.

Panicum pilipes Nees & Arn. ex Buse, in Miquel, Pl. Jungh. 376. 1854. Java.

Cyrtococcum pilipes A. Camus, Bull. Mus. Hist. Nat. (Paris) 27: 118. 1921.

India to Philippines, East Indies, Melanesia, and Polynesia.

Bitokara Mission, Talasea; altitude 100 feet; *Burcham* 139, April 22, 1944. Abandoned native garden; well-drained sandy loam, weathered from obsidian and other volcanic rocks. Creeping perennial, rooting freely at the nodes; associated with *Paspalum* sp., *Oplismenus compositus*, and *O. aristulatus*. Occasional to common in abandoned gardens and along forest trails.

Oplismenus compositus (L.) Beauv. Ess. Agrost. 54. 1812.

Panicum compositum L. Sp. Pl. 57. 1753. Ceylon.

India and south China to Formosa, Philippines, East Indies, New Guinea, and Pacific Islands.

Bitokara Mission, Talasea; altitude 100 feet; *Burcham* 137, April 22, 1944. Same soil and associates as preceding species. Creeping perennial, rooting freely at the nodes; blades erect, broad, short, and thin; sheaths loosely hispid; flowering culms solitary, erect, to 18 inches tall; spikelets sparsely appressed-pilose. Moderately abundant in old gardens and along forest trails, in partial to full shade.

Differs from typical specimens of *Oplismenus compositus* in the longer hairs on the sheaths and the sparsely pilose spikelets.

Oplismenus aristulatus Burcham, sp. nov.

Fig. 1.

Perennis, reptans; culmi decumbentes, nodibus ramosi, subglandulosi; vaginae minute glandulosae, ciliatae, apice auriculatae; ligula lacerata, circa 0.5 mm. longa; laminae patentēs vel suberectae, 4.5–9.8 cm. longae, 1–1.5 cm. latae, lanceolatae, planae, subglabratae; panícula erecta, longa exserta, 3.5–8.5 cm. longa; rachis 1–4 mm. longa, angulis breviter ciliata; spiculae densae pilosae, 3–4.5 mm. longae, teretes, sessiles; glumae subaequales, 1.5–2.5 mm. longae, 5-nerviae; lemma fertile indurata, 5-nervia, aristato summo, arista 0.4–0.6 mm. longa; fructus 2.5 mm. longus.



FIGURE 1.—*Oplismenus aristulatus*. Spikelet and fruit, $\times 10$. (Type.)

Creeping perennial, rooting at nodes; culms decumbent, branching freely from the nodes, the branches 25 to 40 cm. tall, slightly glandular throughout; nodes glabrous; sheaths close, minutely glandular, mostly shorter than internodes, ciliate, the summit notched; ligule membranaceous, lacerate, about 0.5 mm. long; blades spreading or ascending, 4.5 to 9.8 cm. (mostly 5 to 8 cm.) long, the upper longer than the lower, 1 to 1.5 cm. wide, lanceolate, constricted at base, flat, thin, and soft-textured when green, nearly glabrous, slightly roughened on the upper

surface and margins; panicle erect, long-exserted, terminal on the branches or occasionally axillary, 3.5 to 8.5 cm. (mostly 5 to 6.5 cm.) long, the axis flexuous, glabrous or nearly so; racemes 4 to 8, the lower somewhat distant; rachis 1 to 4 mm. (mostly about 3 mm.) long, angled, short-ciliate on the angles; spikelets 3 to 13, densely pilose, 3 to 4.5 mm. long (excluding awns), terete, sessile, solitary or in pairs, in two rows crowded on one side of the rachis; glumes about equal, half as long as the spikelet, 5-nerved, pilose, entire, awned from the tip, the awns slightly reddish, somewhat flattened, that on the first glume 6 to 10 mm. long, on the second 2 to 3 mm. long; sterile lemma longer than glumes or fruit, long-pilose on the upper half, entire, short-awned from the rounded tip, enclosing the hyaline palea; fertile lemma boat-shaped, indurate, 5-nerved, awned from the tip, the awn 0.4 to 0.6 mm. long, the firm margins of the lemma clasping the indurate, nerveless palea; fruit about 2.5 mm. long, hard, plump, and shining.

TYPE: *Burcham* 138, collected April 22, 1944, along forest trail near an abandoned garden, Bitokara Mission, Talasea, New Britain; altitude 50 feet; deposited in the United States National Herbarium, No. 1865731. Growing on well-drained sandy loam, weathered from obsidian and other volcanic rocks. Associated with *Paspalum* sp., *Cyrtococcum oxyphyllum*, *Oplismenus compositus*, other grasses, and woody species. Common in abandoned gardens, forest glades, and along trails.

This species differs from *Oplismenus undulatifolius* (Ard.) Roem. & Schult. and from *O. hirtellus* (L.) Beauv. in the slightly larger, much hairier spikelets and in the awn-tipped fertile lemma, the awn 0.4 to 0.6 mm. long; it further differs from *O. hirtellus* in the nearly glabrous foliage, the smaller blades, shorter racemes, and the short rachis, short-ciliate only on the angles.

Saccharum spontaneum L. Mant. Pl. 2: 183. 1771.

Tropical Asia through Pacific islands to Polynesia.

Cape Gloucester; altitude 100 feet; *Burcham* 142, May 2, 1944. Open grassland, southeast of No. 2 Airstrip; well-drained sandy loam, with much organic matter in the topsoil. A robust perennial; culms erect, to 6 feet tall. Here an occasional clump, associated with *Manisuris* sp., *Andropogon micranthus*, *Imperata* sp., and *Themeda* sp.; elsewhere forming dense, pure stands on well-drained soils.

Ischaemum digitatum Brongn. in Duperrey, Voy. Coquille Bot. 2 (2): 70, pl. 13. 1831. Buru Island, Moluccas.

Borneo, Moluccas, New Guinea, Philippines.

Waru village, Talasea; altitude 750 feet; *Burcham* 140, April 23, 1944. Coconut plantation; well-drained sandy loam, weathered

from basaltic rocks. Stoloniferous perennial; flowering culms erect, to about 30 inches tall; associated with *Paspalum* sp. Abundant in this locality.

Andropogon micranthus Kunth, Rév. Gram. 1: 165. 1829. Based on *Holcus parviflorus* R. Br., not *A. parviflorus* Roxb. 1820.

Holcus parviflorus R. Br. Prodr. Fl. Nov. Holl. 199. 1810. Australia.

Sorghum parviflorum Beauv. Ess. Agrost. 132, 165, 178. 1812.

Anatherum parviflorum Spreng. Syst. Veg. 1: 290. 1825.

Capillipedium parviflorum Stapf in Prain, Fl. Trop. Afr. 9: 169. 1917.

India to Korea, Japan, Philippines, Sumatra, Java, and New Guinea; Africa.

Cape Gloucester; altitude 100 feet; *Burcham* 141, May 2, 1944. Same habitat as *Saccharum spontaneum*, above. Wiry, erect perennial, in small clumps, to 3 feet tall; associated with *Imperata* sp., *Saccharum spontaneum*, *Manisuris* sp., and *Themeda* sp. Locally abundant throughout grasslands.

The collection from this island is so fragmentary that no adequate discussion of the grass flora can be based on these specimens. Therefore, only general observations are presented.

Much of the grassland in the vicinity of Cape Gloucester is very similar to that of Goodenough Island, both in topography and in species composition (pl. 5). It occurs primarily on well-drained areas that receive much direct sunlight; configuration of the terrain varies from gently rolling to mountainous. Dominant species were also the same: *Manisuris rottboellioides*, *Themeda* sp., and *Imperata* sp., in approximately that order of abundance, with *Manisuris rottboellioides* accounting for 60 to 75 percent of the vegetation in many instances. *Saccharum spontaneum* and *Andropogon micranthus* were collected as associated species; *Sorghum nitidum* and *Paspalum* sp. also were noted occasionally.

Saccharum spontaneum occurred as pure stands over considerable areas; the culms were thick and reedlike, frequently an inch or more in diameter, and to 15 feet tall (pl. 6). In places where natives had burned this grass in hunting wild pigs there remained "islands" of such old grass; between them the young growth would be 4 to 5 feet tall. This was the only locality in the Pacific islands where I found concrete evidence of natives having used fire in the grasslands.

A word of explanation regarding the term "kunai grass," so widely used during the war, is appropriate. Strictly speaking, it refers to *Imperata cylindrica* var. *koenigii*, "kunai" supposedly being a corruption of *koenigii*. By extension, then, it is loosely applied to all species of *Imperata*. However, in many parts of the Solomons, New Guinea, and New Britain the native word for either grass or grassland is simply

“kunai.” Thus the term “kunai grass” came to be widely used by our troops in the same manner—to designate any area of coarse tropical grasses, without regard to species.

PAVUVU ISLAND, RUSSELL ISLANDS

Pavuvu Island, in the group of small islands known as the Russell Islands, is located in approximately latitude 9° S. and longitude 159° E. It lies about 35 miles northwest of Cape Esperance, Guadalcanal, within the larger group known as the British Solomons. On some early maps the group now commonly known as the Russells is marked simply “Pawuwu Island”; it is comprised of two larger islands—Pavuvu and Banika Islands—and a number of smaller ones.

The smaller islands are low-lying, recently raised coral reefs; the two principal islands are mountainous in the interior with a fringe of raised coral reefs in evidence in vicinity of the coasts. On Pavuvu Island the highest mountain is some 1,600 feet in elevation—from this and a number of other peaks in the interior the land slopes precipitately nearly to the shoreline. Numerous ravines on the mountain sides, together with irregularities of the raised reefs in coastal areas, give an irregular drainage pattern and terrain that is very dissected indeed.

The hot, humid tropical climate is very similar to that of the Solomon group generally; annual rainfall ranges between 94 and 150 inches; average temperatures are 80° F. to 82° F. the year around, with but little diurnal variation.

The soils of Pavuvu are mostly shallow, with coral outcrops and a considerable admixture of loose coral rock in coastal areas; as one progresses inland the coral is replaced by rocks of volcanic origin, apparently basaltic in the areas observed. Near the coast soil textures are clays and clay loams, frequently with a considerable admixture of well-decayed organic matter in the immediate surface layer. In inland areas there was a noticeable tendency toward coarser textures in soils weathered from volcanic material.

The native vegetation of Pavuvu Island is tropical rain-forest, with a narrow fringe of mangrove (*Rhizophora* sp.) swamps along the immediate coast. About 1910–1915 considerable tracts of land at lower elevations were cleared and planted to coconuts. The usual practice of underplanting the coconut trees with a cover crop and then controlling it by grazing cattle has been followed here. At present a few thousand acres of the northwestern part of Pavuvu, as well as

FIGURE 2.—*Lepturus cinereus*. Plant, $\times \frac{1}{2}$; summit of sheath; 3 segments of spike, side view; back of spikelet sunken in rachis; two views of floret, one showing back of lemma, the other the prolonged rachilla and rudimentary floret; two views of caryopsis, showing hilum and scutellum, all $\times 10$. (Type.)



FIGURE 2.—(See opposite page for legend).

the whole of some smaller offshore islands, are given over to coconut plantations. Otherwise the native vegetation has been scarcely disturbed.

I spent in all six months on Pavuvu Island, during the period May 1944 to early March 1945, and thus had opportunity for a considerable investigation of the grass flora of the area.

GRASSES COLLECTED

Eragrostis amabilis (L.) Wight & Arn. ex Hook. & Arn. Bot. Beechey Voy. 251. 1841.

Poa amabilis L. Sp. Pl. 68. 1753. India.

Poa plumosa Retz. Obs. Bot. 4: 20. 1786. East Indies.

Eragrostis plumosa Link, Hort. Berol. 1: 192. 1827.

Tropics and subtropics of both hemispheres; introduced in the Americas.

East side Hooper Bay; sea level; *Burcham* 186, February 8, 1945. Margin of swamp; shallow, poorly drained clay soil. Small annual with semiprostrate culms, forming open clumps. Occasional, on moist to well-drained sites in vicinity of the seacoast.

Centotheca latifolia (Osbeck) Trin. Fund. Agrost. 141. 1820. (See p. 410.)

East side Hooper Bay; altitude 25 feet; *Burcham* 166, November 14, 1944. Coconut plantation; in part shade, on thin clay soil along a coral ledge. Associated with *Rhaphis aciculata*, *Axonopus compressus*, *Lepturus cinereus*, *Kyllinga brevifolia*, and *Fimbristylis annua*. Rare, this being the only specimen observed on the island; an unusual location for this grass—probably a relict from the nearby rain-forest.

Lepturus cinereus Burcham, sp. nov.

FIG. 2.

Perennis, reptans, colore cinerea; culmi decumbentes, graciles, nodibus omnibus ramosi, glabri; vaginae glabrae, apice minute auriculatae; ligula nulla; laminae plerumque patentes, 2.8–4.5 cm. longae, 3–3.8 mm. latae, subaequales, lanceolatae, planae, rigidae, evidenter nervatae, utrinque glaberrimae; spicae pergraciles, ramos terminantes, 2.3–5 cm. longae, basi inclusae; glumae acuminatae non aristatae, articulis racheos vix longiores vel usque ad $\frac{1}{2}$ longiores.

Creeping perennial, rooting at the nodes, occasionally forming a moderately dense turf; culms decumbent, slender, branching from all nodes, branches 4 to 7 cm. long, glabrous throughout; nodes glabrous throughout; sheaths loose, glabrous, open, mostly shorter than the internodes, margins hyaline, especially at the summit, the summit notched; ligule lacking; blades mostly spreading, occasionally sub-erect, 2.8 to 4.5 cm. (mostly 3 cm.) long, 3 to 3.8 mm. (mostly 3 mm.) wide, markedly uniform in size, lanceolate, flat, rigid, and plainly nerved, entirely glabrous on both surfaces, margins scaberulous; both

sheaths and blades conspicuously pale gray in color (even in growing specimens) giving the herbage an ashy hue; spike very slender, terete, terminal on the branches, 2.3 to 5 cm. (mostly 3 to 4 cm.) long, the lower portion partly enclosed in the sheath; rachis slender, glabrous, disarticulating at maturity; spikelets sessile, embedded in the rachis and falling with the joints; first glume wanting except in the terminal spikelet, second glume closing the cavity flush with the surface, indurate, nerved, acuminate but not awned, from scarcely longer to one-third longer than the rachis joints; lemma hyaline, 3-nerved, shorter than the glume; palea hyaline, a little shorter than the lemma, the rachilla-joint prolonged and bearing a rudimentary floret.

TYPE: *Burcham* 169, collected November 14, 1944, on coral ledge along margin of swamp, east side of Hooper Bay, Pavuvu Island, Russell Islands; altitude 5 feet; deposited in the United States National Herbarium, No. 1866460. Growing here on well-drained, very shallow clay soil; also observed on poorly drained sites near standing water in the swamp. Associated with *Rhaphis aciculata*, *Axonopus compressus*, *Centotheca latifolia*, *Digitaria microbachne*, *Kyllinga brevifolia*, *Fimbristylis annua*, and with several broadleaf herbs and shrubs throughout the area observed. Common to abundant on suitable sites locally, occasionally forming a moderately dense turf over small areas. Observed only in this locality.

This differs from other species of *Lepturus* in the notched summits of the sheaths, absence of the ligule, and particularly in the marked uniformity in size and shape of the small, lanceolate blades; also in their being plainly nerved and entirely glabrous on both surfaces. The color of the herbage, a pale ashy gray, is distinctive in both growing and dried specimens. Further differences are the slenderness of the spike, the lower portion being partly enclosed in the sheath, and the fact that the acuminate glumes are not awned and are proportionately shorter than in other species of the genus.

Sporobolus elongatus R. Br. Prodr. Fl. Nov. Holl. 170. 1810. Australia.

India to Japan, Philippines, East Indies, Melanesia, and Polynesia.

East side Hooper Bay; sea level; *Burcham* 187, February 8, 1945. Margin of swamp, on shallow, poorly drained clay soil. Perennial; culms solitary or a few together; foliage dark green; panicle spikelike, somewhat nodding, often interrupted. Occasional to common, mainly on moist to wet sites, in association with other grasses; rather widely distributed, yet forming only an insignificant proportion of the aggregate.

Eleusine indica (L.) Gaertn. Fruct. et Sem. 1: 8. 1788. (See p. 406.)

East side Hooper Bay; altitude 25 feet; *Burcham* 162, November 14, 1944. Coconut plantation; well-drained clay soil, underlain with

coral at a depth of about 1 foot. Occasional on this island, about habitations and among other grasses.

Digitaria microbachne (Presl) Henr. Med. Rijks Herb. Leiden 61: 13. 1930.
(See p. 411.)

East side Hooper Bay; altitude 20 feet; *Burcham* 170, February 4, 1945. Coconut plantation; very shallow, well-drained clay soil on a coral outcrop. Associated with other grasses; observed only in this locality.

Axonopus compressus (Sw.) Beauv. Ess. Agrost. 12. 1812.

Milium compressum Sw. Prodr. Veg. Ind. Occ. 24. 1788. Jamaica.

Paspalum compressum Raspail, Ann. Sci. Nat. Bot. 5: 301. 1825.

Tropics and subtropics of Western Hemisphere; sparingly introduced in tropics of Eastern Hemisphere.

East side Hooper Bay; altitude 25 feet; *Burcham* 160, November 10, 1944. Coconut plantation; well-drained, shallow clay soil underlain with coral. Stoloniferous perennial with erect flowering culms; to about 18 inches tall; abundant in coconut plantations throughout the Russell Islands. A turf-forming grass, apparently introduced as a cover crop. Here, with *Rhaphis aciculata*, which is likewise abundant, it provides excellent year-long grazing for the semiwild cattle that are used to keep plantations free of objectionable plant growth.

Paspalum orbiculare G. Forst. Fl. Ins. Austr. Prodr. 7. 1786. (See p. 411.)

East side Hooper Bay; sea level; *Burcham* 185, February 8, 1945. Brackish swamp; shallow soil underlain with coral. Occasional throughout the island, on very moist to moderately well-drained sites.

Paspalum vaginatum Sw. Prodr. Veg. Ind. Occ. 21. 1788. Jamaica.

Paspalum littorale R. Br. Prodr. Fl. Nov. Holl. 188. 1810. Australia.

Paspalum distichum L. var. *vaginatum* Sw. ex Griseb. Fl. Brit. W. Ind. 541. 1864.

Tropic and subtropic coasts of both hemispheres.

East side Hooper Bay; sea level; *Burcham* 167, November 14, 1944. In standing water of brackish swamp; soil mucky. A low, stoloniferous, rhizomatous perennial, forming a matted turf. Abundant in brackish swamps and along beaches, growing in standing water as well as on better drained sites.

Panicum reptans L. Syst. Nat. ed. 10. 2: 870. 1759. Jamaica.

Urochloa reptans Stapf, in Prain, Fl. Trop. Afr. 9: 601. 1920.

Tropics and subtropics of both hemispheres.

East side Hooper Bay; altitude 25 feet; *Burcham* 163, November 14, 1944. Coconut plantation; well-drained clay soil, underlain with coral at a depth of about 1 foot; *Burcham* 164, on well-drained clay loam along edge of rain forest. Decumbent annual, forming spread-

ing clumps, rooting freely at the lower nodes. Occurs occasionally, in association with other grasses, on well-drained soils.

Echinochloa colonum (L.) Link, Hort. Berol. 2: 209. 1833. (See p. 407.)

East side Hooper Bay; sea level; *Burcham* 168, November 14, 1944. Brackish swamp; soil poorly drained. A few small, widely spreading clumps growing among *Paspalum vaginatum*, in one of the drier portions of the swamp; the only specimens observed on the island.

Thuarea involuta (G. Forst.) Roem. & Schult. Syst. Veg. 2: 808. 1817.

Ischaemum involutum G. Forst. Fl. Ins. Austr. Prodr. 73. 1786. Society Islands.

Malay Peninsula to Japan, Philippines, Guam, New Caledonia, and Polynesia.

Peninsula southwest of Pepesala Bay; altitude 5 feet; *Burcham* 184, February 7, 1945. Coconut plantation; well-drained clayey soil among coral outcrops near the shore, well above high water, extending 50 to 75 yards inland. Creeping perennial, rooting at the nodes, forming a moderately dense turf; flowering culms borne erect when in bloom, reflexed and among the herbage when mature. Associated with *Axonopus compressus*, *Rhaphis aciculata*, *Vernonia cinerea*, and *Hemigraphis* sp. Common in this locality, the only place observed on this island. (For fruiting habits see fig. 4.)

Imperata exaltata (Roxb.) Brongn. in Duperrey, Voy. *Coquille* Bot. 2 (2): 101. 1831. (See p. 407.)

East side Hooper Bay; altitude 15 feet; *Burcham* 165, November 14, 1944. Small, new clearing in rain forest; well-drained clay loam with considerable organic matter in soil. Associated with *Axonopus compressus*, *Rhaphis aciculata*, *Eleusine indica*, herbs, and shrubs. Only specimens observed on this island.

Rhaphis aciculata (Retz.) Desv. Opusc. 69. 1831. (See p. 414.)

East side Hooper Bay; altitude 25 feet; *Burcham* 158; November 10, 1944. Coconut plantation; well-drained clay soil, underlain with coral at a depth of about 1 foot. Abundant in coconut plantations throughout the island; probably introduced as a cover crop, in admixture with *Axonopus compressus*. Grazed to a considerable extent by plantation cattle, mostly before flowering culms appear.

The species enumerated above are believed to comprise a complete representation of the grasses, exclusive of bamboos, occurring on Pavuvu Island at this time. Some clumps of bamboos were observed at low altitudes in the rain forest, but collections could not be made.

The two dominant grasses are *Axonopus compressus* and *Rhaphis aciculata*, which have apparently been intentionally introduced as a cover crop for the coconut plantation. Together they account for about 98 percent of the grass flora of the island, in the proportions of three parts *Axonopus* and one part *Rhaphis*. They occupy the better sites almost exclusively; other grasses occur either as infrequent specimens or on areas where these two cannot successfully compete. Except for these the grass most widely distributed about the island is *Sporobolus elongatus*; the manner of its occurrence, widespread but forming only an insignificant part of the aggregate, suggests that it was accidentally introduced when the cover crop was planted.

Perhaps only five species can be considered as "native" grasses. Of these, *Centotheca latifolia* was observed only once, a few culms within the coconut plantation removed a short distance from the edge of the rain forest. As this grass habitually occurs only in forest glades it may be either a relict from the time when the rain forest was cleared or a stray from the margin of the present forest, although not observed there. *Paspalum vaginatum* was localized along the seashore and in brackish swamps within about 200 yards of the beach. It was probably established along the shore originally and has extended its range into the swamp since the forest was cleared. The same applies to *Paspalum orbiculare* except for its being somewhat more widely distributed, owing to its adaptability to a variety of sites. The other two species, *Thuarea involuta* and *Lepturus cinereus*, were localized near the coast, mostly on very thin soils over coral outcrops, or in crevices in the coral. Their original ranges have probably been extended locally in competition with *Axonopus compressus* and *Rhaphis aciculata*, which do not thrive on such sterile areas.

The remaining six species found on this island seem to be recent accidental introductions. *Eragrostis amabilis* was localized near the coast; *Eleusine indica* was localized mainly near habitations but had spread about the plantations to a limited extent. *Digitaria microbachne* occurred in one area on poor soil—it appeared to be a new introduction on drier areas. A few clumps of *Echinochloa colonum* were found among *Paspalum vaginatum* in a brackish swamp, apparently a recent introduction there. *Panicum reptans* and *Imperata exaltata* appeared to be recent invaders on better soils and drier sites. The fact that these plantations had been unattended since late in 1941 has no doubt been a contributory factor in enabling many of these invading grasses to gain a foothold on the island.

PELELIU ISLAND, PALAU ISLANDS

Peleliu Island is in the southern part of the Palau (or Pelew) Islands; this group of small islands, of which only seven are inhabited, is the easternmost of the Carolines. Peleliu (Japanese spelling "Periryu") is located in latitude 7° N. and longitude 134°12' E.

The northern islands of the Palau group are of volcanic origin; in the south, including Peleliu, they are recently raised coral reefs. Peleliu Island, about 6 miles long by 2 miles wide, is roughly the shape of a gigantic lobster claw (see map, fig. 3); there is a fringing reef along the east coast and a barrier reef lying from one-half to one mile offshore on the west. Maximum elevations, found in the chain of coral hills in the northern and western part of the island, are about 200 feet. There is but scant evidence of weathering of the coral; in most places the hills retain much of the appearance and configuration of under-water reefs—this results in steep, jagged ridges, sharp cliffs, and many enclosed depressions similar to those seen on reefs still covered with water, with nothing suggesting or resembling the usual drainage pattern. Aside from these hills the land is mostly flat and poorly drained, much of the eastern portion being swamps, and the south end having been leveled to construct the airfield.

The islands of this group have a tropical oceanic climate. Annual rainfall averages about 140 inches, with May to December the rainiest months. The average annual temperature ranges between 80° F. and 82° F.; there is but little seasonal or diurnal variation, the maximum daily temperatures ranging from 85° F. to 89° F. Prevailing winds, though variable, are mainly from the southerly direction, and from light to moderate in intensity. Clear days are usually with a small proportion of cloud; this, combined with the cooling effect of the prevailing winds, produces a climate that is relatively agreeable.

There is nowhere any considerable depth of soil, the single minor exception being along the west side, where wave action has piled a stretch of sandy soil—never more than a few hundred yards wide—along the base of the ridge of coral hills. These shallow soils, mostly sandy or sandy loam, are usually mixed with broken coral or fragments of sea shells; the consistency and light color indicate recent weathering and little humus. In the eastern portion of the island, where soils have been formed by deposition in the swampy area, there is a small but noticeable content of organic matter.

The soils can scarcely be considered fertile. Although there was a moderately heavy tree cover on most of the island, trees were small in comparison with the usual tropical forest; their nourishment has been drawn mainly from pockets of soil in crevices of the coral. Ridges originally had a complete cover of rain-forest; there were extensive swamps of mangrove (*Rhizophora* sp.) in tidal flats of the eastern

portion. At the south end (Ngarmoked Island) and along the south part of the east coast were some small areas where *Casuarina equisetifolia* was dominant. Coconuts had been planted along most of the west coast, particularly north of the airfield, and on the islands lying off the east coast (Ngabad Island). Gardens for vegetables had been attempted in a few areas, but their products were only mediocre.

I was on Peleliu Island from September 15, 1944, through October 27, 1944, and during this time covered approximately 70 percent of the island's area at least once, mostly on foot.

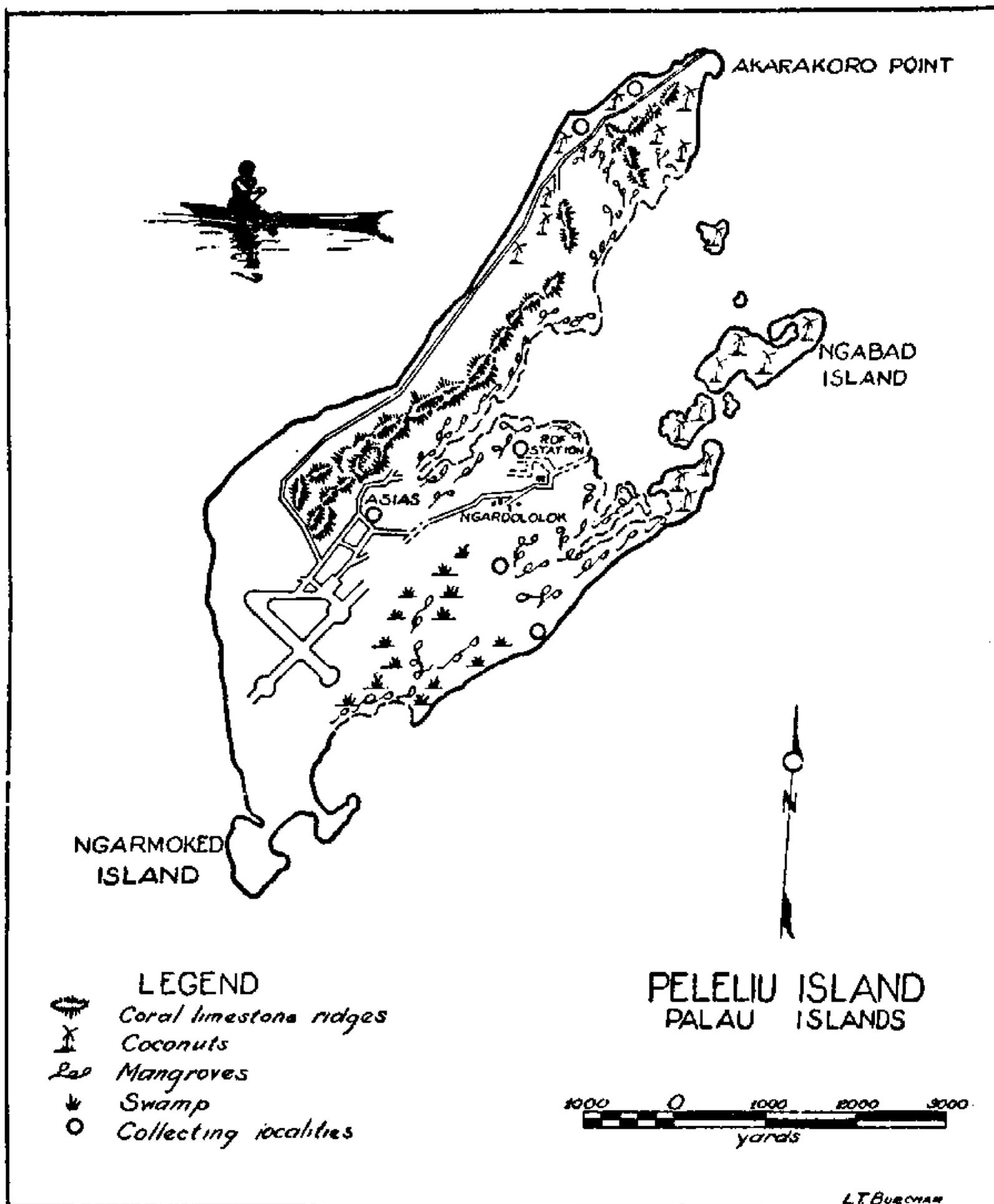


FIGURE 3.—Map of Peleliu Island, Palau Islands.

GRASSES COLLECTED

Eragrostis amabilis (L.) Wight & Arn. ex Hook. & Arn. Bot. Beechey Voy. 251. 1841. (See p. 424.)

North-central Peleliu; altitude 25 feet; *Burcham* 147, October 3, 1944. Near buildings of Radio Direction Finder station, 500 yards north of Ngardololok; shallow sandy soil underlain with coral. Associated with *Lepturus repens*, *Eleusine indica*, *Digitaria longissima*, *Paspalum conjugatum*, *Cenchrus echinatus*, and small shrubs. Occasional, in vicinity of habitations.

Centotheca latifolia (Osbeck) Trin. Fund. Agrost. 141. 1820. (See p. 410.)

Eastern Peleliu; altitude 20 feet; *Burcham* 149, October 3, 1944. Margin of swampy area in rain forest, 800 yards due south of Ngardololok. Associated with *Paspalum conjugatum* and *Schizmatoglottis* sp. Noted occasionally in forest glades and along swamp margins.

Lepturus repens (G. Forst.) R. Br. Prodr. Fl. Nov. Holl. 207. 1810.

Rottboellia repens G. Forst. Fl. Ins. Austr. Prodr. 9. 1786. South Pacific Islands.

Widespread on island coasts, Ceylon to Formosa, Philippines, Bismarck Archipelago, New Guinea, Micronesia, and Polynesia; Queensland, Australia.

North central Peleliu; altitude 25 feet; *Burcham* 143, September 25, 1944. About buildings of RDF station, 500 yards north of Ngardololok; shallow sandy soil underlain with coral. Widely creeping perennial, often forming a turf on small areas; associated species same as *Eragrostis amabilis*, above. Occasional to abundant, and widespread about the island; particularly luxuriant in the deeper sandy soils of Ngabad Island.

Zoysia tenuifolia Willd. ex Trin. Mém. Acad. St. Petersb. VI. Sci. Nat. 2 (1): 96. 1836. Mascarene Islands.

Osterdamia tenuifolia Kuntze, Rev. Gen. Pl. 2: 781. 1891.

Japan; Polynesia.

North coast Peleliu; altitude 5 feet; *Burcham* 154, October 17, 1944. About buildings of Radio Station, 1 mile southwest of Akarakoro Point; fine sandy soil. Low perennial with creeping rhizomes and very fine leaves, forming a thick turf. Only locality observed; apparently introduced.

Eleusine indica (L.) Gaertn. Fruct. et Sem. 1: 8. 1788. (See p. 406.)

North central Peleliu; altitude 25 feet; *Burcham* 146, September 25, 1944. About buildings of RDF station, 500 yards north of Ngardololok; shallow sandy soil, underlain with coral. Associated with *Eragrostis amabilis*, *Lepturus repens*, *Digitaria longissima*, *Pas-*

palum conjugatum, *Cenchrus echinatus*, and shrubs. Common about the island, mostly near habitations.

Digitaria longissima Mez, Repert. Sp. Nov. Fedde 18: 26. 1922.

Digitaria kanehirae Ohwi, Bot. Mag. (Tokyo) 55: 543. 1941.

New Guinea, Bismarek Archipelago, Palau (Peleliu).

North-central Peleliu; altitude 25 feet; *Burcham* 150, October 5, 1944. About buildings of RDF station, 500 yards north of Ngardolok; shallow sandy soil, underlain with coral. Stoloniferous, prostrate perennial, tending to form a moderately thick turf; associated with same grasses as the preceding species. Occurs occasionally.

Digitaria chinensis Hornem. Hort. Hafn. Suppl. 8. 1819. China.

Digitaria propinqua Gaudich. in Freye. Voy. *Uranie* Bot. 410. 1826. Not *D. propinqua* Beauv. 1812. Timor.

Panicum timorensis Kunth, Rév. Gram. 1: Suppl. IX. 1830. Based on *Digitaria propinqua* Gaudich.

Digitaria timorensis Balansa, in Morot, Journ. de Bot. 4: 138. 1890.

India to Japan, Philippines, East Indies, and Polynesia.

North coast Peleliu; altitude 10 feet; *Burcham* 156, October 25, 1944. Secondary growth near road, 1,600 yards southwest of Akarakoro Point; poorly drained sandy soil. Stoloniferous perennial, forming a partial turf, with erect inflorescences, to 10 inches tall; associated with *Paspalum orbiculare* and shrubby species of the secondary growth. Occasional.

Digitaria microbachne (Presl) Henr. Med. Rijks Herb. Leiden 61: 13. 1930.

(See p. 411.)

Near Asias, central Peleliu; altitude 30 feet; *Burcham* 153, October 15, 1944. Near buildings, on well-drained, shallow soil containing much broken coral. Associated with *Eragrostis amabilis*, *Eleusine indica*, *Cenchrus echinatus*, and *Rhaphis aciculata*. Occasional about the island.

Paspalum conjugatum Berg. Act. Helv. Phys. Math. 7: 129. pl. 8. 1762. (See p. 407.)

North-central Peleliu; altitude 25 feet; *Burcham* 145, September 25, 1944. About buildings of RDF station, 500 yards north of Ngardolok; shallow sandy soil, underlain with coral. Associated with *Eragrostis amabilis*, *Lepturus repens*, *Eleusine indica*, *Digitaria longissima*, *Cenchrus echinatus*, and small shrubs. Occasional and widespread; more prevalent in moist areas.

Paspalum orbiculare G. Forst. Fl. Ins. Austr. Prodr. 7. 1786. (See p. 411.)

North coast Peleliu; altitude 10 feet; *Burcham* 155, October 25, 1944. Secondary growth near road, 1,600 yards southwest of Akarakoro



THE AIRFIELD, PELELIU ISLAND

There is no area of natural grassland on Peleliu, but since construction of the airfield it has been invaded by several of the more aggressive introduced grasses. The dominant species here is *Cynodon dactylon*.

Point; poorly drained sandy soil. Associated with *Digitaria chinensis* and shrubby species of the secondary growth. Only specimen observed on the island.

Paspalum vaginatum Sw. Prodr. Veg. Ind. Occ. 21. 1788. (See p. 426.)

East coast Peleliu; sea level; *Burcham* 148, October 3, 1944. Along seacoast, 1,400 yards southeast of Ngardololok; in crevices of coral rock just above high-water mark. Only vegetative parts in evidence; associated with a small rush (Juncaceae) and near *Casuarina equisetifolia* and *Pandanus* sp. Rare; a few clumps noted also along a sandy beach on the north coast.

Pennisetum purpureum Schumach. Beskr. Guin. Pl. 64. 1827. Guinea, Africa.

Tropical Africa; introduced into cultivation in American and Old World Tropics; Hawaii, Guam.

North coast Peleliu; sea level; *Burcham* 157, October 26, 1944. Garden area, 1,000 yards southwest of Akarakoro Point; poorly drained sandy soil. Very coarse, robust perennial, in dense clumps to about 7 feet tall; associated with *Eleusine indica*, *Paspalum conjugatum*, and *Cenchrus echinatus*. Only locality observed; apparently cultivated.

Cenchrus echinatus L. Sp. Pl. 1050. 1753. Jamaica, Curaçao.

Common weed in American Tropics; sparingly introduced in Hawaii, Philippines, and Polynesia.

North-central Peleliu; altitude 25 feet; *Burcham* 144, September 25, 1944. RDF station, 500 yards north of Ngardololok; shallow sandy soil, underlain with coral. Low annual, in small clumps; inflorescence a spike of bristly burs; associated with *Eragrostis amabilis*, *Lepturus repens*, *Eleusine indica*, *Digitaria longissima*, and *Paspalum conjugatum*. Most abundant and widely distributed grass on the island.

Ischaemum intermedium Brongn. in Duperrey, Voy. Coquille Bot. 2 (2): 73. 1831.

Onlan, Caroline Islands.

Philippines, Malay Peninsula, Java, Caroline Islands, Bismarck Archipelago.

North-central Peleliu; altitude 20 feet; *Burcham* 151, October 5, 1944. Swamp, 600 yards northeast of Ngardololok; growing in shallow standing water; soil mucky, mixed with coral fragments. Creeping perennial, with erect flowering culms, to 2 feet tall; associated with *Centotheca latifolia*, *Schizmatoglottis* sp., and *Polygonum* sp. Moderately abundant in swampy or very moist areas.

Rhaphis aciculata (Retz.) Desv. Opusc. 69. 1831. (See p. 414.)

Near Asias, central Peleliu; altitude 30 feet; *Burcham* 152, October 14, 1944. Near buildings on well-drained, shallow soil containing coral fragments. Associated with *Eragrostis amabilis*, *Eleusine indica*,

Digitaria microbachne, and *Cenchrus echinatus*. Observed only in this locality.

* * * * *

The 15 grasses enumerated above comprise all the species observed on Peleliu Island and are believed to be a complete representation of the grass flora, exclusive of bamboos. Bamboos, evidently introduced, occurred only about buildings.

There is no area of natural grassland on Peleliu Island. The nearest approach was on the airfield, which since construction has been invaded by several of the more aggressive, apparently introduced species (pl. 7). The average density of this vegetation would run not more than 20 to 30 percent. The dominant species here was *Cenchrus echinatus*, the most abundant grass encountered on the island; it was associated primarily with *Eleusine indica*, and to a lesser extent with *Eragrostis amabilis*, *Digitaria longissima*, and *D. microbachne*. These same species were found together, in varying proportions, in vicinity of most human habitations on the island.

Zoysia tenuifolia and *Pennisetum purpureum* are evidently recent introductions; the former probably being an accidental introduction, while the latter was found planted in a garden. *Rhaphis aciculata* was collected from the vicinity of buildings in the village of Asias, the manner of its occurrence suggesting an attempt at use for a lawn grass. *Paspalum conjugatum* occurs in limited abundance on a wide variety of sites practically throughout the island.

Grasses that may be regarded as "native" are of very scattered occurrence, because of the considerable disturbance of the vegetation on this small island by man's activities. The most widespread species are *Lepturus repens*, particularly abundant in the coconut plantations of Ngabad Island, and to a lesser extent in the portion of the island north of Ngardolok; and *Ischaemum intermedium*, widely distributed and moderately abundant in swampy areas. *Centotheca latifolia* and *Digitaria chinensis* occur occasionally on suitable sites. *Paspalum vaginatum* was encountered in two areas, both localized along the coast where salt water provided a favorable habitat; only one specimen of *Paspalum orbiculare* was found on the entire island. Activities of our troops on this island, involving concentration of large numbers of men and quantities of materials on such a small area, will doubtless result in a further reduction in the abundance of the grass flora, both native and introduced.

Native vegetation had been disturbed to a major extent prior to our arrival, both by the activities of man and by typhoons which destroyed portions of the forest, especially one reported as occurring about 1933-1935. Remains of trees uprooted at that time were still in evidence, chiefly in the southeastern part of the island. Virtually

all vegetation was denuded from the western and southern portions by our operations. However, configuration of the terrain and nature of the coral bedrock are such that this denudation should produce no erosion problems; as a matter of fact, the net result of these activities should be to accelerate soil formation.

OKINAWA SHIMA, RYUKYU ARCHIPELAGO

Okinawa Shima, or Okinawa Island, is the largest of 55 islands comprising the Ryukyu Archipelago, which forms an arc of small stepping stones between Formosa and southern Japan. This group has been variously called the Ryukyu Retto ("Retto" being the Japanese equivalent of "Archipelago"), the Riu Kiu, the Liu Kiu, the Luchu, the Loochoo, and the Nansei Islands. The central part of Okinawa is located in approximately latitude $33^{\circ}30''$ N. and longitude 128° E. and is about 400 miles from the mainland of Asia across the East China Sea.

Despite the rugged character of the terrain there is no mountain system on the island. Mainly it consists of coral reefs raised above the ocean's surface in small plateaus and isolated hills; some volcanic rocks were encountered, primarily in the southeastern part and on the Motobu Peninsula, but these were distinctly in the minority. Though weathering has progressed farther than on any of the other coral islands visited in the Pacific, much of the configuration of a coral reef is still retained, with little semblance of what we are accustomed to regard as a "normal" drainage pattern. Frequent outcrops of bare coral rock, sheer cliffs along seacoasts and watercourses, and terracing of the fields all further accentuate the irregularities of the topography of this island.

Lying in about the same latitude as Miami, Fla., Okinawa enjoys a similar subtropical climate. Most of the annual rainfall of 84 inches falls between May and October. The average annual temperature of 71° F. ranges from a high of 96° F. to winter temperatures of 38° F.; natives said that frosts were unknown to them. Prevailing southerly winds temper the extremes of climate to an appreciable extent and occasionally whip up to typhoons of destructive force, such as the ones that occurred in September and October 1945.

The people are of mixed ancestry—probably descending from the Ainus, a short-statured, hairy, Mongoloid race originally inhabiting the southern islands of Japan. There has been much intermingling with the Chinese and Japanese, since about 650 A. D., and to a lesser extent with Malays and Koreans. Although the largest island in the Ryukyu Archipelago, Okinawa is but 70 miles long and has an average width of about 7 miles. On this small area there is an average of 900

persons per square mile—in quite vivid contrast to the relatively uninhabited islands of the Southwest Pacific. Moreover, the northern part is but sparsely settled, the major portion of the total population living in the southern two-thirds of the island. This dense population has dictated utilization of every available square foot of ground.

Soils are mostly clays or clay loams, dull red to bright red in color, friable, and moderately deep (on the order of 2 to 6 feet). Based on crops observed in the fields, productivity of these soils would rate above average. Without terracing, the intensive cultivation to which this rough, broken terrain has been subjected would result in erosion at a highly accelerated rate; on cultivated lands there is virtually no evidence of erosion as other than a natural geologic process. In a number of timbered areas the ground was bare or nearly so, the soil hard and compacted, with sheet and gully erosion in evidence.

Several hundred years of settlement and intensive cultivation have greatly modified the natural vegetation of this island. The higher hills and rougher ground are forested with pine (*Pinus massoniana* Lam.); on the Motobu Peninsula and elsewhere on the northern third of the island occur some stands of *Cryptomeria japonica*. These forests show evidence of heavy use—close cutting and grazing—and have apparently been artificially propagated to a considerable extent. Rough outcrops of coral are common throughout the island; these are usually vegetated with clumps of *Cycas circinalis* and a few scattered pines as dominants, and an understory of shade-loving shrubs, herbs, and grasses. For the most part plants occurring in waste places about habitations and fields are those widely distributed in association with man's activities. Those occurring on the frequent uncultivated coral outcrops, and in rougher, forested hills are probably fairly representative of native species originally occupying the island.

I was on Okinawa between April 1, 1945, and July 22, 1945, and during this time visited the area from Yontan Airfield to the south end of the island and spent about 15 days on the Motobu Peninsula in the north.

GRASSES COLLECTED

Eragrostis distans Hack. [Publ.] Bur. Gov. Lab. Philippine Isl. 35: 81. 1906.
(See p. 410.)

Okinawa and Philippine Islands to New Guinea.

This specimen differs from description of the type as follows: (1) It is perennial; (2) it occasionally bears fertile branches; and (3) the florets have a distinct purplish hue, evident in both growing and dried specimens.

Inubi; altitude 70 feet; *Burcham* 211, April 18, 1945. West side of valley, 100 yards north of village; well-drained silty clay soil. Perennial, growing in tight clumps; erect flowering culms to about 20 inches

tall; florets purplish. Associated with *Imperata cylindrica*, *Miscanthus sinensis*, and *Spiranthes sinensis*. Moderately abundant.

Lepturus repens (G. Forst.) R. Br. Prodr. Fl. Nov. Holl. 207. 1810. (See p. 431.)

Motobu Peninsula; sea level; *Burcham* 227, July 11, 1945. One mile north of Nakasoni, 1,000 yards east of Oi-Kawa River; on coral outcrops along the coast. Associated with *Sporobolus virginicus*, *Zoysia tenuifolia*, *Digitaria henryi*, *Paspalum vaginatum*, and *Thuarea involuta*. Occasional.

Alopecurus aequalis Sobol. Fl. Petrop. 16. 1799. Greece.

Alopecurus fulvus J. E. Smith in Sowerby, English Bot. 21. pl. 1467. 1805. England.

Circumpolar Eurasia and America; Siberia, China, Japan, mountains of India.

Inubi; altitude 60 feet; *Burcham* 194, April 12, 1945. 100 yards east of village; clay soil of rice paddies. Low perennial, growing in open clumps in fallow rice paddy; common in standing water and wet places.

Sporobolus elongatus R. Br. Prodr. Fl. Nov. Holl. 170. 1810. (See p. 425.)

Inubi; altitude 60 feet; *Burcham* 195, April 12, 1945. 100 yards east of village; moist clay soil. In small clumps along sodded terraces between rice paddies; associated with *Digitaria violascens*, *Paspalum cartilagineum*, *Panicum repens*, *Sacciolepis indica*, and *Ischaemum crassipes* var. *aristatum*. Common; this species and its associates given here are the ones most frequently encountered in the protective turf, which is maintained on terraces about the fields.

Sporobolus virginicus (L.) Kunth, Rév. Gram. 1: 67. 1829.

Agrostis virginica L. Sp. Pl. 63. 1753. Virginia.

Tropics and subtropics of both hemispheres.

Motobu Peninsula; sea level; *Burcham* 230, July 13, 1945. One mile north of Nakasoni, 1,000 yards east of Oi-Kawa River; coral outcrops along coast. A low, rhizomatous perennial; flowering culms erect, panicle spikelike; associated with *Lepturus repens*, *Zoysia tenuifolia*, *Digitaria henryi*, *Paspalum vaginatum*, and *Thuarea involuta*. Occasional near seashore, on coral outcrops and sandy beaches.

Zoysia matrella (L.) Merr. Philippine Journ. Sci. Bot. 7: 230. 1912.

Agrostis matrella L. Mant. Pl. 2: 185. 1771. Malabar, India.

Zoysia pungens Willd. Ges. Naturf. Freund. Berlin Neue Schrift. 3: 441. 1801. Malabar Coast, India.

Osterdamia matrella Kuntze, Rev. Gen. Pl. 2: 781. 1891.

India and Malay Peninsula to Java, Japan, Philippines, and Yap.

Hanja; altitude 250 feet; *Burcham* 221, June 27, 1945. Northeast outskirts of village; coral outcrops in cultivated field. Low, creeping

perennial, with rhizomes; blades dark green, wiry, sharply pointed; inflorescence erect; associated with *Sporobolus elongatus* and *Sacciolepis indica*. Occasional; also noted along cart roads and on sodded terraces.

Zoysia tenuifolia Willd. ex Trin. Mém. Acad. St. Petersb. VI. Sci. Nat. 2 (1): 96. 1836. (See p. 431.)

Motobu Peninsula; sea level; *Burcham* 228, July 11, 1945. One mile north of Nakasoni, 1,000 yards east of Oi-Kawa River; coral outcrops near seashore. Associated with *Lepturus repens*, *Sporobolus virginicus*, *Digitaria henryi*, *Paspalum vaginatum*, and *Thuarea involuta*. Occurs occasionally.

Leptochloa filiformis (Lam.) Beauv. Ess. Agrost. 71, 161, 166. 1812.

Festuca filiformis Lam. Tabl. Encycl. 1: 191. 1791. South America.

Temperate and tropical Americas; sparingly introduced in southern Asia, Java, Philippines, Mozambique.

Hanja; altitude 250 feet; *Burcham* 219, June 26, 1945. Northeast outskirts of village; well-drained clay soil. Slender annual, in small open clumps; inflorescence an open, elongated panicle; collected from a cultivated field. Occasional.

Cynodon dactylon (L.) Pers. Syn. Pl. 1: 85. 1805.

Panicum dactylon L. Sp. Pl. 58. 1753. Southern Europe.

Capriola dactylon Kuntze, Rev. Gen. Pl. 2: 764. 1891. Based on *Panicum dactylon* L.

World-wide, in temperate and tropical regions.

Hanja; altitude 250 feet; *Burcham* 223, June 27, 1945. Northeast outskirts of village; clay soil. Low, stoloniferous and rhizomatous perennial; associated with *Sporobolus elongatus*, *Digitaria sanguinalis*, *Sacciolepis indica*, and *Isachne globosa*. Occasional to common, mostly on sodded terraces between fields.

Digitaria henryi Rendle, Journ. Linn. Soc. Bot. 36: 323. 1904.

China and Indo-China to Formosa, Philippines, and Samoa.

Motobu Peninsula; sea level; *Burcham* 225, 226, July 11, 1945. One mile north of Nakasoni, 1,000 yards east of Oi-Kawa River; crevices of coral outcrops along seashore. Creeping perennial, with broad, flat blades mostly about 3 inches long; associated with *Lepturus repens*, *Sporobolus virginicus*, *Zoysia tenuifolia*, *Thuarea involuta*, and *Ischaemum murinum*. A second specimen from this locality, *Burcham* 226, has flat, rigid, harsh blades not exceeding 1 inch in length. Occurs occasionally.

Digitaria sanguinalis (L.) Scop. Fl. Carn. ed. 2. 1: 52. 1772.

Panicum sanguinale L. Sp. Pl. 57. 1753. Southern Europe.

Paspalum sanguinale Lam. Tabl. Encycl. 1: 176. 1791.

Syntherisma sanguinalis Dulac, Fl. Haut. Pyr. 77. 1867.

World-wide, in temperate and tropical regions.

Hanja; altitude 250 feet; *Burcham* 222, June 27, 1945. Northeast outskirts of village; clay soil along drainage ditch, occasionally covered with standing water. Low, semiprostrate annual forming dense clumps; associated with *Sporobolus elongatus*, *Cynodon dactylon*, *Sacciolepis indica*, and *Isachne globosa*. Observed occasionally, in fallow fields and waste places.

Digitaria violascens Link, Hort. Berol. 1: 229. 1827. Brazil.

Panicum violascens Kunth, Rév. Gram. 1: 33. 1829.

Paspalum chinensis Nees, in Hook. & Arn. Bot. Beechey Voy. 231. 1836. China.

Digitaria chinensis A. Camus, Not. Syst. Lecomte 4: 48. 1923. Not *D. chinensis* Hornem. 1819.

Southeastern Asia, East Indies, Philippines; introduced in American tropics and subtropics.

Inubi; altitude 60 feet; *Burcham* 197, April 12, 1945. 100 yards east of village; clay soil of terraces between rice paddies. Annual, or perennial in favorable locations; tending to form a turf along terraces; associated with *Sporobolus elongatus*, *Paspalum cartilagineum*, *Panicum repens*, *Sacciolepis indica*, and *Ischaemum crassipes* var. *aristatum*. Occasional to common.

Inubi; altitude 100 feet; *Burcham* 205, April 12, 1945. 300 yards northeast of village; pine forest; in spreading clumps, growing on clay loam spoil from a recently excavated cave.

Eriochloa villosa (Thunb.) Kuntze, Rev. Gram. 1: 30. 1829.

Paspalum villosum Thunb. Fl. Japon. 45. 1784. Japan.

China, Japan.

Motobu Peninsula; altitude 75 feet; *Burcham* 233, July 14, 1945. One mile north of Nakasoni, 1,000 yards east of Oi-Kawa River; cultivated field, well-drained clay loam soil. Annual, forming small, spreading clumps; common volunteer in cultivated fields.

Paspalum conjugatum Berg. Act. Helv. Phys. Math. 7: 129. pl. 8. 1762. (See p. 407.)

Inubi; altitude 150 feet; *Burcham* 209, April 14, 1945. 600 yards northeast of village; well-drained clay soil near native house. Occasional, mostly near habitations.

Paspalum orbiculare G. Forst. Fl. Ins. Austr. Prodr. 7. 1786. (See p. 411.)

Inubi; altitude 60 feet; *Burcham* 196, April 12, 1945. 100 yards east of village; clay soil. Common on sodded terraces separating rice paddies; associated with *Sporobolus elongatus*, *Digitaria violascens*, *Panicum repens*, *Sacciolepis indica*, and *Ischaemum crassipes* var. *aristatum*.

Inubi; altitude 90 feet; *Burcham* 204, April 12, 1945; 200 yards east of village; well-drained clay loam; occasional small erect clumps in understory of pine forest.

Paspalum vaginatum Sw. Prodr. Veg. Ind. Occ. 21. 1788. (See p. 426.)

Motobu Peninsula; sea level; *Burcham* 231, July 14, 1945. East bank of Oi-Kawa River, 1,000 yards north of Nakasoni; sandy soil along estuary. Occasional, along estuaries and seashore, within influence of salt water.

Cyrtococcum patens (L.) A. Camus, Bull. Mus. Nat. Hist. (Paris) 27: 118. 1921. (See p. 412.)

Motobu Peninsula; altitude 75 feet; *Burcham* 234, July 14, 1945. One mile north of Nakasoni, 1,000 yards east of Oi-Kawa River; well-drained clay soil. Tending to form a dense cover, in full shade of *Pinus massoniana*, *Pandanus tectorius*, and *Acacia* sp. Locally abundant on favorable sites.

Panicum repens L. Sp. Pl. ed. 2. 87. 1762. Southern Europe.

Tropical and subtropical coasts of both hemispheres.

Inubi; altitude 70 feet; *Burcham* 214, April 28, 1945. 200 yards northeast of village; clay soil. Robust perennial, with many stout rhizomes; occasional among other grasses on terraces between rice paddies.

Sacciolepis indica (L.) Chase, Proc. Biol. Soc. Washington 21: 8. 1908.

Aira indica L. Sp. Pl. 2; in errata, after index, 1753. India.

Panicum indicum L. Mant. 2: 184. 1771.

Hymenachne indica Buse ex Miquel, Pl. Jungh. 377. 1854.

India to Korea, Japan, Philippines, Malay Peninsula, East Indies, New Guinea, and Fiji.

Inubi; altitude 100 feet; *Burcham* 206, April 12, 1945. 300 yards northeast of village; well-drained clay loam under pine forest; a few small clumps on spoil from a recently excavated cave. Inubi; altitude 70 feet; *Burcham* 213, April 28, 1945; 200 yards northeast of village; clay soil of terraces, and in rice paddies. Slender annual; culms single or a few together, mostly erect; glumes purplish at tips. Occasional, along terraces and in fallow rice paddies.

Isachne globosa (Thunb.) Kuntze, Rev. Gen. Pl. 2: 778. 1891.

Milium globosum Thunb. Fl. Japon. 49. 1784. Japan.

Isachne australis R. Br. Prodr. Fl. Nov. Holl. 1: 196. 1810. Australia.

India and China to Philippines, East Indies, New Guinea, and Australia.

Hanja; altitude 250 feet; *Burcham* 218, June 11, 1945. Northeast edge of village; clay soil of drainage ditch, covered with standing

water part of time. Annual; culms trailing to erect, rooting at nodes; sheaths with bristles which appear to assist the grass in climbing. Common, in standing water or wet to moderately dry sites.

Oplismenus formosanus Honda, Repert. Nov. Sp. Fedde 20: 361. 1924. Formosa. Formosa; Okinawa.

Inubi; altitude 90 feet; *Burcham* 212, April 21, 1945. East side of village; clay soil in overgrown native garden. Creeping perennial, rooting freely at nodes; flowering culms erect, spikelets glabrous, purple; in full shade of bamboo, bananas, and other cultivated plants. Occasional, in moist, shady spots.

Echinochloa hispidula (Retz.) Keng, Sinensia 11: 413. 1940.

Panicum hispidulum Retz. Obs. Bot. 5: 18. 1789. India.

India and China.

Inubi; altitude 70 feet; *Burcham* 215, April 28, 1945; 200 yards northeast of village; clay soil of rice paddies. Coarse annual, growing mostly in semidry rice paddies—sometimes in standing water; associated with *Alopecurus aequalis* and *Sacciolepis indica*. Occasional to common, on wet sites.

Setaria geniculata (Lam.) Beauv. Ess. Agrost. 41, 169, 178. 1812.

Panicum geniculatum Lam. Encycl. 4: 727. 1798. Guadeloupe.

Tropics and subtropics of both hemispheres.

Inubi; altitude 85 feet; *Burcham* 202, April 12, 1945. 100 yards east of village; well-drained clay soil. Slender perennial, with slightly involute blades and spikelike inflorescence; in pine forest, associated with *Paspalum cartilagineum*, *Imperata cylindrica*, *Miscanthus sinensis*, *Pogonatherum paniceum*, *Cymbopogon tortilis*, *Pinus massoniana*, *Spiranthes sinensis*, and *Vaccinium wrightii*. Rare.

Thuarea involuta (G. Forst.) Roem. & Schult. Syst. Veg. 2: 808. 1817. (See p. 427.)

Motobu Peninsula; sea level; *Burcham* 229, July 12, 1945. One mile north of Nakasoni, 1,000 yards east of Oi-Kawa River; sandy beach, just above high water. Associated with *Lepturus repens*, *Sporobolus virginicus*, *Zoysia tenuifolia*, *Digitaria henryi*, and *Ischaemum murinum*. Occasional to rare, in vicinity of the seashore.

Imperata cylindrica (L.) Beauv. Ess. Agrost. 8, 165, 166, 177. pl. 5. f. 1. 1812.

Lagurus cylindricus L. Syst. Nat. ed. 10. 2: 878. 1759. [Southern France.]

Tropics and subtropics of Eastern Hemisphere.

Inubi; altitude 75 feet; *Burcham* 200, April 12, 1945. 100 yards east of village; well-drained clay loam with some coral outcrops. Perennial, with rhizomes; leaves mostly basal, erect; flowering culms erect, to about 20 inches tall. Associated with *Paspalum cartilagineum*,

Miscanthus sinensis, *Pogonatherum paniceum*, *Cymbopogon* sp., *Pinus massoniana*, *Spiranthes sinensis*, and *Vaccinium wrightii*. Occasional to common in understory of pine type; common to abundant in fields and waste places.

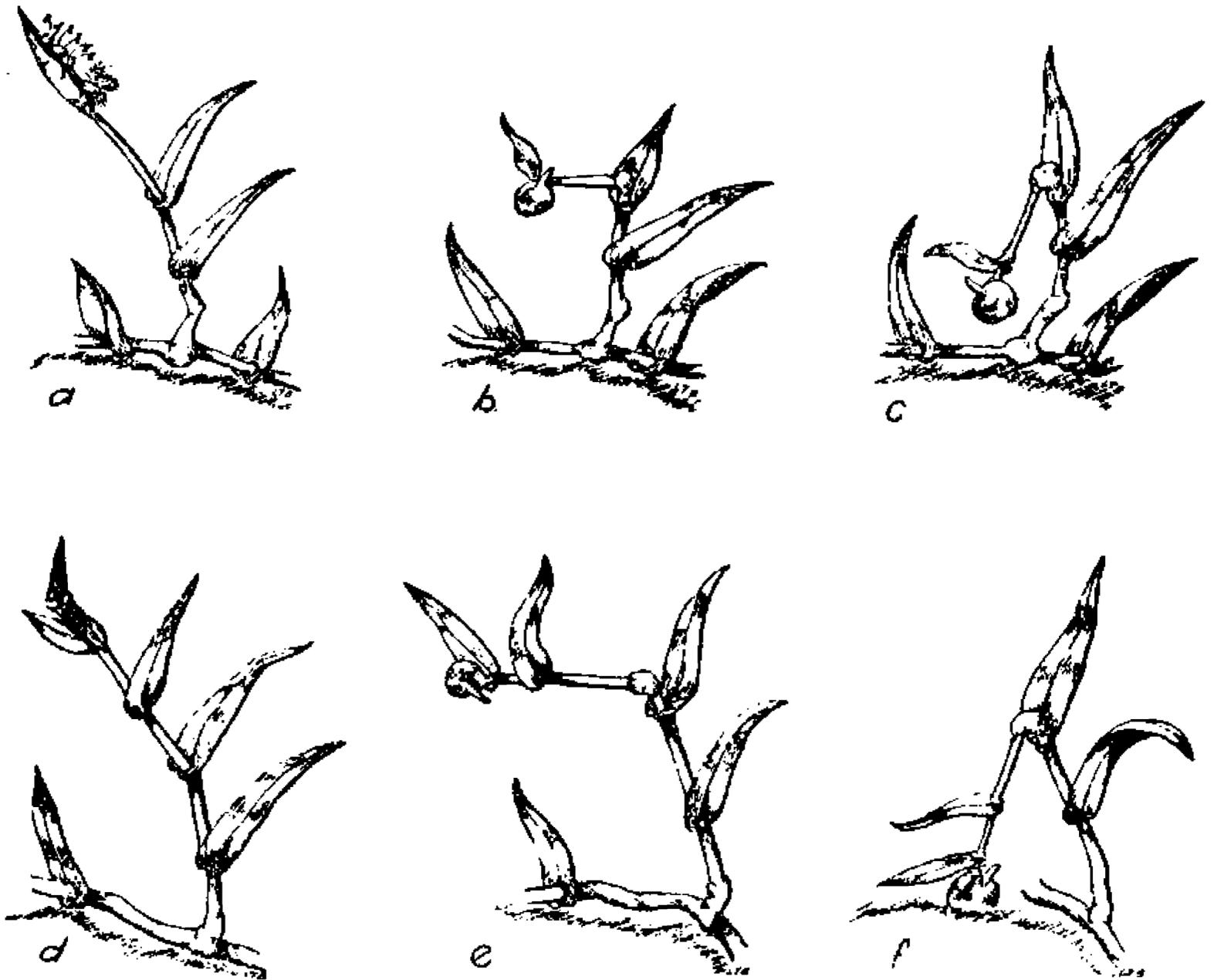


FIGURE 4.—Fruiting habits of *Thuarea involuta*. *a*, Typical inflorescence, about time of fertilization. *b*, Seed in "milk" stage, first and second joints bent about 90° , pushing seed down among leaves. *c*, Mature seed, second joint below seed bent nearly 180° , thrusting seed down into litter at base of plant. *d*, Inflorescence shortly after fertilization; bract beginning to fold over, enclosing seed. *e*, Seed in "milk" stage, second joint below seed bent about 90° , pushing it down among the leaves. *f*, Mature seed. Second joint below seed bent nearly 180° , seed thereby resting on ground surface near base of plant. $\times \frac{3}{4}$.

Miscanthus sinensis Anderss. Öfv. Svensk. Vet. Akad. Förh. 12: 166. 1856.
China.

Eastern Asia; introduced in eastern United States.

Inubi; altitude 75 feet; *Burcham* 198, April 12, 1945. Same soil and associates as preceding species. Robust perennial, in large clumps; numerous leaves mostly basal; flowering culms erect, 4 to 6 feet tall. Common to abundant along streams, margins of fields, and rocky outcrops. Panicles are persistent on the plant after seed has been cast; local inhabitants gather these with a portion of the long culm attached and bind them into small brooms, which are used extensively.

Microstegium vimineum (Trin.) A. Camus, Ann. Soc. Linn. Lyon 68: 201. 1921.
Andropogon vimineus Trin. Mém. Acad. St. Pétersb. VI. Math. Phys. Nat.
 2: 268. 1832. Nepal, India.

Microstegium willdenowianum Nees, in Lindl. Nat. Syst. Bot. 447. 1836.
 Nepal, India.

Pollinia imberbis Nees var. *willdenowiana* Hack. in DC. Monogr. Phan.
 6:178. 1889.

Eulalia viminea Kuntze, Rev. Gen. Pl. 2: 775. 1891.

Pollinia viminea Merr. Enum. Philipp. Pl. 1: 35. 1922.

India to China, Japan, and Philippines; sparingly introduced in eastern United States.

Motobu Peninsula; altitude 35 feet; *Burcham* 236, July 14, 1945. One mile north of Nakasoni, 1,000 yards east of Oi-Kawa River; coral outcrop along face of cliffs. Spreading perennial, with very slender branching culms, rooting at nodes; inflorescence of ascending racemes (inflorescence abnormal in this specimen, probably diseased). Occasional, in part shade.

Spodiopogon kawakamii Hayata, Bot. Mag. (Tokyo) 21: 54. 1907. (Ex description.) Formosa.

Formosa, Okinawa.

Motobu Peninsula; altitude 25 feet; *Burcham* 232, July 14, 1945. East bank of Oi-Kawa River, 1,000 yards north of Nakasoni. Tall perennial, with coarse, broad blades, mostly basal; flowering culm erect, panicle nodding. A single small clump, growing in a handful of decaying vegetable matter, mostly pine needles, on the bare top of a concrete burial vault. Obviously introduced.

Pogonatherum paniceum (Lam.) Hack. Allg. Bot. Zeitschr. 12: 178. 1906.

Saccharum paniceum Lam. Encycl. 1: 595. 1785; Tabl. Encycl. 1: 155. pl. 40.
 f. 3. 1791. East Indies.

Pogonatherum saccharoideum Beauv. Ess. Agrost. 176. pl. 11. f. 7. 1812.

India to Japan, Philippines, New Guinea, Australia.

Inubi; altitude 90 feet; *Burcham* 207, April 12, 1945. 400 yards east of village; well-drained clay soil along intermittent stream. Low perennial, forming small, tight clumps; understory of pine type. Associated with *Paspalum cartilagineum*, *Imperata cylindrica*, *Miscanthus sinensis*, *Cymbopogon* sp., *Pinus massoniana*, *Spiranthes sinensis*, and *Vaccinium wrightii*. Locally common to abundant.

Apluda mutica L. Sp. Pl. 82. 1753. (See p. 413.)

Naha-Yonabaru highway; altitude 25 feet; *Burcham* 224, July 9, 1945. South of highway, 600 yards east of Kokuba; well-drained clay soil along stream. Associated here with *Pogonatherum paniceum* and *Andropogon micranthus*; observed occasionally.

Ischaemum crassipes (Steud.) Thell. var. *aristatum* Nakai, Bot. Mag. Tokyo 37: 121. 1923 (in Japanese); Nakai in Honda, *op. cit.* 38: 53. 1924. Korea.

Korea, Japan, Formosa, Ryukyu Islands.

Inubi; altitude 60 feet; *Burcham* 210, April 18, 1945. 100 yards east of village; moist clay soil. Perennial, with short rhizomes, forming open clumps; associated with *Sporobolus elongatus*, *Digitaria violascens*, *Paspalum cartilagineum*, *Panicum repens*, and *Sacciolepis indica*. Occasional¹, in turf of rice paddy terraces.

Ischaemum murinum G. Forst. Fl. Ins. Austr. Prod. 73. 1786. Tana, New Hebrides.

Tana; Samoa.

This specimen differs from description of the type in having nodes that are entirely glabrous. The species is but little known, from widely separated localities.

Motobu Peninsula; sea level; *Burcham* 235, July 14, 1945. One mile north of Nakasoni, 1,000 yards east of Oi-Kawa River; coral outcrops along the beach. Low, tufted perennial with stoloniferous tendency; inflorescence an erect, digitate spike disintegrating at maturity; here with *Lepturus repens*, *Sporobolus virginicus*, *Zoysia tenuifolia*, *Digitaria henryi*, and *Thuarea involuta*. Common here; only locality observed.

Rottboellia exaltata L. f. Nov. Gram. Gen. 40. pl. 1. 1779. India.

India to China, East Indies, Philippines, and New Guinea; Africa; sparingly introduced in American tropics.

Naha-Yonabaru highway; altitude 50 feet; *Burcham* 217, June 10, 1945. 1,000 yards east of Kokuba, 300 yards south of highway; well-drained clay soil. Coarse, erect annual, in small open clumps; here a volunteer in a field of sweet potatoes. Occasional.

Arthraxon hispidus (Thunb.) Makino var. *cryptatherus* (Hack.) Honda, Bot. Mag. Tokyo 39: 277. 1925.

Arthraxon ciliaris subsp. *langsдорffi* var. *cryptatherus* Hack. in DC. Monogr. Phan. 6: 355. 1889. Japan.

India to Japan; sparingly introduced in eastern United States.

Motobu Peninsula; altitude 65 feet; *Burcham* 237, July 15, 1945. One mile north of Nakasoni, 1,000 yards east of Oi-Kawa River; coral outcrops along face of cliff. Semiprostrate annual, rooting at nodes, with short, broad blades, and digitate inflorescence. Occasional here; also observed as volunteer in fallow fields.

Andropogon micranthus Kunth, Rév. Gram. 1: 165. 1829. (See p. 421.)

Naha-Yonabaru highway; altitude 25 feet; *Burcham* 216, June 9, 1945. 1,000 yards east of Kokuba; well-drained clay soil along stream banks. In small tussocks; with other grasses and a small bamboo. Occasional, along streams.

Cymbopogon tortilis (Presl) A. Camus, Rev. Bot. Appl. Agr. Colon. 5: 206. 1925.

Anthistiria tortilis Presl, Rel. Haenk. 1: 347. 1830. Luzon, Philippines.

Andropogon hamatulus Nees, in Hook. & Arn. Bot. Beechey Voy. 244. 1838.
Macao, China.

Cymbopogon hamatulus A. Camus, Rev. Bot. Appl. Agr. Colon. 1: 284. 1921.

Indo-China to Japan, Formosa, and Philippines.

Inubi; altitude 75 feet; *Burcham* 201, April 12, 1945. 100 yards east of village; well-drained clay soil with some coral outcrops. Tufted perennial, flowering culms erect, to 20 inches tall (specimen from plants of previous season, no spikelets left). Associated with *Paspalum cartilagineum*, *Imperata cylindrica*, *Miscanthus sinensis*, *Pogonatherum paniceum*, *Pinus massoniana*, *Spiranthes sinensis*, and *Vaccinium wrightii*. Most abundant grass in the pine understory.

Rhaphis aciculata (Retz.) Desv. Opusc. 69. 1831. (See p. 414.)

Hanja; altitude 250 feet; *Burcham* 220, June 26, 1945. Northeast outskirts of village; well-drained clay soil, along a cart road; associated with *Cynodon dactylon*, *Isachne globosa*, and *Echinochloa hispidula*. Rare; only locality observed on the island.

The species enumerated above comprise all the grasses observed on Okinawa, with exception of *Dactyloctenium aegyptium* (L.) Beauv., observed on Motobu Peninsula while enroute to the airport for departure from the island, and of bamboos in cultivation about the houses. They are not, however, presumed to be a complete representation of the grass flora of the island, as much of its area was not visited.

For the most part these are grasses widely distributed throughout the world; in turn, they were widely distributed about the island, with minor exceptions. There is a conspicuous number of northern species on the island. Doubtless the strong Asiatic and Japanese floristic elements are in part accounted for by the long history of colonization by Chinese and Japanese.

The greatest number of species was collected from the understory of the pine forest. This is to be expected, since these probably have been disturbed less than other areas, hence they retain a greater number of native plants, plus introduced species which have certainly invaded the forests to some extent. The pine type collection was made on the west slope of the ridge east of Inubi, about 1 mile inland from the east coast of the island. This ridge runs from northwest to southeast, varying from 60 to 150 feet in elevation; the soil is well-drained clay loam, weathered from coral and basaltic rocks—outcrops of coral are frequent and of basalt occasional. The dominant species is *Pinus massoniana* Lam., which on this area averages about 40 feet in height, varies from seedlings to some 20 inches in DBH,³ and forms an open stand in which the crowns of the trees do not quite make a closed canopy. The understory, of ferns, grasses, broadleaf herbs,

³ DBH—Diameter at breast height, 4.5 feet above the average ground level.

and low shrubs in about that order of abundance, is quite open, and 2 to 3 feet high, except for some taller shrubs. Of eight grasses collected in this type, *Cymbopogon tortilis* was most abundant; *Miscanthus sinensis* was common to locally abundant; *Pogonatherum panicum* was locally abundant along drainage lines. *Imperata cylindrica* was common in forest margins, having apparently invaded from adjacent fields and coral outcrops. *Setaria geniculata*, *Digitaria violascens*, and *Sacciolepis indica* were rare in this type, the last two being encountered only once and on recently exposed mineral soil.

Terraces between the small fields serve a dual function—preventing erosion and providing paths for traveling. They are narrow earth embankments, in many cases but little wider than a human foot, grown over with grasses which form a protective sod that is never broken and giving every evidence of careful tending. The grasses on these terraces are thus in a state of semicultivation, serving a very definite purpose in the economy of these people. In rice paddies and similar very moist fields the species occurring on terraces were mainly *Sporobolus elongatus*, *Digitaria violascens*, *Paspalum cartilagineum*, and *Panicum repens*. In well-drained or dry fields the terrace grasses were *Sporobolus elongatus*, *Zoysia matrella* (very limitedly), *Paspalum cartilagineum*, and *Imperata cylindrica*.

The forested areas and terraces about the fields provide the majority of grazing for domestic livestock—mainly goats and a few horses and cows. Goats were tethered along terraces and permitted to feed while the fields were being worked; apparently they were also allowed to roam at large in woodlands during the day, with the smaller children serving as herders. Horses and cows were kept confined for the most part, but occasionally pastured in woodlands and on the uncultivated coral outcrops.

Seven grasses were collected from coral outcrops and sandy beaches along a short stretch of seacoast on the Motobu Peninsula. The most common was *Ischaemum murinum*, a relatively little-known species. Others were *Lepturus repens*, *Sporobolus virginicus*, *Zoysia tenuifolia*, *Digitaria henryi*, *Paspalum vaginatum*, and *Thuarea involuta*; these are widespread grasses typical of seacoasts and beach areas throughout the tropics, and of occasional occurrence in this locality.

When collecting specimens of *Thuarea involuta* on Pavuvu Island I noted that the inflorescence was erect when in bloom and that mature seeds were always on reflexed culms among the herbage, near the surface of the soil. The fruiting habits of this grass have been discussed at some length elsewhere, with chief emphasis on the distribution of its seeds by sea currents.⁴ Obviously the interesting habit of "self-planting" the seeds would be equally important in

⁴ Nieuwenhuis-Uexküll, Margarete, Die Schwimmvorrichtung der Früchte von *Thuarea sarmentosa* Pers. Ann. Jard. Bot. Buitenzorg 18: 114-123. pls. 14, 15. 1902.

maintaining it, once it has become established on a favorable site. While I was on Okinawa, I studied the grass in the field as fully as its limited occurrence there would permit. I observed that after fertilization of the flower the bractlike rachis bearing the pistillate spikelet at its base folds over and forms a corky protective covering enclosing the seed. In addition, the fertile branch exhibits a strong positive geotropism, recurving at one or more nodes immediately below the seed in such a manner that when mature the seed is among the dead herbage and duff at the base of the plant, and at or very near the surface of the soil. The drawings in figure 4, from sketches made on the spot, illustrate this habit. Apparently the seed does not begin to germinate until the corky covering has disintegrated to a considerable extent, and this is hastened by its being planted among the decaying vegetable matter. Since the seeds are not readily detached from this plant they are thus provided with the optimum conditions of moisture and soil available on that site, thereby assuring the perpetuation of the grass in a locality which has proved favorable to it.

NEW CALEDONIA

Although only two specimens were collected on New Caledonia, they are included because these species, from this island, were not previously represented in the United States National Herbarium.

Stenotaphrum secundatum (Walt.) Kuntze, Rev. Gen. Pl. 2: 794. 1891.

Ischaemum secundatum Walt. Fl. Carol. 249. 1788. South Carolina.

Stenotaphrum americanum Schrank, Pl. Rar. Hort. Monac. pl. 98. 1822.

Tropics and subtropics of America; sparingly introduced in Hawaii, Austral and Society Islands, Polynesia, and Australia.

Noumea; altitude about 25 feet; *Burcham* 67a, November 26, 1942. Stoloniferous perennial; flowering culms erect with spikelets embedded in one side of the corky, flattened rachis. Observed occasionally, near buildings and in waste places in the city.

Bothriochloa decipiens (Hack.) C. E. Hubb. Kew Bull. Misc. Inf. 1934: 444. 1934.

Andropogon pertusus Willd. var. *decipiens* Hack. in DC. Monogr. Phan. 6: 483. 1889. Queensland, Australia.

Andropogon decipiens Domin. Biblioth. Bot. 20 (85): 266. 1915.

Queensland and New South Wales, Australia; introduced (?) in New Caledonia.

Camp Goettge (2½ miles south of Noumea); altitude 5 feet; *Burcham* 67, November 26, 1942. Grassland, 100 yards inland from seashore; growing on west slope, in adobe clay soil underlain with coral. Low, creeping perennial; flowering culms erect, inflorescence one to several digitate spikelike racemes. Associated with other grasses and a few trailing herbs. Locally abundant, and closely grazed by cattle.

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