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GEOLOGY OF MOLOKINI

By **HAROLD S. PALMER**

WITH

Notes on the Flora of Molokini

By **EDWARD L. CAUM**

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GEOLOGY OF MOLOKINI

By HAROLD S. PALMER

INTRODUCTION

Molokini is a small, crescent-shaped island, the remnant of the rim of a basalt tuff crater and lies in Alalakeiki Channel between the islands of Kahoolawe and Maui. The Molokini triangulation station of the Hawaiian Territorial Survey, a few feet east of the summit of the island, is in Lat. $20^{\circ} 38' 01.58''$ N., and Long. $156^{\circ} 30' 00.24''$ W. Hawaiian Datum. The center of the circle marked by the arcuate crest of the island may be taken as the position of the vent from which the tuff was ejected. This point is 18 statute miles S. 72° W. of the summit of Haleakala and 7 miles N. 48° E. of the summit of Kahoolawe.

Molokini has an area of 18.9 acres and a maximum elevation of 165 feet above mean lower low tide. Plate 1, A, taken from the northeast, shows the general shape of the island. The inner side of the west horn provides a good landing for small boats in almost all kinds of weather. Going along the rim or crest is easy and entirely safe. With a little care one can descend the inner slopes as far as the crest of the sea cliff, but the outer cliff-like slopes are for the most part inaccessible.

Very little has been written concerning Molokini. The Coast Pilot Notes¹ state correctly that it is a small, barren island of crescentic shape with the opening to the northwest, that a reef makes off about 300 yards from the northwesterly end of the island, and that there is deep water close to the island. Forbes² visited Molokini in 1913 and collected 15 species of plants. He states that the island is "the eroded remnant of an old tufa cone—the length along the ridge being about 1000 feet." His estimate of the length of the island is much too small; the crest measures about 3200 feet. Arago³ passed Molokini en route from Kailua, Hawaii, to Lahaina, Maui, on August 15, 1819, and speaks of "the small rock of Morikini, from whose summit rises a lofty column of smoke, which would have induced us to suspect there was a volcano under it; the pilots on board assured us, however, that this was not the case." In view

¹ U. S. Coast and Geodetic Survey, Coast pilot notes on Hawaiian islands; 2nd Ed., p. 27, August 15, 1919.

² Forbes, C. N. Notes on the flora of Kahoolawe and Molokini, B. P. Bishop Mus., Occ. Papers, vol. 5, pp. 91-92, 1913.

³ Arago, J. Narrative of a voyage around the world in the Uranie and Physicienne Corvettes, commanded by Capt. Freycinet, during the years 1817-1820. pt. II, p. 118, 1823.

of this statement search was made for relatively recent volcanic rocks on Molokini but none was found. The "column of smoke" may have been composed of wind-blown dust.

I am indebted to Mr. R. R. Tinkham, Superintendent of the 19th District of the United States Lighthouse Service, for the opportunity to visit Molokini under conditions most favorable for field work. Mr. Frederick A. Edgecomb, the engineer in charge of the construction work, and Mr. J. H. Jensen, who commanded the lighthouse tender *Kukui*, did me many favors. October 8, 9, and 10, 1925, were spent chiefly in making a contour map of the island. (See fig. 1.) October 12 was devoted to recording geologic data and collecting rock specimens. The morning of October 13 was spent collecting plants, which are discussed by Mr. Edward L. Caum on pages 15-18 of this paper.

In making the contour map a light plane table with telescopic alidade was used. Eleven stations were occupied, 28 points were located by stadia or by intersection, and 15 points on the inner shore and 5 points on the reef were located by depression angles. It was impracticable to sight points on the outer slopes, and the contours for this part of the island are based on profiles taken from photographs made while circumnavigating the island. The soundings, except the two at anchorages of the *Kukui*, were transferred from a blue print map in the Honolulu office of the Lighthouse Service, the original of which was made by the United States Coast and Geodetic Survey ship *Patterson*, in 1904. Certain checks show that the soundings were transferred to the present map with adequate accuracy. The submarine contour lines are only moderately accurate because they were not sketched in the field and because the number of soundings is not large. However, they represent the submarine topography well enough to allow of certain geologic deductions.

THE ROCKS

The most abundant rock on Molokini is tuff or cemented and altered volcanic ash. The weathered surfaces vary from yellow-brown to dark-brown in color, whereas the unweathered material is gray. Most of the tuff is fine grained, but in a few layers the particles are from one-fourth to one-half inch in diameter. The finer grained beds are firmly cemented but the coarser ones are only weakly cemented. No grains large enough for mineralogic identification

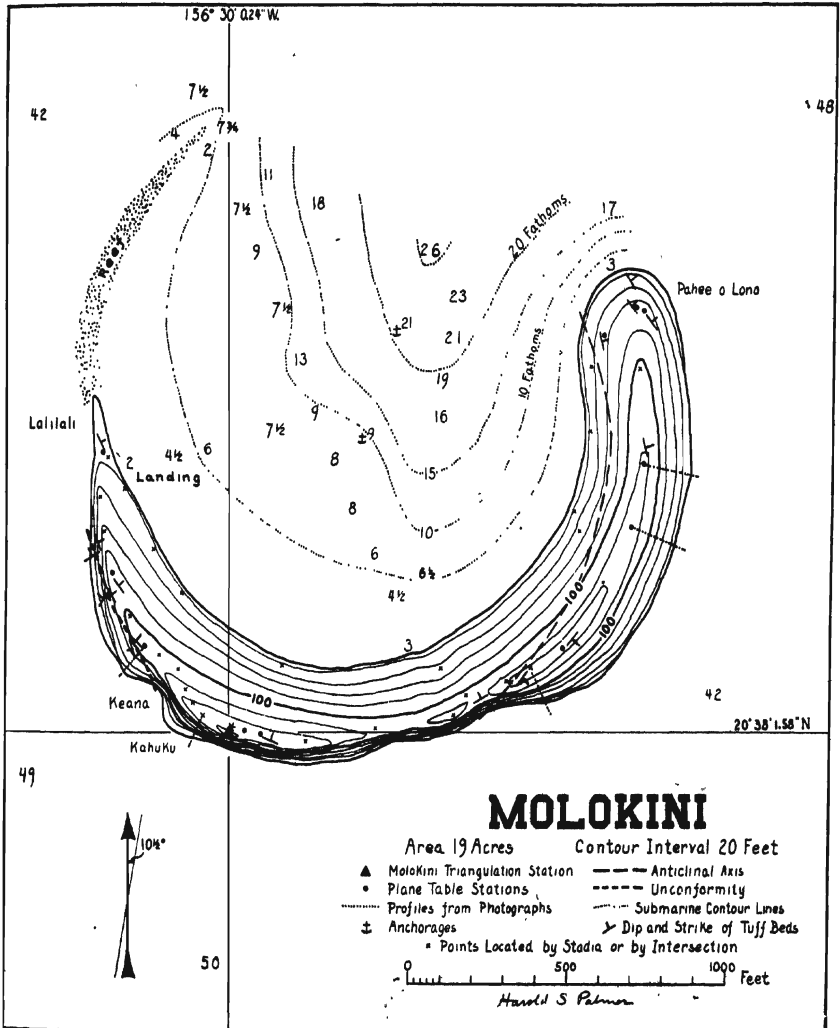


FIGURE 1—Map of Molokini Island

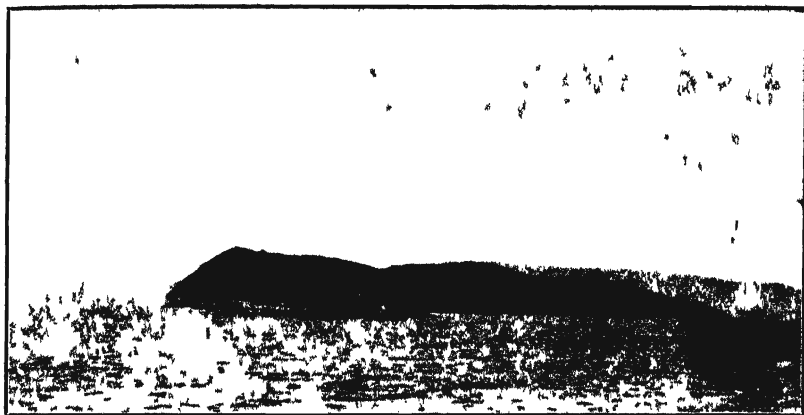
with a hand lens were found. It is reasonable to suppose that the tuff is of the same composition as the basalts which predominate on the other Hawaiian islands. This supposition was corroborated by grinding a portion of the tuff to a powder and examining the powder. With a microscope it was possible to identify a small amount of olivine, and a good deal of magnetite was separated from the powder with a horseshoe magnet. These two minerals are typical of rocks of basaltic composition. They occur in non-basaltic rocks but not in the rather large proportions found by this study.

Blocks of gray to black, vesicular, olivine-free basalt of common Hawaiian types are abundant in a few zones of the tuff. Most of the blocks are only two or three inches in diameter, but a single large one, a foot wide and five inches thick, was found. Very few blocks of coral or other calcareous material were found embedded in the tuff, although search was made for them. The largest measures less than two inches in diameter, and in none could the nature of the original organism be determined. The blocks of lava and of calcium carbonate were undoubtedly torn from the walls of the volcanic conduit by the friction of swiftly ascending gas and lava. No olivine bombs, such as are found on other Hawaiian tuff cones, were discovered.

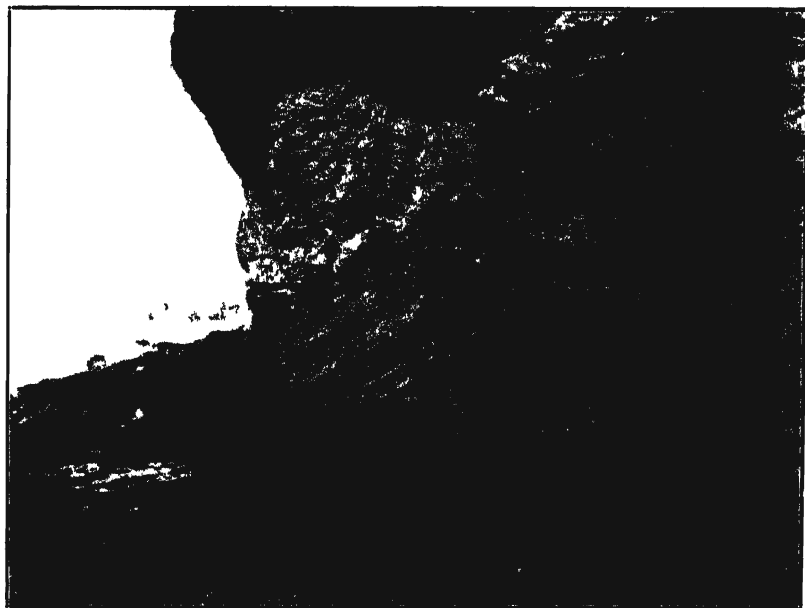
The tuff was undoubtedly ejected as a spray of lava droplets, the fluid lava being broken into droplets by the swift uprush of large amounts of gas, just as the Paris green solution is atomized by the current of air in a gardener's gun. When first broken into droplets the material would be in the molten, liquid state, but these droplets would freeze in the air and become solid before reaching the ground. Much of the gas must have been water vapor which became chilled by expansion so that it condensed as rain and fell with the solid particles making a shower of wet volcanic dust. The ejection was spasmodic rather than continuous so that the material fell in batches each of which made a separate tuff bed. (See Pls. I, B; II; III, A.) Layering would be further ignored by gusts of wind which would drift the particles varying distances to leeward during their rise and fall.

STRUCTURE

If just a single lot of particles were ejected they would fall back to the ground forming a simple, conical mound. But if there were



A



B

PLATE I—Views of Molokini *A* from the Northeast, Island of Kahoolawe in the distance *B* wave-cut terrace, showing bedding of tuff, unconformity between two series of beds, and a fault in the lower series

successive blasts the later ones would clear away the central part of the mound and scatter it laterally, thus making a depression or crater surrounded by a rim. The later layers would fall onto the rim and conform to its slopes, both outer and inner. Thus the parts of the layers nearest the vent would slope downward and inward, the parts falling on top of the rim would be nearly horizontal, and the more distant parts of the layers would slope downward and outward. Thus the rim tends to form an anticline or arch of beds. The crest of the anticline and the crest of the rim would coincide except where erosion has attacked one side more than the other. This has happened at Molokini. On the east horn of the island, the anticlinal crest lies a little west of the ridge crest, about a thousand feet east of the lighthouse. Looking eastward toward the point where the anticlinal crest crosses the ridge crest, the beds in the foreground are seen to dip to the left or inward. Below the crag are beds which dip to the right or outward from the center of the crater. The transition by way of horizontal beds from inward to outward dipping beds can be seen. (See Pl. II, A.)

North of Keana (fig. 1) there is a different relationship between two sets of beds. On the outer side of the island are beds which dip west or northwest. If this were one flank of an anticline the beds on the inner side should dip in the opposite direction, that is, east or southeast. As a matter of fact they dip to the northeast. Moreover, there is no transition by way of horizontal beds from the outer to the inner set of beds. The beds of the inner slope lie unconformably on those of the outer slope; the positions of the two sets do not conform to one another and the beds of the inner slope follow closely a surface cut across the bevelled edges of the beds of the outer slope. (See Pl. II, B.) The unconformity is also seen in Plate I, B where it separates the beds sloping to the left (west) from those sloping to the right (east). The lower beds are obviously the older. Moreover, the inward dipping beds must have had a foundation under them when they were deposited. It is clear that the eruptions which built Molokini came in two epochs.

It is possible that the interval between the two series of eruptions was very short and that the island formed by the first series was suddenly destroyed by a violent eruption which began the second series. On this assumption considerable amounts of coarse tuff and

many large blocks of lava, which had been torn from the walls of the conduit should be found embedded in the lower layers of the second series. Also some blocks of tuff of the first series should be embedded in the tuff of the second series. None of these is found. The extremely infrequent occurrence of excessively violent eruptions in Hawaii also makes it improbable that the interval was short. It seems more probable that the interval was long enough to permit erosion by waves and wind to reduce greatly the size of the island made by the first series of eruptions. The beds made by the second series have encased and in some measure protected a remnant of the earlier island. The attitude of the beds of the first series suggests that the vent, from which the material was ejected, lay a little south of the point at which the later activity centered. Perhaps part of the earlier beds lay above the later vent and were violently removed, whereas the rest of the destructive work done on the earlier island was by slower erosion.

The continuity of the beds is broken in many places by joints or fractures most of which are nearly vertical in position. The joints constitute channels down which water percolates readily and therefore the rock next them weathers more quickly and is more liable to be eroded away. As viewed from a distance, the weathered joints make narrow, vertical shadows and broad shadows appear where blocks bounded by joints have fallen out. (See Pl. III, A.) On the inner side of the island, where cliffs are replaced by slopes of 25 to 30 degrees, the weathered rock has yielded less to erosion. It forms bands of soil which are marked by richer vegetation than in neighboring areas. The strips of grass and herbs give evidence of the joints in the rock below.

Most of the joints are mere cracks separating blocks of tuff which have not been offset. Some of the joints have been changed to faults of small throw as the beds on opposite sides of the fracture have been slightly offset. The offsetting probably occurred as slumping before the beds had become well hardened. At a point on the west coast of the island a fault of several feet throw cuts the older (lower) beds in the miniature cliff (Pl. I, B).

The tentative submarine contour lines (fig. 1) indicate that the crater-rim never was a complete circle, but that the crater opened to the north. Consider the area bounded by the circle that would be

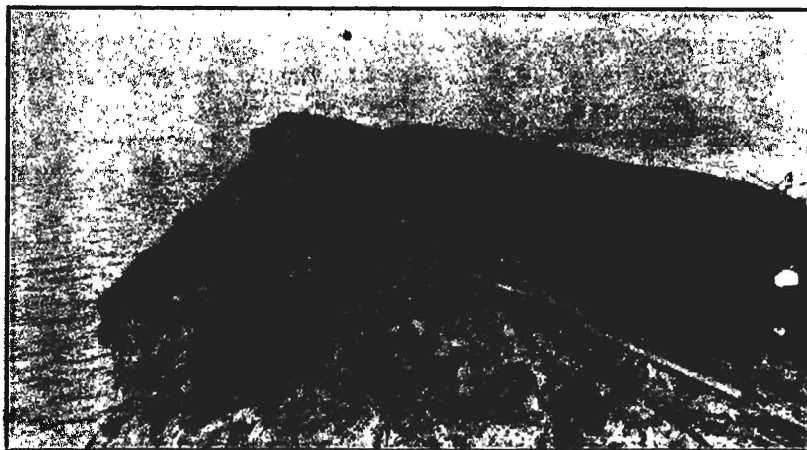
*A**B*

PLATE II.—Views of Molokini: *A*, looking East along the south rim, showing crest of the depositional anticline; *B*, looking North along the west horn, showing unconformity between two series of tuff beds.

made by continuing the present rim until it closed on itself. The deepest sounding within this area is 26 fathoms and is very close to the north edge of such a circle. If there were a complete submarine rim shallower water would be found in going northward, or in any other direction, from the center of this circle. Instead of this, the water is found to be deeper. Molokini is like many other tuff and ash craters and cones in Hawaii in that the prevailing trade winds drifted a large part of the ejecta southwest or south giving rise to unsymmetrical forms by depositing the ejecta unevenly.

As suggested by Brigham⁴ Molokini is a satellite of the great volcano of Haleakala rather than an independent center of eruption. As the 100-fathom line around Haleakala includes Molokini there is no great depth of water between the two. The symmetry of the cone of Haleakala is broken by various irregularities, one of the most conspicuous of which may be called the "Ulupalakua Ridge." It extends west-southwest from the summit as a ridge or protuberance built up by excessive extrusion of lava and ash from numerous minor craters arranged along this line. From the summit to about the 5,000-foot contour line the row of craters bears S. 60°W., which is the direction toward the center of the island of Kahoolawe. At Puu Makua the line forks. The southerly branch bears S. 50°W. and terminates at Puu Kanaloa near the shore, but if it were continued it would pass south of the south side of Kahoolawe. The northerly branch bears S. 80°W. and has Molokini as its most westerly visible point. If continued westerly it would pass well to the north of Kahoolawe. Olai Hill, a cinder cone across the channel from Molokini, is the last center of volcanic action of this branch on Maui.

TOPOGRAPHIC FEATURES

The inner slopes of Molokini are for the most part the original slopes made by the tuff as it fell. In places slabs of tuff have split off along bedding planes and fallen bodily from the lower slopes or have been eroded bit by bit. Erosion has modified the eastern inner slopes much more than the western inner slopes. The original crest has been removed and the present crest lies to the east or outside of the anticlinal crest. Three layers of tuff have evidently been more resistant to erosion than the others and have made step-like interrup-

⁴ Brigham, W. T., Notes on the volcanoes of the Hawaiian islands; Boston Soc. Nat. Hist., Mem., Vol. 1, 1868.

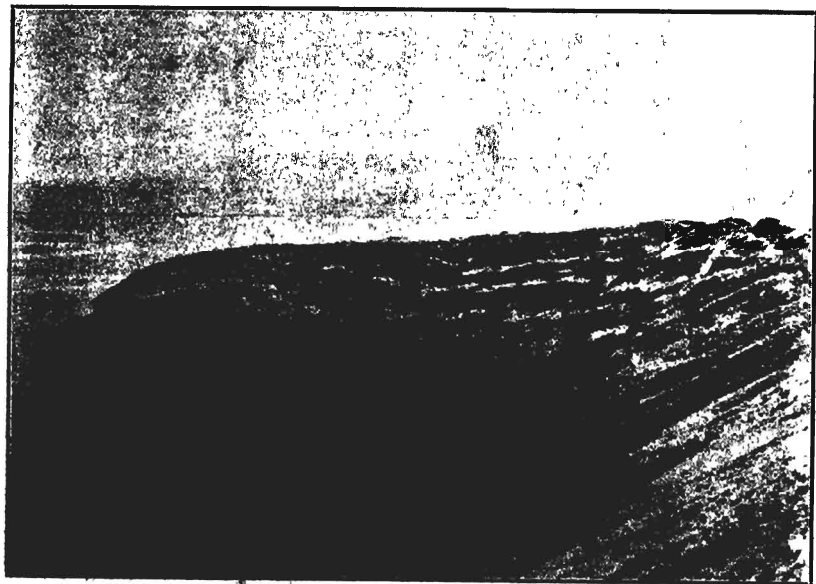
*A**B*

PLATE III—Views of Molokini: *A*, cliffs on the south coast, showing wind-eroded surfaces and joints; *B*, the east horn as seen from near the summit of the island, showing soil bands marked by vegetation along weathered edges of tuff beds.

tions in an otherwise smooth slope. Above the edges of these layers a moderate amount of soil has accumulated, distributed as bands which are made prominent by a decidedly more vigorous growth of grass and herbs (Pl. III, B.)

In general, the outer slope of the east horn of Molokini follows the slope of the tuff beds, but one very extensive slab has sloughed off after being undermined by the cliffs below. (See Pl. I, A.) Small parts of the outer slope of the west horn have been made by clearing off weaker tuff down to a more resistant bed. The rest of the outer west side and all of the outer south side are very irregular cliffs. (See Pl. III, A.) The fantastic details of rock sculpturing are due to the peculiar ability of wind to remove the weaker portions of the rock regardless of position. Undermining and quarrying of joint-bounded blocks by waves has been another factor in causing the ruggedness of these cliffs. A striking, topographic feature of Molokini is the wave eroded terrace which extends along nearly the whole shoreline. (See Pls. I, II, III.) I traversed the terrace in the counter-clockwise direction from the landing to Keana. Mr. Theodore Dranga, of Bishop Museum, informs me that he has traversed the terrace in the opposite direction from the landing along the inner curve and along the outer eastern and south sides to a point about below the summit. At a comparatively recent time the sea stood about fifteen feet higher than its present level and the horizontally directed attack of the waves cut laterally into the island. The first effect was the cutting of a notch like that seen on the east side of the island (Pl. I, A) except that the flat surface was a few feet below sea level where the waves worked most effectively. As the notch was cut in farther the overhanging part became so undermined that its support was inadequate and it fell, making a cliff. By repetition of the process the cliff was forced to recede, especially on the south side of the island. Molokini is so situated that the strongest and most effective waves come from the south as this side is most open to the sea. The waves from this direction are infrequent, as the prevailing winds are the northeast trade winds, but their infrequency is more than compensated for by their greater strength. Therefore the boldest and highest cliffs are found on the south side of the island, despite the fact that it is usually the lee. The lowest cliffs, only 20 to 30 feet high, are on the inner side of the crescent.

GEOLOGIC HISTORY

The following stages in the geologic history of Molokini may be deduced.

1. Building of the great dome of Haleakala, partly above and partly below sea level, until the depth at the future site of Molokini was reduced to 100 fathoms or a little less.

2. Eruption from the west end of the Ulupalakua Rift Line of an older series of tuff beds forming a cone or crater of unknown shape and size, but reaching at least 100 feet above sea level.

3. Partial destruction of the cone or crater, largely by wind and wave erosion with possibly the aid of a violently explosive eruption. During this interval a few corals or other lime-secreting organisms lived on the sea-bottom.

4. Eruption of a younger series of tuff beds in which are embedded fragments of lava and a few fragments of carbonate of lime—torn from the walls of the conduit through which the volcanic matter ascended. These beds covered and in part protected the older beds. They made an island much like the present Molokini in shape except that the middle or southern portion of the crescent was wider, the outer slopes smooth and sloping about 30° outward, and the horns, especially the west horn, extended farther north.

5. Erosion of the island, chiefly by waves which made the cliffs and the wave-cut terraces.

6. Falling of sea level so as to expose the wave-cut terrace and the base of the cliffs behind the terrace. [The interpretation of these wave-cut benches as having been made at a time of higher sea-level is being questioned by some geologists, who ascribe these features to the cutting of storm-waves at the present sea-level.]

7. Renewed erosion which has accomplished little work as yet compared to that done prior to the falling of sea level.

NOTES ON THE FLORA OF MOLOKINI

BY EDWARD L. CAUM

As far as available records show, there have been only two botanical surveys made of Molokini. Mr. Charles N. Forbes, a botanist on the staff of the Bishop Museum, spent part of a day on the islet on February 10, 1913, and Dr. Harold S. Palmer, Professor of Geology at the University of Hawaii, collected as well as circumstances permitted on October 13, 1925. A comparison of Palmer's collection with the list published by Forbes⁵ is rather interesting. Forbes lists 15 species of plants from Molokini, whereas Palmer collected 17, only 10 of which appear in the earlier list. The number of species common to the two lists should be increased by one, however. Forbes records *Jacquemontia sandwicensis*, while Palmer's plant is much nearer to the variety *tomentosa*, noted by Hillebrand⁶ as occurring on the south shore of Molokai. A comparison of Palmer's plant with the specimens collected by Forbes shows them to be undoubtedly the same, and it is of interest to note that Forbes altered his determination subsequent to the publication of his list, as the sheet in the Museum herbarium bears the penciled emendation "var. *tomentosa* Hbd." in Forbes' handwriting. The plant is not typical of the variety *tomentosa*, as the peduncles are much shorter and the flowers smaller than those of the Molokai specimens, but it is much nearer to the variety than to the species, and further study may show it to be worthy of varietal distinction. All together twenty-one species of plants were collected or observed on the islet in these two surveys.

The following list combines the two collections and shows the total number of plant species reported from Molokini. The initials following the names indicate the collector; F, Forbes; P, Palmer.

PORTULACACEAE

- Portulaca lutea* Solander..... (F; P)
Portulaca oleracea Linnaeus..... (F; P)
Portulaca sclerocarpa Gray..... (F; P)

MALVACEAE

- Sida fallax* Walpers..... (F; P)

STERCULIACEAE

- Waltheria americana* Linnaeus..... (F; P)

⁵ Forbes, C. N., Notes on the flora of Kahoolawe and Molokini: B. P. Bishop Mus., Occ. Papers, vol. 5, pp. 91-92, 1913.

⁶ Hillebrand, William, Flora of the Hawaiian Islands, p. 318, 1888.

ZYGOPHYLLACEAE

Tribulus cistoides Linnaeus..... (F; P)

LEGUMINOSAE

Meibomia uncinata (Jacquin) Kuntze..... (F)

Hedysarum uncinatum Jacquin

Desmodium uncinatum (Jacquin) DeCandolle

Leucaena glauca Bentham..... (P)

CACTACEAE

Opuntia megacantha Salm-Dyck..... (P)

COMPOSITAE

Lipochaeta lavarum DeCandolle..... (F; P)

SOLANACEAE

Lycium sandwicense Gray..... (F)

CONVOLVULACEAE

Jacquemontia sandwicensis Gray..... (F)

Jacquemontia sandwicensis tomentosa Hillebrand..... (P)

Cuscuta sandwichiana Choisy..... (P)

VERBENACEAE

Lantana camara Linnaeus..... (F; P)

NYCTAGINACEAE

Boerhaavia diffusa Linnaeus..... (F; P)

CHENOPODIACEAE

Atriplex semibaccata R. Brown..... (P)

CYPERACEAE

Cyperus sp. indet..... (F)

GRAMINEAE

Heteropogon contortus (Linnaeus) Beauvois..... (F; P)

Andropogon contortus Linnaeus

Panicum pellitum Trinius..... (P)

Syntherisma sanguinalis (Linnaeus) Dulac..... (P)

Panicum sanguinale Linnaeus

Digitaria sanguinalis (Linnaeus) Scopoli

FILICES

Doryopteris decipiens (Hooker) J. Smith..... (F)

Pteris decipiens Hooker

The change in the number of species from 1913 to 1925 may be explained in several ways. Great changes may occur in the floral population of a small, rugged island like Molokini in a period of almost thirteen years. There are no data as to the relative abundance of the different species in 1913 as Forbes merely states that "they form a fairly good vegetable covering over the island." It is certain, however, that a count of individual plants would show an overwhelming preponderance of not more than a half dozen species, while the

other species would be represented by very few individuals. Palmer's field notes show that the grasses and *Sida* far exceeded any of the other species in number of individuals, and that *Lantana* is of intermediate abundance. One species, *Leucaena glauca*, was represented by a single plant.

In the vicissitudes of life on a tiny, rugged, wind-swept islet with thin or pockety soil some poorly established species might readily become extinct. On the other hand, the wind and visiting birds might easily bring the seeds of other species some of which falling in favored spots might grow and establish new members of the plant population.

Conditions of life are further changed from season to season by the varying weather. The plants observed on Molokini are all species which normally live in open dry situations. Toward the end of the summer many of them die back and become dormant until revived by the winter rains. In the quiescent state they might readily be overlooked. In this way one could account for the omission from the second (October, 1925) list of some of the species which appear in the first (February, 1913) list, such as *Meibomia* and *Doryopteris*. Consideration of the species omitted from the first but appearing in the second list shows conclusively that some of them at least must be comparatively recent immigrants. The two new grasses are both common species on one or more neighboring islands, and *Atriplex* has been rather extensively planted within recent years on the nearby islands of Lanai and Kahoolawe. *Leucaena* and *Opuntia* almost certainly are new as it is most improbable that Forbes would have overlooked plants as conspicuous and distinctive as these. Moreover, Palmer found only a single individual of *Leucaena* although *Opuntia* was fairly abundant on the east end of the crescent. As *Opuntia* spreads very rapidly wherever it becomes established, it seems that it has not been established on Molokini long enough to allow of its spreading to the center and west end of the island. Moreover, none of the individuals of *Opuntia* is large. *Cuscuta*, also might well be a recent introduction as it is a common beach plant on other islands although not at all common on Molokini. Its yellow stems, matted together and tangled over and around the other vegetation, make it rather conspicuous and unlikely to have been overlooked in the first survey.

Any attempt to explain the differences between the lists of plants from these two surveys is of necessity speculative. In view of the fact that the small size of Molokini makes a complete census of its growing plant species a possibility, a comparison of the two lists, made several years apart and at different seasons of the year, affords interesting material for speculation.

CHECK LIST OF TIPULIDAE OF OCEANIA

By

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CHECK LIST OF THE TIPULIDAE OF OCEANIA

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DISTRIBUTION

The Oceanic islands here considered are Hawaii, the Galapagos, Juan Fernandez, the Marquesas, Society Islands, Austral Islands, Samoa, Tonga, Fiji, New Hebrides, New Caledonia, Solomon Islands, Marshall Islands, Caroline Islands, and the Marianas, together with a multitude of small and isolated islands within the same circumference. Islands and groups of islands lying as immediate satellites of great land masses, as New Guinea with New Britain and certain smaller islands, Australia with Lord Howe and Norfolk islands, and New Zealand with the Kermadec, Chatham, and Subantarctic islands, are omitted. The inclusion of Australia and New Zealand would add nearly 1,200 species of Tipulidae to the present list. New Guinea is still so insufficiently known as regards its tipulid fauna that any indication of its possibilities would be surmise only.

It was formerly believed that the crane fly fauna of the more remote Pacific islands was greatly reduced in number of species. This statement still seems to hold true for the lowlands, but the higher mountains of many of the islands are now known to support a relatively rich tipulid fauna that is entirely endemic. The table shows the generic and subgeneric distribution in five groups of islands that are somewhat better known than the others:

	HAWAII	MARQUESAS	SAMOA	FIJI	NEW HEBRIDES
<i>Ctenacroscelis</i>	X	....
<i>Nephrotoma</i>	X
<i>Limonia</i> (strict sense).....	X	X	....
<i>Libnotes</i>	X	X	X	X	X
<i>Dicranomyia</i>	X	X	X	X	X
<i>Alexandriaria</i>	X	....	X
<i>Idioglochina</i>	X	....	X
<i>Rhipidia</i>	X	....	....
<i>Geranomyia</i>	X	....	....
<i>Pseudoglochina</i>	X	....	....
<i>Doaneomyia</i>	X	X
<i>Thrypticomya</i>	X	X	X
<i>Eurhamphidia</i>	X	....	X
<i>Epiphragma</i>	X
<i>Conqisia</i>	X	....
<i>Mongoma</i>	X	X	X

	HAWAII	MARQUESAS	SAMOA	FIJI	NEW HEBRIDES
<i>Trentepohlia</i>	---	---	---	×	---
<i>Gonomyia</i> (strict sense).....	---	---	---	×	---
<i>Lipophleps</i>	×	×	×	×	×
<i>Trimicra</i>	×	---	---	---	---
<i>Empeda</i>	---	---	×	---	---
<i>Erioptera</i>	---	---	---	×	---
<i>Riedelomyia</i>	---	---	---	×	---
<i>Toxorhina</i>	---	---	×	×	---
<i>Styringomyia</i>	×	---	×	×	×

Hawaii is rich in endemic species of *Dicranomyia*, including the only leaf-mining species of the subgenus so far described. The Marquesas show a somewhat unusual development of *Lipophleps*. Samoa has a remarkably rich fauna in the higher mountains, including several genera and subgenera (*Rhipidia*, *Geranomyia*, *Pseudoglochina*, *Empeda*, *Toxorhina*) not otherwise recorded from Oceania. Fiji likewise has a number of groups (*Ctenacroscelis*, *Conosia*, *Trentepohlia* in the strict sense, *Gonomyia* in the strict sense, *Erioptera* in the strict sense, *Riedelomyia*) not found elsewhere in the Micronesian islands. The New Hebrides have a relatively rich crane fly fauna that is still insufficiently known, including the only hexatomine genus (*Epiphragma*) yet recorded from Oceania. Tahiti is rich in endemic species of *Lipophleps*. Three of the above groups, *Libnotes*, *Dicranomyia*, and *Styringomyia*, with an unusually wide range in the Pacific islands, are represented merely by the presence of three unusually well distributed forms, *Limonia* (*Libnotes*) *perkinsi*, *L.* (*Dicranomyia*) *illingworthi*, and *Styringomyia* *didyma*.

Edwards has considered that the small, widespread crane flies may well have attained their present great range by the aid of the wind. This belief is upheld by the fact that almost all of the Tipulidae of Oceania belong to the subfamily Limoniinae, including small and medium-sized members of the family. The larger and seemingly more vigorous members of the Tipulinae are restricted to islands that are nearest major land masses (*Macromastix*, New Caledonia; *Ctenacroscelis*, Fiji; *Nephrotoma*, New Hebrides, Solomon Islands).

No genus or subgenus of Tipulidae is restricted to Oceania. The most characteristic groups are two subgenera of *Limonia*, *Doaneomyia* and *Idioglochina*. The former has species in Tahiti,

Fiji, and New Hebrides, with one further species in Luzon; the latter group is characteristic of the Pacific islands, with outlying members on the coasts of Australia, New Zealand, Sumatra, Java, and Japan. It is now believed that all or virtually all of the species of *Idioglochina* will be found to be marine in larval habitat. A peculiar group of *Lipophleps*, the *flavidapex* group is characteristic of the more remote Pacific islands, as Samoa and the Marquesas.

SUBFAMILY TIPULINAE

Macromastix cockerellae Alexander: 12,* vol. 5, pp. 85-86 (New Caledonia).

Macromastix novocaledonica Alexander: 12, vol. 5, pp. 83-84 (New Caledonia).

Ctenacroscelis fijiensis Alexander: 5, vol. 8, pp. 562-563 (Fiji).

Ctenacroscelis lepidus Alexander: 8, vol. 13, pp. 45-47 (Fiji).

Ctenacroscelis walkerianus Alexander: 8, vol. 13, pp. 47-48 (Fiji).

Tipula baeckstroemi Alexander: 4, pp. 25-26 (Juan Fernandez).

Nephrotoma opima Alexander: 8, p. 49 (Solomon Islands).

Nephrotoma solomonis Alexander: 8, pp. 48-49 (Solomon Islands).

Nephrotoma species, Edwards: 16, p. 236 (New Hebrides).

SUBFAMILY LIMONIINAE

TRIBE LIMONIINI

Limonia (Limonia) bryaniana Alexander: 12, pp. 86-88 (Samoa).

Limonia (Limonia) dactylolepis Alexander: 5, pp. 552-553 (Fiji).

Limonia (Limonia) stoneri Alexander: 10, pp. 13-14 (Fiji).

Limonia (Limonia) veitchi Alexander: 8, pp. 37-38 (Fiji).

Limonia (Libnotes) fijiensis Alexander: 1, p. 240 [*Teucholabis*] (Fiji, Samoa).

Limonia (Libnotes) greenwoodi Alexander: 8, pp. 40-41 [*Libnotes*] (Fiji).

Limonia (Libnotes) hebridensis Edwards: 16, pp. 233-234 [*Libnotes*] (New Hebrides).

Limonia (Libnotes) hopkinsi Edwards: 18, p. 79 [*Libnotes*] (Samoa).

Limonia (Libnotes) inusitata Edwards: 16, p. 234 [*Libnotes*] (New Hebrides).

* Numbers refer to bibliography, page 11.

- Limonia (Libnotes) manni** Alexander: 8, pp. 41-43 [*Libnotes*] (Solomon Islands).
- Limonia (Libnotes) notata** Van der Wulp; Edwards: 16, p. 223 [*Libnotes*] (New Hebrides).
- Limonia (Libnotes) perkinsi** Grimshaw: 20, pp. 6-7 [*Limnobia*] (Hawaiian islands, Marquesas, Society Islands, Samoa, Fiji).
- Limonia (Libnotes) picta** Alexander: 2, pp. 80-82 [*Libnotes*] (Guam).
- Limonia (Libnotes) punctipennis** de Meijere; Edwards: 16, p. 233; 18, p. 80 [*Libnotes*] (Samoa, New Hebrides).
- Limonia (Libnotes) samoensis** Alexander: 6, pp. 9-10 [*Libnotes*] (Samoa).
- Limonia (Libnotes) solomonis** Alexander: 8, pp. 39-40 [*Libnotes*] (Solomon Islands).
- Limonia (Libnotes) strigivena** Walker: 24, p. 229 [*Limnobia*]; Edwards: 18, p. 81, [*Libnotes*] (Samoa, Tonga, Fiji, New Guinea, northern Queensland).
- Limonia (Libnobia) veitchiana** Edwards: 15, pp. 571-572 [*Libnotes*] (Fiji).
- Limonia (Dicranomyia) apicalis** Grimshaw: see *Limonia (D.) grimshawi* Alexander.
- Limonia (Dicranomyia) brunnea** Grimshaw: see *Limonia (D.) stygipennis* Alexander.
- Limonia (Dicranomyia) bryani** Alexander: 8, p. 35 [*Dicranomyia*] (Hawaiian islands).
- Limonia (Dicranomyia) buxtoni** Edwards: 16, pp. 232-233 [*Dicranomyia*] (New Hebrides).
- Limonia (Dicranomyia) fijiana** Alexander: 8, pp. 36-37 [*Dicranomyia*] (Samoa, Fiji).
- Limonia (Dicranomyia) foliocuniculator** Swezey: 23, pp. 87-89 [*Dicranomyia*] (Hawaiian islands).
- Limonia (Dicranomyia) fullowayi** Alexander: 2, pp. 79-80 [*Dicranomyia*] (Guam).
- Limonia (Dicranomyia) grimshawi** Alexander: 3, pp. 27-28; new name for *Limonia (D.) apicalis* Grimshaw, not *apicalis* Wiedemann, Grimshaw: 20, p. 7 [*Dicranomyia*] (Hawaiian islands).
- Limonia (Dicranomyia) hawaiiensis** Grimshaw: 20, pp. 7-8 [*Dicranomyia*] (Hawaiian islands).
- Limonia (Dicranomyia) illingworthi** Alexander: 1, pp. 239-240;

Edwards: 17, p. 237, as *sordida* Brunetti; Alexander: 12, pp. 89-90 [*Dicranomyia*] (Marquesas, Society Islands, Fiji, New Caledonia, Queensland).

Limonia (Dicranomyia) jacobus Alexander: 3, pp. 28-29 [*Dicranomyia*] (Hawaiian islands).

Limonia (Dicranomyia) kauaiensis Grimshaw: 20, p. 8 [*Dicranomyia*] (Hawaiian islands).

Limonia (Dicranomyia) latifrons Grimshaw: 20, p. 9 [*Dicranomyia*] (Hawaiian islands).

Limonia (Dicranomyia) nigropolita Alexander: 7, pp. 250-251 [*Dicranomyia*] (Hawaiian islands).

Limonia (Dicranomyia) rapae Alexander: 8, p. 36 [*Dicranomyia*] (Austral Islands).

Limonia (Dicranomyia) sancti-georgii Edwards: 17, p. 238 [*Dicranomyia*] (Austral Islands).

Limonia (Dicranomyia) selkirki Alexander: 4, pp. 25-26 [*Dicranomyia*] (Juan Fernandez).

Limonia (Dicranomyia) sordida Brunetti, see *Limonia (D.) illingworthi*, Edwards' records.

Limonia (Dicranomyia) stygipennis Alexander: 3, p. 27, new name for *Limonia (D.) brunnea* Grimshaw, not *brunnea* Doane; Grimshaw: 20, p. 8 [*Dicranomyia*] (Hawaiian islands).

Limonia (Dicranomyia) subsordida Edwards: 18, pp. 83-84 [*Dicranomyia*] (Samoa).

Limonia (Dicranomyia) swezeyi Alexander: 3, p. 29 [*Dicranomyia*] (Hawaiian islands).

Limonia (Dicranomyia) upoluensis Edwards: 18, p. 84 [*Dicranomyia*] (Samoa).

Limonia (Dicranomyia) variabilis Grimshaw: 20, pp. 8-9 [*Dicranomyia*] (Hawaiian islands).

Limonia (Alexandriaria) atromaculata Edwards: 18, p. 82 [*Dicranomyia*] (Samoa).

Limonia (Alexandriaria) semirufa Edwards: 16, p. 231 [*Dicranomyia*] (New Hebrides).

Limonia (Idioglochina) novocaledonica Alexander: 12, pp. 90-91 (New Caledonia).

Limonia (Idioglochina) obesula Edwards: 16, p. 232 [*Dicranomyia*] (New Hebrides).

- Limonia (Idioglochina) parvimacula** Edwards: 16, p. 232 [*Dicranomyia*] (New Hebrides).
- Limonia (Idioglochina) tusitala** Alexander: 6, pp. 10-11 [*Rhipidia*]; Edwards: 18, pp. 84-86 [*Dicranomyia*] (Samoa, Tonga?).
- Limonia (Idioglochina) vilae** Edwards: 16, p. 231 [*Dicranomyia*] (New Hebrides).
- Limonia (Rhipidia) pulcherrima** Edwards: 18, pp. 86-87 [*Rhipidia*] (Samoa).
- Limonia (Geranomyia) samoana** Edwards: 18, p. 86 [*Geranomyia*] (Samoa).
- Limonia (Pseudoglochina) laticincta** Edwards: 18, pp. 78-79 [*Pseudoglochina*] (Samoa).
- Limonia (Doaneomyia) albitarsis** Edwards: 16, p. 233 [*Doaneomyia albitarsis!*] (New Hebrides).
- Limonia (Doaneomyia) fijiensis** Alexander: 8, pp. 33-34 [*Doaneomyia*] (Fiji).
- Limonia (Doaneomyia) tahitiensis** Alexander: 6, p. 12 [*Doaneomyia*] (Tahiti).
- Limonia (Thrypticomyia) aureipennis** Skuse, variety, Edwards: 16, p. 233; 18, pp. 77-78, [*Thrypticomyia*] (Samoa, New Hebrides).
- Limonia (Thrypticomyia) dichromogaster** Edwards: 17, pp. 238-239 [*Thrypticomyia*] (Society Islands).
- Limonia (Thrypticomyia) saltens** Doleschall; Alexander: 1, p. 239; see *Limonia (T.) subsaltens* Alexander.
- Limonia (Thrypticomyia) subsaltens** Alexander: 8, pp. 34-35 [*Dicranomyia*] (Samoa, Fiji, New Caledonia).
- Helius (Eurhamphidia) connectus** Edwards: 18, pp. 87-88 (Samoa).
- Helius (Eurhamphidia) mirandus** Edwards: 16, pp. 234-235 (New Hebrides).

TRIBE HEXATOMINI

- Epiphragma (Epiphragma) hebridensis** Alexander: 8, pp. 44-45 (New Hebrides)

TRIBE ERIOPTERINI

- Conesia irrorata** Wiedemann: 25, p. 574 [*Limnobia*]; Skuse: 22, pp. 837-838; Alexander: 1, p. 244 (Fiji).

- Trentepohlia (Trentepohlia) fijiensis** Alexander: 1, p. 243. [*Mongoma*] (Fiji).
- Trentepohlia (Mongoma) albangusta** Edwards: 18, p. 100 (Samoa).
- Trentepohlia (Mongoma) brevicellula** Alexander: 5, p. 44 (Samoa, Fiji).
- Trentepohlia (Mongoma) brunnea** Edwards: 18, pp. 97-98 (Samoa).
- Trentepohlia (Mongoma) fuscistigma** Edwards: 18, pp. 99-100 (Samoa).
- Trentepohlia (Mongoma) galactopus** Edwards: 16, p. 235 (New Hebrides).
- Trentepohlia (Mongoma) guamensis** Alexander: 2, p. 83 (Guam).
- Trentepohlia (Mongoma) pacifica** Alexander: 6, p. 13 (Samoa).
- Trentepohlia (Mongoma) samoensis** Alexander: 6, pp. 12-13 (Samoa).
- Trentepohlia (Mongoma) spectralis** Edwards: 18, p. 98 (Samoa).
- Trentepohlia (Mongoma) spinulifera** Edwards: 18, pp. 100-101 (Samoa).
- Trentepohlia (Mongoma) valida** Edwards: 18, pp. 96-97 (Samoa).
- Gonomyia (Gonomyia) varipes** Alexander: 1, p. 242 (Fiji).
- Gonomyia (Ptilostena) cockerelli** Alexander: 12, pp. 91-92 (New Caledonia).
- Gonomyia (Lipophleps) adamsoni** Alexander: 13, p. 88 (Marquesas).
- Gonomyia (Lipophleps) dicranura** Edwards: 18, pp. 92-93 (Samoa).
- Gonomyia (Lipophleps) digitifera** Alexander: 8, pp. 43-44 (Fiji).
- Gonomyia (Lipophleps) fijiensis** Alexander: 1, pp. 241-242 (Tonga, Fiji).
- Gonomyia (Lipophleps) flavidapex** Edwards: 17, p. 239 (Society Islands).
- Gonomyia (Lipophleps) fuscocutellata** Alexander: 14, (Society Islands).
- Gonomyia (Lipophleps) hawaiiensis** Alexander: 3, p. 30 (Hawaiian islands).
- Gonomyia (Lipophleps) labidura** Edwards: 18, p. 93 (Samoa).
- Gonomyia (Lipophleps) marquesana** Alexander: 13, p. 88 (Marquesas).
- Gonomyia (Lipophleps) metallescens** Edwards: 17, p. 240; Alexander: 13, p. 88 (Marquesas).

- Gonomyia (Lipophleps) mumfordi** Alexander. 13, p. 90 (Marquesas).
- Gonomyia (Lipophleps) naiadifera** Edwards: 16, pp. 235-236 (New Hebrides).
- Gonomyia (Lipophleps) nigripennis** Edwards: 18, pp. 93-94 (Samoa).
- Gonomyia (Lipophleps) pacifica** Edwards: 18, pp. 90-91 (Samoa).
- Gonomyia (Lipophleps) punctigera** Alexander: 14 (Society Islands).
- Gonomyia (Lipophleps) tahitiensis** Alexander: 14 (Society Islands).
- Gonomyia (Lipophleps) tonnoirella** Alexander: 14 (Society Islands).
- Trimicra lateralis** Grimshaw: see *Trimicra pilipes* Fabricius.
- Trimicra pilipes** Fabricius: 19, p. 324 [*Tipula*]; Grimshaw: 20, p. 11 [*Trimicra lateralis*] (Hawaiian islands).
- Erioptera (Empeda) crassicus** Edwards: 18, pp. 89-90 [*Empeda*] (Samoa).
- Erioptera (Erioptera) oceanica** Alexander: 1, p. 243 (Fiji).
- Riedelomyia teucholabina** Alexander: 5, pp. 553-554 [*Limnobia?*]; 11, pp. 481-482 (Fiji).
- Toxorhina (Toxorhina) infumata** Edwards: 18, pp. 88-89 (Samoa).
- Styrgomyia didyma** Grimshaw 20, p. 10; Grünberg: 21, p. 524 [*Idiophlebia pallida*] (Hawaiian islands, Fanning Island, Samoa, Tonga, Fiji, Society Islands, Caroline Islands, New Hebrides, New Guinea).
- Styrgomyia fumosa** Edwards: 15, p. 572 (Fiji).
- Styrgomyia pallida** Grünberg: see *Styrgomyia didyma* Grimshaw.

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NEW HAWAIIAN SPECIES OF PEPTURUS

By

VLADIMIR KRAJINA

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NEW HAWAIIAN SPECIES OF PIPTURUS

BY VLADIMIR KRAJINA

Pipturus skottsbergii, species nova (Pl. I).

?*Pipturus albidus* β var. Hillebrand: Flora of the Hawaiian islands, p. 414, 1888.

Frutex vel arbor, 3-6 m. alta, ramis sparsis, foliosis dense griseo-puberulentibus, foliis longe petiolatis, ovatis vel ellipticis, rarius rotundatis, 6-25 cm. longis, 3-25 cm. latis, apice acuminatis vel acutis, basi contractis vel retusis, serrato-crenatis, recentibus supra graminose-viridibus, sparsim breviter hispidulis, inter areolis nervulorum manifeste bullosis et rugulosis, infra viride-griseis vel glaucescentibus, breviter dense hispidulis, petiolis 2-10 cm. longis, hispidulis, glaucescentibus, stipulis angustissimis vix prominentibus, caducis. Floribus pauperis glomeratis, axillaribus, sessilibus. Planta dioica vel monoica. Flores masculini perigonio, flores feminini perigonio atque ovario breviter hispiduli, glaucescentes. Stigma 2-3 mm. longum, puberulum, siccum fuscum. Fructus?

Oahu: Waianae Mountains, near the stream in the valley east of Puu Hapapa, altitude 450 to 500 meters, V. Krajina, March 16, 1930. Type, B. P. Bishop Mus. No. 1.

Pipturus skottsbergii, which is named in honor of Carl Skottsberg, Professor of Botany, Gothenburg, Sweden, differs greatly from *P. albidus* A. Gray in its more scattered and bigger branches; its leaves, which are glaucous, not white, below and grass-green above, distinctly bullate, not glabrous; and its densely pubescent flower clusters. It differs from *P. ruber* Heller in its more slender, puberulent, and not hispid branches; its leaves, which are more densely hirsute above (not only in the main nerves but sparingly in the whole surface), finely bullate, not rugose, below less hispidulous with short hairs, not tomentose hirsute, young veins glaucous not red; and its much smaller flower clusters. It differs from *P. kauaiensis* Heller in its stronger and more scattered branches, which are erect and not drooping; its broader, less acuminate leaves, above bullate, not granulose, below glaucous, hispidulous, not white tomentose; its hispidulous petioles; and its more densely pubescent flower clusters. It differs from *P. hawaiiensis* Léveillé, of which doubtful species a specimen is in the herbarium of Bernice P. Bishop Museum, especially in its bullate and rugulose, not granulose, leaves, and also in its glaucous flowers.



PLATE I. *Pipturus skottsbergii* Krajina Type.



PLATE II. *Pipturus forbesii* Krajina. Part of type sheet.

Pipturus forbesii, species nova (Pl. II).

Frutex vel arbor? ramis dense foliosis, longe atque densissime tomentose-hispidulis; foliis breviter petiolatis, ovatis, parvis, 2-5 cm. longis, 1.5-3 cm. latis, crenato-serratis vel serratis, coriaceis, scabris, supra rugosis sparsimque pilis solitariis vestitis, infra tota superficie adpresse glauco-vel rufescenti-(planta sicca!) tomentosa, nervis non solum tribus principalibus, sed etiam secundariis prominentibus, pilis hispidis armatis, petiolis brevissimis, 2-7 mm. longis, pilis hispidis usque 1 mm. longis dense vestitis, stipulis lanceolatis hispidis, 5-7 mm. longis, 2-3 mm. latis, cetera parte folii longius persistentibus. Floribus permultis glomerulis axillaribus adpressis. Planta dioica. Flores masculini ignoti. Ovarium dense hispidum, stigma 4-5 mm. longum, hispidulum, siccum fuscum. Fructus?

Maui: In the vicinity of Ukulele, altitude about 1500 meters, C. N. Forbes, July 13, 1919. Type, B. P. Bishop Mus. No. 979 M.

Pipturus forbesii, which is named in memory of C. N. Forbes, is very different from all species of *Pipturus* as yet known, especially in its small, shortly petiolate, coriaceous, rugose leaves with persistent stipules, and its longer stigmas (4-5 mm.).

GEOLOGY OF THE PACIFIC EQUATORIAL ISLANDS

By

CHESTER K. WENTWORTH

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GEOLOGY OF THE PACIFIC EQUATORIAL ISLANDS

BY CHESTER K. WENTWORTH

INTRODUCTION

The geological survey of five small Pacific islands lying near the Equator, between longitudes 155° and 165° W., was assigned to me as a member of the Whippoorwill Expedition, Trip "A," sent by the Bernice P. Bishop Museum in July and August of 1924.¹ Two days each were spent on Fanning and Jarvis islands, six days each on Christmas and Washington, and three days on Palmyra. The success of the survey owes much to the effective cooperation and vigorous assistance of Commander Samuel Wilder King, U.S.N., who had executive charge of the expedition, and to Captain W. J. Poland, of the *Whippoorwill*, and Professor C. H. Edmondson, Chief of the scientific party.

It is difficult to estimate the debt of the scientific personnel to Commander King. Without his extensive knowledge of Pacific exploration and commerce, and his sympathetic interest and participation in Polynesian research, the activities of the expedition would have been much less profitable.

GEOGRAPHICAL DISTRIBUTION

Palmyra, Washington, Fanning and Christmas islands lie in a northwest-southeast line, about 400 nautical miles in length, and about 1000 nautical miles south of Hawaii. Jarvis Island, which is not a part of this main line, lies 230 miles southwest of Christmas Island and south of the Equator. (See fig. 1.) Fanning Island, the principal shipping center, is 1070 nautical miles from Honolulu, 2880 miles from San Francisco, 1880 miles from Suva, and 4810 miles from Manila. Southeast, south, and west of the equatorial islands there are many islands within a 2000-mile radius, but, with the exception of Hawaii, there is none in the Pacific to the north and east.

The ocean floor surrounding the islands ranges from 15,000 to 18,000 feet in depth. Fanning, Washington, and Palmyra are connected by a low ridge, which maintains depths of less than 12,000 feet between. Depths of over 18,000 feet have been measured over a

¹ The itinerary, the scope of work, and the personnel of the Whippoorwill Expedition are described in the Annual Report of the Director for 1924 (B. P. Bishop Mus., Bull. 21, 1925, pp. 20-28).

considerable area midway between Palmyra Island and ^H Hawaii, and in another area about 500 miles southwest of Jarvis Island. From the reef margins to depths of 4000 or 5000 feet, the submarine slope is

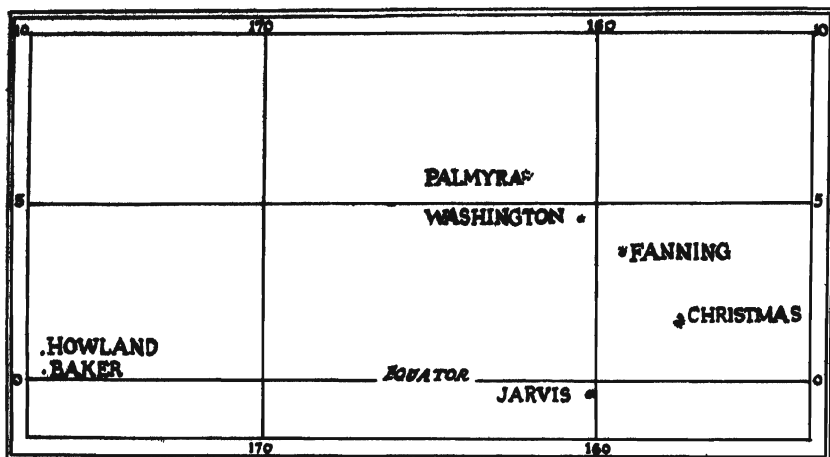


FIGURE 1.—Map showing islands surveyed by the Whippoorwill Expedition.

very steep, amounting in many places to 2500 or 3000 feet to the mile; at greater depths the slope probably becomes more gentle, but the details are not well known.

OCEAN CURRENTS

All the islands surveyed are in the zone of west-flowing currents which are due in part to persistent trade wind acceleration and in part to the established equatorial currents which are prevalent throughout the year. The configuration of several of the islands is markedly related to these currents and it appears that the current is more persistent and strong at the north part of the group than at the south.

CLIMATE

Climatic data recorded by Christophersen² show that the wind on the equatorial islands is prevailing from the east, northeast, and southeast, and deviates from these directions not over 8 per cent of the time. The temperature extremes for all the islands are 68° F.

² Christophersen, Erling, *Vegetation of Pacific equatorial islands*: B. P. Bishop Mus., Bull. 44, pp. 9-12, 28, 37-38, 45-47, 57, 1922.

minimum, and 106° F. maximum. The maximum has been recorded only on Christmas Island and the minimum on Fanning Island. Variation between summer and winter monthly means are in general 3° to 5°.

Rainfall on Christmas Island is extremely variable; fragmentary records show a range from 10 inches to as much as 100 inches. More complete records for Fanning Island show an average annual rainfall of about 110 inches. Judging from the few measurements available, Washington Island receives about 10 per cent less rainfall than Fanning Island, which agrees with the general vegetal and hydrologic conditions observed. For Jarvis Island, the condition of the soil and the preservation of timbers indicates less rainfall than is received on Christmas Island. Christophersen concluded that Jarvis Island has a distinctly desert climate, and that Palmyra Island is comparable with Fanning Island in its rainfall and moisture conditions.

DESCRIPTION OF THE ISLANDS

FANNING ISLAND

Fanning Island is an oval atoll 11 miles long by 7 miles wide.⁸ The land rim ranges in width from a few feet to one mile and is broken in three places. The enclosed lagoon has an area of 42.6 square miles, and a maximum depth of slightly more than 50 feet. Over an area of about 0.75 square mile, its depth exceeds 30 feet. The distance around the rim of the atoll is about 30 miles, and the total land area, approximately 13 square miles. (See fig. 2.) The maximum elevation of land observed by the writer on Fanning Island was 12 or 13 feet. Much of the atoll rim is less than 10 feet above sea level at the crest. This is usually very close to the outer shore and at many points coincides with the crest of the existing beach.

Only that part of the island along the west coast near English Harbor and Whalers Landing was seen by the writer, but it is believed that features here are fairly typical of the whole island. Seaward from the waterline, the outer shore is bordered by a reef platform, 100 to 300 feet wide, parts of which are just awash at low tide and covered with 2 to 3 feet of water at high tide. The landward part of this platform is smooth, or cut by shallow radial channels. The seaward part is made up of alternate rocks of living coral and

⁸ Transoceanic distances are here recorded in nautical miles. In the detailed descriptions of the islands, distances and areas are given in statute miles.

other organisms, and deep under-cut channels paved with calcareous debris. (See fig. 3.)

The west and southwest shores of Fanning Island are composed in part of sand with small quantities of shells and coral fragments.

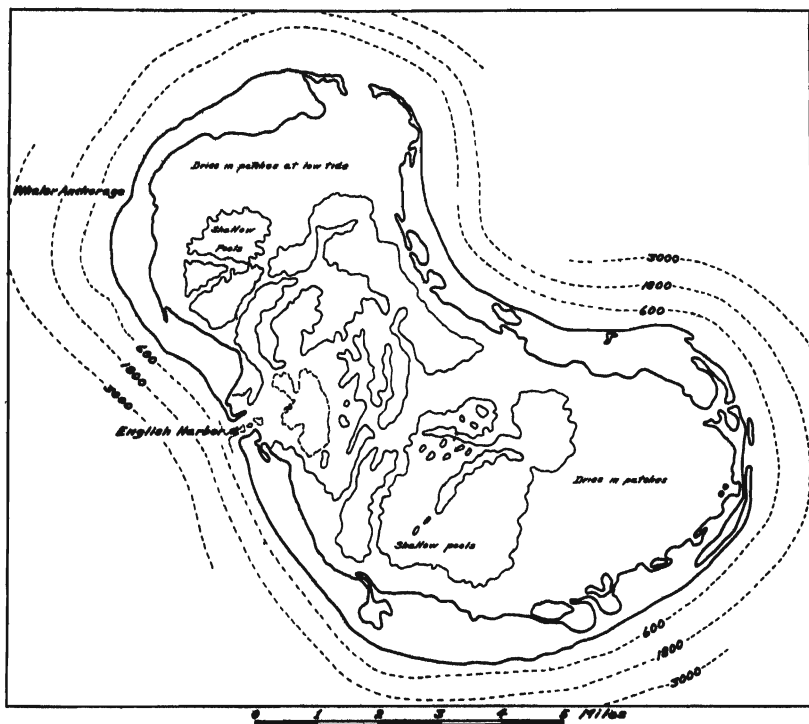


FIGURE 2.—Map of Fanning Island: pool margins inside lagoon shown in light solid lines; contour lines, showing depths in feet, are dashed. (Data from U. S. Hydrographic Office, Chart No. 1824.)

and in part of coarse, coral shingle made up of flat discoid fragments. The structure of these discs shows that they are definite coral units; position of growth may be determined by inspection. In some places the active beach reaches but 3 to 4-feet above mean sea level but at others the waves are building the beach crest 10 to 12 feet above sea level. The slope of the beach varies at different places and probably, at different times, at the same places from 6 to 8 degrees to as high as 30 degrees. (See Pls. I, A and B.) The steepest slope is

produced chiefly by erosion of previously deposited materials which slump down at the angle of rest. Along much of the west coast the outer part of the island is built up of a succession of beach ridges composed of coarse coral debris. In some places the furrowed plain, produced by this means, is 100 to 200 yards wide. The surface layers are weathered to a dark gray and the coral fragments are deeply etched. But the action is very superficial; 2 or 3 feet below the

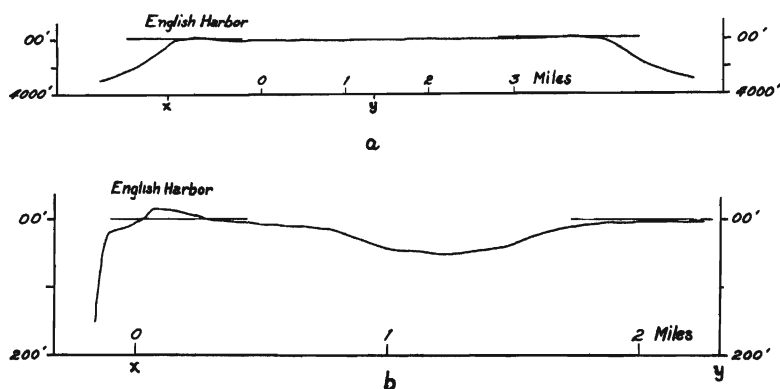


FIGURE 3.—Fanning Island: *a*, profile across the whole island, northwest from English Harbor (vertical and horizontal scales the same); *b*, greatly exaggerated vertical scale of section between *x* and *y*.

surface the coral is as white and apparently fresh as when first deposited.

In general, the surface of the land declines gradually from the outer beach crest toward the lagoon shore. Most of the surface is underlain by gray-brown coral sand and gravel which is mixed with a small amount of humus. Nearly everywhere, digging a few inches, one may uncover white and pink, fresh, coral debris. On such soil, when the bulk of the gravel does not exceed 5 centimeters in diameter, the coconut palm stands in flourishing groves and produces copra, the principal source of revenue of the island. The land crab is the most conspicuous terrestrial animal and its burrows, in some places, so honeycomb the ground as to inconvenience travel on foot or by automobile along the few unpaved roads.

Along the low, gently-sloping lagoon shore, the writer saw no land that was more than 4 or 5 feet above sea level. At two or

three places on the outer margin of the west coast, detrital limestone, found at 12 feet above tide suggests that Fanning Island was probably an encircling reef, just awash at low tide, and protecting a gradual accumulation of debris on its inner margin before emergence to its present position.⁴

In its physiographic development, Fanning Island is distinctly younger than Christmas, Jarvis or Washington islands. How much this is due to a lesser age in years, and how much to such factors as greater depth of lagoon, differences in rainfall, and botanical history, is difficult to say. In the writer's opinion, Fanning Island is younger than Christmas and Jarvis islands, but probably at least as old in years as Washington Island. Along the west coast, abrasion of shore debris is very active even in quiet weather. At low tide, the waves break at the reef margin and send rippling swells over the shallow bench pool. At high tide the swells run ashore from the first breaker line and dash with great force against the beach. Beaches composed of pebbles 3 to 20 centimeters in diameter are subject to constant shuffling and rearrangement to a depth of 6 to 12 inches, even in ordinary weather. Freshly broken coral slabs show appreciable abrasion during a period of 1.5 hours. No time was available for prearranged measurements of rounding.

As a typical atoll of rather large size and small openings between sea and lagoon, Fanning Island presents some interesting theoretical problems concerning movements of water. High tide in the lagoon lags behind high tide outside by a considerable period—perhaps as much as 2 hours. Water continues to run through the channel at English Harbor with a velocity of 5 or 6 miles an hour, until the receding tide of the ocean reaches the same level as the still rising tide of the lagoon. The tidal range of the lagoon is thus less than that outside. Its mean tide level is also higher because the carrying capacity of the channels is greater at high than at low water, and the height of swells in the open ocean greater than that in the lagoon. The effect of these factors is to keep the mean level of the lagoon slightly above mean sea level.

After observing these relations in the field, a theoretical problem was considered which approximated the conditions at Fanning Island. Using what appeared to be reasonable assumptions as to size, shape,

⁴ Wentworth, C. K., and Palmer, H. S., Eustatic bench on islands of the North Pacific: *Geol. Soc. America, Bull.*, vol. 36, pp. 521-544, 1925.

and length of channel connecting the ocean and the lagoon, and an assumed lagoon size similar to that at Fanning Island, flow and fill computations were made for half-hour periods over a total of about 36 hours. At this time the curve of tidal height in the lagoon had begun to repeat its pattern with a negligible error and the error of initial assumption of equal mean tide had been practically eradicated. These computations showed a mean lagoon tide of about 5 inches higher than mean ocean tide for an assumed ocean tide amplitude of 1 meter or about 40 inches.⁵

CHRISTMAS ISLAND

Christmas Island is said to be the largest coral atoll in the world. It is about 35 miles long in a northwest-southeast direction, and 24 miles in width. Its perimeter is about 105 miles. Enclosed within the outer coast is an area estimated at 382 square miles, of which approximately 250 are land, and 107 square miles lagoon; about 25 square miles are contained in the numerous salt lakes. (See fig. 4.) The highest point reached by the writer was the top of the sand hills called "Mont d'Auvergne" by Father Rougier. This was 22 feet above sea level. Considerably higher points, probably built of wind-blown sand, are reported in the southeast part of the island. Only a very small fraction of the whole area of land is over 10 feet above sea level and broad areas are under 5 feet in elevation. The rim of the atoll is broken in two places on the west side by channels having widths of slightly over a mile each. The lagoon extends 7.5 miles south and 4.5 miles north of the entrance. The north, east, and southeast parts of the island constitute a broad plain which is dotted with shallow lakes.

Most of the beaches on the western side of the island are composed of sand with a small quantity of shell and coral debris. The beach crest is commonly 10 or 12 feet above sea level and in many places is continued inland for several hundred feet by a succession of ridges of coarse coral debris. (See Pl. II, *A*.) Only one point on the east or windward coast was visited by the writer. At this place there was a steep beach of rough angular coral debris which was flanked landward by a broad expanse of coarse debris ranging from 15 to 50 centimeters in diameter. It is probable that gravel

⁵ Johnson, Douglas, Studies of mean sea level: National Research Council, Bull. no. 70. pp. 12-20, 1929.

beaches line much of the windward coast and they are known at a few places on the west coast.

A reef platform ranging from 100 to 300 or 400 feet in width extends seaward from the shore line around all parts of Christmas Island which were visited. Toward the seaward margin the reef becomes cut into alternate channels and ridges which run parallel to

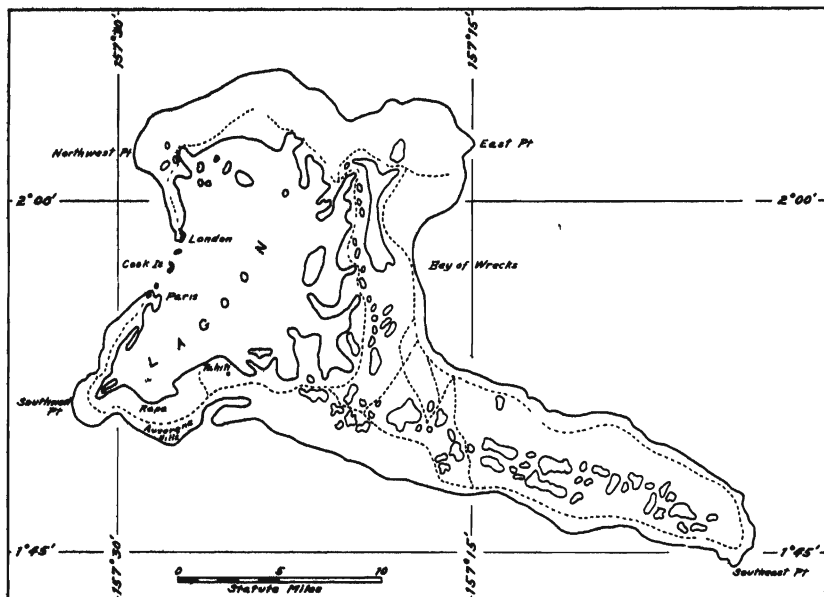


FIGURE 4.—Sketch map of Christmas Island (drawn from a map compiled under the direction of Commander S. W. King, based on maps and data furnished by Father Rougier, owner of the island).

the direction of the prevailing waves. These ridges are seen not only on the fringing reef margin near low tide level but also on the bottom at greater depths, where a white sand in the channels is in strong contrast to the colored coral masses of the ridges. The exact origin of such linear arrangement of the coral masses is not known, but it is clearly an advance in economy of movement of food-bearing currents of water to the coral, in the running out of the undertow water, and in mechanical resistance of coral to strong currents. Somewhat analogous arrangement of the *kiawe* (algaroba) trees in files

parallel to the wind direction may be seen on certain windward shores of Hawaii.

Masses of marine reef rock which stand 10 to 12 feet above sea level are found at a number of places in the interior of Christmas Island. Where elevations were determined, they were commonly about 10 feet and none was seen which indicated a probable former stand of the sea of over 12 feet higher than at present.

The rim of the north and northeast parts of the island consists of an outer and higher plain and an inner and lower flat which is but a foot or two above sea level. Between the two benches is a scarp which is not over 5 to 7 or 8 feet in height and relatively gentle in slope. This slope is the principal site of coconut trees on this part of the island at the present time and probably is more favorable because of greater amounts of ground water. The higher flat is covered with low grasses and much of the lower flat is bare. The outer margin of the upper flat merges with the beach-ridge plain or is lined with low sand dunes. The soil of the coconut groves and grass-covered areas is slightly weathered coral and shell debris with a small amount of humus material in the surface layers. In places where groves of older trees have stood for some years, a considerable amount of phosphatic material derived from the excrement of sea birds is mingled with other soil elements.

All of the numerous lakes of the island are salt and most, if not all, are much more concentrated than normal sea water. They are fed by seepage springs round their margins and are probably maintained at least a few inches above sea level. Not uncommonly there is a difference of a foot or more between the levels of adjacent lakes separated by narrow barriers. These dissimilarities are doubtless due to different ratios between inflow and evaporation losses. The water of the springs is brackish and not particularly palatable, though it could, in emergency, be used for drinking purposes. The lakes are commonly not over a few feet in depth and have gently sloping shores and bottom configuration. Usually several shore lines can be seen on the beaches above the existing water line. These, because of the very gentle slope, indicate large fluctuations in area with changes in elevation of not over 1 or 2 feet. It is believed by the writer that these changes of level are due to slight alternating and perhaps periodic changes in the height of the water table due to fluctuation in rainfall and evaporation. Such changes, involving large alterations

in the areas of shallow lakes, are known in all regions of enclosed salt lakes. Aside from the supposed eustatic shift of sea level,⁶ it is believed that the relation between land and sea at Christmas Island has remained fixed in recent time.

The shores of some of the lakes are strewn with the shells of thousands of small molluscs, some pelecypods, others gastropods. These form extensive flats and beach ridges and the animals must either be living in the lakes at present or have become extinct at a very recent date. Broad areas of land adjacent to the lakes and also at various places elsewhere are covered with a hard pavement of 0.5 to 2 inches thick. The surface color of this crust is dark-gray and fresh breaks show lighter buff colors. Below the pavement is loose and commonly moist coral debris. The crust is clearly the result of cementing of the coral sand and mud by a calcareous cement deposited from water which is constantly evaporated at the surface. This crust is of terrestrial origin, is being formed at the present time, and should not be confused with the massive reef rock and coral heads which were formed when the sea stood over Christmas Island. In most places where the crust is well developed there is little vegetation and that which is present grows in linear and radial arrangement along cracks in the pavement which appear to be due mainly to expansion and contraction.

The leeward shores of the lakes are frequently bordered by zones of white foam, several feet in width, which is picked up by the wind and blown and rolled along the adjacent flats. It is not certain whether the excessive formation of foam is due to the high salinity or is connected with the presence of organic matter, such as algae, in the water.

Christmas Island appears to be the oldest of the islands visited. It probably possessed a considerable land area produced by the depositional shoaling of large parts of its lagoon before the lowering of the sea level, which took place some thousands of years ago. At that time the island probably assumed nearly its present form. Minor changes in the levels and connections of lakes have, no doubt, taken place since, as well as the building of shore dunes and the growth of the more luxuriant and arboreal vegetation which is found there today.

⁶ Wentworth, C. K., and Palmer, H. S., Eustatic bench on islands of the North Pacific: *Geol. Soc. America, Bull.*, vol. 36, pp. 521-544, 1925.

JARVIS ISLAND

Jarvis Island is situated in longitude $160^{\circ}00'$ and latitude $00^{\circ}23'$ S. It is 1.9 miles long in an east-west direction and 1.125 miles wide. The total land area is about 1.66 square miles. The highest points, which are on the northwest side, reach 23 feet above sea level. About 40 percent of the rim is above 20 feet and probably less than 25 percent is below 15 feet in elevation. The lowest point of the rim on the northeast side is just under 10 feet above sea level.

Outside the rim the land slopes steeply to the water line. (See fig. 5.) Around most of the shore the beach is composed of cal-

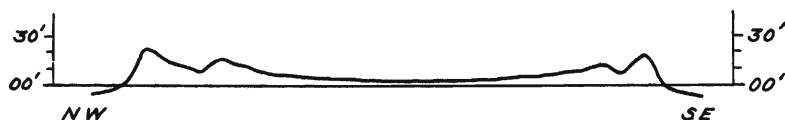


FIGURE 5.—Sketch profile (northwest to southeast) across Jarvis Island. (Elevations approximate, in part from hand level notes.)

careous sand. At many places along the lower part of the beach cemented calcareous sandstone is exposed and this material makes up the bulk of the bench which extends from the shoreline for an average distance of 200 feet. At the seaward margin of the bench are alternating rock masses extending 1 or 2 feet above mean tide and channels cut 3 or 4 feet below mean tide. The main bench is bare in spots at low tide and covered by 2 or 3 feet of water at high tide. No detailed examination of the bench was made but from the composition of the landward margin and the clear stratification of dipping beds in some parts of the seaward portion it is believed to consist almost wholly of sandstone and conglomerate. (See Pl. II, B.) Corals and other reef-forming organisms which now grow on it form a fringe and a veneer rather than the bulk of its mass. On the northeast coast of Jarvis Island is a considerable extent of coral shingle consisting of flat and rounded slabs thrown up by the waves to angles of 20 to 30 degrees.

Detailed account of the sandstone, conglomerate and of the modern sediments of the Jarvis beach will be reserved till the examina-

tion of specimens is complete,⁷ but attention should be called to the extensive wreckage now lying on the west shore and derived from the break-up of the barkantine *Amaranth* of San Francisco in 1913. The coal pebbles which now lie on the west and northwest beaches of Jarvis have been rounded by abrasion since the coal was strewn there in 1913.

A study of the rounding and abrasion of these pebbles has recently been made.⁸ According to the tests made, the wear sustained by these pebbles in eleven years is equal to that of 602 days of continuous milling in the 20-inch mill used, with a velocity of 20 revolutions per minute, and mixed with 3000 grams of pebbles of size comparable to that of the coal pebbles. This is equivalent to about 16,000 miles of peripheral travel.

The very gentle slopes of the basin, which lies inside the rim, are in striking contrast to the steeper outer slopes. Nevertheless the basin is a very considerable depression, which in its deeper parts reaches sea level. The larger part of the basin is less than 10 feet above sea level and higher land is confined to the peripheral parts of the island. Jarvis Island is the nesting place of thousands of sea birds and much of the basin is covered to the depth of several feet with phosphatic earth or guano. This was reported by Hague who also described evidences of emergence on Jarvis, Baker, and Howland islands.⁹

The structure of the island is shown in the ideal cross section of fig. 5. At the present time it is being cut away by erosion. The main growth of reef which formed the atoll took place prior to the last change in sea level when the water stood about 12 feet higher than now. For a considerable period this growth must have been very active in order to supply the great quantities of sand and gravel which were deposited as beach debris and now remain in part as eroded remnants of sandstone and conglomerate around the whole island.

No reef formations were found at elevations greater than 12 feet. All the land above 12 feet has been formed of detrital material flung up into beach ridges by the waves, or blown by the wind.

⁷ Wentworth, C. K., and Ladd, H. S., Pacific island sediments: Univ. Iowa, Studies in natural history, vol. 13, no. 2, 1931.

⁸ Wentworth, C. K., Pebble wear on the Jarvis Island beach: Washington Univ., Studies, Science and Technology Ser., no. 4, 1931.

⁹ Hague, J. D., Guano islands of the Pacific Ocean: American Jour. Sci. 2d ser., vol. 34, pp. 224-243, 1862.

WASHINGTON ISLAND

Washington Island is 3.8 miles long measured in a direction N. 70° W. and has an average width of slightly over a mile. The total area of the island is about 4 square miles and its perimeter is about 9 miles. (See fig. 6.) The island is roughly lenticular in form with no

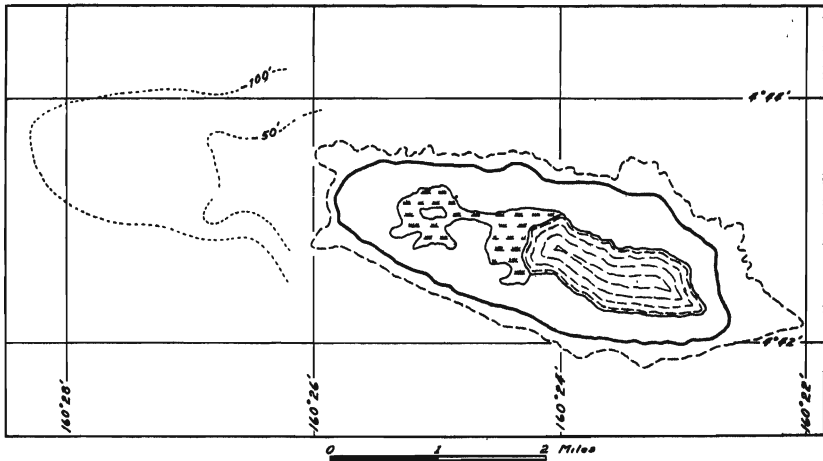


FIGURE 6.—Map of Washington Island: reef margin shown by dashed line; depths in feet shown by dotted contours. (Data from U. S. Hydrographic Office, Chart No. 1839.)

abrupt breaks in the shore line. At the west end is a fresh water lake 0.75 by 1.5 miles which is the remnant of a much larger salt lagoon of former times. Most parts of the shore reach elevations of 9 or 10 feet at the crest of the beach and a few places have elevations of 15 to 16 feet, especially toward the west end. No part of the island seen by the writer has an elevation as great as 20 feet above sea level. (See Pl. IV, *A*.)

Washington Island is densely wooded and has an aspect of great fertility. The forest extends to the shore practically everywhere and the sand beach is overhung by trees at many places. The island is noted for its heavy seas and violent wave action around its shores. As a consequence, the reef which surrounds the island is less well known than those adjacent to some of the other islands visited. At the places examined it is 50 to 200 yards wide and stands from a few

inches to 2 or 3 feet below tide level. The landward portion is relatively flat but the seaward margin is cut into the usual alternating rocks and furrows. At a very few places detrital sandstone is exposed as a part of the reef platform but by far the larger part appears to be the result of active coral growth in the very recent past.

A distinguishing feature of the beaches of Washington Island is the almost complete absence of gravel or shingle. Only one place was seen round the whole shore line where the beach was made of gravel averaging as coarse as 10 millimeters. Nearly everywhere the sand of the beach is veneered in patches with a trifling amount of coarse coral debris and shells but, at least at the time of the writer's visit, there were no shingle beaches like those of the other islands. The height of the upper margin of the beach above mean sea level varies from 5 to 15 feet and the width of the beach from 15 to 200 feet. The most prominent sand beach of the island extends west and northward from the village. It represents the excessive sand accumulation at the west end of the island by westward shore drift along both north and south shores. It is probable that the island is being extended somewhat in this manner and the configuration of the ocean bottom off the west end shows much additional aggradation. Here an area of nearly 2 square miles has depths of less than 20 and more than 5 fathoms and constitutes a relatively flat plain.

Around the west end of the island and including the boat landing now in use the beach crest is 12 to 15 feet above sea level. The beach profile is a smooth cycloidal curve reaching a slope of 30 to 40 degrees at the upper end. At high tide even in ordinary weather the waves dash up this beach slope and not uncommonly spill over the crest and out on the gentle back-slope beyond.

Rock fragments up to 30 centimeters in diameter are shifted to and fro on the sand beaches and at some places have a drift along the shore amounting probably to one or two miles a day. On the south, north, and east coasts the highest beach crest is made of coarse coral debris, whereas the more active, normal beach is of sand.

As is true of most of the other atolls visited, the highest points on Washington are close to the beach and the land declines gently toward the interior. The rim of the island between the shore and the interior lagoon and bogs, supports a dense growth of coconut trees, ferns and other plants. (See Pl. III, B.) Wherever the underlying rock is visible it is seen to consist of coral debris. At a few

places sandstone and conglomerate, which are not of eolian origin are exposed, and suggest that they were formed when the island was more completely submerged than now. No true reef rock was seen in the interior.

The fresh water lake and the two adjacent peat bogs constitute an interesting and most unexpected feature of the island.¹⁰ The bogs are now completely filled and may be crossed on foot without sinking into the ground by more than a few inches at any place. The surfaces are very flat and stand between 2 and 3 feet above sea level. The central parts are covered with a thick growth of bullrushes 3 to 5 feet high. The peripheral parts for 100 or 200 feet are more open and carry patches of *ape* (*Alocasia macrorhiza*). At the extreme edge *Pandanus* trees grow in patches and are overlooked by the towering coconut trees of the peripheral higher lands. The peat is a dense interlaced mass of plant fiber which appears to be mainly bullrushes and contains practically no sediment. Over the central parts of the bogs, the peat is 3 to 3.5 feet thick and in a few places reaches 5 feet. Around the margins the thickness declines with great regularity to a few inches. Under the peat is a hard bottom of white coral sand which is easily reached at all points by pushing down a slender rod or staff.

An island of coconut trees and other higher vegetation in the westernmost bog was found by Christophersen to be underlain by normal peat.¹⁰ The fresh water lake has a surface elevation of about 3 feet according to hand level estimates. On the west end it is bordered by an area of bog but around much of the shore it is flanked directly by coconut groves. The lake water is fresh to the taste and flow through the porous rocks to the sea is adequately balanced by rains. Evaporation plays a relatively small part in the cycle here. The lake is reported to have a maximum depth of about 30 feet. It has a clean sandy bottom except where it is covered with accumulations of vegetable matter. The deeper parts of the bog areas have thus a sand bottom which is 1 or 2 feet below present sea level, and those of the lake go to somewhat over 25 feet below sea level.

It is believed that Washington Island, like several others of the group, was first built as an atoll with reference to a higher sea level and that it became emerged through a lowering of sea level. It seems

¹⁰ Wentworth, C. K., A tropical peat bog [Abstract]: Geol. Soc. America, Bull. 36, 1925. Christophersen, Erling, Vegetation of Pacific equatorial islands: B. P. Bishop Mus., Bull. 44, pp. 49-56, 1927.

most probable that the fixing of the lagoon as a closed basin took place at this time and that the position of Washington in a zone of abundant rainfall was responsible for the conversion of the salt lagoon into a fresh water lake. Since the volume of water in the lake and in the rocks of the island is perhaps several times the volume of water falling in a year and the process of freshening a very slow one, it seems likely that several hundred years elapsed before the lake became sufficiently fresh to favor the growth of plants which have now filled large parts of the former lagoon. No bullrushes were observed in positions where they were encroaching on water areas but it seems almost certain that they have done so in the past.

PALMYRA ISLAND

This group of tiny islets is the northwesternmost member of the Line Islands. It includes upward of forty small islets which are arranged in an atoll ring 4 miles long and 1.5 miles wide. These stand on a reef platform 6 miles in extreme length and 2 miles wide. (See fig. 7.) The axis of the shallow reef platform trends almost exactly east and west and is continued at each end by shallow water for some distance farther. The total area enclosed with the 60-foot line is 11 miles in length. At the west end of this area is a pool which is somewhat deeper than 60 feet and inside the reef platform proper and inside the ring of islets are three principal pools which have depths from 100 to 150 feet. Outside the 60-foot line the submarine slope is steep, ranging from 2500 to 3000 feet to the mile and descending to the general depth of about 15,000 feet.

None of the islets is over 50 acres in extent and most comprise less than 5 acres. (See Pl. IV, B.) Around the north, east, and south sides of the ring, the spaces between the islets are considerably narrower than are the islets. The west end is open with a distance of over a mile between the two ends of the atoll loop. This is in close accord with the form of the reef platform which presents a single blunt point to the prevailing ocean current and has two sharp "fish-tail" points extending westward in the opposite direction. It is apparent that the most favorable places for growth are at the currentward point and at the two points, one north and one south, where the along-shore currents run out past the main part of the platform.

Practically all parts of the reef platform are accessible by wading at low tide, the only exceptions being the central pools and the inter-

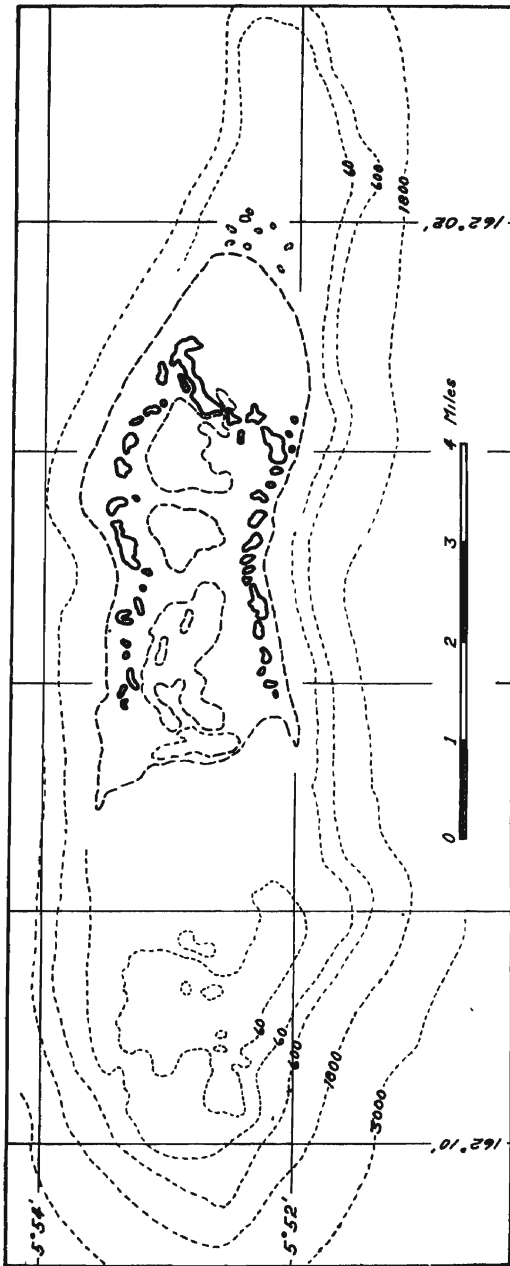


FIGURE 7.—Map of Palmyra Island: reef margin shown by dashed line; contour lines, showing depths in feet, by dotted lines. (Data from U. S. Hydrographic Office, Chart No. 1839.)

islet channels. The writer found no points on any of the islets over 5 feet above sea level and is confident that the maximum elevations will be found to be less than 10 feet in elevation.

No detailed or extensive examination was made by the writer of the reef surrounding Palmyra but it showed to casual observation similar features to those of the other atolls visited. Because of the large number of breaks between islets, study of the channels across the atoll rim was more effective here than at others of the Line Islands. No data are at hand to show the amount of lag between high tide outside the lagoon and that inside but it probably amounts to a considerable part of an hour at the least. During the approach of high tide and for this unknown period afterward, there is a strong current through each of the interislet channels which keeps the bottom scoured clean and maintains depths of 4 to 8 feet. Coral debris carried by the channel current is deposited well inside the narrower part of the channel in a fan which is commonly not over 1 or 2 feet below low tide and in places is emergent at low tide. These fans merge more or less inside the islet ring and the debris is spread widely over the detrital plain which occupies the whole area inside the rim, except the central pools, as shown on the map.

So far as the writer was able to observe, the outgoing current, which is set up with the reversal of tidal relations, is less strong and of shorter duration—probably in part due to the greater amount of water which flows out the west end of the atoll. Though a small amount of debris is probably carried out at this time, it is small in amount in comparison to that which is carried in by the ingoing current and because of exposure to rollers of the open ocean no fans corresponding to those of the inner side are formed. At the east end, several hundred yards eastward of the dry islets, a few small emergent sand patches were seen and one of these bore a single tree marking the beginning of conditions which will lead to stabilization. These were not visited but seem clearly to indicate that the more favorable growth of reef-forming organisms, in the direction of the prevailing currents, is more than competent in spite of severe wave abrasion to maintain its position.

In the central pools and around their margins, as well as in and adjacent to the interislet channels, there is a considerable amount of living coral and associated organisms, but the growth here is apparently much less vigorous than outside the rim and it is gradually being

overwhelmed by the calcareous debris which is constantly carried in from the outer reef.

The outer beaches of the Palmyra Islets are composed largely of sand but some are made of coarse coral gravel. The inner beaches are low and less well defined, being composed of fine calcareous sand and mud. The angle is very low and the water line fluctuates widely between high and low tide. On the dry portions of the islets visited by the writer, mostly on the south side of the lagoon, no true coral reef rock was seen. There is thus no clear indication of a former sea level above that of the present day. The inner parts of the islets consisted chiefly of loose detrital material though certain ones were more largely made up of cemented sandstone and conglomerate; particularly with an inner line of islets on the east end, where the outermost islets seem to be more recent and doomed in time to be superseded by a line of isles flung still farther eastward toward the margin of the reef platform.

There are two plausible explanations of the lack of high reef rock on Palmyra. It is possible that the island had not come into being at the time of the 12-foot eustatic shift of sea level which is believed to be responsible for the emergent position of most of the Line Islands. On the other hand, it may have had an imperfect development and been cut away by the waves instead of becoming fixed as a dry land area as was Jarvis Island. If Palmyra Island were to emerge at the present time by 12 feet it would form an island about 5 miles long with three interior lagoons of a size and form not differing greatly from the interior basins of Washington Island, except that the former have a greater depth. It is conceived that the complete closing of the atoll rim for considerable distances on Washington, Fanning and Christmas islands was greatly aided by an emergence which took place apparently before Palmyra Island had developed to such an extent as to profit by it.



A



B

PLATE I—Fanning Island *A*, steeply sloping beach of coral shingle formation, probably aided by erosion and slumping *B*, west coast, showing shingle beach and ledge of old beach conglomerate, now being eroded

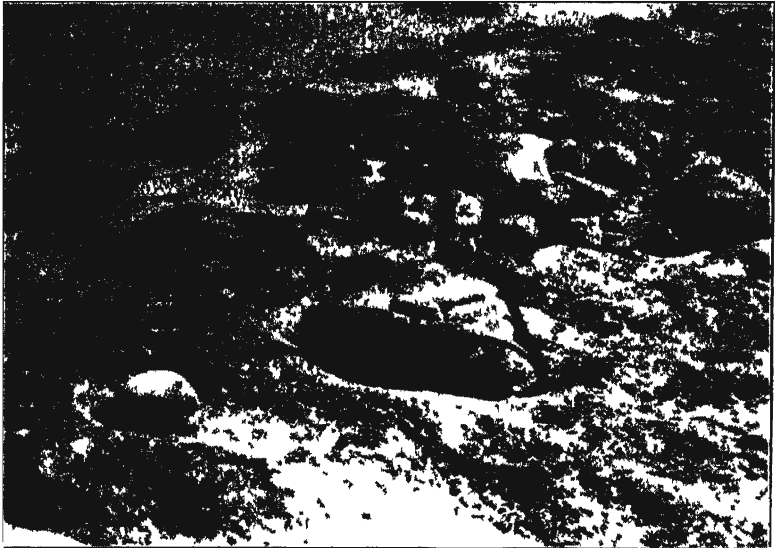


A



B

PLATE II.—Christmas and Jarvis islands: *A*, plain of coarse coral debris, looking eastward from near the crest of the west beach of Christmas Island, north of London (the coconuts are growing on lower ground, 5 or 6 feet above sea level, probably former lagoon bottom); *B*, west coast of Jarvis Island showing ledges of beach sandstone formed during a time of higher sea level, but in the same attitude as at present (the change of dip in the middle appears to mark the limit of wave transportation of sand when the beach was built).



A

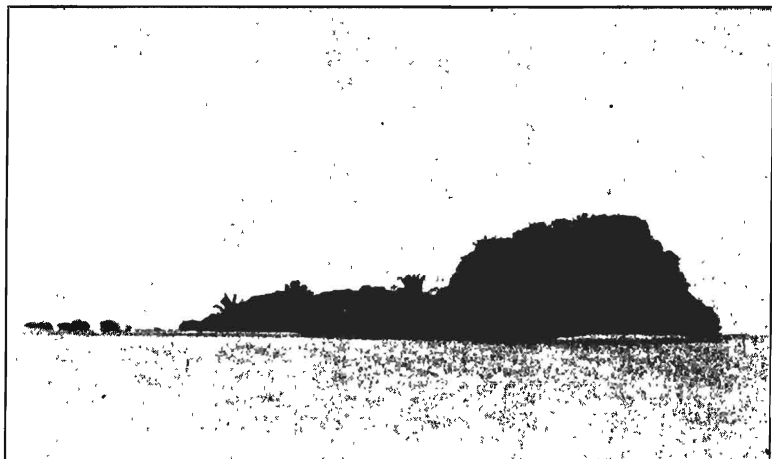


B

PLATE III—Washington Island *A*, detail of surface of reef platform at low tide, showing the rocks of coral, or coral derivatives, which are being rounded and abraded and in turn are abrading and potholing the platform surface; *B*, forest on higher ground just back from the beach crest, south coast



A



B

PLATE IV.—Washington and Palmyra islands: *A*, Washington Island landing, showing plain margin and sharp crest of the beach (14 feet above mean sea level), over which occasional waves slop on ordinary days; *B*, view of Palmyra Islet, south rim, looking southeast.

NEW POLYNESIAN PLANTS

By

FOREST B. H. BROWN

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NEW POLYNESIAN PLANTS

By FOREST B. H. BROWN

PANDANACEAE

FREYCINETIA Gaudichaud

***Freycinetia victoriperrea* Solms-Laub.¹**

Freycinetia demissa R. Brown.

Leaves linear lanceolate, 60-80 cm. in length, up to 4 + cm. in width, somewhat dilated at the base, acuminate, spinulose-serrate along margin and keel in the apical portion of the blade; inflorescence terminal; spadices in fascicles of four, the carpellate ones with small bracts 2-3 cm. in length at the base, ovate-cylindrical, 7-9 cm. in length, on peduncles 5-6 cm. in length, $5 \pm$ mm. in thickness, scabrid; fruits free, slightly fleshy, ovate, contracted into a conical beak with $6 \pm$ stigmas at the end.

Tahiti, Vaheria, altitude 700 meters, June 3, 1927, L. H. MacDaniels, no. 1597, reference type.

Endemic in Tahiti. Native name: *ieic*.

PANDANUS Linnaeus

***Pandanus pulposus* Martelli.**

Pandanus tectorius var. *pulposus* Warburg: Das Pflanzenreich, vol. 3, pt. 4, no. 9, p. 49, 1900.

Pandanus pulposus Martelli: Webbia, vol. 4, p. 409, fig. 39, 1914. Original description amplified by Forest B. H. Brown:

Drupes broadly turbinate, tapering from the middle, strongly contracted at the base, 5-8 cm. long, 5-6 cm. wide, 5-6-sided, free in the upper half, convex at the apex; sutures prominent, with or without deep narrow furrows; carpels 7-12 in number, broad, irregular, the outer ones broadest, convex or convexopyramidal at the apex, angular, separated by deep narrow or obscure furrows; endocarp osseous, thick walled, rimose, situated above or mostly above the center of the drupe, dorsiventrally compressed, nearly as broad as the drupe, $3 \pm$ cm. in axial thickness, irregularly convex above, flat or concave below; apical mesocarp chambers with rather thin lateral walls, transversed by coarse fibrovascular strands with intrafascicular pith and broad intrafascicular cavities; basal mesocarp abundant, fleshy, traversed by slender fibrous strands imbedded in thin walled, succulent parenchyma stored with starch and sugar; seeds small, $15 \pm$ mm. long.

***Pandanus pulposus* var. *cooperi* Martelli.**

Drupes 7.5 cm. long, 3.5 cm. diam., composed of 8-9 locules; endocarp 2.5 cm. thick, located mostly above the center of the drupe.

¹ All plants described in this paper are in the herbarium of Bernice P. Bishop Museum.

In Martelli's description it is stated that the endocarp is found at the center of the drupe; this is evidently an error, because his published illustrations (op. cit., table 38, fig. 3), also those of Rock (College of Hawaii, Bull. 4, fig. 3, 1916), show clearly the position of the endocarp completely or almost completely above the center.

The species occurs on Marshall and Radack islands; the variety, on Palmyra Island.

***Pandanus bergmanii*, new species (fig. 1).**

Shrubs $5 \pm$ m. in height. Leaves 110 cm. long, $5 \pm$ cm. broad at the base, tapering gradually to an acute apex, coarsely spinose-serrate along the margin, except at the base, the midrib with distant spines in the upper position; the spines sharp, stout, $2 \pm$ mm. in length; syncarpium broadly ellipsoidal, 29×34 cm., composed of $87 \pm$ drupes; drupes of great size, long pyriform in shape, irregularly pentagonal in cross-section outline, $12 \pm$ cm. long, $6.5 \pm$ cm. in diameter, tapering and curving inwardly from the upper third into a long narrow base, free and divergent in the upper third, slightly convex at the apex; apical sutures prominent, shallow; lateral sutures prominent, separating the carpels by narrow furrows of moderate depth, rarely superficial; stigma subhippocrepiform, suborbicular, small, $3 \pm$ mm. in diameter, oblique, slightly protruding, situated in an apical depression of the drupe, centrally located in the central drupes, inwardly eccentric in the outer drupes; carpels (locules) $6-9 +$ in number, concentrically arranged, the outer ones of large diameter, the inner ones much reduced; endocarp situated in the center of the upper half of the drupe, irregularly circular in longitudinal section, small, $3.5 \pm$ cm. in diameter, rimose, composed partly of hard osseous tissue, and partly of light-colored rather soft material; apical mesocarp divided into well defined locular chambers, the outer ones large, 2.5 cm. in diameter, the inner ones small, $1 \pm$ cm. in diameter, traversed by distant fibrovascular strands with large intrafascicular air cavities and air-containing pith (aerenchyma); basal mesocarp abundant, $8 \pm$ cm. long, succulent, with slender fibrovascular strands 0.1-0.2 mm. in diameter, imbedded in succulent parenchyma stored with starch and aleurone; seeds small, $12 \pm$ mm. in length.

Washington Island, August 18, 1924, H. F. Bergman, no. 104, type.

A distinct species with very large drupes, each containing a small endocarp situated well above the center. It is evidently rather closely related to *P. leram* (Section *Hombronia* Warburg), of Nicobar and Andaman islands, but differs from this species in the relatively primitive concentric arrangement of the carpels—a sectional character which, however, may not indicate a wide phylogenetic relationship of the two species, as continued reduction of the central carpels would ultimately result in a 1-2-serried arrangement very similar to that of *P. leram*. Certain characters of the drupe, such as the large proportion of edible mesocarp tissue and small nonedible endo-

carp tissue, may be the result, partly, of selective cultivation by early races of man.

Endemic in Washington Island. It is not improbable that this species may be a variety of ancient cultivation and of aboriginal introduction in Washington Island. It is of interest to note, in this connection, that Hedley (Australian Mus., Mem., vol. 3, p. 30, 1896-

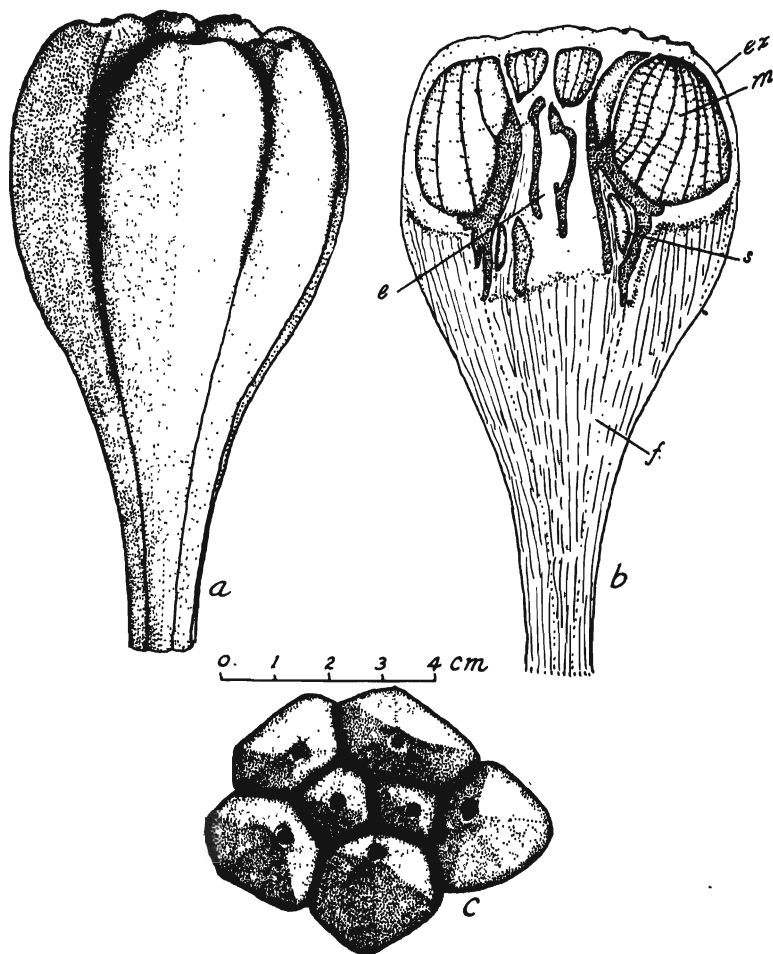


FIGURE 1.—Coral island type of *Pandanus*, *P. bergmanii*: *a*, lateral view; *b*, fruit (*e*, endocarp; *f*, fibrous mesocarp; *ex*, exocarp; *m*, apical mesocarp; *s*, seed); *c*, apical view.

1897) finds that one of the edible varieties of Funafuti, called *fala kai* (edible *fala*) by the natives, was introduced from Gilbert Islands.

LEPTURUS R. Brown

Lepturus repens R. Brown var. **maldenensis**, new variety (fig. 2, a).

Plant $30 \pm$ cm. in height; leaves $10 \pm$ cm. in length, convolute; ligule $0.5 \pm$ mm.; spikelets with one fertile and one vestigial flower; outer glume short, $5 \pm$ mm. in length, puberulent at the end, acute; fertile glume and palea $4.5 \pm$ mm. long.

Malden Island, November 22, 1924, Gerrit P. Wilder, no 1, type.

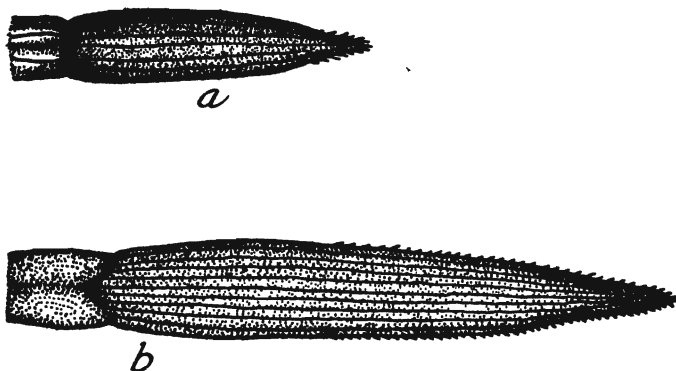


FIGURE 2.—Glumes of *Lepturus repens*: a, variety *maldenensis*; b, variety *palmyrae*.

Lepturus repens R. Brown var. **palmyrae**, new variety (fig. 2, b).

Stems long, $65 \pm$ cm. in height, [if supported]; leaf blades very long, $7-35 +$ cm. in length, flat, $4-7 +$ mm. in width, spinulose serrate, glabrate; ligule short, $0.5 \pm$ mm., ciliate; spikes long, up to $15 +$ cm. in length; rachis slender, minutely puberulent; spikelets with one fertile and one vestigial floret; outer glume $9 \pm$ mm., acute, ciliate; fertile glume and palea 5 mm., the glume minutely puberulent in the upper portion.

Palmyra Island, July, 1913, J. F. Rock, no. 10276A, type.

ISCHAEMUM Linnaeus

Ischaemum lutescens Hackel.

Ischaemum byrone (Trinius) Hitchcock.

Original description amplified by Forest B. H. Brown:

Culm erect, free from the sheaths only for a short distance from the inflorescence; nodes weakly bearded or glabrous; sheaths compressed, glabrous or, in young growth, bearing scattered long hairs on the lower surface; ligule 3-4 mm. long, thin and hyaline in the center, thicker at the sides and joined with the auriculate lobes of the sheath; leaf blades 5-20 + cm. in length, 3-5 + mm. in width, glabrous; spikes 2 in number attached at the end of the culm, 4-10 cm. in length; joints of the rachis and pedicels subequal, 3-4 mm. in length, thick, $1 \pm$ mm. in diameter, triangular, concave and tridentate at the end, pilose at the base and along the angles. Sessile spikelet lanceolate, $7 \pm$ mm. long, violet in color in the upper portion, pilose at the base with silky hairs one-half the length of the spikelet; glume no. 1 bidentate at the apex, pilose with long hairs on the back; glume no. 2 carinate, nearly of the same length as the first, scabrous toward the tip, minutely bidentate at the apex, bearing an awn of nearly one-half the length of the glume, long pilose in variety *pilosum*; third glume slightly shorter, lanceolate; fourth glume nearly one-half as long as the second, thin, glabrous or ciliate, 2-lobed at the apex, bearing an awn of 12-20 + mm. from the sinus, the twisted column extending beyond the glumes; anthers 2 mm. long. Pedicellate spikelets $5 \pm$ mm. in length, pilose at the base, the first glume terminating in a short awn of nearly one-fourth the length of the spikelet, pilose on the dorsal surface; awns of second glume and fourth glume similar to those of the first but shorter.

***Ischaemum lutescens* Hackel var. *typicum*.**

Third glume of sessile spikelet glabrous.

Distributed in Hawaii.

***Ischaemum lutescens* Hackel var. *pilosum*, new variety.**

Third glume more or less long-pilose on the dorsal surface.

Cook Islands, Aitutaki, near seashore, April 15, 1925. Gerrit P. Wilder, no. 337, type. Native name: *matic*.

CYPERACEAE

CYPERUS Linnaeus f.

***Cyperus tenellus* Linnaeus var. *australiensis*, new variety.**

Culms 1-8 cm. in height; spikelets large in comparison with the size of the plant, 1-3 in number; involucre bracts two in number, one erect, much longer than the second which is spreading; glumes light-green to brown in color, 5-8-veined; stamens 1-2.

Australia, New South Wales, October, 1908. J. H. Camfield; Australia, Victoria, October to December, 1912, J. E. Tilden. Type, Camfield no. 1; reference types, Tilden nos. 860 and 724. In Australia and North Island, New Zealand, "sea level to 500 meters altitude."

CLADIUM P. Browne

Cladium angustifolium Bentham and Hooker.

Stem compressed, $100 \pm$ cm. in height, smooth along the angles; leaves somewhat as in *Cladium meyenii* but broader ($25 \pm$ mm.), $150 \pm$ cm. in length; panicle somewhat lax, the branches rather slender, slightly sinuate, smooth; basal bracts with long sheaths and short blades not as long as the panicle branches; spikelets grouped $7 \pm$ in a cluster, dark-brown in color, $6 \pm$ mm. long, with $4 \pm$ flowers, the $7 \pm$ glumes 2-ranked; style 3-parted, the branches exserted, somewhat thickened and pubescent at the base; achenes sharply triangular, $2 \pm$ mm. in length.

Tahiti, altitude about 700 meters, June 3, 1927, L. H. MacDaniels; Tahiti, altitude about 1848 meters, E. H. Quayle. Reference types: MacDaniels, no. 1600; Quayle nos. X (August 1-3, 1922) and 49 (September 23, 1921).

Area of distribution includes Society Islands and Hawaii.

CAREX Linnæus

Carex tahitensis, new species (fig. 3).

Perennial; culms short, $20 \pm$ cm. in length, sharply triangular with convex sides, sharply spinulose serrate on the angles; leaves much longer than the culm, up to $60 +$ cm. in length, and 5 mm. in width, sharply spinulose serrate along the margin and keel, the basal leaves reduced to sheaths of 1-7 cm.; inflorescence 10-20 cm. in length, composed of $6 \pm$ cylindrical, long-pedunculate, loosely racemose spikes single from the axil of long foliaceous or subulate clasping bracts, the lowest two or three extending beyond the raceme; spikes $3 \pm$ cm., dark to light brown in color, commonly carpellate and $8 \pm$ mm. in diameter in the basal two-thirds and staminate in the apical third; peduncles slender, compressed, suberect, very sharply spinulose serrate along the angles, 1-7 + cm. in length, the basal one longer than the rest; lower floral bracts leaf-like, clasping at the base, the basal one $25 \pm$ cm. in length, the succeeding one or two shorter but longer than the inflorescence, the upper ones subulate, shorter than the inflorescence; scale of staminate floret lanceolate, $3 \pm$ mm. long, $1 \pm$ mm. in width, mucronulate, 1-veined, or indistinctly 3-veined; scale of carpellate flower oblong lanceolate, $2.5 \pm$ mm. in length, $1 \pm$ mm. in width, 3-veined; perigynium 3-4 + mm. long, irregularly biconvex, many veined, the apex acute, the mouth bidentate; achene dull-yellow to brownish in color, minutely punctuate under strong magnification, compressed, biconvex, orbicular-obovate in outline, apiculate, $1.7 \pm$ mm. in length, $1.2 \pm$ mm. in width; style 2-parted, with slender stigmatic branches of $1 \pm$ mm.

Tahiti, south slopes of Orohena, altitude about 1200 meters, May 15, 1927, L. H. MacDaniels, no. 1542, type.

Closely allied to *Carex feani* of the Marquesas, from which it is readily distinguished by the dwarf habit, short culm, minute-bidentate mouth of perigynium. Endemic, infrequent at high altitudes. Native name: *matie*.

ELEOCHARIS (HELEOCHARIS) R. Brown

Eleocharis caribaea Blake (**Eleocharis capitata** auct.).

Original description amplified by Forest B. H. Brown:

Perennial; culms caespitose, 10-50 + cm tall, slender, erect or nodding, longitudinally furrowed; inner leaf sheath 15 to 30 + mm. long, the opening oblique and acutely pointed at one side, glabrous, brownish-yellow or purple in color; spikelet ovoid to subglobose in shape, 3-5 + mm. in length, 3 ± mm. wide, brown or purplish in color when dry; glumes numerous, compactly imbricate in several ranks, all fertile except one or two at the base, deciduous, broadly ovate, concave, subacute or obtuse, broadly truncate at the base, 2 ± mm. long, glabrous, brown or purple in color with a hyaline border and green keel; stamens 3 in number, the thin compressed filaments 1-2 + mm. in length, the anthers narrowly lanceolate, acuminate, 0.5 ± mm. long; hypogynous bristles 6 ± in number, 1.5 ± mm. in length, retrorsely barbulate; style short, 0.2-0.7 mm long, abruptly dilated at the base, the two, rarely three, stigmatic branches 1 ± mm. in length; achene shortly stalked, obovate, 0.7 ± mm in length, jet black in color, tipped by a whitish, tubercle-like persistent base of the style.

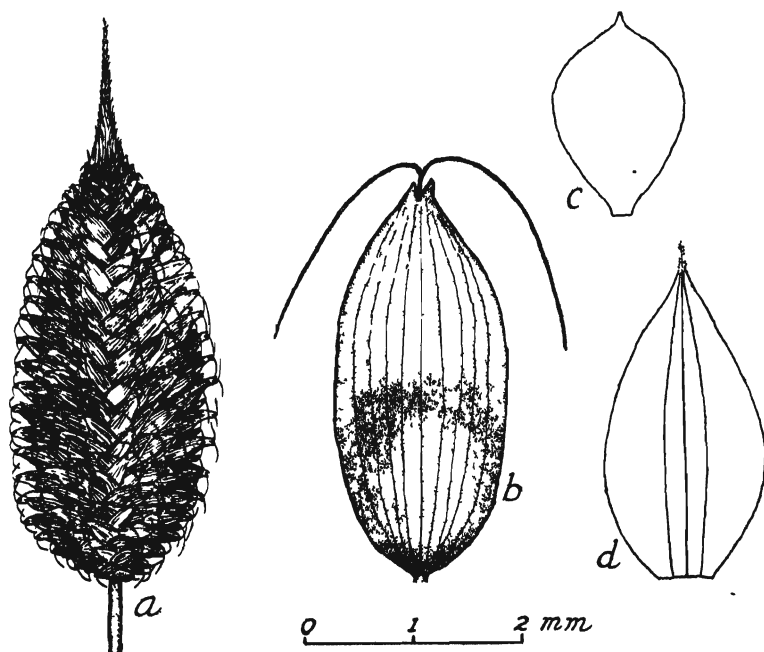


FIGURE 3—Features of *Carex tahitensis*: a, spike; b, perigynium containing achene, style branches exerted from the bidentate mouth; c, achene; d, scalelike glume from carpelate portion of spike.

Scale applies to b, c, d.

Reference types show variations as follows:

Setchell no. 269. Culms $20 \pm$ cm. tall; inner sheath $15 \pm$ mm., purplish, oblique and acutely pointed, not dentate at the opening; glumes $2 \pm$ mm., obtuse, light-brown in color with a greenish keel and hyaline border; filaments 2 mm.; 6 hypogynous bristles 1.5 mm. in length; style 2-parted, very short, 0.2 mm. in length, the branches 1 mm.; achene obovate, 0.7 mm. in length, jet-black.

Setchell no. 133. Culms up to $50 \pm$ cm. tall; inner sheath 30 mm., yellow with a purple base; spikelets 5 mm., long, 3 mm. broad; glumes 2 mm.; filaments 1.5 mm.; 6 hypogynous bristles of $1.5 \pm$ mm.; achene 0.7 mm.; style 0.3 mm. with two stigmatic branches of 1 mm.

Wilder no. 316. Culms 7 cm. tall; inner sheath 13 mm., yellowish with a purple base; spikelet 3 mm. in length, 2.5 mm. in width; glumes 2 mm.; filaments 1.5 mm.; 6 hypogynous bristles of 1.5 mm.; achene 0.7 mm.

Tahiti, W. A. Setchell: no. 133, May 25, 1922; no. 269, June 5, 1922; reference types. Tahiti, Papieri, March 20, 1925, Gerrit P. Wilder, no. 316, reference type.

The Tahitian variety of this pantropic species is distinguished by (1) the oblique, acutely pointed (not unidentate) opening of the leaf sheath, (2) light-brown color of the glumes, (3) filaments of 0.2 mm., (4) 6 hypogynous bristles of 1.5 mm., (5) very short style of 0.2 mm. with two branches of 1 mm.

LILIACEAE

ASTELIA Banks and Solander

Astelia nadeaudi Drake.

Original description amplified by Forest B. H. Brown:

Plant $1 \pm$ m. in height, white, pubescent; leaves narrowly lanceolate, 50-100+ cm. in length, 2-4+ cm. wide, tapering to a long slender tip, the margin incurved, with a single prominent midvein and several less prominent ones, white pubescent on the under surface, pubescent to glabrate above; floral leaves from the lower branches of the panicle, 10-30+ cm. in length; panicle $30 \pm$ cm. with branches of 5-20+ cm., white pubescent, supported on a slender stem of $50 \pm$ cm.; staminate flowers on pedicels of $8 \pm$ mm., the stamens with rather slender filaments of $1.5 \pm$ mm., the sterile ovary prominent, conical, $1 \pm$ mm. in height; carpellate flowers on relatively short thick pedicels; perianth segments glabrous on the inner surface, oblong-lanceolate, acute, $4 \pm$ mm. in length, the outer ones pubescent on the outer surface, the inner ones with a tuft or line of hairs on the outer surface; seeds numerous, black, oblong, curved, $1.5 \pm$ mm. in length, the outer covering hard.

Tahiti, altitude 1650 meters, May 16, 1927, L. H. MacDaniels, nos. 1494 and 1488, reference types. Tahiti, Aorai Ridge, altitude 386-2000 meters, E. H. Quayle, nos. C1, C2, C3, (August 1-3, 1922) and 68 (September 23-27, 1921), reference types.

Endemic in Society Islands.

DIANELLA Lamarck

Dianella intermedia Endlicher var. **norfolkensis**, new variety.

Leaves 50-100 cm. in length 12-18 + mm. in width, obscurely spinulose-serrate to smooth along the margin and keel; flowers small; tepals 5 mm. long, the outer series 5-veined, greenish-white to purplish in color, not distinctly punctate; inner tepals somewhat broader, 3-veined with a wide hyaline border, nearly white in color; anthers $2.5 \pm$ mm. in length, commonly longer than the filaments; seed broadly oval, subacute, truncate at the base, $3.5 \pm$ mm. long.

New Zealand, Kauri Gulch, near Auckland, January 16, 1921, F. B. H. Brown, no. 162, reference type.

Leaves obscurely serrulate to smooth, $60 \pm$ cm. in length, $18 \pm$ mm. in width; panicle of nearly the same height as the leaves; flowers small; tepals 5 mm. long, not distinctly punctate; outer tepals 5-veined, greenish in color; inner tepals slightly wider, 3-veined, nearly white; anthers 2.5 mm., nearly twice the length of the filaments; seed broadly ovate-elliptical in outline, obtuse to subacute at the apex, truncate or obtusely rounded at the base, 4 \pm mm. in length, 2.5-3 mm. in width.

Fiji, Lakemba, September 3, 1924, Edwin H. Bryan, Jr., no. 534, reference type.

The area of distribution includes Norfolk Island, Fiji at moderate altitudes, and New Zealand from sea level to about 800 meters (Cheeseman: Manual of New Zealand flora, p. 320, 1925). Native names in New Zealand are *pepe*, *piopio*, and *turutu*; in Fiji, *vara vara*.

ORCHIDACEAE

PHAJUS Loureiro.

Terrestrial or epiphytic herbs with or without pseudobulbs; leaves large, plicate, petiolate or subsessile; scape lateral, axillary or, apparently, terminal, bearing a raceme of showy flowers, violet, yellow, or white in color; sepals and petals subequal, or the petals relatively narrow; labellum commonly with a pocket or a tubular spur at the base, the lateral lobes directed upward around the column; column elongated, 2-angular or 2-alate; anther 2-locular; 8-pollinia; capsule ellipsoidal with prominent ribs.

About 50 species similar to *Calanthe* in distribution, centering in Indo-Malaya and best represented in Java, extending south to Australia, north to Japan and eastward through New Caledonia, Fiji, Samoa, to Tahiti; few species in Africa or Madagascar or New Guinea; absent from America, Europe, New Zealand, and the Marquesas.

Phajus tahitensis Schlechter (fig. 4).

Calanthe grandiflora Nadeaud.

Original description amplified by Forest B. H. Brown:

Terrestrial herb 1 ± meters in height, resembling *Calanthe* in general appearance; stem 30 ± cm. in height, terminating in 5 ± closely approximate leaves with 4 ± sheathing bracts in the lower portion, slightly thickened at the base forming a slender pseudobulb; leaves lanceolate, acuminate, the blades 10-60 + cm. in length, 5-11 + cm. in width with 5 ± prominent longitudinal veins and numerous smaller ones, glabrous, permanently dark-green in color, subplicate, tapering gradually to a narrow sheathing base, or forming a petiole 2-25 + cm. in length, widely dilated and sheathing at the base; scape axillary, glabrous, up to 70 + cm. in length, terminating in a raceme of 10-20 + showy flowers, the lower portion with 3 ± sterile persistent bracts of 5 ± cm., forming an obliquely pointed sheath closed at the base; inflorescence bracts lanceolate boat-shaped, 35 ± mm., 5-7-veined, glabrous, folded around the flower bud, deciduous; pedicel and ovulary 2-3 cm., glabrous; sepals,

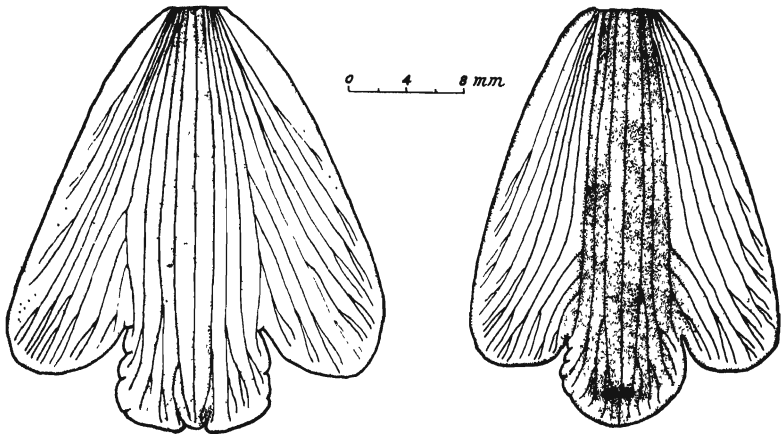


FIGURE 4.—*Phajus tahitensis*, showing variations in form of labellum.

petals, and labellum 28 ± mm., white in color with prominent dark veins; sepals lanceolate, acute, 10 ± mm. broad, 5-6-veined, thin, glabrous; petals thin oblanceolate, subacute, 8 ± mm. broad, glabrous, with 5 ± prominent veins; labellum cuneate when spread flat, many-veined, 21-26 + mm. broad, attached to the base of the column, without spur or distinct pocket, the broad anterior portion 3-lobed, the lateral lobes slightly posterior with reference to the apical one, subsemicircular, 6-10 mm. broad, 7 ± veined, the anterior lobe 6 ± mm. long, 8 ± mm. wide, retuse or subtruncate or obtusely rounded; central portion of labellum densely pubescent with brittle, fusiform, unicellular hairs of 0.2-0.6 + mm.; column free, 2-ate, subcylindrical, 20 ± mm. long, 1.5 ± mm. broad near the base, 3 ± mm. broad near the end; fruiting pedicel reflexed, 10-18 + mm.; capsule ellipsoidal, 40 ± mm. in length, beaked by the persistent column.

The single species from the Society Islands (*P. tahitensis*) apparently belongs to the section *Persomeria* Schlechter of Madagascar and the Mascarene Islands. This section is characterized by an

elongated stem, lateral scape, and spur reduced to a shallow pocket or tubercle; according to Schlechter (Die Orchidaceen von Deutsch-Neu-Guinea, Band 1, Heft 5, p. 373, 1912), members of this section occur in New Guinea as well as Madagascar; this species is also remarkably similar to *Phajus gracffei* of Fiji and Samoa in shape of labellum, sepals and petals as illustrated by Rechinger (Akad. Wiss. Wien, Denk., vol. 3, pl. 1, fig. 8, 1910).

In Tahiti two forms may be distinguished by the shape of the labellum. In reference type MacDaniels no. 1468, the labellum is broad, $26 \pm$ mm. in width, the anterior lobe subtruncately rounded and retuse at the apex, $11 \pm$ mm. in width, $8 \pm$ mm. in length. In reference type MacDaniels no. 1636, the labellum is the same as in the type except that the apical lobe is subtruncately rounded, not retuse. (See fig. 4.)

***Phajus tahitensis* Schlechter form *typica*.**

Labellum broad, $26 \pm$ mm. in width, the anterior lobe subtruncately rounded and retuse at the apex, $11 \pm$ mm. in width, $8 \pm$ mm. in length.

Tahiti, Papenoo Valley, altitude 200 meters, May 18, 1927, L. H. MacDaniels, no. 1468, reference type. Papenoo Valley is the type locality for the species.

***Phajus tahitensis* Schlechter form *obtusa*.**

Same as *typica* but the apical lobe subtruncately rounded, not retuse.

Tahiti, Maere Valley, altitude 300 meters, June 7, 1927, L. H. MacDaniels, no. 1636, type.

CALANTHE R. Brown

***Calanthe gracillima* Lindley (fig. 5, a).**

Original description amplified by Forest B. H. Brown:

Perennial terrestrial herb, $140 \pm$ cm. in height; leaves $4 \pm$ in number from a short stem, the leaves 40-90 + cm. long, including petiole; blades

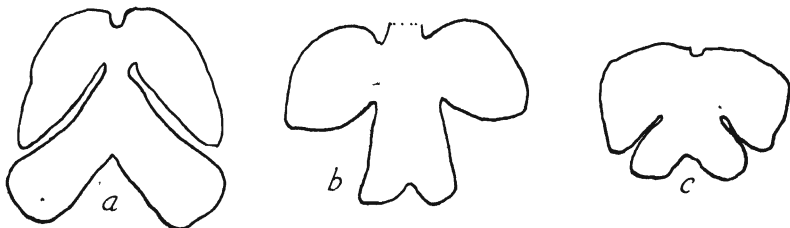


FIGURE 5.—Forms of labellum in *Calanthe*: a, *Calanthe gracillima*; b, *Calanthe tahitensis* var. *typica*; c, *Calanthe tahitensis* var. *deltoidea*.

lanceolate, acute, $50 \pm$ cm. in length, $8-15 +$ cm. in width, with $5 \pm$ prominent longitudinal veins and numerous smaller ones, subplicate, permanently dark-green in color, glabrous, narrowed into a concave petiole of $25 \pm$ cm. sheathing at the base; scape lateral or terminal, $140 \pm$ cm., bearing a subspicate minutely puberulent, numerous flowered raceme of $15 \pm$ cm. at the end; flowers commonly single from the axil of each bract, white in color; pedicel and ovulary $15-25 +$ mm. puberulent; sepals subequal, broadly elliptical, $10-12 +$ mm. in length, $5-6 \pm$ mm. in width, white in color, puberulent outside, especially at the apex, $5 \pm$ veined; petals narrower and commonly somewhat shorter than the sepals, obovate, subspatulate, obtuse or acute at the apex, $10-11 +$ mm. in length, $3-4$ mm. in width, 3-veined or imperfectly 5-veined, white in color, glabrous or glabrate; labellum broadly obovate in outline, auriculate at the base, slightly longer than broad, not exceeding the sepals, as a rule, $8-10 +$ mm. long, glabrous, distinctly veined, nearly white in color, the lobes 4 in number, subequal, the lateral ones obtuse or subacute in the upper apical portion, somewhat shorter than the 2-lobed apical portion of the labellum, the 2 lobes of which diverge at an angle of nearly 90 degrees, forming an apical sinus of $3-4$ mm. in depth; callous appendages present near the base, plainly visible with a lens, yellow in color; spur much longer than the sepals, $15 \pm$ mm., rather thick, $1-1.5 \pm$ mm. in diameter, puberulent; capsule ellipsoidal, $25 \pm$ mm. long, nearly black when dry; fruiting pedicel $10-20$ mm.

Tahiti, Papara, head of moist valley, altitude 400 meters, June 28, 1925, L. H. MacDaniels, no. 1719, reference type. Tahiti, August 1-3, 1922, E. H. Quayle, no. 133, reference type. Tahiti, Pirae-Moua Aorai Trail, August 1-3, 1922, E. H. Quayle, no. X, reference type.

Evidently very closely allied to the relatively primitive Indo-Malayan *Calanthe vcratrifolia* R. Brown (not Hooker and Arnott), distributed from Asia through the East Indies to Australia, eastward to Samoa; readily distinguished from *Calanthe vcratrifolia* by the short labellum, the relatively short thick spurs, shorter sepals and petals. This is evidently the *Calanthe vcratrifolia* of Hooker and Arnott. (The botany of Captain Beechey's voyage, p. 71, London, 1833-40). Endemic to Society Islands. Native name *tupu* in Tahiti. Cheeseman (The flora of Rarotonga, Linnaean Soc. London, vol. 6, pt. 6, pp. 261-313, 1903) states that in the Cook Islands the name *nutupu* is applied to *Phajus grandifolius*.

Calanthe tahitensis* Nadeaud var. *typica, new variety (fig. 5, b).

Labellum $8-9 +$ mm. long, distinctly auriculate at the base, the anterior portion elongated, subligulate in shape, $5 \pm$ mm. long, $4 \pm$ mm. wide at the emarginate apex, $3 \pm$ mm. broad below, the lateral sinuses very broad.

Tahiti, Virao, altitude 250 meters, June 15, 1927, L. H. MacDaniels, no. 1690, type.

Distribution confined to Society Islands.

Calanthe tahitensis Nadeaud var. **deltoidea**, new variety (fig. 5, c).

Labellum 7-8 + mm., slightly auriculate at the base, the anterior portion inversely triangular, very short, $2.5 \pm$ mm. in length, broad at the apex which measures $5.5 \pm$ mm. in width; lateral sinuses very narrow.

Tahiti, south side of Mount Orohena, altitude about 1400 meters, May 16, 1927, L. H. MacDaniels, no. 1497, type.

DENDROBIUM Swartz

Epiphytic herbs; stem elongated, somewhat woody in some species, or short, with or without pseudobulbs; leaves various, never plicate; inflorescence lateral or pseudoterminal; flowers medium, few, small; sepals subequal, the two lateral ones wide at the base, adnate with the column forming a sac or short spur; petals narrower than the sepals as a rule, wider in few specimens; labellum contracted at the base, incumbent or adnate with the foot of the column, commonly 3-lobed, the lateral lobes either embracing the column or spreading, or, in some species, reduced, the terminal lobe flat or saccate; column short, 2-alate, or bidentate at the end, in most specimens produced at the base in a long foot; anther terminal, lid-like; 4 pollinia; capsule obovoid or oblong.

About 600 species, centering in the Malaysian region, extending into southeastern Asia, south to Australia, through New Zealand into subantarctic Stewart Island, eastward to the Society Islands; not collected in the Marquesas.

Key

- | | | |
|---|-----------------------------------|-----------------------------|
| 1 | Leaves cylindrical..... | <i>Dendrobium crispatum</i> |
| 1 | Leaves flat (2) | |
| 2 | Leaves linear-lanceolate..... | <i>Dendrobium biflorum</i> |
| 2 | Leaves ovate-lanceolate | <i>Dendrobium involutum</i> |

Dendrobium biflorum Swartz (Kränzlin: Das Pflanzenreich, vol. 45, pt. 4, 50, p. 168, fig. 11, 1910); Samoan form shown in habitat photograph (Rechinger: Akad. Wiss. Wien, Denk., vol. 3, p. 85, fig. 11, 1910).

Original description amplified by Forest B. H. Brown:

Epiphytic; pseudobulbs absent; stems long, slender, drooping, $70 \pm$ cm. in length, $2 \pm$ mm. in diameter, smooth, shining, yellow in color when dry, woody with a hollow center; leaves numerous, distichous, $2 \pm$ cm. distant, the blades linear-lanceolate, 5- to 10 + cm. long, $4 \pm$ mm. wide, 3-veined, attenuate acute or acutely 2-lobed, somewhat contracted at the base, glabrous; leaf sheath $18 \pm$ mm., glabrous; inflorescence lateral from $3 \pm$ scalelike bracts of $4 \pm$ mm.; flowers of medium size, nearly 3 cm. in diameter when spread out, creamy-white and pink in color, 2 in each fascicle, few in number; pedicels slender $1 \pm$ cm., from a common peduncle of $5 \pm$ mm.; sepals linear-lanceolate, $16 \pm$ mm., 5-veined, terminating in a long slender tip, creamy-white in color, the 2 lateral ones dilated and united at the base, adnate with the column, forming a shallow pocket or sac; petals relatively short, narrow, narrowly lanceolate, acute, 3-veined, $8 \pm$ mm., white in color; labellum

narrowed at the base and adnate with the column, the anterior portion broadly elliptical in outline from a short clawlike junction with the adnate base, $9 \pm$ mm. long, $5 \pm$ mm. wide, yellowish-white in color shading to bright-pink, 3-lobed, the lateral lobes short, subacute, spreading or ascending, glabrous, entire, the central lobe broad at the base, tapering into a long narrow acuminate acute tip, $4 \pm$ mm. long, conspicuously papillose under a lens with a fimbriate lateral margin; young capsule oblong ellipsoidal, $7 \pm$ mm. in length, $3 \pm$ mm. in width, finally 30 mm. x 9 mm.

Samoa, no date, D. W. Garber, no. 575 (without fruit or flowers), reference type. Tahiti, Mount Aorai, Noha Ridge, altitude 1100 meters, September 27, 1921, E. H. Quayle, no. 58, reference type. Tahiti, June 22, 1922, W. A. Setchell, no. 456, reference type. Tahiti, altitude 200 meters, June 15, 1927, L. H. MacDaniels, no. 1686, reference type.

Closely allied to the somewhat more primitive *Dendrobium cunninghamii* of New Zealand, which extends through the North and South Islands of New Zealand to the subantarctic region of Stewart Island; distinguished from *cunninghamii* by its longer leaves, reduced inflorescence, narrow petals and sepals and the narrow anterior lobe of the labellum. The stem of the Samoan plant is somewhat thicker and the leaves smaller than in the specimens from Tahiti, which suggests that the Society Islands form may not be identical with that from Samoa, and probably Fiji. No. 578, however, is without flowers or fruits, so that accurate comparison is impossible at present. The upper central surface of the labellum bears crowded, simple or forked thin-walled hairs $9 \pm \mu$ in length, which are rich in protoplasmic contents and may serve the purpose of forage hairs (*Futterhaare*) for visiting insects. Although very prominent in the representatives from Tahiti and Raiatea, they are apparently not mentioned or illustrated in the specimens from Fiji or Samoa. Drake del Castillo (*Flora de la Polynesie Francaise*, Paris, 1892) states that this species is found on trees at altitudes of about 200 meters. He gives as native names *mare* and *ofe-ofe*. Credited (not verified) also to Samoa and Fiji.

***Dendrobium involutum* Lindley.**

Original description amplified by Forest B. H. Brown:

Epiphytic; stems several from a short rhizome, rather slender, cylindrical, drooping or suberect, 10-80 + cm. in length, $1.5 \pm$ mm. in diameter, the internodes $8 \pm$ mm., enclosed in the leaf sheath, somewhat woody; leaves distichous, the blade ovate-lanceolate, 2-4 cm., rarely 5 + cm., in length, $8 \pm$ mm. in width, obliquely 2-lobed at the apex, glabrous, coriaceous; sheaths $1 \pm$ cm.,

striated; flowers lateral in fascicles of 2, from a cone of short obtuse bracts; peduncle very short, $1.5 \pm$ mm., not extending beyond the basal cone of bracts; pedicel $5 \pm$ mm.; ovulary $4 \pm$ mm.; flowers few in number, $15 \pm$ mm. in diameter, light-yellow in color; sepals lanceolate, $7 \pm$ mm. long, $2 \pm$ mm. wide at the base, 3-5-veined, terminating in a thickened curved apex, the lateral ones dilated and united at the base, adnate with the column, forming a pocket-like sac; petals narrower and slightly shorter, narrowly lanceolate acute, $1 \pm$ mm. in width, 3-veined; labellum light-yellow (slightly pinkish tinge ?) narrowed at the base which is adnate with the foot of the column, the anterior free portion broadly elliptical in outline, $6 \pm$ mm., 3-lobed, the 2 lateral lobes short, $2 \pm$ mm. long, spreading, subacute, the central lobe triangular ovate, acute, $4 \pm$ mm. in length, $2 \pm$ mm. in width, fimbriate along the lateral margin, conspicuously papillose-pubescent on the surface; column with 2 short obtuse processes at the end; anther suborbicular, stalked; young capsule fusiform, $1 \pm$ cm. in length, $3 \pm$ mm. in diameter.

Tahiti, Papenoo Valley, altitude 100 meters, May 19, 1927, L. H. MacDaniels, nos. 1517 and 1522, reference types. Tahiti, Pirae-Moua Aorai Trail, August 1-3, 1922, E. H. Quayle, no. X, reference type. Samoa, Fitiuta Trail, August 4, 1921, D. W. Garber, no. 557, reference type.

Closely allied to *Dendrobium biflorum*. MacDaniels no. 1298, without flowers or fruits, may be a distinct form or variety; leaves up to 7 cm. in length and $1 \pm$ cm. in width resembling Garber no. 557 from Samoa.

The area of distribution includes Society Islands, where it grows on trees at an altitude of about 100 meters.

***Dendrobium crispatum* Swartz.**

Original description amplified by Forest B. H. Brown:

Epiphytic on trees; stem slender, 1-2 + mm. in diameter, $40 \pm$ cm. in length, the internodes 5- to 20 + mm., smooth, rather woody, with numerous lateral branches terminating in a single cylindrical leaf; leaf blade cylindrical, 10-15 + cm. in length, $2 \pm$ mm. in diameter, soon deciduous, the sheath thin, persistent after the fall of the blade, $1 \pm$ cm.; raceme subterminal, $7 \pm$ cm., bearing $5 \pm$ flowers, light-yellow, fragrant ($10 \pm$ flower scars); ovulary and pedicel 1-2 + cm.; sepals $18 \pm$ mm., light-yellow in color, 3-veined, the dorsal one $3 \pm$ mm. wide at the base tapering gradually to a subacute tip, the 2 lateral ones united at the base forming a hood of $4 \pm$ mm.; petals nearly as long as the sepals, slightly narrower, 3-veined, light-yellow in color; labellum pink to yellow in color, narrowly ovate-lanceolate in outline, cuneate at the base, gradually acuminate toward the apex, $15 \pm$ mm. long, $5 \pm$ mm. wide near the base, 3-lobed, the lateral lobes shallow, subacute, the median lobe $1 \pm$ cm. in length, narrow, acuminate, $4 \pm$ mm, broad at the base, curled along the margin, glabrous, bearing three prominent, keel-like wavy longitudinal crests near the center.

Tahiti, south of Orohena, altitude 1200 meters, May 15, 1927, L. H. MacDaniels, no. 1476, reference type. Tahiti, Mount Aorai,

Noha Ridge, altitude 1090 meters, September 27, 1921, E. H. Quayle, no. 63, reference type. Tahiti, Virao, windward slopes, altitude 60 meters, October 14, 1921, E. H. Quayle, no. 120, reference type.

Area of distribution includes Society Islands. Credited to New Caledonia by Kränzlein (*Das Pflanzenreich*, vol. 45, pt. 4, 50, p. 293, 1910) and to Fiji by Seemann (*Flora Vitiensis*, p. 303, London, 1865-1873).

CIRRHOPETALUM Lindley

Herbs with pseudobulbs, unifoliolate; scape from the side of the pseudobulb, bearing a subumbellate cluster of flowers at the end; posterior sepal very short; lateral sepals elongated; petals shorter than the lateral sepals; labellum small, stipitate, joined with the end of the column, entire or auriculate; column 2-alate, short; anther hemispherical, operculate; 4 pollinia; capsule ovoid to fusiform.

About 75 species native chiefly of Asia and the Malay Archipelago; not collected in the Marquesas.

Cirrhopetalum thouarsii Drake.

Original description amplified by Forest B. H. Brown:

Epiphyte 10-20 + cm. in height, with a single leaf terminating a broadly ovate pseudobulb of 1-2 cm. in length, the blade oblong elliptical, 5-12 + cm. in length, 1.5-3 cm. wide, glabrous, emarginate at the apex, coriaceous, many veined, contracted at the base into a petiole of 1-2 cm.; scape slender, from the base of the pseudobulb, 10-20 + cm., with 2 or more clasping bracts of 1-2 cm.; flowers large, yellow in color, fragrant, subumbellate at the end of the scape; pseudobulb 4 ± cm. long; posterior sepal ovate, mucronate, acuminate, 8 ± mm., 5-veined; lateral sepals linear, 30 ± mm. long, 4 ± mm. wide, tapering to an acute apex; petals broadly ovate, 5 ± mm. in length, 3-veined, long ciliate, terminating in a bristle; labellum tongue-shaped, fleshy, 5 ± mm., curved near the base forming an auriculate hook of 2 ± mm.; apex of the column bidentate; fruiting pedicel 10-15 ± mm.; capsule 25-30 ± mm. long, 4 ± mm. broad.

Moorea, July 7, 1922, E. H. Quayle, no. 611, reference type.

According to Schlechter, this is not the same as *Cirrhopetalum thouarsii* Lindley of Madagascar (Setchell: Univ. California Pub., Botany, vol. 12, p. 163, 1926.)

The plant occurring in Tahiti and Moorea may therefore be a new variety or a new species.

ERIA Lindley.

Epiphytic or terrestrial; stems moderately elongated, with or without pseudobulbs; leaves commonly more than one, with or without distinctly articulated base; racemes lateral or axillary; lateral sepals with or without a saclike

base; petals differing little from the sepals; labellum entire or lobed, parallel with the column; column short and thick; anther 2-locular; pollinia 8 in number, pear-shaped, 4 in each locule of the anther; capsule narrow, elongated or fusiform.

About 80 species, distributed from southern Asia through Malaysia and the Pacific islands; absent from Australia and New Zealand; one species in the Society Islands; not collected in the Marquesas.

***Eria setchellii* Schlechter.**

Eria setchellii Schlechter, Setchell: Carnegie Inst. Washington, Pub., vol. 20, p. 162, 1924.

Eria viellardi of Drake del Castillo (Flore de la Polynésie Française, p. 242, pls. XLI and 14, Paris, 1892), non Reichenbach.

Original description amplified by Forest B. H. Brown:

Stems without pseudobulbs, cylindrical, with short internodes 10-30 + cm. in height, bearing several leaves near the end and clasping scales in the lower portion; leaves oblong-lanceolate, acute or obtuse, 2-lobed at the apex, 5-20 + cm. in length, 10-25 mm. in width, rather thin; racemes axillary, up to 16 + cm., commonly longer than the subtending leaf; bracts broadly lanceolate-ovate, 5-7 + mm. in length, 1.5 ± mm. in width, with one or rarely two flowers in the axil; flowers small, creamy-white in color, on short pedicels; sepals oblong-lanceolate, acute, 5 ± mm. in length, 1.5 ± mm. in width, somewhat longer than the petals; petals 4.5 ± mm. long; labellum narrowly triangular-lanceolate, 5 mm. long, 1.5 ± mm. broad at the base, rolled in the form of a conical beak; ovary and pedicel at first subequal to the bract, elongating in fruiting to 25 mm. (pedicel 3 ± mm.); capsule narrowly spindle-shaped, 20 ± mm. in length, less than 2 mm. in width when dry.

Tahiti, L. H. MacDaniels, no. 1296, (altitude, 200 meters, May 7, 1927), no. 1475 (altitude, 1200 meters, May 15, 1927), no. 1559 (altitude, 150 meters, May 19, 1927), no. 1706 (Vaita Valley, Taaitiva, June 23, 1927), reference types. Tahiti, July 28, 1922, E. H. Quayle, no. 606, reference type. Tahiti, July 7, 1922, W. A. Setchell, no. 516, altitude 600-900 meters, reference type.

Evidently closely allied to *Eria viellardi* Reichenbach of New Caledonia, to which the Tahitian species was referred by Drake del Castillo. Endemic to Society Islands, where it is common on trees at altitudes of 150 to 1200 meters.

PHREATIA Lindley

Epiphytic herbs; stems short, with or without pseudobulbs; leaves with flat or subcylindrical blades articulated with the compressed sheaths; racemes many flowered, from the axils of the lower leaves or on a leafless scape

springing from the base of the stem or rhizome; flowers minute, white or yellowish in color; sepals free and subequal or the 2 lateral ones united to form a hood; petals smaller, free; labellum contracted at the base, articulate with the foot of the column, simple or lobed; anther 2-locular; 8 pollinia; capsule short, broad, commonly subglobose.

About 70 species distributed from Indo-Malaya to Norfolk Island and Tahiti; not collected in the Marquesas. Closely allied to *Eria*, with which it is united by some authors; distinguished from *Eria* by the short stem, complicate leaves, minute flowers, and relatively broad capsules.

Key

- Plant 15-25 cm. in height; leaves single
 from the rhizome.....*Phreatia tahitensis*
 Plant 5-12 cm. in height; 5 ± leaves.....*Phreatia matthewsii*

***Phreatia tahitensis* Lindley.**

Eria tahitensis Reichenbach.

Original description amplified by Forest B. H. Brown:

Plant 15-25 cm. in height, epiphytic on trees; leaves single from the rhizome, the blade narrowly elliptical oblong in outline, 10-18 cm. in length, 15 ± mm. in width, obtusely 2-lobed at the apex, crowded and complicate at the base which is inclosed in a closed sheath of 3 ± cm.; flowers numerous along the upper half or third of a leafless scape of 10-20 + cm. springing from the rhizome, as high as or somewhat higher than the leaves; floral bracts broadly lanceolate, obtuse or acute, 4 ± mm. long, subequal to the ovulary and pedicel, around which it is folded; bracts of the lower portion of the scape sheathing, 1 ± cm., 5 ± in number; pedicel 1 ± mm.; lower sepal oblong ovate, subacute, 2.3 ± mm. long; lateral sepals of nearly the same (2.3 ± mm.) length, triangular-acute, dilated and united at the base forming a hood with a saclike posterior protrusion; petals ovate acute, slightly shorter than the sepals; labellum broadly triangular, acute, 2.5 ± mm. long, contracted into a curved claw; rostellum with two short, slender, curved, acute appendages; capsule obovoid, 6 ± mm. in length, 4.5 ± mm. in diameter.

Tahiti, L. H. MacDaniels, no. 1507 (Papenoo Valley, altitude 800 meters, May 19, 1927), no. 1558 (Papenoo Valley, altitude 150 meters, May 19, 1927), no. 1582 (Pueu, altitude 250 meters, May 26, 1927), no. 1702 (Tii Valley, June 22, 1927), reference types. Tahiti, August 1-3, 1922, E. H. Quayle, no. X (Pirae-Moua Aorai Trail), reference type.

Endemic to Society Islands, where it is common at an altitude of 150 to 800 meters.

***Phreatia matthewsii* Reichenbach.**

Eria matthewsii Reichenbach.

Original description amplified by Forest B. H. Brown:

Stem very short, $1 \pm$ cm. long, without distinct pseudobulb in dry specimens; leaves 2-ranked, $5 \pm$ in number, the blades oblong linear, $5-12 \pm$ cm. in length, $4 \pm$ mm. in width, obtuse, obliquely 2-lobed at the apex, complicate and narrow at the base, distinctly articulated with the sheath, glabrous; raceme axillary from the lower leaves or from persistent sheaths lower down on the stem, as long as or longer than the leaves, the rachis glabrous, slender, numerous flowered in the upper portion, bearing $2 \pm$ sheathing bracts of $3 \pm$ mm. in the lower portion; floriferous bracts lanceolate, setaceous-acuminate, glabrous, $2 \pm$ mm. in length, as long as the pedicel and ovulary; flowers minute, nearly white in color; lateral sepals broadly triangular acute, $1.5 \pm$ mm. long, $1 \pm$ mm. broad at the base, slightly united forming a small posterior sac, the lower sepal $0.5 \pm$ mm. in width; petals narrowly lanceolate, acute, shorter than the sepals; labellum broadly ovate, subacute, of nearly the same length as the lateral sepals, slightly longer than broad, obscurely 3-lobed near the apex, the middle lobe apiculate; rostellum without appendages; capsule subcylindrical, $2.5 \pm$ mm. in length, $1 \pm$ mm. in diameter, supported on a slender pedicel of $0.5 \pm$ mm.

Tahiti, Papenoo Valley, May 19, 1927, L. H. MacDaniels, no. 1508 (altitude 800 meters), no. 1560 (altitude 150 meters), reference types. Tahiti, Varao, 1922, E. H. Quayle, no. X, reference type.

Endemic to Society Islands, on tree trunks at altitudes of 28 to 800 meters.

LIPARIS Richard

Liparis clypeolum Lindley var. **tahitensis**, new variety.

Sepals $7 \pm$ mm. in length, $2 \pm$ mm. in width; petals 7 mm. by 0.4 mm.; labellum $7.2 \pm$ by $7 \pm$ mm.; cusp $0.5 \pm$ mm.; pedicel and ovulary $9 \pm$ mm.; bracts $1 \pm$ mm.; capsule $12 \pm$ mm. in length, $5 \pm$ mm. in width; column 3 mm.; fruiting pedicel $7 \pm$ mm.

Tahiti, June 28, 1927, L. H. MacDaniels, no. 1726 (Papara, altitude 400 meters), type; no. 1493 (south side of Orohena, altitude 1600 meters, on moist soil, in shade, May 16, 1927), reference type. Tahiti, Mount Aorai Trail, altitude 1848 meters on moss-covered, inclined trunks of trees, September 23, 1921, E. H. Quayle, no. 48, reference type.

Endemic to Society Islands, on trees and moist substrata, at altitudes of 400 to 1848 meters.

Liparis revoluta Hooker and Arnott.

Original description amplified by Forest B. H. Brown:

Epiphytic, herbaceous, $8-25 +$ cm. in height; pseudobulb ovoid, $1.5 \pm$ cm. long, single or $2-6 +$ in a cluster; a single leaf blade, elliptical lanceolate in outline, $5-10 +$ cm. in length, $5-10 +$ mm. in width, acute, glabrous, commonly 10-veined, constricted at the base and articulate with the apical node of the pseudobulb, deciduous soon after maturity of the capsules; other leaves reduced to acute sheathing scales, $3 +$ in number, $2-15 +$ mm. in length, arti-

culate with the base of the pseudobulb, deciduous soon after maturity of the capsules; other leaves reduced to acute sheathing scales, 3 or more in number, 2-15 + mm. in length, articulate with the base of the pseudobulb, deciduous; scape terminal, $10 \pm$ cm. compressed, commonly 2-axate, bearing 5-20 + flowers in the upper third portion and $3 \pm$ triangular setose bracts of 5-12 mm. in the lower two-thirds; floriferous bracts triangular acuminate, mucronate, $2 \pm$ mm. long; pedicel and ovulary nearly as long as the bract; flowers small, 4-5 mm. in diameter, light-yellow to greenish in color; sepals broadly oblong lanceolate, acute, $2 \pm$ mm. in length, $1 \pm$ mm. in width, the lateral ones relatively broad; petals narrowly linear, as long as the sepals, reflexed; labellum equal to the sepals in length and somewhat broader, acute, the basal sides rolled upward clasping the column; column subcylindrical, $1 \pm$ mm. in length, with 2 short auricles at the end; anther subcircular, operculate; capsule broadly obovate, $3 \pm$ mm. long, $2.5 \pm$ mm. broad, somewhat compressed, 6-costate; fruiting pedicel 1-2 + mm.

Allied to the more primitive *Liparis savaiiensis* of Samoa and the Indo-Malayan *Liparis longipes*. It is not improbable that the specimen without flowers from Tahiti, doubtfully referred to *Bulbophyllum* by Cheeseman (Manual of New Zealand flora, p. 207, 1925), may prove to be a form of *Liparis revoluta*. Not collected in the Marquesas.

MICROSTYLIS Nuttall

Microstylis resupinata (Forster) Drake (fig. 6).

Original description amplified by Forest B. H. Brown:

Plant $50 \pm$ cm. in height; leaves $4 \pm$ in number, attached to the lower portion of the stem, the blades broadly elliptical in outline, 5-20 cm. in length, 4-8 + cm. in width, acuminate, tapering to a sheathing petiole-like base of $10 \pm$ cm., glabrous, thin, with $5 \pm$ prominent longitudinal veins and numerous small interstitial ones; scape terminal, longer than the leaves, up to 50 + cm. in height, glabrous with $3 \pm$ acute bracts of $9 \pm$ mm. in the lower portion; floriferous bracts lanceolate, acute, $5 \pm$ mm.; flowers, small, purple in color, with yellow shading, 10-20 + in number; pedicel and ovulary 5-7 + mm.; lateral sepals broadly elliptical, obtuse, $4 \pm$ mm. in length, $3 \pm$ mm. in width, faintly 3-veined, light-yellow in color shaded with purple; third sepal relatively narrow, elliptical, acute, 4 mm. x 2 mm., 3-veined, light-yellow in color shading to purple; petals linear, 5 mm. x 1 mm., yellowish-white tinged with purple, faintly 3-veined; labellum suborbicular in outline when spread flat, the column central in position, $5 \pm$ mm. broad, 6-7 + mm. long, purple shading to light-yellow in the auricles, glabrous, with 8-12 lacinate teeth in the apical portion, the 2 auricles forming the posterior semicircular portion, separated by a narrow sinus extending to the base of attachment at the foot of the column; column very short, $1.2 \pm$ mm. in length, thick, with 2 projecting arms at the end; anther subcircular in outline, operculate, subterminal; fruiting pedicel 1-5 mm.; capsule obovate, 10-20 mm. in length, $5 \pm$ mm. in width.

Tahiti, May and June, 1927, L. H. MacDaniels, no. 1299 (Vahira Valley, altitude 200 meters), nos 1586 and 1586 A-C (Pueu, altitude

300 meters), nos, 1645 and 1645 A-D (Teahupo district, Maire Valley), no. 1705 (Taii Valley, altitude 275 meters), no. 1733 (Papara, altitude 450 meters), no. 1734 (Papara, altitude 350 meters), reference types. Tahiti, Fautaua, July 28, 1922, E. H. Quayle, nos. 612 and 612A, reference types.

The labellum is not quite constant in form even in flowers from the same plant, the number of lacinae tending to vary in number from 8-10 or from 10-12, and the relative length of the central pair of lacinae differs. However, in the specimens examined, the number of which is given above, the labellum in some specimens tends to be relatively narrow, with 10-12 lacinae, the central pair of which are relatively short and more or less connate. In others, the labellum tends to be more nearly suborbicular in outline, the lacinae fewer in number (8-10), with the central pair long and free.

Endemic to Society Islands at altitudes of 200 to 450 meters, rarely 70 meters.

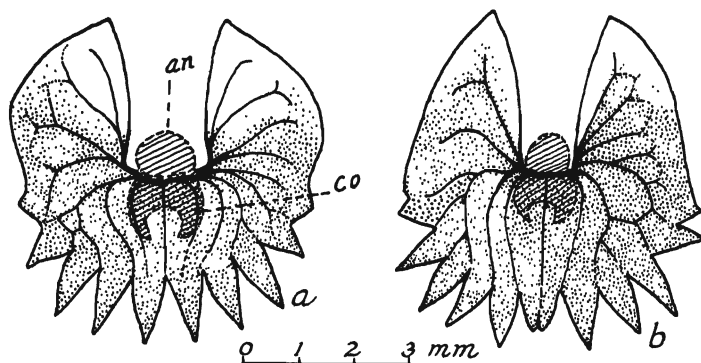


FIGURE 6.—Features of *Microstylis resupinata*: a, labellum, wide form; b, labellum, narrow form (an, position of anther; co, position of column).

**FRESH-WATER FISHES
FROM THE MARQUESAS AND
SOCIETY ISLANDS**

By

HENRY W. FOWLER

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FRESH-WATER FISHES FROM THE MARQUESAS AND SOCIETY ISLANDS

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INTRODUCTION

The fish reported in this paper were obtained by the Pacific Entomological Survey for Bernice P. Bishop Museum. The collection consists of 229 specimens, most of which are from the Marquesas. Nine species are represented, several of which are rare or uncommon and are noted in detail or figured here. In the Gobiidae a new genus, *Bryanina*, together with its genotype, *B. inana*, and a new species, *Sicyopterus marqucsensis*, were collected.

MURAENIDAE

Muraena mauritiana (Bennett).

One, 262 mm., from Vaikeu, Taiohae Valley, Nukuhiva, Marquesas Islands, October 11, 1929, Mumford and Adamson. Native name, *kuce*.

OPHICHTHYIDAE

Caecula polyophthalmus (Bleeker).

Depth $28 \frac{3}{5}$ to $30 \frac{1}{5}$; tail $1 \frac{1}{8}$ to $1 \frac{1}{5}$ in rest of body; head 9 to $10 \frac{2}{5}$, $4 \frac{5}{6}$ to 5 to vent, width $3 \frac{3}{4}$ to 4 in its length. Snout $4 \frac{1}{2}$ to $5 \frac{1}{5}$ in head; eye 15 to 20, $3 \frac{2}{5}$ to $3 \frac{1}{2}$ in snout, 1 to $1 \frac{1}{3}$ in interorbital; mouth cleft $2 \frac{1}{5}$ to $2 \frac{1}{4}$ in head; 4 or 5 premaxillary teeth in angular series, several of largest visible with jaws closed; teeth in jaws pointed, slender, recurved, uniserial, also uniserial row on vomer; front nostril slit nearly midway in snout length, followed by small fleshy papilla; hind nostril slit in upper lip before eye, with conspicuous barbel or papilla-like point; interorbital 20 to 22, narrow, level. Gill opening well inclined, with larger duplicature anteriorly, interspace less than gill opening, which $1 \frac{1}{3}$ to $1 \frac{2}{3}$ in snout.

Dorsal origin behind gill opening space equal to $3 \frac{1}{4}$ to $3 \frac{3}{4}$ in head.

Brown above, under surface cream white, with median narrow band of dark or dusky dots on head below and belly, also group just before vent. Head and predorsal above with double row of buff round spots and transverse buff band or bar across head posteriorly. Row of yellow spots, wide spaced, along lateral line. Lips pale or creamy, with groups of dark dots. Iris gray.

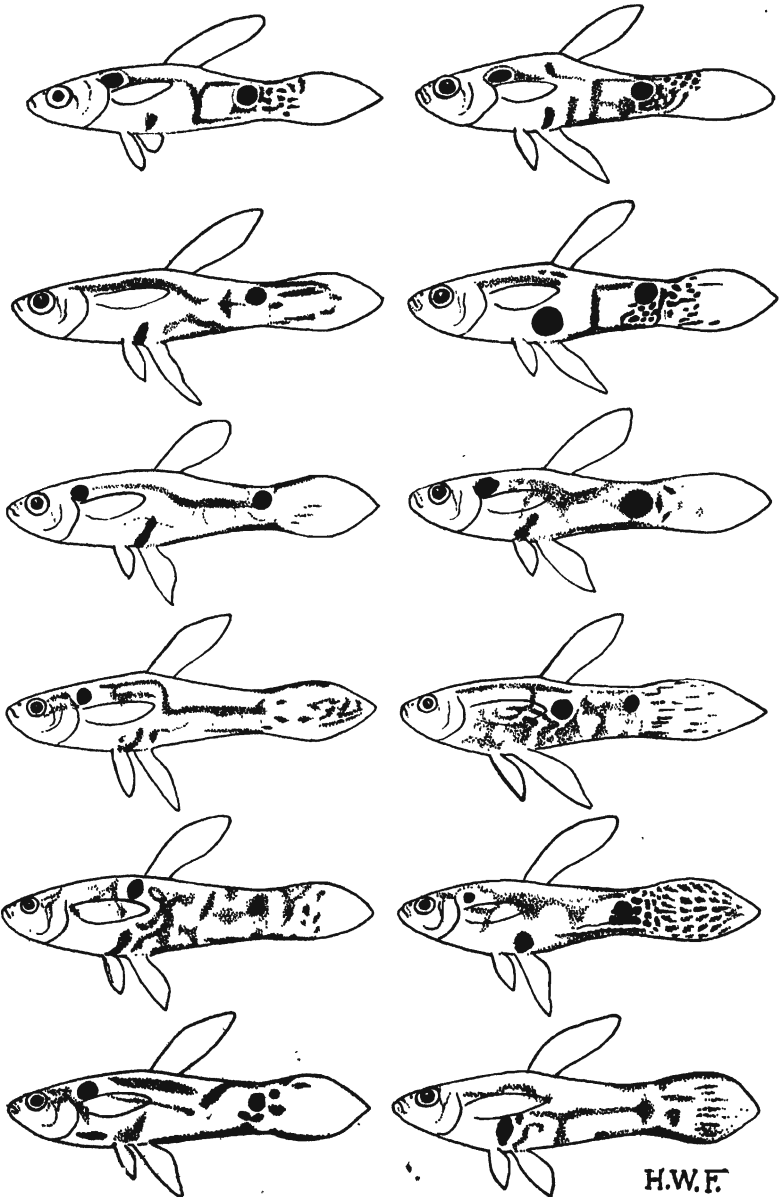


FIGURE 1. Variation of color pattern of males, *Lebistes reticulatus* (Peters).

Six, 180 to 212 mm., found burrowing in sand at mouth of stream, Tahauku Bay, Hivaoa, Marquesas Islands, Mumford and Adamson.

POECILIIDAE

Lebistes reticulatus (Peters) (fig. 1).

Twenty-one males, 20 to 28 mm., and eleven females, 25 to 42 mm., Lake Vaihiria, Tahiti, Society Islands, November 1, 1929, A. M. Adamson.

All these examples agree well with the descriptions of this introduced species. All show the scales of the back and upper surfaces darker marginally. They differ, however, in one feature which I do not find in either description or figure. In the females not only the dorsal, but also the anal, have a dark subbasal horizontal band. None shows the variegated markings of the male.

MUGILIDAE

Mugil macrolepis A. Smith (fig. 2).

Depth $3\frac{2}{3}$ to $3\frac{3}{4}$; head $3\frac{1}{4}$ to $3\frac{1}{3}$, width $1\frac{2}{3}$ to $1\frac{7}{8}$. Snout $3\frac{1}{5}$ to 4 in head; eye $3\frac{1}{5}$ to $3\frac{1}{2}$, greater than snout, 1 to $1\frac{1}{8}$ in interorbital, without adipose lids; mouth as seen below forms broadly obtuse angle, width $3\frac{1}{4}$ to $3\frac{1}{3}$ in head; maxillary well exposed below pectinate lower edge of preorbital, reaches eye, length in profile $3\frac{2}{5}$ to $3\frac{2}{3}$ in head; row of equal minute teeth only in upper jaw; interorbital $2\frac{3}{4}$ to $2\frac{7}{8}$, nearly level. Gill rakers 24 + 35, fine, slender, $\frac{3}{4}$ of gill filaments, which $\frac{1}{2}$ of eye.

Scales 29 to 30 in median lateral series to caudal base; 11 transversely between second dorsal and anal origins; 20 or 21 predorsal; 3 rows on cheek.

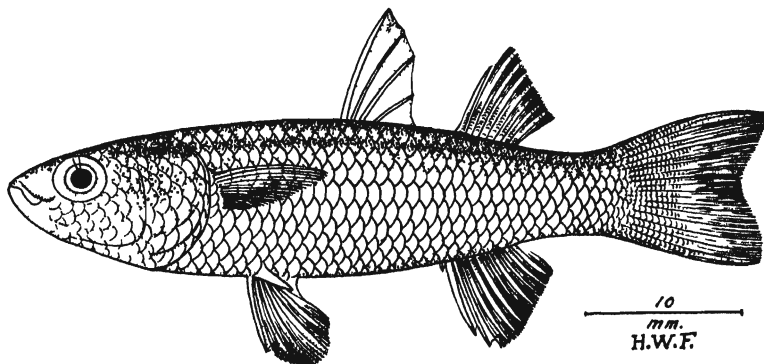


FIGURE 2. *Mugil macrolepis* A. Smith.

Few small scales on soft dorsal basally. Caudal scaly basally. No long pectoral axillary scale. Scales with 6 or 7 basal radiating striae; circuli fine, obscure apically.

D. IV-I, 8, 1, first spine $1\frac{1}{2}$ to $2\frac{1}{3}$ in head, first branched ray $1\frac{4}{5}$ to 2; A. III, 9, 1, first branched ray $1\frac{3}{4}$ to $2\frac{1}{10}$; caudal 1, well forked; least depth of caudal peduncle $2\frac{1}{4}$ to $2\frac{2}{5}$; pectoral $1\frac{2}{5}$ to $1\frac{3}{5}$; ventral $1\frac{2}{5}$ to $1\frac{3}{5}$.

Back olive with gray-brown tinge, sides grayish and under surfaces whitish. Muzzle dusted with brown. Iris silver gray. All fins brown, except whitish ventrals and pectorals darker basally.

Five, 39 to 60 mm., near sea level, Hakahetau Valley, Uapou, Marquesas Islands, December 4, 1931, LeBronnec. Native name, *eava*.

SYNGNATHIDAE

Coelonotus platyrhynchus (Duméril).

Five, 95 to 119 mm., near mouth of river, Hanavave Valley, Fatuhiva, Marquesas Islands, September 12, 1930, LeBronnec. Native name, *potu hoone*.

Five, 100 to 113 mm., at mouth of river, Hakahetau, Uapou, Marquesas Islands, December 4, 1931, LeBronnec. Native name, *tokvai*.

Curiously, only in the largest specimen is the snout depressed, as shown in my previous Uahuka material.¹ All the others have it strongly compressed, so that its width is less than its depth. Also interesting is the brood pouch, abdominal, containing 34 eggs longitudinally and 5 rows transversely, all agglutinated in a single layer. In a smaller specimen I count 28 longitudinally and 4 rows transversely. The eggs are gray to yellowish. The black ocelli are variable and may extend on the tail anteriorly. Dunker and Mohr's figure of this species fails to show the black ocelli, which are small though always prominent on the trunk.

ELEOTRIDAE

Eleotris fusca (Schneider).

Four, 55 to 100 mm., Papuae Valley, Hivaoa, Marquesas Islands, August 30, 1929, Mumford and Adamson.

¹Bowles, H. W., Fishes of the Pinchot expedition: U. S. Nat. Mus., Proc., vol. 80, art. 6, p. 7, fig. 2, 1932.

Six, 54 to 155 mm., near sea level, Omoa [Oomoa]² Valley, Fatuhiva, Marquesas Islands, September, 1930, LeBronnec. Native names *topu* and *hahutu*.

In small examples 2, or sometimes 3, blackish blotches before pectoral base, of which uppermost usually darker and more persistent.

GOBIIDAE

***Sicyopterus marquesensis*, new species (fig. 3).**

Depth $5\frac{2}{3}$ to $6\frac{1}{2}$; head 4 to $4\frac{1}{5}$, width $1\frac{3}{5}$ to $1\frac{4}{5}$. Snout $2\frac{1}{2}$ to $2\frac{3}{4}$ in head; eye 4 to 5, $1\frac{1}{4}$ to 2 in snout, $1\frac{2}{5}$ to $2\frac{1}{4}$ in interorbital; maxillary reaches $\frac{1}{2}$ in eye, length 2 to $2\frac{1}{5}$ in head; upper lip entire, toothless, with slight median notch and more conspicuous lateral one each side below nostril; within upper lip small whitish papilla below median notch and dozen each side before teeth; upper teeth of three contracted cusps, long, conic, pointed, tip of each bent, appearing bifid or simple; lower teeth with outer row of fine, short, flexible, uniserial slender points, tips bent or slightly recurved inward; lower jaw with inner row of six strong, erect, simple, conic teeth on each ramus, first largest, each little curved and sixth next in size after first; interorbital 3 to $3\frac{1}{5}$, broad, level. Gill rakers as 12 small rudimentary papillae, much shorter than gill filaments, which $\frac{3}{4}$ of eye.

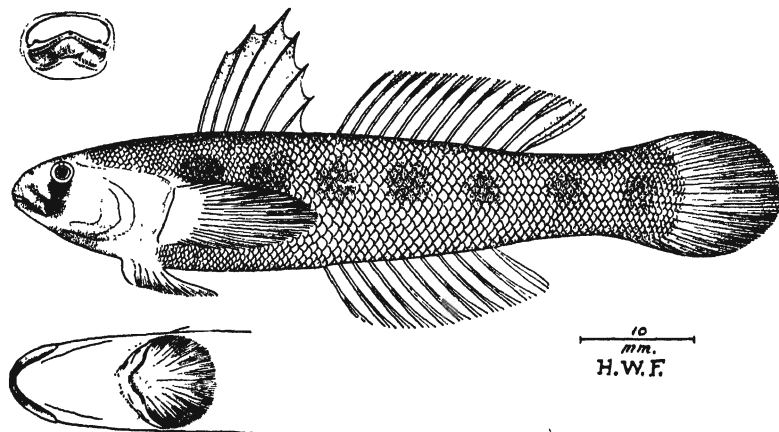


FIGURE 3. *Sicyopterus marquesensis*, new species. Type.

Scales 55 to 62 in median lateral series to caudal base and 7 or 8 more on latter; 16 to 18 transversely at soft dorsal and anal origins, 23 predorsal. Head largely naked, except scaly occiput. Scales small and crowded on predorsal, front of back and belly. Scales with 13 to 16 straight slender apical uenticles, in one row; 12 to 13 basal radiating striae; circuli very fine.

² Geographical names in the collection records of the Pacific Entomological Survey are preserved in brackets where they differ from Museum usage.

D. VI-12, 1, third spine $1\frac{1}{8}$ to $1\frac{2}{3}$ in head, second ray $1\frac{1}{2}$ to 2; A. 11, 1, fourth ray $1\frac{3}{4}$ to $2\frac{1}{5}$; caudal 1, rounded; least depth of caudal peduncle $1\frac{2}{3}$ to 2; pectoral $1\frac{1}{8}$ to $1\frac{1}{5}$; ventral $1\frac{2}{5}$.

Dark olive brown generally. About 7 large, indistinct, dark or neutral black blotches along side. Under surface of body, belly, and tail whitish. Lips neutral gray. Iris dark neutral gray. Fins, except pale or whitish ventrals, all dark neutral gray. Upper and lower edges of both caudal and pectorals sometimes pale to light or even whitish.

Diagnosis. Apparently differs from *Sicyopterus cymocephalum* (Valenciennes), as described from the Moluccas by Ogilvie-Grant³ from three specimens 124 mm. long, in the smaller eye and fewer scales. He gives the eye as "half the interorbital space" and scales "L. lat. 75-80." He also says, "Dorsal and anal fins orange, second dorsal sometimes with large regular brown spots on the rays."

Type no. 3493, Bernice P. Bishop Museum, elevation, 1,700 feet, Tohetaivau, Omoa [Oomoa] Valley, Fatuhiva, Marquesas Islands, August 27, 1930, LeBronnec. Native name, *tuivi*. Length, 65 mm. Also 12 others with same data, paratypes, 42 to 63 mm.

Three, 31 to 46 mm., Omoa [Oomoa] Valley, Fatuhiva, Marquesas Islands, elevation 300 feet, September 16, 1930, LeBronnec. Native name, *tuivi*.

***Stiphodon elegans* (Steindachner) (fig. 4).**

Depth $5\frac{3}{4}$ to $6\frac{2}{5}$; head $4\frac{4}{5}$ to 5, width $1\frac{2}{5}$ to $1\frac{3}{5}$. Snout $3\frac{4}{5}$ to 4 in head; eye $3\frac{1}{5}$ to $3\frac{1}{4}$, greater than snout or interorbital; maxillary reaches $1/3$ to $2/5$ in eye, length 3 to $3\frac{1}{5}$ in head; lips entire; teeth slender, clavate, appearing as simple swollen conic points, though evidently contracted tricuspid with median cusp of each longest; inner pair of lower wide set front canines; interorbital $3\frac{1}{5}$ to $3\frac{1}{2}$, level or but slightly concave. Gill rakers very minute or vestigial papillae; gill filaments $1\frac{4}{5}$ in eye.

Scales 27 or 28 in median lateral series to caudal base and 3 more on latter; 10 transversely between soft dorsal and anal origins; 10 or 11 predorsal to occiput. Head naked. Scales smaller on belly than elsewhere. Scales with row of 17 or 18 parallel, slender, rather long, apical spinules; 11 to 16 basal radiating striae; circuli moderately coarse.

D. in male VI, in female VII-10, third spine $1\frac{1}{3}$ in head in male, $1\frac{1}{8}$ times head in female, second ray $1\frac{1}{4}$ to $1\frac{1}{2}$ in head; A. 10, second ray $1\frac{1}{5}$ to $1\frac{3}{4}$; caudal $1\frac{1}{3}$ times head; pectoral $1\frac{1}{8}$ to $1\frac{1}{3}$; least depth of caudal peduncle $1\frac{2}{3}$ to $1\frac{7}{8}$ in head; ventral $1\frac{1}{5}$ to $1\frac{3}{5}$.

Male with back and tail above light brown. Under surface of head, abdomen, and tail whitish, peritoneum showing through on abdomen silvery gray. Dark or dusky brown streak each side of snout above, over eye, and then forks to form single dark line to predorsal. Dark or dusky brown line from behind eye bounding brown color of back to upper surface of caudal peduncle. Down middle of back row of 5 pale spots. Blackish band around snout, below

³ Ogilvie-Grant, W. R., A revision of the genera *Sicydium* and *Lentipes*: Zool. Soc. London, Proc., p. 166, 1884.

eye back to pectoral, then brownish black as broad dark lateral band to caudal base, appearing as if with about 10 still darker blotches in its course, with rounded jet black spot less than eye at caudal base. Iris dark gray. Each dorsal spine and ray with 3 or 4 dark spots, on soft dorsal subbasal spot blackish. Anal with similar, though much paler, dark spots. Caudal pale or whitish, with 4 blackish transverse bands. Pectoral pale, with 4 or 5 very indistinct transverse bands. Ventral transparent whitish.

Female dark or dusky brown on back. Sides with numerous indistinct, parallel, vertical, close-set, obscure brownish streaks. Under surface of body paler, head below and belly tinged with grayish. Iris dark gray. Fins all dark gray to dusky, upper and lower caudal edge paler. Ventrals gray.

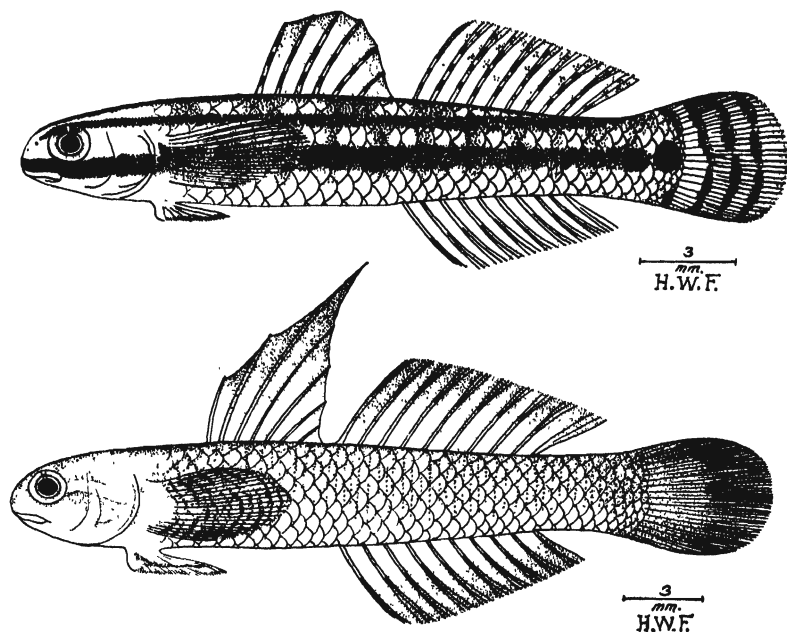


FIGURE 4. *Stiphodon elegans* (Steindachner): upper, male from Hakahe-tau River, Uapou, Marquesas; lower, female from Vai Tuoru River, Tahiti, Society Islands.

Twenty-three, 16 to 30 mm., elevation 350 feet, Vai Tuoru River, Papenoo Valley, Tahiti, Society Islands, October 26, 1928, A. M. Adamson. Native name, *tuivi*.

Twenty-three, 14 to 17 mm., Taiohae, Nukuhiva, Marquesas Islands, September, 1929, Mumford and Adamson.

Twenty-four, 17 to 28 mm., elevation 300 feet, Omoa [Oomoa] Valley, Fātihiva, Marquesas Islands, September 16, 1930, LeBron-nec. Native name, *tuivi*.

Seventy-eight, 15 to 28 mm., Hakahetau River near sea level, Uapou, Marquesas Islands, December 4, 1931, LeBronnec. Native name, *inaka*.

This species is figured by Beaufort,⁴ who identifies the genotype of *Stiphodon* (*Stiphodon scimoni* Weber) with the present species. His figures, especially that of the female, do not show exactly the type of color pattern of my material.

BRYANINA new genus

Type *Bryanina inana*, new species.

Body elongate, moderately slender, trunk and tail compressed. Head moderate. Muzzle obtuse. Eye large, high, anterior. Mouth small, inferior. Lips entire. Lower labial teeth fine, slender, small. Pair of wide-set inner lower canines. Scales large, begin on posterior half of trunk, ctenoid, uniform. Dorsal spines 6, rays 10. Anal rays 11. Caudal longer than head.

Diagnosis. Differs from *Sicyopus* Gill in the presence of distinct lower labial teeth and greater anterior scaleless region of trunk. Not only is the head scaleless, but also the entire front half of the trunk. Named for Edwin H. Bryan, Curator of Collections, Bernice P. Bishop Museum.

Bryanina inana, new species (fig. 5).

Depth $5\frac{1}{4}$ to $7\frac{3}{4}$; head $4\frac{1}{8}$ to $4\frac{1}{5}$, width $1\frac{1}{3}$ to $1\frac{7}{8}$. Snout $3\frac{1}{2}$ to $3\frac{3}{4}$ in head; eye $3\frac{2}{5}$ to $3\frac{1}{2}$, subequal with snout or interorbital; maxillary reaches $\frac{1}{5}$ to $\frac{1}{4}$ in eye, length $2\frac{1}{2}$ to $2\frac{4}{5}$ in head; upper lip entire; teeth fine, slender, close-set, upper simple and lower forked or bifid; pair of lower wide set, rather large, inner curved canines; interorbital $2\frac{2}{3}$ to $3\frac{1}{2}$, level. Gill rakers as minute or vestigial papillae; gill filaments $1\frac{3}{4}$ in eyes.

Scales 30 to 32 in median lateral series to caudal base and 3 more on latter, beginning on body below middle of spinous dorsal; 14 transversely. Head, predorsal, chest and trunk till opposite middle of first dorsal and belly nearly to vent, naked. Caudal base scaly. Scales with row of 6 to 8 slender, long, straight, apical denticles; 10 basal radiating striae; circuli rather large and coarse.

D. VI-10, third spine $1\frac{1}{2}$ to $1\frac{4}{5}$ in head, third ray $1\frac{1}{2}$ to $1\frac{4}{5}$; A. 11, third ray $1\frac{1}{3}$ to $1\frac{3}{4}$; caudal $1\frac{1}{8}$ times head; least depth of caudal of peduncle $1\frac{7}{8}$ to 2 in head; pectoral $1\frac{1}{5}$ to $1\frac{1}{4}$; ventral $1\frac{2}{3}$ to $1\frac{3}{4}$.

Pale or light brown, still paler to whitish on under surfaces. Along side

⁴ Beaufort, Fishes of the eastern part of the Indo-Australian archipelago . . . : Bijdr. tot de Dierkunde kon. zoöl. genoots. nat.-art. magistra, Afl. 19, p. 143, 1913.

of head 3 large darker brown blotches and 7 or 8 on rest of body, of which third forked above and sprinkled with some minute black dots. Dark or dusky spot below eye. Iris gray. Dorsals and caudal grayish, other fins pale to whitish.

Diagnosis. Contained in the genus. Differs from *Sicyopus zosterophorus* (Bleeker) and *S. multisquamatus* Beaufort, in coloration.

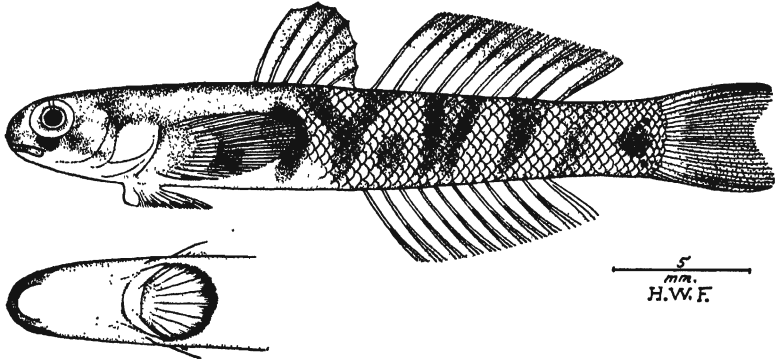


FIGURE 5. *Bryanina inana*, new species. Type.

Type no. 3494, Bernice P. Bishop Museum, elevation 350 feet, Vai Tuoru River, Papenoo Valley, Tahiti, Society Islands, October 26, 1928, A. M. Adamson. Length, 33 mm. Also two paratypes, same data, 30 to 32 mm.

Eight, 19 to 29 mm., at mouth of river, Hanavave Valley, Fatuhiva, Marquesas Islands, September 12, 1930, LeBronnec. Native name, *inana*.

One, 25 mm., elevation 300 feet, Omoa [Oomoa] Valley, Fatuhiva, Marquesas Islands, September 16, 1930. Native name, *inana*.

NEW HAWAIIAN PLANTS

By

EDWARD L. CAUM

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NEW HAWAIIAN PLANTS

By EDWARD L. CAUM

The first two plants here considered, *Gunnera kauaiensis* and *Hibiscus brackenridgei* var. *molokaiana*, were found a number of years ago by Dr. J. F. Rock, who drew up the descriptions and deposited the type specimens in the Herbaria of the Board of Agriculture and Forestry and the University of Hawaii, respectively. Both these herbaria have since been combined with that of the Bernice P. Bishop Museum. As these two descriptions had not been given publication prior to Dr. Rock's departure from Hawaii and the type material accordingly was not recognized as such, it seems appropriate to include them in this paper, especially as the second variety of *Hibiscus brackenridgei* (here described as *kauaiana*) was found by Dr. Rock, and specimens of the original collection preserved. One of the palms, *Pritchardia elliptica*, is here described under joint authorship because the name was suggested by Dr. Rock, when he recognized a few stray fruits as being those of a species of *Pritchardia* hitherto unknown, although the description of the species is mine.

HALORAGACEAE

GUNNERA Linnaeus

Gunnera kauaiensis Rock, new species (Pl. I).

Plant 1.5-2 meters high, caudex semierect or more or less prostrate, sometimes rising 1 meter or more, 15 cm. or more thick, fleshy, with a huge crown of leaves measuring about 3 meters in diameter. Leaves peltate, not reniform, perfectly orbicular, 1-1.5 meters in diameter, 10-lobed, on petioles more than 1 meter in length and several cm. in diameter, distinctly muricate throughout and pubescent with brownish hair, the apex of the petiole attached to the center of the orbicular leaf and radiating into five main veins which branch dichotomously, the lateral veins again forking several times, rugose and muricate at the upper surface and with scattered short brownish hair, glabrous beneath save the veins and numerous prominent nerves which are covered with a fawn-colored pubescence. Panicle terminal, the deeply grooved rachis 1 meter or more long, hirsute, branching from near the base, the undivided branches about 14 cm. long, hirsute. Bracts linear-oblong, 12-14 mm. long, 5 mm. wide, triplinerved, obtuse, rounded at the apex. Flowers unknown. Fruits sessile, clustered in threes or fours or single the entire length of the branches, bright red, ovoid, 3-4 mm. long, 2.5 mm. in diameter near the base, crowned by the two calycine lobes.

Kauai, along the stream beds of Kaluiti and Kailiili, just below the summit of Waialeale, elevation 4800 to 5000 feet, September 22, 1909 (fruiting), J. F. Rock no. 5053. Type, B. P. Bishop Mus.

This species is at once distinguished from *G. petaloidea* Gaudichaud, occurring on nearly all the other islands of this group, by the distinctly peltate leaves and smaller bracts; there may be floral differences also, but in the absence of flowers this cannot be determined. The leaves of *G. petaloidea* are decidedly reniform and have broad and open basal sinuses.

The species found on Kauai is evidently related to *G. peltata* Philippi, which was once considered identical with *G. chilensis* Lamarck. *G. petaloidea*, though of course closest to *G. kauaiensis*, is nevertheless closely allied to the second species from Juan Fernandez, *G. masafueræ* Skottsberg.

The genus *Gunnera* inhabits in the Hawaiian islands the steep cliffs along mighty waterfalls, as in the Kawainui gorge in the Kohala Mountains on Hawaii, the deep ravines of West Maui, and along the stream beds of Waikamoi and Puohokamoa on the northern slopes of Haleakala, East Maui, at an elevation of between 3000 and 4000 feet and higher. On Molokai, *G. petaloidea* occurs on the palis of Pelekunu, as well as in the forest on the high swampy plateau of the same island. On Oahu the same species occurs in the Waianae Mountains on the summit of Puu Kaala, and also in the Koolau Range. *G. kauaiensis* is peculiar to the oldest island of the group, Kauai.

G. kauaiensis is associated with *Hillebrandia sandwicensis*, *Trematolobelia kauaiensis*, *Tetraplasandra waialealae*, *Labordia waialealae*, *Schiedea lychnoides*, *Cyanea hirtella*, *Gahnia beecheyi*, species of *Pelea*, etc. The locality which this new species inhabits receives an enormous rainfall, amounting to 60 inches and more per month.

MALVACEAE

HIBISCUS Linnaeus

Hibiscus brackenridgei Gray var. **molokaiana** Rock, new variety (Pls. II, III).

Involucral bracts 8-9, linear, subulate, terete, decidedly glanduliferous especially on the inner side, 2.5 cm. long, 2.5 mm. thick, hirsute with long yellowish hair, adnate to the base of the calyx. Calyx campanulate, carmine-red, the tube

about 10 mm., the lobes lanceolate, 1.5 cm. long, 7 mm. wide at the base, each lobe with a thick midrib without an oblong gland at the base, the margins thickened, hirsute with yellowish hair throughout but more so towards the base, paler and pubescent inside. Corolla canary-yellow, the tube deep purple; tube 25 mm. deep, the petals then spreading, pubescent beneath, glabrous above, 10-12-nerved, the nerves dichotomous at the apex, 5 cm. long, 4.5 cm. wide. Ovary densely villous-pubescent with whitish hair. Staminal column thick, 4 cm. long, irregularly antheriferous with anthers scattered or in groups at intervals of 4-10 mm., naked at the base for 10 mm., pubescent. Filaments 2.5 mm. long or the uppermost shorter. Stigmatic lobes 2 mm. long, hirsute. Stigmas depressed, capitate.

Molokai, west end, back of Kalaeokalaau, 1910 (fruiting only). J. F. Rock. Molokai, west end, February, 1920, J. F. Rock; type, B. P. Bishop Mus. After the discovery of this variety Mr. James Munro found a number of plants, and in the spring of 1920 fine flowering material was collected and photographed. Cuttings grown on the campus of the University of Hawaii flowered January 20, 1919.

This variety differs from *H. brackenridgei* in the glandular hirsute involucreal bracts, the deep-purple corolla tube, the petals horizontally spreading and not reflexed, the irregularly scattered stamens, and in the absence of the oblong gland at the base of the median nerve of each calycine lobe in the species. The calyx is 5-nerved instead of 10-nerved.

Hibiscus brackenridgei Gray var. **kauaiana** Caum, new variety (Pl. IV).

An erect to spreading light-wooded shrub, to about 1 meter tall with stiff leafy branches tomentose at the ends and beset below with short hairlike spines. Leaves dentate, cordate, shallowly 3-lobed, 8 cm. long, 8 cm. broad, densely pubescent on both surfaces, on densely pubescent petioles of 4-5 cm. Stipules setaceous. Peduncles solitary in the axils of the uppermost leaves, 1.5 cm. long. Involucreal bracts 5, halberd-shaped, not terete, not glanduliferous, 3 cm. long, 8 mm. broad, running out to a fine hairlike tip, hirsute with short hair, adnate to the base of the calyx. Calyx campanulate, green, the lobes triangular, adnate for a distance of 1 cm., the free end 1.5 cm. long, 1 cm. broad at the base, each with an oblong gland at the base of the thick midrib, hirsute with colorless hair throughout on the outer side but more so toward the base and particularly on the veins, glabrous on the inner side. Corolla to 12 cm. in diameter, light lemon-yellow to canary-yellow, the throat dark reddish-purple, 3 cm. deep. Petals spreading and slightly reflexed at the tip, 6 cm. long, 5 cm. broad, imbricate, slightly pubescent at the base beneath, glabrous above, 14-16-nerved, nerves branching at the apex. Ovary pubescent with short colorless hair. Staminal column thick, 3 cm. long to the base of the stigmatic lobes, irregularly antheriferous for its entire length, glabrous. Lower filaments 5 mm. long, the upper ones shorter. Stigmatic lobes 2 mm. long, hirsute. Stigmas

approximate, capitate, depressed, deep reddish-purple. Capsule woody, ovoid, acute at the tip, 2.5 cm. high, 17 mm. in diameter at the widest part, glabrate with short colorless hair. Seed broad-reniform, 3 mm. long, hirsute with short gray hair, with longer golden-brown hair around the hilum.

In the spring of 1919 Dr. J. F. Rock brought from the island of Kauai (the particular locality not stated) two plants of a species of *Hibiscus* which was unknown to him. They were in neither flower nor fruit. One of these plants was given to me, and I have had it and its progeny growing in my garden since that time. It is in flower and fruit almost constantly and volunteers freely, preferring partial shade for its best development. The plant is apparently very close to *H. brackenridgei* Gray, from which it differs in several points, and as it likewise differs from the only known variety of this species, it is here considered as a new variety. Material from the type plants is in the Herbarium of Bernice P. Bishop Museum.

In this Herbarium also are two collections of this plant, Rock nos. 16038 and 17141, two sheets each, labeled in Rock's handwriting "Hibiscus, collected April 1919, at Waiawa, Kauai," no. 16038 with the additional note "V. Knudsen's home." It seems probable that these specimens were taken from the plants brought to Honolulu by Dr. Rock.

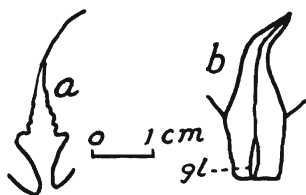


FIGURE 1.—*Hibiscus brackenridgei* var. *kauaiana*: a, involucre bract; b, calyxine lobe (gl, gland).

The plant differs from *H. brackenridgei* but resembles the variety *molokaiana* in the 5-nerved calyx, the hirsute involucre bracts, and the dark reddish-purple throat. (See fig. 1.) It differs from this variety but resembles the species in the nonglanduliferous involucre bracts, the color of the calyx, the presence of a gland at the base of the midrib of each calyxine lobe, and the greater number of petaline nerves. It differs from both forms in the very shallowly lobed leaves, the shape, form, and number of involucre bracts, the completely antheriferous staminal column, and the conspicuous purple color of the stigmas.

Hibiscus kokio Hillebrand var. **pukoonis** Caum, new variety
(Pl. V).

A light straggling shrub, to 2 meters tall. Leaves ovate to elliptico-oblong, acuminate, sinuately crenate, 10-12 cm. long, 5.5-6.5 cm. broad, bright green, scarcely palmately nerved, the lateral nerves not extending beyond the middle, soft-chartaceous, on petioles 3-4 cm. long. Stipules setaceous, 5-8 mm. long, 0.3-0.5 mm. wide. Peduncles solitary, axillary near the ends of the branches, 2-4.5 cm. long, articulate within the distal quarter, pubescent. Involucral bracts 6-8, linear, half-terete, 10-13 mm. long, 1 mm. broad, not adnate to the calyx, glabrate. Calyx tubular, 2.5 cm. long, 10 mm. in diameter, cleft for about 1 cm., each lobe acute, glabrate, tripli-nerved, the nerves swollen, not glanduliferous, the lateral nerves fusing 5-10 mm. below the cleft, the calyx tube thus being 10-nerved at or near the base only. Corolla 6.5 cm. in diameter, light red throughout; throat 2.5 cm. deep, the petals spreading slightly upward from the horizontal. Petals very slightly ciliate at the edge, obovate, the outer edge below coincident with the notch of the calyx, slightly reflexed at the tip, 5.5 cm. long, 3 cm. broad, imbricate, 6-nerved, the nerves branching, often near the base. Staminal column 5 cm. long, slender, glabrous, light red, acutely 5-lobed at the top. Filaments 3-4 mm. long, crowded in the distal fifth of the column. Style extending 2 mm. above the column, then branching, the branches 7 mm. long, spreading slightly upward from the horizontal, light red, ciliate. Stigmas capitate, 1 mm. in diameter, red. Ovary truncate-conical, 5 mm. high, 3 mm. in diameter at the base, sparsely pubescent with short appressed colorless hair, this heavier at the apex, where it stands erect. Capsule glabrous, 17.5 mm. long, much exceeded by the dried sepals. Seed reniform, 4 mm. long, covered with a coarse brown pubescence.

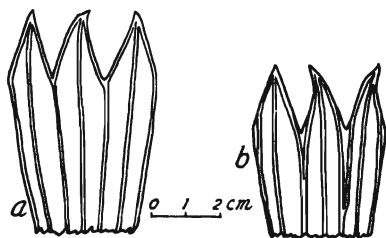


FIGURE 2.—Venation of calyxes: *a*, *Hibiscus kokio*; *b*, *Hibiscus kokio* var. *pukoonis*.

Molokai, bottom of Pukoo Valley, just inside the native forest (neither flower nor fruit), February, 1921, E. L. Caum, no. 155. Material from the type plants in the Herbarium of B. P. Bishop Mus.

Cuttings brought to Honolulu rooted readily, and two plants in my garden have flowered frequently. These plants do not flower freely and very rarely set fruit, even when hand-pollinated. The plant under consideration differs from the species in the texture and other characters of the leaf, in the shape and color of the petals, and hence in the

general appearance of the flower, in the venation of the calyx and in other less conspicuous characters. (See fig. 2.)

Hibiscus kokio, the *kokio ulaula* of the Hawaiians, was described by Hillebrand in Flora, p. 173, 1873, and republished in his Flora of the Hawaiian islands, p. 48, 1888, where it is recorded from Oahu, Molokai, and Kauai. The true species, as generally accepted today, is restricted to Oahu. As Hillebrand's specimens are not available for examination, I am not familiar with his collection from Molokai, but it is not improbable that it may be accounted for by the variety here considered. It is entirely probable that the record of specimens from Kauai is covered in part by *Hibiscus kahili*, described by Forbes (B. P. Bishop Mus., Occ. Papers, vol. 5, p. 4, 1911) and in part by other forms of red *Hibiscus* known to occur on that island, but which have not been critically studied. *Hibiscus kokio*, as known on Oahu today, is rather variable, and several geographic races are recognized and known locally as the "Mokuleia red," the "Kawaihapai red," the "Ahuimanu red," etc. The plant here considered comes nearer to the general form from Oahu than does *H. kahili*, but seems farther removed from it than are the various geographic races mentioned above. It is not sufficiently different to warrant specific rank, but seems worthy of varietal distinction. Hillebrand's description is somewhat too general to show the differences between the form from Oahu and the variety from Molokai, and to make these differences clear a new description of Hillebrand's species was drawn up from a typical plant from Oahu, which was collected some years ago by Dr. Rock and planted on the campus of the University of Hawaii, and is here given for comparison.

Hibiscus kokio Hillebrand.—A tall shrub, 2.5-5 meters high, dividing from near the base into long straggling branches, the young shoots with discreet stellate pubescence. Leaves oblong-ovate, serrate, 11.5-12.5 cm. long, 5.5-6.5 cm. broad, deep green to yellowish-green, glossy, stiff, scarcely palmately nerved, the lateral nerves not extending beyond the middle, on petioles 1.5-3 cm. long. Stipules linear, 12-15 mm. long, 1 mm. wide. Peduncles solitary, axillary near the ends of the branches, averaging about 3.5 cm. long, articulate in the distal third, pubescent. Involucral bracts 8-9, broad-linear, acute, 12-15 mm. long, 2 mm. wide, not alternate to the calyx, glabrate. Calyx tubular, 3 cm. long, 12 mm. in diameter, cleft for about 1 cm., each lobe acute, glabrate, tripli-nerved, the nerves swollen, not glanduliferous, the lateral nerves fusing immediately below the cleft, the calyx tube thus being 10-nerved throughout. Corolla 6 cm. in diameter, bright red throughout; throat 3 cm. deep, the petals then spreading horizontally to slightly downward. Petals strap-shaped, 5.5 cm. long, 1.5 cm. wide, standing well apart, imbricate at the base only, curled upward at the tip,

the outer edge below not coincident with the notch of the calyx, ciliate at the tip and along the outer edge, 3-4-nerved, the nerves branching near the base. Staminal column 6 cm. long, rather heavy, glabrous, white to pinkish in color, acutely 5-lobed at the top. Filaments 3-4 mm. long, crowded in the upper quarter of the column. Style extending 5 mm. above the column, then branching, the branches 8 mm. long, spreading horizontally, red, ciliate. Stigmas capitate, 1.5-2 mm. in diameter, red. Ovary truncate-conical, 6 mm. high, 4 mm. in diameter at the base, pubescent with short colorless hair. Capsule glabrous, 2.5 cm. long, exceeded by the dried sepals. Seed reniform, 4 mm. long, covered with a coarse brownish pubescence.

LABIATAE

PHYLLOSTEGIA Bentham

Phyllostegia longiflora Caum, new species (Pl. VI).

Plant suberect, woody, the new growth pubescent with short, appressed, gray, silky hairs. Leaves glabrous above, the veins pubescent beneath with similar hairs, ovate, crenate, almost truncate at the base, narrowing sharply into the petiole, 3.5-4.5 cm. long, 3.3-3.5 cm. wide, on petioles of 1.4-1.8 cm. Racemes axillary near the tips of the branches, semierect, 8 cm. long, the flowers 2 in each leaf axil, but sometimes crowded into whorls of 6 in a seemingly terminal raceme, when each pair is subtended by a minute bract; pedicels 5-8 mm. long. Calyx puberulous, 9-12 mm. high, with broad, blunt teeth. Corolla white, pubescent (decidedly so in the bud), 6-7.5 cm. long, the tube far exserted, being 4.5-6 cm. long, the limb 1.5 cm long. Style branches subulate, blunt. Fruit not known.

East Maui, Kula Pipe Line trail, edge of a gulch in deep forest. February 7, 1929, H. L. Lyon and E. L. Caum, no. 150. Type, B. P. Bishop Mus.

Only one plant was seen of this extremely large-flowered species (the corolla tube is twice the length of that of *P. grandiflora* from West Maui, the largest species previously known). It was rather low and diffuse, being semierect to semiscandent, and was immediately noticeable by its conspicuous large white flowers, clustered near the ends of the branches.

RUBIACEAE

STRAUSSIA Gray

Straussia grandiflora Caum, new species (Pl. VII).

Leaves ovate to obovate, obtuse at either end, 6-8.5 cm. long, 4-4.5 cm. wide, on petioles of 5-10 mm., chartaceous, the nerves little prominent, glabrous. Stipules long-triangular, acute, 6-10 mm. high, deciduous. Panicles nodding,

7.5-10 cm. in length, the peduncles 4.5-6 cm. long to the proximal whorl, puberulous. Calyx 2 mm. long, the limb very bluntly dentate, glabrate. Corolla tube 15 mm. long, the lobes 5 mm., waxy white, becoming reddish-brown to maroon in dried specimens. Drupe ovoid to suborbicular, 12-15 mm. long, 8-14 mm. in diameter, prominently ribbed when dry, crowned by the calycine limb.

Kauai, near Kokee, February 28, 1925, H. L. Lyon and A. W. Duvel, no. 5012 L. Type, B. P. Bishop Mus.

This very distinct species is a small tree, 15 to 20 feet tall, and may be distinguished at once by its flowers, which are by far the largest of any known species. The corolla tube is four to five times the length of that of any species previously described, and the lobes are only one-third the length of the tube, whereas in the other species they are at least equal to the tube in length.

PALMAE

PRITCHARDIA Seemann and Wendland

Pritchardia kamapuaana Caum, new species (Pl. VIII; Pl. XIV, fig. 2).

A small palm, 4-5 meters tall, trunk about 30 cm. in diameter. Leaf blade large, 1.3 meters from the tip of the ligule to the apex, deep green above, covered below with a closely appressed silvery tomentum; segments about 52, 5 cm. wide at their disjunction places, the median segment divided for a distance of 16 cm. Ligule asymmetric, cuspidate, 5 mm. high. Petiole about 90 cm. long, glabrous above, with a closely appressed silvery tomentum on the edges below, glabrous in the central part with occasional scattered hyaline, much-fringed lepidia. Spathes tubular at the proximal part, expanded above into a broad lanceolate blade. Spadix paniculate, 70-75 cm. long, the peduncle 45-50 cm., the panicle 25 cm. The rachis is finely rusty-tomentose, flattened, the diameters 15 and 10 mm. at the base of the first branch. The panicle consists of a few 2-4-partite branches at the proximal end and simple branches elsewhere, these being finely rusty-tomentose, 10-14 cm. long, 4 mm. in diameter. Flowers (unopened) 15 mm. long, 5 mm. in diameter near the base, narrowed above to an obtusely trigonous acute point. Calyx ventricose-cylindric, 6 mm. long, slightly tomentose at the upper part, with three acute teeth. Corolla 9 mm. long, the segments elongate-triangular, acute, with 15 explanate ribs. Staminal ring included within or protruding very slightly beyond the calyx; filaments heavy-filiform, anthers elongate-sagittate. Ovary turbinate, strongly sculptured above, narrowing sharply into a trigonous, sulcate, thick style; stigmas punctiform. Fruit large, ovoid, 5-5.5 cm. long and 3.5-3.8 cm. in diameter at the center. The young fruit is distinctly pointed at the distal end. Walls of the pericarp (in undried fruit) are 5-6 mm. thick at the sides and distal end, 9 mm. at the proximal end. Seed ovoid, rounded at both ends, 20 mm. in diameter, 30 mm. long, approximately centered in the fruit; hilum orbicular; embryo 8 mm. from the center of the hilum. Fruiting perianth shortly pedicelliform, 4-5 mm. high, 7-8 mm. wide.

Oahu, Koolau Range, Hauula-Kaluanui ridge, elevation about 2300 feet, January 7, 1927, E. L. Caum, no. 151. Type, B. P. Bishop Mus.; cotype, Herbarium of L. H. Bailey, Ithaca, N. Y.

The stand consists of some 15 or 20 trees, scattered for some distance along the Kaluanui side of the ridge. The species is apparently closely related to *P. rockiana*, occurring along the main ridge of the Koolau Range above Punaluu, about three miles to the south of this station in a direct line, and to the following species, *P. maedanielsi*. It differs from *P. rockiana* in the silvery tomentum and larger size of the leaf and in the internal anatomy of the fruit, as well as in minor characters. Its principal distinctions from *P. macdanielsi* lie in the panicle.

The species is dedicated to the Swine God Kamapuaa, whose ancient home was in Kaluanui Valley and whose people still range these mountains.

Pritchardia macdanielsi Caum, new species (Pl. IX; Pl. XV, fig. 3).

A small palm, trunk to 5 meters tall, 30 cm. in diameter. Leaf blade 1-1.5 meters from the ligule to the tips of the median segments, deep green above, covered below with a closely appressed gray tomentum, as are the upper edges of the costae; segments 42 in one specimen, 4.5 cm. wide at their disjunction places, the median segment divided for a distance of 28 cm. Ligule asymmetric, cuspidate, 15 mm. high. Petiole about 90 cm. long, glabrous above, with a closely appressed gray tomentum on the edges below. Spathes tubular at the proximal part, expanded above into a broad-lanceolate blade. Spadix paniculate, about 80 cm. long, the peduncle 60-65 cm., rusty-tomentose, the panicle 15-20 cm. Rachis glabrous, flattened, the diameters at the base of the first branch 10-18 mm. by 7-12 mm. The panicle consists of a few 2-4-partite branches at the proximal part and simple branches elsewhere, these 9-11 cm. long, 1-2 mm. thick. Flowers (unopened) 10 mm. long, 3.5 mm. in diameter at the base, narrowed above to an obtusely trigonous point. Calyx ventricose-cylindric, 4 mm. long, glabrous, with three acute teeth. Corolla 6 mm. long, the segments elongate-triangular, acute, with 12 explanate ribs. Staminal ring protruding slightly beyond the calyx; filaments filiform; anthers linear. Ovary turbinate, strongly sculptured above, narrowing sharply into a trigonous, sulcate, thick style; stigmas punctiform. Fruit ovoid, 4 cm. long, 2.5 cm. in diameter at the center, pointed at the distal end. Walls of the pericarp 6 mm. thick. Seed ovoid, rounded at both ends, 25 mm. long, 15 mm. in diameter, centered in the fruit; hilum irregularly orbicular; embryo 4 mm. from the center of the hilum. Fruiting perianth shortly pedicelliform, 4.5 mm. high, 7-8 mm. wide.

Oahu, Koolau Range, Hauula-Kaluanui ridge, elevation about 2000 feet, January 7, 1927, L. H. MacDaniels, no. 168. Type, B. P. Bishop Mus.; cotype, Herbarium of L. H. Bailey, Ithaca, N. Y.

The stand consists of a few scattered trees only, on the Kaluanui side of the ridge. The species is related to *P. rockiana*, the palm from Punaluu, and more closely to *P. kamapuaana*, near which it occurs. It differs from *P. kamapuaana* principally in the size of the leaf, the smaller, more delicate, and glabrous panicles and smaller flowers.

The species is named for Dr. L. H. MacDaniels of Cornell University, a member of the party that discovered this palm and *P. kamapuaana*, and who collected and brought down the specimens from which this description was drawn.

Pritchardia donata Caum, new species (Pl. X; Pl. XIV, fig. 1).

A medium-sized palm, trunk about 3 meters tall. Leaf blade 1.5 meters from the ligule to the tips of the median segments, equally green on both surfaces, rather thickly sprinkled beneath with minute irregular punctiform to linear lepidia, the proximal parts of the costae densely lanate with large fringed lepidia; segments numerous (82 in one specimen), stiff, divided for $\frac{1}{5}$ their length into two acuminate laciniae which taper gradually to very fine filamentose apices, the largest intermediate segments 25-28 mm. wide at their disjunction places, and 55 cm. long to the capillary end, the outer segments similar but smaller. Petiole about 1 meter long, quite glabrous except at the distal end where it is slightly lanate; ridged in the center of the upper side. Ligule asymmetric, pyramidal, apiculate in the middle. Spadix elongate, 1.75 meters long to the first branches of the panicle, bifid from the middle or above. Each inflorescence a loose panicle with its own broad-lanceolate spathes, which are furnished with a few scattered large, fringed lepidia. Panicle entirely glabrous, the fructiferous branchlets slightly angled, about 15 cm. long, 4 mm. thick at the base. Flowers spirally arranged, widely spaced on the branchlets, large, only a small proportion maturing. Unopened flowers 14 mm. long, acuminate, the calyx 6 mm. high to the tips of the sharp teeth, 5 mm. in diameter at the base; petals 8 mm. long, lanceolate, sharply ridged on the inner surface. Staminal ring protruding 1-1.5 mm. beyond the calyx; filaments rigid, nearly erect. Ovary turbinate. Fruit globose-ovoid, acutely mucronate by the remains of the sterile carpels, asymmetric at the proximal end, 45 mm. long, 35 mm. in diameter, surface slightly ridged. Walls of the pericarp 5 mm. thick, grumose. Seed ovoid, centered in the fruit. Fruiting perianth depressed-pedicelliform, 4 mm. high, 6 mm. in diameter, the staminal and corolla tube forming a narrow toothed ring.

Oahu, Honolulu, E. L. Caum, May 11, 1927, no. 152, and September 14, 1927, no. 153. Type, B. P. Bishop Mus.

This species is thus far known from a single tree, which is growing in premises on Keeaumoku Street, Honolulu, formerly belonging to the late Walter M. Giffard, by whom the palm was planted. As far as the history of the tree is known, it was given to Mrs. Giffard as a small seedling, about the year 1900, by Hawaiian friends who

brought it from Molokai. Its nearest relatives seem to be *P. lowreyana* and *P. brevicalyx*, both from Molokai.

***Pritchardia kahukuensis* Caum, new species (Pl. XI; Pl. XV, fig 5).**

A tall palm, trunk to 10 meters high to the lower leaves. Leaf blade 1.3 meters from the ligule to the tips of the median segments, bright green on the upper surface, the lower surface thickly covered with a silvery tomentum; segments numerous (68 in one specimen), stiff, divided for 1/3 their length into two acuminate laciniae, which taper to blunt apices, the largest intermediate segments 25 mm. wide at their disjunction places, and 46 cm. long to the tip, the outer segments similar but smaller. Petiole 1 meter long, slightly glaucous with minute lepidia in the upper central part, lanate at the edges on both surfaces, slightly ridged in the center of the upper side. Ligule decidedly asymmetrical in the younger leaves, more symmetrical in the older, distinctly mucronate in the middle. Spadix elongate, simple, 1.5-2 meters to the first branches of the panicle. Panicle rusty-tomentose, 30-50 cm. long, the proximal branches 5-8-partite, the distal simple. Fructiferous branches round, 9-15 cm. long, 4-8 mm. thick at the base. Spathes broad-lanceolate, rusty-villous. Flowers spirally arranged, rather closely set on the branches. Mature flowers not known. Immature flowers, from unopened panicle, 6-7 mm. long, acuminate; calyx 4 mm. high to the tips of the sharp teeth, 3 mm. broad at the base (probably full size). Petals too immature to afford data of diagnostic value. Fruit ovoid, bluntly mucronate by the remains of the sterile carpels, slightly asymmetric at the proximal end, 15 mm. long, 11 mm. in diameter. Walls of the pericarp 1 mm. thick. Seed ovoid, centered in the fruit. Fruiting perianth pedicelliform, 2 mm. high, 3 mm. in diameter, the staminal and corolla tube forming a rather prominent toothed ring.

Oahu, Kahuku uka, Pupukea-Malaekahana trail, elevation about 1600 feet, September 29, 1927. E. L. Caum, no. 154. Type, B. P. Bishop Mus.

Six widely scattered adult and several immature trees were seen of this tall, heavy-crowned palm. The species differs from any with which I am acquainted in its habit of holding the long flowering and fruiting spikes at an angle of about 45 degrees to the trunk, above and often somewhat exceeding the leaves in the axils of which they arise.

***Pritchardia kaalae* var. *minima* Caum, new variety (Pl. XII).**

Leaf blade 75 cm. long from the ligule to the tips of the median segments, which are parted for about 1/3 of their length. This separation is proportionately much greater than in the typical form. Petiole 50-60 cm. long, 3 cm. wide at the ligule, 14 cm. at the base. Ligule very low, decidedly oblique, linear, not triangular. Peduncle about 2 meters long to the first branches of the panicle; panicle 20 cm. long. Floriferous branches 7.5-12.5 cm. long, not angled, the proximal ones flattened, the distal cylindrical. Petiole and lower costae of the leaf are much less densely lanate than in the species, and the transverse veinlets

are not at all distinct on the lower surface. Calyx not strongly striate, with short and broadly acute teeth. Mature fruit not known.

Oahu, Waianae Mountains, Makua-Makaha ridge, elevation about 2600 feet, July 12, 1928, Max F. Landgraf, no. 25. Type, B. P. Bishop Mus.

This variety differs from the species in minor details, mainly of size. It is rather consistently smaller than typical *P. kaalae*, but otherwise quite similar. These differences may be mainly environmental, *P. kaalae* occurring at an elevation of 1200 feet in the deep, wet forest of a valley bottom on the north side of Puu Kaala, while the variety grows at more than twice that elevation on open, wind-swept ridges on the west side of that mountain. But considering the extreme localization of the Hawaiian species of *Pritchardia*, as these species are now interpreted, the plant in question seems worthy of varietal rank.

Pritchardia elliptica Rock and Caum, new species (Pl. XIII; Pl. XV, fig. 4).

A medium-sized palm, trunk to about 3 meters tall, slender. Leaf blade large, to 1.3 meters from the tip of the ligule to the apex, by 1.6 meters in width, according to the collector. The leaf in the type specimen is smaller, being 70 cm. long by 95 cm. wide, equally green on both surfaces, the proximal part of the costae on both surfaces covered with a closely appressed ferruginous tomentum, the lower surface closely sprinkled with ferruginous punctiform lepidia; segments about 56, the median segments 4 cm. wide at their disjunction places, and divided for a distance of 25 cm., the laciniae stiff. Ligule asymmetric, mucronate, 5 mm. high in the center, 10 mm. near the ends. Petiole length not taken, width 25 mm. at the distal end, glabrous except for a closely appressed ferruginous tomentum on the outer edges below and a little above at the ligule. Spathes tubular with broad-lanceolate blades. Spadix paniculate, about 1 meter long, the unbranched peduncle about 75 cm. in length. Rachis glabrous, 6 mm. in diameter at the base of the first branch of the panicle, which consists of several 2-3-partite branches at the proximal end and simple branches elsewhere, these being glabrous, to about 10 cm. long. Flowers small, closely set on the branches, the calyx ventricose-cylindric, 3 mm. high to the tips of the acute teeth, 2 mm. in diameter at the base. Staminal ring protruding 1 mm. beyond the calyx; filaments heavy-filiform; anthers elongate-sagittate. Ovary turbinate, lightly sculptured above, narrowing gradually into a long trigonous, sulcate, thick style; stigmas punctiform. Fruit (mature) elliptic, about 3 cm. long, 2.5 cm. in diameter, with two rather prominent lateral ridges; immature fruit long-elliptic, 18 mm. long, 10 mm. in diameter, distinctly pointed at the distal end. Seed elliptic, centered in the fruit, rounded at the distal end, pointed at the proximal. Walls of the pericarp, in dried specimens, 1 mm. thick. Fruiting perianth pedicelliform; 2 mm. high, 3 mm. in diameter.

Lanai, Kunoa Valley, elevation 2500 feet, October 18, 1927, George C. Munro. Type, B. P. Bishop Mus.

The plants were growing in thick scrub on a very steep hillside. According to the collector the trunks bore distinct swellings on the under side at the ground level, where they project out from the hillside. The existence of this species was surmised long before the date of the collection, as Rock states¹ that fruits belonging to an entirely different plant were found by him mixed with those of *P. lanaiensis* in the Herbarium of the Bishop Museum, and he designated this otherwise unknown species *P. elliptica*. I have, of course, retained this name for the species, adequate material of which was collected after Dr. Rock had left Hawaii. There is no doubt that this is the plant referred to, as not only do the fruits compare well with those mentioned by Rock, but Mr. Munro, who is thoroughly familiar with Lanai, remembered collecting those fruits, and took the specimens here described from the same grove of palms.

¹ Beccari, O., and Rock, J. F., A monographic study of the genus *Pritchardia*: B. P. Bishop Mus., Mem., vol 8, no. 1, p. 17, 1921.

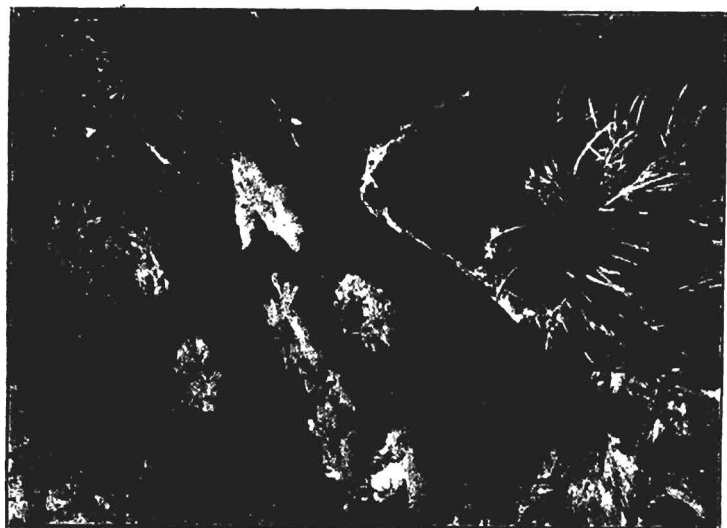


PLATE I.—*Gunnera kauaiensis* Rock, growing along Kailiili Stream, near the ridge leading to the summit of Waialeale, Kauai, at an elevation of about 4800 feet.



PLATE II.—*Hibiscus brackenridgei* var. *molokaiana* Rock.



PLATE III.—*Hibiscus brackenridgei* var. *molokaiana* Rock, photographed in situ on the western end of Molokai, growing in arid regions at an elevation of 600 feet.



PLATE IV.—*Hibiscus brackenridgii* var. *kauoiana* Caum.



PLATE V.—*Hibiscus kokio* Hillebrand (right), *Hibiscus kokio* var.
pukoonis Caum (left).



PLATE VI.—*Phyllostegia longiflora* Caum.



PLATE VII.—*Straussia grandiflora* Caum.

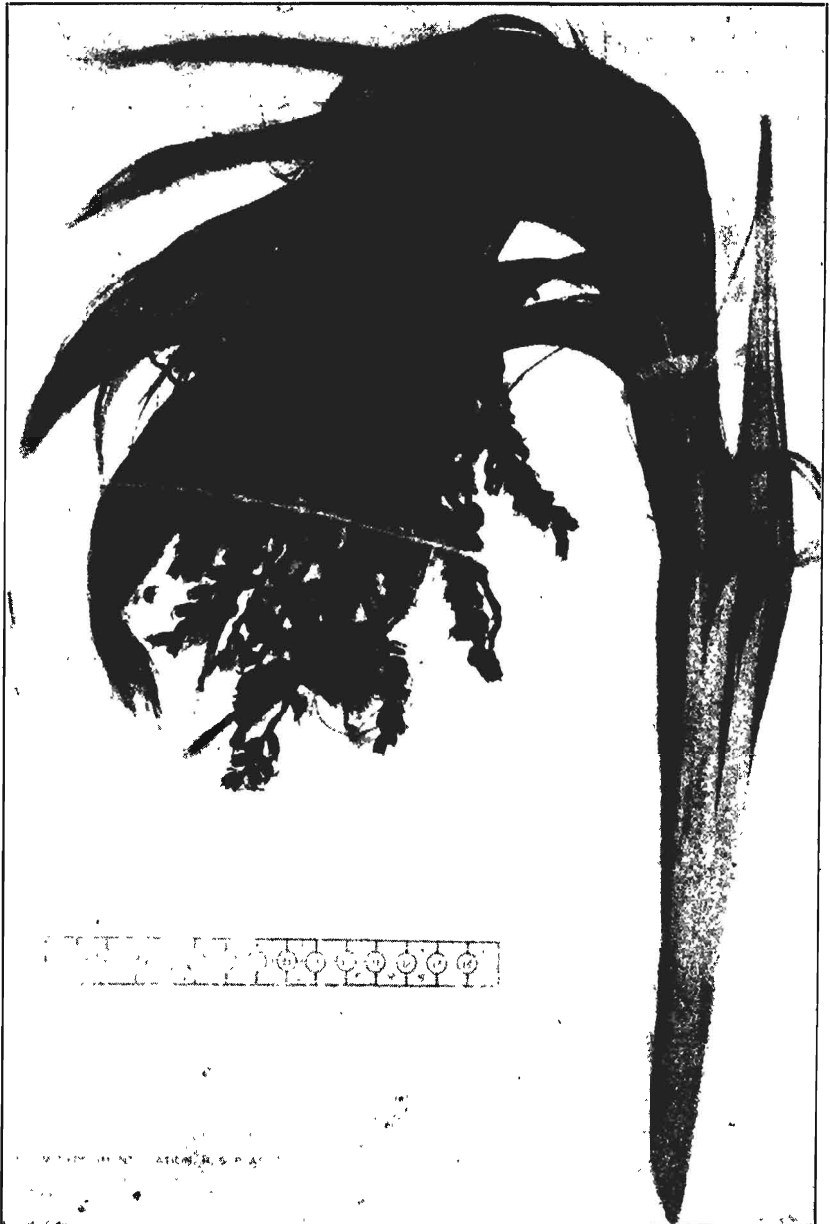


PLATE VIII.—*Pritchardia kamapuaana* Caum, flowering panicle.



PLATE IX.—*Pritchardia macdanielsi* Caum, flowering panicle.

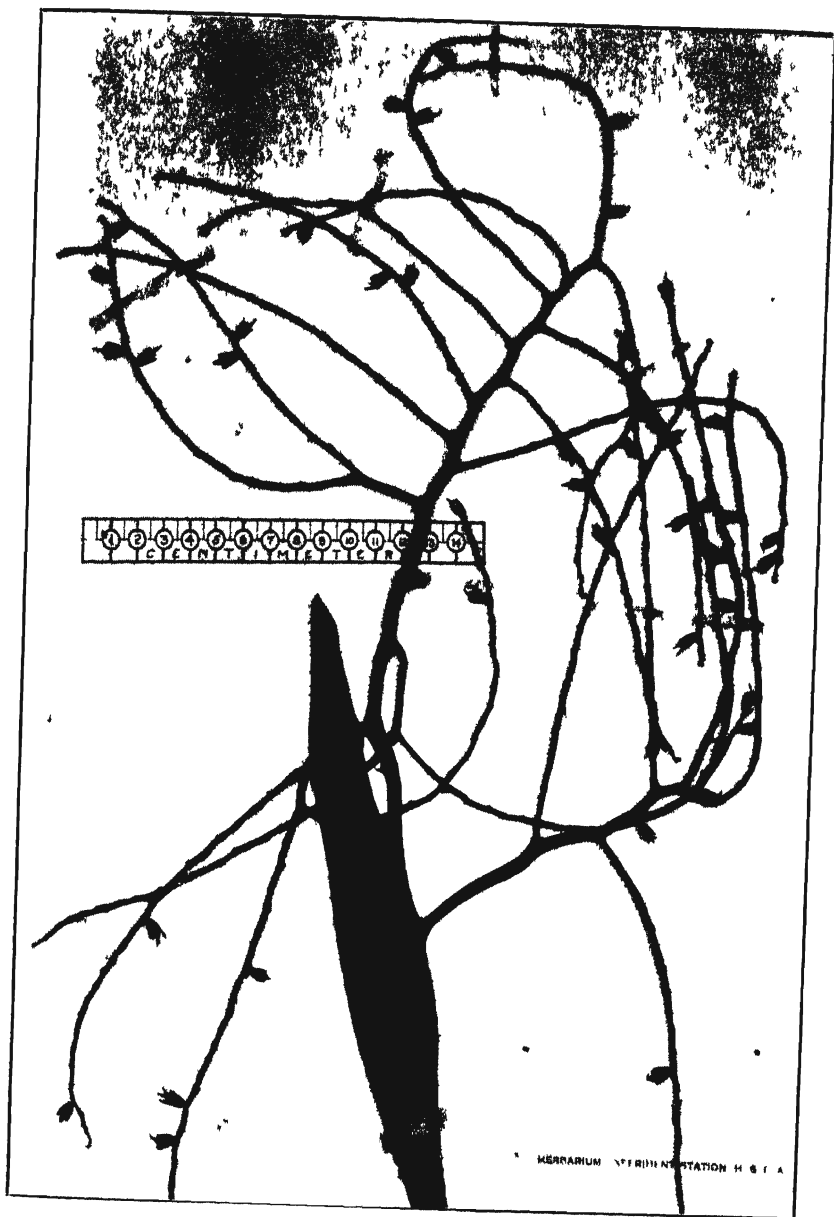


PLATE X—*Pritchardia donata* Caum, flowering panicle

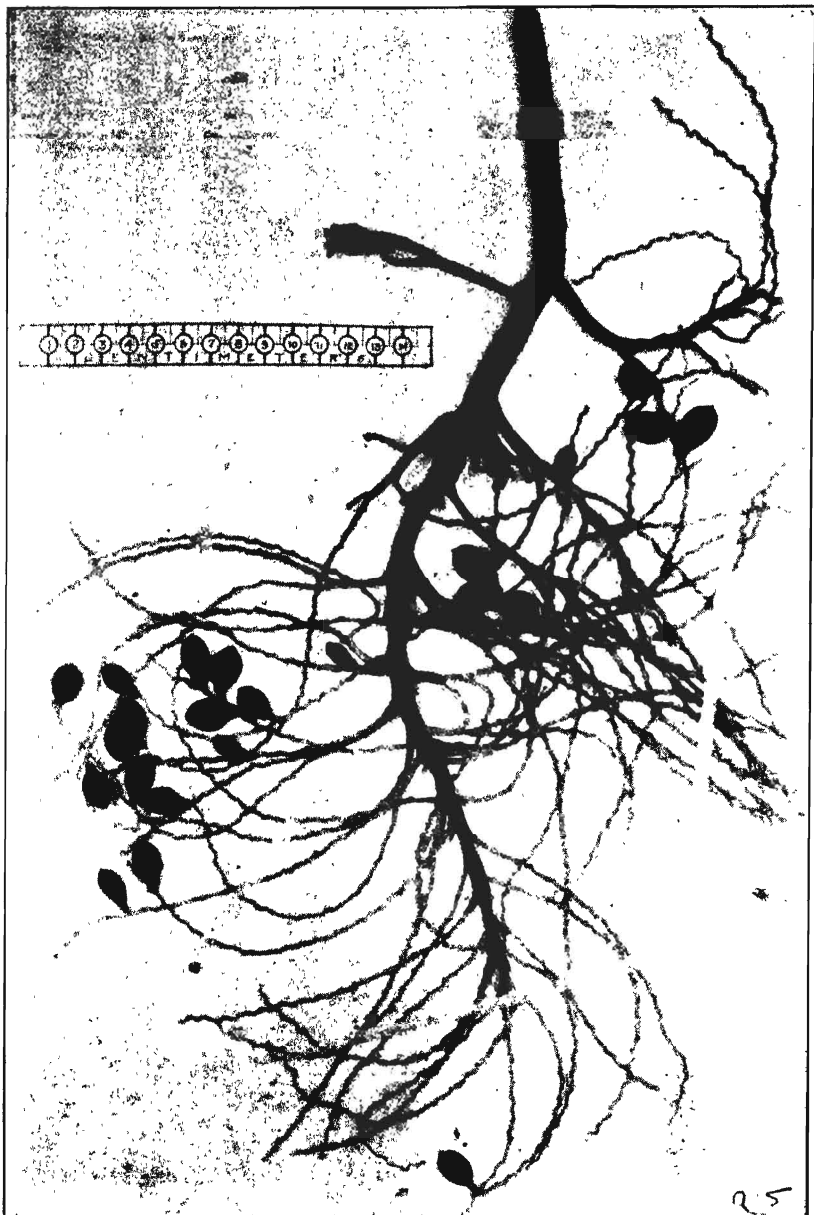


PLATE XI.—*Pritchardia kahukuensis* Caum, fructing panicle.

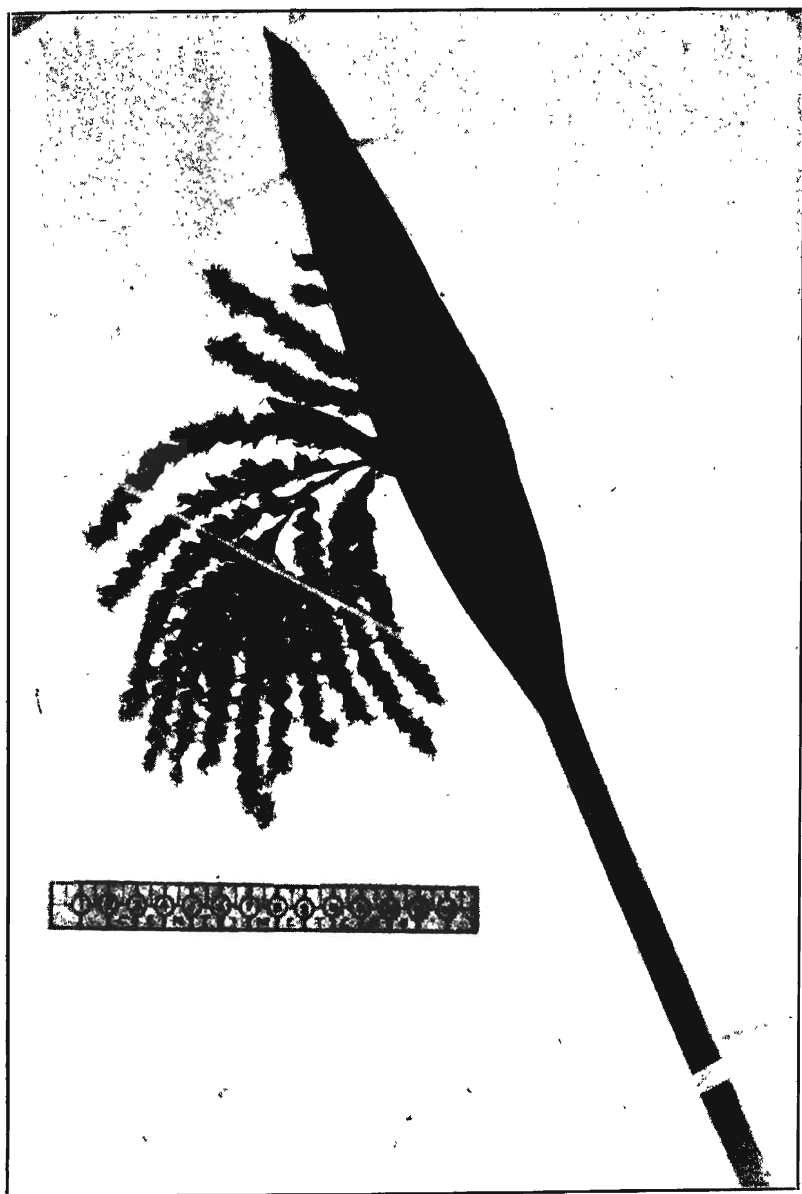


PLATE XII.—*Pritchardia kaalae* var. *minima* Caum, flowering panicle.



PLATE XIII.—*Pritchardia elliptica* Rock and Caum, old spadix and flowering panicle.

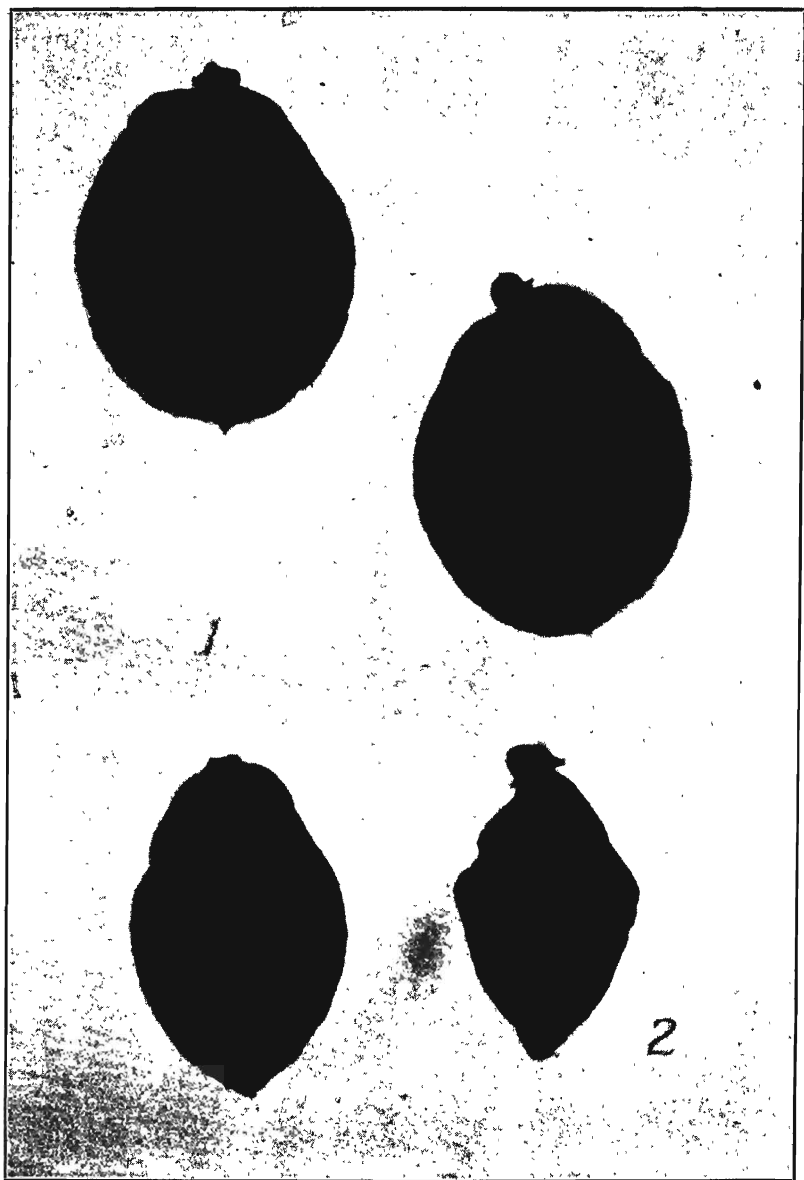


PLATE XIV.—Fruits of *Pritchardia* (natural size) : 1, *Pritchardia donata* Caum ; 2, *Pritchardia kamapuaana* Caum. The specimens of *Pritchardia kamapuaana* pictured are somewhat smaller than is typical, as the fruits were green when collected and have shrunk somewhat in drying.

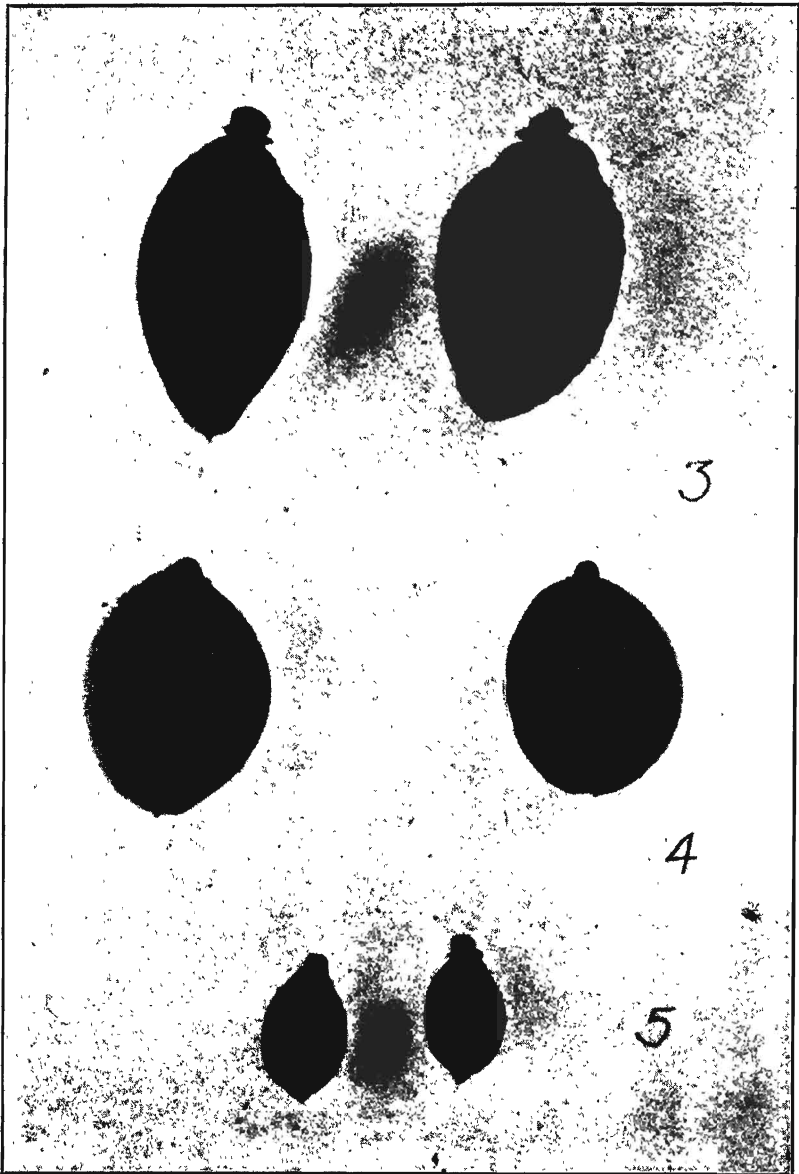


PLATE XV.—Fruits of *Pritchardia* (natural size): 3, *Pritchardia macdanielsi* Caum; 4, *Pritchardia elliptica* Rock and Caum; 5, *Pritchardia kahukuensis* Caum.

NEW HAWAIIAN MEDUSAE

By

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NEW HAWAIIAN MEDUSAE

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CREEPING MEDUSAE

In a revision of the genus *Eleutheria* Quatrefages by Lengerich (12)¹ certain genera of previous authors, including the long-recognized *Cladonema* of Dujardin and the more recent *Cnidonema* of Gilchrist are placed in synonymy.

According to this revised classification *Eleutheria* comprises those Anthomedusae with branched tentacles the divisions of which bear groups of nematocysts or suckers or both. A velum is present and in some there is a brood pouch dorsal to the stomach.

Although some of its members are adapted for swimming, the genus also includes the creeping medusae of which all known species are small in size and inhabit shallow water.

The polyp phases of all species of *Eleutheria*, so far determined, are Tubularian hydroids.

While investigating the fauna associated with seaweeds about the shores of Oahu, there came to my attention several forms of creeping medusae apparently distinct from any previously reported.

***Eleutheria oahuensis*, new species (figs. 1, 2).**

Bell typically convex dorsally, flattened ventrally but capable of considerable change of shape; mouth occupying the center of the ventral surface which is often greatly protruded; brood pouch dorsal to the stomach communicating with the bell cavity by a series of small openings; radial canals apparently 8 in number but in living specimens usually obscured by the granular substance of the bell; tentacles as many as 18, bifurcated, dorsal branch, when mature, provided with two clusters of nematocysts on the aboral border, in addition to those of the capitate extremity; ventral branch of each tentacle terminating in a sucker; crimson eye-spot at the base of each well-developed tentacle; color of bell brown or reddish brown by transmitted light; tentacles clear, transparent, except for the granular contents of the axial canals; diameter of bell 0.5 mm.

Type locality, Waikiki reef, Oahu, where it is especially abundant.

In a typical specimen of this creeping medusa various degrees of development are seen in the tentacles. The early phases of the

¹ The numbers in parenthesis refer to Literature Cited (p. 16).

tentacles are represented by finger-like lobes without branches, suckers or nematocysts. As development takes place the lobes become bifurcated, a sucker appearing at the distal extremity of the ventral branch and the dorsal one is terminated by a spherical group of nematocysts. Later a cluster of stinging cells appears on the aboral border of the tentacle proximal to the capitate extremity and in a fully developed tentacle another group of nematocysts is formed on the same border but near the bifurcation. (See fig. 1, *a.*)

When the animal is at rest mature tentacles are extended to a length of about twice the diameter of the bell. When moving, the tentacles are successively raised and lowered in short, rapid jerks, the suctorial branches being used as organs of locomotion. (See fig. 1, *b.*) If turned on its back the animal is capable of moving to a limited extent, supporting itself on the capitate extremities of the dorsal tentacular branches. This abnormal position is soon corrected, however, by the animal righting itself. On being dropped into a container of quiet water the medusa settles straight to the bottom, showing no adaptation for swimming. Positive thigmotaxis is expressed in a very high degree in the behavior of the creeping medusa.

The phototropic behavior of the medusa was determined by shading one-half of a petrie dish partially filled with water and placing ten specimens on the line between light and shade. During the first hour movement was more or less at random, some specimens penetrating the darkened area and others moving about in the light. At the end of three hours all medusae were at rest in the lightest area, showing a positive response to strong but diffused light of the laboratory near a window.

The habitat of the medusa is correlated with its general behavior. The species is associated with *Ulva* and other seaweeds near the shore line where there often is high light and heat intensity as well as considerable dilution of sea water. Specimens placed on a fragment of *Ulva* covered by 3 mm. of water survived direct sunlight for one hour, the temperature of the water during this time reaching 30.2°C. When transferred directly to fresh water the animal dies in three or four minutes, disintegration of the tentacles beginning almost at once. The medusa will, however, survive indefinitely in sea water diluted by an equal part

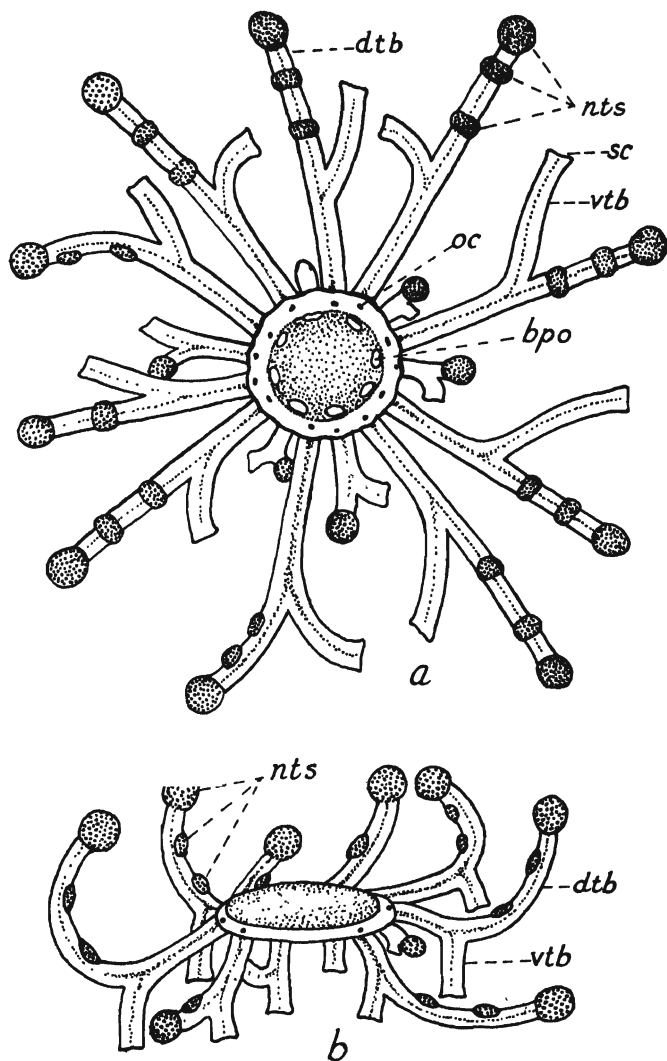


FIGURE 1.—*Eleutheria oahuensis*, new species: *a*, dorsal view with tentacles extended; *b*, lateral view, animal creeping; *bpo*, opening of brood pouch; *dtb*, dorsal tentacular branch; *nts*, nematocysts; *oc*, ocellus; *sc*, sucker; *vtb*, ventral tentacular branch.

of fresh water. Rain, surface water and sewage doubtless often reduce the salinity of the near-shore waters in which these animals live.

Nematocysts of the medusa are clear, oval cells, having, in an undischarged state, spindle-shaped axes. (See fig. 2, *c*.) When discharged, the contents of the cell are thrust out as a thick, basal projection with lateral spines and a long, tubular thread. (See fig. 2, *d*.)

In the aboral umbrellar tissue near the base of each well-developed tentacle and in line with its axis there is a crimson ocellus or eye-spot. Normally the eye-spot is a concentrated group of pigment granules but in some ocelli the granules are greatly diffused.

Budding, which commonly occurs, is the only method of reproduction observed in this medusa. A mature animal elongates, becoming constricted near the middle, and finally separates into two parts. (See fig. 2, *a*.) The daughter medusa when detached varies in size from about one-fourth to one-half the diameter of a full-grown individual. (See fig. 2, *b*.) The presence of numerous medusae of small size, each bearing a few completely formed tentacles, indicates that budding is a constant method of multiplication in this species, if not the exclusive one. Complete divisions have been observed to take place in from 12 to 20 hours. No polyp phase of this medusa is known. Some creeping medusae alternate with Tubularian hydroids, none of which has been observed in the shallow waters of Hawaii.

The principal food of the medusa seems to be minute copepods which abound among *Ulva* and other seaweeds. By means of its stinging cells the medusa paralyzes a copepod and completely engulfs it, often becoming greatly distorted in the process of ingestion.

There is no direct evidence that the medusa is the prey of other organisms. Because of its defensive weapons and the great numbers of individuals observed, the presumption is that it is well protected against possible enemies. Loss of tentacles, however, is apparently of common occurrence. Medusae taken from matted seaweeds which adhere closely to stones and support a rich fauna of polychaetous worms, isopods, and other organisms, often show a large proportion of mature individuals with but one or a few

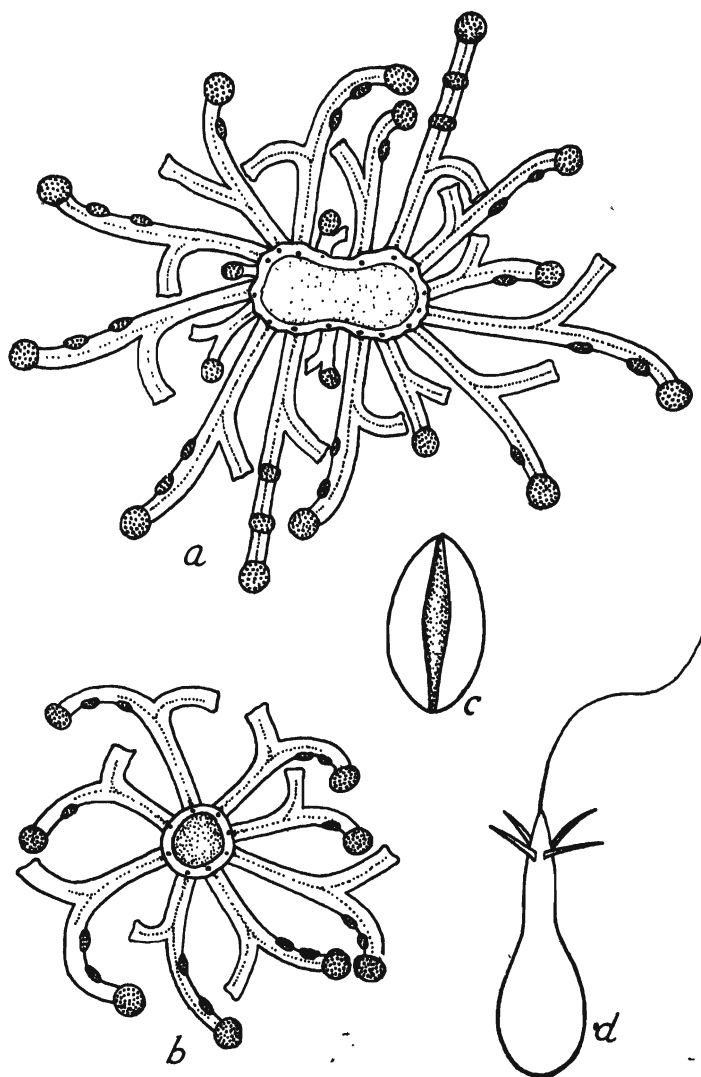


FIGURE 2.—*Eleutheria oahuensis*, new species: *a*, specimen undergoing division; *b*, daughter medusa separated from parent; *c*, undischarged nematocyst; *d*, discharged nematocyst.

tentacles, the others evidently having been destroyed. Although I have not observed any organism attacking medusae it is probable that enemies are responsible for the depletion of their tentacles. Caprellids which are very destructive of hydroid colonies, feeding ravenously on the polyps, apparently do not molest creeping medusae although they are associates of the same habitat. Four specimens of the medusa were confined with an adult caprellid in a small watch glass. After 18 hours the crustacean had not devoured the medusae, and while observed showed evidence of actually avoiding their well-defended tentacles.

The species has been collected on both the windward and leeward shores of Oahu and is especially abundant near the Marine Biological Laboratory at Waikiki.

***Eleutheria bilateralis*, new species (fig. 3).**

This species differs from *Eleutheria oahuensis* chiefly in the arrangement of the clusters of nematocysts on the dorsal tentacular

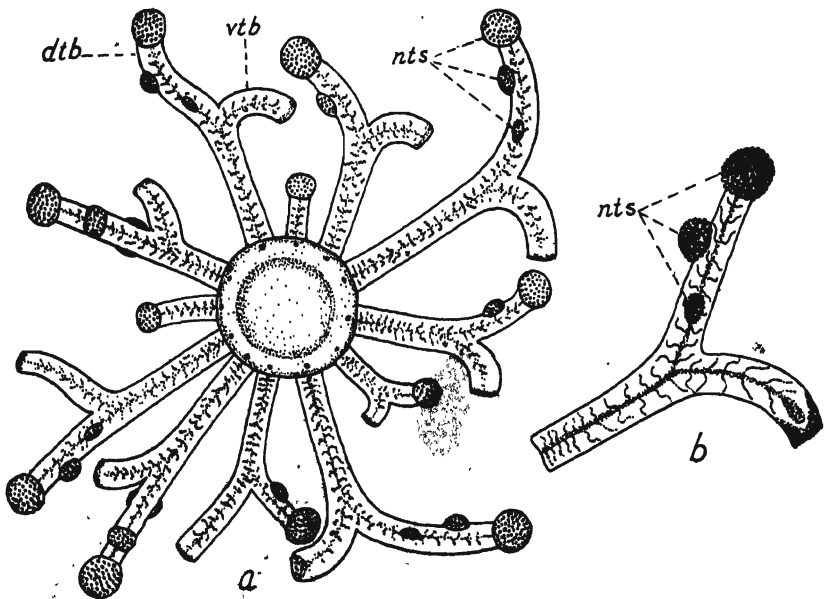


FIGURE 3.—*Eleutheria bilateralis*, new species: *a*, dorsal view with tentacles extended; *b*, tentacle showing clusters of nematocysts; *dtb*, dorsal tentacular branch; *nts*, nematocysts; *vtb*, ventral tentacular branch.

branch. Instead of two groups of nematocysts on the aboral border supplementary to the capitate extremity as in *E. oahuensis* one is placed aborally and two others are bilaterally arranged, one on either lateral border of the tentacle proximal to the aboral one. (See fig. 3, *a*, *b*.)

Although variable in number, the tentacles usually number about 12 and are stouter than in *E. oahuensis*. There is a brood pouch dorsal to the stomach and a crimson ocellus at the base of each tentacle.

Reproduction by budding has been observed. Color of bell, by transmitted light, brown. Diameter of bell of large specimen 0.6 mm.

Type locality, Waikiki reef, Oahu, where it occurs among algae near shore. The species has also been collected at Kawai-aloa and at Hanauma Bay, Oahu. At Waikiki it is less common than *E. oahuensis*.

Eleutheria acuminata, new species (fig. 4).

Shape of body resembles that of *Eleutheria oahuensis* and *Eleutheria bilateralis* but differs from both in the number and form of tentacles and the number and arrangement of the clusters of tentacular nematocysts.

The tentacles may number as many as 24, their bases so closely crowding the margin of the bell that some of the series may occupy a more ventral position than others. A marked acumination of the dorsal branch of each tentacle occurs toward its distal extremity, which is capped by a spherical cluster of nematocysts. Supplementary groups of nematocysts consist of two on the aboral border of the tentacle, one on the oral border and a small cluster, proximal to the others, on each lateral border. (See fig. 4, *a*, *b*.)

The radial canals are obscured by the granular substance of the bell. A dorsal brood pouch opens into the bell-cavity by a variable number of pores, as many as 18 having been observed by transmitted light. The granular substance of the umbrella extends into the bases of the tentacles in such a way as to give the body of the medusa a stellate appearance when viewed dorsally. A crimson ocellus is at the base of each tentacle.

Reproductive processes have not been observed in this species. Color of bell, by reflected light, pearl-white, by transmitted light, brown. Diameter of bell of large specimen 0.8 mm.; tentacles twice the length of diameter of the bell.

Type locality, Hanauma Bay, Oahu, where the species is abundant among algae in shallow water

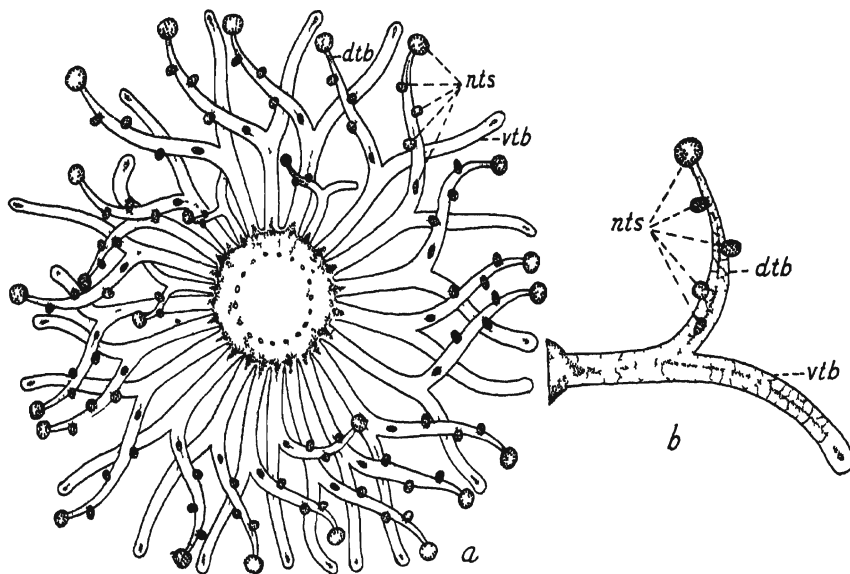


FIGURE 4—*Eleutheria acuminata* new species *a*, dorsal view with tentacles extended, *b*, tentacle showing clusters of nematocysts, *dtb*, dorsal tentacular branch, *nts*, nematocysts, *vtb*, ventral tentacular branch

The acuminate extremities of the tentacles, which taper to less than one-half their basal diameters, are very distinctive of this species and cause the capitate tips to appear unusually prominent

***Eleutheria alternata*, new species (fig 5)**

Bell with densely granulate area restricted to the central area surrounded by a clear peripheral zone through which 8 radial canals extend. Circular canal remote from the clear margin of the bell which overhangs the bases of the tentacles. Tentacles as many as 13 in number, stout, not tapering toward their distal extremities. Capitate group of nematocyst supplemented by 6 clusters of stinging cells arranged in two alternating series on the aboral border of the dorsal tentacular branch (See fig 5, *a, b*). Color of central region of bell dark brown by transmitted light, other parts clear, transparent with canals of umbrella and tentacles defined by granules. Diameter of bell of a large specimen 0.8 mm

Type locality, Hanauma Bay, Oahu.

This form is distinct from other Hawaiian species of creeping medusae in the character of the umbrella and in the arrangement

of the clusters of nematocysts on the tentacles. So far but three specimens have been observed, all from the type locality and all presenting identical characteristics.

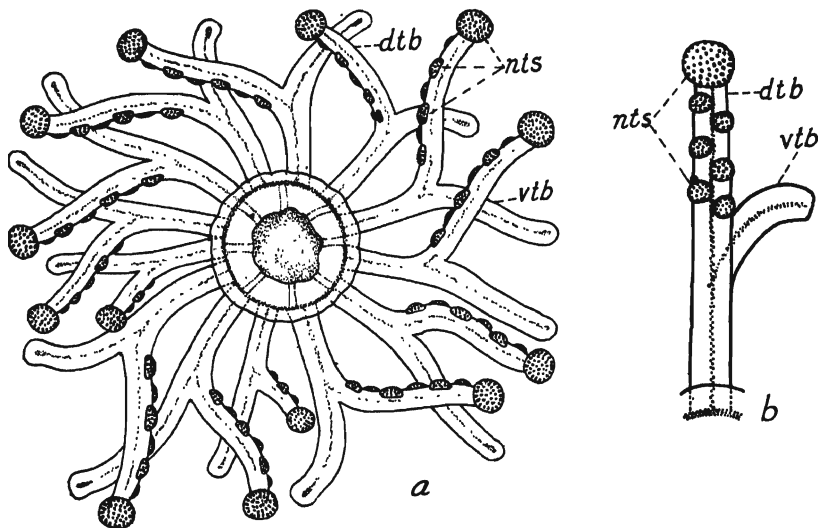


FIGURE 5.—*Eleutheria alternata*, new species: *a*, dorsal view with tentacles extended; *b*, aboral view of tentacles showing clusters of nematocysts; *dtb*, dorsal tentacular branch; *nts*, nematocysts; *vtb*, ventral tentacular branch.

On revising the genus *Eleutheria* the following species and synonymy were recognized by Lengerich (12):

- Eleutheria radiata* (Dujardin)
- Cladonema radiatum* Dujardin (6).
- Dendronema stylodendron* Haeckel (8).
- Eleutheria perkinsii* (Mayer)
- Cladonema perkinsii* Mayer (13).
- Eleutheria robsonia* Lengerich (12).
- Eleutheria claparèdei* Hartlaub (9)
- Eleutheria dichotoma* Claparède (5).
- Eleutheria dichotoma* Quatrefages (16)
- Eleutheria vallengini* Browne (3)
- Wandalia charcoti* Bedot (1).
- Eleutheria hodgsoni* Browne (4).
- Cnidonema capensis* Gilchrist (7).
- Cnidonema haswelli* Briggs (2).

Kishinouye (11) described *Urashimea globosa*, which he considered to be one of the Cladonemidae. Mayer (14) was not cer-

tain of the position of this species and Lengerich does not recognize it.

Of the six species of *Eleutheria*, as arranged by Lengerich, three (*E. radiata*, *E. perkinsii*, and *E. robsonia*) are adapted for swimming, and three (*E. claparèdei*, *E. dichotoma*, and *E. vallentini*) for creeping. Of the creeping forms two are European in distribution: *Eleutheria claparèdei* Hartlaub, described from the Bay of Naples, and *Eleutheria dichotoma* Quatrefages, known from the shores of England, Belgium, and France, and from the Mediterranean Sea. Both of these possess tentacles with nematocysts only at the capitate extremities of the dorsal branches. With respect to the location of the defensive organs of the tentacles all known Hawaiian forms show distinct differences from the European species.

The third previously recognized species of creeping medusa, *Eleutheria vallentini* Browne (3), known only from the southern hemisphere, was first described from the Falkland Islands in 1902. More recently medusae considered by Lengerich to be synonymous with this species have been reported from various localities, including Wandel Island by Bedot (1), McMurdo Sound by Browne (4), the Kerguelen Islands by Vanhöffen (17), Cape of Good Hope by Gilchrist (7) and Port Jackson, Australia, by Briggs (2).

The species of the southern hemisphere, if the several forms are to be considered identical, is more closely allied to the Hawaiian ones than are the Hawaiian to those of Europe. An affinity between *Eleutheria vallentini* and the Hawaiian species is seen in that all possess clusters of nematocysts on the dorsal branch of each mature tentacle in addition to the capitate group at its extremity. In *Eleutheria vallentini*, however, the clusters of nematocysts may be numerous and are not confined to the aboral margin of the tentacle but are also distributed on its lateral and oral borders.

Based on the arrangement of the clusters of nematocysts, it is seen that two of the Hawaiian forms, *Eleutheria oahuensis* and *Eleutheria alternata* are more remotely related to *Eleutheria vallentini* than the other two. In *Eleutheria bilateralis* of Hawaii the two proximal clusters of nematocysts are lateral in position but none is on the oral border of the tentacle. In *Eleutheria acuminata* one cluster occupies an oral position and two are laterally

placed. The large number of tentacles and their acuminate character would, however, seem to be sufficient to specifically distinguish it from the species of the southern hemisphere. Moreover, *Eleutheria vallentini* is five or six times as large as any of the Hawaiian species.

The Hawaiian forms seem to be transitional between the northern (European) species and the one ranging through the southern seas. They represent the first creeping medusae to be reported from the North Pacific Ocean.

The following key includes the species of Hawaiian *Eleutheria*:

- A. Clusters of nematocysts (supplementary to capitate group) confined to aboral border of tentacles.
 - a. Margin of umbrella not overlapping the base of tentacles..... **E. oahuensis.**
 - b. Margin of umbrella overlapping the base of tentacles..... **E. alternata.**
- B. Clusters of nematocysts (supplementary to capitate group) not confined to aboral border of tentacles.
 - a. Tentacles acuminate at distal extremities. Clusters of nematocysts on aboral, lateral and oral borders of tentacles..... **E. acuminata.**
 - b. Tentacles not acuminate at distal extremities. Clusters of nematocysts on aboral and lateral borders of tentacles only..... **E. bilateralis.**

A SESSILE MEDUSA

Of the five orders of Scyphomedusae recognized by Mayer (14) the Stauromedusae represent a peculiar and highly specialized group. Correlated with their sessile mode of life are evidences of degeneration, as shown by the absence of such sense organs as ocelli and otocysts and in the loss of power of pulsation exhibited by free-swimming forms.

Degrees of specialization are also observed within the order. In some genera capitate tentacles are typical of the notches between the marginal lobes. These tentacles may be modified into adhesive bodies or anchors serving as accessory clinging organs. In other genera the anchors are absent entirely or present in the early stages, disappearing with the maturity of the individuals.

The larval phases of the sessile medusae also exhibit degenerate features. Planulae are without cilia and have no power of swimming, their mode of locomotion being confined to creeping.

Except in the family Tesseranthinae of Haeckel (8), all adult

Stauromedusae are attached by a peduncle developed from the aboral surface, seaweeds usually serving as a support. A typical mature specimen resembles, in a general way, the scyphistoma stage of the more regular Scyphomedusae.

The normal habitat of previously recorded species of sessile medusae is the shallow water of cold latitudes. Up to this time none has been reported from tropical or subtropical localities.

Of the sessile Stauromedusae Mayer (14) considered nine genera as well established and two as doubtful. The best-known genera are *Lucernaria* O. F. Müller and *Halyclystus* Clark, the former being characterized by the absence of marginal anchors in the mature stage and the presence of a single-chambered peduncle, the latter by the presence of anchors and four perradial chambers in the stalk.

Oka (15) described a species from Japan as *Lucernaria naga-tensis* which was placed by Kishinouye (10) under the preoccupied generic term *Schizodiscus*. Mayer (8) established a new genus to accommodate this species now recognized as *Kishinouyea naga-tensis* (Oka).

The genus *Kishinouyea* resembles *Lucernaria* in the absence of anchors or perradial marginal tentacles but differs from it in having four perradial chambers in the stalk. A canal in the lower part of the peduncle opening by a pore in the middle of the flattened foot or surface of attachment is another characteristic of the genus *Kishinouyea*. The Hawaiian species here recorded belongs to this genus.

***Kishinouyea hawaiiensis*, new species (fig. 6).**

Medusa symmetrically bell-shaped, the aboral surface broadly rounded, and sharply differentiated from the peduncle. Eight arms united in pairs, the interradial notches about one-half the depth of the perradial. No perradial tentacles or anchors. Adradial tentacles short, capitate and adhesive, from 16 to 21 terminating each lobe. (See fig. 6, *a*.) Peduncle cylindrical with four perradial chambers (fig. 6, *b*) and a canal terminating in a pore in the middle of the flattened foot (fig. 6, *c*). Gonads five pairs of oblong sacs laterally arranged on the medial surface of each united pair of lobes. (See fig. 6, *d*.) Color in life, greenish brown.

Type specimen from Kahana Bay, Oahu, on seaweeds in shallow water.—Height of bell (preserved specimen) 6.5 mm., greatest diameter, 4.8 mm.; length of peduncle 1.8 mm., diameter of

peduncle 1.25 mm. Type specimen and another taken on Waikiki reef, Oahu, in the Bishop Museum.

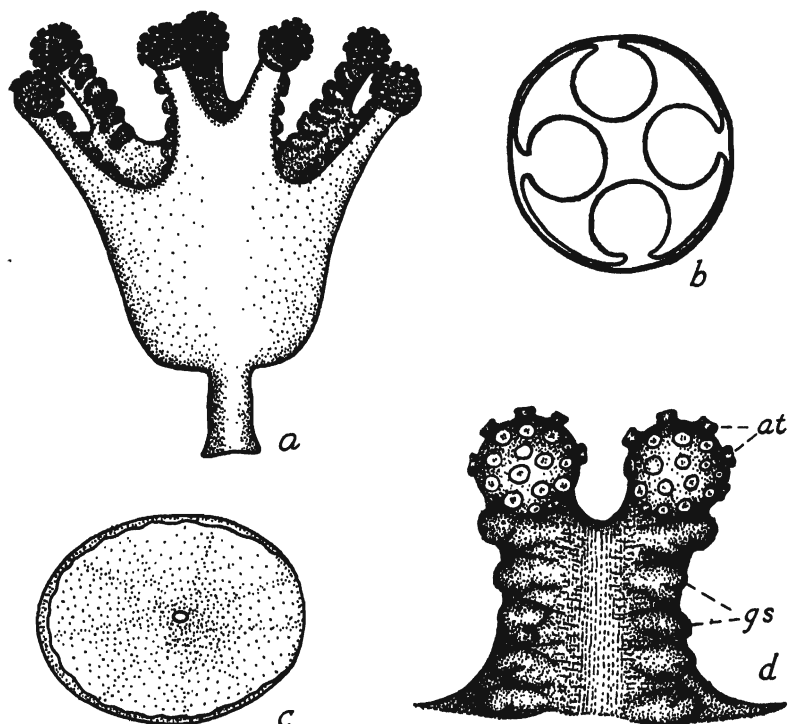


FIGURE 6.—*Kishinouyea hawaiiensis*, new species: *a*, lateral view of the medusa; *b*, cross section of peduncle showing four chambers; *c*, basal end of peduncle showing central pore-opening of a canal of the peduncle; *d*, medial surface of a lobe showing gonads and adhesive tentacles; *at*, adhesive tentacles; *gs*, gonads.

From *Kishinouyea nagatensis* the Hawaiian species differs in the adradial lobes not being bent at right angles to the oral surface, as reported for the Japanese form, but only slightly reflected outward. Adradial tentacles in the Hawaiian species are not arranged in clusters of five as in *Kishinouyea nagatensis*. The gonads seem to be arranged in a similar manner in the two species but are fewer in number in the Hawaiian form. Sections of the stalk of the Hawaiian species show four symmetrically arranged chambers, the same number being present in *Kishinouyea nagatensis*.

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**EFFECT OF ULTRAVIOLET RAYS
IN REGENERATION OF CHELIPEDS**

By

CHARLES HOWARD EDMONDSON

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EFFECT OF ULTRAVIOLET RAYS IN REGENERATION OF CHELIPEDS

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INTRODUCTION

Although it is very generally believed that ultraviolet rays possess properties of therapeutic value, considerable evidence has accumulated during the past eight years tending to show that such radiant energy, under well-directed administration, may be highly injurious to the metabolic processes of animals.

Burge and Wickwire¹ showed that the utilization of sugar by animal cells (Protozoa) was greatly decreased under ultraviolet radiation. Harvey² demonstrated that the luminescence of ctenophores was inhibited by ultraviolet rays. Lillie and Baskerville^{3, 4} pointed out that the influence of ultraviolet was similar to other physical agents in modifying and malforming blastulae and gastrulae of echinoderms. Hinrichs^{5, 6} radiated the ova and sperm of sea urchins and noted a reduction in the power of fertilization and an interference in the development of the zygote if fertilization was accomplished.

Bovie and Barr⁷, Child⁸ and Hinrichs⁹ have shown there is a differential susceptibility to radiation in living animals. According to these investigators, regions of high activity are first affected by ultraviolet and other stimuli and more readily inhibited and suppressed than regions where metabolic processes go on more slowly. These most active parts are also the first to recover if the injury from the stimulus be slight.

¹ Burge, W. E., and Wickwire, G. C., The decrease in sugar metabolism and destruction of insulin by ultra-violet radiation: Journ. Biol. Chemistry, vol. 72, pp. 827-833, 1927.

² Harvey, E. N., Studies on Bioluminescence, XVII, Fluorescence and inhibition of luminescence in Ctenophores by ultra-violet light: Journ. Gen. Physiology, vol. 7, pp. 331-339, 1925.

³ Lillie, R. S., and Baskerville, M., The action of ultraviolet rays on starfish eggs: Amer. Jour. Physiology, vol. 61, no. 1, pp. 57-71, 1922.

⁴ Lillie, R. S., and Baskerville, M., The action of ultraviolet rays on Arbacia eggs especially as affecting the response to hypertonic sea-water: Amer. Jour. Physiology, vol. 61, no. 2, pp. 272-288, 1922.

⁵ Hinrichs, M. A., Ultraviolet radiation and the fertilization power of Arbacia sperm: Biol. Bull., vol. 50, pp. 473-489, 1926.

⁶ Hinrichs, M. A., Ultraviolet radiation and the fertilization reaction in Arbacia punctata: Biol. Bull., vol. 53, no. 6, pp. 416-437, 1927.

⁷ Bovie, W. T. and Barr, C. E., Photocytolysis as a measure of metabolic activity: Science, vol. 59, no. 1514, p. 22, 1924.

⁸ Child, C. M., Modification of development in relation to differential susceptibility: Amer. Nat., vol. 58, pp. 237-253, 1924.

⁹ Hinrichs, M. A., A demonstration of the axial gradient by means of photolysis: Jour. Experimental Zoology, vol. 41, no. 1, pp. 21-31, 1924.

METHOD OF INVESTIGATION

The species selected as the subject of the experiments here described was *Atya bisulcata* (Randall), a fresh water prawn, endemic in Hawaii and abundant in the mountain streams.

The prawn is nocturnal in habits, being concealed during the day under stones and vegetation and at all times is shielded from light except that of a very weak and diffused character. Representing an ancient group of crustaceans the species has lived in semi-darkness for a long time and shows in its movements strong negative phototropic responses. Because of its habitat the species probably has not developed through inheritance any special protective measures against sunlight or strong radiant energy except the pigment of its integument.

Edmondson¹⁰ has shown that the regeneration of chelipeds after mutilation, under normal conditions, is rapid in this species and progresses at a regular rate for a period of from 8 to 12 days when increase is inhibited and the appendage remains in a stable condition until the next molt, immediately after which the cheliped assumes the adult form. A length of from 2.5 mm. to 3 mm. is reached in from 8 to 12 days and any marked variation from this normal rate of regeneration is readily detected.

The source of ultraviolet light used in this investigation was a Cooper-Hewitt 110-watt Uviarc lamp. By means of a simple device the animals were held in any position desired by the experimenter during the treatments. The specimens were removed from the water and exposed to the direct rays of the Uviarc in the air. That a short period out of water daily (5 minutes) is not deleterious to the animals is shown by their ability to live out of water in the shade for from 8 to 10 hours.

On removing one or more of the four chelipeds of *Atya* exposures of from 1 to 5 minutes daily of the dorsal or ventral surfaces of the animal at 20, 32, 44 and 52 cm. from the arc were made. Single treatments during a period of 10 days were also made as well as treatments on alternate days. All were compared with untreated controls.

To eliminate heat developed by the Uviarc as a possible factor in affecting the rate of regeneration two methods were employed. Crushed ice was packed about the container in which the animal was

¹⁰ Edmondson, C. H., Hawaiian Atyiidae: B. P. Bishop Mus. Bull. 66, pp. 1-36, 1929.

held while being illuminated. The exposure was thus made in an air temperature ranging from 20°C. to 24°C. which approximates that of the mountain streams in which the species lives. The other method was by adjusting a 250-watt Mazda lamp at such a distance as to produce in a 5-minute period temperature equal to that developed by the Uviarc lamp in the same time at 52 cm. The rate of regeneration shown by specimens under the Mazda lamp was compared with that resulting from radiation by the Uviarc.

Animals with mutilated chelipeds were exposed to direct sunlight 5 minutes daily for periods of 10 days and other specimens were illuminated by the ultraviolet lamp with a plate of window glass interposed between the arc and the animals.

RESULTS

A dorsal exposure of specimens to the ultraviolet light at 52 cm. from the arc resulted in no significant variation in the rate of regeneration from that shown in untreated controls.

Ventral radiation resulted in marked retardation of regeneration at all distances from the arc and at all lengths of exposure, if the treatments were made daily.

Ventral exposures made but once during a period of 10 days had no effect on the rate of regeneration. Treatments made on alternate days showed little or no effect.

Neither dorsal or ventral exposure to direct sunlight (5 minutes daily) had any effect on the rate of regeneration. Animals illuminated by the Uviarc lamp with window glass intervening regenerated at a rate normal to untreated controls.

That heat produced by the ultraviolet lamp is not an important factor in retardation of regeneration is shown by the fact that normal development follows treatments up to 5 minutes daily under the Mazda lamp in an air temperature equal to that developed by the Uviarc lamp at 52 cm. At this distance radiation of the ventral surface 5 minutes daily by ultraviolet slows up the rate of regeneration by at least 50 per cent. (See fig. 1.)

Experiments in which a jacket of ice cooled the air surrounding the animal during radiation by the Uviarc resulted no more favorably on the rate of regeneration than exposures to ultraviolet without the cooling process.

At short ranges, 32 cm. and 20 cm. from the arc, both dorsal

and ventral exposures to ultraviolet resulted in retardation of regeneration. As at the greater distances, however, the ventral illumination was followed by more suppressing effects. (See fig: 1.)

With altered dosage a differential inhibition was more or less clearly noted. A ventral exposure for 5 minutes daily at 52 cm.

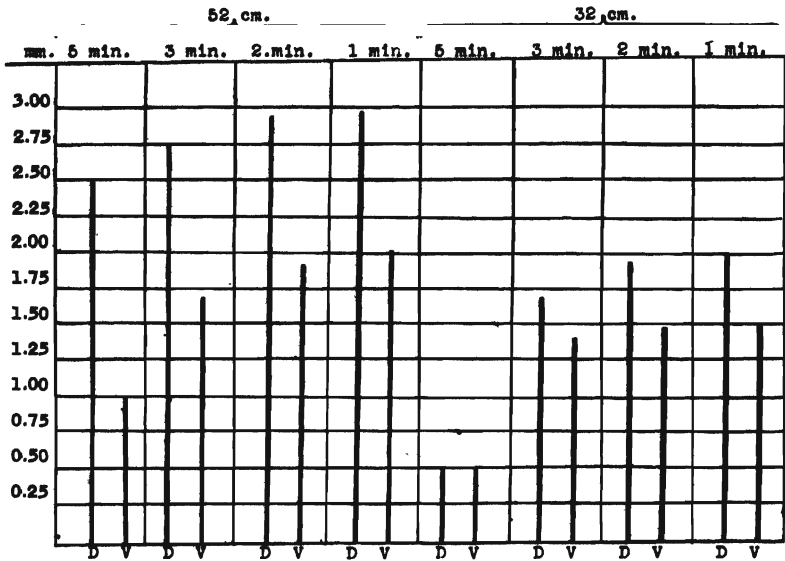


FIGURE 1.—Diagram showing the regeneration of chelipeds of *Atya bisulcata* during a period of 8 days; treated 1, 2, 3, and 5 minutes daily with ultraviolet rays, 52 cm. and 32 cm. from the arc. D, dorsal exposure; V, ventral exposure.

from the arc had a more retarding effect than an exposure for 3 minutes daily at the same distance and the influence grew progressively less as the time of exposure decreased. (See fig. 1.) Altering the dosage by grading the distance from the arc also showed a differential, the longer ranges having less unfavorable effects on the rate of regeneration.

CONCLUSIONS

It is suggested that in radiating the ventral surface of the animals from which chelipeds have been removed the rays fall directly upon the stumps of the mutilated appendages which are regions of high metabolic activity. Under normal conditions multiplication of cells occurs here at a rapid rate. Radiant energy of ultraviolet probably

interferes with the metabolism of the superficial cells, retarding or inhibiting their activity.

On a dorsal exposure, at the greater distances from the arc (52 cm. or 44 cm.) the rays probably do not penetrate the chitinous exoskeleton and have no appreciable effect on the metabolism of the animal.

At closer range (32 cm. or 20 cm.) the radiant energy seems to be sufficient to affect the metabolism of the animal in a suppressing manner whether the rays fall upon the dorsal or ventral surface.

NEW HAWAIIAN CRUSTACEA

By

CHARLES HOWARD EDMONDSON

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NEW HAWAIIAN CRUSTACEA

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NEW SPECIES OF PROCESSA

Two species of *Processa* have previously been recorded from Hawaiian waters. Rathbun¹ reported *P. processa* (Bate) from the Albatross collections and it was taken in shallow water from the leeward islands of Hawaii by the Tanager Expeditions in 1923. Dana² describes *P. hawaiiensis* (Dana) from local waters, probably Maui, although the locality is doubtful.

In *P. processa* the rostrum is as long as the eyes and the carpus of the second, right leg has about 65 segments. The rostrum of *P. hawaiiensis* is shorter than the eyes and the carpi of the second legs have 11 segments.

Among recent collections from Oahu there have appeared specimens of an apparently new species which bears closer relationship with *P. hawaiiensis* than with *P. processa* but is quite distinct from either.

***Processa paucirostris*, new species (fig. 1).**

Rostrum shorter than eyes, straight, without keels, spines or hairs. Eyes large, the pigmented area occupying about one-half the bulbous portion. A sharp suborbital spine as long as the rostrum on the front border of the carapace. Pterygostomial border rounded. (See fig. 1, *a, b*.)

Basal segment of antennular peduncle longer than the last two segments combined. Antennular peduncle slightly shorter than antennular peduncle; scale exceeding the antennular peduncle in length and equal to the antennular peduncle. (See fig. 1, *c, d*.) Third maxilliped straight and stout. (See fig. 1, *e*.)

First leg on the right side chelate, smooth and unarmed; carpus one-half as long as the merus and equalling the palm in length. Fingers nearly as long as palm. (See fig. 1, *f*.) First leg on left side about as stout as the cheliped but terminating in a sharp claw. (See fig. 1, *g*.) Carpus of second leg on the right side with 18 segments; merus also segmented, eight faint transverse sutures being evident. (See fig. 1, *h*.) Fourth leg slender; propodus twice as long as dactylus, both bearing a few tufts of short bristles. (See fig. 1, *i*.)

Telson marked longitudinally by two nearly parallel crests bearing two pairs of short, sharp spines. Three small spines arm the posterior border of the telson. (See fig. 1, *j*.) Uropods slightly longer than telson, narrow with smooth surfaces. (See fig. 1, *k*.)

¹ Rathbun, Mary J., *Brachyura and Macrura of the Hawaiian islands*: U. S. Fish Comm., Bull., vol. 23, pt. 3, p. 912, 1906.

² Dana, J. D., *Crustacea*: United States Expl. Exped. [Wilkes], vol. 13, pt. 1, p. 538, 1852; pl. 33, fig. 7, *a-h*, 1855.

Type specimen a female; length from tip of rostrum to extremity of telson 17 mm. Type locality, Kahana Bay, Oahu, in shallow water. Bishop Museum collections No. 1533.

This species is quite distinct from *P. processa* in the brevity of

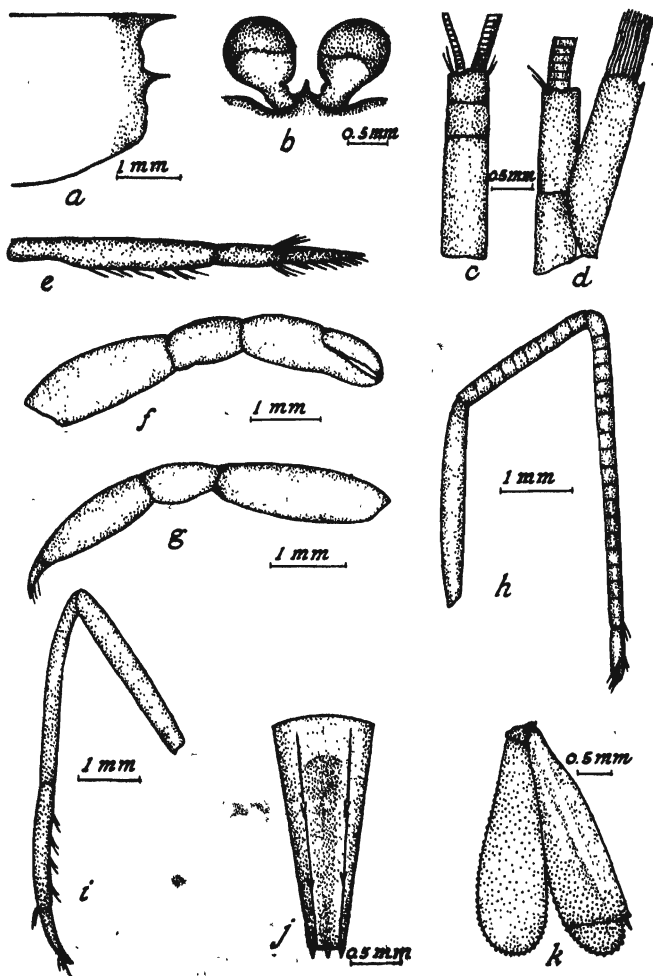


FIGURE 1.—*Processa paucirostris*, new species: a, front region of carapace, lateral view; b, rostrum and eyes, dorsal view; c, antennular peduncle; d, antennal peduncle; e, outer maxilliped; f, first leg, right side; g, first leg, left side; h, second leg, right side; i, fourth leg, left side; j, telson; k, uropod, right side.

the rostrum and in having fewer carpal segments of the second leg. From *P. hawaiiensis* it differs in the larger number of carpal segments in the second leg and in the rostrum being straight.

HAWAIIAN SPECIES OF *JOUSSEAUMEA*

Preceding the publication of the monograph on the Alpheidae of the Siboga Expedition in 1911, but 5 species of the genus *Jousseau-*mea** were known. Three of these, *J. serratidigitus*, *J. latirostris* and *J. cristatus*, were described by Coutière³ from the Gulf of Aden; one, *J. trigona* Rathbun,⁴ from Porto Rico, and one, *J. ortmanni* Coutière, from the coast of North America. Two species, *J. sibogae* and *J. hilarula* were described by de Man⁵ from collections of the Siboga Expedition taken in the east Indian seas. Now the appearance of 2 additional species, apparently new, among the shallow water fauna of Hawaii is supporting evidence of the wide distribution of this genus of the snapping shrimps.

*Jousseau-*mea* mauiensis*, new species (fig. 2).

Rostrum triangular, sharply pointed, a little longer than broad at base, slightly curved down, lower border narrowly rounded, upper surface carinate. Extra-corneal teeth triangular, directed straight forward, their medial border forming less than a right angle with the lateral border of the rostrum. Tip of rostrum extending beyond the posterior border of the third segment of the antennular peduncle. Second segment of the antennular peduncle as long as the visible portion of the first; third segment one and one-half times as long as the second. Stylocerite extending to the middle of the third antennular segment and slightly longer than the rostrum. (See fig. 2, *b*.) Carpocerite as long as antennular peduncle but shorter than the antennal scale; third segment of carpocerite as long as the combined length of the first and second. (See fig. 2, *c*.)

Carapace with pterygostomian angle rounded; surface smooth, scantily covered with short, yellow hairs. Telson a little less than twice as long as broad at base, which breadth is approximately twice that of the distal extremity. Two pairs of minute spinules are on the dorsal surface of the telson and the median notch of its posterior margin is a shallow, rounded depression. There are 2 spinules on either side of the median notch, the lateral ones being the shorter, and 3 feathered bristles medial of the spinules on either side of the mid-line. (See fig. 2, *g*.) The uropods extend slightly beyond the tip of the telson.

The large, right cheliped has a slender ischium and merus, both segments convex above and concave below, fitting closely about the curvature of the palm

³ Coutière, Henri, Note sur quelques genres nouveaux . . . : Museum d'Hist. Nat., Bull., vol. 2, p. 382, Paris, 1896; vol. 3, p. 234, Paris, 1897.

⁴ Rathbun, Mary J., Brachyura and Macrura of Porto Rico: U. S. Fish Comm., Bull., vol. 20, pt. 2, p. 111, 1900.

⁵ de Man, J. G., Decapoda of the Siboga expedition, Alpheidae: pt. 2, pp. 158-162, 1911.

as the appendage is folded beneath the body. Palm twice as long as high, surface smooth; fingers slightly shorter than palm, strongly hooked at tip and distinctly toothed. (See fig. 2, *d*.) Second leg slender, proximal segment of carpus five times the length of the second segment; third and fourth segments equal in length, shorter than the second; fifth segment longer than second. (See fig. 2, *e*.) In type specimen the posterior border of propodus of third leg is armed with 5 spinules increasing in length toward the distal extremity;

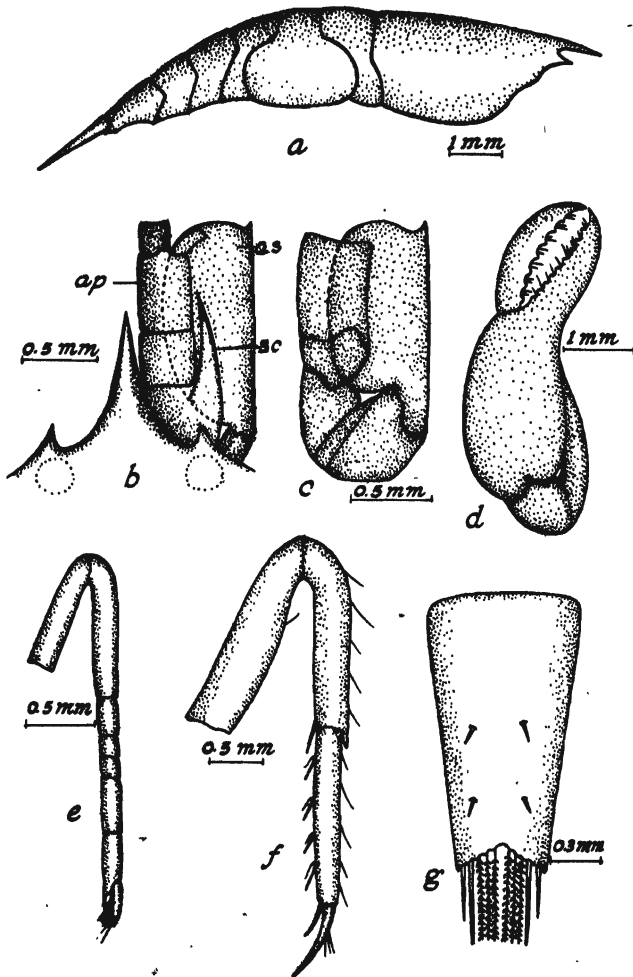


FIGURE 2.—*Jousseaukea mauiensis*, new species: *a*, carapace and abdomen from right side; *b*, frontal region, including antennular peduncle *ap*, stylocerite, *sc*, and antennal scale, *as*; *c*, antennal peduncle and scale; *d*, large (right) cheliped; *e*, second leg, right side; *f*, third leg, right side; *g*, telson.

dactylus long, curved. (See fig. 2, f.) The chief difference between the third and fourth legs is in the more slender and shorter merus and carpus of the latter appendage. The fifth leg is more slender than the fourth.

Type specimen a female; length from anterior tip of rostrum to posterior extremity of telson 13.75 mm. Type locality, island of Maui. Collected by Mrs. F. K. Skinner in shallow water among dead coral heads. Bishop Museum collections No. 2612.

The species from Maui differs from those described from the Gulf of Aden in having but 2 spinules on either side of the median notch of the posterior border of the telson instead of 4. In the number of these spinules *J. mauiensis* resembles the two species described from the Siboga collections but differs from each in the form of the median, posterior notch of the telson and in details of the appendages. In both *J. sibogae* and *J. hilarula* the posterior notch of the telson is trapeziform and much deeper than in *mauiensis*.

The front of the carapace of the Maui specimen more nearly resembles that of *J. latirostris* than other described species, the angle between the rostrum and the extra-corneal spine, however, being less acute in *J. mauiensis* because of the greater relative breadth of the base of the rostrum in *J. latirostris*.

In *J. mauiensis* the scale of the antenna exceeds in length the peduncle of the antennule while in *J. sibogae* it equals it and in *J. hilarula* it is much shorter. There is also a heavier armature of spinules and bristles on the walking legs in *J. mauiensis* than in either of the species of the Siboga Expedition.

With the type specimen a paratype was collected and other specimens have been taken from the reefs of Oahu in crevices of dead coral heads. Living specimens are orange-yellow in color but soon fade to white in alcohol. On Oahu the species has always been found associated with a large, flesh-colored polychaetous worm.

***Jousseamea brevirostris*, new species (fig. 3).**

Rostrum sharp pointed, straight, short, reaching but to the distal extremity of the first antennular segment, upper surface with a carina which extends half the length of the carapace. Extra-corneal teeth half as long as the rostrum and separated from its base by wide, shallow depressions. (See fig. 3, b.)

Second and third antennular segments equal in length and each equal to the exposed portion of the first. Stylocerite extends to the base of the third antennular segment. Carpocerite as long as stylocerite but shorter than the antennal scale, which extends slightly beyond the antennular peduncle. (See fig. 3, b, c.)

Carapace with surface smooth, covered with fine, short, yellow hairs; pterygostomian border rounded. (See fig. 3, *a*.) Telson with two pairs of spinelets on dorsal surface; posterior border with a deep, narrow notch provided on either side with three feathered bristles and two spinules, the outer one being the shorter. (See fig. 3, *g*.)

The large, right cheliped is usually folded beneath the body, the slender

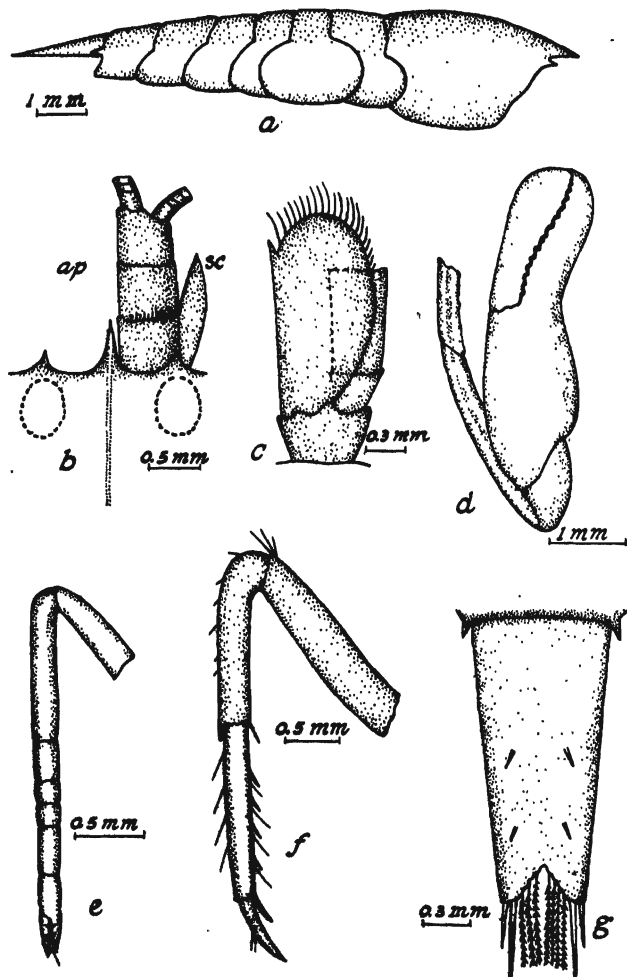


FIGURE 3.—*Jousseumea brevirostris*, new species: *a*, carapace and abdomen from right side; *b*, frontal region including antennular peduncle, *ap*, and stylocerite, *sc*; *c*, antennal peduncle and scale; *d*, large (right) cheliped; *e*, second (left) leg; *f*, third (left) leg; *g*, telson.

ischium and merus being concave and fitting closely about the palm in the flexed condition. Palm smooth, fingers deep, thin, slightly bent down and strongly toothed. (See fig. 3, *d*.) Basal segment of carpus of slender second leg about four times the length of the second segment, which is shorter than the fifth; third and fourth segments equal (See fig. 3, *e*.) Third, fourth and fifth legs of similar form but becoming progressively shorter and more slender; propodus in each armed on the posterior border with spinelets; dactylus long and sharp. (See fig. 3, *f*.)

Type specimen a female; length from anterior tip of rostrum to posterior extremity of telson 14 mm. Type locality, Waikiki reef, Oahu, in shallow water in a dead coral colony. Bishop Museum collections No. 3335.

Jousseamea brevirostris differs from *J. mauiensis*, chiefly in the character of the rostrum, extra-corneal teeth and the notch of the posterior border of the telson. It more nearly resembles *J. sibogae* de Man and *J. hilarula* de Man in the form of the notch of the telson, but the short rostrum with the extra-corneal teeth widely separated seems to be a distinctive feature of this species. As in *J. mauiensis* it is bright-yellow in life. A male specimen, 11 mm. in length, was taken at Kahala, Oahu.

NEW SPECIES OF AXIOPSIS

According to de Man's classification of the Axiidae, the Hawaiian species recognized up to this time are as follows:

Axius (*Eiconaxius*) *asper* (Rathbun⁶); *Axius* (*Paraxius*) *tridens* (Rathbun⁶); *Axiopsis* (*Axiopsis*) *pailoensis* (Rathbun⁶); *Axiopsis* (*Axiopsis*) *rudis* (Rathbun⁶); *Axiopsis* (*Axiopsis*) *spinosissima* (Rathbun⁶); and *Axiopsis* (*Axiopsis*) *serratifrons* (A. M. Edwards⁷). Of these *asper*, *tridens* and *rudis* are known only from dredged material in Hawaiian waters, while *spinosissima* and *serratifrons* have wider-known ranges and in some localities occur on reefs close to shore. In Hawaii, *Axiopsis spinosissima* has been taken from the stomach of a common food fish (*opakapaka*), and also dredged at 23 to 24 fathoms on the south coast of Molokai. No recent records of *Axiopsis serratifrons* from Hawaii are known, but it was reported from this locality by A. M. Edwards in 1873.

⁶ Rathbun, Mary J., *Brachyura and Macrura of the Hawaiian islands*: U. S. Fish Comm., Bull., vol. 23, pt. 3, pp. 893-896, 1906.

⁷ Edwards, A. M., *Description de quelques Crustacés, nouveaux ou peu connus*: Jour. Museum Godeffroy, vol. 4, p. 87, 2, fig. 6, 1873.

There are specimens in Bishop Museum from Howland, Christmas, and Fanning islands.

Three specimens of an apparently new species of *Axiopsis* were collected in 1927 at Pearl and Hermes Reef.

***Axiopsis (Axiopsis) irregularis*, new species (Plate 1, *A*; fig. 4).**

Rostrum sharp pointed, longer than broad at base and reaching to the distal end of the second segment of the antennular peduncle; lower surface with a low keel, upper surface concave and bearing in the mid-line a dentate ridge terminating the median row of teeth of the carapace.

Front portion of upper surface of the carapace marked by five longitudinal rows of teeth, the median one consisting of nine teeth exclusive of a ridge which extends forward on the rostrum. Sub-median row on the left side with four teeth and that on the right side with five teeth. Lateral rows each with four teeth. The posterior teeth in the sub-median and lateral rows terminate smooth, elongated ridges. (See fig. 4, *a*.)

Cervical groove, without teeth but bordered with hairs, reaching the front border of the carapace and terminating just above the pterygostomial tooth. Orbit of eye shallow; a small tooth on the front border of carapace at the base of antennal peduncle and a large one at the pterygostomial angle.

Basal segment of antennular peduncle concave dorsally, its length visible from above subequal to the combined length of the second and third segments. (See fig. 4, *c*.) Distal extremity of second segment of antennal peduncle on a level with the extreme end of the antennular peduncle. Antennal thorns long and large, the longer one extending almost to the extremity of the second segment of the peduncle. (See fig. 4, *d*.) Eyes half as long as rostrum, pigmented. Surface of carapace on sides and posterior to cervical groove bearing a few scattered yellow hairs.

Telson slightly longer than broad, lateral borders parallel, each with three teeth, the posterior one very minute. Posterior border of telson rounded with a double margin, the dorsal one bearing three minute teeth toward the lateral side and some hairs medially; ventral margin fringed with long hairs. A prominent tooth marks the mid-line of the posterior border of the telson. Upper surface of telson with a medial concavity in the posterior two-thirds of its length and bearing two pairs of strong spines, the anterior pair being larger and closer together. Three tufts of long hairs are carried on the upper surface of the telson, one originating between the anterior pair of spines and one on each side more lateral and anterior in position. The posterior border of the sixth segment of the abdomen gives rise to three tufts of long hairs which extend backward over the telson. (See fig. 4, *g*.)

The uropods are slightly longer than the telson; exopodite armed with strong teeth on the outer border and bearing four teeth on a longitudinal ridge on the upper surface. Five strong teeth mark a similar ridge on the endopodite (See fig. 4, *j*.)

In the large cheliped, which is the left in the type specimen, the ischium is serrated above and bears three teeth below, the larger being distal; lower border of merus serrated and carrying five prominent teeth; upper border smooth except for one tooth about the middle of the distal half. (See fig. 4, *f*.) The carpus is smooth; hand elongate, with palm more than twice as long as deep; fingers more than half as long as palm. Palm without spines or tubercles,

upper border defined by a rounded crest, lower border marked by a similar but less prominent ridge; tufts of fine yellow hairs are arranged in longitudinal rows on both outer and inner surfaces. (See fig. 4, e.)

Carpus and palm of second leg subequal in length; ischium and merus bear teeth on lower borders, and the segments are fringed below with long hairs. (See fig. 4, h.) Third leg longer than second; a tooth is carried at the lower

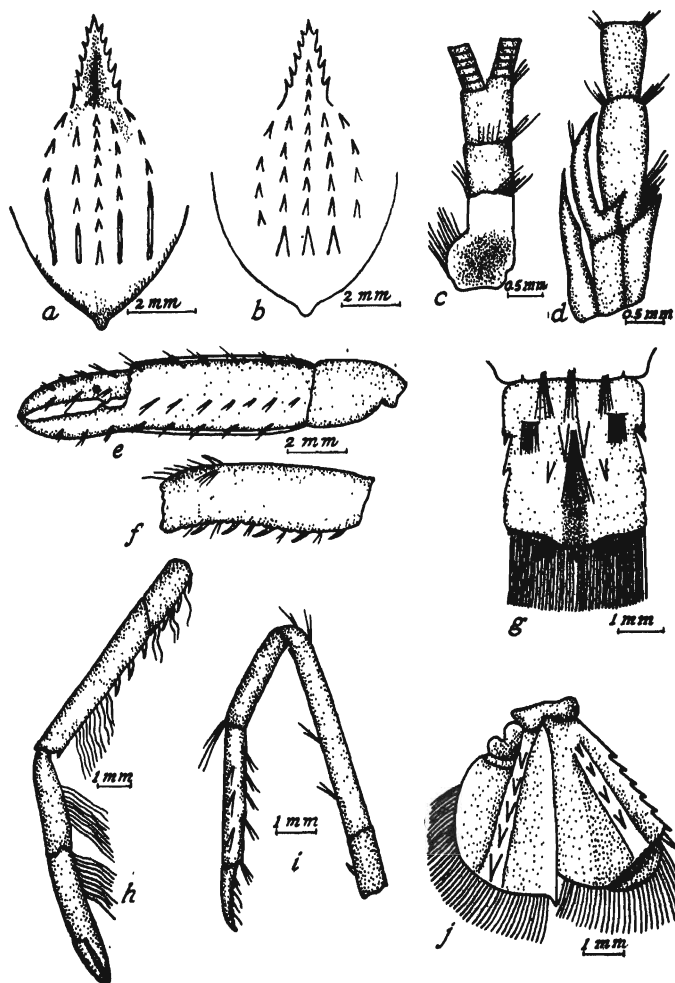


FIGURE 4.—*Axiopsis* (*Axiopsis*) *irregularis*, new species: a, dorsal view of gastric region of carapace and of rostrum; type specimen; b, same of cotype specimen; c, antennular peduncle; d, antennal peduncle and thorns; e, large cheliped, hand and wrist, left side; f, arm of left cheliped; g, telson; h, second (left) leg; i, third (left) leg; j, uropod, right side.

distal extremity of the merus; lower border of propodus bears tufts of bristles and that of the dactylus is covered with spinules (See fig. 4, i.) The fourth and fifth legs are shorter and more slender than the third.

Type specimen a female 34 mm. in length from the anterior tip of the rostrum to the posterior extremity of the telson. Type locality, Pearl and Hermes Reef, in shallow water. Collected by T. T. Dranga, 1927. Bishop Museum collections No. 3336.

This species seems to be closely related to *Axiopsis* (*Axiopsis*) *consobrina* de Man⁸ collected by the Siboga Expedition in the east Indian seas at moderate depths. It differs from *A. consobrina*, however, in the armature of the gastric region, in the extent of the cervical groove and in the posterior border of the telson. In *A. consobrina* there is a larger number of teeth in each of the five rows on the dorsal region of the carapace, the median row having thirteen, the sub-median rows seven or eight, and the lateral rows nine each. The lateral portions of the cervical groove in *A. consobrina* do not reach the anterior border of the carapace, and the posterior border of the telson is more rounded than in the new species here described.

The features of the chelipeds correspond closely in the two species except for the presence of small tubercles on the outer face of the palm of *A. consobrina*.

The species *A. serratifrons* differs from this new form in having numerous teeth between the carinae on the gastric region and *A. spinosissima* differs in having five rows of teeth on the gastric region and in the cervical groove being bordered with spines.

Considerable variation in the number of teeth of the gastric and rostral areas is seen among the three specimens collected at Pearl and Hermes Reef. A cotype (fig. 4, b) differs from the type specimen in lacking the smooth carinae at the base of the posterior teeth of the sub-median and lateral rows, but, instead, the posterior teeth of the median and sub-median rows are greatly enlarged. In this cotype also the teeth of the median row extend forward on the rostrum, the two anterior ones taking the place of the smooth carina in the type specimen. Four teeth occupy the right border of the rostrum and five the left in the cotype. These variations are responsible for the specific name *irregularis* by which the new form is designated.

⁸ de Man, J. G., Decapoda of the Siboga expedition, Axidae: pt. 6, p. 80, fig. 13-13 c, 1925.

NEW GENUS AND SPECIES OF PORTUNIDAE
FAMILY PORTUNIDAE
SUBFAMILY CAPHRYINAE

Coelocarcinus, new genus.

Carapace subcircular, the antero-lateral regions deeply concave; gastric, cardiac and post-cardiac areas elevated; front prominent, slightly turned down, concave dorsally. Antero-lateral border curved upward with lobes separated by slight incisions. Basal antennal joint narrow, elongated, the flagellum lying within the orbit. Ischium of outer maxilliped elongated, merus short; exopodite as long as ischium and without a flagellum. Chelipeds longer and stouter than legs. Last pair of legs normal in position; propodus and dactylus developed into rounded, foliaceous swimming paddles; dactylus without claw.

This new genus is apparently more closely allied to *Lissocarcinus*⁹ than to other genera of the subfamily. It differs from *Lissocarcinus*, however, in the character of the surface of the carapace, in the form of the basal joint of the antenna and in the outer maxilliped. It is distinguished from *Sphaerocarcinus*¹⁰ and *Caphrya*¹⁰ by the last pair of legs being attached on the same level as the preceding pair, and in having both propodus and dactylus greatly expanded. In *Sphaerocarcinus* and *Caphrya* the last legs are subdorsal in position and are not much different from the preceding ones.

Coelocarcinus foliatus, new species (Pl. 1, B; fig. 5).

Carapace subcircular, length and breadth approximately equal; branchial region broadly and deeply concave. Gastric region elevated with a raised ridge continuing in the medial area to the posterior border of the carapace. Of this elevated ridge the cardiac region is the highest portion.

Front extending prominently in front of the eyes, slightly curved downward, tip and dorsal surface with a broad, deep concavity. Supraorbital angles not distinguished from the front. Measured between the eyes the breadth of the front is approximately one-fourth the greatest breadth of the carapace. Antero-lateral borders sharply turned upward, which, with the concave branchial regions, give the carapace a cupped appearance when viewed dorsally. Antero-lateral borders cut into four low lobes separated by slight incisions. (See fig. 5, a.) These lobes resemble, in a general way, those of *Lissocarcinus orbicularis* Dana.

Dorsal surface of carapace, although smooth to the unaided eye, under a strong lens is seen to be closely set with very minute tubercles of unequal size.

⁹ Dana, J. D., Crustacea: United States Expl. Exped. [Wilkes], vol. 13, pt. 1, p. 288, 1852; pl. 18, fig. 1 a-c, 1855.

¹⁰ Alcock, Alfred., Materials for a carcinological fauna of India. No. 4, The Brachyura Cyclometopa: Asiatic Soc. Bengal, Jour., vol. 68, p. 8, 1899.

Orbits small, their greatest diameter approximately one-fourth the width of the front between the eyes; an inconspicuous notch in the upper border; inner angle of lower margin a blunt, prominent tooth. Basal segment of antenna narrow, resting against the relatively large basal segment of the antennule, but not touching the front. The antennal flagellum lies in the orbit. (See fig. 5, b.)

The ischium of the third maxilliped is long and straight; merus less than one-half of the length of the ischium; exopodite large and pointed, extending beyond the distal extremity of the ischium and without a flagellum. (See fig. 5, d.) Telson of type specimen having third, fourth and fifth segments fused together. (See fig. 5, e.)

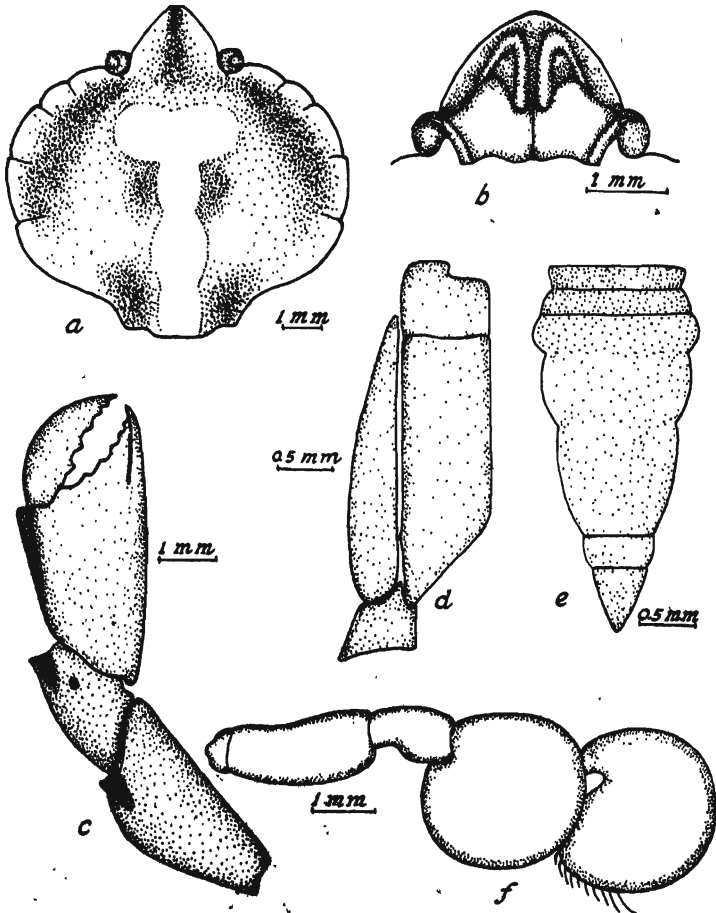


FIGURE 5.—*Coelocarcinus foliatus*, new species: a, dorsal surface of carapace; b, ventral surface of front; c, right cheliped; d, outer maxilliped; e, telson; f, fifth leg.

Chelipeds longer than carapace and longer and stouter than either of the other legs. Segments of chelipeds smooth; merus with an incomplete fringe of hairs along the anterior border; wrist stout, a blunt lobe at the inner angle. Palm increasing in height distally; outer surface convex, inner face concave, upper border with a distinct crest. Fingers stout, the cutting edges toothed and in contact when closed. Inner concave surfaces of both chelipeds covered with short hairs. (See fig. 5, c.)

Second, third and fourth pairs of legs progressively smaller and shorter but otherwise similar; segments slightly flattened, smooth; dactylus long, stout and fluted as in *Lissocarcinus*. Fifth leg (fig. 5, f) equalling the fourth in length and modified into a swimming appendage. Propodus and dactylus each expanded into a thin, circular, foliaceous lobe, the propodus being slightly the larger. The dactylus is without a claw but has a few hairs fringing the posterior margin. It may be folded against the side of the propodus and completely concealed.

Holotype, a male; length of carapace 9 millimeters, breadth subequal to length. Type locality, Waikiki beach, Oahu, in the sand near shore. Bishop Museum collections No. 2664.

NEW SPECIES OF PALICUS

Palicus maculatus, new species (Pl. 1, C; fig. 6).

Carapace convex in both directions and marked by elevations and ridges separated by broad, shallow grooves. The entire surface of carapace, including the grooves, ornamented by low tubercles of unequal size. A short, delicate pile interspersed among the tubercles.

Front deflexed, anterior margin with four rounded lobes separated by shallow depressions, the median pair of lobes being more prominent than the lateral ones. Supraorbital border tumid, interrupted by two deep fissures. A broad depression posterior to each orbit is marked by a deep crimson color in the living specimen. (See Pl. 1, C.)

Antero-lateral border of carapace with five teeth, including the small outer orbital lobe. The second of the five teeth is a rounded lobe slightly larger than the outer orbital one from which it is separated by a small groove. Third tooth triangular, more prominent than the second. Fourth tooth broadly triangular and largest of all. The fifth tooth is inconspicuous, terminating a low ridge extending posteriorly from the base of the fourth. (See fig. 6, a.)

Eye-stalk short, thick with a rounded tubercle and a fringe of short hairs above. Outer half of orbit fringed with stiff hairs. Suborbital border with two fissures. The basal segment of the antenna joins the supraorbital border, excluding the flagellum from the orbit. Antero-medial border of the ischium of the external maxilliped extending beyond the articulation of the merus; merus deeply excavated for the insertion of the palp; exopodite nearly as long as combined length of ischium and merus; flagellum slender. (See fig. 6, d.)

Abdomen of the type specimen of seven segments and covered, as is the general under surface of the animal, with low tubercles like those of the upper surface of the carapace. The seventh segment is elongate, rounded at the tip and smoother than the others.

Chelipeds unequal, the right being the larger. The outer surface of both

chelipeds covered by tubercles of nearly uniform size, those of the carpus being somewhat larger and more irregular. Near the upper border of the outer surface of each palm is an elongate, swollen area. Fingers shorter than the palm, pointed and overlapping at the tip when closed. (See fig. 6, *b, c*.) Second, third and fourth legs somewhat similar in form, the second being the smallest of these and having a narrower and smoother merus. Carpus and propodus of each grooved on the lateral face, the channels carrying fine hairs; lower border of propodus with a series of small spines and upper and lower borders fringed with hairs; dactyli stout. (See fig. 6, *e, f*.) Fifth leg slender, roughened by tubercles. (See fig. 6, *g*.) In the living specimen a broad crimson band of color crosses the propodi of the chelipeds and walking legs, becoming progressively less intense toward the fifth leg. (See Pl. 1, *C*.)

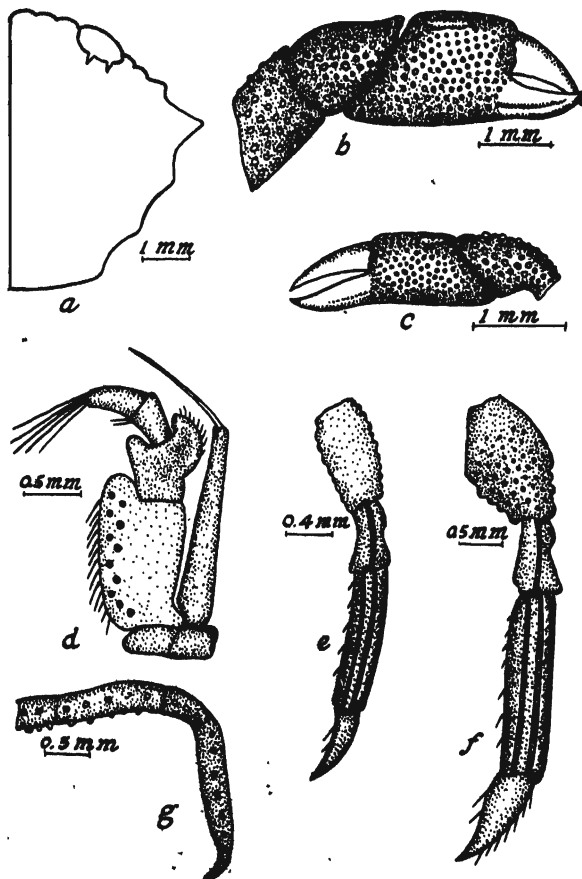


FIGURE 6.—*Palicus maculatus*, new species: *a*, outline of right half of carapace; *b*, large (right) cheliped; *c*, small (left) cheliped; *d*, outer maxilliped; *e*, second leg, right side; *f*, third leg, right side; *g*, fifth leg, right side.

Type specimen a male; length of carapace 6 mm., breadth 9 mm., front 3 mm. Type locality, Waikiki reef, Oahu, in shallow water. Bishop Museum collections No. 3337.

This species, collected among the branches of a clump of coralline algae on Waikiki reef, Oahu, differs from *Palicus tuberculatus* Edmondson,¹¹ specimens of which have been taken in the same vicinity, in the teeth of the antero-lateral border of the carapace and in the chelipeds. In *P. tuberculatus* the fifth tooth of the antero-lateral border is as long as the fourth, but narrower. In *P. maculatus* the tubercles of the upper and lower surfaces of the animal are less prominent than in *P. tuberculatus*, the fingers of the chelipeds are less deflexed and the inner borders of the hands are free from hair.

This new species is distinguished from *P. fisheri* and *P. oahuensis*, described by Rathbun¹² from Hawaiian waters, by features of the carapace and chelipeds. The species *oahuensis* was collected on Honolulu reef and in moderately deep water off the south coast of Oahu. The species *fisheri* has not been taken in shallow water.

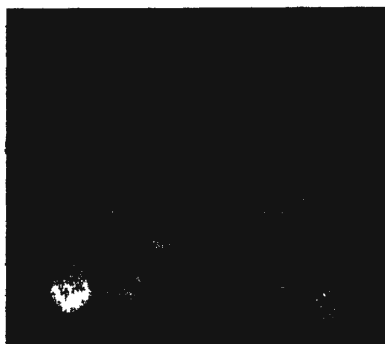
Although the crimson spots on the carapace and appendages of *P. maculatus* are apparently distinctive color markings in the living specimen, they are not permanent features, but fade almost completely after the specimen is preserved in alcohol for six months.

¹¹ Edmondson, C. H., Marine Zoology of tropical central Pacific, Crustacea: B. P. Bishop Mus., Bull., 27, p. 57, pl. 4, fig. 8, c-g, 1925.

¹² Rathbun, Mary J., Brachyura and Macrura of the Hawaiian islands: U. S. Fish Comm., Bull., vol. 23, pt. 3, pp. 835-837, 1906.



A



B



C

PLATE 1.—Hawaiian Crustacea: *A*, *Axiopsis* (*Axiopsis*) *irregularis*, new species, $\times 1.6$; *B*, *Coelocarcinus foliatus*, new species, $\times 3$; *C*, *Palicus maculatus*, new species, $\times 3$.

NEW SPECIES OF PARTULA

By

C. MONTAGUE COOKE, Jr., and HENRY E. CRAMPTON

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NEW SPECIES OF PARTULA

By C. MONTAGUE COOKE, JR., AND HENRY E. CRAMPTON

The novel forms described in this paper are few in number, but their individual characters render each of them particularly noteworthy. Naturally the intrinsic characters of each type and its geographical situation are the primary items, as in all taxonomic studies. But in the genus *Partula*, newly-discovered species gain added importance by virtue of the comprehensive biological and geographical scheme into which they enter.

It is well known that representatives of the genus *Partula* occur in certain islands of Polynesia, Micronesia, and Melanesia, and that as a rule each group of islands, each island of a group, and each valley of some islands possesses characteristic species, varieties, or local races that are not found elsewhere. At least 120 species are comprised in the whole taxonomic and geographical scheme. Although large areas of Oceania remain to be explored—areas undoubtedly possessing species of *Partula* that would be useful in the study of general problems of relationship and distribution, nevertheless, there is a substantial body of information, particularly for the Society Island forms, which renders the genus especially valuable for comprehensive studies on the evolution of terrestrial mollusca. Hence, these new species are worthy of record for the sake of their individual intrinsic interests as well as for their values as items in a relatively organized body of knowledge concerning the genus *Partula* and its distribution.

***Partula cytherea*, new species (Pl. I, A).**

The shell is sinistral, flatly perforate, broadly ovate-conic, and solid in texture. Whorls 5 to $5\frac{1}{2}$, slightly convex. Spire conic. The aperture is sub-auriform, with a strongly oblique axis. The lip is thickened, inwardly contracted, and rounded in profile; the margin is shouldered at its parietal insertion. Parietal callus well marked. The columella is straight and only slightly flaring at its insertion. Parietal tooth invariably present and usually well-developed.

The body-whorl is tawny to buckthorn brown. The spire is much deeper in color, and in almost all of the specimens its whorls are purplish-brown as the result of decortication; a few shells are decorticated throughout. Surface smooth and glossy, very faintly striated with lines of growth; the faint, microscopic decussations are almost evanescent on the body-whorl.

The embryonic young, while variable, are uniformly colored in some

shade of brown. The egg capsules are oblong-ovate, 3.6 mm. by 2.3 mm. The wall is strongly impregnated with calcareous salts.

The direct measurements of the two cotypes are: *a*, Bishop Museum, No. 10851, length 18.6 mm., width 11.8 mm., length of aperture 10.5 mm., width of aperture 7.7 mm.; *b*, Crampton collection, length 17.6 mm., width 11.1 mm., length of aperture 9.6 mm., width of aperture 7.2 mm.

Habitat: on the higher slopes of Mount Orohena, central portion of Papenoo Valley, Tahiti, Society Islands. Collected by K. P. Emory (1925) and G. H. McDaniels (1927). Paratypes no. 87053, Bishop Museum.

On account of its solid texture and general form, *Partula cytherea* seems on first inspection to be a near ally of the *otaheitana* series of varieties, and especially of *Partula otaheitana affinis* which is occasionally sinistral in the lower reaches of Papenoo Valley. Closer study reveals consistent differences of specific degree, notably in the obliquity of the aperture, in the more open umbilicus, and in the sub-auriform contour of the whole aperture; the form of the aperture suggests a relationship to *Partula mooreana* Hartman, of the neighboring island of Moorea. Furthermore, the shells are remarkably uniform in coloration, and the consistently purple-brown color of the spire is another point of contrast with the *P. otaheitana* series. Were it not for the consistent reversal in coil, the shells here named *P. cytherea* might be referred to *Partula stolidia* Pease, a species of problematic status in the literature.

The comprehensive statistical description of 33 measurable adult shells is as follows:

Character	Range (class values)	Mean	Standard deviation
Shell, length, mm.	16.5 — 19.8	18.3318 ± .0696	0.8386 ± .0984
width, mm.	10.5 — 13.3	11.7666 ± .0505	0.6083 ± .0715
proportions, per cent	56.5 — 72.5	64.0455 ± .2890	3.4823 ± .4088
Aperture, length, mm.	8.9 — 11.9	9.6666 ± .0534	0.6432 ± .0755
width, mm.	6.5 — 8.7	7.6697 ± .0388	0.4674 ± .0549
proportions, per cent	67.5 — 83.5	76.9546 ± .3245	3.9087 ± .4589
Length aperture ÷ length shell, :			
proportions, per cent	49.5 — 63.5	54.2273 ± .2323	2.7990 ± .3286

The habitat of *Partula cytherea* in the remote interior of Tahiti, is very difficult of access. For this reason it escaped the notice of Garrett and of others who have been concerned primarily with what

might be called the horizontal distribution of the species and varieties dwelling in the coastward portions of the valleys. Without doubt, other new species of *Partula*, with more or less restricted habitats, will come to light on more intensive exploration. From the neighboring island of Moorea 10 full species are now known, and from Raiatea more than a score. To Tahiti, a much larger island, 9 species are now accredited, including *Partula stolidus* as a doubtful member of the list.

***Partula lanceolata*, new species (Pl. I. B).**

Shell dextral, flatly rimate, long ovate-conic, rather thin. The spire is narrowly conic and produced, with almost straight sides. Whorls $5\frac{1}{2}$, nearly flat, with vaguely marginated suture. The aperture is subovate and unusually simple, and the two insertions of the border approach one another; the intervening callus is thin and shining. The lip is notably thin and narrow, and slopes inwardly from the margin with a slight inner incassation. The columella is dilated above. Parietal tooth very weakly developed in most of the shells is entirely absent in others.

The colors are chamois or cream-buff, lightened in some shells by decortication, excepting on the apex, which always retains the full neanic tints. Surface smooth, with faint and widely spaced lines of growth.

The egg capsules are elliptical and unusually large, measuring about 4.2 mm. by 2.5 mm.; their walls are impregnated with calcareous material.

The direct measurements of the two cotypes are: *a*, Bishop Museum, No. 10852, length 20.4 mm., width 11.6 mm., length of aperture 10.8 mm., width of aperture 7.3 mm.; *b*, Crampton collection, length 19.9 mm., width 10.7 mm., length of aperture 9.6 mm., width of aperture 6.9 mm.

Habitat: Mango Island (Maugo), Fiji, southwest limestone ridge, one-quarter to one-half mile inland, altitude 200 to 500 feet. Collected by E. H. Bryan, Jr. (1924). Paratypes, nos. 78940-78942, Bishop Museum.

This form is extremely important because hitherto the only species correctly recorded in the literature as an inhabitant of the Fiji islands is *Partula lirata* Mousson, a type that is remarkable for its occurrence in several islands of eastern Fiji as well as in Lauthala and Taviuni of western Fiji. E. H. Bryan, Jr., who collected the *Partula lanceolata* material, also obtained a few shells of *Partula lirata* on Mango, thus corroborating Layard (Ann. Carnegie Mus., p. 451, 1901-1902). A second species occurring in Fiji is *Partula nematoraphe* Pilsbry, hitherto of unknown locality and presumed to be a member of the New Hebrides series; an authentic collection of undoubted *nematoraphe* came from Moala Island, Fiji (Bishop Museum, collected by E. H. Bryan, Jr., No. 77131).

The new species, *Partula lanceolata*, now the third in the Fijian list, is obviously a close relative of *Partula lirata* from which it differs most markedly in the absence of the spiral ridges that render *P. lirata* unique within its genus. In addition, the growth lines of *P. lanceolata* are far less prominent than in its relative. Furthermore, the shells of *P. lirata* collected on Mango are consistently longer and narrower than those of the associated *P. lanceolata*.

The comprehensive statistical description of 53 adult and perfect shells is as follows:

Character	Range (class values)	Mean	Standard deviation
Shell, length, mm.	18.0 — 21.6	19.5867 ± .0837	0.8691 ± .0592
width, mm.	10.1 — 11.9	11.0061 ± .0416	0.4316 ± .0294
proportions, per cent	50.5 — 60.5	56.2551 ± .1893	1.9644 ± .1238
Aperture, length, mm.	9.5 — 11.3	10.2755 ± .0365	0.3761 ± .0266
width, mm.	6.5 — 7.7	7.1122 ± .0241	0.2504 ± .0170
proportions, per cent	65.5 — 72.5	69.1531 ± .1692	1.7560 ± .1196
Length aperture ÷ length shell, proportions per cent.....	40.5 — 54.5	52.4388 ± .1340	1.3010 ± .0047

Partula thurstoni, new species (Pl. I, C).

The shell is dextral, perforate, broadly ovate-conic, and very thin in texture. Whorls $5\frac{1}{4}$, markedly convex. Spire conic; body whorl inflated. Aperture ovate and simple. Lip thin and only slightly flaring, with a very weak internal thickness increasing toward the columellar insertion. Columella flaring above. Parietal callus excessively thin. No parietal tooth.

The general color is almost uniform dark olive-buff, lightened on the embryonic whorls; the suture is margined with white, and the outer rim of the lip is also white. Surface glossy, marked with faint lines of growth; the revolving sculpture is exceedingly weak.

The measurements of the type are as follows: length 18.5 mm., width, 11.9 mm.; length of aperture 10.0 mm., width of aperture 7.9 mm. Proportions of shell 64 per cent; proportions of aperture 79 per cent; proportions of aperture length to shell length 54 per cent.

Habitat: Ofu Island, Samoa, near the summit of the highest peak. Collected by Theodore Dranga (1926).

The original material of *Partula thurstoni* consists of six specimens obtained by Mr. Theodore Dranga for Mr. Lorrin Thurston during the course of an expedition to Ofu. Of the three individuals presented to the Bishop Museum, one is adult and two are juveniles.

Type, B. P. Bishop Museum no. 10853; two juvenile paratypes, no. 83121.

This species is clearly related to *Partula stevensoniana* Pilsbry, from Upolu Island, Samoa. It is a valuable addition to the *Partula* series of Samoa on its own merits, and also because it is authentically recorded from the small and remote island of Ofu. It must be exceedingly rare, as no additional material was found by Cooke, Judd, and Dranga in the course of a later visit extending over three days. Almost without question the animals dwell on the higher limbs of the trees. Dranga's original material was found on ti leaves a few days after a devastating hurricane had occurred, when the animals had apparently been shaken down from their accustomed situations. Ofu did not yield any *Partulae* of the *zebrina* series, which has its representatives on Tutuila, Upolu, and Savaii, and is in greatest abundance on Tutuila in the form of *Partula zebrina* itself.

***Partula montana*, new species (Pl. I, D).**

The shell is dextral, perforate, ovate-conic, and rather thin in texture. Whorls $4\frac{1}{3}$, markedly convex, the protoconch strongly flattened; suture slightly impressed. Spire narrowly conic despite the convexity of the whorls and their small number. Aperture elliptical, very slightly oblique. Peristome thin, flattened, narrowed at its outer and inner insertions, and inwardly thickened. Columella straight, receding at its junction. Parietal tooth wanting.

Surface rough, with evanescent spirally-engraved lines, and with low revolving ridges weakly developed near the base. Color dull whitish, with a tawny epidermis remaining locally after extensive decortication. The egg capsule is large, 4 mm. by 3 mm., with impregnated walls.

The measurements of the unique specimen, in the Crampton collection, are: length 17.9 mm., width 11.5 mm.; length of aperture 10.8 mm., width of aperture 7.5 mm.; proportions of shell 64 per cent; proportions of aperture 69 per cent; proportions of aperture length to shell length 60 per cent.

Habitat: high forest of the Afiamalu region, altitude about 2500 feet, near Tiapapala Pass, 5.75 miles south of Apia, Upolu, Samoa. Collected by Crampton (1909).

Although the fauna of Upolu is not well known, and in consequence the range of variation of the recorded species has not been determined, nevertheless, this unique snail presents so many points of contrast with each and all of the known species that it must be accorded full specific status.

The dextral coil, general shape, and the form of the aperture suggest a relationship to *Partula stevensoniana* Pilsbry; but *P. montana* is much smaller, it is not so openly perforate, the columella is

not widely flaring at the insertion, and the color is different. The small number of whorls seems to relate it to the *P. zebrina* series, which is represented in Upolu by *Partula expansa* Pease, and which includes local races with shells not unlike *P. montana* in general form. But the peculiar protoconch of *Partula montana* definitely excludes it from such an association. Its rugose basal sculpture, weak as it is, suggests the type of ornamentation exhibited by the unique *Partula lirata* of the Fiji islands.

The possible identity of this new form with *Partula brazieri* Pease involves a number of considerations, of which only a few may be noted here. Pease's species was established on the basis of a single shell which Brazier asserts most positively was obtained by him at Tutuila; this shell is in the collection of the Academy of Natural Sciences of Philadelphia, and it is regarded as different from *P. montana* by Pilsbry as well as by Crampton. The fact that the single example called *Partula brazieri* does not agree closely with Pease's original description, and the further fact that it resembles well-authenticated species of the New Hebrides, are beside the point in the present discussion. It is certain that *P. montana* came from a locality in the high mountains of Upolu, and it is equally certain that it holds a distinct position with full specific status.



A



B



C



D

PLATE 1.—New species of *Partula*: *A*, *Partula cytherea*; *B*, *Partula lanceolata*; *C*, *Partula thurstoni*; *D*, *Partula montana*.

NOTES ON JOINVILLEA

By

ERLING CHRISTOPHERSEN

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PLATE 1—*Jomvillea ascendens* nos 16, and *Jomvillea elegans* nos 7-26,
 reproduction of Pl 39-40, Atlas, "Voyage autour du monde sur La Bonite"

NOTES ON JOINVILLEA

By ERLING CHRISTOPHERSEN

The small genus *Joinvillea*, as known at present, is distributed from the Malay Peninsula to Hawaii. A total of six published species, which have been reduced to three, are known from the Malay Peninsula, Sumatra, Borneo, the Philippines (Palawan only), New Caledonia, Isle of Pines, New Hebrides, Fiji, Samoa, and Hawaii.

The genus was established by Gaudichaud,¹ who published detailed drawings of a fruiting specimen of *Joinvillea elegans* and a sterile specimen of *J. ascendens*. Though no descriptions were published, the generic name is not invalidated, as the illustrations present detailed analyses of *J. elegans*. (See Pl. 1.)

Regarding the locality where the specimens were collected there are likewise no original data, and the explanatory remarks published later by d'Alleizette² unfortunately contain incorrect statements. He gives New Caledonia as the locality for *J. ascendens*, deliberately using the data from specimens of *Flagellaria (Chortodes) plicata* Hooker f., collected after Gaudichaud's publication, making it appear that he never saw the original labels. According to Brongniart and Gris³ the specimens from which the drawings were made are not to be found in the herbarium of the Musée National d'Histoire Naturelle, a fact that I confirmed by a visit there.

The route of *La Bonite*, on which voyage the plants were supposedly collected, runs through the Pacific from Guayaquil directly to Hawaii, where stops were made at Kealakekua Bay and at Kailua on the island of Hawaii, and at Honolulu on Oahu. From there directly to Manila, then to Macao, Tourane, Singapore, Malacca, Pulo Pinang, and Calcutta. Along this route *Joinvillea* has since been collected only in Hawaii and the Malay Peninsula. However, from neither of these places have specimens appeared that correspond to the drawing of *J. elegans*, published by Gaudichaud. Subsequently specimens which probably belong to this species have been collected on

¹ Gaudichaud—Beaupré, C., Voyage autour du monde. . . sur La Bonite. . . Histoire naturelle, Botanique, Atlas, Pls. 39, 40, 1846-1849? [The date of publication of the Atlas has been obtained from Ann. Mag. Nat. Hist., 7th ser., vol. 7, p. 391, 1901.]

² Gaudichaud—Beaupré, C., Voyage autour du monde. . . sur La Bonite. . . Botanique, vol. 3, Explication et description des planches de l'atlas par C. d'Alleizette, p. 56, 1866.

³ Brongniart, A., and Gris, A., Note sur le genre *Joinvillea* de Gaudichaud et sur la famille des Flagellariées: Bull. Soc. Bot. France, vol. 8, p. 265, 1861.

the Isle of Pines and New Caledonia proper, far off the track of *La Bonite*.

In Hawaii, *Joinvillea* has been collected on all the big islands (Hawaii, Maui, Molokai, Oahu, Kauai), and more numerous collections exist for this area than for any other. The material is very uniform and is different from *J. elegans*, so that it may reasonably be doubted that Gaudichaud collected this species here. Besides, all the new species discovered by Gaudichaud on the *La Bonite* voyage have since been rediscovered (perhaps with the exception of one of the *Pritchardias*).

Regarding *Joinvillea ascendens*, the other plant pictured by Gaudichaud still less certainty exists, as the drawing ("Pl. 39 et 40, 1 à 6") represents only a sterile shoot with young leaves. It differs from the drawing of *J. elegans* in its longer ligules and its smooth ribs on the lower leaf surface. Both surfaces have scabrous ribs in *J. elegans*.

Brongniart and Gris⁴ referred plants collected by Remy on Kauai (Remy No. 156 A; the locality given on the original label is "Kauai ou Nihau [Niihau]") to *J. ascendens* Gaudichaud, though specimens in Remy's collection from Hawaii, Maui, Molokai, and Oahu were referred to a new species, *J. gaudichaudiana*⁵ Brongniart et Gris. The basis for referring the Kauai specimens to *J. ascendens* seems to me very weak. Gaudichaud's drawing of the sterile shoot with three juvenile leaves offers, as far as I can see, no characters for specific determination. From an examination of the material in most of the larger herbariums, with a view to a revision of the genus, it appears that the leaf blades of all species are very much alike, and useless in the distinction of species. But even so, the leaf blade of Remy's specimen has scabrous ribs below, disagreeing in the only point of difference in the blade between *J. ascendens* and *J. elegans* as pictured.

A character of possible specific significance is the long ligule. But this is variable, at least in the Hawaiian plants, a variation of from 4 to 31 mm. in length having been observed in specimens of the same collection number. And again, Remy's specimen has short ligules. Specimens of *Joinvillea* from the Malay Peninsula may with

⁴ Brongniart, A. and Gris, A., Note sur le genre *Joinvillea* de Gaudichaud et sur la famille des Flagellariées: Bull. Soc. Bot. France, vol. 8, p. 269, 1861.

⁵ At the request of the author, attention is called to the fact that in the capitalization of generic and specific names Bishop Museum follows the procedure of the United States Government Printing Office.

equal justification be referred to *J. ascendens* Gaudichaud, coming just as close in characters of the leaf.

And then comes the fact that the original specimens are lost, no locality is known, and the other species published on the same plate has not been rediscovered in Hawaii or any of the other places where the *La Bonite* expedition touched.

All later authors have followed Brongniart and Gris in attributing *J. ascendens* Gaudichaud to Hawaii. But they have disregarded *J. gaudichaudiana* Brongniart et Gris, extending the range of *J. ascendens* to cover not only Kauai, but also the other Hawaiian islands.

The opposite procedure seems, however, to be the better one. As presented in Gaudichaud's drawing, the species *J. ascendens* is altogether too vaguely characterized. As no analysis accompanies the illustration, the species should be rejected according to the International Rules (articles 37 and 51, 4). An examination of Remy's specimens in Musée National d'Histoire Naturelle, and a large number of specimens in Bernice P. Bishop Museum, shows no justification for the separation of two species. The stated difference in the shape of the leaf is based partly on the upper young leaves, and does not hold good in the light of the more ample material now available. Furthermore, the filiform acumen of the outer tepals, supposed to be characteristic of *J. gaudichaudiana*, is present also in specimens from Kauai, but is as a rule broken off with age, which may explain its absence from Remy's specimen, which is in ripe fruit. The inner tepals are not always mucronulate, partly for the same reason. The supposed difference in the starch granules I have not been able to verify. *J. gaudichaudiana* Brongniart et Gris is, therefore, the proper name to be applied, and should be extended to include also the specimens from Kauai.

***Joinvillea gaudichaudiana* Brongniart et Gris, emendavit.**

Joinvillea gaudichaudiana Brongniart et Gris: Bull. Soc. Bot. France, vol. 8, p. 269, 1861.—Ann. Sci. Nat. Bot., 5th ser., vol. 1, p. 337, 1864.

Joinvillea ascendens Gaudichaud, Brongniart et Gris: Bull. Soc. Bot. France, vol. 8, p. 269, 1861.—Ann. Sci. Nat. Bot., 5th ser., vol. 1, p. 337, 1864.

Joinvillea ascendens Gaudichaud, Wawra: Flora, vol. 58, p. 248, 1875.

Joinvillea adscendens Gaudichaud, Hillebrand: Flora of the Hawaiian islands, p. 447, 1888.

Plants erect, to 4 (5) meters high, growing in clumps in the manner of bamboo. Stem unbranched, terete, hollow except at the nodes, smooth, glabrous, reaching a diameter of 2 cm. at the base, in the lower part of some specimens split within the sheaths, internodes 4-9 cm. long in the upper part, increasing

in length downwards. Sheaths long, covering the internodes, open, contracted at the base of the leaf blade, with a narrow scarious margin, striped, smooth, or slightly scabrous, shortly pubescent, becoming glabrous with age. Ligule bilobed, lobes with a scarious margin, variable in length and form, usually ligulate, rounded at the apex, 3-31 mm. long. Leaf blade linear-lanceolate from a constricted base, slightly concave, more or less gradually attenuately acuminate, plicate, 9-13 folds on each side of the midrib, scabrous on the prominent ribs of both surfaces, hairy below, the hairs appressed or ascending, wavy, often bunched, glabrous above, at maturity 50-60 cm. long, 8-10 cm. broad when flattened out. Inflorescence an erect open terminal panicle, pyramidal, 15-20 cm. long, 15-25 cm. broad, main axis and branches densely tomentose with short woolly hairs, primary branches 15-24, bracts short, triangular or shortly acuminate, bracteoles triangular or shortly acuminate, 1 mm. or less long, or attenuate acuminate, 2-4 mm. long. Flowers sessile along the branchlets. Perianth of two rows, outer tepals 3, oval, keeled, obtuse to acute, saccate at base, only one distinct vein running out in a reflexed mucro, towards the apex with a broad scarious margin, 2.5-3 mm. long, 1.5-2 mm. broad when flattened out, inner tepals 3, broadly oval, concave, obtuse, distinctly 3-veined, the veins converging below the apex, rarely mucronulate, with a broad scarious margin above, 2.5-3.5 mm. long, 2-2.5 mm. broad when flattened out. Stamens 6, anthers sagittate, linear, obtuse, 2 mm. long on short filaments. Stigmas 3, plumose, exerted. Fruit globose, shining, orange-yellow, with a fragile epicarp, 4-5 mm. in diameter. Seeds 3 (or fewer by abortion), dark-red, rugulose, filled with starch. Embryo minute, lenticular.

Differs from *J. elegans* Gaudichaud primarily in the shape and relative size of the tepals.

Hawaiian islands specimens examined are as follows:

Hawaii: Remy no. 156 (Paris, Gray Herbarium); Hillebrand and Lydgate (Bishop Mus.).

Mau: Remy no. 156 (Paris); Rock, Nov. 18, 1908 (Bishop Mus.); Rock, May, 1911 (Bishop Mus., Gray Herbarium); Forbes nos. 245 M., 499 M., 1641 M. (Bishop Mus.); Munro no. 664 (Bishop Museum.).

Molokai: Remy no. 156 (type, Paris); Rock, March, 1909 (Bishop Mus., Gray Herbarium); Forbes no. 285 M. (Bishop Mus.); Munro no. 697 (Bishop Mus.); Krajina, March 23, 1930 (Bishop Mus.).

Oahu: Macrae, May, 1825 (Kew Herbarium); Macrae, June, 1825 (Gray Herbarium); Remy no. 156 (Paris); Guppy in 1897 (Kew Herbarium); Forbes nos. 1711 O., 2205 O. (Bishop Mus.); Topping no. 3133 (Univ. California, Buitenzorg); St. John nos. 10109, 10177 (Bishop Mus.); Christophersen no. 1286 (Bishop Mus.).

Kauai: "Kauai ou Nihau [Niuhau]" Remy no. 156 A (Paris);

Mann and Brigham no. 330 (British Mus., Gray Herbarium) ; Forbes nos. 42 K., 564 K., 623 K. (Bishop Mus.).

Hawaiian islands: Hillebrand (British Mus.).

In the Musée National d'Histoire Naturelle, the specimen from Molokai and one of those from Hawaii in Remy's collection are labeled *Joinvillea gaudichaudiana* Brongniart et Gris, in Brongniart's handwriting. Both specimens correspond to the original description, but the perianths of the one from Molokai are better preserved, as the specimen is in young fruit only, and is perhaps best suited to represent the type. The other specimens in Musée National originally cited as *Joinvillea gaudichaudiana* Brongniart et Gris (Maui, Oahu, both Remy no. 156) are labeled *Joinvillea ascendens* Gaudichaud with a question mark.

**VASCULAR PLANTS OF JOHNSTON AND
WAKE ISLANDS**

By

ERLING CHRISTOPHERSEN

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VASCULAR PLANTS OF JOHNSTON AND WAKE ISLANDS

By ERLING CHRISTOPHERSEN

The present paper deals with the vascular plants of Johnston and Wake islands, being a report on the collections made by the Tanager Expedition of July and August, 1923.¹ (See fig. 1.) The plants

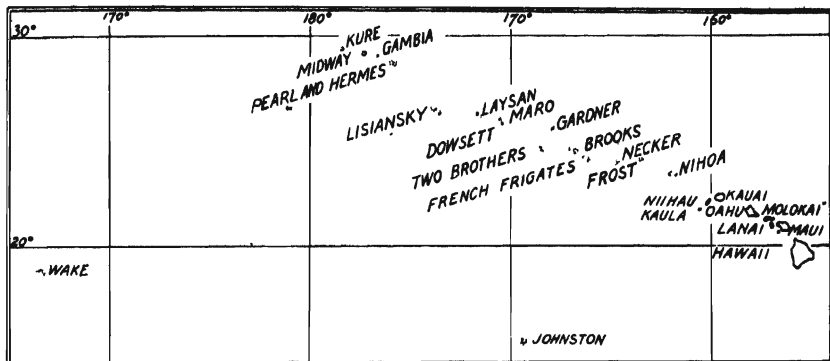


FIGURE 1.—Map showing position of islands surveyed by the Tanager Expedition.

were collected by Dr. J. B. Pollock, Professor of Botany, University of Michigan, assisted by Mr. E. H. Bryan, Jr., Entomologist with the expedition, and Mr. Orme E. Cheatham, both of the staff of Bernice P. Bishop Museum.

Dr. F. B. H. Brown has passed his opinion on all the plants represented, for which I am greatly indebted to him. I am also indebted to Dr. E. D. Merrill for his determination of *Calonyction grandiflorum*, which has involved the revision of a very complicated synonymy.

Mr. E. H. Bryan, Jr., has prepared notes on the vegetation of Johnston and Wake islands, compiled from his field notes and records. I am also indebted to him for preparing sketch maps of the islands. He writes:

Johnston Island is a low sand and coral island, 717 miles WSW. from Honolulu. It is 800 yards long, about 200 yards wide, and reaches a height of 48 feet at Summit Peak. A mile and a half to the NE. lies a small sand islet

¹Gregory, H. E., Report of the Director for 1923: B. P. Bishop Mus., Bull. 10, p. 22, 1924.

(Sand [Agnes] Island) 200 yards in diameter. Both islets are enclosed by a semicircular reef, nearly continuous on the north, but open to the south. (See fig. 2.)

Both islets are entirely covered by vegetation behind the sand or raised coral beaches. Only three species of plants are present. These are: *Lepturus repens*, growing in low, dry, brown bunches, forming a fairly dense, dominant stand (Pl. I, A); scattered patches of *Tribulus cistoides*, and a few numbers of plants of *Boerhaavia diffusa*. On the larger island *Tribulus cistoides* ranks second in abundance, being scattered generally among the bunches of *Lepturus repens* (Pl. I, B). *Boerhaavia diffusa* is most abundant at the east end of the island, on the seaward slopes of the highest hill; being sparingly found elsewhere. On Sand (Agnes) Island *Boerhaavia diffusa* is more abundant than *Tribulus cistoides*, but neither begins to compare with the bunch grass in extent. A single kukui nut (*Aleurites moluccana*) and a *Mucuna* seed were picked up on the south beach.

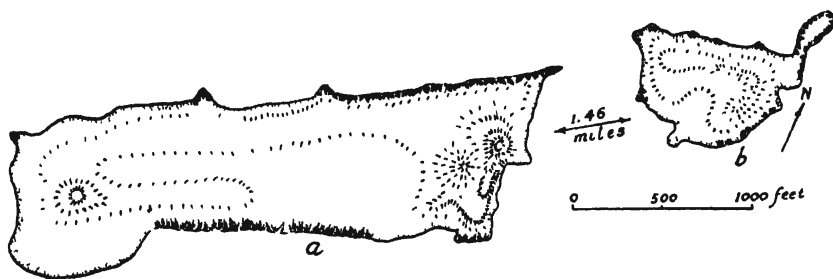


FIGURE 2.—Map of Johnston Island: a, main island; b, Sand (Agnes) Island; c, Summit Peak. (Based on a survey by James B. Mann, H. S. Palmer, and E. H. Bryan, Jr., 1923.)

Wake Island is a coral atoll, consisting of three islets (fig. 3): the largest, which is wedge-shaped—the two arms being three miles long by less than half a mile wide—carries the name of the group; the two smaller islets, each about a mile and a half long by a quarter to a half mile wide, are named for Wilkes and Peale of the United States Exploring Expedition that visited the island in 1841. Wilkes² writes:

There is no fresh water on the island, and neither pandanus nor coconut trees. It has upon it the shrubs which are usually found on the low islands of the Pacific, the most abundant of which was the *Tournefortia*.

The two ends of the smaller islets are connected by a broad, flat reef, portions of which are visible at low tide. The lagoon thus en-

² Wilkes, C., U. S. Exploring Expedition, Narrative, vol. 5, p. 285, 1844.

closed is shallow, in few places exceeding one or two fathoms in depth; and the entire east end of it is a sand flat, dry at low tide.

The flora here is much richer than that on Johnston Island. A total of 16 (possibly 17) species were collected: *Graminea* indet.,

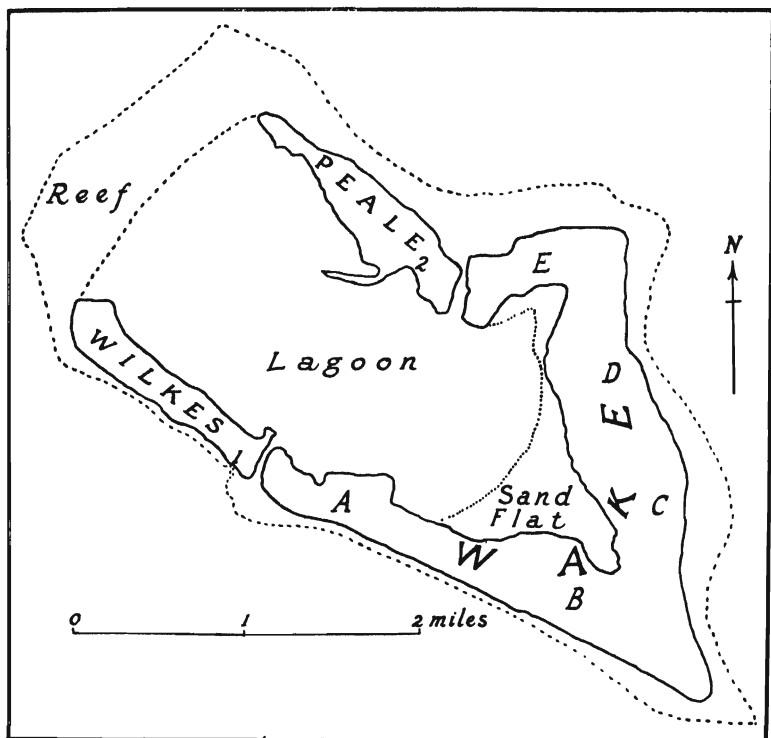


FIGURE 3.—Map of Wake Island: A-E, areas in which records of vegetation were made; 1, camp of the Tanager Expedition; 2, remains of a Japanese camp. (Surveyed by James B. Mann and H. S. Palmer, 1923.)

Boerhaavia diffusa, *Ceodes* sp., *Sesuvium portulacastrum*, *Portulaca lutea* (?), *Portulaca oleracea*, *Lepidium owaihiense*, *Sida fallax*, *Gossypium hirsutum* var. *religiosa*, *Pemphis acidula*, *Calonyction grandiflorum*, *Ipomoea pes-caprae*, *Cordia subcordata*, *Heliotropium anomalum*, *Tournefortia argentea*, *Nicotiana tabacum*, and *Scaevola frutescens*.

Of these several species are trees or shrubs and give the vegeta-

tion an aspect quite different from that of Johnston Island. Bryan³ writes: "Behind a broad beach of sand and broken coral, with numerous coral boulders, rises a dense stand of low trees and shrubs."

The following notes on the vegetation of the island are furnished by Bryan:

Wilkes Island. The dominant plants at the east end are *Tournefortia* and *Pemphis* (Pl. II, A), with an undergrowth of *Portulaca*, red-stemmed *Boerhaavia*, fine-leaved grass (much dried up), *Lepidium*, *Sida*, and beach heliotrope.

As one goes west the *Tournefortia* becomes more dominant, with *Pemphis* only in clumps along the lagoon beach. At one place a "finger" of *Pemphis* runs almost across the island, but this is young growth, around a few older plants, which seems to be crowding in upon the *Tournefortia*. About three-eighths of a mile from the west end of the island the *Tournefortia* trees are more stunted and scattered, and *Pemphis* entirely disappears. The herbs here are more abundant. Just before reaching the west end there is a thicket of larger *Tournefortia*, about which is an area covered with large rocks and a quantity of dead limbs and trunks, some up to two feet in diameter. Finally there is a narrow beach, with beach heliotropes, broken coral, and then the broad reef, which runs in a sweeping curve northwest to the west point of Peale Island.

Near the east end are the remains of a small Japanese shack and grave.

Wake Island. The vegetation covering the southwest arm of Wake Island (fig. 3, A) is made up largely of a forest of *Pemphis* and *Tournefortia* with here and there thickets of *Cordia* and *Scaevola*. *Portulaca* grows on the ground between the trees, and the climbing vine (*Calonyction*) covers large rocks, brush, fallen limbs, and climbs into the trees. There are numerous open spaces, in which grow both the red, and the green-stemmed *Boerhaavia* creepers. The *Cordia*, for the most part, forms small, stunted thickets, with much dead wood, although there are some fine, luxuriant trees, with leaves 9 inches long by 5 inches wide.

Along the lagoon side there is an almost continuous stand of *Pemphis*, with dried-up tufts of a fine-leaved grass, and open flats covered with *Sesuvium*. The *Calonyction* vine climbs over both dead and live *Pemphis*, as well as *Tournefortia* and *Cordia*. In these nest frigate birds and boobies.

Along the ocean side (fig. 3, B) is a growth of *Tournefortia* trees, 15 to 20 feet high, with open spaces which contain piles of dead branches and brush, with avenue-like lanes connecting them. Here and there are thickets of *Cordia* and *Scaevola*. Underneath, the ground is covered with sand and broken coral, upon which there is a sparse growth of *Boerhaavia*, *Portulaca*, and stunted *Sida*. The climbing *Calonyction* vine grows over rocks and up into the trees. The flightless rail is most abundant in this region. The ocean beach is rocky, with areas of raised reef; single trees of *Tournefortia* and patches of the beach heliotrope are present (Pl. II, B).

Toward the lagoon side there are patches of *Pemphis*, separated by clearings carpeted with *Sesuvium*, in the sand, beneath which are many shearwater (*Cuneatus*) burrows.

³ Bryan, E. H., Jr., *Insects of Hawaii, Johnston Island, and Wake Island*: B. P. Bishop Mus., Bull. 31, p. 8, 1926.

The area on the east side of the main island (fig. 3, C) is somewhat different. Starting from the lagoon side, there is a sand flat, partly covered with *Sesuvium*, and partly bare, with areas where the sand has solidified into a crust. Through this are channels, showing either the work of heavy rainfall, or storms which have broken over from the ocean side. This gives way to short (waist-high) *Pemphis* and tangles of *Calonyction* vine. The patches of these are interspersed with patches of *Sida* (vigorously growing and in blossom), broad-leaved bunch grass, and tussocks of a finer grass. Toward the ocean side the ground becomes rocky, with an open stand of *Tournefortia* and *Cordia*. The beach here is pebbly and quite narrow, but with a broad reef. An occasional *buka* tree (*Ceodes* sp.) is seen, although these are more abundant toward the north side. *Scaevola*, which forms clumps on the south side, further west, is rare here.

In the eastern part is another area (fig. 3, D), which is similar to the area just described (fig. 3, C), except that the coral rocks of the sea beach are found almost across the rim of the island, and the *Tournefortia*, which is thicker, with more *Sida*, *Boerhaavia*, and *Portulaca*, grows most of the way across, the fringe of *Pemphis* and *Sesuvium* being confined to the edge of the sand flat on the lagoon side. (See Pl. III, B.) There is also a little more beach heliotrope in evidence.

Between "D" and "E", at the northeast angle of the lagoon (fig. 3, D and E), are a few extensive patches of *Cordia*, some in fruit and flower, and a small tangle of a sprawling shrub (*Gossypium*) with long slender, blackberry-like branches.

The area along the northwest arm of Wake Island (fig. 3, E) has the largest growth on the three islands. Facing the north sea beach and about 200 yards from the water line, is an almost impenetrable wall of vegetation. This is made up of *Tournefortia*, *Cordia*, and great, gnarled *buka* trees (*Ceodes*). The latter (Pl. IV), despite their squat, stunted appearance, reach a height of 20 to 25 feet, with trunks 3, 4, and even 5 feet in diameter at the ground, the lateral roots spreading out along the surface of a rocky coral soil. Between this long line of trees and the shore is a stretch of high, rocky coral beach, in places over twenty feet above high water, constituting the highest land on the island. It is bare except for small patches of broad-leaved bunch-grass and stunted *Cordia* and *Tournefortia*.

On the lagoon side is an area covered with a tangle of vines and dead stumps, suggesting that it might have been burned over. Even the rocks have a crumbly, burned appearance. In the continuous thicket only one break was found, a narrow bare path, about 40 feet wide, which looked as if it might have been the track of a small tornado or such like, which had left only rotting stumps, over which had grown a tangle of vines. Here *Pemphis* occurs sparingly only on the edge of the lagoon.

Peale Island. The vegetation on Peale Island appeared at the time to be more luxuriant than elsewhere, *Sida* and *Boerhaavia* being abundant and in flower, beneath the vigorously growing *Tournefortia*. A patch of broad-leaved bunch grass borders the north entrance to the lagoon, and *Pemphis* is seen only at the extreme east end, where it appears to be a recent arrival from the southern and eastern islets.

Along the ocean beach there are alternate stretches of sand, coral ledge, and broken coral shingle, in front of which is a broad, flat reef, exposed at low tide. On the sandy beaches one finds a considerable amount of drift: timbers,

boards, railway ties, cork, fish net floats, and refuse from ships, such as walnut shells, tooth powder cans and empty bottles. One log was seen, which was 50 or 60 feet long.

On the south side is a long, narrow arm, ending in a coral reef which runs well out into the lagoon. On this arm nest a considerable colony of terns, both in the open, among the *Sida*, *Boerhaavia*, and beneath the scattered *Tournefortia* trees.

The vegetation toward the west end consists of an open stand of *Tournefortia*, in some places very open. The sand between, with its scattered coral rocks, is bare or with clumps of beach heliotrope. Toward the middle of the island the *Tournefortia* trees are a little lower, with *Portulaca*, the climbing *Calonyction*, *Lepidium*, and both forms of *Boerhaavia*, the one having reddish stems, green leaves with red veins, and lavender flowers, and the other yellowish-green stems, light green leaves, and white flowers. Toward the east end of the island the former seems to merge by slow degrees into the latter. A broad-leaved bunchgrass begins about a third of the distance east.

Near the east end of Peale Island are the remains of a Japanese camp. Part of an inscription on one of the walls was translated to mean a date (November 13, 1908). Here is a large patch of *Ipomoea pes-caprae*, the only one seen on the three islands.

LIST OF VASCULAR PLANTS

(In the citation of specimens it is stated, preceding the date, whether flowers or fruits are present; the abbreviations used are: *fl*, flower; *fr*, fruit; *b*, bud; *y*, young.)

GRAMINEAE

Lepturus repens (Forster) R. Brown: Prodr. Fl. Nov. Holl., p. 207, 1810.

Johnston: Main island, on the dunes, *fl*, July 13, 1923, Pollock No. 3; Sand Island, *fl*, July 15, 1923, Pollock No. 6. Grows all over the island.

A sterile specimen of grass from Peale Island, Pollock and Bryan No. 23, with broad leaves, apparently does not belong to *Lepturus repens* (Forster) R. Brown. Two other collections of sterile grasses were made on the Wake Island group, but the specimens have not been seen.

NYCTAGINACEAE

Boerhaavia diffusa Linnaeus: Sp. pl., p. 3, 1753.

Johnston: Main island, in sandy soil on the upper beach, *fl*, *fr*, July 11, 1923, Pollock No. 2; Sand Island, *fl*, *fr*, July 15, 1923, Pollock No. 5. Wake: Main island, in sand on the upper beach, *fl*, *fr*, July 30, 1923, Pollock No. 11; Peale Island, in sand, *fl*, *fr*, July 31, 1923, Pollock and Bryan No. 30.

The plants from Wake Island differ from those of Johnston Island in their lanceolate, relatively narrower and sharply acute leaves, their more slender peduncles, and the less dense pubescence with absence of glandular hairs. The leaves of the Johnston Island plants are rounded or broadly acute, ovate or suborbicular, the peduncles stout and stems and petioles are densely pubescent with presence of glandular hairs.

The Wake Island specimens may well be referred to *Boerhaavia diffusa* Linnaeus, but the Johnston Island specimens belong to a fairly distinct group of Polynesian *Boerhaavia* found especially on the coral islands, characterized by relatively broad, often suborbicular leaves, number of stamens two to five, generally a rather stout habit and varying from glabrate to densely hirsute or viscose. In the glabrate

end of the series we find plants corresponding closely with the type of *B. tetrandra* Forster⁴ from Huahine, Society Islands, and in the viscose and hirsute end we find approximations to the West Indian *B. caribaea* Jacquin (*B. viscosa* Lagasca et Rodriguez). Dr. P. C. Standley has kindly examined two specimens of this latter type (Bergman No. 10 A, Christmas Island, published in B. P. Bishop Mus., Bull. 44, p. 23, 1927, as *B. hirsuta* Linnaeus, and Caum No. 47, Pearl and Hermes Reef), and, referring them to *B. diffusa* Linnaeus, he states that "there is no need nor justification for using the name *B. caribaea* for the Pacific plants" [personal communication].

Plants of this group have generally been referred to *B. tetrandra* Forster. Those from Johnston Island, however, do not agree with Forster's type in British Museum, and the best thing at present, until the various Polynesian forms are better understood and the status of this species, if it is a distinct species, is made clear, is probably to refer these plants to *B. diffusa* Linnaeus sens. lat. as outlined, at least for the old world, by Heimerl (Engler and Prantl, Nat. Pfl.-fam., III, 1b, p. 26, 1889). Standley (North American Flora, 21, pt. 3, 1918) does not include *B. diffusa* Linnaeus.

Ceodes sp. (Pl. V).

Wake: Main island, July 28, 1923, Pollock and Wetmore No. 9; July 29, 1923, Pollock and Andersen No. 14; male *fl, fr*, August 3, 1923, Pollock, Bryan and Cheatham No. 39.

The Pacific species of *Pisonia* have been segregated into a distinct genus by Heimerl (Oesterr. Bot. Zeitschr., vol. 63, pp. 19-21, 279-290, 1913), who gave it the name *Calpidia* Du Petit-Thouars. This segregation has been followed by Wilson and Rehder (Jour. Arnold Arb., vol. 1, p. 117, 1919) and by Skottsberg (Meddel. Göteborg. Bot. Trädg., vol. 2, p. 231, 1926). The latter author, however, has restored the older name *Ceodes* Forster, arguing that Forster's *Ceodes umbellifera* is congeneric with the species of *Calpidia* cited by Heimerl.

The *Ceodes* plants from Wake Island are probably referable to a species of wide distribution on the coral islands of the Pacific. They come very close to specimens from the Equatorial islands (Fanning, Palmyra, Christmas⁵) and Rose atoll, Samoa. They differ from these in their relatively broader and shorter leaves, and wider calyx of the

⁴ Examined at the British Museum by Mr. G. Taylor. A photograph of the type is published by Satchell (American Samoa, Pl. 84, A, Washington, 1924).

staminate flowers, but in other characters, however, there is good agreement, the fruiting perigone agreeing closely with Cooper No. 10275, from Palmyra Island, the only fruiting specimen available for examination. These specimens have been referred to *Pisonia grandis* R. Brown, by Rock (Palmyra Island, p. 50, Honolulu, 1916), Setchell (American Samoa, p. 247, Washington, 1924), and Christophersen (B. P. Bishop Mus., Bull. 44, pp. 24, 42, 55, 1927). Merrill (Interpret. Herb. Amb., p. 216, 1917) accredits this species with a wide distribution on the small uninhabited islands of Malaya and Polynesia. This identification may be correct, but a complete revision of the Pacific species is much needed and probably necessary to settle this point. The species is not included in the treatment by Heimerl (Oesterr. Bot. Zeitschr., vol. 63, pp. 279-290, 1913).

AIZOACEAE

Sesuvium portulacastrum⁵ Linnaeus: Syst. Nat., ed. 10, p. 1058, 1759.

Wake: Main island, in dense mats on the coral beach just above high water, *fl*, July 29, 1923, Pollock No. 12; U. S. Expl. Exped. in 1841, acc. to A. Gray (U. S. Expl. Exped., Botany, pt. 1, p. 142, 1854).

PORTULACACEAE

Portulaca lutea Solander: in Forster, De. pl. esc., p. 72, 1786.

Wake: Wilkes Island, *fr*, July 29-30, 1923, Pollock No. 18. Peale Island, *fl, fr*, July 31, 1923, Pollock and Bryan No. 27.

Portulaca lutea Solander is no doubt a good species, in fresh material very distinct from *P. oleracea* Linnaeus in its almost suffrutescent habit with scaly bark in the lower part of the stems, and its much larger flowers. In the herbarium, however, the distinction between the two species is not so apparent due to the fact that the delicate petals wither away soon after they are gathered, and that the difficulty in drying the fleshy plants usually results in poor herbarium specimens. Setchell (American Samoa, pp. 250-51, Washington, 1924) discusses at length the differences between *P. lutea* Solander and *P. oleracea* Linnaeus, but probably not all the characters mentioned by him serve to distinguish the two species. An

⁵ At the request of the author, attention is called to the fact that in the capitalization of specific names Bishop Museum follows the procedure of the United States Government Printing Office.

examination of fresh material of *P. lutea* from Kaena Point on Oahu, agreeing in details with Solander's description and a tracing of Parkinson's drawing at British Museum⁶ as compared with fresh material of *P. oleracea* from the same locality, as well as from Honolulu, reveals the following differences:

<i>P. lutea</i>	<i>P. oleracea</i>
Lower part of stems almost suffrutescent with scaly bark.	Lower part of stems herbaceous, no scaly bark.
Flowers large, sepals in anthesis 7-10 mm. high [dry: 5-7 (8) mm.], petals 10-12 mm. high (dry: 9-10 mm.), number of stamens 24-46.	Flowers small, sepals in anthesis 3-5 mm. high (dry: 3-4 mm.), petals 2-4 mm. high (shrinking but little when dried), number of stamens 12 or less.
Seeds stellately rugulose but not prominently warty, 1-1.1 mm. long.	Seeds stellately rugulose (less distinctly stellate) prominently warty on the edge, 0.7 mm. long.

Both species may have a prostrate or erect habit, the leaves of both are distinctly petiolate with short hairs in the axils, not always dark in fresh material, and the bracts enclosing the calyx seem to offer no distinguishing characters.

The most convenient herbarium character is the appearance of the seeds. The height of the sepals is also useful, but only when they are fully grown.

Portulaca oleracea Linnaeus: Sp. pl., p. 445, 1753.

Wake: Main island, in sand, *fl, fr*, August 4, 1923, Pollock (and Cheatham) No. 40.

It is with doubt that this specimen is referred to *P. oleracea*. There are no ripe seeds attached, but seeds in a separate envelope show essentially the characters of *P. lutea*. The stamens number 19 in one flower, the sepals are 3.5 mm. high, and the stem is rather suffrutescent at the base. On the field label is written: "Flower small, yellow, different from the large flowered upright." *

Pollock (B. P. Bishop Mus., Bull. 28, pp. 16-17, 1926) states that both *P. oleracea* and *P. lutea* are present on Wake Island. But he cites A. Gray erroneously when he states that Gray only gave *P. oleracea* from Wake Island in the report of the United States Exploring Expedition. Gray (U. S. Expl. Exped., Botany, pt. 1, p. 139, 1854) writes as follows: "This is enumerated in Dr. Pickering's list

⁶ This drawing, I suppose, is to be considered the type since no specimens are to be found as stated by Seemann (Fl. Vitensis, p. 9, 1865), a fact that I could only confirm at the British Museum. A photograph of the drawing is reproduced by Setchell (American Samoa, pl. 34, C, Washington, 1924), and Solander's manuscript description is given in full by Seemann.

under the name of *Portulaca lutea* of Forster, which it undoubtedly is, as distinguished from the *P. oleracea*; but the specimens do not furnish any tangible distinctive characters."

CRUCIFERAE

Lepidium owaihiense Chamisso et Schlechtendal: *Linnaea*, vol. 1, p. 32, 1826.

Wake: Main island, *fl, fr*, July 30, 1923, Pollock and Bryan No. 10; Wilkes Island, *fl, fr*, July 30, 1923, Pollock No. 16; Peale Island, *fl, fr*, July 31, 1923, Pollock No. 28.

These specimens show the broad emarginate short-style fruits characteristic of *L. owaihiense*, but differ somewhat from Hawaiian specimens in the leaves, being more densely serrate in nos. 10 and 16.

ZYGOPHYLLACEAE

Tribulus cistoides Linnaeus: *Sp. pl.*, p. 387, 1753.

Johnston: Main island, in sandy soil, *fl, fr*, July 11, 1923, Pollock No. 1; Sand Island, *fl, fr*, July 15, 1923, Pollock No. 4.

MALVACEAE

Sida fallax Walpers, *Nov. act. acad. Caes. Leop.-Carol. Nat. Cur.*, vol. 19, suppl. 1, p. 306, 1843.

Wake: Wilkes Island, July 29-30, 1923, Pollock and Bryan No. 17; Peale Island, *fl*, July 31, 1923, Pollock and Bryan No. 25; U. S. Expl. Exped. in 1841 acc. to A. Gray (*U. S. Expl. Exped., Botany*, pt. 1, p. 161, 1854).

Gossypium hirsutum Linnaeus var. **religiosa** Watt: *Wild cultiv. cotton*, p. 201, London, 1907.

Wake: Main island, August 1, 1923, Pollock and Bryan No. 33.

In the northeastern part of the main island a patch of this cotton was found. It is characterized by its long slender branches which do not grow erect, its tomentose, cordate, and long-petioled leaves with 3 triangular acute or obtuse and mucronate lobes, its free, moderately lacinate bracteoles, its four-celled fruits with seeds covered by a dense rust-colored short fuzz and a firmly adherent longer floss which may be rust-colored or white.

LYTHRACEAE

Pemphis acidula Forster: *Charact. gen. pl.*, p. 68, t. 34, 1776.

Wake: Wilkes Island, *fl, y fr*, August 1, 1923, Pollock and Cheatham No. 31. Grows all over the island.

CONVOLVULACEAE

Calonyction grandiflorum (Jacquin) Choisy: *Mem. Soc. Phys. Genève*, vol. 6, p. 442, 1833.

Wake: Main island, on coral sand, *y fl*, August 3, 1923, Pollock No. 37; "Peale, Wilkes, and Wake," climbing on *Tournefortia* trees, Pollock and Bryan No. 21.

A specimen of Pollock's collection No. 37 was sent to Dr. E. D. Merrill who has kindly given the above determination. According to Dr. Merrill this widely distributed species was misinterpreted by House (*Bull. Torr. Bot. Club*, vol. 31, p. 591, 1904) as being identical to *Ipomoea alba* Linnaeus, which, however, is the species with tailed sepals. The oldest valid specific name for the species with blunt sepals is contained in *Convolvulus grandiflorus* Jacquin (*Hort. Vind.*, 3, 39, t. 69, 1776).

Ipomoea pes-caprae (Linnaeus) Roth: *Nov. pl. sp.*, p. 109, 1821.

Wake: Peale Island, on the beach, *passée fl, b*, July 31, 1923, Pollock and Bryan No. 22.

BORAGINACEAE

Cordia subcordata Lamarck: *Illustr. gen.*, vol. 1, p. 421, 1791-97.

Wake: Main island, in coral sand, July 29, 1923, Pollock No. 13, Pollock and Wetmore No. 19; *fl, fr*, August 1, 1923, Pollock and Bryan No. 34; Peale Island, in coral sand back of the beach ridge, *fl*, July 31, 1923, Pollock No. 26.

Heliotropium anomalum Hooker et Arnott: *Bot. Beech.*, p. 66, 1830-32.

Wake: Main island, on the coral beach, *fl*, August 1-3, 1923, Pollock No. 36.

Tournefortia argentea Linnaeus fil.: Suppl. syst. veg., p. 133, 1781.

Wake: Wilkes Island, in sand and on coral rocks, *fl, fr*, August 1, 1923, Pollock and Cheatham No. 32.

Stated to grow on all the three islets of Wake Island.

SOLANACEAE

Nicotiana tabacum Linnaeus: Sp. pl., p. 180, 1753.

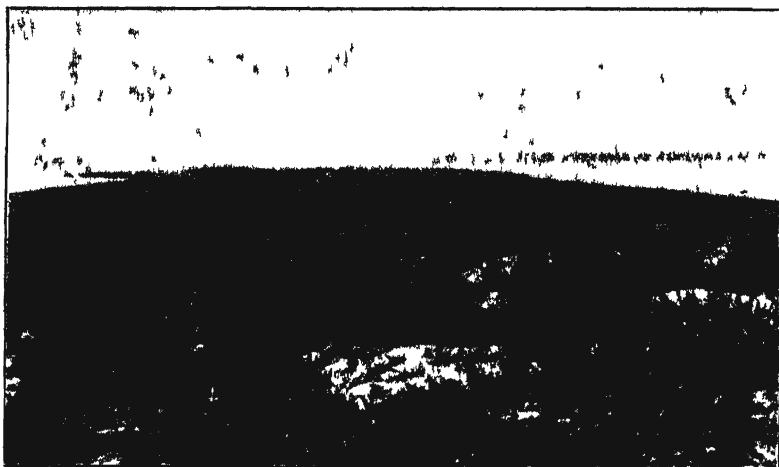
Wake: Peale Island, *y fr*, July 31, 1923, Pollock No. 29.

Found only in the vicinity of an abandoned shack. Introduced.

GOODENIACEAE

Scaevola frutescens (Miller) Krause: Engl. Pflanzenreich, IV, 277, p. 125, 1912.

Wake: Wilkes Island, *fl*, July 29, 1923, Pollock and Bryan No. 20.



A



B

PLATE I—Johnston Island A, view looking west from Summit Peak, vegetation of *Lepturus repens*, B, boobies nesting in *Tribulus cistoides*, grass is *Lepturus repens* (photographs by E. H. Bryan, 1923)



A

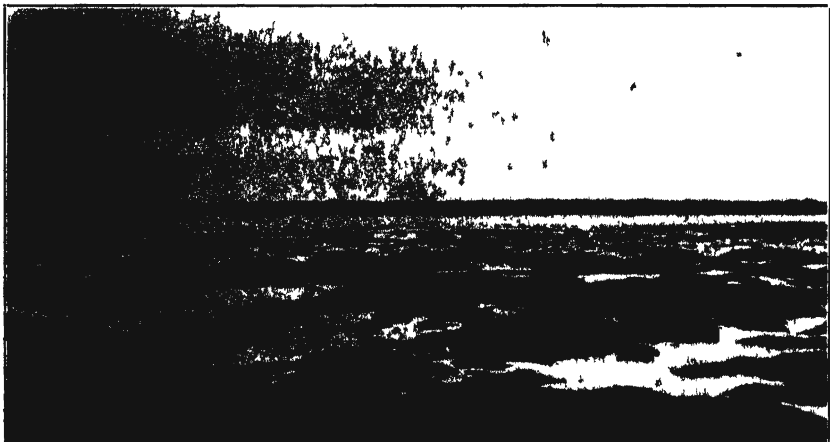


B

PLATE II—Wake Island A, forest of *Pemphus acidula* and *Tournefortia argentea* on Wilkes Island (photograph by H S Palmer, 1923), B, single trees of *Tournefortia argentea* and abundant growth of *Heliotropium anomalum* on south shore (photograph by E H Bryan, 1923)



A



B

PLATE III—Wake Island. A, *Tournefortia argentea* on the beach (photograph by H. S. Palmer, 1923), B, mats of *Sesuvium portulacastrum* in the northeastern part of the central lagoon (photograph by E. H. Bryan, 1923)



PLATE IV.—Trunk of *Ceodes* at northwest end of Wake Island (photograph by E. H. Bryan, 1923).

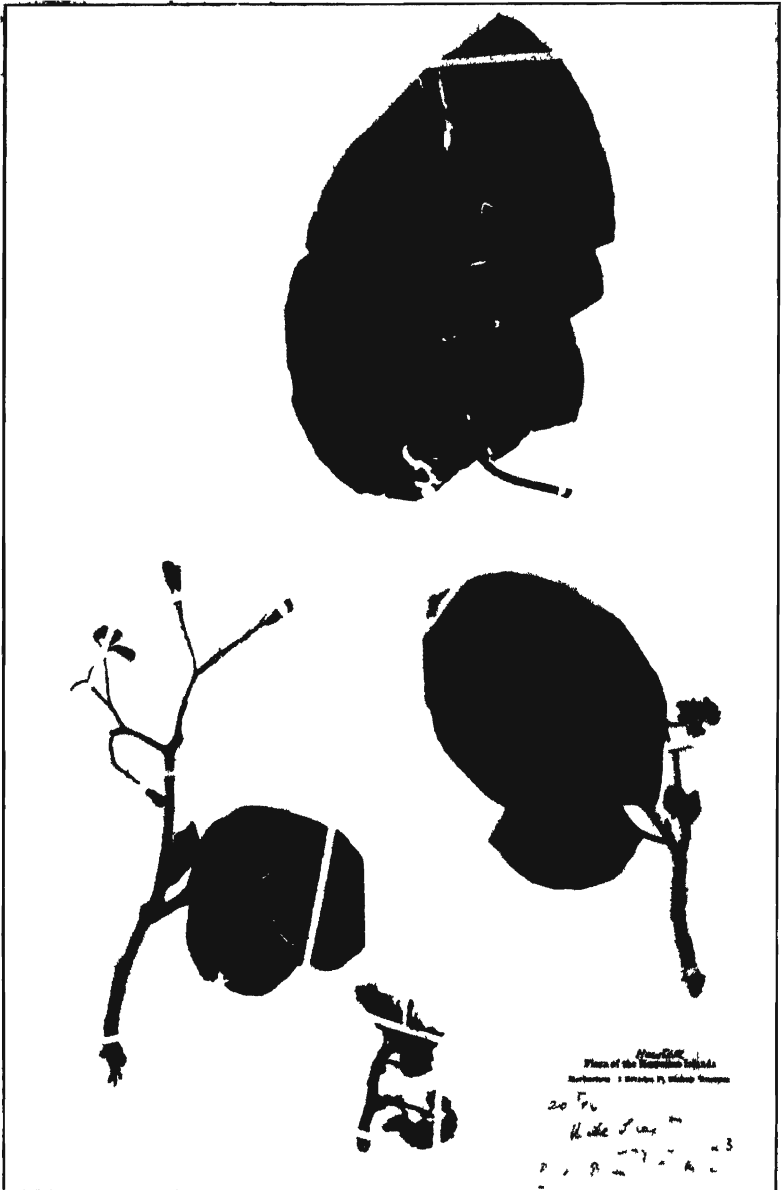


PLATE V—*Ceodes* sp Wake Island

ADDITIONS TO THE FLORA OF NIIHAU

By

HAROLD ST. JOHN

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ADDITIONS TO THE FLORA OF NIIHAU

By HAROLD ST. JOHN

. The only recent and extensive account of the vascular flora of the island of Niihau is by Charles N. Forbes, late botanist of the B. P. Bishop Museum.¹

He included in his report the few published records of the early collectors: Lay and Collie in 1826-1827, J. Remy between 1851 and 1855, and Dr. W. T. Brigham in 1865. His principal source of information, however, was the collection made during January, 1912, by J. F. G. Stokes.

Niihau is a low, arid island, only 73 square miles in extent and 1304 feet in height. Its original flora was probably small and it has long been subjected to grazing. Forbes enumerated in his catalog 25 endemic Hawaiian, and 39 indigenous species, as well as 10 of aboriginal introduction, and 41 of recent introduction.

There have been no more recent botanical explorations of Niihau. While working on the undetermined plants in the Bishop Museum, I found two bundles of Niihau plants. It was soon obvious that these were a part of the Stokes collection upon which Forbes's "Enumeration" was based. Most of them were duplicates of species and numbers already in the herbarium. Some, however, were numbers not included there, and a small number were additional records. In this collection some species were represented only by fragmentary or sterile material so that identification was difficult. Besides these, there were several numbers of excellent material that had been left undetermined. These were members of critical groups, as *Lobelia* and *Panicum*. Apparently Mr. Forbes did not name them in time for inclusion in his list, and then the bundle was shelved. Because of the isolation and the relative inaccessibility of Niihau, it seems desirable to print this list of additions to its vascular flora.

Family GRAMINEAE

Cenchrus echinatus Linnaeus.

A single bur, mixed with a collection of *Hydrocotyle* from Kaali.

Digitaria debilis (Desfontaines) Willdenow. ³

No data.

¹ Forbes, C. N., An Enumeration of Niihau Plants: B. P. Bishop Mus., Occ. Papers, vol. 5, no. 3, pp. 17-26, 3 Pl., 1 map, 1913.

PLATE I—*Panicum mihauense* St John Type

Panicum niuhauense St. John, new species (Pl. I).

Perennial and apparently caespitose; culms 50-53 cm. tall, velutinous, erect, leafy throughout, the nodes more or less pilose; leaf sheaths 5-10 cm. long, usually exceeding the internodes, densely velutinous with a narrow hyaline margin towards the base, and remotely hispid ciliate; ligule membranous, 0.3 mm. long, ciliate with white hispidulous hairs nearly 1 mm. long; leaf blades 15-30 cm. long, 7-9 mm. wide, stiff, ascending, linear, tapering, densely velutinous, the nerves prominent, the margins involute; panicle 13-17 cm. long, 5-15 mm. in diameter, enclosed in the uppermost sheath, later partly or almost entirely exerted, strict, dense, and narrowly cylindrical, the branches all ascending and appressed; the axis and branches velutinous; branches not verticillate; pedicels mostly shorter than the spikelets, velutinous or pilosulous at least along the angles; spikelets 3-4 mm. long, glabrous, with strong raised nerves; first glume 5-nerved, long acuminate; second glume similar, only slightly shorter, 7-nerved; sterile lemma 2 mm. long, 7-nerved, short acuminate; fertile lemma pale, cartilaginous, 1.2-1.5 mm. long, acute; palea similar to and equaling the lemma.

Perenne caespitosum, culmis 50-53 cm. altis velutinis foliosis, vaginis 5-10 cm. longis, ligulis membranaceis ciliatisque, laminis 15-30 cm. longis 7-9 mm. latis rigidis velutinis involutis, paniculis 13-17 cm. longis compactis cylindricis, spiculis 3-4 mm. longis glabris valde nervosis, glumis acuminatis, lemmis 1.2-1.5 mm. longis acutis.

Niuhau, foot of Mountain on West side, January, 1912, J. F. G. Stokes. Type in B. P. Bishop Museum.

This collection was determined by C. N. Forbes as *Panicum nephelophilum* Gaudichaud, var. *xerophilum*? and listed by him under that name. It is somewhat similar to that plant, but of the Hawaiian members of the genus it comes closer to the species than to the variety. The two may be distinguished as follows: *Panicum nephelophilum* Gaudichaud has the culms 1-1.5 m. tall, glabrous; the sheaths papillose-pilose or glabrate; the ciliations of the ligule 4 mm. long; the blades flat, glabrous or ciliate on the margin, 8-25 mm. wide; the panicle open, as much as 50 cm. long and 30 cm. wide, the branches ascending, glabrous, or the axils pilosulous; the pedicels glabrous or sparsely scaberulous; the spikelets 2-2.5 mm. long; the glumes equal, the second acute; and the fertile lemma about 1.7 mm. long. *Panicum niuhauense* St. John has the culms 50-53 cm. tall, velutinous; the sheaths velutinous; the ciliations of the ligule 1 mm. long; the blades with involute margins, densely velutinous, 7-9 mm. wide; the panicle strict, not over 17 cm. long and 15 mm. wide, the branches erect, velutinous; the pedicels velutinous or pilosulous at least along the angles; the spikelets 3-4 mm. long; the glumes

unequal, the second glume longer, acuminate; and the fertile lemma 1.3-1.5 mm. long. It is a member of the section *Eupanicum* of Hackel or the subgenus *Eupanicum* as it is treated by some recent authors.

In seeking for similar species in this large and intricate genus, I have not found any that appear intimately related. Perhaps the closest is *Panicum amplexicaule* Rudge which is an aquatic or sub-aquatic, and has the culm up to 1 meter tall, decumbent and rooting at the lower nodes, glabrous; the nodes dark; the sheaths ciliate; the blades scabrous on the margins; the spikelets 5-5.5 mm. long; the first glume one-third the length of the spikelet; and the second glume and sterile lemma scabrous nerved. *Panicum niuhauense* St. John, on the other hand, is a xerophyte and has the culms 50-53 cm. tall, erect, velutinous; the nodes not dark; the sheaths velutinous; the blades velutinous; the spikelets 3-4 mm. long; the first glume eleven-twelfths the length of the spikelet; and the second glume and sterile lemma glabrous.

The name is formed from the name of the island Niihau and the Latin suffix *ensis*, to indicate it as a native of this small, out-lying, arid island of the Hawaiian group.

Family CYPERACEAE

Scirpus maritimus Linnaeus, var. **digynus** Boeckeler.

Ponds, southern end.

This sterile material is perhaps the basis of the entry in the list by Forbes:

"**Cyperus** species. Only leaves collected."

Family PIPERACEAE

Peperomia Candollei St. John, new species (Pl. II).

Somewhat fleshy herb; stem decumbent at base, rooting at the lower nodes, then ascending, leafy throughout, hirtellous, 15-26 cm. tall, fleshy, when dried 1.5-3 mm. thick at base; internodes usually 1.5-2 cm. long; nodes swollen; leaves opposite or 1-2 of the median nodes with whorls of 3 leaves; petioles 1-5 mm. long, densely hirtellous with hairs that are brownish when dried; blades 9-30 mm. long, 6-17 mm. wide, fleshy, on both sides densely hirtellous from dark papillose bases, palmately 5-nerved, the main nerves and the reticulate veinlets distinctly visible, elliptic to obovate, obtuse, cuneate or subcuneate at base; spikes terminal or terminal and axillary, solitary or few; peduncles 5-11 mm. long, slender, hirtellous at base, sparsely so above; spikes 4-6.5 cm.

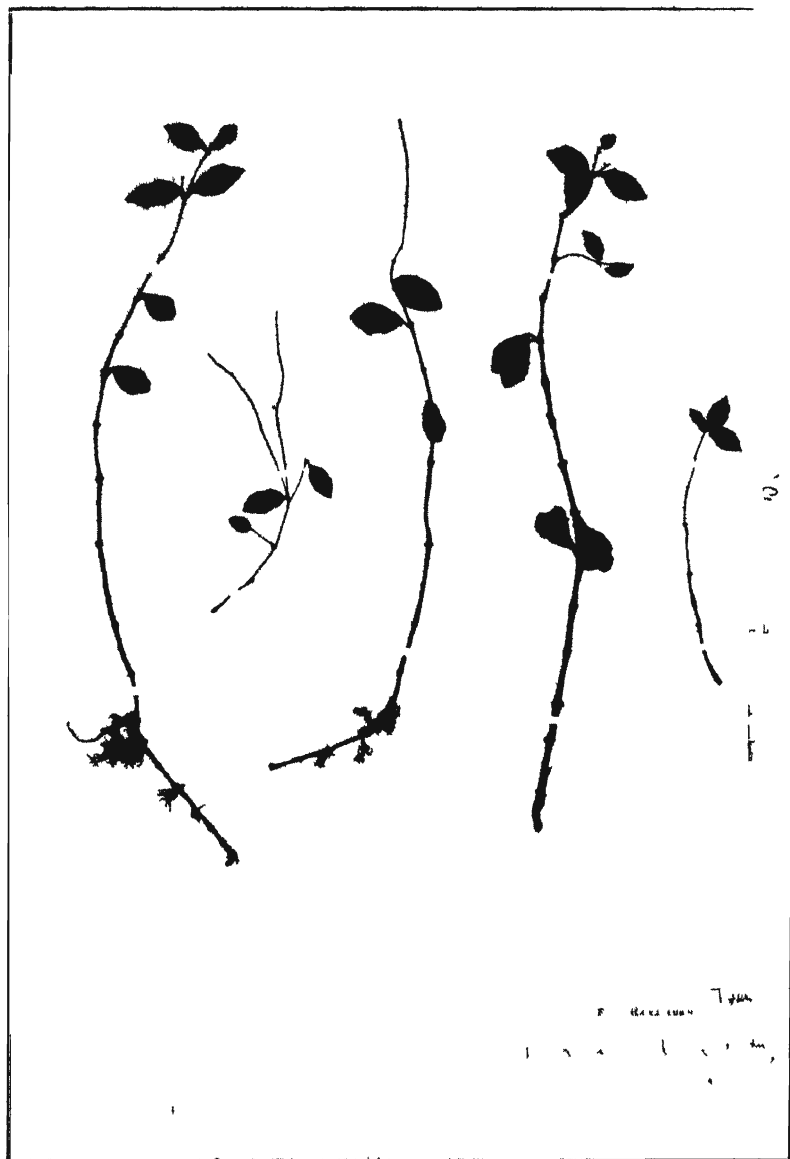


PLATE II.—*Peperomia Candollei* St. John. Type.

long, 0.5-0.7 mm. thick when dried, glabrous, densely flowered, foveolate; bracts 0.7 mm. in diameter, suborbicular, pedicellate, peltate $\frac{1}{3}$ of the distance from the margin; stamens 2; filaments shorter than the anthers, oblong-oval, yellowish, with 2 parallel sacs, 0.2 mm. long; ovary ovoid; stigma terminal minute, undivided; fruit 0.5-0.7 mm. long, broadly ellipsoid to subspherical, densely papillose glandular.

Herba carnosa, caulibus decumbentibus ad basim 15-26 cm. altis, foliis oppositis vel verticillatis, petiolis 1-5 mm. longis hirtellis, laminis 9-30 mm. longis 6-17 mm. latis hirtellis 5-nervis ellipticis obovatisve obtusis cuneatis, amentis 4-6.5 cm. longis 0.5-0.7 mm. latis glabris terminalibus paucis, pedunculis 5-11 mm. longis gracilibus hirtellis, bracteis 0.7 mm. latis suborbicularibus peltatis, staminibus 2, stigmatibus terminalibus integris, baccis 0.5-0.7 mm. longis ellipsoideis papilloso-glandularibus.

Niihau, foot of Mountain on West side, January, 1912, J. F. G. Stokes. Type in B. P. Bishop Museum.

It is not without hesitancy that I publish a new species of the large and intricate genus *Peperomia*. Yet, this collection from Niihau differs in numerous particulars from any other Hawaiian species, as it also seems to from any known extra-Hawaiian species. It is closest to *P. Helleri* C. de Candolle, from the nearest island, Kauai. This species has the leaves acute, the upper surface dark glandular papillose and sparsely hispid or glabrate, the lower surface similar but more hispid; the spikes 3-4 cm. long, half longer than the leaves; and the stigma oblique, below the summit of the ovary. *P. Candollei* St. John has the leaves obtuse with both surfaces densely hirtellous from dark papillose bases; the spikes 4-6.5 cm. long, 2-4-times longer than the leaves; and the stigma terminal, minute, undivided. Of the exotic species the most similar is *P. pubicaulis* C. de Candolle, from Lombok, which has the stem about 12 cm. long, hirsute; the leaves 3-nerved, the peduncles 15 mm. long; the bracts about 0.5 mm. in diameter; and the stigma papillose. In contrast, *P. Candollei* St. John has the stem 15-26 cm. tall, hirtellous; the leaves 5-nerved; the peduncles 5-11 mm. long; the bracts 0.5-0.7 mm. in diameter; and the stigma glabrous.

The species is named in honor of the late Anne Casimir Pyramus de Candolle, the monographer of this genus and family. It is curious that no species of *Peperomia* bears this specific name, but he was for so many years the authority on this group that he had almost a monopoly of its study. Hence, it is with pleasure that I give the specific name in honor of de Candolle, the fourth botanist in direct line in the most noteworthy family of botanists.

Family MALVACEAE

Malva rotundifolia Linnaeus.

Talus, north Kona cliffs. (Sterile.)

Family LABIATAE

Ocimum Basilicum Linnaeus.

Foot of plateau, southeast.

Family CUCURBITACEAE

Cucumis dipsaceus Ehrhart.

Talus, north Kona cliff.

Family LOBELIACEAE

Lobelia niihauensis St. John, new species (Pl. III).

Low and probably prostrate shrub; stems solid, gnarled or twisted, branched several times, woody and strong, but on drying shrinking and wrinkling between the leaf-scars, 2-3.5 dm. or perhaps more in length, at base as much as 2.5 cm. in diameter, the young leafy twigs 7-10 mm. in diameter, the bark tan-colored or yellowish brown, with the prominent lunoid leaf-scars scattered along 5-10 cm. of stem, then closely massed along the 2-5 cm. of somewhat swollen leafy tips; leaves 7-14 cm. long, 9-14 mm. wide, subsessile, subcoriaceous, glabrous, linear oblanceolate, entire or occasionally minutely undulate towards the tip; flowering branches ascending, remotely leafy below, scape-like and merely bracted for about 1 dm.; raceme 12-15 cm. long, 27-60-flowered, subvirgate, hispidulous; bracts linear-lanceolate, 3-5 mm. long, hispidulous; pedicels 10-25 mm. long, curved downwards, then upwards and to one side, slender, hispidulous; calyx-tube turbinate, at least when dried much constricted below the receptacle, 2-3 mm. long, glabrous or with a few lines of hairs; calyx-teeth 1-2 mm. long, deltoid-lanceolate, sparsely hispidulous; buds falcate; corolla apparently lavender or magenta, 2.5-2.8 cm. long, glabrous, cleft between the upper lobes more than half way to the base, the two upper lobes linear, equaling the tube, becoming reflexed and curled or spiraled, the three lower lobes lanceolate, 6 mm. long; filament-tube stout, 20-23 mm. long, remotely puberulent at base, glabrous above; anthers 7-9 mm. long, glabrous except for the penicillate lower ones; immature capsule turbinate to subglobose, 4 mm. long.

Frutex depressus, ramis furcatis, 2-3.5 dm. longis, foliis subsessilibus glabris subcoriaceis lineari-oblanceolatis integris subintegrisve 7-14 cm. longis 9-14 mm. latis, racemis 12-15 cm. longis 27-60-floriferis, pedicellis 10-25 mm. longis, corollis 2.5-2.8 cm. longis glabris, antheris superis 7-9 mm. longis glabris, inferis penicillatis.

Niihau, Kaali, January, 1912, J. F. G. Stokes. Type in B. P. Bishop Museum.



PLATE III.—*Lobelia mihauensis* St John Type

This plant appeared in Forbes's "Enumeration of Niihau Plants," B. P. Bishop Mus., Occ. Papers, vol. 5, no. 3, p. 25, 1913, as *Lobelia neriifolia* Gray, var. ———. However, as shown by the six sheets at hand, this collection represents a new species, one that is most closely related to *Lobelia tortuosa*, instead of to *Lobelia neriifolia*. The following tabular material will indicate the distinctive differences between the two species. *Lobelia tortuosa* Heller has the leaves membranaceous, narrowly lanceolate-oblong, acuminate at apex, serrate nearly to the base, 8-21 cm. long, 10-18 mm. wide, somewhat puberulent above, pale and densely soft puberulent beneath; the bracts subulate, tomentose; the calyx-tube and lobes densely puberulent; and the corolla puberulent. It is endemic to Kauai. *Lobelia niihauensis* St. John has the leaves subcoriaceous, linear-oblanccolate, glabrous, entire or occasionally minutely undulate towards the tip, 7-14 cm. long, 9-14 mm. wide; bracts linear-lanceolate, hispidulous; the calyx-tube glabrous or with a few lines of hairs, the lobes sparsely hispidulous; and the corolla glabrous.

This list of additional species adds to the flora of Niihau 3 endemic Hawaiian species, 1 indigenous species, and 5 plants of recent introduction.

MOSSES OF RAIATEA

By

EDWIN B. BARTRAM

BERNICE P. BISHOP MUSEUM

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OCTOBER, 1931

MOSSES OF RAIATEA, SOCIETY ISLANDS

By EDWIN B. BARTRAM

The Raiatean mosses collected by Mr. John W. Moore between October 5, 1926 and May 31, 1927 consist of 92 numbers, some mixed, representing 51 species as shown in detail in the accompanying list. Many of these are fairly well-known Tahitian types, as might naturally be expected, but the list is by no means lacking in items of unusual interest.

The species not previously reported from the Society Islands comprise: *Syrrhopodon ciliatus*, *Syrrhopodon mamillatus*, *Syrrhopodon aristifolius*, *Calymperes tenerum*, *Philonotis laxissima*, *Meiothecium serrulatum*, *Acroporium sigmatodotium* and *Isopterygium albenscens*. The species described as new are: *Fissidens raiatensis*, *Calymperes moorci*, *Garovaglia tahitense* var. *brevicuspadata* and *Scmatophyllum moorci*, the type collections of which have been deposited in the herbarium of Bernice P. Bishop Museum and in the herbarium of the writer.

FISSIDENTACEAE

Fissidens raiatensis Bartram, new species (fig. 1, a-g).

Plantae gregariae. Folia plurijuga, infima minuta, sicca flexuosa, anguste lanceolata, lamina dorsalis ad basin folii enata. Costa infra summum apicem folii evanida. Limbus bi-triseriatus, bistratosus, infra apicem folii desinente; margines sinuato-denticulati. Cellulae hexagonae, parietibus tenuibus, papillosae, circa 8-10 μ . Seta saepe geniculata, ad 2.75 mm. alta, theca inclinata, circa 0.7 mm. longa, operculo rostrato. Caetera ignota.

Dioicous: male flower terminal on a smaller plant. Small, rather closely gregarious plants, pale or sordid green. Stems erect or decumbent, the fertile up to 2 mm. long with 4 or 5 pairs of leaves, the sterile up to 5 mm. long with more numerous leaves. Leaves linear-lanceolate, short acuminate, the lowermost minute, rapidly larger upward, the upper leaves about 1.5 mm. long; dorsal lamina slightly narrowed below, rounded at the base, ending abruptly just below the insertion of the duplicate blades; costa pale, ending just below the apex; margin sinuate-denticulate all around; apical and dorsal blades bordered with 2-3 rows of rather short rectangular or rhomboidal cells in two layers ending a little way below the apex; duplicate blades bordered below with 2-3 rows of long narrow cells gradually becoming shorter and rhomboidal upward; leaf cells hexagonal, thin-walled, papillose, 8-10 μ in diameter. Perichaetial leaves slightly larger than the upper stem leaves; seta erect from a geniculate base, about 2.75 mm. long, pale when young becoming reddish with age; capsule inclined, ovoid-cylindric, urn 0.7 mm. long; lid conic-rostrate, 0.5 mm. long (capsule immature).

Type: on wet rocks on floor of *mapu* grove, Faaroa Valley, Raiatea, Society Islands, Jan. 7, 1927, John W. Moore No. 8.

A species with some of the characteristics of *F. rigidulus* Hooker, filius, and Wilson but much smaller in every way. The narrow inconspicuous leaf border fades out entirely some distance below the apex of the leaf.

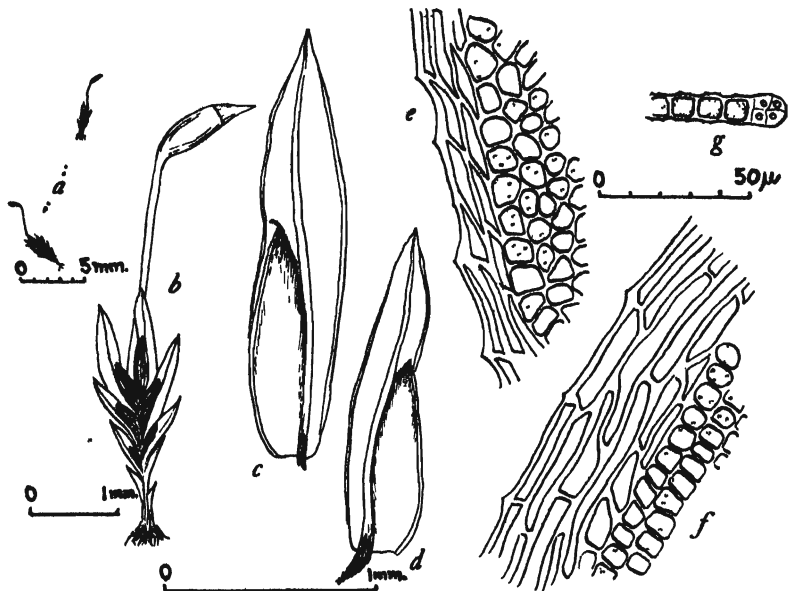


FIGURE 1—*Fissidens raiatensis* Bartram, new species *a* two plants, *b*, moist plant, *c*, perichaetial leaf *d*, stem leaf, *e*, cells and margin of apical blade, *f*, cells and margin of duplicate blade, *g*, cross section of leaf margin

DICRANACEAE

Campylopodium euphorocladum (C Muller) Bescherelle

Highest mountain, west side, on wet rock, no 41.

Campylopus sulphureus Bescherelle.

Faaroa Bay, on moist red clay soil, elevation 100 meters, no 70

Thysanomitrium umbellatum Arnott.

Mt. Temehani, on wet rocks near the "Hole," elevation 450 meters, no. 22.

A slender form with the hyaline hair-points of the leaves nearly obsolete.

Leucoloma limbatulum Bescherele.

Temehani range, south end, on soil in shade of shrubs, elevation 500 meters, no. 50; also, intermixed with liverworts on branches of shrubs, no. 47.

LEUCOBRYACEAE

Leucobryum tahitense Longstrom.

West side of highest mountain, on wet branches of trees, elevation 500 meters, no. 25; Faaroa Bay, north side, on top of mountain among other mosses, elevation 500 meters, no. 54.

Leucophanes prasiophyllum Bescherele.

Faaroa Valley, on decaying base of fern (*nehe*), elevation 100 meters, no. 71.

In this species the median band of stereid cells is exposed on the dorsal side of the leaf while in *L. tahiticum* it is covered with a row of large thin-walled cells.

Leucophanes tahiticum Bescherele.

Third valley south of Uturoa, on coconut tree, elevation 50 meters, no. 6.

Octoblepharum longifolium Lindberg.

With the preceding species, no. 6a.

Arthrocnemum schimperii Dozy and Molkenboer.

Faaroa Bay, on dead *purau* branch, elevation 200 meters, no. 53.

Exodictyon dentatum (Mitten) Cardot

Averaiti Valley, upper end, on dead branch of tree over stream bed, elevation 300 meters, nos. 76 and 83a.

CALYMPERACEAE

Syrrophodon banksii C. Müller, cum fructibus.

Tioo, on coconut tree near the beach, elevation 1 meter, no. 51.

Syrrophodon tristichellus Bescherele.

West side of highest mountain, on moist branches of trees, elevation 400 meters, no. 36a.

Syrrhopodon mamillatus C. Müller.

Faaroa Valley, on decaying base of fern (*nehe*), elevation 100 meters, no. 71a.

Known from Samoa and Fiji but new to the Society Islands.

Syrrhopodon ciliatus (Hooker) Schwaegrichen.

With the preceding species, mixed with *I. cucophanes prasiophyllum*, no. 71b.

The occurrence of this species in Raiatea extends its range widely to the eastward.

Syrrhopodon aristifolius Mitten.

Averaiti Valley, upper end, on dead branch of tree over stream bed, elevation 300 meters, no. 76b; also, on shrub, elevation 500 meters, no. 92.

Previously known only from Samoa.

Syrrhopodon nadeaudianus Bescherele.

Faaroa Bay, on dead *purau* branch, elevation 200 meters, no. 53a; highest mountain on tree branches, elevation 800 meters, no. 91.

Thyridium constrictum (Sullivant) Mitten.

North side of Faaroa Bay, mountain, on wet branches of tree, elevation 400 meters, no. 65; Faaroa Valley, on decaying wood in moist soil, elevation 100 meters, no. 67.

Thyridium obtusifolium (Lindberg) Fleischer.

Averaiti Valley, upper end, on wet branch of tree, elevation 300 meters, nos. 78, 83, 86

Calymperes tenerum C. Muller.

Island of Nao Nao, on lichens, on bark of *hatu* tree, elevation 1 meter, no. 88.

Calymperes aongstroemii Bescherele.

Faaroa Valley, on base of *mape* tree, elevation 150 meters, no. 9; Tioo, on bark of *mape* tree in shade, no. 84.

Calymperes moorei Bartram, new species, (figure 2, a-h).

A *C. chamaeleontum* C. Muller affine sed foliis latioribus; marginibus basilaribus et laminalibus integris; cellulis laevibus haud papillosis.

Plants 3-4 mm. high, yellowish-green at the tips, brown below. Leaves erect with incurved points when dry, spreading when moist, the normal leaves

slightly contracted above the short base to an oblong-ovate blade, obtuse, about 1.5 mm. long by 0.5 mm. wide; margin plane, entire; costa smooth, percurrent or ending just below the apex, in cross section with stereid bands on both sides of the median row of guide cells; leaf cells rounded hexagonal, thin-walled, turgid on the free surfaces but not papillose, cancellinae shorter than the leaf base, truncate above or higher toward the margins than near the costa; tenioiae narrow but distinct, ending a short distance above the shoulders of

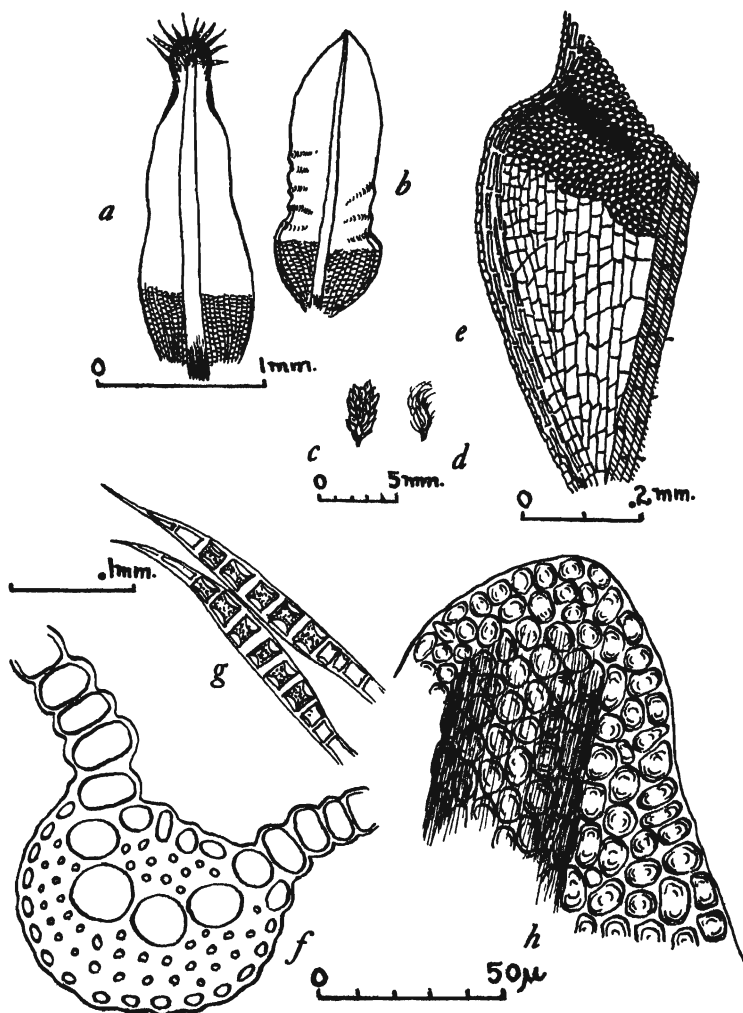


FIGURE 2.—*Calymperes moorei* Bartram, new species: *a*, abnormal leaf; *b*, normal leaf; *c*, moist plant; *d*, dry plant; *e*, one side of leaf base; *f*, cross section of costa; *g*, two propagulae; *h*, apex of normal leaf.

the leaf base; abnormal leaves constricted just below the rounded apex and bearing numerous septate, spindle-shaped propagulae on the inner side of the flaring throat. Sporophyte unknown.

Type: 1 kilometer south of Fatuna, on bark of coconut tree, elevation 1 meter, Raiatea, Society Islands, May 23, 1923, John W. Moore, no. 85.

Calymperes tahitense (Sullivant) Mitten.

Mount Temehani, on bare wet rocks, elevation 400 meters, no. 19; Averaiti Valley, on rotten log along stream, elevation 300 meters, no. 73.

BRYACEAE

Bryum weberaceum Beschereille?

Tioo, on soil in coconut grove, elevation 1 meter, no. 90.

A sterile collection with the costa excurrent in a longer point than in typical plants from Tahiti. It may be a distinct species.

Bryum leptothecium Taylor.

Temehani range, south end, among other mosses on branches of shrubs, elevation 500 meters, no. 46e.

HYPNODENDRACEAE

Hypnodendron vescoanum Beschereille.

Averaiti Valley, upper end, on *Pandanus* tree, elevation 300 meters, no. 74.

Mniodendron tahiticum Beschereille.

Highest mountain, west side, on wet branches of trees, elevation 800 meters, no. 45; Temehani range, south end, among other mosses on branches of shrubs, elevation 500 meters, no. 46a; Averaiti Valley, upper end, on wet branches of trees in deep shade, elevation 400 meters, no. 57; north side of Faaroa Bay, mountain, on wet branches of tree in shade, elevation 400 meters, nos. 61 and 62; Averaiti Valley, on dead branch of tree above stream bed, elevation 300 meters, no. 77.

BARTRAMIACEAE

Philonotis laxissima (C. Müller) van den Bosch and Lacoste:
Bryologica Javanica, 1855-1861.

Averaiti Valley, upper end, on rock of small waterfall, elevation 300 meters, no. 75.

I have not seen the type of *P. jardini* (Bescherelle) Brotherus, from Tahiti, but there is little or nothing in the description to distinguish it from *P. laxissima* which apparently ranges from Java to Hawaii.

SPIRIDENTACEAE

Spiridens balfourianus Greville.

Small valley below Mt. Temehani, on wet branches of *Pandanus* trees, elevation 250 meters, no. 18.

ORTHOTRICHACEAE

Macromitrium subtile Schwaegrichen.

Faaroa Valley, on branches of *purau* tree, on ridge, elevation 100 meters, no. 17; Mount Temehani, on dry branches of shrub, on ridge, east of mountain, elevation 250 meters, no. 20; Tioo, on coconut tree, elevation 1 meter, no. 52; north side of Faaroa Bay, on ridge of mountain, on branch of tree, elevation 150 meters, no. 89.

PTYCHOMNIACEAE

Ptychomnium aciculare (Bridel) Mitten.

Mount Temehani, on wet *Pandanus* branches, in valley east of mountain, elevation 300 meters, no. 24; highest mountain, west side on branches of shrubs in shade, elevation 700 meters, no. 56; ditto, on branch of shrub, elevation 500 meters, no. 59.

PTEROBRYACEAE

Garovaglia tahitense Bescherelle var. **brevicuspidata** Bartram,
new variety (fig. 3).

Apex foliorum saepe raptim brevius acuminatus.

The leaves of the Raiatean plants are consistently more abruptly contracted to a shorter point than those of typical plants from Tahiti.

Highest mountain, in shade on tree branches, small valley, west side of mountain, elevation 600 meters, no. 27 (type); highest mountain, west side, on wet tree branches, elevation 800 meters, no. 44; Temehani range, south end, among other mosses on branches of shrubs, elevation 500 meters, no. 46.

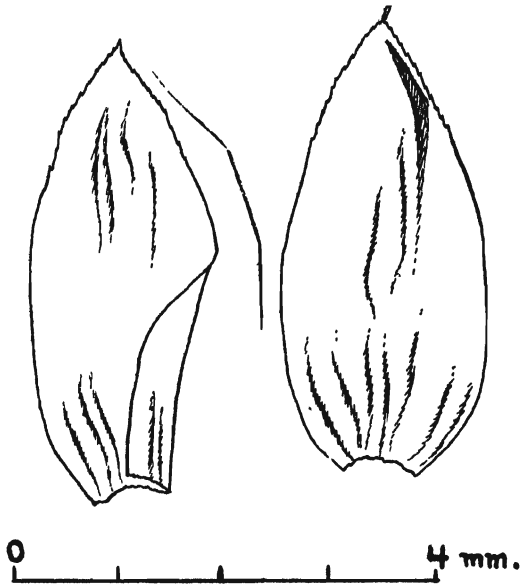


FIGURE 3.—*Garovaglia tahitense* Beschereille var. *brevicuspidata* Bartram, new variety: two leaves.

METEORIACEAE

Papillaria helictophylla (Montagne) Brotherus.

Highest mountain, west side, on tree branch in shade, elevation 800 meters, no. 43; Temehani range, south end, among other mosses on branches of shrubs, elevation 500 meters, no. 46f.

Floribundaria aeruginosa (Mitten) Fleischer.

North side of Faaroa Bay, mountain, on old *farapepe*, elevation 400 meters, no. 68.

NECKERACEAE

Neckeropsis lepineana (Montagne) Fleischer.

Temehani range, south end, among other mosses, on branches of shrubs, elevation 500 meters, no. 46g.

HYPOPTERYGIACEAE

Hypopterygium arbusculosum Bescherele.

Temehani range, south end, among other mosses, on branches of shrubs, elevation 500 meters, no 46d.

SEMATOPHYLLACEAE

Meiothecium serrulatum Dixon.

Temehani range, south end, on branch of shrub, elevation 500 meters, no. 49.

Sematophyllum moorei Bartram, new species (fig. 4, a-g).

Autoicum? robustiusculum, caespites aureo-lutescentes, nitidi. Caulis repens, dense ramosus, ramis sub-erectis, dense foliosus. Folia erecta, concava, saepe spiraliter imbricata, oblongo-ovata, acuminata; marginibus recurvis, superne reflexis; cellulis linearibus, incrassatis, porosis, laevibus. Folia perichaetalia erecta, superne serrulata; seta ad 14 mm. longa, rubra; theca erecta vel inclinata, oblongo-cylindrica, sub ore constricta, cellulae exothecii collenchymaticae; operculum conico-rostratum; sporae papilloso, ad 30 μ .

Autoicum? male flowers not seen. Robust plants in deep, dense tufts or mats, bright golden yellow, very glossy. Stems creeping, radiculose, nearly or quite denuded of leaves, very densely and compactly branched, branches erect or ascending, up to 3.5 cm. long, simple below, fasciculately branched above the middle, branchlets short and erect. Leaves closely imbricated, erect, \pm distinctly seriate in spiral rows below, oblong-ovate, short acuminate, very concave, up to 1.7 mm. long by 0.5 mm. wide; margin broadly reflexed from just below the apex in the upper half, narrowly recurved on one or both sides below, minutely denticulate at the apex, entire below; costa none; leaf cells linear, 5-6 μ wide by 12-18 times as long, incrassate, strongly pitted, several rows across the width of the insertion shorter and broader, golden-yellow, 3 or 4 cells at the basal angles greatly enlarged, oval-oblong, yellow or golden-brown. Perichaetial leaves erect, oblong-lanceolate, gradually acuminate, sharply serrate in the upper half, up to 1.5 mm. long; seta red, smooth, about 14 mm. long; capsule erect or slightly inclined, oblong-cylindric, contracted under the mouth when dry, urn 1 mm. long, brown, exothecal cells rounded, very collenchymatous; peristome teeth yellowish, cross-striate, with a fine zigzag median line, not furrowed, strongly trabeculate on the inner surface, inner peristome pale, papillose, basal membrane less than half as long as the teeth; lid conic-rostrate, as long as the urn; spores papillose, up to 30 μ .

Type: Mount Temehani, on wet *Pandanus* branches, in valley east of mountain, elevation 300 meters, Raiatea, Society Islands, Jan. 15, 1927, John W. Moore, no. 23.

A beautiful species comparable to no other with which I am familiar. The plants are unusually robust for the genus, rather rigid, densely and compactly matted together and of a brilliant golden-yellow color. The small, short pointed leaves are closely imbricated in a neat trim manner and frequently, but not always, in distinct spiral rows.

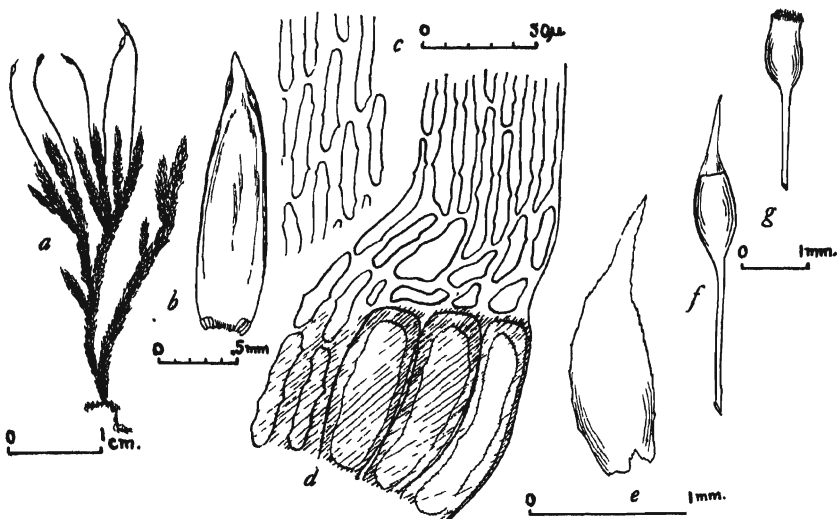


FIGURE 4.—*Sematophyllum moorei* Bartram, new species. *a*, plant; *b*, stem leaf; *c*, upper leaf cells; *d*, basal angle of leaf; *e*, inner perichaetial leaf; *f*, moist operculate capsule; *g*, dry deoperculate capsule.

***Acroporium sigmatodontum* (C. Müller) Fleischer.**

Mount Temehani, on wet *Pandanus* branches in deep shade, elevation 450 meters, no. 7; west side of highest mountain, on wet branches of trees, elevation 400 meters, no. 37.

***Acroporium lepinei* (Bescherelle) Fleischer.**

Mount Temehani, on wet *Pandanus* branches in deep shade, elevation 450 meters, no. 7a; Mount Temehani, on wet *Pandanus* branches, east of mountain, elevation 300 meters, no. 21; highest mountain, on wet branches of trees in small valley, west side of mountain, eleva-

tion 500 meters, no. 26; Mount Temehani, on wet *Pandanus* branches, east of "Hole," elevation 300 meters, no. 29; small valley, west side of highest mountain, on wet branches of trees, elevation 700 meters, nos. 30 and 31; Faaroa Bay, north side, on top of mountain, among other mosses, elevation 500 meters, nos. 54a, 60, 62a, 63, 64a, 69; Averaiti Valley, upper end, on wet branches of trees in shade, elevation 400 meters, nos. 55, 58, 81.

Judging from the number and abundance of the collections, this must be one of the commonest species on the island. The leaf points vary considerably as far as the degree of acumination is concerned but average is decidedly shorter than in the preceding species.

Trichosteleum hamatum (Dozy and Molkenboer) Jaeger.

Small valley, west side of mountain, on branches of trees, elevation 500 meters, no. 32; highest mountain, west side of ridge, on branches of trees, elevation 800 meters, nos. 34, 36, 38; Averaiti Valley upper end, on *Pandanus* tree in river bed, elevation 300 meters, no. 79; ditto on branch of tree in shade, nos. 82, 87.

Trichosteleum orthophyllum (Bescherelle) Brotherus.

West side of highest mountain on wet branches of trees, elevation 600 meters, no. 35.

These plants compare very closely with those from Tahiti, distributed under this name by Bescherelle. The species is far from convincing and should, in all probability, be considered as a form of *T. hamatum*.

Trichosteleum patens Bescherelle.

Highest mountain, west side, on wet clay soil, elevation 500 meters, no. 39.

Taxithelium trachaelocarpum (Aongstrom) Brotherus.

West side of highest mountain, on wet branches of trees, elevation 600 meters, no. 35a.

Taxithelium vernieri (Duby) Bescherelle.

Third valley south of Faaroa, on moist rocks in shade, elevation 80 meters, no. 4.

HYPNACEAE

Ectropothecium sodale (Sullivant) Mitten.

Faaroa Valley, on moist branches of trees in shade, elevation 100 meters, nos. 10, 12, 13, 15, 16; west side of highest mountain, small valley, in shade of shrubs, elevation 800 meters no. 28; Temehani range, on branches of shrubs in shade, elevation 400 meters, No. 48.

Ectropothecium sandwichense (Hooker and Walker Arnott) Mitten.

Third valley south of Faaroa Bay, on moist rocks in moist shady *mape* grove, elevation 100 meters, no. 3.

Isopterygium albescens (Schwaegrichen) Jaeger.

North side of Faaroa Bay, mountain, on branch of tree in shade, elevation 400 meters, no. 64. Averaiti Valley, upper end, on moist rock in stream bed, elevation 300 meters, no. 72.

As far as I can see there is nothing to distinguish *Isopterygium argyrocladum* Bescherelle from the above species which is widely distributed from the Indo-Malayan regions to Hawaii.

Isopterygium albescens (Schwaegrichen) Jaeger var. **applanata** Fleischer.

Averaiti Valley, on tree branches in shade, elevation 300 meters, no. 80.

Vesicularia inflectens (Bridel) C. Müller.

Uturoa, on wet wood in stream bed, elevation 50 meters, no. 1; Third valley south of Faaroa Bay, on moist rocks in damp shady *mape* grove, elevation 100 meters, no. 2; Third valley south of Faaroa Bay, on dripping rocks, elevation 80 meters, no. 5; Faaroa Valley, on moist rocks in deep shade, elevation 100 meters, nos. 11, 14.

POLYTRICHACEAE

Pogonatum tahitense Bescherelle.

Highest mountain, west side, on wet rock, elevation 600 meters, no. 40.

**NEW CRUSTACEANS FROM KAUAI, OAHU
AND MAUI**

By

CHARLES HOWARD EDMONDSON

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NEW CRUSTACEANS FROM KAUAI, OAHU AND MAUI

By CHARLES HOWARD EDMONDSON

ISOPOD

In August, 1931, numerous specimens of an apparently undescribed isopod were collected under the lava stones that border the shore of Kalihiwai Bay, Kauai.

Ligyda kauaiensis, new species (fig. 1).

Body oblong-ovate, a little more than twice as long as broad. Head twice as broad as long. Eyes large, compound, occupying the lateral margins of the head and separated in front by a distance equal to about three-fourths the length of an eye. First antenna minute; second pair long, the first two segments of the peduncle short, equal, the third as long as the first and second together, the fourth three times as long as the third, and fifth four times as long as the third; flagellum with 33 segments and terminating in a sharp point.

Mandible (fig. 1, *b*), triangular in shape with five teeth grouped together and an oval, flat, molar process. Outer maxilliped (fig. 1, *c*), with palp consisting of five segments, the distal medial border of each of the last four being somewhat produced and tipped with short, stiff hairs.

First segment of thorax the longest, each of the following six being slightly shorter than the preceding one. Lateral margins of thoracic segments produced backward into sharp points and indistinctly marked off from the dorsal portion by faint lines. The six segments of the abdomen distinct, the first two covered laterally by the seventh thoracic segment. Terminal segment (fig. 1, *d*), a little less than twice as broad as long, its posterior margin bluntly pointed in the middle and bearing two small lobes medial to the sharp, lateral angles.

First pair of legs in the male (fig. 1, *e*) with a bluntly pointed process at the distal end of the propodus, and carpus and merus thickened with sharp ventral borders. The thickening gradually diminishes with successive pairs of legs disappearing with the third pair. First leg of female (fig. 1, *f*) without process at the distal end of the propodus, and carpus and merus not much larger than the propodus. In both sexes the dactyli of all legs are biunguiculate.

Uropods (fig. 1, *a*) long, the basal segment about four times as long as its greatest breadth; branches subequal in length and slightly less than twice as long as the basal segment.

Color of specimens dark green with irregular dashes and specks of pale yellow and white. Surface of thorax and abdomen sparsely covered with minute granules and the terminal segment of the abdomen bears a few fine, short hairs.

Type specimen a male: length of body 16 mm.; length of uropods 15 mm.; length of second antennae 16 mm. Type locality, shore of Kalihiwai Bay, Kauai, under lava stones near the edge of the water. B. P. Bishop Museum No. 3438.

This species which falls within the group of isopods with long antennae and uropods differs from *Ligyda olfersii* (Brandt) and *Ligyda budiniana* (Milne Edwards) in having the distal end of the propodus of the first leg of the male armed with a bluntly pointed

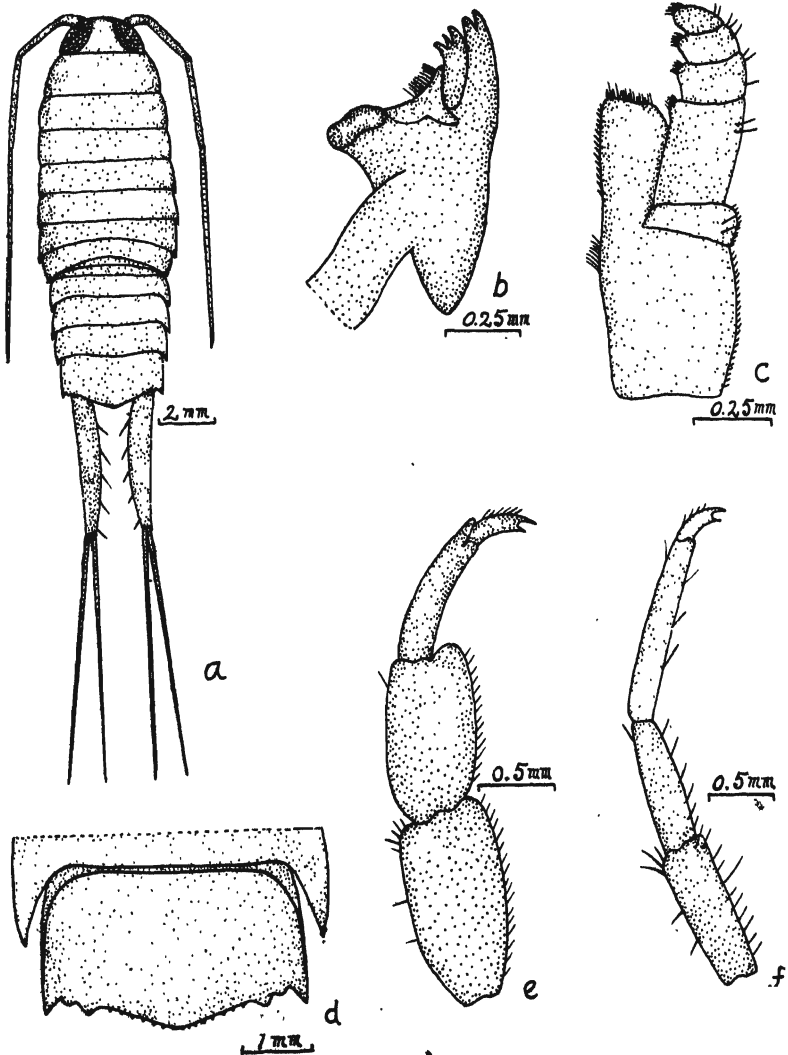


FIGURE 1.—Structural features of *Ligyda kauaiensis*, new species: a, dorsal view of type specimen; b, mandible; c, outer maxilliped; d, terminal segment of abdomen; e, first leg of male; f, first leg of female.

process, and from *Ligyda exotica* (Roux) in the form of the body, the structure of the appendages, and in color. The species *exotica*, which also occurs in Hawaii, is black in color, has a more cylindrical body, and the flagellum of the antenna is composed of more than 50 segments.

In *Ligyda hawaiiensis* (Dana), recorded from both Oahu and Kauai, the eyes are separated by a space less than one-half the length of an eye and the flagellum of the antenna is composed of but 27 or 28 segments. The posterior margin of the sixth abdominal segment in *L. hawaiiensis* seems to be slightly more pointed than in *L. kauaiensis* and Dana does not mention a blunt process on the side of the distal extremity of the propodus, typical, however, of males only. Dana's type specimen and that of *L. kauaiensis* closely correspond in size, but the largest co-type of *kauaiensis* has a body length of 25 mm. and uropods 19 mm. long.

SPECIES OF CORALLIOCARIS

Two specimens of an apparently new species, tentatively included in the genus *Coralliocaris*, were taken on Waikiki reef, Oahu, associated with the echinoid *Heterocentrotus mammillatus* to the spines of which they were clinging.

Coralliocaris mammillata, new species (Pl. I; fig. 2).

Body of type specimen somewhat depressed, stout, antennal spine present, but no hepatic spine. Rostrum broad, sharp pointed, concave above with a slight median crest bearing four minute spines; lower border smooth. (See fig. 2, *a*.) Antennular peduncle stout, extending slightly beyond the tip of rostrum; inner branch of antennule simple, outer branch bearing a fringe of long hairs and subdivided near the tip. (See fig. 2, *b*.) Antennal scale large, extending beyond the antennular peduncle and fringed with hairs on the inner margin and on the outer from the distal extremity to the tooth on the lateral border. (See fig. 2, *b*, *c*.) Eye pyriform in shape, bluntly pointed anteriorly; outer border flattened and almost wholly occupied by the ocular area. (See fig. 2, *f*.)

Second maxilliped long, slender, folded on itself; last two segments short, plate-like, the terminal one bordered by a fringe of short, stiff hairs. (See fig. 2, *d*.) Third maxilliped with endopod broad at the base tapering to a narrowly rounded extremity, the terminal segment twice the length of the preceding one; exopod nearly as long as endopod, its distal one-third faintly segmented and the extremity bearing a tuft of long hairs. (See fig. 2, *c*.)

First pair of legs short, slender, chelate, the dactylus shorter than the palm. (See fig. 2, *g*.) Second legs long, stout, equal; fingers slightly more than one-half the length of the palm; carpus short, about one-half as long as merus, which slightly exceeds the ischium in length. (See fig. 2, *h*.) The three

posterior pairs of legs short, the dactylus with a single claw and a large, quadrangular basal protuberance which bears sharp and blunt spines. (See fig. 2, *i, j*.) Telson bordered posteriorly by three pairs of short spines, and

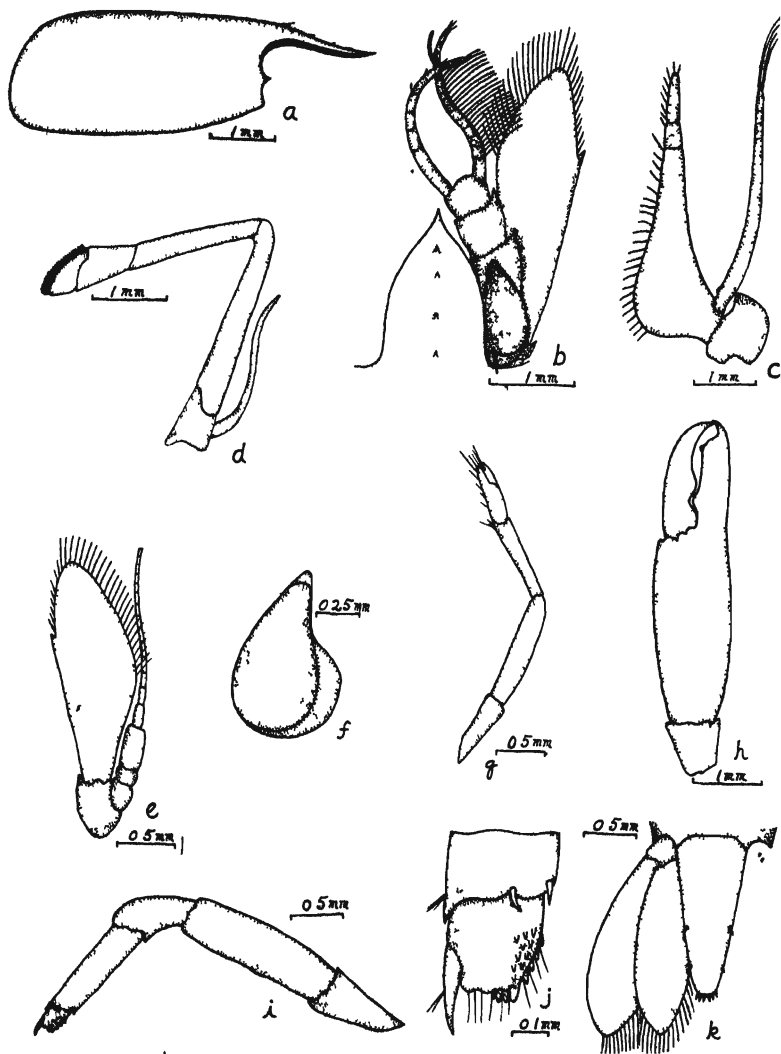


FIGURE 2.—Structural features of *Coralhocaris mammillata*, new species: *a*, lateral view of carapace; *b*, dorsal view of rostrum, eye, antennule, and scale of antenna; *c*, outer maxilliped; *d*, second maxilliped; *e*, basal part of antenna and scale; *f*, eye; *g*, first leg; *h*, wrist and hand of second leg; *i*, third leg; *j*, dactylus of third leg; *k*, telson and uropod

bearing two pairs of spinules on the dorsal surface. Uropods longer than telson. (See fig. 2, *k*.)

General color pale red, intensified by minute deep crimson pigment spots arranged on carapace and abdomen in more or less regular, longitudinal lines close together; pigment irregularly scattered on large chelipeds. Three posterior pairs of walking legs, telson and uropods less highly colored than carapace.

Type specimen an ovigerous female; length from tip of rostrum to extremity of telson, 12 mm. B. P. Bishop Museum No. 3436.

The color of this crustacean harmonizes perfectly with the color of the spines of the echinoid to which it clings. When at rest it is disposed longitudinally on a spine with the large chelipeds extended straight in front and close together.

If the species here described is rightly included under *Coralliocaris* it apparently is the first of the genus to have been observed associated with an echinoid. Previously described species of shallow water have been found in corals. Other related genera, *Periclemenes* and *Stegopontonia*, include species recorded from echinoids. The Waikiki species is excluded from *Periclemenes* in having a basal protuberance on the dactyli of the last three legs, and from *Stegopontonia* in that the basal protuberance is single instead of paired.

SPECIES OF PILUMNUS

Associated with masses of sponges, tunicates and barnacles which are attached to buoys, floats, and piling in Pearl Harbor, Oahu, is a small form of *Pilumnus* apparently representing a new species.

Pilumnus oahuensis, new species (Pl. II; fig. 3, *a*, *b*).

Carapace convex in both directions, more strongly so antero-posteriorly, smooth, with little indications of areas, the deepest groove being that extending backward from the median incision of the front. Surface of carapace more or less covered with short and long hairs, some of the latter being in tufts. Front prominent, consisting of two rounded lobes, deeply separated, each of which is subdivided by a shallow notch into a large rounded inner, and a small, tooth-like outer division, the latter being fused with the inner orbital angle.

Antero-lateral border of carapace bearing three sharp teeth besides the outer orbital angle, which may be prominent but is not acutely pointed. Upper border of orbit granular with two faint notches. Lower border notched below the outer orbital angle and dentate, but without a prominent suborbital tooth.

Ischium of outer maxilliped a little longer than broad, surface smooth with a longitudinal furrow; merus broader than long, its surface granular. (See fig. 3, *a*.)

Abdomen of type specimen (male) consisting of seven separate segments, the terminal one longer than broad. (See fig. 3, *b*.)

Chelipeds unequal, a row of teeth on upper and lower borders of arm; outer surface of wrist granular, a sharp tooth at the inner angle. Palm of large cheliped smooth except for a few granules near the articulation with the wrist and along the upper border; fingers stout, toothed. Outer and upper surfaces of palm of small cheliped ornamented with longitudinal rows of minute, conical tubercles; fingers toothed and grooved longitudinally. Hairs similar to those of the carapace cover the outer surfaces of both chelipeds except the palm of the larger one, which is but sparsely coated with hairs along the posterior border. Walking legs smooth, covered with long hairs.

Type specimen a male: breadth of carapace 11 mm.; length 8 mm. Type locality, Pearl Harbor, Oahu. Bernice P. Bishop Museum No. 3432.

In this species considerable variation is seen in the extent of granulation and coating of hairs on the outer surface of the large cheliped. Male specimens usually have the palm quite free of granules and hairs. In females granules and hairs may cover one-third the outer surface. Variation is also observed in the outer orbital angle. In some specimens it is merely a blunt elevation, in others it is a tooth-like process, but never spiniform.

In *Pilumnus hirsutus* Stimpson, which somewhat resembles this species, the coating of hairs is more dense, the outer angle of the orbit is spiniform like the other teeth of the lateral border, and the outer surface of the palm of the larger hand, even in males, is more fully covered with hairs and granules, some of the latter being spine-like.

The Pearl Harbor species differs from *Pilumnus andersoni* de Man in having a less flattened carapace posteriorly and a more prominent front; the granules of the wrist and large hand are not spiniform and occupy less area in males.

A new and clearly defined species of *Pilumnus* has been collected at various localities about the shores of Oahu and Maui. It occurs at Waikiki, Kahala, and Hanauma Bay, Oahu, and is known from Hana and Maalaea bays, Maui. Its typical habitat seems to be the shore line, where it lives under stones and is often associated with species of *Pseudosquilla*.

***Pilumnus planus*, new species (Pl. III; fig. 3, c, d).**

Carapace slightly broader than long, very flat, smooth and quite free from areolations posteriorly, where it is covered with microscopic granules which are slightly elongated in a transverse direction. Front half of carapace distinctly areolated and frontal, hepatic, and antero-lateral regions thickened and sharply declivitous. These regions roughened by prominent elevations

separated by deep grooves and covered with tubercles which become blunt spines on the summit of the elevations, their apices being directed forward. A coating of short, stiff hairs is borne on the anterior and lateral regions of the carapace, being denser on the declivitous borders.

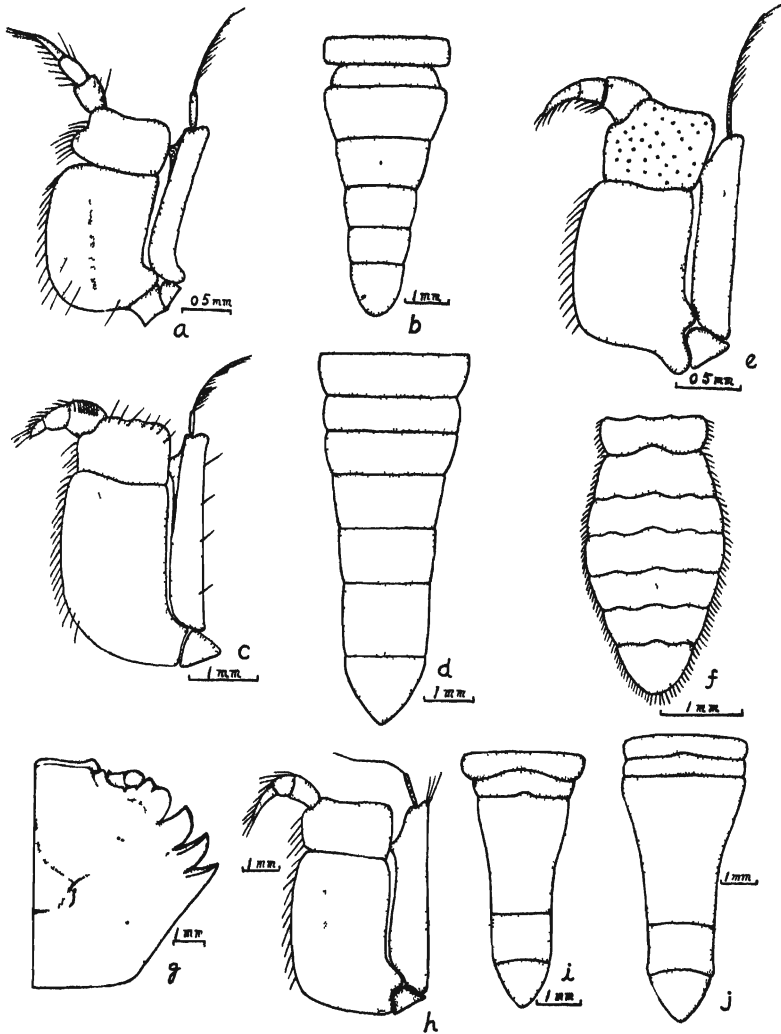


FIGURE 3—Structural features of new Hawaiian crabs: *a*, third maxilliped; *b*, abdomen (male) of *Pilumnus oahuensis*, *c*, third maxilliped; *d*, abdomen (male) of *Pilumnus planus*, *e*, third maxilliped, *f*, abdomen (female) of *Megametope sulcatus*, *g*, right half of carapace, *h*, third maxilliped; *i*, abdomen (male) of *Panopeus pacificus*, *j*, abdomen (male) of *Neopanope* sp. (?).

Front divided into two lobes by a broad, deep fissure. Each lobe, which is more prominent medially, recedes laterally, terminating in a strong spine. Margin of front spinous.

Besides the outer orbital angle, which is a small sharp tooth, four strong, spine-like teeth with smaller ones about their bases are borne on the antero-lateral border, which is directed downward toward the lower margin of the orbit, and is not sharply defined because of the declivity of this region. Orbital borders spinous, the superior one with two notches, the inferior one with a v-shaped incision. Under surface of carapace granular and hairy.

Ischium of outer maxilliped smooth, with a faint longitudinal groove; merus quadrangular, the three following segments short and thick. (See fig. 3, c.) Abdomen of male with seven distinct segments, the sixth being the longest, the terminal one triangular. (See fig. 3, d.)

Chelipeds subequal; outer, and to some extent inner borders of wrists and palms covered with conical tubercles and stiff hairs. Fingers toothed, tubercles and hairs extending over the dorsal border of the movable one for half its length. (See Pl. III, c, d.) Merus of walking legs with a row of blunt tubercles on the narrow upper border; segments of legs, especially carpus, propodus, and dactylus well coated with stiff hairs.

Type specimen a male: breadth of carapace 24 mm.; length 18 mm. Color, reddish-brown. Type locality, Maalaea Bay, Maui, under stones at the edge of the water. B. P. Bishop Museum No. 3440.

This species seems to differ from *Pilumnus scabriusculus* Adams and White in the character of the surface of the carapace and the antero-lateral borders. In *Pilumnus scabriusculus* the granules of the surface each bear several stiff setae; the antero-lateral border is provided with three wide denticulated teeth and the upper border of the orbit with one rounded indentation.

The distinctive features by which the Hawaiian species is easily recognized are the flat, smooth, posterior half of the carapace, from which comes the specific name *planus*, and the thickened, declivitous front, and antero-lateral borders which are densely covered with granules, spines and hairs.

SPECIES OF MEGAMETOPE

Of the genus *Megametope* but three species have been recognized up to this time, all of them from the south and southeast coasts of Australia and one of them also from Cook Strait and Foveaux Strait, New Zealand. The status of the genus is discussed and a key to the known species presented in a recent paper by McNeill.¹

¹ McNeill, F. A., Studies in Australian carcinology, no. 2: Rec. Australian Mus., vol. 1, no. 1, p. 131, 1926.

It is interesting now to find a representative of the genus in the shallow waters of Hawaii, quite distinct, however, from those of the colder latitudes of the Southern Hemisphere.

Megametope sulcatus, new species (Pl. IV, *A*; fig. 3, *e*, *f*).

Carapace slightly broader than long, marked by broad, shallow grooves and covered by granules of microscopic size. Front prominent, broad, more than one-third the width of the carapace, strongly turned down; front margin sinuose, slightly indented in the middle, the two lobes separated laterally from the salient orbital borders by shallow notches.

A broad, shallow groove beginning behind the frontal margin extends in the median line to the gastric area; a parallel groove on each side of the medial one divides at the anterior border of the protogastric area, one branch continuing almost through this area, the other bounding it laterally. A broad shallow depression extends from the posterior border of the orbit to beyond the level of the third antero-lateral tooth.

Antero-lateral border of carapace thin and sharp, bearing four teeth besides the antero-lateral angle, which is not strongly developed. First of four teeth smallest, second, third, and fourth about equally developed, being blunt, granular points. From the fourth and fifth antero-lateral teeth there extend medially ridges, bounding shallow grooves which are directed toward the gastric and cardiac areas.

Anterior portion of superior border of orbit a thickened ridge; posterior portion of superior border low, with two minute notches. Inferior border of orbit concave, granular. Basal segment of antenna touching the frontal process, the short flagellum resting in the orbit. Granules cover the surface of the outer maxilliped, being larger on the quadrangular merus. (See fig. 3 *e*.) Abdomen of female (type specimen) of seven segments, the fourth being the widest; surface smooth. (See fig. 3, *f*.)

Chelipeds unequal in both sexes, surface closely and finely granulated as the carapace. Arms without spines or teeth, upper and lower borders beaded; outer and upper surfaces of wrist reticulated by ridges and raised lines of granules with depressions between. Upper and superior half of outer surface of palm of large cheliped sculptured as the wrist, there being in addition five well-defined longitudinal ridges, the stronger ones above. The margin of the most superior ridge is formed into three blunt teeth. Lower half of outer surface of palm, inferior border, and inner surface smooth, but finely granulated. Fingers about one-half as long as palm and strongly toothed.

Palm of small cheliped marked in a manner similar to the large one, but the granules are larger and the ridges more numerous, being disposed over almost the whole of the outer surface; fingers relatively longer than in the large hand, thinner and less strongly toothed. (See Pl. IV, *A*, *b*, *c*.)

Walking legs of smooth appearance, but closely covered with fine granules; upper border of merus sharp, that of carpus, propodus, and dactylus grooved.

Type specimen a female: breadth of carapace 8 mm.; length 6 mm. Color, white. Type locality, Makena, Maui. Collected by Mrs. J. K. Skinner among dead coral blocks near shore. B. P. Bishop Museum No. 2588.

This species, which has been collected in shallow water on the shores of both Maui and Oahu, is clearly distinguished from either of the three species previously described from Australia. Instead of the carapace being pitted, as in the Australian forms, the Hawaiian species is recognized by the broad shallow furrows which traverse the dorsal surface both antero-posteriorly and transversely. It also differs from *Megamctope rotundifrons* (Milne Edwards) and *Megamctope punctatus* (Haswell) in having the antero-lateral margins of the carapace thin, and resembles those species in that the front is strongly bent down.

The Hawaiian species conforms to *Megamctope carinata* (Baker) in that both have thin antero-lateral borders and show evidences of a notch at the inner orbital angle. In *Megamctope carinata*, however, the front is nearly horizontal.

SPECIES OF PANOPEUS

The "mud crabs" of the genus *Panopeus* are represented on the east and west shores of North and South America and adjacent islands in the Atlantic Ocean by about a dozen species. Two species have been recorded from the west coast of Africa. The discovery of a representative of this genus in Hawaii is, therefore, of considerable interest from a distributional point of view.

Associated with sponges, barnacles and tunicates attached to buoys and floats in Pearl Harbor, Oahu, is a small form of an apparently new species of *Panopeus*. The barnacle (*Balanus cburneus* Gould), among which the crab is found, is a typical species of the east coast of the United States, which is suggestive of the view that both crabs and barnacles may have been transported to Hawaii through shipments of oysters or on the bottoms of ships. The crab, however, seems to be unlike any previously described species.

Panopeus pacificus, new species (Pl. IV, *B*; fig. 3, *g-i*).

Carapace somewhat convex, with areas defined by shallow grooves; surface smooth except for granules scattered along the lateral borders and disposed in a few interrupted raised lines in a transverse direction. Although the granular lines vary somewhat in length and position in different specimens there are usually two crossing the protogastric area and one the gastric area. Two cross the branchial area in line with the third and fifth antero-lateral teeth, and there is a shorter one about the middle of the postero-lateral border. This latter line is but a row of prominent granules among those thickly covering this area. (See fig. 3, *g*.)

Front approximately one-third the breadth of the carapace, consisting of two lobes separated in the middle by a notch, and terminating laterally in a raised process separated from the blunt inner orbital angle by a broad groove. Margin of front thick, beaded above and below. Upper border of orbit granular with two notches.

Antero-lateral border bearing five teeth, the first and second separated by a shallow groove; third and fourth about equally developed; fifth straight, and narrower than the fourth at the base, its posterior border sloping into the postero-lateral border of the carapace, which is shorter than the antero-lateral border. Inferior border of orbit notched below the outer orbital angle, concave in the middle and terminating medially in a prominent suborbital tooth which is visible from above. Flagellum of antenna longer than the orbit in which it rests. Outer maxilliped with ischium about twice the length of the merus, granulated and marked by a longitudinal groove. (See fig. 3, *h*.)

Chelipeds unequal, finely granulated; upper border of arm sharp and entire except for a subterminal notch. Outer surface of wrist roughened by a few granular tubercles and impressed by a deep groove near the distal border parallel with the articulation of the hand; a strong blunt spine at inner angle of wrist. Inner and outer surfaces of palm with granules tending to be disposed in transverse lines especially on lower half where they are smaller and not so crowded. Lower border of palm rounded, smooth. Palm increasing in height distally, slightly longer than greatest height; upper border traversed by a shallow, longitudinal furrow.

Fingers of larger hand short and stout, furrowed longitudinally and strongly toothed; dactylus with a large rounded basal tooth. Fingers of smaller hand relatively longer, thinner and less strongly toothed. Color of fingers of both hands dark brown with lighter tips, the color not extending back on the palm. A few hairs are borne on the chelipeds, mostly fringing the arm and articulations. (See Pl. IV, *B, b, c*.)

Upper borders of walking legs somewhat granular, that of merus narrow but not sharp; a short, blunt tooth at the upper distal extremity of the carpus. Long yellow hairs border the segments and together with shorter ones form a dense coating on propodus and dactylus.

Abdomen of male with third, fourth, and fifth segments fused, the sixth approximately as long as broad and the terminal one triangular. (See fig. 3, *i*.)

Type specimen a male: breadth of carapace 12 mm.; length 9 mm. Color yellowish-brown. Type locality Pearl Harbor, Oahu, among sponges, tunicates, and barnacles which are attached to buoys. B. P. Bishop Museum No. 3435.

The Pearl Harbor form shows relationship with the American species *Panopeus convexus* A. M. Edwards and *Panopeus occidentalis* Saussure in the following features: a nearly smooth carapace, depressed granules, broadly coalesced antero-lateral teeth (first and second), and the smooth outer surface of the chelipeds without the dark color of the immovable finger extending on the palm. It also resembles *P. occidentalis* in the distal depression of the carpus parallel with the articulation with the hand. It differs

from both of these species in a relatively broader front and the longitudinal groove traversing the superior border of each cheliped. It is also smaller than either of these species. The species *P. convexus* is known from Chile only; *P. occidentalis* ranges from South Carolina through the Gulf of Mexico to Brazil and is also recorded from Bermuda.

Neopanope, sp. ?, (Pl. IV, C; fig. 3, j).

Another form associated with *Panopeus pacificus* closely resembles it in general appearance, but presents some differences in the chelipeds and the abdomen of male specimens. The outer surfaces of the palms of the hands are not so granular; the fingers are longer, more slender, and less strongly toothed. The dactylus of the large hand is without a stout basal tooth and the immovable finger is more deflexed, its color continuing somewhat on the surface of the palm. (See Plate IV, C.) In the abdomen of the male the lateral borders of the sixth segment are slightly concave and the terminal segment is equal in length to that of the sixth. (See fig. 3, j.)

In features of the carapace, including areolation, disposition of granules, front, orbit, and antero-lateral border, this form seems to be identical with *Panopeus pacificus*. The absence of a large basal tooth on the dactylus of the larger hand, the slender, acute fingers with the color of the immovable one slightly extended on the palm, and the contour of the lateral margins of the abdomen are, however, features tending to exclude the form from *Panopeus*. It is tentatively placed within the genus *Neopanope*. The largest specimen observed, a male, is 18 mm. in breadth of carapace, and 12 mm. long. B. P. Bishop Museum No. 3437.

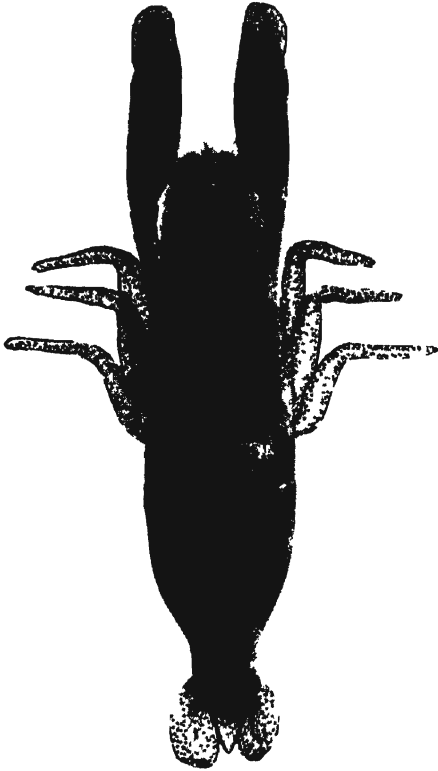


PLATE I.—*Coralliocaris mammillata*, new species, $\times 6.2$.

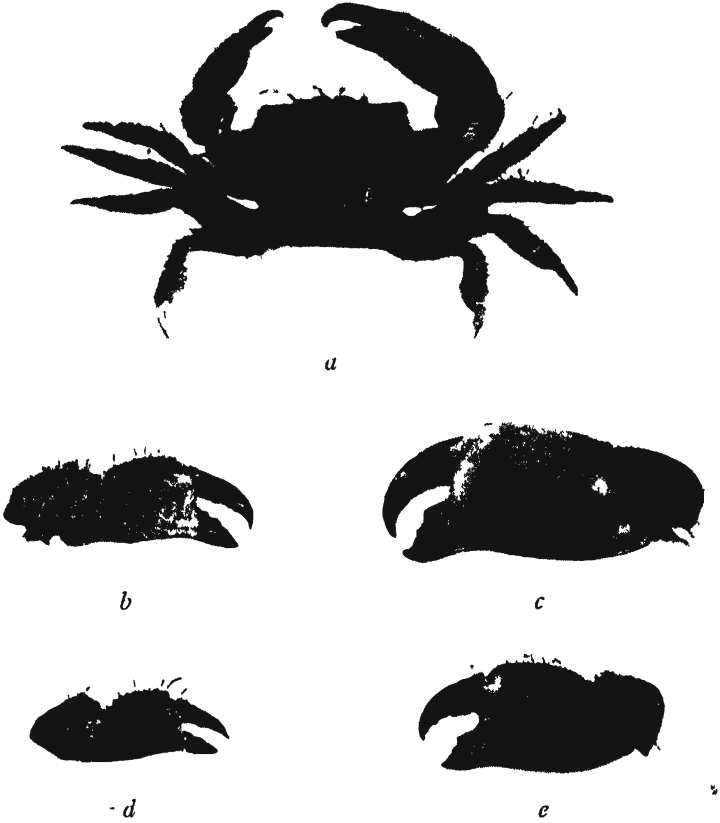


PLATE II.—*Pilumnus oahuensis*, new species: *a*, dorsal view, $\times 2.5$; *b*, *c*, right and left chelipeds of male, $\times 3.5$; *d*, *e*, right and left chelipeds of female, $\times 3$.



a



b



c



d

PLATE III.—*Pilumnus planus*, new species: *a*, dorsal view, $\times 1.5$; *b*, ventral view, $\times 1.5$; *c*, *d*, right and left chelipeds, $\times 3$.

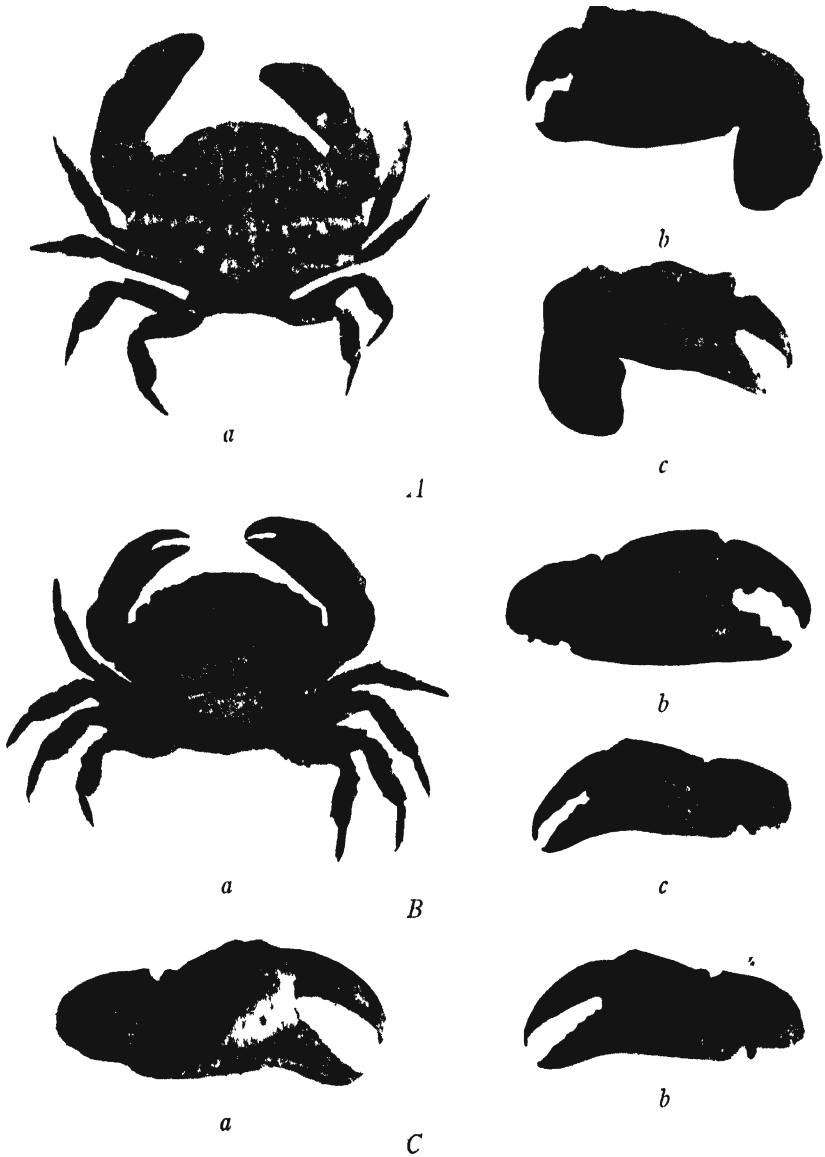


PLATE IV.—A, *Megametope sulcatus*: a, dorsal view, $\times 4.5$; b, c, left and right chelipeds, $\times 10$; B, *Panopeus pacificus*: a, dorsal view, $\times 2.5$; b, c, right and left chelipeds, $\times 4.3$; C, *Neopanope* sp. (?): a, b, right and left chelipeds, $\times 4.3$.

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INTRODUCTION

The several collections discussed in this paper were procured through the solicitation of Dr. Erling Christophersen while he was investigating the flora of the Samoan islands in the fall and winter of 1929. The collections total 162 specimens and represent 66 species. The first lot of specimens is represented by seven species without any other locality than "Samoa." Two lots collected in September and October are labeled "Apia, Upolu" and "Fagamalo, Savaii." Most of the specimens were obtained in Pago Pago harbor in November and December by Mr. P. T. Diefenderfer. They represent the smallest number of species with definite locality. None of the species are new to science, but a number establish new records for Samoa. In this paper seven species of taxonomic interest are described and one figured.

The material is deposited in the Bernice P. Bishop Museum, with a duplicate series in the Academy of Natural Sciences of Philadelphia.

CLUPEIDAE

Harengula punctata (Rüppell).

Three from Apia, 114 to 136 mm. Depth 4. Maxillary reaches 2/5 in eye. Lower gill rakers 30. Scales 42 in median lateral series to caudal base.

I follow Regan 1917 in the arrangement of the synonyms of this species, for the specimens agree best with his description. In addition, they show the last two anal rays distinctly enlarged and dorsal origin much nearer mandible tip than caudal base. Compared with the original small figure of *Clupea punctata* Rüppell, the row of eleven black spots shown along the edge of the back are not evident. Compared with Bleeker's figures of *Clupea (Harengula) kunzei* and *Clupea (Harengula) moluccensis*, both fail to show the greatly venulose cheeks, preopercle, opercle, and humeral region. The last two anal rays are not enlarged. Otherwise, the proportions are in agreement. Many of the scales are denuded. Where they have fallen from the back close along and below its dark area a dark, diffuse line, though distinct, extends from about even with the eye center and back along upper side of caudal peduncle.

Parr¹ has recently shown the necessity of changing the status of some of the myctophids as given in my "Fishes of Oceania" (B. P. Bishop Mus. Mem., vol. 10, 1928) and a re-examination of the available materials has altered others as follows:

Myctophum nigro-ocellatum (Günther) replaces *Centrobranchus choerocephalus* Fowler (p. 67).

Myctophum andreae (Lütken) with specific name misprinted *andrae*.

Myctophum pristillepis (Gilbert and Cramer) replaces *Dasy Scopelus asper* Fowler in part.

Myctophum crenulare Jordan and Gilbert for *Myctophum affine* Fowler in part (p. 69). New to the fauna of Oceania.

Myctophum fibulatum Gilbert and Cramer replaces *Myctophum pterotum* Fowler (p. 70). *Myctophum hollandi* Jordan and Jordan is also likely a synonym of this species.

Diaphus rafinesquel (Cocco) replaces *Diaphus nanus* Fowler (p. 68).

Diaphus urolampus Gilbert and Cramer replaces *Diaphus dumerili* Fowler.

POECILIIDAE

Lebistes reticulatus (Peters).

Two, 62 to 70 mm., both males with the intronittent organ in agreement with the diagram made by Regan². Introduced. Samoa.

Holocentridae

Holocentrus ruber (Forskål).

One from Pago Pago, 98 mm. Agrees in almost every detail with Jordan and Seale's figure of *Holocentrus praslini*.

Holocentrus unipunctatus Günther.

Depth $2\frac{4}{5}$; head $2\frac{3}{5}$, width 2. Snout $3\frac{2}{5}$ in head from snout tip; eye $3\frac{2}{5}$, equals snout, much greater than interorbital; maxillary reaches $\frac{1}{4}$ in head, expansion 2 in eye, length $2\frac{4}{5}$ in head from snout tip; lower jaw very slightly longer than upper; teeth finely villiform, in rather narrow bands in jaws, on vomer and palatines; interorbital 7, very slightly concave with eye impinging slightly on upper profile; preopercle spine $1\frac{3}{8}$ in eye; opercle spines 2, upper slightly larger. Gill rakers $7 + 11$, lanceolate, $3\frac{1}{8}$ in eye, 4 uppermost and 3 lowermost rudimentary; gill filaments subequal.

Scales 42 in lateral line to caudal base and 5 more on latter; 5 above, 9 below, 9 predorsal, 5 rows on cheek. Soft vertical fins scaly basally. Lateral line complete, slopes high at first along caudal peduncle to caudal base medially. Scales with 3 wide set basal points and apically scale edge with 5 or 6 short wide set points; 46 basal, parallel, concentric striae.

D. XI, 1, 14, 1, fourth spine $2\frac{1}{10}$ in total head length, third branched ray 2; A. IV, 10, 1, third spine $1\frac{2}{3}$ or not quite equals first ray, which is $1\frac{4}{5}$; caudal $1\frac{3}{5}$, deeply forked; least depth of caudal peduncle $4\frac{1}{4}$; pectoral $1\frac{3}{5}$; ventral $1\frac{2}{3}$.

¹Parr, A. E., Notes on the species of myctophine fishes represented by type specimens in the U. S. National Museum; U. S. Nat. Mus., Proc., vol. 76, art. 10, 1930.

²Regan, C. Tate, A revision of the Cyprinodont fishes of the subfamily Poeciliinae; Zool. Soc. London, Proc., p. 1008, text fig. 173 D, 1913.

Back olive brown with pink shade. Sides with each row of scales with obscure longitudinal band following in scale junctures, less distinct above lateral line. Iris rosy slate. Under surface of body but little paler than back. Spinous dorsal very pale yellow with scattered diffuse deeper yellow blotches and small dusky spot close to base of first membrane. Other fins all pale brownish with slight rosy tint, anterior lobe of soft dorsal and anal also slightly darker. Inner pectoral base with dusky blotch.

One from Pago Pago, 116 mm. Agrees with the excellent figure made by Günther, except that the very pale or yellowish spinous dorsal, in contrast with the dark or sooty tint of the back and body, is very conspicuous. Günther gives the color as olive with violet tint, more purplish in a young example, which is also said to have some indistinct streaks. Fins and hind caudal edge, red. This species suggests *Holocentrus spinifer* in miniature, but is differently colored, has a higher spinous dorsal, shorter preopercle spine, and shorter maxillary. New to Samoa.

***Holocentrus lacteoguttatus* Cuvier.**

Two from Apia, 88 to 96 mm.

***Holocentrus diadema* Lacépède.**

One from Pago Pago, 118 mm.

***Holocentrus microstomus* Günther.**

Two from Fagamalo, 138 to 155 mm.

***Holocentrus sammara* (Forskål).**

One from Pago Pago, 166 mm.

***Holocentrus opercularis* Valenciennes.**

One from Fagamalo, 128 mm. Differs from Günther's figure in that each scale on head and body with dark spot.

***Holotrachys lima* (Valenciennes).**

One from Fagamalo, 109 mm. Bright vermilion.

***Myripristis murdjan* (Forskål).**

One from Apia, 78 mm. and four from Fagamalo, 127 to 138 mm.

ATHERINIDAE

***Hepsetia pinguis* (Lacépède).**

Depth 5; head $3\frac{2}{3}$, width $1\frac{3}{4}$. Snout $4\frac{1}{4}$ in head; eye $2\frac{7}{8}$, greater than snout, equals interorbital; maxillary reaches $\frac{1}{2}$ in eye, length 2 in head; teeth villiform, fine, in narrow bands in jaws, on vomer and palatines; interorbital $2\frac{7}{8}$ in head, slightly concave. Gill rakers 5 + 20, finely lanceolate, nearly $\frac{1}{4}$ longer than gill filaments or $2\frac{1}{8}$ in eye.

Scales, 40 in median lateral series to caudal base and 4 more on latter; 8 transversely, 20 predorsal. Ventral axillary scale $1/3$ of fin. Scales with three strong basal denticles and circuli of 31 close set parallel vertical striae; apical half of scale entire, edge ragged.

D. IV—I, 1, 9, 1, second spine $27/8$ in head, first branched ray $21/6$; A. I, 1, 13, 1, first branched ray $19/10$; caudal 1, deeply forked, lobes pointed and lower little longer; least depth of caudal peduncle $32/3$; pectoral $11/4$; ventral $14/5$. Vent slightly before ends of depressed ventrals, well before spinous dorsal origin.

Back brown, base of each scale darker or dusky. Sides and lower surfaces pale to silvery white. Broad silvery white band, $3/5$ width vertical eye diameter, from shoulder to caudal base; all along its upper edge pale blue gray line. Vertical fins grayish, dusted with dusky on lobes of soft dorsal, anal and caudal terminally, also of pectoral. Ventral whitish, with grayish along front edge.

One from Apia, 106 mm.

MUGILIDAE

Mugil trichilus Vaillant and Sauvage.

No adipose eyelids. Scales 34 in median lateral series to caudal base and 4 more on latter. Axillary pectoral scale $31/5$ in fin. Spinous dorsal origin nearer caudal base than snout tip. A. III, 9, 1. Pectoral $11/10$ in head.

One from Apia, 130 mm.

I cannot place this specimen with *Mugil engeli* Bleeker, as Weber and Beaufort say, "a gelatinous eyelid covers the largest part of the iris." They also give the spinous dorsal origin midway between snout tip and caudal base, or slightly nearer caudal base.

In his description of *Mugil kelaartii* in 1877 Günther³ says, "Auge mit breiter Hautfalte." His figure of a South Seas example shows an obscure and rather narrow adipose eyelid and the spinous dorsal origin nearer caudal base than snout tip. Day's figure of *Mugil kelaartii* also shows a similar adipose eyelid.

Mugil macrolepis Andrew Smith.

Depth $33/4$. Adipose eyelid covers $1/3$ of eye. Scales 31 in median lateral series to caudal base and 3 more on latter. Axillary pectoral scale $22/5$ in fin. A. III, 9, 1. Pectoral $11/6$ in head.

Agrees fairly with Boulenger's figure of a Natal specimen,⁴ except for a more developed or broader adipose eyelid and more slender body.

One from Apia, 128 mm.

³ Fische der Südsee, pt. 6: J des Mus. Godeffroy, Hamburg, vol 2, p. 215, 1877.

⁴ Boulenger, G. A.: Catalogue of the fresh-water fishes of Africa in the British Museum (Natural History), vol. 4, p. 94, fig 56, 1916.

DULEIDAE

Dules rupestris (Lacépède).

Two from Apia, 107 to 145 mm.

Dules taeniurus Cuvier.

One from Apia, 120 mm.

SERRANIDAE

Serranus corallicola Valenciennes.

Differ a little from figure by Bleeker of *Serranus altiveloides* in having a black saddle-like blotch below last dorsal spines, two below soft dorsal, and one on upper surface of caudal peduncle.

One from Fagamalo, 100 mm., and two from Apia, 135 mm.

Serranus merra (Bloch).

One labeled Samoa, 78 mm.; one from Apia, 126 mm.; and one from Pago Pago, 148 mm. The Apia specimen with five black saddles along back.

Plesiops nigricans (Rüppell).

Depth $3\frac{1}{3}$ to 4; head $2\frac{2}{5}$ to $2\frac{1}{2}$, width 2 to $2\frac{3}{4}$. Snout 5 to $5\frac{3}{5}$ in head; eye $3\frac{1}{3}$ to $4\frac{1}{4}$, greater than snout or interorbital; maxillary reaches hind eye edge or little beyond, expansion $1\frac{3}{5}$ to 2 in eye, length 2 in head; teeth villiform, in bands of 5 or 6 irregular series in jaws, with 5 front outer upper each side slightly larger; narrower bands of similar teeth on vomer and palatines; interorbital $7\frac{1}{4}$ to $7\frac{1}{2}$, slightly concave. Gill rakers 6 + 9, clavate, robust, half gill filaments or $1\frac{4}{5}$ in eye.

Scales 16 to 18 in upper section of lateral line, 11 to 13 in lower section to caudal base and 3 or 4 more on latter; 2 or 3 above, 9 or 10 below; 8 or 9 predorsal scales to occiput; 5 or 6 rows on cheek. Dorsals, anals, and caudal well scaled basally. Scales with 17 to 20 basal radiating striae and 17 to 22 apically less distinct; circuli fine.

D. XII, 6, 1, first spine 5 to $7\frac{2}{3}$ in total head length, twelfth spine $2\frac{1}{8}$ to $2\frac{1}{3}$, fifth ray $1\frac{1}{3}$ to $1\frac{2}{3}$; A. III, 8, 1, third spine $2\frac{4}{5}$ to 3, sixth ray $1\frac{1}{4}$ to $1\frac{7}{8}$; caudal subequal with head, ends in long median point behind; least depth of caudal peduncle $2\frac{1}{3}$ to $2\frac{2}{3}$; pectoral $1\frac{3}{5}$ to $1\frac{3}{4}$; ventral 1.

Brown above, variably dark to dusky and below but little paler. Scattered gray or whitish dots on head and body, usually one to a scale, often clustered about dorsal and anal bases. Blackish ocellus with pale to whitish border on opercle below. Fins all more or less dusky to blackish, edges of soft dorsal and anal whitish.

I have based the above description on seven examples from Apia, 65 to 118 mm., reported by Jordan and Seale in 1906 and now in the Academy of Natural Sciences in Philadelphia, though they are not contained in the Bishop Museum collections from Samoa. There are

four others in the Academy, 41 to 150 mm., from Padang, Sumatra, obtained by Harrison and Hiller—the finest I have seen.

Günther's figure of *Plesiops corallicola* shows only 6 branched dorsal rays, and as his description gives 7, evidently the last ray split to the base is included. Likewise, for the anal he gives 8, whereas his figure shows only 7. It is much stouter than any of my specimens and is without any blue dots on the cheek or opercle.

***Plesiops melas* Bleeker.**

Plesiops melas Bleeker: Bataviaasch Genoot., Verh. (Bali), vol. 22, p. 9, 1849 (type locality, Boleling, North Bali). Beaufort: Bijd. Dierk. Amsterdam, p. 112, 1913 (Sao-nek; Waigiu).

Pharopteryx melas Jordan and Seale: U. S. Bur. Fisher., Bull. vol. 25, p. 261, pl. 38, fig. 3, 1905 (1906) (Apia; Pago Pago). Fowler and Silvester: Carnegie Inst., Marine Papers, p. 118, 1922 (Pago Pago).

Plesiops nigricans var. *apoda* Kner: Akad. Wiss. Wien, Sitzs. vol. 57, pt. 1, p. 346, 1868 (type locality, Savay, Samoa; Kandavu).

Plesiops nigricans (non Rüppell) Fowler and Bean: U. S. Nat. Mus., Bull. no. 100, vol. 10, p. 313, 1930 (description; part).

Depth 3 to 3 3/5; head $1\frac{1}{2}$ to $2\frac{3}{4}$, width $1\frac{2}{3}$ to $1\frac{7}{8}$. Snout 3 to $4\frac{1}{2}$ in head from snout tip; eye $2\frac{4}{5}$ to 4, greater than snout or interorbital; maxillary reaches opposite hind eye edge in young or slightly beyond with age, expansion $1\frac{2}{5}$ to $1\frac{3}{4}$ in eye, length $1\frac{7}{8}$ to $2\frac{1}{8}$ in head from snout tip; teeth villiform, in bands in jaws of 3 to 5 irregular series, narrower and fewer series in young; narrower bands of similar teeth on vomer and palatines; bony interorbital $6\frac{1}{2}$ to 8, narrowly concave. Gill rakers 5 or 6 + 9, lanceolate, $1\frac{2}{5}$ in gill filaments or $2\frac{1}{8}$ in eye.

Scales 17 to 20 in upper section of lateral line, 7 to 10 in lower section to caudal base and 2 or 3 more on latter; 2 or 3 above, 9 or 10 below, 8 or 9 predorsal to occiput, 3 to 5 rows on cheek with preopercle flange naked. Scales with 11 to 14 basal radiating striae, apical 14 or 15; apical denticles 85 to 87, slender, in 4 transverse series; circuli very fine.

D. X to XII, 6, 1 or 7, 1, first spine $3\frac{2}{3}$ to 6 in total head, last spine $1\frac{4}{5}$ to 2, sixth or seventh ray $1\frac{1}{2}$ to $1\frac{2}{3}$; A. III, 7, 1 or 8, 1, third spine $2\frac{2}{5}$ to $2\frac{3}{4}$, sixth or seventh ray $1\frac{2}{3}$ to $1\frac{4}{5}$; caudal $1\frac{1}{4}$ to $1\frac{1}{3}$, ends in median point behind; least depth of caudal peduncle 2 to $2\frac{1}{2}$; pectoral $1\frac{1}{2}$ to $1\frac{3}{5}$; ventral 1 to $1\frac{1}{8}$, or $2\frac{1}{4}$ to $2\frac{1}{2}$ in combined head and body to caudal base.

Generally blackish brown. In alcohol each scale with a pale gray or pale subdud spot on body, sometimes darker than general body color, though usual

appearance uniformly dark. Head sometimes paler brown and often an obscure blackish spot at hind eye edge above, another below, or still another as a streak along upper maxillary edge, and sometimes a second parallel below may also be present. Scales on head may show traces of pale or dark spots. Lower hind edge of gill opening often livid or neutral black. Iris neutral black. Spinous dorsal usually black with broad white terminal margin, each terminal cutaneous flap whitish with sub-basal dusky parallel line. Many soft dorsals black with some upper edges more narrowly white than spinous dorsal edge. Though none with other than diffuse blackish shade on last dorsal rays basally, sometimes entire basal regions of dorsals, anals and caudal variably gray white. Caudal usually blackish or blackish brown, with gray streak obliquely over each hind terminal portion. Anal usually neutral blackish. Pectoral dark gray or brownish. Ventral brownish, with membranes finely spotted or dotted irregularly with darker.

Two from Apia, 52 to 102 mm. For comparison, 27 in the Academy—also from Apia and reported by Jordan and Seale in 1906 as *Pharoptyryx melas*—25 to 66 mm. Comparison with the description of Philippine material as *Plesiops nigricans* by Fowler and Bean show its body depth should have been given as $3 \frac{1}{3}$ to $3 \frac{1}{2}$ and not $2 \frac{1}{3}$ to $2 \frac{1}{2}$ as printed. Though I follow Weber and Beaufort in their arrangement of the species of this genus I am unable to make any distinction in the formula of the dorsal fins of the two Samoan species under consideration. *Plesiops melas*, though without the black ocellus on the opercle, is sometimes marked with gray white to blue spots. It has been reported from Christmas Island in the Indian Ocean, from the East Indies, Philippines, Japan, Queensland and Polynesia.

The nominal *Plesiops altivelis* Steindachner is in agreement with the present species except its D. XI, 9 and its coloration with the head and body dotted is a character of little value.

LUTJANIDAE

Lutjanus vaiigiensis (Quoy and Gaimard).

Two from Samoa, 120 to 265 mm., and one from Apia, 117 mm. Although *Lutjanus marginatus* (Cuvier) is admitted as a distinct species in "Fishes of Oceania" (B. P. Bishop Mus. Mem., vol. 10, 1928) subsequent studies of Philippine material show it to be synonymous with the present species.

TERAPONIDAE

Terapon jarbua (Forskål).

One from Apia, 208 mm. Compared with a large example from Suva, Fiji, it appears much more slender.

SPARIDAE

Pentapodus aurolineatus (Lacépède).

Two from Pago Pago, 145 to 155 mm.

Monotaxis grandoculis (Forskål).

One from Fagamalo, 195 mm.

MULLIDAE

Mulloidichthys samoensis (Günther).

One from Fagamalo, 198 mm.

CHAETODONTIDAE

Chaetodon trifasciatus Mungo Park.

One from Fagamalo, 108 mm. Still has spinous anal vermilion, fading to crimson on soft anal. Sides of abdomen rather dark golden.

Chaetodon citrinellus Cuvier.

One from Fagamalo, 124 mm., and four from Pago Pago, 70 to 86 mm. Agree with Günther's figure.

Chaetodon auriga Forskål.

One from Apia, 108 mm. Agrees with Günther's figure of *Chaetodon setifer*.

Chaetodon reticulatus Cuvier.

One from Pago Pago, 110 mm. Like Garrett's excellent figure as published by Günther as *Chaetodon collaris*. The hind edge of the anal is pale brown—evidently scarlet in life—to the hind angle of the fin, as noticed by Jordan and Seale.

Chaetodon vagabundus Linnaeus.

One from Fagamalo, 124 mm., and two from Pago Pago, 92 to 100 mm.

Chaetodon trifascialis Quoy and Gaimard.

One from Fagamalo, 117 mm. Listed as *Megaprotodon strigangulus* in "Fishes of Oceania" following Günther. Differs from his colored plate of *Chaetodon strigangulus* in much more orange along base of spinous dorsal and more brilliantly contrasted coloration.

Holacanthus flavissimus Cuvier.

Brilliant orange, paler below. Color of back extends over vertical fins. Paired fins, dorsal and anal spines bright lemon yellow. Iris golden, narrow orbital border blackish brown, also similar border on opercle submarginally

behind. Large example shows lower lip dark brown, a spot on head below followed by three smaller and paler on median line of chest. Oblique brown bar below pectoral base. Edges of soft vertical fins with narrowly dusky submarginal line, entire fin edges narrowly whitish.

Two from Fagamalo, 80 to 98 mm.

HEPATIDAE

Ctenochaetus strigosus (Bennett).

One from Apia, 116 mm.; one from Fagamalo, 90 mm.; and 34 from Pago Pago, 101 to 146 mm.

Hepatus lineatus (Linnaeus).

One from Apia, 103 mm.

Hepatus lineolatus (Valenciennes).

Black axillary spot at base of last dorsal and another at last anal rays. Some of smallest show hind caudal edge within emargination very narrowly white.

One from Fagamalo, 108 mm., and six from Pago Pago, 97 to 125 mm.

Hepatus olivaceus (Schneider).

One from Pago Pago, 160 mm.

Hepatus guttatus (Schneider).

One from Apia, 83 mm.

Hepatus triostegus (Linnaeus).

One from Apia, 94 mm.

SIGANIDAE

Siganus argenteus (Quoy and Gaimard). (See fig. 1).

Depth $3\frac{1}{4}$ to $3\frac{2}{5}$; head $3\frac{1}{2}$ to $3\frac{3}{5}$, width $2\frac{1}{8}$ to $2\frac{1}{4}$. Snout $2\frac{3}{4}$ to 3 in head; eye $3\frac{2}{5}$ to $3\frac{2}{3}$, $1\frac{1}{5}$ to $1\frac{1}{3}$ in snout, 1 to $1\frac{1}{10}$ in interorbital; maxillary reaches $\frac{3}{5}$ to $\frac{2}{3}$ in eye, expansion $2\frac{1}{3}$ to $2\frac{1}{2}$ in eye, length $3\frac{2}{3}$ to $4\frac{1}{2}$ in head; mouth width $4\frac{4}{5}$ to 5, lower jaw slightly shorter; interorbital $3\frac{1}{5}$ to $3\frac{1}{4}$, broadly convex, low. Gill rakers 5 + 13, short weak points, hardly $\frac{1}{5}$ of gill filaments, which $1\frac{1}{4}$ in eye.

Skin smooth. Some parallel striae on each parietal region, close set in area mostly posterior to eye.

D. XIII, 10, 1, seventh spine 2 to $2\frac{1}{3}$ in head, first ray $2\frac{3}{4}$ to $2\frac{4}{5}$; A. VII, 9, 1, fourth spine $2\frac{1}{3}$ to $2\frac{2}{3}$, first ray 3 to $3\frac{2}{5}$; caudal $1\frac{1}{3}$ to $1\frac{2}{3}$, well emarginate; least depth of caudal peduncle 5 to $5\frac{1}{5}$; pectoral $1\frac{1}{2}$ to $2\frac{1}{4}$; ventral $1\frac{1}{2}$ to $1\frac{7}{8}$.

Neutral gray, speckled with darker, especially on head. Markings on fins assume nebulous blotches on membranes and dark spots on spines and rays. Markings on caudal and ventrals form more or less as transverse bands.

Eleven from Pago Pago, 61 to 70 mm. The original figure of Quoy and Gaimard is surely the present species. It does not, however, show any of the obscure markings of my specimens. Known from New Guinea, Guam and Fiji. New for Samoa.

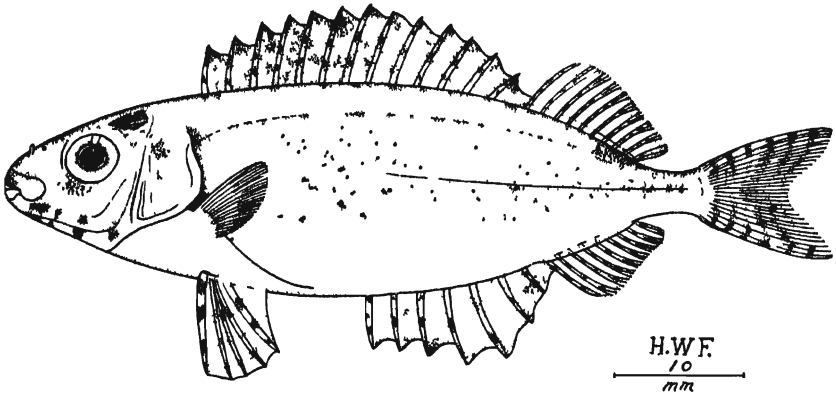


FIGURE 1—*Siganus argenteus* (Quoy and Gaimard)

SCORPAENIDAE

Synanceja verrucosa Schneider.

One from Apia, 136 mm.

ABUDEFDUFIDAE

Dascyllus aruanus (Linnaeus).

Three from Pago Pago, 46 to 61 mm.

Chromis caeruleus (Cuvier).

Three from Fagamalo, 77 to 98 mm, and two from Pago Pago, 70 to 77 mm.

Pomacentrus albofasciatus Schlegel and Muller.

Two from Pago Pago, 62 to 95 mm.

Pomacentrus vaiuli Jordan and Seale.

Show three dark lines along side of back anteriorly and larger specimens more uniformly dark in color, perhaps due to formaline.

Three from Fagamalo, 63 to 77 mm.

Pomacentrus pavo (Bloch).

Fins all more or less neutral gray, spinous dorsal and most of anal blackish.

One from Fagamalo, 54 mm. Resembles Jordan and Seale's colored figure, though much darker, evidently due to formaline.

***Pomacentrus lividus* (Schneider).**

Two from Apia, 80 to 90 mm.

***Pomacentrus nigricans* (Lacépède).**

One from Fagamalo, 218 mm.; three from Pago Pago, 80 to 89 mm.; and one labeled Samoa, 103 mm.

***Abudefduf sordidus* (Forskål).**

One from Apia, 85 mm. In poor condition.

***Abudefduf lacrymatus* (Quoy and Gaimard).**

Caudal peduncle and soft dorsal posteriorly pale brownish. Scattered small blue spots—seen under a lens—on head, back, and bases of dorsals.

Two from Fagamalo, 78 to 90 mm.

***Abudefduf glaucus* (Cuvier).**

Gray brown on back, paler on lower sides, where tinged with yellowish, especially about anal base and belly. Iris gray. Lips neutral dusky. Under surface of head soiled brownish. Yellowish olive tints along dorsal bases. Dorsals neutral dusky to blackish terminally. Caudal and anal dark neutral gray. Pectoral pale olive basally, dark neutral gray terminally. Ventral olive.

One from Apia, 70 mm.

LABRIDAE

***Epibulus insidiator* (Pallas).**

Pale yellowish, most brilliant below. Scales along sides medially each with small gray spot near hind edge of scale exposure. Iris gray. All fins very pale, nearly whitish. Interorbital and top of snout grey, obscure, pale mauve streak from lower and another from hind eye edge. Dusky blotch on first and second membranes of spinous dorsal.

One from Apia, 90 mm.; one from Fagamalo, 205 mm.

***Halichoeres centriquadrus* (Lacépède).**

Caudal bright orange yellow, also two marks on back, both reflected on dorsals. Soft dorsal, largely yellow. Mandible yellow. Anal largely pinkish yellow, pale gray terminally. Lines and marks on head pink. Pectoral grayish olive, pinkish basally. Ventral buff.

One from Apia, 110 mm.; one from Fagamalo, 200 mm.

***Leptojulius pardalis* Kner.**

One from Fagamalo, 85 mm.

***Cheilinus trilobatus* Lacépède.**

Pale lines radiate from front eye edge to mouth, and several above eye posteriorly broken or incomplete, though usually slope upward. On right side

of head pair on postocular of which posterior bar forms hook directed backward and below.

One from Pago Pago, 198 mm.

***Cheilinus fasciatus* (Bloch).**

One from Fagamalo, 200 mm.

CALLYODONTIDAE⁵

***Callyodon forsteri* (Valenciennes).**

Agrees well with Jordan and Seale's figure of *Callyodon bataviensis*. It shows the dark brown spot on the pectoral close above the fin origin more pronounced. The lines on the head and borders of all the fins light green.

One from Fagamalo, 250 mm.

***Callyodon spinus* (Kner).**

One labeled "Samoa," 205 mm. Markings on head very similar to figure of *Callyodon kelloggii* by Jordan and Seale and includes all the other markings, only differing in a greenish longitudinal band on the pectoral. (In "Fishes of Oceania," p. 380, the reference to Kner's original description should be volume 58, not 57 as printed.)

***Callyodon oviceps* (Valenciennes).**

One from Fagamalo, 197 mm. Resembles figure by Günther of *Pseudoscarus oviceps* except a dark saddle present behind the yellow band from the last dorsal spines. Also a diffuse dark blotch at base of caudal.

***Callyodon dubius* (Bennett).**

One from Apia, 100 mm., and one from Pago Pago, 172 mm.

***Callyodon guttatus* (Schneider).**

One labeled "Samoa," 195 mm. Greatly like Jordan and Seale's colored figure of *Callyodon prasiognathus*.

ECHENEIIDAE

***Leptecheneis naucrates* (Linnaeus).**

One from Apia, 417 mm. Cephalic disk with 25 plates.

ELEOTRIDAE

***Eleotris fusca* (Schneider).**

Two from Apia, 86 to 123 mm.

⁵ *Scarus kreussi* E. K. Jordan: U. S. Nat. Mus., Proc., vol. 66, p. 30, pl. 2, fig. 1, 1925 (type locality, Honolulu), is evidently synonymous with *Callyodon perspicillatus* (Steindachner). Overlooked in "Fishes of Oceania."

GOBIIDAE

Gobiodon citrinus (Rüppell).

D. VI, 1, 10, 1. First three dorsal spines subequal, high as soft fin. Black spot at upper angle of opercle and two pale vertical lines with dark edges on head and another down over pectoral base.

One labeled "Samoa," 46 mm.; one from Pago Pago, 33 mm.

Glossogobius biocellatus (Valenciennes).

Depth $5\frac{3}{4}$; head $2\frac{3}{4}$, width $1\frac{3}{4}$. Snout $3\frac{3}{4}$ in head from snout tip; eye $4\frac{2}{3}$, $1\frac{2}{3}$ in snout, greatly exceeds interorbital; maxillary reaches $\frac{4}{5}$ in eye, length $2\frac{1}{4}$ in head from snout tip; teeth depressible, outer upper row little smaller than inner, similar in mandible; tongue with deep median notch in front; interorbital $2\frac{1}{2}$ in eye, shallowly concave. Gill rakers as 7 lower rudimentary tubercles, gill filaments $1\frac{2}{5}$ in eye.

Scales 30 in median lateral series to caudal base and 3 more on latter; 8 transversely, 18 predorsal; cheek with 4 weak, low, horizontal ridges. Scales with 27 basal radiating striae; 40 + 38 short apical denticles; circuli very fine.

D. VI—I, 9, fourth spine $1\frac{4}{5}$ in total head length, first branched ray 2; A. I, 8, first branched ray $2\frac{3}{5}$, sixth ray $1\frac{4}{5}$; caudal $1\frac{2}{3}$, ends in median point behind; least depth of caudal peduncle $3\frac{3}{4}$; pectoral $1\frac{1}{2}$; ventral $1\frac{2}{5}$.

Dark to dusky brown, little paler on under surface of trunk and tail. Each row of scales on body with dark or dusky median streak. Cheek and opercles like top of head and pale or whitish broad bar along each preopercle flange. Iris dark gray. Fins all grayish. Spinous dorsal with dark terminal blotch between first and second spines and large one on last membrane, with small white specks on penultimate and last membranes. Other vertical fins with more or less distinct dark or dusky spots on each ray.

One from Apia, 85 mm. Jordan and Seale's figure of *Glossogobius vaisiganus* shows the last membrane of the spinous dorsal evidently torn away and its pectoral does not show the two black spots, so characteristic at the fin base.⁶

BLENNIIDAE

Salarias aneitensis Günther.

Depth $4\frac{1}{3}$; head $4\frac{1}{3}$, width $1\frac{1}{5}$. Snout 3 in head; eye $4\frac{1}{2}$ in snout, equals interorbital, short supraocular flap $1\frac{4}{5}$ in eye; maxillary reaches $\frac{1}{2}$ in eye, length 2 in head; mouth width $1\frac{3}{4}$; teeth minute, slender, even, flexible and pair of short, small lower canines, none above; interorbital $3\frac{3}{4}$, broadly convex; short flap each side of nape $\frac{1}{2}$ of eye. Gill rakers 11 + 16, short slender points, $\frac{1}{3}$ of gill filaments, which $1\frac{1}{3}$ in eye.

⁶ *Opua nephodes*, Jordan, E. K.: U. S. Nat. Mus., Proc., vol. 66, p. 36, pl. 2, fig. 2, 1925 (type locality, Honolulu). Insert in "Fishes of Oceania" (B. P. Bishop Mus., Mem., vol. 10, 1928) after *Vaimosa javanica* (Bleeker), p. 408.

Paragobioides grandoculis Kendall and Goldsborough: Mus. Comp. Zool., Mem. vol. 26, p. 324, pl. 6, fig. 2, 1911 (type locality, Arno Atoll, Marshall Islands). Insert after *Boleophthalmus viridis* (Buchanan-Hamilton).

Mr. G. S. Myers called my attention to the omission of the preceding species and my error in confusing the present species with *Paragobiodon echinocephalus* (Rüppell). The reference to the type and the statement about its abnormally divided ventrals ("Fishes of Oceania," p. 399) may therefore be abandoned.

Skin soft, smooth. Lateral line complete, arched well above pectoral along upper side of back, then less distinct and median along side of tail to caudal base.

D. XII, 16, spines flexible and third two in head, fourth ray $1\frac{1}{2}$; A. I, 18, fourth ray $2\frac{1}{10}$; caudal 1, convex behind; least depth of caudal peduncle $2\frac{1}{5}$; ventral $1\frac{1}{4}$; pectoral $4\frac{1}{4}$ in combined head and body to caudal base, rays 14.

Body neutral brown, with olivaceous to yellowish green tint. On head and trunk above, numerous, small, neutral-black, close set dots, which on trunk less defined though present in more or less contrasted longitudinal dark streaks or bands. On lower sides broad bands formed by dark spots forming dark borders. Both trunk and tail with transverse vertical bars of dark underlaid gray brown, though not so dark as spots or bands. Some dark, neutral blotches before pectoral; otherwise, entire under surface of head écu drab or neutral gray. Belly largely white. Iris neutral gray. Dorsals with greenish olive tints, otherwise gray to whitish; spinous dorsal with 2 or 3 blackish spots on each spine and very obscure connecting gray streaks; soft dorsal with more black spots and connecting lines, dark gray, all more strongly contrasted. Anal paler or more whitish, grayish terminally, with 2 median neutral black longitudinal bands and a subterminal blackish spot. Caudal with 5 pairs of blackish spots on each ray. Pectoral with olive green and gray, each ray with 4 or 5 neutral black spots. Ventral gray white.

One from Apia, 132 mm. Agrees with figure by Günther, though it shows neither the supraocular nor the nuchal flaps.

BALISTIDAE

Balistapus undulatus (Mungo Park).

Large black blotch at membrane behind first dorsal spine terminally and much smaller one behind end of second dorsal spine. Eleven inclined parallel dark broad bands on side of body. Spines on caudal peduncle rudimentary.

One from Pago Pago, 68 mm.

CANTHIGASTERIDAE

Canthigaster margaritatus (Rüppell).

One from Pago Pago, 87 mm. Agrees with *Tetrodon solandri* as figured by Günther, except that the gray spots—shown as green in his figure—are far more numerous. The blue green parallel lines along the belly are not evident.

TETRODONTIDAE

Tetrodon nigropunctatus Schneider.

Still yellowish on lower sides of head and paler tints on dorsal, pectoral, and anal. Few small, scattered, neutral-black spots.

One from Fagamalo, 130 mm.

NOTES ON PRITCHARDIA

By

HAROLD ST. JOHN

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NOTES ON PRITCHARDIA

By HAROLD ST. JOHN

NECTAR SECRETION

The palm trees of the genus *Pritchardia* are known from 38 species: 1 from Cuba and the Isle of Pines in the West Indies, 30 (and 6 varieties) from Hawaii, 2 from Fiji, 2 from the Tuamotus, and 3 from rather indefinite locations in Polynesia.

The genus has recently been given a monographic study by Beccari and Rock¹ in which Professor Beccari states (p. 8) that he has no evidence that the flowers of these palms secrete any nectar.

On collecting trips to the upper ridges of the Koolau Mountains of Oahu I have become acquainted with several of the species. On January 19, 1930, the type locality of *Pritchardia martioides* Rock and Caum was visited. Here on the divide between Kahana and Wahiawa, where they are a conspicuous feature of the vegetation, the trees attain a height of 30 feet in the woods below the crest, whereas at the nearly bare, wind-swept divide the dwarfed trees fruit at a height of 5 feet. Specimens were collected on the Wahiawa side (St. John no. 10180). One of the panicles contained numerous unopened buds. During two days in the laboratory many of its flowers opened. After the dehiscence of the cap of petals, the large anthers radiate out at an angle of 45 degrees. The free tip of each filament is subulate and 2-2.5 mm. long. The anthers are borne by a staminal cup, 6 mm. long, which often protrudes 2 mm. above the calyx. The ovary is seated in the base of this cup, and the stigma barely equals its rim. Fully formed buds are dry within, but those just mature are found to be nearly filled with liquid. After anthesis, the staminal cup is brimming full of a viscous, yellowish liquid that is perceptibly sweet to the taste. Professor R. S. Bean kindly aided in testing this liquid. With a capillary pipette two large drops were collected from some ten flowers. With Fehling's solution a strong test for sugar was obtained.

Careful dissection did not reveal any localized nectar glands. However, the whole staminal cup is of yellow tissue, 0.5 mm. thick. Its inner surface glistens and seems to be glandular and to secrete the nectar generally over its entire area.

¹ Beccari, O., and Rock, J. F., A monographic study of the genus *Pritchardia*: B. P. Bishop Mus., Mem., vol. 8, no. 1, pp. 1-77, 1921.

On February 14, 1932, several groves of *P. Rockiana* Beccari were discovered at altitudes of from 1500 to 1800 feet on Laie-Malaekahana Ridge in the Koolau Range, Oahu. The weather was rainy, and the specimens collected (St. John no. 11559) showed no nectar. The next morning fresh flowers opened in the laboratory. All these had their staminal cups filled with sweet nectar.

It can now be stated that, at least in *P. martioides* and *P. Rockiana*, nectar is secreted in abundance.

VALIDITY OF THE HAWAIIAN SPECIES OF PRITCHARDIA

In 1888 Hillebrand² recognized two species and a suggested but unnamed variety of *Pritchardia*. Subsequent local collectors gradually added to the knowledge of this striking group of palms. The work culminated in that of Rock, who made extensive explorations and collections and cooperated with Beccari in a monographic revision of the genus.³ In the body of the text and the appended section, these authors recognize 25 species and 5 varieties in the Hawaiian islands. This number has been raised by the publication of 5 additional species and 1 variety by Caum.⁴

Of this considerable total, 10 species and 1 variety are from the island of Oahu. The plants are not common; they appear as small groves along the ridges or in the upper valleys of the two principal mountain ranges, the Koolau and the Waianae. The present system of classification has practically resulted in recognizing each grove of trees as a distinct species or variety. This large number of species with minute ranges is uncommon, but not incredible.

In the Koolau Mountains in the valley of Kaluanui Stream at an altitude of 1960 feet on December 8, 1929, I found a small grove of small trees of *Pritchardia*. Flowering and fruiting branches and a leaf were collected and the trees were photographed. On either slope of the valley were a few larger, scattered trees. On checking up the material, I found it to differ in many particulars from any described species. Wishing to verify these observations, I revisited the grove on September 28, 1930, and made additional collections from the same tree. I was much surprised to find on careful study that the

² Hillebrand, William, *Flora of the Hawaiian islands*, Heidelberg, 1888.

³ Beccari, O., and Rock, J. F., *A monographic study of the genus Pritchardia*: B. P. Bishop Mus., Mem., vol. 8, no. 1, pp. 1-77, 1921.

⁴ Caum, E. L., *New Hawaiian plants*: B. P. Bishop Mus., Occ. Papers, vol. 9, no. 5, 1930.

1930 collection differed conspicuously from the 1929 collection, gathered from the same tree. The 1929 specimens showed glabrous floriferous branchlets, and the fruit was subspherical, 4.5 by 4.5 cm. The 1930 specimens had densely rusty tomentose floriferous branchlets, and the fruit ellipsoid, 4.5-4.8 by 2.8-3.2 cm. To be sure, the 1930 fruits were not fully ripe, but they were nearly so, and, I suspect, as much so as many of the specimens upon which species have been based. Several other scattering groups of *Pritchardias* were found on the Punaluu-Kaluanui divide at altitudes between 2200 and 2400 feet. They were in exposed situations and were all low trees with small leaves and short petioles. They were in all stages from bud to fully ripened fruit. The flowering and most of the fruiting branchlets were rusty tomentose, but on the tree with the largest fruits, the fruits were broadly ellipsoid to suborbicular, 4.5-5.5 cm. long and so ripe that they had turned dark brown. On this specimen the panicle was apparently glabrous, though close examination revealed that they were really glabrate. So this grove provided a confirmation of the inconstancy of the pubescence of the floriferous branchlets.

The key in Beccari and Rock's monograph is poorly constructed, but its lengthy paragraphs detail numerous characters and indicate those considered important. Great emphasis is laid on the pubescence of the floriferous branchlets, whether glabrous, glabrate, or permanently rusty tomentose, and on the shape and size of the fruits. Also the length of the petiole and leaf blade and the pubescence are indicated as of fundamental importance.

I have not made lengthy or extensive studies of the Hawaiian *Pritchardias*, but when a tree from an unreported grove is, upon the accepted standards of classification, one new species in 1929 and still a different one in 1930, I feel qualified to report the fact. Incidentally I shall refrain from publishing either of the apparent species. Also I challenge the validity of the taxonomic characters that have been used to divide the genus *Pritchardia* into such a large number of species. Under varying ecological conditions and different stages of maturity, they show considerable variability. Mr. E. L. Caum has observed that many of the species of *Pritchardia* cultivated in Honolulu, including some planted by J. F. Rock from type collections, are now so much modified by their growth under artificial conditions that it is impossible to make them fit into the described species.

FISHES OBTAINED AT FIJI IN 1929

By

HENRY W. FOWLER

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FISHES OBTAINED AT FIJI IN 1929

By HENRY W. FOWLER

INTRODUCTION

The collection of Fijian fishes obtained at Suva in 1929 by Mr. Percy J. Turner contains 145 specimens representing 53 species, many of which are interesting new records for Fiji and several of which are important as additions to the fish fauna of Oceania. None of the species are new to science. In this paper three species are described and five variations figured.

The collection is deposited in the Academy of Natural Sciences of Philadelphia and a series of duplicates has been reserved for the collection of Bernice P. Bishop Museum.

OPHICHTHYIDAE

Pisodonophis boro (Buchanan-Hamilton).

Depth $30 \frac{1}{4}$, $12 \frac{1}{4}$ to vent; head $4 \frac{4}{5}$, 7 to end of tail; head width $2 \frac{3}{4}$; combined head and trunk $1 \frac{2}{5}$ in tail. Snout $5 \frac{7}{8}$ in head; eye $14 \frac{1}{4}$, $2 \frac{2}{3}$ in snout, 2 in interorbital; mouth cleft $3 \frac{2}{3}$ in head, lower jaw much shorter; teeth short, rounded, convex, forming broad bands, premaxillary in about 6 irregular series, 7 on vomer and 5 or 6 series in each jaw; front nostril in short thick tube long as eye; hind nostril begins eye diameter before eye in lip; interorbital $7 \frac{1}{2}$, broadly convex. Gill opening $8 \frac{1}{3}$ in head.

Lateral line distinct, midway along side of tail.

Dorsal origin $\frac{3}{4}$ length of pectoral behind depressed pectoral tip, fin rather low; anal similar; caudal forms strong, compressed, blunt point as end of tail; pectoral $4 \frac{1}{5}$ in head.

Uniform olive brown above, sides lighter to mars brown or cinnamon and under surface of head and belly ecru drab to pinkish buff. Length 1240 mm.

According to Mr. Turner, "This eel inhabits the same locality as the Lo Walu and has a very firm pointed tail. They dig themselves into the soft mud always tail first." New for Fiji.

ECHIDNIDAE

Evenchelys macrurus (Bleeker). "Lo Walu."

Depth $38 \frac{1}{2}$, $13 \frac{1}{3}$ to vent; head $4 \frac{2}{3}$, 12 in total length, width $4 \frac{3}{4}$; combined head and trunk $1 \frac{4}{5}$ in tail. Snout $9 \frac{1}{4}$ in head; eye $2 \frac{1}{2}$ in snout, 2 in interorbital, situated at first third of mouth cleft; mouth cleft $3 \frac{3}{5}$ in head, lower jaw very slightly protruding; teeth rather large, conic, largely uniserial in jaws; row of four large depressible fangs on vomer, gradually larger to last; single row on each palatine close to upper jaw series

opposite and posterior to eyes; short broad nasal tube each side of snout tip; hind nostril in short tube on top of head above front eye edge; interorbital 12 $\frac{4}{5}$ in head, slightly convex. Gill opening 13 $\frac{3}{5}$ in head.

Lateral line distinct, midway along side of tail.

Dorsal origin begins about last $\frac{2}{5}$ in head or well before gill opening and fin moderately high; anal similar; caudal long as snout, obtusely rounded.

Uniform brown. Iris dark gray. Length 1830 mm.

Mr. Turner writes: "I have known it to grow to over 9 feet in length or possibly larger, but I have not seen one much over 9 feet and at that length it weighed exactly 9 pounds. They inhabit the creeks in the mangrove swamps and belong to salt water." New for Fiji.

PLOTOSIDAE

Plotosus anguillar (Bloch).

Three, 210 to 230 mm.

BELONIDAE

Strongylura incisa (Valenciennes).

Depth 14 $\frac{3}{4}$, body subcylindrical; head 2 $\frac{2}{3}$, width 6 $\frac{7}{8}$. Snout 1 $\frac{1}{2}$ in head from its own tip; eye 10 $\frac{1}{3}$, 7 in snout, 2 $\frac{1}{3}$ in postocular, 1 $\frac{1}{4}$ in interorbital; maxillary reaches $\frac{1}{5}$ in eye; canines straight, slender, vertically erect; interorbital 8 $\frac{1}{2}$ in head from snout tip, 2 in postocular. Gill rakers as 10 very low tubercles on lower branch; gill filaments $\frac{1}{2}$ of eye.

Scales 202 in median lateral series to caudal base and 11 more on latter; 15 above, 6 below, 104 predorsal to occiput. Fins except caudal base scaleless. Scales vertically ellipsoid; vertically parallel striae well separated medially, 58 + 27.

D. 11, 18, 1, origin over base of second branched anal ray, first branched ray 4 $\frac{1}{6}$ in total head; A. 11, 20, 1, first branched ray 4 $\frac{9}{10}$, 1 $\frac{1}{10}$ in postocular; caudal (damaged) apparently slightly emarginate; caudal peduncle over keel, deep as wide, least depth 4 in postocular; pectoral 4 $\frac{1}{4}$ in total head length or slightly greater than postocular; ventral 1 $\frac{1}{2}$ in postocular or 6 $\frac{1}{6}$ in total head length.

Back pale brownish, edges of scales darker. Blue gray line along upper side as narrow band from shoulder to caudal base, dividing brown of back from silvery white sides and lower surfaces. Iris silvery white, also under surface of head. Dorsal whitish basally, gray terminally. Anal similar, only more whitish. Caudal gray. Paired fins grayish. Length 710 mm., caudal damaged.

New for Fiji.

HOLOCENTRIDAE

Holocentrus spinifer (Forskål).

One, 283 mm. Brilliant vermilion, fading rosy or pink in alcohol.

Myripristis murdjan (Forskål).

One, 205 mm. Much like *Myripristis violaceus*¹ but a little more grayish or mauve. It also has a blackish area in the pectoral axil. Though most of the fins are pale yellowish white the caudal is grayish. Following Weber and Beaufort's recent studies it will then be necessary to merge *Myripristis violaceus* with the present species.

SYNGNATHIDAE

Syngnathus spicifer Rüppell.

One, 137 mm.

Corythoichthys conspicillatus (Jenyns).

One, 110 mm.

MUGILIDAE

Mugil macrolepis Andrew Smith.

One, 151 mm. Scales 32 in median lateral series to caudal base; predorsal 22; pectoral with axillary scale. Adipose eyelids narrow. First dorsal origin nearer caudal base than snout tip. A. 111, 9, 1. Above neutral gray. Sides below and under surfaces silvery white. Iris silvery white.

SPHYRAENIDAE

Sphyraena barracuda (Walbaum).

One, 425 mm. caudal ends broken. Scales 80 in lateral line to caudal base and 7 more on latter. Median portions of both second dorsal and anal neutral black and greatly contrasted with rest of anal fin, which is white.

SCOMBRIDAE

Scomber brachysomus (Bleeker).

Two, 295 to 297 mm. Agree with the figure of Jordan and Dickerson, 1908. They are, however, neutral olivaceous on the back with 3 obscure slightly darker longitudinal bands above and as many below. Sides of head and body as well as under surfaces whitish.

LEIOGNATHIDAE

Leiognathus equula (Forskål).

One, 225 mm. Differs from most descriptions in that there are a number of slightly darker brown blotches along and within the

¹ BLEEKER, PIETER, Atlas ichthyologique des Indes orientales néerlandaises, vol. 9, pl. (3) 357, fig. 5, 1877.

brown color of the back. These blotches horizontally elongate and in 2 rows below lateral line and 1 or 2 rows of smaller and less defined ones above. Still higher or along profile of back short dark vertical bars.

AMIIDAE

Apogonichthys polystigma Bleeker.

One, 72 mm.

Amia aroubiensis (Hombron and Jacquinot).

Two, 50 to 60 mm.

Amia fraenata (Valenciennes).

One, 120 mm.

Amia laterale (Valenciennes).

Three, 80 to 92 mm.

SERRANIDAE

Cephalopholis argus Schneider.

Two, 175 to 188 mm.

Serranus merra (Bloch).

Five, 41 to 162 mm.

LUTJANIDAE

Lutjanus monostigma (Cuvier).

Two, 180 to 230 mm. New for Fiji.

POMADASYIDAE

Plectorhinchus albovittatus (Rüppell).

Two, 159 to 185 mm. Both Rüppell's and Bleeker's figures appear to represent smaller fish than these. In my larger one the soft dorsal is broadly black above with greater lower portion whitish. Also great upper part of caudal whitish and lower lobe black. The pale longitudinal lines on the body quite indistinct. New for Fiji.

Scolopsis bilineatus (Bloch).

One, 198 mm. Agrees with Bleeker's figure.

In this connection I wish to call attention to my subgenus

Ctenoscolopsis, with type *Holocentrus ciliatus* Lacépède, an exact synonym of *Lycogenis* Cuvier 1830, virtually with the same genotype. Mr. Whitley has kindly called my attention to it in a subsequent letter. *Lycogenis* therefore holds as the proper subgeneric name for *Scolopsis ciliatus* (Lacépède).

TERAPONIDAE

Terapon jarbua (Forskål).

Two, 160 to 280 mm. "Inhabits beaches all over Fiji," according to Mr. Turner.

GERRIDAE

Gerres macrosoma Bleeker.

Depth $2\frac{3}{5}$. Scales 42 in lateral line to caudal base and 3 more on caudal base; 4 above.

One, 152 mm. Agrees with Bleeker's figure of *Diapterus macrosoma*. New for Fiji.

MULLIDAE

Mulloidichthys samoensis (Günther).

One, 210 mm. New for Fiji.

Upeneus vittatus (Forskål).

Two, 200 to 280 mm.

Pseudupeneus barberinus (Lacépède).

One, 265 mm.

CHAETODONTIDAE

Chaetodon melannotus Schneider. Figure 1.

Two, 130 to 152 mm. Larger one varies in the dark lines or rows of spots more horizontal and waved on left side of body.

Chaetodon auriga Forskål.

One, 167 mm. Agrees with Bleeker's figure of *Tetragonopterus (Linophora) auriga*. It shows, however, a much shorter dorsal fila-

ment and front upper edge of soft dorsal with a much broader black border, much wider than hind black border on soft dorsal.

Chaetodon vagabundus Linnaeus.

One, 133 mm.

Chaetodon rafflesii Bennett.

One, 158 mm. This is the largest I have ever seen. It agrees entirely with Garrett's figure as published by Gunther.

Holacanthus imperator (Bloch). Figure 2.

One, 132 mm. Differs considerably from Garrett's figure published by Gunther and more like the figure of *Acanthochaetodon imperator* of Bleeker.

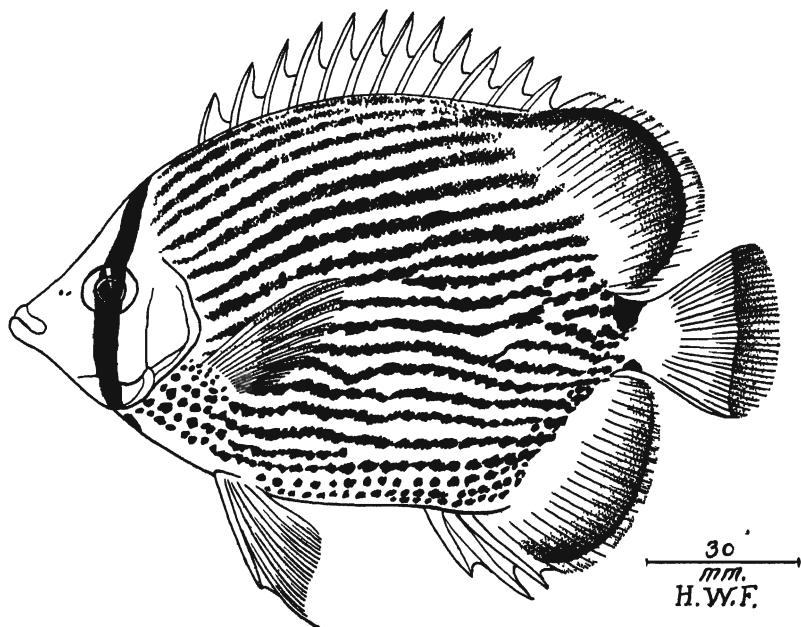


FIGURE 1.—*Chaetodon melannotus* Schneider. Variation

HEPATIDAE

Hepatus triostegus (Linnaeus).

Two, 143 to 162 mm.

Hepatus nigricans (Linnaeus).

Three, 173 to 250 mm.

SIGANIDAE

Siganus vermiculatus (Valenciennes) "Nuqu (Nungu)"

One, 170 mm, December 10, 1929, which, compared with Day's figure of *Teuthis vermiculata*, shows slightly wider pale vermiculating lines and broken as very fine numerous spots on caudal. New for Fijian

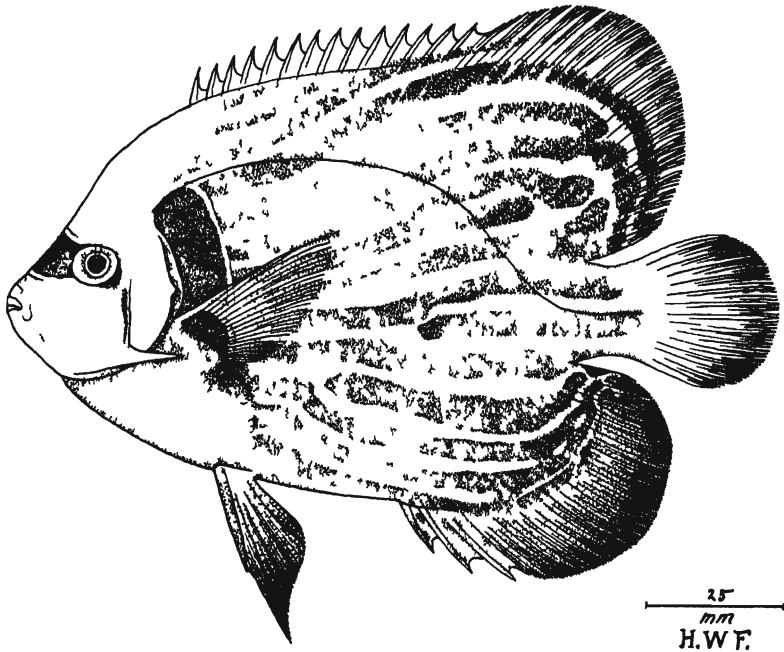


FIGURE 2—*Holacanthus imperator* (Bloch) Variation

SCORPAENIDAE

Scorpaenodes scabra (Ramsay and Ogilby)

Three, 69 to 93 mm. Agrees with Jordan and Seale's figure, in 1906, as *Sebastopsis scabra*, though with very few skinny flaps

ABUDEFDUFIDAE

Dascyllus aruanus (Linnaeus)

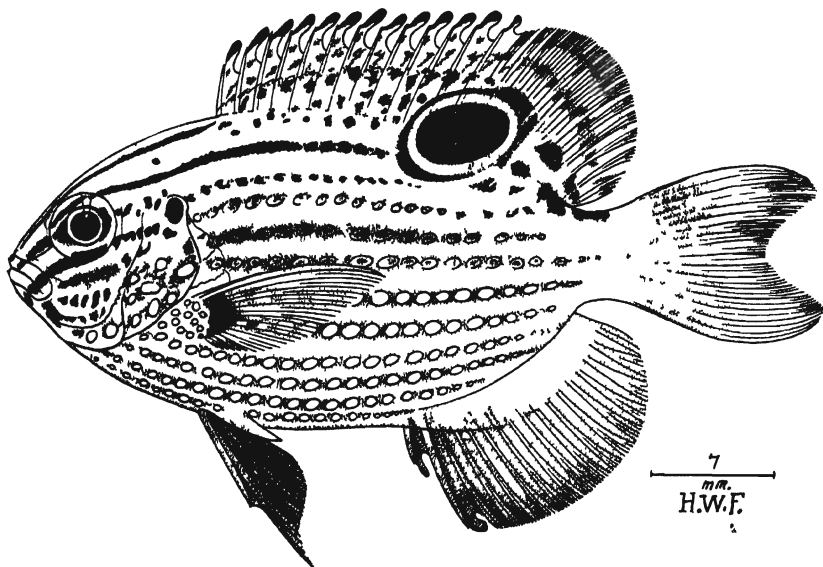
Nine, 35 to 59 mm

Chromis caeruleus (Cuvier).

Nine, 35 to 75 mm.

Pomacentrus vaiuli Jordan and Seale Figure 3.

One, 42 mm. Differs from the original colored figure in the markings on the back in a single dark blue band from the snout through the eye and back to a few scales before large soft dorsal ocellus. An upper parallel blue line extends close along each side of the upper profile line from the snout tip to the spinous dorsal origin, but not touching the eye. Another feature is the posterior position of the black dorsal ocellus in the adult, as shown by Samoan specimens at hand. Morita's figure does not show the squamation at the base of the spinous dorsal or extensive over the anal.

FIGURE 3—*Pomacentrus vaiuli* Jordan and Seale Young.**Pomacentrus tripunctatus** Cuvier.

Three, 51 to 60 mm. Two with pale yellowish tails approach figure 6 of Bleeker's plate of *Pomacentrus trilineatus*, though both also show a small dark spot on the uppermost pectoral scale at the pectoral origin. One is somewhat like his figures 1 and 2 in the same work, though with the large black ocellus on the last dorsal rays with a complete pale bordering ring, no blue lines on the head

above and predorsal or on the anal. Its caudal is also pale as in figure 2, though the blue spots on the scale not now evident if ever present.

Pomacentrus lividus (Schneider).

Two, 56 to 74 mm. Both with slate black small spot about size of pupil at uppermost scale of opercle and another at origin of pectoral fin. Smaller example also with diffuse blackish spot at axil of last dorsal ray.

Pomacentrus nigricans (Lacépède).

Five, 101 to 125 mm. Dorsal spines XII.

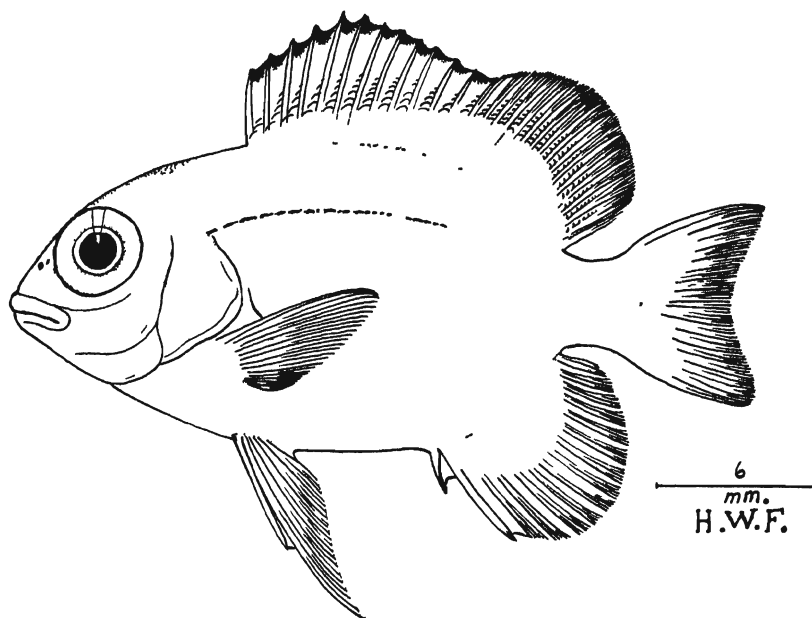


FIGURE 4—*Abudedefduf behni* (Bleeker). Young

Abudedefduf behni (Bleeker) Figure 4.

One, 26 mm. Young, agrees in many ways with Jordan and Dickerson's description and figure of *Abudedefduf corneyi*. The fewer dorsal spines (12) for this nominal species are not beyond the limits of variation usual in the species of this genus.

Abudedefduf uniocellatus (Quoy and Gaimard).

Forty-six, 21 to 68 mm. Though most all with back and upper

surface of body brilliant cobalt blue, some of the smaller ones, from which the scales have dropped, with the resulting exposed skin dark brown.

Abudefduf zonatus (Cuvier).

Two, 57 to 73 mm. These greatly resemble Günther's figures C and E of *Glyphidodon brownriggii*. The smaller of my specimens shows a large black gray edged ocellus at the last 4 dorsal spines and first 2 dorsal rays basally. This condition hardly evident in the larger specimen.

LABRIDAE

Thalassoma hardwicke (J. W. Bennett).

Three, 105 to 128 mm.

CALLYODONTIDAE

Callyodon sordidus (Forskål).

One, 290 mm. At present pale brownish generally, tinged with pale green. Markings, especially on head and fins, all viridian to sea green. Surely close to the nominal *Callyodon cyanogrammus* Jordan and Seale.

Callyodon dubius (Bennett).

Preopercle flange with 4 scales in row on each side of head. Largely uniform brown, fins all paler. Teeth pale.

One, 152 mm.

ELEOTRIDAE

Eleotris fusca (Schneider).

One, 87 mm.

GOBIIDAE

Periophthalmus koelreuteri (Pallas).

One, 60 mm.

BLENNIIDAE

Salaria fuscus Rüppell.

One, 90 mm. Agrees largely with Rüppell's rather crude original figure though differing in the presence of a nuchal tentacle a

little shorter than the eye each side of the occiput. Though McCulloch and McNeill have given "no nuchal tentacles" in their key to *Salaria* as a distinction for *Salaria fuscus*, Day's figure 2 on plate 80 apparently shows one as a short white line below and before the front of the dorsal.

BROTULIDAE

Brotula mulleri Gunther. Figure 5.

Head and body brown, little paler on under surface of head and belly. Few small dusky spots clustered on postocular and others scattered on the belly. Iris gray. Vertical fins neutral dusky or dark gray and margined narrowly all around with white. Barbels and paired fins whitish.

One, 60 mm.

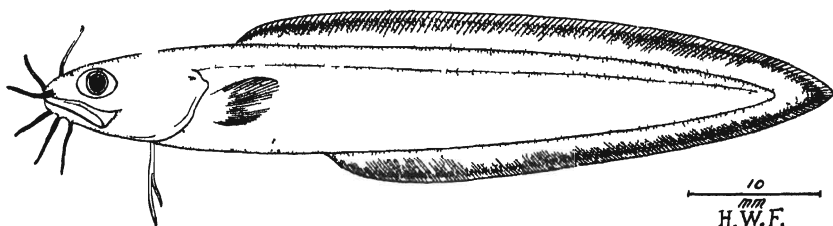


FIGURE 5—*Brotula mulleri* Gunther Young.

BALISTIDAE

Balistapus undulatus (Mungo Park).

One, 225 mm.

OSTRACIONTIDAE

Ostracion cubicus (Linnaeus).

One, 285 mm.

TETRODONTIDAE

Tetrodon unimaculatus Schneider.

Sixteen dark longitudinal lines on each side of body.

One, 225 mm.

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EXPERIMENT STATION, HAWAIIAN SUGAR PLANTERS' ASSOCIATION

INTRODUCTION

Under the auspices of the Pacific Entomological Survey, Amy Suehiro, Assistant Entomologist, Bernice P. Bishop Museum, has compiled a card catalog of the insects recorded from the area bounded by Hawaii on the north, by the Bonin, Bismarck, and Trobriand islands on the west, by New Caledonia and the Tuamotus on the south, and by Easter Island and the Galapagos on the east. Records from the Kermadec Islands and from Chatham Island, well south of this area, are included. New Zealand, although a part of Polynesia, is not represented in the catalog. This check list is based upon the portion of that catalog which refers to the beetles of the family Elateridae. A few new locality records have been obtained from collections in Bernice P. Bishop Museum.

The arrangement of genera into groupings which attempt to express their relationships (the subfamilies used here are perhaps more properly tribes) depends for accuracy more upon a knowledge of larval, than of adult, characters. Because some genera are unknown in the larval stages their position is necessarily somewhat uncertain.

In this list each specific name is followed by the name of the author, in parentheses if the species was placed by him in a genus other than that to which it is now assigned. The first citation following the author's name is of the original description, and takes this form: title of the publication indicated by a number in bold-face type corresponding to a number in the bibliography (pp. 25-28), series number placed in parentheses, volume number, page numbers, plate and figure references, and date of publication. Citations which follow the original one are undated unless reference is made to society proceedings which have no volume number. Following the bibliographical citations is given the known geographical distribution of the species within the area under discussion. The type locality is noted for species originally described from regions outside this area. (See

map.) The important synonyms conclude the citations for each species.

The geographical classification of the Pacific island groups used here is that employed by Bernice P. Bishop Museum, and is as follows:

Polynesia: Austral, Chatham, Cook, Easter, Ellice, Hawaii (Hawaii to Kure), Kermadec, Line (Palmyra to Jarvis), Manihiki, Marquesas, New Zealand, Phoenix, Samoa, Society, Tokelau (Union), Tonga, Tuamotu.

Melanesia: Admiralty, Bismarck Archipelago, Fiji, Loyalty, New Caledonia, New Hebrides, Santa Cruz, Solomon, Trobriand.

Micronesia: Bonin, Caroline, Gilbert, Marianas (Guam), Marshall, Palau, Volcano, Wake.

Eastern Pacific: Galapagos, Juan Fernandez.

Extensive use has been made here of the Schenkling catalog of Elateridae; catalogs antedating it have been generally ignored unless they contain distribution records not otherwise available.

SUBFAMILY ADELOCERINAE

Genus **AGRYPNUS** Eschscholtz: 18, p. 32, 1829.

(Type, *Elater tomentosus* Fabricius.)

Agrypnus bifoveatus Candèze: 11, vol. 1, p. 41, 1857; 49, pp. 5, 511.

Marianas: Guam.¹ (Type locality, Philippine Islands.)

Agrypnus pacificus Candèze: 12, fasc. 3, p. 1, 1881; 49, p. 6 (erroneously cites New Guinea); 56, p. 236, 1927.

Trobriand: Woodlark.

Agrypnus resectus Candèze: 11, vol. 1, p. 45, 1857; 14, p. 99³; 15, p. 189; 33, pp. 170, 173; 49, p. 6.

Admiralty: Pock. Bismarck Archipelago: New Ireland. (Type locality, Australia.)

Agrypnus soricinus Candèze: 12, fasc. 3, p. 1, 1881; 31, vol. 7, p. 428; 49, p. 6 (erroneously cites Woodlark).

Bismarck Archipelago: New Britain. (Type locality, New Guinea.)

¹Hawaii Agricultural Experiment Station loan collection, B. P. Bishop Museum, determined by W. Schultz.

Genus **LACON** Laporte de Castelnau: **54**, p. 11, 1836.

(Type, *Elater atomarius* Fabricius.)

Lacon modestus (Boisduval): **5**, p. 108, 1835 (*Agrypnus*); **1**, (9), vol. 20, p. 171; **3**, p. 240; **11**, vol. 1, pp. 71, 72 (*Adelocera*); **22**, pp. 23, 24; **27**, p. 124; **46**, p. 129; **48**, p. 93; **49**, p. 12; **53**, p. 368; **55**, p. 387, 1891; **60**, p. 112; **61**, p. 129; **67**, p. 348. Hawaii: Oahu. Line: Fanning.² Marquesas: Eiao, Hivaoa, Mohotani, Uahuka. Samoa: Upolu. Society: Tahiti. New Caledonia. Gilbert. Marianas: Guam.³ Synonyms: *Adelocera pruinosa* Fairmaire; *Adelocera squalida* Fairmaire.

Genus **ADELOCERA** Latreille: **38**, p. 451, 1829.

(Type, *Elater ovalis* Germar.)

Adelocera cribosa (Eschscholtz): **18**, p. 32, 1829 (*Agrypnus*); **11**, vol. 1, p. 161, (" . . . ressemble au *Lacon caliginosus* Guerin"; not recognizable); **49**, p. 28.

"Sandwichii insulae." (Hawaii may be intended, but the type locality is as likely to be Sandwich Island off New Ireland. The species is unknown.)

Adelocera glirina (Candèze): **12**, fasc. 1, p. 11, 1865 (*Lacon*); **13**, p. 81; **49**, p. 28; **55**, p. 267, 1881.

Fiji: Taveuni,⁴ Vanua Levu,² Viti Levu.²

Adelocera gracilentia (Schwarz): **17**, p. 306, 1902 (*Lacon*); **31**, vol. 7, p. 428; **49**, p. 28; **58**, p. 119.

Bismarck Archipelago: New Britain. Solomon: Guadalcanar,² Tuilagi.

Adelocera gracilis (Candèze): **13**, p. 83, 1874 (*Lacon*); **31**, vol. 7, p. 428.

Bismarck Archipelago: New Britain. Solomon: Guadalcanar.² (Type locality, Moluccas, New Guinea, etc.)

Adelocera limosa (Candèze): **12**, fasc. 3, p. 10, 1881 (*Lacon*); **31**, vol. 7, p. 429; **49**, p. 29.

Bismarck Archipelago (?): New Britain. (Type locality, New Guinea.)

² B. P. Bishop Museum collection.

³ Hawaii Agricultural Experiment Station loan collection, B. P. Bishop Museum.

⁴ British Museum collection.

Adelocera stricticollis (Fairmaire): 55, (6), vol. 1, p. 266, 1881 (Lacon); 49, p. 30; 63, p. 32.
Fiji.

SUBFAMILY HEMIRHIPINAE

Genus **AL AUS** Eschscholtz: 18, p. 32, 1829.
(Type, *Elater oculatus* Fabricius.)

Alaus bituberosus Fairmaire: 41, vol. 3, p. 381, 1881; 24, p. 16; 49, p. 48.

Bismarck Archipelago: Duke of York, New Britain.

Alaus bituberosus variety **lamassaensis** Heyden: 33, pp. 170, 175, 1915; 49, p. 48.

Bismarck Archipelago: New Ireland.

Alaus breviplicatus Fairmaire: 24, p. 17, 1883; 49, p. 48.

Bismarck Archipelago: Duke of York.

Alaus constrictus Schwarz: 17, p. 312, 1902; 49, p. 48.

Tokelau: Atafu.

Alaus costulicollis Fairmaire: 23, p. 267, 1878; 49, p. 48 (erroneously cites New Caledonia); 55, (6), vol. 1, p. 267.

Fiji: Viti Levu.

Alaus cristatus Candèze: 13, p. 150, 1874; 49, p. 48.

New Hebrides: Aneiteum.

Alaus depressicollis Schwarz: 17, p. 305, 1900; 49, p. 48.

Palau.

Alaus farinosus (Montrouzier): 55, p. 255, 1860 (*Agrypnus*)¹; 12, fasc. 3, p. 2; 13, p. 149; 16, p. 34; 27, p. 125; 32, p. 248; 49, p. 48; 55, p. 387, 1891; 56, p. 163, 1911.

Loyalty: Lifu, Netché. New Caledonia: Art, Canala, Isle of Pines.

Synonym: *Alaus nivellus* Fauvel.

Alaus montravelli (Montrouzier): 55, p. 253, 1860 (*Agrypnus*); 12, fasc. 3, p. 2; 13, p. 149; 27, p. 125; 32, p. 248; 49, p. 49; 55, p. 387, 1891.

Loyalty: Lifu. New Caledonia: Canala, Isle of Pines.

- Alaus montraveli** aberration **roseicollis** Fleutiaux : 55, p. 387, 1891 ; 49, p. 49.
New Caledonia.
- Alaus samoensis** Van Zwaluwenburg : 60, p. 112, fig. 1, 1928.
Samoa : Upolu.
- Alaus sulcicollis** Schwarz : 17, p. 313, 1902 ; 49, p. 49.
Shortland (probably Shortland Island in the Solomon Islands, but possibly Shortland Island off southeast New Guinea).
Solomon : Russel.⁵
- Alaus tuberculatus** (Montrouzier) : 44, p. 14, 1855 (*Elater*) ; 16, p. 91 (*Monocrepidius*) ; 49, p. 111 ; 56, p. 236, 1927.
Trobriand : Woodlark.
- Alaus velentinus** Candèze : 15, p. 189, 1880 ; 49, p. 49.
Bismarck Archipelago : New Britain. (Type locality, New Guinea.)
- Alaus velentinus** variety **bennigseni** Schwarz : 17, p. 314, 1902 ; 49, p. 49.
Bismarck Archipelago : New Ireland.

SUBFAMILY CHALCOLEPIDINAE

Genus **CHALCOLEPIDIUS** Eschscholtz : 18, p. 32, 1829.
(Type, *Chalcolepidius zonatus* Eschscholtz.)

- Chalcolepidius erythroloma** Candèze : 11, vol. 1, p. 282, 1857 ; 3, p. 240 ; 12, fasc. 2, p. 9 ; 28, p. 172 ; 31, vol. 1, p. 11, vol. 4, pp. 42, 286, vol. 6, p. 15 ; 46, p. 130 ; 49, p. 55 ; 53, p. 368.
Hawaii : Oahu. (Immigrant from western South America.)
Synonym : *Chalcolepidius albertisi* Candèze.

Genus **DIOXYPTERUS** Fairmaire : 41, vol. 3, p. 406, 1881 ; 55, p. 267, 1881 (redescribed).
(Type, *Dioxypterus nigrotransversus* Fairmaire.)

- Dioxypterus basalis** Schwarz : 17, p. 315, 1902 ; 49, p. 67.
Bismarck Archipelago : New Britain.

⁵ British Museum collection.

Dioxypterus bennigseni Schwarz: 17, p. 314, 1902; 49, p. 67; 51, p. 53, pl. 2, fig. 15.
Bismarck Archipelago: New Britain.

Dioxypterus flexuosus Fairmaire: 41, vol. 3, p. 406, 1881; 49, p. 67; 55, p. 268, 1881 (redescribed).
Fiji: Viti Levu.⁶

Dioxypterus guttulatus Fairmaire: 41, vol. 3, p. 406, 1881; 49, p. 67; 55, p. 269, 1881 (redescribed).
Fiji: Viti Levu.⁶

Dioxypterus makirensis (Montrouzier): 44, p. 14, 1855 (*Elater*); 16, p. 76 (*Monocrepidius*); 49, p. 109; 56, p. 236, 1927.
Trobriand: Woodlark.

Dioxypterus montrouzieri Fleutiaux: 56, p. 15, 1928.
Solomon.

Dioxypterus nigrotransversus Fairmaire: 41, vol. 3, p. 406, 1881; 49, p. 67; 55, p. 268, 1881 (redescribed).
Fiji.

Dioxypterus vagepictus Fairmaire: 41, vol. 3, p. 406, 1881; 16, p. 192 (*variegatus*); 49, p. 67; 55, p. 269, 1881 (redescribed).
Fiji.

Genus **OXYSTETHUS** Fairmaire: 41, vol. 5, p. 238, 1883.
(Type, *Oxystethus scapulatus* Fairmaire.)

Oxystethus scapulatus Fairmaire: 41, vol. 5, p. 238, 1883; 43, p. 322; 49, p. 68.
Bismarck Archipelago: New Britain.

SUBFAMILY DICREPIDIINAE

Genus **HETEROCREPIDIUS** Guérin-Ménéville: 30, pp. 23, 24, pl. 229, fig. 1, 1838.
(Type, *Elater* [*Dicrepidius*] *ventralis* Guérin.)

Heterocrepidius puberulus Boheman: 4, p. 66, 1858; 49, p. 77.
Galapagos.

⁶B. P. Bishop Museum collection.

Genus **PROPSEPHUS** Hyslop: 35, p. 666, 1921.

(Type, *Psephus beniniensis* Candèze.)

Propsephus aenescens (Blair): 1, (9), vol. 20, p. 172, 1927
(*Psephus*).

Marquesas: Fatuhiva.

Propsephus euaensis (Schwarz): 17, p. 352, 1901 (*Psephus*); 49,
p. 97; 60, p. 115.

Samoa: Tutuila. Tonga: Eua.

Propsephus gracilicornis Van Zwaluwenburg: 60, p. 116, fig. 3,
1928.

Samoa: Upolu.

Propsephus major (Candèze): 12, fasc. 2, p. 25, 1878 (*Anchastus*);
16, p. 106; 49, p. 97 (erroneously cites Tongatabu); 55, p.
270, 1881; 60, p. 115.

Samoa: Upolu. Fiji.

Propsephus rufipes (Schwarz): 17, p. 351, 1901 (*Psephus*); 49,
p. 98; 60, p. 115.

Samoa: Tutuila. Tonga: Tongatabu, Vavau.

Propsephus tongaensis (Candèze): 12, fasc. 2, p. 25, 1878 (*An-*
chastus), fasc. 3, p. 42 (erroneously cites Hawaii); 1, (9),
vol. 20, p. 173; 49, pp. 92, 98; 55, p. 270, 1881; 60, p. 114.
Phoenix: Hull. Samoa: Savaii, Tutuila, Upolu. Tonga:
Tongatabu.

Synonym: *Ischiodontus hawaiiensis* Candèze. (The species
does not occur in Hawaii).

Propsephus upoluensis Van Zwaluwenburg: 60, p. 113, fig. 2, 1928.

Samoa: Upolu.

Genus **LAMONONIA** Van Zwaluwenburg: 60, p. 118, 1928.

(Type, *Lamononia monticola* Van Zwaluwenburg.)

Lamononia monticola Van Zwaluwenburg: 60, p. 118, figs. 5, 6,
1928.

Samoa: Upolu.

SUBFAMILY PACHYDERINAE

Genus **SIMODACTYLUS** Candèze: 11, vol. 2, p. 169, 1859.(Type, *Aeolus cinnamomeus* Boisduval.)

Simodactylus cinnamomeus (Boisduval): 5, p. 106, 1835 (*Aeolus*); 1, (9), vol. 20, p. 171; 2, p. 1, 1881; 3, p. 240; 11, vol. 2, p. 170, pl. 3, fig. 18; 21, p. 35; 22, p. 21; 24, p. 17; 31, vol. 4, p. 467, vol. 7, p. 298; 40, p. 220; 43, p. 321; 46, p. 129; 49, p. 101; 53, p. 369; 57; 60, p. 119; 61, p. 130; 62; 63, p. 31; 64, p. 511.

Austral: Rurutu.⁷ Hawaii: Hawaii, Kauai, Maui, Molokai, Oahu. Marquesas: Fatuhiva, Hivaoa, Nukuhiva, Uahuka, Uapou. Samoa: Upolu. Society: Moorea, Raiatea,⁷ Tahiti. Tuamotu: Fakarava, Makatea. Bismarck Archipelago: Duke of York. Fiji: Viti Levu.⁷ New Hebrides. Solomon: Guadalcanar.⁷ Gilbert: Tarawa. Marianas: Guam.⁸ Marshall: Jaluit.

Synonyms: *Monocrepidius chazali* Le Guillou, *Monocrepidius sericans* Fairmaire, *Monocrepidius subcastaneus* Fairmaire.

Simodactylus delfini Fleutiaux: 28, p. 175, 1907; 29, p. 307; 49, p. 101.
Easter.

Simodactylus fasciolatus Fairmaire: 41, vol. 5, p. 238, 1883; 43, p. 321; 49, p. 101.
Bismarck Archipelago: New Britain.

Simodactylus pembedtoni Van Zwaluwenburg: 31, vol. 7, p. 431, 1931.
Bismarck Archipelago: New Britain.

Simodactylus similis (Candèze): 14, p. 111, 1878 (*Monocrepidius*); 16, p. 66; 31, vol. 7, p. 432; 49, p. 101.
Bismarck Archipelago: New Britain. (Type locality, Misori Island.)

Simodactylus tasmani Candèze: 12, fasc. 5, p. 24, 1893; 27, p. 125; 32, p. 248; 49, p. 101; 60, p. 120.
Ellice: Nui, Nukufetau. Samoa: Tutuila.⁹ Fiji: Naitamba,⁹ Viti Levu.⁹ Loyalty: Lifu. New Caledonia. New Hebrides.

⁷ B. P. Bishop Museum collection.

⁸ Hawaii Agricultural Experiment Station loan collection, B. P. Bishop Museum.

⁹ B. P. Bishop Museum collection.

Simodactylus tastui (Le Guillou): 40, p. 221, 1844 (*Dicrepidius*); 16, p. 66; 22, p. 19; 31, vol. 8; 49, p. 101 (erroneously cites Hawaii).

Samoa. (Originally cited, "Hamo".)

Simodactylus trivittatus Schwarz: 17, p. 353, 1906; 49, p. 101. Shortland. (Probably Shortland Island in the Solomon Islands; possibly Shortland Island off New Guinea.)

Genus **ROGGEVEENIA** Van Zwaluwenburg: 60, p. 120, 1928. (Type, *Roggeveenina buxtoni* Van Zwaluwenburg.)

Roggeveenina buxtoni Van Zwaluwenburg: 60, p. 121, figs. 7-9, 1928.

Samoa: Tutuila, Upolu.

SUBFAMILY CONODERINAE

Genus **CONODERUS** Eschscholtz: 18, p. 31, 1928. (Type, *Conoderus fuscofasciatus* Eschscholtz.)

Conoderus brachypterus (Fauvel): 27, p. 127, 1904 (*Monocrepidius*); 32, p. 248; 49, p. 526.

Loyalty: Lifu.

Conoderus exsul (Sharp): 1, (4), vol. 19, p. 470, 1877 (*Monocrepidius*); 6, p. 294; 10, pp. 10, 48; 31, vol. 4, pp. 467, 522, vol. 5, pp. 11, 279, vol. 6, pp. 211, 244, 350, 392, vol. 7, pp. 43, 298, 409; 46, p. 130; 49, p. 108; 53, p. 369; 57.

Hawaii: Hawaii, Kauai, Lanai, Maui, Molokai, Oahu, Midway. Kermadec. (An immigrant to Hawaii from Australia or New Zealand).

Conoderus leluti (Le Guillou): 40, p. 220, 1844 (*Monocrepidius*); 11, vol. 2, p. 229; 14, p. 114; 16, p. 74; 49, p. 108.

"Polynesia" (?). (Type locality, Torres Strait region.)

Synonym: *Monocrepidius cincreus* Blanchard.

Conoderus limbithorax (Fleutiaux): 55, p. 388, 1891 (*Monocrepidius*); 27, p. 126; 32, p. 248; 49, p. 108.

New Caledonia.

Conoderus pallipes (Eschscholtz): 18, p. 32, 1829 (*Monocrepidius*); 1, (9), vol. 20, p. 171; 2, p. 1, 1881; 11, vol. 2, p. 238; 22, p. 20; 49, p. 109; 56, p. 237, 1927; 60, p. 122 (Manuae, not Manua); 61, p. 131; 63, p. 33; 64, p. 511.

Austral: Rurutu, Raivavae (Vavitaio).¹⁰ Cook: Manuae, Rarotonga. Ellice. Line: Palmyra, Fanning, Washington. Phoenix: Hull. Samoa: Savaii, Tutuila, Upolu. Society: Borabora, Moorea, Raiatea, Tahiti. Tonga: Nukualofa. Fiji: Fulanga,¹⁰ Ovalau,¹¹ Taveuni,¹¹ Viti Levu,¹¹ Wailangilala.¹⁰ New Hebrides. Solomon: Guadalcanar.¹⁰ Gilbert. Marshall: Jaluit. Tuamotu: Makatea.

Synonyms: *Monocrepidius rufangulus* Fairmaire, ? *Elater variabilis* Montrouzier.

Conoderus pauper (Schwarz): 52, p. 76, 1907 (*Monocrepidius*); 49, p. 109.
Fiji.

Conoderus pauperatus (Candèze): 14, p. 113, 1878 (*Monocrepidius*); 49, p. 109.
Solomon: Guadalcanar.¹⁰ (Type localities, Ternate and New Guinea.)

Conoderus umbraculatus (Candèze): 12, fasc. 1, p. 25, 1865 (*Monocrepidius*); 48, p. 91; 49, p. 111.
Ellice: Funafuti. (Type locality, New Guinea.)

Conoderus variabilis (Montrouzier): 44, p. 15, 1855 (*Elater*); 27, p. 126; 32, p. 248; 48; 49, p. 111; 55, p. 256, 1860, p. 388, 1891; 56, p. 237, 1927.
Ellice: Funafuti. Loyalty: Lifu. New Caledonia: Art. Trobriand: Woodlark.
Synonyms: *Athous* ? *ferrugineus* Montrouzier, *Ludius leucopoda* Montrouzier.

Conoderus species undetermined.

Hawaii: Oahu. (Obviously an immigrant; first taken 1931.)

¹⁰ B. P. Bishop Museum collection.

¹¹ British Museum collection.

SUBFAMILY ELATERINAE

Genus **ELATER** Linnaeus: 42, p. 404, 1758.(Type, *Elater sanguineus* Linnaeus.)

Elater boisduvali (Fauvel): 25, p. 142, 1862 (*Ludius*); 27, p. 129;
32, p. 248; 49, p. 157; 55, p. 388, 1891.

New Caledonia.

Elater boisduvali aberration **gambeyi** Fleutiaux: 55, p. 388, 1891;
27, p. 129; 49, p. 157.

New Caledonia.

Elater candezei (Fauvel): 26, p. 185, 1867 (*Ludius*); 27, p. 129;
32, p. 248; 49, p. 157; 55, p. 388, 1891.

Loyalty: Lifu. New Caledonia: Isle of Pines, Prony Bay.

Elater candezei aberration **niger** Fleutiaux: 55, p. 388, 1891; 49,
p. 157.

New Caledonia.

Elater fauveli Fleutiaux: 55, p. 388, 1891; 27, p. 129; 49, p. 157.

New Caledonia: Isle of Pines, Noumea.

Elater frontalis Fauvel: 27, p. 128, 1904; 32, p. 248; 49, p. 531.

Loyalty: Lifu.

Elater guillebeaudi Perroud: 47, p. 102, 1864 (*guillebelli*); 27, p.
129; 32, p. 249; 49, p. 158; 55, p. 389, 1891.

New Caledonia: Isle of Pines, Canala.

Elater marginellus Fauvel: 27, p. 129, 1904; 32, p. 249; 49, p. 531.

New Caledonia.

Elater melanopterus Montrouzier: 44, p. 15, 1855; 56, p. 236, 1927
(suggests the possibility that this is a melasid).

Trobriand: Woodlark.

Elater nigrita Fauvel: 27, p. 128, 1904; 32, p. 248; 49, p. 531.

New Caledonia.

Elater taitensis Boheman: 4, p. 68, 1858; 49, p. 158.

Society: Tahiti.

Genus **EOPENTHES** Sharp: 3, p. 153, 1885.

(Type, *Eopenthes basalis* Sharp.)

Eopenthes ambiguus Blackburn: 3, pp. 155, 241, 1885; 53, p. 380.

Hawaii: Oahu.

Eopenthes antennatus Sharp: 53, p. 378, 1908.

Hawaii: Oahu.

Eopenthes arduus Sharp: 53, p. 378, 1908.

Hawaii: Oahu.

Eopenthes auratus Sharp: 53, p. 371, 1908.

Hawaii: Molokai.

Eopenthes basalis Sharp: 3, pp. 153, 240, 1885; 53, p. 371, pl. 13,

fig. 7.

Hawaii: Oahu.

Eopenthes caeruleus Sharp: 53, p. 370, 1908.

Hawaii: Lanai, Molokai.

Eopenthes celatus Sharp: 53, p. 376, 1908.

Hawaii: Molokai.

Eopenthes cognatus Sharp: 53, p. 375, 1908 ("somewhat doubtfully distinct" from *Eopenthes kona*).

Hawaii: Hawaii.

Eopenthes debilis Sharp: 3, pp. 154, 241, 1885; 53, p. 380.

Hawaii: Oahu.

Eopenthes deceptor Sharp: 53, p. 374, 1908.

Hawaii: Molokai.

Eopenthes divisus Sharp: 53, p. 374, 1908.

Hawaii: Oahu.

Eopenthes funebris Sharp: 53, p. 377, 1908.

Hawaii: Kauai.

Eopenthes germanus Sharp: 53, p. 373, 1908.

Hawaii: Oahu.

Eopenthes gracilis Sharp: 53, p. 376, 1908.

Hawaii: Molokai.

- Eopenthes humeralis** (Karsch): 2, vol. 25, p. 5, pl. 1, fig. 7, 1881
(*Elater*); 3, p. 240; 53, p. 372.
Hawaii: Maui.
- Eopenthes kauaiensis** Sharp: 53, p. 373, 1908.
Hawaii: Kauai.
- Eopenthes kona**e Blackburn: 3, pp. 154, 241, 1885; 46, p. 130; 53,
p. 375.
Hawaii: Hawaii.
- Eopenthes longicollis** Sharp: 53, p. 371, 1908.
Hawaii: Kauai.
- Eopenthes marginatus** Sharp: 53, p. 381, 1908 ("It may prove to
be a variety of the male of *E. parvulus*"); 31, vol. 7, p. 230.
Hawaii: Oahu.
- Eopenthes mauiensis** Sharp: 53, p. 376, 1908.
Hawaii: Maui.
- Eopenthes muticus** Sharp: 53, p. 380, pl. 13, fig. 6, 1908.
Hawaii: Kauai.
- Eopenthes oahuensis** Sharp: 53, p. 378, 1908.
Hawaii: Oahu.
- Eopenthes obscurus** Sharp: 3, pp. 154, 241, pl. 4, fig. 19, 1885; 53,
p. 372.
Hawaii: Oahu.
- Eopenthes pallipes** Sharp: 53, p. 373, 1908.
Hawaii: Oahu.
- Eopenthes parvulus** Sharp: 53, p. 381, 1908; 31, vol. 7, p. 230.
Hawaii: Oahu.
- Eopenthes perkinsi** Sharp: 53, p. 374, 1908.
Hawaii: Oahu.
- Eopenthes plebeius** Sharp: 53, p. 377, 1908.
Hawaii: Lanai.
- Eopenthes politus** Sharp: 53, p. 373, 1908.
Hawaii: Maui.

Eopenthes satelles Blackburn: 3, pp. 155, 241, 1885 (description initialed by Sharp but, from the context, plainly Blackburn's); 53, p. 379.

Hawaii: Lanai.

Eopenthes tarsalis Sharp: 53, p. 381, 1908.

Hawaii: Kauai.

Eopenthes tinctus Sharp: 53, p. 379, 1908.

Hawaii: Hawaii.

Eopenthes unicolor Sharp: 53, p. 377, 1908.

Hawaii: Kauai.

Eopenthes varians Sharp: 53, p. 379, 1908.

Hawaii: Molokai.

Genus **MEGAPENTHES** Kiesenwetter: 37, p. 353, 1858.

(Type, *Elater lugens* Redtenbacher.)

Megapenthes brunniventris Candèze: 15a, p. 804, 1892; 31, vol. 7, p. 433; 49, p. 171 (*brunneiventris*).

Solomon: Guadalcanar.¹² (Type locality, New Guinea.)

Megapenthes madidus Candèze: 12, fasc. 5, p. 37, 1893; 49, p. 172.

Fiji.

Megapenthes puberulus (Montrouzier): 55, p. 259, 1860 (*Athous*):

27, p. 130 (*puberulus*); 49, p. 172; 55, p. 390, 1891.

Loyalty: Lifu. New Caledonia.

Megapenthes tricarinatus Fleutiaux: 55, p. 389, pl. 8, fig. 4, 1891;

27, p. 130; 32, p. 249; 49, p. 172.

New Caledonia.

Genus **MELANOXANTHUS** Eschscholtz: 19, p. 91, 1833.

(Type, *Elater melanocephalus* Fabricius.)

Melanoxanthus caledonicus (Fleutiaux): 55, p. 390, pl. 8, fig. 6, 1891 (*Megapenthes*); 27, p. 130; 49, pp. 171 (*Megapenthes*),

533.

New Caledonia.

¹² B. P. Bishop Museum collection.

Melanoxanthus melanocephalus (Fabricius): 21, p. 272, 1781 (*Elater*); 3, p. 240; 11, vol. 2, p. 512, pl. 7, fig. 12; 24, p. 17; 31, vol. 3, p. 16, vol. 5, p. 280, vol. 6, p. 2; 43, p. 322; 46, p. 129; 49, p. 177; 53, p. 369; 59, part 3, p. 63; 60, p. 123. Hawaii: Hawaii, Maui, Molokai, Oahu. Line: Baker, Palmyra. Samoa: Upolu. Bismarck Archipelago: Duke of York. (As far westward as Madagascar and Zanzibar.)

Melanoxanthus picturatus Fauvel: 27, p. 131, 1904; 32, p. 249.
New Caledonia.

Melanoxanthus picturus Schenkling: 49, p. 534, 1927 (new name for *Melanoxanthus pictus* Montrouzier, preoccupied); 27, p. 130; 55, p. 257, 1860 (first description), p. 390, 1891.
New Caledonia: Art.
Synonyms: *Elater* (*Limonius*) *pictus* Montrouzier, *Melanoxanthus gratus* Fauvel.

Melanoxanthus picturus variety **personatus** Fauvel: 27, p. 131, 1904; 32, p. 249; 49, p. 534.
New Caledonia.

Melanoxanthus picturus aberration **rufithorax** Fauvel: 27, p. 131, 1904; 32, p. 249; 49, p. 534.
New Caledonia.

Melanoxanthus rotundicollis (Fleutiaux): 55, p. 390, pl. 8, fig. 11, 1891 (*Pyrophorus*); 49, p. 534.
New Caledonia.

Melanoxanthus tetraspilotus Fairmaire: 41, vol. 5, p. 239, 1883; 49, p. 179.
Bismarck Archipelago: New Britain.

Genus **PACIFICOLA** Van Zwaluwenburg: 61, p. 131, 1932.
(Type, *Pacificola obscura* Van Zwaluwenburg.)

Pacificola adamsoni Van Zwaluwenburg: 61, p. 141, 1932.
Marquesas: Hivaoa.

Pacificola bella Van Zwaluwenburg: 61, p. 139, 1932.
Marquesas: Tahuata.

Pacificola compta (Van Zwaluwenburg): 60, p. 123, fig.10, 1928
(*Melanoxanthus*); 61, p. 133 (paratype to *Pacificola*).
Samoa: Upolu, Tutuila.

Pacificola contracta Van Zwaluwenburg: 61, p. 136, 1932.
Marquesas: Fatuhiva.

Pacificola convexa Van Zwaluwenburg: 61, p. 138, 1932.
Marquesas: Nukuhiva.

Pacificola fasciata Van Zwaluwenburg: 61, p. 142, 1932.
Marquesas: Uapou.

Pacificola grandis Van Zwaluwenburg: 61, p. 140, 1932.
Marquesas: Hivaoa.

(?) ***Pacificola instabilis*** (Fairmaire): 22, p. 22, 1849 (*Oophorus*);
1, (9), vol. 20, p. 172 (doubt as to specific identity); 11, vol.
2, p. 382 (perhaps *Heteroderes*); 49, p. 130; 61, p. 133.
(?) Marquesas: Fatuhiva, Hivaoa. Society: Tahiti.

Pacificola insularis Van Zwaluwenburg: 61, p. 134, 1932.
Marquesas: Uahuka.

Pacificola montana Van Zwaluwenburg: 61, p. 140, 1932.
Marquesas: Hivaoa.

Pacificola mumfordi Van Zwaluwenburg: 61, p. 138, 1932.
Marquesas: Nukuhiva.

Pacificola nana Van Zwaluwenburg: 61, p. 139, 1932.
Marquesas: Hivaoa.

Pacificola obscura Van Zwaluwenburg: 61, p. 134, 1932.
Marquesas: Uahuka.

Pacificola remota Van Zwaluwenburg: 61, p. 142, 1932.
Marquesas: Fatuhiva.

Pacificola silvestris Van Zwaluwenburg: 61, p. 136, 1932.
Marquesas: Fatuhiva.

Pacificola vitiensis Van Zwaluwenburg: 61, p. 137, 1932.
Fiji: Viti Levu.

SUBFAMILY PHYSORHININAE

Genus **ANCHASTUS** Le Conte: 39, p. 459, 1853.

(Type, *Anchastus digitatus* Le Conte.)

Anchastus galapagoensis (Waterhouse): 1, vol. 16, p. 25, 1845
(*Physorhinus* ?); 11, vol. 2, p. 394; 49, p. 187.
Galapagos.

Anchastus swezeyi Van Zwaluwenburg: 31, vol. 7, p. 489, figs. 1-6,
1931.
Hawaii: Maui.

Anchastus vitiensis Van Zwaluwenburg: 31, vol. 7, p. 489, 1931.
Fiji: Koro,¹³ Taveuni,¹³ Vanua Levu,¹³ Viti Levu.

SUBFAMILY CARDIOPHORINAE

Genus **COPTOSTETHUS** Wollaston: 66, p. 238, pl. 4, fig. 8, 1854.
(Type, *Coptostethus femoratus* Wollaston.)

Coptostethus williamsi Mutchler: 45, p. 227, fig. 44, 1925.
Galapagos.

Genus **HORISTONOTUS** Candèze: 11, vol. 3, p. 243, 1860.
(Type, *Horistonotus flavidus* Candèze.)

Horistonotus insularis (Boheman): 4, p. 70, 1858 (*Cardiophorus*);
11, vol. 3, p. 262; 49, p. 259.
Society: Tahiti.

SUBFAMILY MELANOTINAE

Genus **NEODIPLOCONUS** Hyslop: 35, p. 658, 1921.
(Type, *Diploconus peregrinus* Candèze.)

Neodiploconus nigrifrons (Schwarz): 50, p. 272, 1902 (*Diploconus*);
49, p. 268.
Bismarck Archipelago: Gardner (off New Ireland).

Neodiploconus nitidus (Schwarz): 50, p. 274, 1902 (*Diploconus*);
49, p. 268.
Bismarck Archipelago: New Britain, Nusa (off New Ire-
land).

¹³ British Museum collection.

Genus **MELANOTUS** Eschscholtz: 18, p. 32, 1829.
(Type, *Elater fusciceps* Gyllenhal.)

Melanotus, species: 33, p. 168, 1915.
Bismarck Archipelago: New Britain.

SUBFAMILY PYROPHORINAE

Genus **PHOTOPHORUS** Candèze: 11, vol. 4, p. 72, 1863.
(Type, *Photophorus jansonii* Candèze.)

Photophorus bakewellii Candèze: 11, vol. 4, p. 74, 1863; 49, p. 354.
New Hebrides.

Photophorus jansonii Candèze: 11, vol. 4, p. 73, pl. 1, fig. 23, 1863;
49, p. 354; 55, p. 271, 1881.
Fiji: Ovalau,¹⁴ Taveuni,¹⁴ Viti Levu.¹⁵

Genus **HIFO** Candèze: 12, fasc. 3, p. 94, 1881.
(Type, *Hifo pacificus* Candèze.)

Hifo pacificus Candèze: 12, fasc. 3, p. 94, 1881; 49, p. 355.
Tonga: Tongatabu.

SUBFAMILY LEPTUROIDINAE

Genus **ELATICHROSIS** Hyslop: 35, p. 644, 1921.
(Type, *Chrosis exarata* Candèze.)

Elatichrosis bifoveolata (Schwarz): 50, p. 291, 1902 (*Pristilophus*);
17, 1906, p. 326 (*Chrosis*); 49, p. 405.
Tonga: Tongatabu.

Elatichrosis caledonica (Schwarz): 17, p. 390, 1903 (*Chrosis*): 49.
p. 405.
New Caledonia.

Genus **AMYCHUS** Pascoe: 1, (4), vol. 17, p. 49, 1876.
(Type, *Amychus candezei* Pascoe.)

Amychus candezei Pascoe: 1, (4), vol. 17, p. 49, 1876; 9, p. 94;
49, p. 407.
Chatham: Pitt.

¹⁴ British Museum collection.

¹⁵ Hawaiian Sugar Planters' Experiment Station collection.

Genus **PSOROCHROA** Broun: 7, p. 301, 1883.

(Type, *Psorochroa granulata* Broun.)

Psorochroa granulata Broun: 7, p. 301, 1883; 6, p. 773; 8, p. 146;
49, p. 407.
Chatham.

Psorochroa rotundicollis (Schwarz): 17, p. 193, 1901 (*Amychus*);
49, p. 407; 51, p. 232.
Chatham.

Psorochroa schauinslandi (Schwarz): 17, p. 194, 1901 (*Amychus*);
49, p. 407; 51, p. 232.
Chatham.

Genus **ITODACNUS** Sharp: 3, p. 156, 1885.

(Type, *Itodacnus gracilis* Sharp.)

Itodacnus blackburnianus Sharp: 53, p. 383, 1908; 31, vol. 2, p.
302; 49, p. 408.
Hawaii: Hawaii.

Itodacnus chloroticus Sharp: 53, p. 384, 1908; 49, p. 408.
Hawaii: Oahu.

Itodacnus collaris Sharp: 53, p. 384, 1908; 49, p. 408.
Hawaii: Molokai.

Itodacnus coruscus (Karsch): 2, vol. 25, p. 5, pl. 1, fig. 6, 1881
(*Corymbites*); 3, p. 241; 49, p. 408; 53, p. 382.
Hawaii: Maui.

Itodacnus gracilis Sharp: 3, pp. 156, 241, pl. 4, fig. 18, 1885; 46,
pp. 130, 193; 49, p. 408; 53, p. 382.
Hawaii: Hawaii, Oahu.

Itodacnus kauaiensis Sharp: 53, p. 383, 1908; 49, p. 408.
Hawaii: Kauai.

Itodacnus major Sharp: 53, p. 382, 1908; 49, p. 408.
Hawaii: Kauai.

Itodacnus novicornis Van Zwaluwenburg: 10, p. 50, fig. 8, 1926.
Hawaii: Necker.

Itodacnus sordidus Sharp: 53, p. 383, 1908; 49, p. 408.
Hawaii: Kauai.

Genus **DACNITUS** Sharp: 53, p. 384, 1908.
(Type, *Dacnitus currax* Sharp.)

Dacnitus currax Sharp: 53, p. 385, pl. 13, fig. 8, 1908; 49, p. 408.
Hawaii: Kauai.

SUBFAMILY STEATODERINAE

Genus **NEOTRICHOPHORUS** Jakobson: 36, p. 742, 1913.
(Type, *Trichophorus guillebelli* Mulsant.)

Neotrichophorus dilaticollis (Fairmaire): 41, vol. 5, p. 239, 1883
(*Ludius*); 43, p. 323; 49, p. 428; 51, p. 260.
Bismarck Archipelago: New Britain, (?) New Hebrides.

Genus **COMPSELUS** Candèze: 12, fasc. 2, p. 48, 1878.
(Type, *Compshelus flavus* Candèze.)

Compshelus flavus Candèze: 12, fasc. 2, p. 48, 1878; 49, p. 438;
55, p. 270, 1881.
Fiji.

Genus **MECASTRUS** Sharp: 1, (4), vol. 19, p. 469, 1877.
(Type, *Mecastrus convexus* Sharp.)

Mecastrus convexus Sharp: 1, (4), vol. 19, p. 469, 1877; 8, p. 146;
49, p. 440.
Chatham.

Genus **OCHOSTERNUS** Candèze, 11, vol. 4, p. 445, 1863.
(Type, *Elater [Limonius] zealandicus* White.)

Ochosternus caledonicus Fleutiaux: 55, p. 395, 1891; 27, p. 135;
49, p. 478.
New Caledonia.

Ochosternus canalensis Fleutiaux: 55, p. 394, pl. 8, fig. 2, 1891;
27, p. 134 (*kanalensis*); 32, p. 249; 49, p. 478.
New Caledonia.

- Ochosternus cribriceps** Fauvel: 27, p. 134, 1904; 32, p. 249; 49, p. 478.
New Caledonia.
- Ochosternus dubius** Fleutiaux: 55, p. 394, 1904; 27, p. 134; 32, p. 249; 49, p. 478.
New Caledonia.
- Ochosternus montrouzieri** Fleutiaux: 55, p. 394, pl. 8, fig. 1, 1891; 27, p. 134 (*montrousieri*); 32, p. 249; 49, p. 478.
New Caledonia.
- Ochosternus pacificus** Fauvel: 27, p. 134, 1904; 32, p. 249; 49, p. 478.
New Caledonia.
- Ochosternus potensis** (Montrouzier): 55, (3), vol. 8, p. 257, 1860 (*Elater*, corrected in footnote to *Cratonychus*); 27, p. 135; 32, p. 249; 49, pp. 284 (*Melanotus*), 478, 541; 55, p. 396, 1891 (not recognizable).
New Caledonia: Pott.
- Ochosternus punctiger** Fleutiaux: 55, p. 394, 1891; 27, p. 134; 32, p. 249; 49, p. 478.
New Caledonia.
- Ochosternus zealandicus** (White): 65, p. 7, 1846 (*Limonius*); 1, (4), vol. 19, p. 25; 6, p. 298; 11, vol. 4, p. 446; 49, p. 478.
Kermadec: Sunday.

Genus NYCTERILAMPUS ¹⁶ Montrouzier: 55, p. 258, 1860.

(Type, *Nycterilampus lifuanus* Montrouzier.)

- Nycterilampus lifuanus** Montrouzier: 55, p. 258, 1860; 12, fasc. 3, p. 105; 27, p. 132; 32, p. 249; 49, p. 478; 55, p. 392, pl. 8, fig. 9, 1891.
Loyalty: Lifu. New Caledonia: Lafoa.
Synonym: *Ochosternus gigas* Candèze.
- Nycterilampus velutinus** Fleutiaux: 55, p. 393, pl. 8, fig. 10, 1891; 27, p. 133; 32, p. 249; 49, p. 479; 56, p. 108, 1903.
Loyalty: Lifu. New Caledonia.

¹⁶ "Le nom de *Nycterilampus* tombe en synonymie de *Tetrigus* Cand. 1857." (Communication from Dr. E. Fleutiaux, September 22, 1932.)

Genus **THORAMUS** Sharp: 1, (4), vol. 19, p. 399, 1877.
(Type, *Thoramus wakefieldi* Sharp.)

Thoramus laevithorax (White): 65, p. 7, pl. 1, fig. 6, 1846 (*Ctenicerus*); 1, (4), vol. 19, p. 402, 1877; 8, p. 146; 49, p. 479.
Chatham.

Thoramus wakefieldi Sharp: 1, (4), vol. 19, p. 399, 1877; 8, p. 146;
49, p. 479.
Chatham.
Synonym: *Thoramus obscurus* Sharp.

SUBFAMILY DENTICOLLINAE

Genus **MACROMALOCERA** Hope: 34, p. 13, 1834.
(Type, *Macromalocera coenosa* Hope.)

Macromalocera caledonica Fleutiaux: 55, p. 395, 1891; 32, p. 249;
49, p. 502.
New Caledonia.

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¹⁷ References marked with an asterisk are not available in Hawaii and have not been seen by the writer.

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Species of two closely related genera of marine crabs, *Latreillia* Roux, and *Latreillopsis* Henderson, because of their elongated walking legs, bear superficial resemblance to spider crabs (Maiidae). A critical examination, however, shows their affinity to be with the tribe Homolidea of the primitive Brachyura.

In the genus *Latreillia* the carapace, which has a narrow and extended anterior border, is triangular in outline. The antennae are short, and in the female the fourth, fifth, and sixth abdominal segments are fused.

Representatives of the genus *Latreillopsis* have a subquadrangular carapace, the front of which is broader than in *Latreillia*. The antennae are long and the abdominal segments are distinct in both sexes. A line (*linea anomurica*) extends from the orbit along each lateral border to the posterior margin of the carapace. In *Latreillia* the *linea anomurica* is wanting.

In species of both genera the carapace is longer than broad, and is relatively deep with vertical side walls. The rostrum terminates in a sharp spine; on each side is a long supraocular spine. At least the first three pairs of walking legs are very long. The fourth pair is placed more dorsally than the others and is subchelate. Known species of the genera inhabit moderate depths ranging from about 30 to 800 fathoms.

Five species of the genus *Latreillia* are known. One, *Latreillia elegans* Roux, is recorded from the Mediterranean Sea and from widely separated regions of the Atlantic Ocean. Two species, *Latreillia phalangium* de Haan and *Latreillia valida* de Haan, were described from Japanese waters. The latter species has also been taken off Zebu, Philippine Islands. Another species, *Latreillia australiensis* Henderson, is known from the waters of New South Wales; *Latreillia pennifera* Alcock was taken in the East Indian region near the Kei Islands.

Although few specimens of any of the five species of *Latreillia* have been observed, all which have been recorded are of small size.

None reach 1 inch in length of carapace. No member of the genus has been reported from Hawaiian waters and none is known from the Central Pacific area.

Up to this time four species of *Latreillopsis* have been described. The type species, *Latreillopsis bispinosa* Henderson,¹ a female with a carapace 14 mm. long, was taken by the Challenger Expedition off Zebu, Philippine Islands, at a depth of 95 fathoms. In this form the hepatic areas stand out like little wings, and each is capped by a sharp spine as long as that of the rostrum. The posterior legs are longer than the chelipeds. Alcock records this species from off the Andaman Islands. One of his individuals was an ovigerous female 8 mm. long. The species has also been reported from the coasts of Japan. All specimens so far observed are of small size.

The Siboga Expedition obtained a species, *Latreillopsis multipinosa* Ihle,² from near the Kei Islands at a depth of 200 meters. The specimen, an ovigerous female, has a carapace 23 mm. long, without the rostrum. It is characterized by long sharp spines (39 in number) borne on the dorsal, lateral, and ventral surfaces. The supraocular spines are slightly longer than the carapace, and all of the walking legs are longer than the chelipeds.

In 1904 Grant³ described a small form, a male 6.55 mm. long, from off Port Jackson, Australia, depth 250 to 300 fathoms, under the name *Latreillopsis petterdi*. McCullock⁴ reported a male of the same species with a carapace 79 mm. long from a depth of 800 fathoms 39 miles due east of Sydney, Australia. This form has the carapace well covered with granules and spiniform tubercles. The hands of the chelipeds are swollen and covered with small round granules. The first three pairs of walking legs are much longer and the fourth pair slightly longer than the chelipeds.

Stebbing⁵ described *Latreillopsis alcocki* from Algoa Bay, South Africa, taken at a depth of 40 fathoms. It is a female with a carapace 45 mm. long and bears numerous short heavy spines on the

¹ Henderson, J. R., Report on the Anomura collected by H. M. S. Challenger during the years 1873-1876: Challenger Reports, vol. 27, pp. 22, 23, pl. 2, fig. 3, 1888.

² Ihle, J. E. W., Die Decapoda Braychyura der Sigoga-Expedition I., Dromiacea, Monograph 39b, pp. 78-81, pl. 4, figs. 19-21, 1913.

³ Grant, F. E., Crustacea dredged off Port Jackson in deep water: Linn. Soc. New South Wales, Proc., vol. 30, p. 317, pl. 10, fig. 2, 1904.

⁴ McCullock, A. R., Fishes and crustaceans from 800 fathoms, the results of deep-sea investigation in Tasman Sea II., The expedition of the Woy Woy: Australian Mus. Records, vol. 6, pp. 353-355, pl. 65, 1905.

⁵ Stebbing, T. R. R., South African Crustacea, pt. 10: South African Mus., Ann., vol. 17, p. 255, pl. 24, 1920.

dorsal and lateral surfaces. All of the walking legs are longer than the chelipeds.

On June 20, 1932, Ubaldo Costales, a fisherman, caught by hook and line at a depth of 30 fathoms, off Watertown, Oahu, a strange form of crab, which through the courtesy of the Territorial Board of Agriculture and Forestry was presented to Bernice P. Bishop Museum. It proved to be a new species of *Latreillopsis*.

***Latreillopsis hawaiiensis*, new species (pl. 1, fig. 1).**

Type, male: length of carapace, without rostral spine, 125 mm.; greatest width, 110 mm.

Carapace subquadrangular in outline, broadest behind the middle; upper surface slightly convex in both directions and marked by undulations and irregular depressions which to some degree outline the areas. Greatest depth of carapace about one-half that of its length. Surface covered with conical tubercles which are small on the posterior half but strong and spiniform anteriorly and on the vertical sides. Short, stiff, yellow hairs are scattered over the carapace and densely clothe some of the appendages.

Rostral spine (fig. 1, *c*) 17 mm. long, depressed but curved upward distally, supraocular spines stout, 20 mm. long, directed forward and upward; the left one (fig. 1, *e*) bearing two teeth on its postero-lateral border, one below the middle and one above, both directed upward; the right supraocular spine bearing but one tooth and that above the middle.

Orbit broad, shallow, and incomplete, the lateral border bearing a strong spine which also stands just above the base of the antenna. Eye-stalks (fig. 1, *c*) stout, cylindrical, slightly thicker at the basal end. Eyes quadrangular, somewhat thicker basally; ocular portion black.

Protogastric area of carapace bearing several sharp spines, the largest of which is 10 mm. long, situated 18 mm. postero-lateral of the supraocular spine. The median gastric elevation is capped by a stout conical tubercle with 16 small spiniform tubercles lateral and posterior to it. Cardiac elevation nearly smooth, the tubercles of the posterior area of the carapace becoming small and blunt. A distinct *linea anomurica* may be traced from the orbit to the posterior margin of the carapace. The line is smooth anteriorly, but becomes groove-like posteriorly.

Lateral to the *linea anomurica* at the angle of the carapace the tubercles increase in size and become spine-like, the larger ones being anterior. Sharp spines cover the vertical side walls of the carapace, those situated dorsally and anteriorly being long and stout. Hepatic area slightly inflated, bearing two sharp spines above, the anterior one the larger, and several smaller ones below.

Length of antenna (fig. 1, *a*) two-thirds that of the carapace, its basal segment prolonged forward and downward as a blunt tooth-like lobe which rests against the epistome. Second segment of antenna stout, three-fifths the length of the third segment and bearing a small tooth about the middle of its lower border, and two stouter ones at the distal end; third segment slender, cylindrical, more than twice the length of the fourth segment; both third and fourth segments are smooth. Lateral to the base of the antenna is a sharp spine

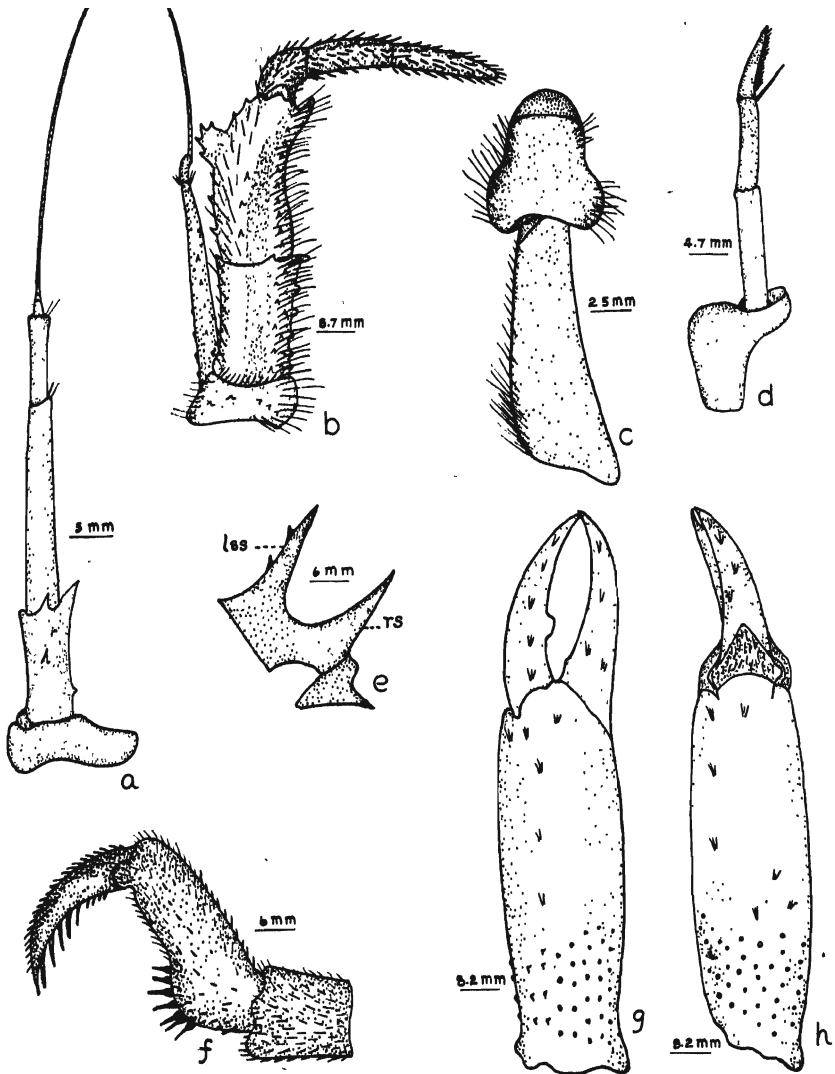


FIGURE 1. Structural features of *Latreillopsis hawaiiensis*, new species: a, antenna from right side; b, outer maxilliped, right side; c, eye-stalk and eye, right side; d, antennule from right side; e, rostral spine (*rs*) and left supraocular spine (*lss*); f, extremity of last walking leg, left side; g, h, outer surface and upper border, respectively, of hand of right cheliped.

directed downward; a stouter one stands above the base of the antenna on the lateral border of the orbit.

Antennule (fig. 1, *d*) about one-half the length of antenna; basal segment stout, irregular in shape; second and third segments subequal in length; terminal segment spine-like, two-thirds the length of the third segment; a small spine-like process articulates with the lower distal extremity of the third segment.

Outer maxilliped (fig. 1, *b*) long, foot-like; ischium slightly shorter and stouter than merus, a row of stout, blunt teeth on its median margin and smaller ones scattered over the outer surface. A shallow, longitudinal groove traverses the outer surface of the ischium and continues the entire length of the merus. Merus strongly curved, a longitudinal row of small spines near its median border and a shorter row about the middle of its exposed surface. The lateral margin bears a few spines and a toothed lobe. Carpus about one-half the length of the propodus, which in turn is slightly shorter than the dactylus. The stout peduncle of the exopodite of the outer maxilliped extends to the middle of the merus and is followed by a short segment and a flattened, jointed flagellum. Yellow bristle-like hairs form a long dense fringe on the median margin of the outer maxillipeds.

Chelipeds subcylindrical, length three and three-fifths times that of the carapace; merus covered with sharp tubercles, an irregular row along the postero-dorsal border being longer and more spiniform; carpus slightly more than one-half the length of the merus, increasing in diameter toward the distal extremity and covered by short conical tubercles. Length of hand (fig. 1, *g*, *h*), including fingers, slightly less than merus and carpus combined; palm subcylindrical, a little higher than wide. Basal one-third of palm bearing small tubercles which extend slightly farther forward on the outer than on the inner surface; remainder of palm smooth except for a few worn and scattered tufts of yellow bristles. Fingers slightly more than one-half the length of the palm, stout, curved inward, the cutting edges not in contact, except at the tips when fingers are closed. There is a blunt, rounded tooth on the cutting edge of the dactylus posterior to the middle, and a smaller sharper one at the base of the immovable finger. Yellow bristles clothe a V-shaped depression in the upper surface of the dactylus at its base, and tufts of bristles are scattered over the surfaces of both fingers.

First, second, and third walking legs subequal, the second slightly longer, the tip of its dactylus reaching to the middle of the palm of the cheliped. The upper, posterior, and ventral surfaces of the merus of each walking leg bear spiniform tubercles with a row of spines of unequal size along the dorsal border. A short curved spine with a thick base terminates the upper distal end of the merus. Front surface of merus unarmed except for a few small tubercles at the basal extremity. The cylindrical carpus and compressed propodus are free from tubercles, but densely coated with short bristles directed distally. These become stronger toward the lower distal border of the propodus, where they terminate in several horny spinelets. The compressed dactylus is covered with short bristles on both flattened surfaces and armed on the lower edge with a row of sharp spinelets increasing in length toward the horny tip.

The fourth walking leg is more slender and much shorter than either of the preceding ones. Its length is approximately one-half that of the cheliped.

The merus and carpus are similar to corresponding segments of the other legs except being smaller in size. The propodus (fig. 1, *f*), which is compressed, has an enlarged basal lobe bearing seven sharp, horny spines with thick, conical bases. The dactylus folds back against the propodus, its horny tip closing among the spines of the basal lobe.

The abdomen of the type specimen completely covers the space between the basal segments of the legs. It is broader in the middle, the fifth segment being 62 mm. wide. The first segment, somewhat rectangular in outline, 20 mm. wide, bears a spine on its median, posterior margin. Segments 2 to 6 are marked by a median longitudinal ridge which bears tubercles, those of the second and third segments being sharp. Groups of small sharp tubercles are carried near the lateral borders of these segments. The seventh segment (telson) is much narrower than the sixth and longer than broad. Its lateral margins are elevated and the distal half of the surface is marked by a median, longitudinal groove.

Type locality, off Watertown, Oahu, depth 30 fathoms, Bernice P. Bishop Museum no. 3640.

The Hawaiian species more closely resembles *Latreillopsis petterdi* than any of other previously described members of the genus. It differs from the Australian species, however, in the greater length and smoother surface of the chelipeds and also in the relatively shorter length of the fourth pair of walking legs.

In the Hawaiian specimen the third walking leg on the left side, though perfect in form, is less than one-half the size of the corresponding leg of the opposite side. The undersized appendage is probably a result of regeneration. On the outer surface of the carpus of the right cheliped are two round punctures where the skeleton has been crushed through. The punctures are about the size of the blunt tooth of the dactylus of the cheliped and doubtless are the result of physical combat between individuals. There is a similar puncture in the outer surface of the carpus of the right cheliped and one through the basal portion of the dactylus of the same appendage. The vertical wall of the carapace on the right side shows an old puncture probably of a similar origin.

The discovery of this giant specimen, together with the record of the large Australian form, is suggestive that the type specimens of some of the described species of the genus may represent immature individuals.

Edmondson—A Giant *Latreillopsis*



PLATE 1. *Latreillopsis hawaiiensis*, new species: A, dorsal surface; B, ventral surface; $\times 1/6$.

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