RECENT AND FOSSIL MARINE MOLLUSCA OF TONGATABU

BY

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Recent and Fossil Marine Mollusca of Tongatabu

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INTRODUCTION

As a member of the Tongan Expedition[1] under the leadership of Professor William A. Setchell, I spent the months of July and August, 1926, in a field study of the marine molluscan fauna of Tongatabu, and the greater part of four successive summer vacations in working up the material collected.

The chief purpose of this paper is to throw light on the geological age of the limestone of Tongatabu and on the climatic and ecological conditions under which it was formed. To facilitate this undertaking, heed was given to the suggestion of Professor Setchell that a study of the recent molluscan fauna be made the basis of the study of the fossil forms. Such a procedure is especially appropriate where the geological formation in question is a comparatively recent one—late Tertiary or Pleistocene—and living species are well represented by fossils. By having at hand large collections of living species from the region surrounding that in which the fossiliferous strata are located, and obtained from as many situations as possible—sand flats, mud flats, rocky beaches, shore and offshore reefs, deep water—determination of the fossil species can be made with much greater speed and assurance. With this object in view, collections were made of the living forms with notes on their particular habitats and on the local variations resulting from different environments.

In determining the living species, the Garrett collection, rich in South Pacific forms, in Bernice P. Bishop Museum, has been of great aid. Verification of each species identified by comparison with specimens in the collections has been made by means of the Museum's conchological literature insofar as this has permitted the tracing of each species to its original author. In the description of species I have given the sources of identification so that any person studying the collections may examine the literature on which my conclusions have been based. It must, however, be borne in mind that when insufficient material and data are available, it is impossible to decide whether a certain form should be ranked as a species, as a variety, or be

[1] The organization, personnel, and accomplishments of the Tongan Expedition are outlined in the Report of the Director for 1926: B. P. Bishop Mus., Bull. 41, pp. 27-29, 1927.

treated merely as a synonym. In the use of generic names I have chosen an older name in preference to the later one for genera whose revised names are questionable. The Chitons, of which a few species were found in the living state, await identification.

I am most grateful to Professor W. A. Setchell for his invaluable advice and suggestions in respect to field work. I also wish to express my appreciation and thanks to Dr. Herbert E. Gregory, Director of the Bernice P. Bishop Museum, for his help and encouragement; to Dr. C. Montague Cooke, Jr., for valuable advice and hints in preparation of the manuscript; and to Mr. Ditlev Thaanum for his helpfulness in taxonomic difficulties. Thanks are also due to Tongan people, native and white, for their aid and hospitality during my stay among them.

GEOGRAPHY

General Features

As shown on the map (fig. 1) Tongatabu is an irregular elongate-triangular island that includes a large lagoon connected with the sea on the leeward side. The entire island is rather low and level; its greatest elevation is less than 300 feet above sea. Its northern (leeward) shore is bordered by low, level land with an average elevation of about 5 feet above sea level; its southwestern and southeastern (windward) shores are bounded by a vertical sea cliff 30 to 100 feet high.

Fringing Reef

The northern side of Tongatabu is protected by a fringing reef. Along the southeastern two thirds of the island it skirts the shore as a reef flat 500 to 1500 feet wide. Along the northwestern third the reef widens greatly; its outer edge lies about 4 miles from the shore and bounds an extensive mud flat or sand flat, submerged at high water and in places dry at low water. Near the middle of the island, about opposite the town of Nukulofa, the fringing reef appears most typical. It is here about 900 feet wide, and, according to well-pronounced physical conditions and equally well defined distribution of animals, may be divided into four faunal zones.

1. Shore zone. The widest zone consists of a compact yellowish mud, which here and there forms low bars with shallow depressions between them. A grasslike alga covers large areas. Echinodermata of the classes Holothuroidea and Asteroidea are found here.

2. Zone of rough coral rock. The very rough surface appears to consist of eroded dead coral reef. Growth of alga is scanty. Arthropods are represented by crustaceans. This zone merges into zone 1.

3. Shallow water zone. A depression filled with water 2 to 4 feet deep at low tide supports a luxuriant growth of alga and madreporarian corals, principally of the genus *Acropora*.

4. Zone of level surface of coral rock. In this compact mass the corals are dead, except along its outer border, where it is margined by a rich growth of *Acropora*. This

zone is about 300 feet wide. Its surface is completely exposed at low tide and presents then a peculiar aspect: it is strewn with a vast number of whole or more or less fragmented dead coral heads which have been torn from the outer edge of the reef and widely scattered by hurricane, and which may be referred to as "hurricane blocks". Echinodermata are represented in this zone by members of the classes Echinoidea, Ophiuroidea, and Crinoidea. Numerous crabs and shrimps represent the class Crustacea. The many loose coral heads furnish shelter to a profusion of marine animals.

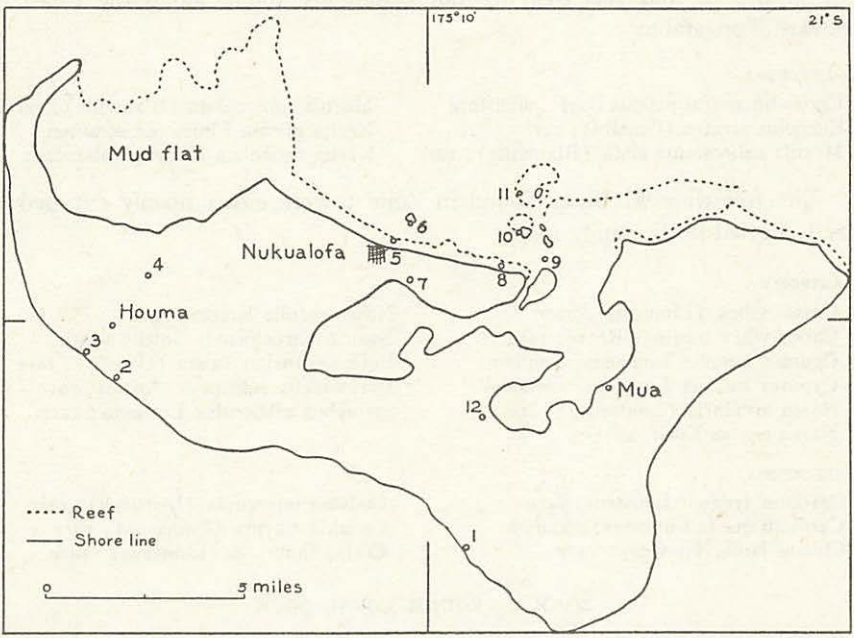

FIGURE 1.—Map of Tongatabu showing stations at which living and fossil mollusks were collected: 1, Hufagalupe; 2, Haakama sea cliff; 3, Houma sea cliff; 4, Holoipepe Quarry; 5, Nukualofa fringing reef; 6, Monu Reef; 7, Nukualofa Quarry; 8, fringing reef east of Nukualofa; 9, Nukunuku shore bar; 10, Pagaimotu; 11, Makahaa Reef; 12, Mua Road Quarry.

DISTRIBUTION AND ECOLOGY

Owing to the marked contrasts which the reef zones present to one another and the corresponding differences in their faunal distribution, an exceptional opportunity is offered for studying the particular habitats and ecology of the Mollusca. All collections and observations were made by day. Collection trips averaging about three hours during low tide were made almost daily during July.

The following list of Mollusca inhabiting the fringing reef includes living specimens only. The shells of dead animals found in some of the zones are not included in the list as they do not furnish reliable evidence on habitat. Nor have any specimens brought in by native people or others been considered.

Reef at Nukualofa (Station 5)

Zone 1. Shore Zone

Along a portion of the shore, west of the pier that leads to the wharf at Nukualofa, are heaps of imported basaltic rocks, on which grow the following species of mollusks that are not commonly found along the shore of leeward Tongatabu.

Gastropoda

Cerithium morus patiens Bayle; abundant
Euchelus atratus (Gmelin); rare
Morula ochrostoma elata (Blainville); rare
Morula tuberculata (Blainville); rare
Nerita plicata Linnaeus; common
Nerita reticulata Karsten; abundant

The following Mollusca found in Zone 1 were either openly exposed or partly buried in the sandy mud.

Gastropoda

Cassis vibex (Linnaeus); rare
Cassis vibex torquata Reeve; rare
Cypraea annulus Linnaeus; common
Cypraea moneta Linnaeus; common
Nassa arcularia (Linnaeus); rare
Nassa crassa Koch; rare
Nassa monile Kiener; rare
Natica marochiensis Gmelin; rare
Polinices melanostoma (Gmelin); rare
Pyramidella sulcata A. Adams; rare
Strombus gibberulus Linnaeus; rare

Pelecypoda

Cardium fragum Linnaeus; rare
Cardium uneda Linnaeus; common
Chione lamarckii Gray; rare
Codakia interrupta (Lamarck); rare
Codakia tigrina (Linnaeus); rare
Corbis fimbriata (Linnaeus); rare

Zone 2. Rough Coral Rock

The Mollusca found in this zone, openly exposed on the jagged coral rocks, are as follows.

Gastropoda

Cerithium piperitum Sowerby; rare
Conus catus Hwass; rare
Conus ebraeus Linnaeus; abundant
Conus ebraeus vermiculatus Hwass; rare
Conus eburneus Hwass; rare
Conus flavidus Lamarck; rare
Conus lividus Hwass; common
Conus miles Linnaeus; rare
Conus miliaris Hwass; rare
Conus miliaris aristophanes Duclos; common
Conus rattus Hwass; common
Conus vitulinus Hwass; rare
Coralliophila galea deformis (Lamarck); rare
Coralliophila neritoidea (Lamarck); rare
Cymatium chlorostomum (Lamarck); rare
Cymatium tuberosum (Lamarck); rare
Cypraea annulus Linnaeus; rare
Cypraea carneola Linnaeus; rare
Cypraea moneta Linnaeus; rare
Cypraea vitellus Linnaeus; rare
Drupa ricinus (Linnaeus); rare
Mitra chrysalis Reeve; common
Mitra litterata Lamarck; rare
Morula morus striatus (Pease); rare
Morula ochrostoma (Blainville); rare
Morula undata (Chemnitz); rare
Nerita albicilla Linnaeus; rare
Strombus floridus Lamarck; rare

Pelecypoda

Arca antiquata Linnaeus; rare
Chlamys pallium (Linnaeus); rare

ZONE 3. SHALLOW WATER

Because of the profuse growth of the sharp and jagged *Acropora* of the madreporarian corals, no attempt was made at collecting in this zone.

ZONE 4. LEVEL CORAL ROCK

Nearly all the Mollusca collected in zone 4 were concealed under hurricane blocks, to whose underside they were clinging, or lodged in shallow depressions of the reef floor that were covered by hurricane blocks. These blocks were turned over in order to secure the specimens.

The only species in this zone that were found conspicuously displayed in the open, as well as under the coral blocks, were *Cypraea moneta* and *Cypraea annulus*. Because marine Mollusca in general are nocturnal in habit, it is natural to assume that during the night they may be found scattered over the reef floor, away from their daylight place of concealment.

The Mollusca of the fringing reef are best represented in this zone. They include the following species.

GASTROPODA

Astragalus petrosum (Martyn); rare
Bursa granifera (Lamarck); rare
Cantharus fumosus (Dillwyn); rare
Cantharus undosus (Linnaeus); abundant
Columbella versicolor Sowerby; rare
Cypraea annulus Linnaeus; abundant
Cypraea arabica Linnaeus; rare
Cypreae caput-serpentis Linnaeus; common
Cypraea caurica Linnaeus; rare
Cypraea erosa Linnaeus; common
Cypraea errones Linnaeus; common
Cypraea interrupta Gray; common
Cypraea isabella Linnaeus; rare
Cypraea lynx Linnaeus; common
Cypraea moneta Linnaeus; abundant
Cypraea neglecta Sowerby; rare
Cypraea tigris Linnaeus; rare
Drupa digitata (Lamarck); rare
Drupa horrida (Lamarck); rare
Drupa ricinus (Linnaeus); rare
Engina reevei Tryon; rare
Euchelus atratus (Gmelin); rare
Fasciolaria filamentosa Lamarck; rare
Haliotis ovina Chemnitz; rare
Haliotis stomatiformis Reeve; common
Iopas sertum Bruguière; rare
Latirus craticulatus (Linnaeus); common
Latirus polygonus (Gmelin); rare
Leucozonia smaragdula (Linnaeus); rare
Mitra cucumerina Lamarck; rare
Morula fiscellum (Chemnitz); rare
Morula morus aspera (Linnaeus); rare
Morula ochrostoma elata (Blainville); common
Morula ochrostoma spectrum (Reeve); common
Morula tuberculata (Blainville); common
Nerita plicata Linnaeus; rare
Peristernia spinosa (Martyn); rare
Peristernia subincarnata Garrett; rare
Pisania ignea (Gmelin); rare
Trochus calcaratus Souverbie; rare
Trochus tubiferus Kiener; rare
Turbo chrysostomus Linnaeus; common

PELECYPODA

Arca fusca Bruguière; rare
Arca maculata Reeve; rare
Cardita variegata Bruguière; rare
Chlamys pallium (Linnaeus); rare
Chlamys squamosus (Gmelin); rare

Reef East of Nukualofa (Station 8)

About 3 miles east of Nukualofa and near the lagoon entrance, the fringing reef is only about 500 feet wide as compared with nearly 1,000 feet at Nukualofa. Here also the reef shows some departure from its typical condition. The third faunal zone is wanting, the fourth zone is proportionately narrower than the first, and the second has only a few hurricane blocks.

Although the molluscan distribution at Station 8 corresponds to that of the typical reef at Nukualofa (Station 5), two species found here were not seen on other parts of the reef. These are: *Columbella versicolor* Sowerby, abundant on rocks of second zone; *Lima fragilis* Chemnitz common in sandy mud of second zone.

Nukunuku Sand Bar (Station 9)

About 3.5 miles east of Nukualofa at the lagoon entrance is the island of Nukunuku, about 1 mile long and 0.5 mile wide. It might well be considered a part of Tongatabu, because it is separated from it by only a narrow depression of a few hundred feet in width, most of it above water at low tide. Furthermore, the outer shore of Nukunuku conforms almost to the general shore line of Tongatabu. But the shore is not bounded by a coral reef as elsewhere; a sandy flat, submerged at high tide and running seaward about 0.25 mile, takes its place. Along the outer edge of this sand bar, the part continuously under water, are strewn a number of large limestone boulders; the rest forms a uniform, featureless sand bar, poor in marine life.

Openly exposed on the sand bar near shore were found two gastropods: *Cypraea annulus* Linnaeus, not common; *Cypraea moneta* Linnaeus, not common.

In the outer zone the following species were found either openly exposed on the boulders or concealed under them.

Gastropoda

Cypraea carneola Linnaeus; common
Cypraea caurica Linnaeus; rare
Cypraea clandestina Linnaeus; rare
Cypraea erosa Linnaeus; common
Cypraea errones Linnaeus; abundant
Cypraea helvola Linnaeus; rare
Cypraea lynx Linnaeus; not common
Cypraea staphylaea interstincta Wood; rare
Cypraea vitellus Linnaeus; common

It is remarkable that no mollusks other than Cypraea were found during two visits to this locality. *Cypraea vitellus* collected are noteworthy for their much greater size than those found on the fringing reef at Nukualofa. *Cypraea errones,* also, is a little larger and of a distinctly lighter color. *Cypraea erosa* shows much greater range in size than on the fringing reef at Nukualofa.

These differences can not be considered varietal or racial, but purely ecological, and subject to a certain range of fluctuation controlled by that

particular environment in which the mollusk lives. That such acquired characters are wholly free from being hereditary is not a safe conjecture to make; but it appears that they break down if the young, during their larval stage, are carried by the ocean currents into a different environment, there to remain to maturity. Collections made along the shores of Oahu, Hawaii, of large series of the common *Cypraea caput-serpentis* from 10 different localities with more or less obviously different conditions, show one or more distinctive characters in each series.

Leeward Reefs and Islands

Monu reef (station 6)

The outer edge of the fringing reef of Tongatabu drops abruptly into about 10 fathoms of water, and a shallow sea 6 to 50 fathoms deep extends about 30 miles to the north, with its eastern and western flanks falling off rather abruptly to a depth of 300 to 400 fathoms. In this shallow sea are scattered a number of small, low islands and coral reefs. The reefs are partly above water at low tide and quite accessible.

Closest to Tongatabu is Monu reef, distant about half a mile from shore. It is about 0.5 mile in diameter and partly laid bare at low tide. In general it supports a rich growth of madreporarian corals and is dissected by numerous narrow, shallow channels through which a small row boat can pass. One visit to the reef resulted in the following collections.

Gastropoda

Cymatium pileare (Linnaeus); rare
Fasciolaria filamentosa Lamarck; rare
Haliotis ovina Chemnitz; common
Nerita albicilla Linnaeus; abundant
Trochus obeliscus Gmelin; common

Pelecypoda

Arca fusca Bruguière; abundant
Tridacna gigas Lamarck; common

Island and reef of Makahaa (station 11)

About 1.75 miles north of Nukunuku is the isle of Makahaa, less than a fifth of a mile long and half as wide, and almost entirely surrounded by a fringing reef ranging from 0.25 to 0.5 mile in width.

Faunal zones at Makahaa agree to a great extent with those at Nukualofa, but a number of different species not seen on the fringing reef of Tongatabu were found. The greater part of the reef next to the island is submerged at low tide in 1 to 3 feet of water. Most of the outer area is above water and, like the typical fringing reef, is heavily littered with hurricane blocks. During two visits made to Makahaa reef during low tides, the following mollusks were collected by members of the expedition. The numbers in parenthesis indicate the number of specimens found.

GASTROPODA

Bursa granifera (Lamarck) (2)
Cerithium nodulosum Bruguière (1)
Conus ebraeus Linnaeus (3)
Conus ebraeus vermiculatus Hwass (1)
Conus flavidus Lamarck (1)
Conus imperialis Linnaeus (1)
Conus miliaris Hwass (4)
Conus miliaris aristophanes Duclos (1)
Conus sumatrensis Hwass (1)
Cymatium pileare (Linnaeus) (1)
Cypraea annulus Linnaeus (3)
Cypraea caput-serpentis Linnaeus (1)
Cypraea erosa Linnaeus (1)
Cypraea errones Linnaeus (1)
Cypraea isabella Linnaeus (1)
Cypraea tigris Linnaeus (3)
Cypraea vitellus Linnaeus (1)
Drupa ricinus Linnaeus (2)
Latirus polygonus (Gmelin) (1)
Leucozonia smaragdula (Linnaeus) (4)
Mitra episcopalis Linnaeus (1)
Murex adustus Lamarck (2)
Murex ramosus Linnaeus (1)
Ovula ovum (Linnaeus) (2)
Pterocera lambis (Linnaeus) (2)
Strombus floridus Lamarck (2)
Thais pica (Blainville) (1)
Trochus obeliscus Gmelin (2)
Turbo argyrostomus Linnaeus (2)

PELECYPODA

Arca antiquata Linnaeus (2)
Arca fusca Bruguière (2)
Chlamys pallium (Linnaeus) (5)
Chlamys squamosus (Gmelin) (4)
Pinctado cumingii (Reeve) (2)
Pteria castanea (Reeve) (1)
Tridacna gigas Lamarck (1)

Owing to the brief collecting time that the tide permitted at Makahaa, no record was kept of the particular habitat in which each species was found. But as far as my observations went, the species found here, which also occurred on the Nukualofa reef, had quite similar habitats, particularly with reference to sandy or rocky bottom. The following species were found on or under hurricane blocks in the outer reef zone.

GASTROPODA

Cypraea caput-serpentis Linnaeus
Cypraea erosa Linnaeus
Cypraea errones Linnaeus
Cypraea tigris Linnaeus
Ovula ovum (Linnaeus)
Thais pica (Blainville)
Leucozonia smaragdula (Linnaeus)
Trochus obeliscus Gmelin
Turbo argyrostomus Linnaeus

PELECYPODA

Arca antiquata Linnaeus
Arca fusca Bruguière

In shallow water with sandy bottom near the shore of Makahaa three gastropods were found: *Mitra episcopalis* Linnaeus; *Pterocera lambis* (Linnaeus); *Cypraea annulus* Linnaeus.

In view of the fact that reef conditions at Makahaa appear to be like those on the Tongatabu shores where these species are so abundant, it is remarkable that *Cypraea moneta* was not found here, and that only three specimens of *Cypraea annulus* were seen.

PAGAIMOTU (STATION 10)

About half way between the islands of Makahaa and Nukunuku is the island of Pagaimotu, about one third of a mile long and one fourth of a mile

wide. In low tide one can wade between it and Nukunuku, a shore bar of a compact calcareous mud connecting the two islands.

On a visit to the island a brief survey was taken of its western shore. This shore consists chiefly of a sandy mud densely covered by a grasslike alga which in low tide is submerged by 1 to 2 feet of water. It seems strangely devoid of marine animals. Even *Cypraea moneta* and *C. annulus* are absent, notwithstanding conditions that seem favorable to these common shoal-water species.

On the shore of the island three dead shells were found: *Tonna olearium* (Bruguière); *Terebra cerithina* Lamarck; *Cardium lyratum* Sowerby.

Windward Tongatabu

The windward or southern shore of the island of Tongatabu is a vertical sea cliff that rises 30 to 100 feet above mean tide. At the foot of this cliff is a wave bench which is laid bare at low tide and against which the in-rolling waves break with terrific force, producing numerous "blow holes". During high tide the sea sweeps freely over the wave bench and against the sea cliff, which is considerably undercut. The exposed southern shore of Tongatabu thus present a strong contrast to that of the northern or leeward with its placid waters, protecting reefs, and sheltering islands. The fauna of the southern shore also differs markedly from that of the northern in the absence of species and in the occurrence of many which were not encountered on the northern shores.

Hufagalupe (station 1)

The sea cliffs of windward Tongatabu are almost everywhere precipitous. Only along stream courses can ascent and descent be made with little difficulty. Such erosion has broken down the sea cliff at a point about half-way between the eastern and western extremes of the island, forming an excavation known as Hufagalupe. Here the shore line is accessible from the plateau above and the wave bench, laid bare at low tide, can be reached. This wave bench, 200 to 300 feet wide, drops abruptly into 150 fathoms of water 2 miles off the shore. Landward the bench is hemmed in by a vertical cliff 100 feet high. Like the sea cliff, the bench consists of firmly cemented limestone. On its fairly smooth and level surfarce a few small sand pockets and narrow fissures appear. Its seaward edge is sculptured with chasms and crevices as a result of wave action.

Two visits were made to the wave bench at Hufagalupe, where, with the assistance of other members of the Expedition, I collected in a living state from sandy pockets the following species. Numbers in parenthesis indicate the amounts collected.

GASTROPODA

Conus ceylonensis Hwass (1)
Conus ceylonensis nanus Broderip (80)
Conus ceylonensis sponsalis Chemnitz (17)
Conus miliaris Hwass (90)
Conus miliaris aristophanes Duclos (42)
Imbricaria virgo Swainson (17)
Mitra litterata Lamarck (24)
Mitra zebra Garrett (3)
Vexillum nodosum (Swainson) (12)

The following species of mollusks were found exposed on the wave bench or in fissures. They include both living and dead specimens.

GASTROPODA

Bursa bufonia venustula (Reeve) (2)
Cantharus undosus (Linnaeus) (1)
Conus ebraeus Linnaeus (36)
Conus ebraeus vermiculatus Hwass (3)
Conus flavidus Lamarck (2)
Conus lividus Hwass (1)
Conus rattus Hwass (3)
Cypraea arabica Linnaeus (1)
Cypraea caput-serpentis Linnaeus (1)
Cypraea helvola Linnaeus (2)
Cypraea poraria Linnaeus (4)
Cypraea ventriculus Lamarck (1)
Drupa digitata (Lamarck) (1)
Drupa horrida (Lamarck) (62)
Drupa ricinus (Linnaeus) (80)
Engina mendicaria (Linnaeus) (6)
Leucozonia smaragdula (Linnaeus) (4)
Morula chaidea (Duclos) (4)
Morula morus (Lamarck) (5)
Morula ochrostoma spectrum (Reeve) (3)
Morula tuberculata (Blainville) (40)
Murex tripterus Born (1)
Nerita plicata Linnaeus (1)
Peristernia nassatulla (Lamarck) (1)
Strombus floridus Lamarck (1)
Thais hippocastaneum (Lamarck) (2)
Thais hippocastaneum distinguenda (Dunker) (2)
Thais hippocastaneum intermedia (Kiener) (1)
Thais pica (Blainville) (4)
Trochus incrassatus creniferus Kiener (7)
Turbo argyrostomus Linnaeus (2)
Turbo setosus Gmelin (10)
Vasum ceramicum (Linnaeus) (2)

No pelecypod mollusks were found at Hufagalupe. Some of the gastropods are abundantly represented. The common Indo-Pacific species *Drupa horrida* and *D. ricinus,* which are very common in Hawaii, appear here in greater abundance than in any other locality in Tonga where collections were made. In most of the *Drupa ricinus* collected the base is white; in a few it is regularly marked with orange-yellow blotches; and in a few others the base and aperture are purple. These color variations also appear in Hawaiian forms, but they are rare. Of the *Conus miliaris,* which is abundant in sand pockets, the variety *aristophanes* is less common, occurring with the species in a ratio of about 4 to 9. On the Nukualofa reef the variety is more common.

HOUMA SHORE (STATION 3)

The southern shore of Tongatabu, about 5 miles from the northwestern extremity of the island, is reached by a road passing through the village of Houma. The shore line here is bounded by a limestone sea cliff about 35 feet high, at the base of which is a wave bench 100 to 200 feet wide and exposed at low tide. The sea cliff is deeply undercut and its lower portion is the habitat of rock-climbing mollusks.

The following mollusks were distributed over the even surface of the wave bench. The numbers in parenthesis indicate the number of specimens found.

GASTROPODA

Conus catus Hwass (1)
Conus ceylonensis Hwass (1)
Conus ebraeus Linnaeus (11)
Conus lividus Hwass (6)
Conus miliaris Hwass (1)
Conus miliaris aristophanes Duclos (7)
Morula chaidea (Duclos) (10)
Strombus floridus Lamarck (4)
Thais hippocastaneus bituberculata (Lamarck) (1)
Trochus incrassatus creniferus Kiener (1)
Turbo argyrostomus Linnaeus (1)
Turbo crassus Wood (1)
Turbo setosus Gmelin (1)

PELECYPODA

Modiolus metcalfei Hanley (5 separate valves).

On the sea cliff near its base two species of gastropods were found: *Morula tuberculata* (Blainville) (2); *Nerita plicata* Linnaeus (2).

HAAKAMA (STATION 2)

About 1 mile southeast of Houma is located the village of Haakama. From there the shore line can be reached without great difficulty and descent made down the sea cliff to the wave bench. Shore conditions are similar to those of Houma, but with the sea cliff a few feet higher and more indented. During a visit during low tide, the following gastropods were collected on the wave bench. Numbers in parenthesis indicate the number of specimens found.

GASTROPODA

Conus catus Hwass (3)
Conus ceylonensis nanus Broderip (6)
Conus ceylonensis sponsalis Chemnitz (5)
Conus ebraeus Linnaeus (10)
Conus ebraeus vermiculatus Hwass (4)
Conus flavidus Lamarck (2)
Conus miliaris Hwass (18)
Conus miliaris aristophanes Duclos (4)
Drupa horrida (Lamarck) (1)
Drupa ricinus (Linnaeus) (13)
Engina mendicaria (Linnaeus) (36)
Mitra litterata Lamarck (6)
Morula chaidea (Duclos) (5)
Strombus floridus Lamarck (3)
Turbo setosus Gmelin (6)

On the lower part of the sea cliff two species of gastropods were found: *Morula tuberculata* (Blainville) (7); *Nerita plicata* Linnaeus (10). On the wave bench two other gastropods were found: *Thais hippocastaneum* (Lamarck) (30); *Thais hippocastaneum distinguenda* (Dunker) (11).

ISLAND OF EUA

On the island of Eua, which lies approximately 12 miles southeast of Tongatabu, dead shells were obtained from beach material by H. E. Parks. They are included in the following list.

GASTROPODA

Conus catus Hwass (1)
Conus ebraeus Linnaeus (14)
Conus ebraeus vermiculatus Hwass (1)
Conus flavidus Lamarck (18)
Conus lividus Hwass (1)
Conus miles Linnaeus (1)
Conus tulipa Linnaeus (1)
Cypraea argus Linneaus (2)
Cypraea caput-serpentis Linnaeus (15)
Cypraea carneola Linnaeus (1)
Cypraea isabella Linnaeus (1)
Cypraea lynx Linnaeus (1)
Cypraea talpa Linnaeus (1)
Drupa horrida (Lamarck) (1)
Mitra pontificalis Lamarck (1)
Tonna perdix (Linnaeus) (1)
Turbo crassus Wood (operculum) (1)
Turbo petholatus Linnaeus (1)

PELECYPODA

Arca pusca Bruguière (one valve)
Chama iostoma Conrad (one valve)
Tellina scobinata Linnaeus (1)

GEOLOGY

GENERAL FEATURES

As revealed by marine erosion and by quarry excavations, the island of Tongatabu consists of a sedimentary marine limestone, more or less firmly cemented and in some places highly fossiliferous. A surface soil supporting a rich vegetation is in most places well developed, so that the limestone, where not exposed by erosion, is revealed only in quarries.

The animal groups best represented in a fossil state are the gastropod and pelecypod mollusks and madreporarian corals. Most of the shells of gastropods and pelecypods are in a fair state of preservation with sufficient of their original material to show details of sculpturing; some are represented only by external or internal moulds; a few are unidentifiable.

The geologic features at stations from which fossils listed in table 1 were collected are outlined in the following paragraphs.

At Station 7 a quarry on the outskirts of Nukualofa about 0.75 mile from the shore line is about 20 feet deep and not more than 10 feet above sea level. It was in process of excavation at the time of my visit to Tongatabu. The rock quarried is a firmly united limestone, part of which seemed to be coral reef in places. It is overlaid by several feet of earth and clay. Some madreporian coral heads were visible, and a number of shells of gastropods and pelecypods were obtained from the lower part of the quarry by Dr. J. E. Hoffmeister and me (table 1).

At Station 4 in the western part of Tongatabu, about 8 miles from Nukualofa and less than 3 miles from the *liku,* or windward shore, is the limestone quarry known as Holoipepe, which was being worked at the time of my visit. The rock in its freshly exposed walls is compact except for pockets of rather soft limestone. As in the Nukualofa quarry, fossils are not numerous. Those obtained by Dr. Hoffmeister and me were from the lower level, as the higher parts were not accessible (table 1).

At Station 3 the shore line opposite the village of Houma is bounded by a vertical cliff, which constitutes part of a continuous sea wall that borders windward Tongatabu. This bulwark of the sea, which attains here an elevation of about 35 feet above sea level, consists of extremely hard and jagged limestone, considerably recrystallized on its seaward face. On its upper surface are exposed large heads of madreporarian corals. Here also are found crevices and pockets filled with loosely cemented beach debris containing numerous fossilized Gastropod shells, fragmented and whole. On the seaward face of the cliff, fossils have been destroyed by waves and by recrystallization. Hence all the fossils listed in table 1 are from the 35-foot level. On the two collecting trips to this locality I was assisted by a young Tongan lad named Toa. The great abundance of fossil *Turbo argyrostomus* is worthy of note. The extreme scarcity of living specimens seems to indicate that the species is rare in Tonga at the present day.

At Station 2 about 1 mile southwest of Houma is the village of Haakama, from which a path leads to the sea about a fourth of a mile distant. The sea cliff, reaching about 40 feet above sea level, is here broken by stream erosion, so that large vertical areas of its limestone are exposed. The rock is firmly cemented like that of Houma, but no crevices or pockets containing fossils were found. The shells of few mollusks could be seen imbedded in the hard limestone which walled in the stream bed. On a brief collecting trip to this cliff I was assisted by Professor W. A. Setchell and Dr. J. E. Hoffmeister.

Of the species listed in table 1, *Cypraea caput-serpentis* and *Chlamys pallium* are remarkable for their fine state of preservation, as they are the only Tonga fossils in which the coloration is preserved.

From the sea cliff at Fahefa, a village near Haakama, a fossil *Cypraea carneola* was found by Professor Setchell. From no other localities on windward Tongatabu were fossils collected. At Hufagalupe, where the sea cliff is greatly excavated by stream erosion and large sections of the limestone made accessible, no fossils were seen. There is, however, no obvious reason why some should not be found if continued search were made.

At Station 12, near the lagoon and the road connecting the village of Mua with Nukualofa is a limestone quarry from which Dr. J. E. Hoffmeister obtained the fossil listed in table 1.

Vavau, which lies about 200 miles north of Tongatabu, is second in size of the Tongan islands. It is about 12 miles long. It is deeply indented on its windward side by an inlet from the sea and attains an elevation of about 600 feet.

A day's stay on Vavau in company with Dr. J. E. Hoffmeister permitted an excursion into the interior and the visit to two limestone exposures, one

near Neiafu quarry and another about 3 miles north. The Neiafu quarry, 1 mile from the harbor of Neiafu and about 100 feet above sea level, was being worked at the time of our visit; large quantities of white chalky limestone had been stored near its entrance. From this sparsely fossiliferous rock one gastropod and four pelecypods were collected. (See table 1.)

The small exposure about 3 miles north of Neiafu at the roadside is, perhaps, the result of erosion and quarrying. The limestone here is similar in color and consistency to that at the Neiafu quarry. The only mollusks found were one *Cypraea isabella* Linnaeus and two *Arca fusca* Bruguière.

Table 1. Fossil Mollusks of Tonga

	Station					
Gastropoda	2	3	4	7	12	Vavau
Astralium petrosum virescens Pease				×	×	
Conus catus Bruguière	×					
Conus catus Hwass						
Conus flavidus Lamarck		×				
Conus glans Hwass		×				
Conus miliaris Hwass			×	×		
Conus striatus Linnaeus			×	×		
Cypraea arabica Linnaeus				×		
Cypraea argus Linnaeus		×	×	×		
Cypraea caput-serpentis Linnaeus	×					
Cypraea carneola Linnaeus	×		×	×		
Cypraea helvola Linnaeus			×			×
Cypraea interrupta Gray						×
Cypraea isabella Linnaeus			×	×		×
Cypraea lynx Linnaeus		×		×		
Cypraea mauritiana Linnaeus	×					
Cypraea poraria Linnaeus						×
Cypraea punctulata Gmelin				×		
Haliotis ovina Chemnitz			×			
Iopas sertum Bruguière			×			
Pisania ignea (Gmelin)						×
Trochus incrassatus creniferus Kiener		×				
Trochus obeliscus Gmelin		×				
Trochus tubiferus Kiener	×	×	×			
Turbo argyrostomus Linnaeus	×	×	×	×		
Turbo crassus Wood		×				
Turbo petholatus Linnaeus				×		
Pelecypoda						
Antigona reticulata (Linnaeus)		×	×	×		
Arca divaricata Sowerby			×			
Arca fusca Bruguière			×	×		×
Cardita variegata Bruguière				×		
Cardium maculosum Wood				×		
Cardium orbita Broderip and Sowerby			×		×	
Chlamys pallium (Linnaeus)	×			×		
Codakia tigerina (Linnaeus)				×		
Lima squamosa Lamarck			×	×	×	
Lithophaga corrugata (Philippi)			×	×	×	
Tellina cruciata Spengler					×	
Trapezium oblongum (Linnaeus)			×	×		
Tridacna gigas Lamarck				×		

Of the fossils in the list the following species were not found in the living state in Tonga by the Expedition of 1926, but are reported living in other localities.

Gastropoda

Astralium petrosum virescens Pease: Gilbert Islands (Tarawa Island)—Tryon and Pilsbry.

Conus glans Hwass: Philippines, Australia, New Caledonia, Polynesia—Tryon.

Cypraea mauritiana Linnaeus: Samoa, New Caledonia, Borneo, Ceylon—Tryon; Hawaii —Dranga, Thaanum, Ostergaard; Tonga (Velitoa Island)—Gifford, 1920.

Cypraea punctulata Gmelin: New Caledonia, Loyalty Islands, Australia—Tryon; Hawaii—Dranga, Thaanum, Ostergaard; Tonga (Nukualofa), 2 beach shells—Ostergaard.

Pelecypoda

Antigona reticulata (Linnaeus): Ceylon, Philippines, New Caledonia—Pfeiffer, 1869; Howland Island, Christmas Island, Baker Island (abundant)—Whippoorwill Exped., 1924: Samoa (Opolu), Hawaii (Oahu)—Ostergaard.

Arca divaricata (Sowerby): Indian Ocean (Mauritius, Seychelle Islands) and into Polynesia—Kobelt, 1891.

Cardium maculosum Wood: Tuamotu Islands, Ceylon—Garrett.

Cardium orbita Broderip and Sowerby: Baker Island—Whippoorwill Exped., 1924; Marquesas Islands—Delmas, 1922; Hawaii—Thaanum, Ostergaard; Tonga—W. C. McKern, 1921.

Lima squamosa Lamarck: Samoa—Garrett.

Lithophaga corrugata Philippi: Fiji—Garrett.

Trapezium oblongum (Linnaeus): Fanning Island—Whippoorwill Exped., 1924; Hawaii —Thaanum.

SYSTEMATIC TREATMENT

Gastropoda

Astralium petrosum (Martyn).

Astralium petrosum (Martyn): Tryon and Pilsbry, Man. Conch., vol. 10, p. 234, pl. 64, figs. 65, 66, 1888.

Trochus petrosum Martyn: Martini and Chemnitz; Conch.-Cab., *Turbo, Trochus,* etc., R. A. Philippi, p. 312, pl. 44, fig. 17, 1846.

Tongatabu, Nukualofa, outer zone of fringing reef, 4 shells with typical spinous development.

Astralium petrosum virescens Pease.

Astralium petrosum virescens Pease: Tryon and Pilsbry, Man. Conch., vol. 10, p. 235, pl. 49, fig. 50, 1888.

Nukualofa quarry, 4 fossils, Hoffmeister; Mua Road quarry, Hoffmeister.

Tryon and Pilsbry refer to varieties of *A. petrosum* in which the revolving rows of spines are reduced to fine knobs. These fossils agree most closely with a similar variety described by Pease from Tarawa Island, Gilbert Islands.

Bulla australis oblonga A. Adams.

Bulla australis Quoy and Gaimard: Tryon and Pilsbry, Man. Conch., vol. 15, p. 346, pl. 35, figs. 12-14, 1893.

Three miles east of Nukualofa, on reef, 8 dead shells.

The forms figured and described by Tryon and Pilsbry are more constricted at the posterior end than are specimens from Tonga or Fiji.

Bursa bufonia venustula (Reeve).

Ranella venustula Reeve, Conch Icon., vol. 2, sp. 37, 1844.
Ranella bufonia variety *venustula* Reeve: Tryon, Man. Conch., vol. 3, p. 39, pl. 20, fig. 13, 1881.
Windward Tongatabu, wave bench, 2 well-preserved hermit crab specimens.

A variety easily recognized by its unique characters.

Bursa granifera (Lamarck).

Ranella granifera Lamarck, Animaux s. Vert., 2d ed., vol. 9, p. 548, 1843.
Ranella granifera Lamarck: Tryon, Man. Conch., vol. 3, p. 41, pl. 22, figs. 35-37, 1881.
Ranella granifera Lamarck: Kiener, Icon. des Coquille Vivantes, Rocher, *Triton*, Ranelle, p. 16, pl. 11, fig. 1.
Nukualofa, outer zone of fringing reef, under hurricane blocks, 10 specimens.

This species offers little difficulty of identification, as it appears to be fairly constant in its sculpturing, though it may vary somewhat in form. These shells are much under average size, as are two others found at Makahaa. Similar small forms were found living near Suva, Fiji. The Hawaiian form attains a much greater size.

Bursa gyrina (Linnaeus).

Murex gyrinus Linnaeus: Syst. Nat., 10th ed., p. 748, 1758.
Ranella gyrina (Linnaeus): Tryon, Man. Conch., vol. 3, p. 43, pl. 23, fig. 48, 1881.
Ranella gyrinus Deshayes: Reeve, Conch. Icon., vol. 2, sp. 49, 1844.
Nukualofa, reef, 1 dead shell; 3 miles east of Nukualofa, 1 semifossil shell.

A well-defined species. The description of Linnaeus, although too brief, should be accepted by reason of priority.

Cantharus fumosus Dillwyn.

Cantharus fumosus Dillwyn: Tryon, Man. Conch., vol. 3, p. 155, pl. 73, figs. 247-255, 1881.
Nukualofa, outer zone of fringing reef, under hurricane blocks, 13; 2 miles east of Nukualofa, similar habitats, 2.

A specimen found at Suva, Fiji, is of larger size than Tongan forms. Tryon recognizes many forms of this species.

Cantharus undosus (Linnaeus).

Buccinum undosum Linnaeus: Syst. Nat., 10th ed., p. 740, 1758.
Buccinum undosum Linnaeus: Reeve, Conch. Icon., vol. 3, sp. 55, 1846.
Cantharus undosus (Linnaeus): Tryon, Man. Conch., vol. 3, p. 162, pl. 74, figs. 280-282, 1881.
Nukualofa, outer zone of fringing reef, in great numbers under hurricane blocks; Makahaa, reef, similar habitat, 2; windward Tongatabu, Hufagalupe, wave bench, 2. One specimen was found on the reef at Apia, Samoa.

This species is very distinct and appears to be constant in form and coloration.

Cassis vibex (Linnaeus).

Buccinum vibex Linnaeus: Syst. Nat., 10th ed., p. 737, 1758.
Buccinum erinaceus Linnaeus: Syst. Nat., 10th ed., p. 736, 1758.
Cassis vibex erinacea (Linnaeus): Tryon, Man. Conch., vol. 7, p. 277, pl. 7, fig. 90, 1885.
Cassis vibex (Linnaeus): Reeve, Conch. Icon., vol. 5, sp. 15, figs. 15, *a-d*, 1848.
Tongatabu, Nukualofa, inner zone of fringing reef, in sandy mud, 1 juvenile.

Linnaeus' description of *C. erinacea,* as Reeve points out, clearly includes the tuberculate forms of *C. torquata* and *C. vibex, C. torquata* having been confounded with *C. vibex* until Reeve found it distinct and described it. It is therefore necessary to suppress *C. erinacea* as a species and as a variety.

Cassis vibex torquata Reeve.

Cassis torquata Reeve: Conch. Icon., vol. 5, sp. 1, figs. 1, *a-c*, 1848.
Cassis torquata Reeve: Tryon, Man. Conch., vol. 7, p. 278, pl. 7, figs. 92, 93, 1885.
Nukualofa, inner reef, in sandy mud, 1 specimen.

Tryon remarks: "This is perhaps only an extreme variety of *C. vibex*; like that species it has a spinose-shouldered variety." As Tryon had anticipated, specimens have been found (Bernice P. Bishop Museum: Tumon Bay, Guam, collected by H. G. Hornbostle) which show a combination of characters of *C. vibex* and *C. torquata,* therefore reducing *C. torquata* to varietal rank. The two forms from the same locality, collected by Hornbostle, are also distinct. In Hawaii they are distinct in form, size, and coloration, so in the absence of exotic specimens there need be no hesitation in treating them as distinct species.

The intergradation in Guam may be explained in one of two ways: first, by an intercrossing of *C. vibex* with *C. torquata* as closely related but distinct species, producing a combination of characters; second, by considering Guam or neighboring regions as a center of divergence of a common ancestor which gave rise to forms that may be considered distinct species. If Guam was a center of divergence, the presence of well-defined forms of both species in the same locality can be accounted for by a later migration from other regions after the two species were formed.

Cerithium morus Lamarck.

Cerithium morus Lamarck: Animaux s. Vert., 2d ed., vol. 9, p. 302, 1843.
Cerithium morus Lamarck: Tryon, Man. Conch., vol. 9, p. 133, pl. 24, figs. 29-33, 35-37, 39, 41, 43, 45, 47; pl. 25, figs. 55, 57, 58, 65, 66, 1887.
Nukualofa, on basaltic boulders in front of the queen's palace, at high water mark, *Cerithium morus patiens* Bayle in large numbers; Nukualofa, inner reef zone, 2 dead finely granulated specimens of *C. morus.*

The species varies greatly in size, form, and coloration.

Cerithium nodulosum Bruguière.

Cerithium nodulosum Bruguière: Tryon, Man. Conch., vol. 9, p. 122, pl. 19, figs. 13, 14; pl. 20, fig. 15, 1887.
Cerithium nodulosum Bruguière: Martini and Chemnitz, Conch.-Cab., *Cerithium*, Kobelt, p. 76, pl. 15, fig. 1, 1898.
Off Tongatabu, reef of Makahaa, on rocky bottom, 1 specimen.

This large nodose species approaches *C. erythraeonense* Lamarck, but appears to be distinct from it.

Cerithium piperitum Sowerby.

Cerithium piperitum Sowerby: Tryon and Pilsbry, Man. Conch., vol. 9, p. 144, pl. 27, figs. 31, 32, 1887.
Cerithium piperitum Sowerby: Reeve, Conch. Icon., vol. 15, sp. 81, 1865.
Nukualofa, fringing reef, 2d zone, 1 shell.

Apparently distinct in form and peculiarity of markings.

Clava aspera (Linnaeus).

Murex asper Linnaeus, Syst. Nat., 10th ed., p. 756, 1758.
Cerithium asperum (Linnaeus): Tryon, Man. Conch., vol. 9, p. 148, pl. 28, figs. 62, 63, 1887.
Nukualofa, fringing reef, 1st zone, 3 dead shells.

This species is peculiar for its sculpturing. The brown spiral lines are sometimes absent.

Clava obeliscus (Bruguière).

Cerithium obeliscus Bruguière: Tryon, Man. Conch., vol. 9, p. 146, pl. 27, figs. 39, 40, 1887.
Cerithium sinense (Gmelin): Martini and Chemnitz, Conch.-Cab., *Cerithium*, Kobelt, p. 20, pl. 4, figs. 2-8, 1898.
Off Tongatabu, Pagaimotu Island, beach of sandy mud, 1 dead shell.

Colubraria distorta (Schubert and Wagner).

Triton distortus Schubert and Wagner: Tryon, Man. Conch., vol. 3, p. 26, pl. 14, figs. 125, 126, 1881.
Nukualofa, fringing reef, 1 dead, broken shell.

This species is unique on account of its curved spire.

Columbella versicolor Sowerby.

Columbella versicolor Sowerby: Tryon, Man. Conch., vol. 5, p. 110, pl. 45, figs. 84-96, 1883.
Columbella versicolor Sowerby: Martini and Chemnitz, Conch.-Cab., Columbelliden, Kobelt, p. 23, pl. 3, figs. 10-20, 1897.
Nukualofa, fringing reef, outer zone, under hurricane blocks, about 25 shells; 3 miles east of Nukualofa, in rocky places near shore, 25 shells.

Tryon's description is too brief for definite determination, but Martini and Chemnitz give a full description of the species which agrees in minute details with specimens at hand.

Conus capitaneus Linnaeus.

Conus capitaneus Linnaeus: Syst. Nat., 10th ed., p. 713, 1758.
Conus capitaneus Linnaeus: Tryon, Man. Conch., vol. 6, p. 40, pl. 12, figs. 21-24, 1884.
Conus capitaneus Linnaeus: Reeve, Conch. Icon., vol. 1, sp. 54, 1843.
Nukualofa, 2nd zone of fringing reef, 1 dead shell.

This species has considerable variation in form and coloring.

Conus catus Hwass.

Conus catus Hwass: Tryon, Man. Conch., vol. 6, p. 63, pl. 20, figs. 6-9, 1884.
Conus catus Hwass: Reeve, Conch. Icon., vol. 1, sp. 79, figs. 79, *a, b,* 1843.
Windward Tongatabu, wave bench at Haakama, openly exposed, 4; Nukualofa, 2d zone of fringing reef, on rock, 1; near Tongatabu, Eua, 1 beach shell, Parks; Haakama, sea cliff, 1 fossil.

Characterized by deeply incised spiral striations.

Conus ceylonensis Hwass.

Conus ceylonensis Hwass: Tryon, Man. Conch., vol. 6, p. 23, pl. 6, fig. 95, 1884.
Conus ceylonensis Hwass: Enc. Meth., vol. 1, pt. 2, p. 636.
Windward Tongatabu, Hufagalupe, wave bench, in sand pocket, 1; found with *C. ceylonensis nanus* Broderip and *C. miliaris* Hwass; windward Tongatabu, Houma, on wave bench, 1.

This form is found on Oahu, Hawaii, where it appears to intergrade with the variety *nanus*.

Conus ceylonensis nanus Broderip.

Conus ceylonensis nanus Broderip: Tryon, Man. Conch., vol. 6, p. 24, pl. 6, fig. 100, 1884.
Conus nanus Broderip: Reeve, Conch. Icon., vol. 1, sp. 150, 1843.
Windward Tongatabu, Hufagalupe, in sand pockets of wave bench, abundant; Haakama, wave bench, openly exposed, several shells.

As I found this form to intergrade with *C. ceylonensis* Hwass at Waialua, Oahu, I do not hesitate to consider it a variety instead of a distinct species.

Conus ceylonensis sponsalis Chemnitz.

Conus sponsalis Chemnitz: Martini and Chemnitz, Conch.-Cab., Conidae, Küster and Weinkauff, p. 86, pl. 14, figs. 7, 8, 1875.
Conus ceylonensis sponsalis Chemnitz: Tryon, Man. Conch., vol. 6, p. 23, pl. 6, fig. 99, 1884.
Conus sponsalis Chemnitz: Reeve, Conch. Icon., vol. 1, sp. 109, 1843.
Hufagalupe, wave bench, in sand pockets, abundant; Haakama, wave bench, openly exposed, several specimens.

I believe that this shell intergrades with *C. ceylonensis* Hwass and should therefore be termed a variety of that species, as Tryon places it.

Conus ebraeus Linnaeus.

Conus ebraeus Linnaeus: Syst. Nat., 10th ed., p. 715, 1758.
Conus hebraeus Linnaeus: Tryon, Man. Conch., vol. 6, p. 20, pl. 5, fig. 75, 1884.
Conus hebraeus Linnaeus: Reeve, Conch. Icon., vol. 1, sp. 104, 1843.

Nukualofa, fringing reef, 2d faunal zone, on exposed rocks, abundant; Hufagalupe, on wave bench, common; Haakama and Houma, on wave benches, several juveniles; 3 miles east of Nukualofa, on rocks at low tide, common; Makahaa, 1 shell; Eua, abundant, Parks.

This common and widely distributed Indo-Pacific species is always distinguishable by its revolving bands of black hieroglyphics on a white ground. It is the most generally distributed species of the genus in southern Tonga; in many places it is the most common species. This is true for Hawaii also, where it is generally larger and where the largest known specimens in the world have been found. The species is not so common on the reef at Suva, Fiji.

An error in spelling appears to have been made at an early date and has been quoted by succeeding authors. An *h* has been placed before the first letter in *ebraeus,* the original name.

Conus ebraeus vermiculatus Hwass.

Conus hebraeus vermiculatus Hwass: Tryon, Man. Conch., vol. 6, p. 20, pl. 5, fig. 77, 1884.

Conus hebraeus vermiculatus Lamarck: Reeve, Conch. Icon., vol. 1, sp. 104, fig. 104 *a*, 1843.

Nukualofa, 2d reef zone, openly exposed, 8 shells; windward Tongatabu, Haakama, on wave bench, exposed, 4; Hufagalupe, on wave bench, 3; leeward Tongatabu, Makahaa, on reef, 1; Eua, 1, Parks.

This is a well-marked variety of smaller size than the species. It is found in the same habitats as the species but is comparatively rare. Owing to the constancy of its peculiar markings this form may be considered a distinct species.

Conus eburneus Hwass.

Conus eburneus Hwass: Tryon, Man. Conch., vol. 6, p. 11, pl. 2, figs. 24, 25, 1884.

Conus eburneus Hwass: Reeve, Conch. Icon., vol. 1, sp. 106, figs. 106, *a*, *b*, 1843.

Nukualofa, 2d zone, fringing reef, exposed on rocks, 3 shells.

This species approaches *C. literatus* Linnaeus, but is much smaller, proportionately broader at the base, and has smaller spots. Its thin rust-brown epidermis is similar to that of *C. pulicarius* Hwass.

Conus flavidus Lamarck.

Conus flavidus Lamarck: Animaux s. Vert., 2d ed., vol. 11, p. 45, 1845.

Conus flavidus Lamarck: Tryon, Man. Conch., vol. 6, p. 44, pl. 13, figs. 48-50, 1884.

Conus flavidus Lamarck: Reeve, Conch. Icon., vol. 1, sp. 207, 1843.

Nukualofa, fringing reef, 2d zone, 2 shells; Makahaa, on reef, 1 specimen of long, slender form with weak lirations; Hufagalupe and Haakama, on wave benches, 2 juveniles; Eua, many beach shells, Parks; Houma, 35 feet above sea, in cliff, 1 fossil.

A common and widely distributed Indo-Pacific species usually found with *C. lividus* Hwass, to which it appears to be closely related but from which it can usually be separated by its smooth spire.

Conus glans Hwass.

Conus glans Hwass: Tryon, Man. Conch., vol. 6, p. 79, pl. 25, figs. 26-28, 1884.
Conus glans Hwass: Reeve, Conch. Icon., vol. 1, sp. 145, 1843.
Houma, sea cliff, 1 fossil.

Easily distinguished by its peculiar form and strong lirations.

Conus imperialis Linnaeus.

Conus imperialis Linnaeus: Syst. Nat., 10th ed., p. 712, 1758.
Conus imperialis Linnaeus: Tryon, Man. Conch., vol. 6, p. 9, pl. 1, figs. 11-13, 1884.
Conus imperialis Linnaeus: Reeve, Conch. Icon., vol. 1, sp. 60, 1843.
Leeward Tongatabu, Makahaa, reef, 1 shell.

A common, uniquely marked Indo-Pacific species.

Conus lividus Hwass.

Conus lividus Hwass: Tryon, Man. Conch., vol. 6, p. 45, pl. 13, figs. 54-57, 1884.
Conus lividus Hwass: Reeve, Conch. Icon., vol. 1, sp. 211, 1843.
Windward Tongatabu, Houma, wave bench, 6 (4 juveniles); Hufagalupe, on wave bench, 1 juvenile; Nukualofa, 2d zone of fringing reef, on rocks, 1 adult; Eua, 1 beach specimen, Parks.

Investigations in Tonga and Oahu have disclosed the peculiar fact that young specimens of *C. lividus, C. flavidus,* and *C. ebraeus* constitute the greater number of individuals found on reefs and wave benches bordering deep water, while in sheltered reefs and bays nearly all those seen are almost or fully adult. This may be explained from the fact that these animals seek the protected waters for spawning grounds, as has been observed on Waikiki reef, Honolulu, Hawaii.

This common Indo-Pacific species is usually found with *C. flavidus* Lamarck, to which it appears to be closely related. Typically it differs from *C. flavidus* by its coronated whorls, more slender form, its greenish-brown color, and thinner epidermis. Shells collected at Suva, Fiji, have nearly smooth whorls and a coloration nearer that of *C. flavidus,* but the characteristic thin epidermis of their species.

Conus miles Linnaeus.

Conus miles Linnaeus: Syst. Nat., 10th ed., p. 713, 1758.
Conus miles Linnaeus: Tryon, Man. Conch., vol. 6, p. 40, pl. 11, fig. 16; pl. 27, fig. 11, 1884.
Conus miles Linnaeus: Reeve, Conch. Icon., vol. 1, sp. 9, 1843.
Nukualofa, 2d zone of fringing reef, openly exposed on rocks, 2 nearly adult shells; Eua, 1 beach specimen, Parks.

A common and widely distributed Indo-Pacific species, easily distinguished by its peculiar markings.

Conus miliaris Hwass.

Conus miliaris Hwass: Tryon, Man. Conch., vol. 6, p. 21, pl. 5, figs. 84-90, 1884.
Conus miliaris Hwass: Reeve, Conch. Icon., vol. 1, sp. 198, 1843.

Hufagalupe, wave bench, buried in sand pockets, abundant; Haakama, wave bench, openly exposed, common; Nukualofa, 2d zone of fringing reef, rare, in ratio of about 1 to 4 with *C. miliaris aristophanes*; Makahaa, on reef, 4; Nukualofa quarry, 1 fossil.

This species may be distinguished by its bulbous form, small size, coronated spire, and fine revolving pitted grooves on the body whorl. *C. miliaris aristophanes* Duclos, usually found with it, appears to be a good variety, as it differs from *C. miliaris* Hwass in form and colorations. None of the specimens collected in Tonga show intergradation between the two.

The Hawaiian variety, *C. miliaris abbreviatus* Nuttall, differs from other varieties of *C. miliaris* by the constancy of its revolving brown dots and bluish or pinkish zones. Specimens in the Garrett collection from Fiji show a similarity to *C. miliaris aristophanes*; otherwise I should have considered the variety *C. miliaris abbreviatus* a distinct species.

Conus miliaris aristophanes Duclos.

Conus miliaris aristophanes Duclos: Tryon, Man. Conch., vol. 6, p. 22, pl. 5, fig. 90, 1884.

Hufagalupe, wave bench, in sand pockets, abundant with *C. miliaris:* Houma, wave bench, openly exposed, several shells; Haakama, wave bench, openly exposed, several (mostly juvenile). On leeward Tongatabu, in 3 localities a few miles apart: Nukualofa, 2d zone of fringing reef, common, in ratio of 4 to 1 with *C. miliaris,* majority large and adult; 3 miles east of Nukualofa, reef, 1; Makahaa, reef, 1.

In the specimens collected at Tongatabu *C. miliaris aristophanes* Duclos differs from *C. miliaris* Hwass by having a shorter, heavier shell, bluntly rounded at the anterior end, by being clouded with brown on a pale bluish ground color, by having revolving lines of alternating brown and white dashes instead of delicate brown dots, as in *C. miliaris.*

Conus omaria Hwass.

Conus omaria Hwass: Tryon, Man. Conch., vol. 6, p. 92, pl. 31, figs. 19-28, 1884.

Three miles east of Nukualofa, reef, 1 immature dead shell; Nukualofa, reef, 1 adult dead shell.

Several local varieties are found in Hawaii. The species is remarkable for having no free-swimming stage of its veliger larva, according to laboratory investigations. The Tongan form is more slender and of lighter weight than any Hawaiian varieties observed.

Conus rattus Hwass.

Conus rattus Hwass: Tryon, Man. Conch., vol. 6, p. 41, pl. 12, figs. 25-27, 1884.

Nukualofa, 2d zone of fringing reef, common, nearly half the specimens young and less than half-grown; Hufagalupe, wave bench, openly exposed, 3 juveniles and 1 very large dead shell.

Tongan specimens resemble closely those of Hawaii in form, size, and coloration. Some authors refer to this form as *C. taheitensis* Hwass, but since large series from many localities do not seem to justify even a varietal distinction, *C. taheitensis* Hwass should be treated as a synonym.

Conus striatus Linnaeus.

Conus striatus Linnaeus: Syst. Nat., 10th ed., p. 716, 1758.
Conus striatus Linnaeus: Tryon, Man. Conch., vol. 6, p. 85, pl. 26, fig. 67, 1884.
Conus striatus Linnaeus: Reeve, Conch. Icon., vol. 1, sp. 179, 1843.
Near Nukualofa, fringing reef (?), 1 living shell, collected by Tongan native; Holeipepe quarry, 1 fossil, Hoffmeister.

This widely distributed species is easily recognized by its characteristic form and revolving brown striae.

Conus sumatrensis Hwass.

Conus sumatrensis Hwass: Tryon, Man. Conch., vol. 6, p. 39, pl. 11, figs. 11, 12, 1884.
Conus sumatrensis Hwass: Reeve, Conch. Icon., vol. 1, sp. 12, 1843.
Makahau, reef, 1 living shell, collected by Tongan fisherman.

This common Indo-Pacific species has a number of variations of color. Its characteristic form seems very constant. In Hawaii it rarely attains so large a size.

Conus tulipa Linnaeus.

Conus tulipa Linnaeus: Syst. Nat., 10th ed., p. 717, 1758.
Conus tulipa Linnaeus: Tryon, Man. Conch., vol. 6, p. 87, pl. 28, figs. 80, 81, 1884.
Eua, 1 beach shell, Parks.

This species approaches *C. geographicus* Linnaeus but seems to be fully distinct from it.

Conus vitulinus Hwass.

Conus vitulinus Hwass: Reeve, Conch, Icon., vol. 1, sp. 132, 1843.
Conus vitulinus Hwass: Tryon, Man. Conch., vol. 6, p. 51, pl. 14, figs. 86, 87, 1884.
Nukualofa, 2d zone of fringing reef, openly exposed, 4 specimens (1 dead).

The thick brown epidermis characteristically forms closely set revolving rows of short bristles. The Hawaiian form does not seem to be distinguished from the Tongan. The species is closely related to *C. lineatus* Chemnitz.

Coralliophila galea deformis (Lamarck).

Coralliophila galea deformis (Lamarck): Martini and Chemnitz, Conch.-Cab., *Buccinum, Purpura,* Küster, p. 176, pl. 29, figs. 9, 10, 1858.
Coralliophila deformis (Lamarck): Tryon, Man. Conch., vol. 2, p. 208, pl. 65, fig. 364, 1880.
Nukualofa, outer zone of fringing reef, under hurricane block, 1 shell.

Tryon treats this mollusk as a monstrosity of *C. galea*; Pease regards it as a distinct species; Martini and Chemnitz place it as a variety of *C. galea,* which seems to be the best determination.

Coralliophila neritoidea (Lamarck).

Coralliophila neritoidea (Lamarck): Tryon, Man. Conch., vol. 2, p. 206, pl. 65, fig. 355, 1880.
Nukualofa, 2d zone of fringing reef, 1 specimen.

This is a rather unusual form. Besides being young, its whorls are more rounded and its spire more elevated than in the typical form.

Cymatium chlorostomum (Lamarck).

Triton chlorostomum Lamarck, Animaux s. Vert., 2d ed., vol. 9, p. 636, 1843.
Triton chlorostomus Lamarck: Tryon, Man. Conch., vol. 3, p. 13, pl. 7, figs. 47, 48, 1881.
Triton chlorostomus Lamarck: Reeve, Conch. Icon., vol. 2, sp. 25, 1844.
Nukualofa, 2d zone of fringing reef, openly exposed, 2 specimens.

This species appears to be very constant in form and coloring and quite distinct from all others. It is well figured by Reeve.

Cymatium distortum (Schubert and Wagner).

Triton distortus Schubert and Wagner: Tryon, Man. Conch., vol. 3, p. 26, pl. 14, figs. 125, 126, 1881.
Nukualofa, fringing reef, one broken dead specimen.

This species is unique on account of its curved spire.

Cymatium gemmatum (Reeve).

Triton gemmatus Reeve: Conch. Icon., vol. 2, sp. 60, figs. 60, *a*, *b*, 1844.
Triton gemmatus Reeve: Tryon, Man. Conch., vol. 3, p. 13, pl. 7, figs. 41-44, 1881.
Three miles east of Nukualofa, fringing reef, 1 shell.

This species is apparently closest to *C. rubecula* (Linnaeus) but quite distinct from it.

Cymatium pileare (Linnaeus).

Marex pileare Linnaeus: Syst. Nat., 10th ed., p. 749, 1758.
Triton pilearis (Linnaeus): Tryon, Man. Conch., vol. 3, p. 12, pl. 6, figs. 31-36, 1881.
Triton pilearis (Linnaeus): Reeve, Conch. Icon., vol. 2, sp. 23, 1844.
One mile from Nukualofa, Monu reef, 1 specimen, Makahaa, on reef, 1.

This species is extremely variable in form, size, and coloration and has a very extensive Indo-Pacific distribution. Linnaeus reports it from the Mediterranean, which is a doubtful habitat.

Cymatium tuberosum (Lamarck).

Triton tuberosum Lamarck, Animaux s. Vert., 2d ed., vol. 9, p. 635, 1843.
Triton tuberosus Lamarck: Tryon, Man. Conch., vol. 3, p. 23, pl. 13, figs. 111-113, 1881.
Triton tuberosus Lamarck: Reeve, Conch. Icon., vol. 2, sp. 1, figs. 1, *a*, *b*, 1844.
Nukualofa, 2d zone of fringing reef, openly exposed, 4; about 3 miles east of Nukualofa, near shore, on rocks, 2.

In spite of wide range of color and size, this is a well-defined species.

Cypraea annulus Linnaeus.

Cypraea annulus Linnaeus: Syst. Nat., 10th ed., p. 723, 1758.
Cypraea annulus Linnaeus: Tryon, Man. Conch., vol. 7, p. 178, pl. 11, figs. 57-61; pl. 23, figs. 70-72, 1885.
Cypraea annulus Linnaeus: Reeve, Conch. Icon., vol. 3, sp. 71, 1845.

Nukualofa, fringing reef, 1st, 2d, and 4th faunal zones, common; inner margin of 4th faunal zone, openly exposed and under hurricane blocks, abundant; inner zone, among algae, abundant; Nukunuku, several specimens.

It is rather remarkable that so common a species should be so restricted in its distribution. It is found in great abundance on the shore bar near Suva, Fiji. It has a general Indo-Pacific distribution but is not known in Hawaii, either living or fossil. It is closely related to *C. moneta* Linnaeus and also to *C. obvelata* Lamarck, with which it appears to be intergrading in southeastern Polynesia.

Cypraea arabica Linnaeus.

Cypraea arabica Linnaeus: Syst. Nat., 10th ed., p. 718, 1758.
Cypraea arabica Linnaeus: Tryon, Man. Conch., vol. 7, p. 174, pl. 8, figs. 18, 19, 1885.
Cypraea arabica Linnaeus: Reeve, Conch. Icon., vol. 3, sp. 2, 1845.

One mile west of Nukualofa, outer edge of fringing reef, under hurricane blocks, 2; Nukualofa, 4th zone of fringing reef, under hurricane blocks, 1 living and 1 dead; Nukualofa quarry, 1 fossil.

This common and well-known Indo-Pacific species has several well-marked varieties, among which are *C. eglantina* Duclos, and *C. niger* Roberts. Closely related species are *C. reticulata* Martyn and *C. histrio* Meusch. It is rare in southern Tonga but common in Fiji and Samoa. Not known in Hawaii.

Cypraea argus Linnaeus.

Cypraea argus Linnaeus: Syst. Nat., 10th ed., p. 719, 1758.
Cypraea argus Linnaeus: Tryon, Man. Conch., vol. 7, p. 164, pl. 1, figs. 1, 2, 1885.

Eua, beach, 2 shells, Parks; Nukualofa and Holoipepe quarries, several fossils; Houma, upper surface of sea cliff, several shells.

This is one of the most distinct species of the genus. It has no closely related species and seems always constant in form and markings.

Cypraea caput-serpentis Linnaeus.

Cypraea caput-serpentis Linnaeus: Syst. Nat., 10th ed., p. 720, 1758.
Cypraea caput-serpentis Linnaeus: Reeve, Conch. Icon., vol. 3, sp. 44, 1845.

Nukualofa, 4th zone of fringing reef, under hurricane blocks, abundant; Hufagalupe and Haakama, 1 dead shell from each; Haakama, 2 fossils; Eua, several beach shells, Parks.

This common and well-known Indo-Pacific species is one of the most distinct of the genus. Its closest relative appears to be *C. mauritiana* Linnaeus. In Hawaii, where it is the commonest species of the genus, it shows a racial difference from the South Pacific form by darker marginal filling and brown interstices of the teeth.

Cypraea carneola Linnaeus.

Cypraea carneola Linnaeus: Syst. Nat., 10th ed., p. 719, 1758.
Cypraea carneola Linnaeus: Tryon, Man. Conch., vol. 7, p. 166, pl. 3, figs. 26-28, 1885.
Cypraea carneola Linnaeus: Reeve, Conch. Icon., vol. 3, sp. 19, 1845.

Nukualofa, 2d zone of fringing reef, under loose stones, 2 specimens; Nukunuku, shore bar, under boulders, common; Holoipepe and Nukualofa quarries, 1 fossil from

each; east of Houma, Fahefa, sea cliff, 1, Setchell; Eua, windward side, 7 feet above sea, 1 fossil, Hoffmeister.

C. carneola from Tonga is uniformly small, both fossil and living. This may be a racial character. In Hawaii, the Tuamotus, and Ceylon, it attains a large size. Specimens from Tonga are remarkable for the scarred condition of their shells, probably the result of the thin shell in juveniles being broken by crabs.

Cypraea caurica Linnaeus.

Cypraea caurica Linnaeus: Syst. Nat., 10th ed., p. 723, 1758.
Cypraea caurica Linnaeus: Tryon, Man. Conch., vol. 7, p. 171, pl. 5, figs. 88-90, 1885.
Cypraea caurica Linnaeus: Reeve, Conch. Icon., vol. 3, sp. 46, 1845.
Nukualofa, 4th zone of fringing reef, under hurricane blocks, several shells; Nukunuku, on bar, under loose boulders, 2 small shells.

This widely distributed species is distinct from all others, although many varieties of form, size, and coloration are found.

Cypraea clandestina Linnaeus.

Cypraea clandestina Linnaeus: Syst. Nat. (Gmel. ed.), vol. 1, p. 3410, 1788.
Cypraea clandestina Linnaeus: Reeve, Conch. Icon., vol. 3, sp. 106, 1846.
Cypraea clandestina Linnaeus: Tryon, Man. Conch., vol. 7, p. 187, pl. 16, figs. 37, 38, 1885.
Nukunuku, shore bar, under boulder, 1.

This species is characterized by fine teeth and extremely faint transverse brown lines. However, there are two or more varieties in which the transverse lines are absent.

Cypraea erosa Linnaeus.

Cypraea erosa Linnaeus: Syst. Nat., 10th ed., p. 723, 1758.
Cypraea erosa Linnaeus: Tryon, Man. Conch., vol. 7, p. 192, pl. 18, figs. 90, 100, 1, 1885.
Cypraea erosa Linnaeus: Reeve, Conch. Icon., vol. 3, sp. 43, 1845.
Nukualofa, 4th zone of fringing reef, under hurricane blocks, common (with juveniles); Nukunuku, shore bar, under boulders, common (with juveniles).

Nukunuku shells are smaller than those at Nukualofa. This is a very distinct species and of wide Indo-Pacific distribution. It is easily distinguished by its marginal blotches, extensive teeth on the outer lip, and pitted margins. It is apparently almost extinct in Hawaii but common in fossil state on Oahu.[2]

Cypraea errones Linnaeus.

Cypraea errones Linnaeus: Syst. Nat., 10th ed., p. 723, 1758.
Cypraea errones Linnaeus: Tryon, Man. Conch., vol. 7, p. 183, pl. 14, figs. 88, 89, 7, 1885.
Cypraea errones Linnaeus: Reeve, Conch. Icon., vol. 3, sp. 56, 1845.
Nukualofa, outer zone of fringing reef, under hurricane blocks, common; Nukunuku, on shore bar, under boulders, abundant (with some juveniles).

[2] Ostergaard, J. M., Fossil marine mollusks of Oahu: B. P. Bishop Mus., Bull. 51, p. 28, 1928.

Most of the specimens found at Nukunuku were of paler color and larger size than those from Nukualofa. The species has a wide range in size, form, and color pattern. The variety of Tongatabu is small and of a pale color. Base and margins are white; dorsal surface white or bluish white, sprinkled with brown flecks; the centrally located brown dorsal blotch, characteristic of the type, is faint, and absent in some individuals. The variety collected at Suva, Fiji, shows a marked difference. It has nearly twice the linear measurement of the Tongan form; its base and margins are yellowish brown, dorsal surface blue and densely crowded with brown flecks, which gives the shell in dorsal aspect a very dark appearance; the dorsal blotch is absent or faintly traceable in some individuals. More than 30 specimens were collected in each locality. *C. errones* is closely related to *C. sophiae* Brazier, *C. subviridis* Reeve, *C. subcylindrica* Sowerby.

Cypraea helvola Linnaeus.

Cypraea helvola Linnaeus: Syst. Nat., 10th ed., p. 724, 1758.
Cypraea helvola Linnaeus: Tryon, Man. Conch., vol. 7, p. 194, pl. 19, figs. 8, 9, 1885.
Cypraea helvola Linnaeus: Reeve, Conch. Icon., vol. 3, sp. 72, 1845.

Nukunuku, shore bar, under boulder, 2; Hufagalupe, wave bench, 3 dead shells; Holoipepe quarry, 2 fossils; Neiafu quarry, Vavau, 1 fossil.

This common and widely distributed Indo-Pacific species varies geographically in intensity of its dorsal and ventral colorations. The Hawaiian variety is characterized by its grayish-brown base and margins and its deep violet extremities. Tryon's note on the Hawaiian form is as follows: "Those from the Sandwich Islands are often pale yellow, faintly spotted, with a whitish base and extremities." This description applies only to faded dead shells of which vast quantities were dredged from Honolulu harbor channel at various times. Living specimens are always dark. *C. helvola* approaches *C. citrina* Gray, which is confined to South Africa.

Cypraea interrupta Gray.

Cypraea interrupta Gray: Tryon, Man. Conch., vol. 7, p. 167, pl. 3, figs. 36, 37, 1885.
Cypraea interrupta Gray: Reeve, Conch. Icon., vol. 3, sp. 103, 1846.

Nukualofa, outer reef zone, fairly common; Vavau, Neiafu quarry, 1 fossil.

The Tongan form is small and has interrupted bands showing faintly.

Cypraea isabella Linnaeus.

Cypraea isabella Linnaeus: Syst. Nat., 10th ed., p. 722, 1758.
Cypraea isabella Linnaeus: Tryon, Man. Conch., vol. 7, p. 165, pl. 1, figs. 6, 7, 1885.
Cypraea isabella Linnaeus: Reeve, Conch. Icon., vol. 3, sp. 51, 1845.

One mile west of Nukualofa, outer reef zone, under hurricane blocks, fairly common; Makahaa, on reef, 2; Eua, on beach, 2, Parks. Fossils were collected from the following localities: Nukualofa quarry, 4, Hoffmeister; Holoipepe quarry, 2, Hoffmeister and Ostergaard; Neiafu quarry, Vavau, 1, Hoffmeister; limestone exposure about 3 miles north of Neiafu, 1, Ostergaard.

This common Indo-Pacific species can always be identified by a combination of four characters: cylindrical form; brown extremities; longitudinally striated dorsal surface; and extremely fine teeth.

Cypraea lynx Linnaeus.

Cypraea lynx Linnaeus: Syst. Nat., 10th ed., p. 721, 1758.
Cypraea lynx Linnaeus: Tryon, Man. Conch., vol. 7, p. 183, pl. 14, figs. 86, 87, 98, 1885.
Cypraea lynx Linnaeus: Reeve, Conch. Icon., vol. 3, sp. 33, 1845.

Nukualofa, outer reef zone, under hurricane blocks, fairly common; Nukunuku, shore bar, under loose boulders, several; Eua, 1 beach shell, Parks; Nukualofa quarry, 2 fossils, Hoffmeister; Houma, sea cliff, 1 fossil, Ostergaard.

This common Indo-Pacific species is distinct in form and color pattern from all other species of the genus.

Cypraea mauritiana Linnaeus.

Cypraea mauritiana Linnaeus: Syst. Nat., 10th ed., p. 721, 1758.
Cypraea mauritiana Linnaeus: Tryon, Man. Conch., vol. 7, p. 173, pl. 7, figs. 8-11, 1885.
Cypraea mauritiana Linnaeus: Reeve, Conch. Icon., vol. 3, sp. 1, figs. 1, *a*, *b*, 1845.

Haakama, sea cliff, 1 fossil. No living shells were found, but two in Bernice P. Bishop Museum collection are from Velitoa, off leeward Tongatabu, collected by E. W. Gifford in 1920.

This very distinct and widely distributed species is apparently related to *C. caput-serpentis* Linnaeus.

Cypraea moneta Linnaeus.

Cypraea moneta Linnaeus: Syst. Nat., 10th ed., p. 723, 1758.
Cypraea moneta Linnaeus: Tryon, Man. Conch., vol. 7, p. 177, pl. 10, fig. 46; pl. 11, figs. 51-54; pl. 23, figs. 60-69, 1885.
Cypraea moneta Linnaeus: Reeve, Conch. Icon., vol. 3, sp. 74, 1845.

Nukualofa, 1st, 2d, and 4th faunal zones of fringing reef, common in 1st zone, abundant at inner margin of 4th zone; Nukunuku, near shore, several; Nukualofa, on fringing reef, openly exposed and under stones with *C. annulus*.

This common shoal-water Indo-Pacific species is represented by many forms and has a color range from pure white to bright orange. It is apparently always distinct from its nearest ally, *C. annulus*.

Cypraea neglecta Sowerby.

Cypraea neglecta Sowerby: Tryon, Man. Conch., vol. 7, p. 170, pl. 4, figs. 61-63, 1885.
Cypraea neglecta Sowerby: Reeve, Conch. Icon., vol. 3, sp. 100, 1846.

Nukualofa, 4th zone of fringing reef, under hurricane blocks, several specimens.

This species appears to be quite distinct but shows close relationship to *C. hirundo* Linnaeus.

Cypraea poraria Linnaeus.

Cypraea poraria Linnaeus: Syst. Nat., 10th ed., p. 724, 1758.
Cypraea poraria Linnaeus: Tryon, Man. Conch., vol. 7, p. 193, pl. 18, figs. 2, 3, 1885.
Cypraea poraria Linnaeus: Reeve, Conch. Icon., vol. 3, sp. 99, 1846.

Hufagalupe, wave bench, several dead shells; Neiafu limestone quarry, Vavau, 1 fossil.

This common Indo-Pacific species may easily be recognized by its purplish colored base and margins and its ocelli. It resembles *C. albuginosa* Mawe of the Gulf of California.

Cypraea punctulata Gmelin.

Cypraea punctulata Gmelin, Linnaeus, Syst. Nat. (Gmel. ed.), vol. 1, p. 3404, 1788.
Cypraea tabescens Solander: Tryon, Man. Conch., vol. 7, p. 170, pl. 5, figs. 82, 83, 84, 1885.
Nukualofa quarry, 1 fossil, Hoffmeister; Nukualofa, 2 beach shells.

There is good reason for believing that *C. punctulata* Gmelin was *C. tabescens* Solander and not a synonym of *C. cylindrica* Linnaeus, as Tryon states it to be. Gmelin's description could not fit a form of *C. cylindrica,* for no mention is made of the terminal blotches so characteristic of that species. *C. punctulata* is closely related to *C. teres* Gmelin and *C. rashleighana* Melville. The latter is endemic in Hawaii and apparently intergrades with *C. punctulata,* which reduce it to a varietal rank.

Cypraea staphylaea Linnaeus.

Cypraea staphylaea Linnaeus: Syst. Nat., 10th ed., p. 725, 1758.
Cypraea staphylaea Linnaeus: Tryon, Man. Conch., vol. 7, p. 196, pl. 20, figs. 39-44, 1885.
Cypraea staphylaea Linnaeus: Reeve, Conch. Icon., vol. 3, sp. 82, figs. 82*a*, 82*b*, 1845.
Nukunuku, shore bar, under boulder, 2 (1 dead).

Reeve should be given much support in his statement: "This I consider, without exception, the most variable species of the genus." It varies from a small highly pustulated form of a white or yellowish color to a large smooth form with dark brown dorsal coloration. Literature on the named varieties of this species is in such a state of confusion that it is inadequate for reference. The many variations are, however, almost always recognized by the yellowish-brown coloring of the teeth and extremities. The varieties are distributed throughout the Indo-Pacific and some of them might be considered subspecies, others geographical races. A small white pustulated form approaches *C. nucleus* Linnaeus so closely that the two are separated with difficulty. The endemic *C. semiplota* Mighels of Hawaii is closely related to *C. staphylaea* and is also variable in form and size.

Cypraea talpa Linnaeus.

Cypraea talpa Linnaeus: Syst. Nat., 10th ed., p. 720, 1758.
Cypraea talpa Linnaeus: Tryon, Man. Conch., vol. 7, p. 167, pl. 3, figs. 31-33, 1885.
Eua, beach, 1 worn shell.

This widely distributed Indo-Pacific species is closely related to *C. exusta* Sowerby, a rare species of the Red Sea, the two constituting a very distinct group in the genus. I found no trace of this species on Tongatabu. People on the island showed me fresh specimens, but their data were questionable.

Cypraea tigris Linnaeus.

Cypraea tigris Linnaeus: Syst. Nat., 10th ed., p. 721, 1758.
Cypraea tigris Linnaeus: Tryon, Man. Conch., vol. 7, p. 180, pl. 11, figs. 49, 50, 1885.
Cypraea tigris Linnaeus: Reeve, Conch. Icon., vol. 3, sp. 12, 1845.
Nukualofa, 4th zone of fringing reef, outer edge, 1; Makahaa, outer part of reef, on hurricane blocks, openly exposed, 3; leeward Tongatabu, Fafa, 1 living shell, collected by Tongan fisherman. Species said to be common at night on outlying reefs.

This large and beautiful Indo-Pacific species is always recognized by a combination of characters. It approaches *C. pantherina* Solander of the Indian Ocean, but is entirely distinct from it.

Cypraea ventriculus Lamarck.

Cypraea ventriculus Lamarck: Animaux s. Vert., 2d ed., vol. 10, p. 501, 1844.
Cypraea ventriculus Lamarck: Tryon, Man. Conch., vol. 7, p. 172, pl. 6, figs. 95, 96, 1885.
Cypraea ventriculus Lamarck: Reeve, Conch. Icon., vol. 3, sp. 28, 1845.
Hufagalupe, wave bench, 1 large, fresh specimen occupied by hermit crab.

This large, heavy South Pacific species is readily distinguished from all others by its form, size, and coloration.

Cypraea vitellus Linnaeus.

Cypraea vitellus Linnaeus: Syst. Nat., 10th ed., p. 721, 1758.
Cypraea vitellus Linnaeus: Tryon, Man. Conch., vol. 7, p. 182, pl. 13, figs. 72, 73, 1885.
Cypraea vitellus Linnaeus: Reeve, Conch. Icon., vol. 3, sp. 14, 1845.
Nukualofa, 2d zone of fringing reef, in cavities of rocks, many shells of uniformly small size; Nukunuku, shore bar, on boulders, concealed or openly exposed, very common, ranging from small size of Nukualofa specimens to nearly twice their linear measurements; Makahaa reef, 1 shell.

On the shore and off-shore bar at Suva, Fiji, the species is common and of small size. This common Indo-Pacific species is entirely distinct and is remarkable for its great range in size. It appears to be related to *C. nivosa* Broderip and *C. broderipii* Gray, species of great rarity from the Indian Ocean.

Drupa digitata (Lamarck).

Ricinula digitata Lamarck: Animaux s. Vert., 2d ed., vol. 10, p. 50, 1844.
Ricinula digitata Lamarck: Tryon, Man. Conch., vol. 2, p. 185, pl. 57, fig. 203, 1880.
Ricinula digitata Lamarck: Reeve, Conch. Icon., vol. 3, sp. 2, fig. 2, *a*, 1846.
Hufagalupe, wave bench, openly exposed, 1; Haakama, at base of sea cliff, 1; Nukualofa, 4th zone of fringing reef, under hurricane block, an immature shell.

This species is very distinct and easily recognized by its orange-colored base and aperture.

Drupa horrida (Lamarck).

Ricinula horrida Lamarck: Animaux s. Vert., 2d ed., vol. 10, p. 47, 1844.
Ricinula horrida Lamarck: Tryon, Man. Conch., vol. 2, p. 184, pl. 56, figs. 201, 202, 1880.

Hufagalupe, wave bench, on rocks, openly exposed, very common, majority fully adult, a few juvenile stages found; Haakama, wave bench, openly exposed, several; Nukualofa, 4th zone of fringing reef, on rock, openly exposed, 1; Eua, 1 beach specimen, Parks.

As in Hawaii, where the species is also common, its favorite habitat is in places reached by a strong surf. This large and conspicuous species possesses such distinctive characters that it may always be recognized easily. Its form and violet aperture remain constant, but racially it varies much in size.

Drupa ricinus (Linnaeus).

Murex ricinus Linnaeus: Syst. Nat., 10th ed., p. 750, 1758.
Ricinula ricinus (Linnaeus): Tryon, Man. Conch., vol. 2, p. 184, pl. 56, fig. 200; pl. 57, figs. 204, 206, 212, 1880.
Ricinula arachnoides Lamarck: Kiener, Icon. des Coquille Vivantes, p. 10, pl 1, figs. 3, 3*a*.
Ricinula arachnoides Lamarck: Reeve, Conch. Icon., vol. 3, sp. 5, 1846.
Ricinula arachnoides Lamarck: Martini and Chemnitz, Conch.-Cab., *Ricinula,* Küster, p. 6, pl. 1, figs. 8, 9, 1862.
Ricinula arachnoides Lamarck: Animaux s. Vert., 2d. ed., vol. 10, p. 49, 1844.

Hufagalupe, wave bench, openly exposed, abundant; Haakama, wave bench, fairly common; Nukualofa, 4th zone of fringing reef, under hurricane blocks, several; Makahaa, reef, 2 shells in which the orange blotches on the columella and outer lip were most highly developed.

Lamarck (Animaux s. Vert., 2d ed., vol. 10, p. 49) calls attention to an apparent error of Linnaeus, who finished his description of this species with the words *fauce violacea.* The footnote reference is as follows: "Cependant Linné dit que quelquefois l'ouverture est violette, ce qui nous fait croire que, parmi les individues du Murex ricinus, il s'en était glissé quelques-uns du *Ricinula horrida* Lamarck." Reeve, in his remarks on *Ricinula arachnoides,* points out that this species is identical with *R. albolabris* Blainville. This contention can now be little doubted. The orange spots encircling the aperture of *R. arachnoides* signify only a color variation. To this may be added a form of a pale purple aperture of which there are many specimens in the present lot. Trace of the purple aperture is noticeable in some specimens collected on Nihoa Island, Hawaii, by the Tanager Expedition, 1923.

Engina mendicaria (Linnaeus).

Voluta mendicaria Linnaeus: Syst. Nat., 10th ed., p. 731, 1758.
Engina mendicaria (Linnaeus): Tryon, Man. Conch., vol. 5, p. 196, pl. 63, figs. 62, 73, 1883.
Ricinula mendicaria (Linnaeus): Martini and Chemnitz, Conch.-Cab., *Ricinula,* Küster, p. 13, pl. 2, figs. 14, 15, 1862.

Nukualofa, on loose stones by pier, common; Nukualofa, 4th zone of fringing reef, under hurricane blocks, several shells; 2 and 3 miles east of Nukualofa, on and under loose stones, several; Haakama wave bench, openly exposed, very abundant; Hufagalupe, wave bench, openly exposed, several.

The shells collected in Tonga vary in coloring; some have two yellow bands on the body whorl, others one, and some none.

Engina reevei Tryon.

Engina reevei Tryon, Man. Conch., vol. 5, p. 191, pl. 62, fig. 29, 1883.
Ricinula trifasciata Reeve, Conch. Icon., vol. 3, sp. 41, 1846.
Nukualofa, 4th zone of fringing reef; under hurricane blocks, 2; 3 miles east of Nukualofa, near shore, 1.

This species appears distinct in form, sculpturing, and marking.

Euchelus atratus (Gmelin).

Turbo atratus Gmelin: Linnaeus, Syst. Nat. (Gmel. ed.), p. 3601, 1788.
Euchelus atratus (Gmelin): Tryon and Pilsbry, Man. Conch., vol. 11, p. 439, pl. 38, fig. 22; vol. 10, pl. 41, figs. 25, 26, 1889.
Trochus atratus (Gmelin): Martini and Chemnitz, Conch.-Cab., *Turbo, Trochus,* etc., Philippi, p. 174, pl. 27, fig. 14, 1846.
Nukualofa, outer zone of fringing reef, several; 2 miles east of Nukualofa, near shore, on rocky bottom, several; 3 miles east of Nukualofa, near shore, on rocks, several.

There can be no doubt as to the identification of this species. The description of Tryon and Pilsbry agrees in minute details with specimens from Tonga.

Fasciolaria filamentosa Lamarck.

Fasciolaria filamentosa Lamarck: Animaux s. Vert., 2d ed., vol. 9, p. 434, 1843.
Fasciolaria filamentosa Lamarck: Tryon, Man. Conch., vol. 3, p. 75, pl. 59, figs. 8-10, 1881.
Nukualofa, outer zone of fringing reef, under hurricane block, 1; leeward Tongatabu, Monu reef, 1.

Lamarck makes the following diagnostic comments on this species, which fit closely with the Tongan specimens: "Celle-ci est remarquable par sa forme allongée, peu ventrue, et par ses tubercules comprimés, à peine saillans."

Haliotis ovina Chemnitz.

Haliotis ovina Chemnitz: Martini and Chemnitz, Conch.-Cab., *Haliotis,* Weinkauff, p. 18, pl. 6, fig. 11, 1883.
Haliotis ovina Chemnitz: Tryon and Pilsbry, Man. Conch., vol. 12, p. 124, pl. 19, figs. 7, 8, 1890.
Haliotis ovina Chemnitz: Reeve, Conch. Icon., vol. 3, sp. 28, 1846.
Nukualofa, Monu reef, common; Nukualofa, outer zone of fringing reef, under hurricane blocks, 2; Holoipepe quarry, 1 fossil, Hoffmeister.

Reeve refers to this as an extremely characteristic species.

Haliotis stomataeformis Reeve.

Haliotis stomataeformis Reeve: Conch. Icon., vol. 3, sp. 73, 1846.
Haliotis stomataeformis Reeve: Tryon and Pilsbry, Man. Conch., vol. 12, p. 89, pl. 3, fig. 4, pl. 49, figs. 30-35, 1890.
Nukualofa, outer zone of fringing reef, under hurricane blocks, several.

Reeve remarks that this species is well distinguished by its conspicuous convex oblong form.

Imbricaria virgo Swainson.

Imbricaria virgo Swainson: Tryon, Man. Conch., vol. 4, p. 200, pl. 58, fig. 683, 1882.
Hufagalupe, wave bench, in sand pockets, abundant.

Tryon made the following comment on this species: "Although so bulbous, I can not help thinking that this will prove to be an extreme variation of *I. punctata.*" His prediction seems correct. A specimen in Bernice P. Bishop Museum collection from Washington Island appears intermediate between the two species, having the elevated spire of the one and the blackish-violet base of the other.

Iopas sertum Bruguière.

Iopas sertum Bruguière: Tryon, Man. Conch., vol. 2, p. 180, pl. 55, figs. 181, 188-190, 1880.
Nukualofa, outer zone of fringing reef, under hurricane blocks, several; Holoipepe quarry, 1 large fossil, Hoffmeister.

The rough Tongan form and smooth Hawaiian form intergrade and show no varietal difference.

Latirus craticulatus (Linnaeus).

Murex craticulatus Linnaeus: Syst. Nat., 10th ed., p. 755, 1758.
Latirus craticulatus (Linnaeus): Tryon, Man. Conch., vol. 3, p. 93, pl. 69, fig. 159, 1881.
Nukualofa, outer zone of fringing reef, under hurricane blocks, several.

Tryon says that *L. sanguifluus* Reeve may be a short variety of *L. craticulatus* Linnaeus.

Latirus polygonus (Gmelin).

Murex polygonus Gmelin: Linnaeus, Syst. Nat. (Gmel. ed.), vol. 1, p. 3555, 1788.
Latirus polygonus (Gmelin): Tryon, Man. Conch., vol. 3, p. 88, pl. 66, figs. 106-108; pl. 67, figs. 109-114, 1881.
Turbinella polygona Lamarck: Reeve, Conch. Icon., vol. 4, sp. 1, figs. 1, *a-c*, 1847.
Nukualofa, 4th zone of fringing reef, under hurricane blocks, several; Makahaa reef, 1.

Latirus rollandi Bernardi.

Two miles east of Nukualofa, fringing reef, on rocks, 2.

Determination of this species is based entirely on a comparison with shells in the Garrett collection in Bernice P. Bishop Museum. I failed to find any literature on it.

Leucozonia smaragdula (Linnaeus).

Buccinum smaragdulus Linnaeus: Syst. Nat., 10th ed., p. 739, 1758.
Leucozonia smaragdula (Linnaeus): Tryon, Man. Conch., vol. 3, p. 96, pl. 70, figs. 185, 186, 1881.
Nukualofa, 4th zone of fringing reef, under hurricane blocks, several; Hufagalupe, wave bench, exposed on rocks, several; Makahaa, reef, under hurricane blocks, several.

Its very bulbous form and fine transverse striations make this species easily recognizable.

Littorina obesa Sowerby.

Littorina obesa Sowerby: Tryon, Man. Conch., vol. 9, p. 247, pl. 43, fig. 53, 1887.
Littorina obesa Sowerby: Reeve, Conch. Icon., vol. 10, sp. 41, 1857.
Houma, on shore rocks above high tide, 1.

This species appears to possess several distinctive characters by which it may be readily identified.

Malea pomum (Linnaeus).

Buccinum pomum Linnaeus: Syst. Nat., 10th ed., p. 735, 1758.
Dolium (Malea) *pomum* (Linnaeus): Tryon, Man. Conch., vol. 7, p. 265, pl. 5, fig. 26, 1885.
Three miles east of Nukualofa, rocky bottom near shore, in sand pockets, several; Nukualofa, inner zone of fringing reef, 1 dead shell.

Quite distinct and easily separated from the other species of the genus, *M. ringens* (Swainson).

Mitra chrysalis Reeve.

Mitra chrysalis Reeve: Conch. Icon., vol. 2, sp. 200, 1844.
Mitra chrysalis Reeve: Tryon, Man. Conch., vol. 4, p. 144, pl. 42, fig. 233, 1882.
Nukualofa, 2d zone of fringing reef, openly exposed on rocks, restricted to small area, about 20.

Tryon remarks: "Very closely allied to *M. cucumerina* but differs in its smaller size, more compressed form, and lighter color." Specimens found on the shore bar at Suva, Fiji, seem identical with the Tongan form.

Mitra cucumerina Lamarck.

Mitra cucumeriana Lamarck: Animaux s. Vert., 2d ed., vol. 10, p. 332, 1844.
Mitra cucumerina Lamarck: Tryon, Man. Conch., vol. 4, p. 143, pl. 42, figs. 227-229, 1882.
Mitra cucumerina Lamarck: Martini and Chemnitz, Conch.-Cab., Volutacea, Menke, p. 65, pl. 12, figs. 10, 11.
Nukualofa, outer zone of fringing reef, under hurricane blocks, 2 immature shells.

Distinguishable from *M. chrysalis* Reeve by its more depressed form and darker color.

Mitra espiscopalis (Linnaeus).

Voluta mitra episcopalis Linnaeus: Syst. Nat., 10th ed., p. 732, 1758.
Mitra episcopalis (Linnaeus): Tryon, Man. Conch., vol. 4, p. 111, pl. 32, fig. 1, 1882.
Makahaa, reef, sand pocket in rock, 1 shell.

This well-known Indo-Pacific species, the largest of the genus, has considerable range in size. The shell found measures over 4 inches in length, which is about average size.

Mitra filaris nexilis Martyn.

Mitra filaris nexilis Martyn: Tryon, Man. Conch., vol. 4, p. 138, pl. 40, fig. 174, 1882.
Nukualofa, reef, 1 dead shell.

Tryon recognizes several other varieties of *M. filaris*.

Mitra litterata Lamarck.

Mitra litterata Lamarck, Animaux s. Vert., 2nd ed., vol. 10, p. 339, 1844.
Mitra litterata Lamarck: Tryon, Man. Conch., vol. 4, p. 155, pl. 46, figs. 338, 339, 1882.
Hufagalupe, wave bench, in sand pockets, many specimens; Nukualofa, 2d zone of fringing reef, exposed on rock, 1 shell.

This common, widely distributed species can be easily recognized by its form and markings. The Tongan form resembles closely that of Oahu, Hawaii.

Mitra pontificalis Lamarck.

Mitra pontificalis Lamarck: Animaux s. Vert., 2d ed., vol. 10, p. 300, 1844.
Mitra pontificalis Lamarck: Tryon, Man. Conch., vol. 4, p. 111, pl. 32, fig. 3, 1882.
Eua, 1 beach shell, Parks.

This well-known species is easily recognized by its coronated whorls and distinctive coloration.

Mitra versicolor Martyn.

Mitra versicolor Martyn: Tryon, Man. Conch., vol. 4, p. 112, pl. 32, figs. 6-8, 1882.
Nukualofa, 2d zone of fringing reef, 1 dead shell.

Apparently closely related to *M. lamarckii* Deshayes.

Mitra zebra (Garrett).

Strigatella zebra Garrett: Jour. of Conch., vol. 3, p. 35 (not figured), 1880.
Hufagalupe, wave bench, in crevices, 3 specimens.

As Tryon remarks, this species seems to approach rather closely *M. virgata* Reeve, examples of which are also well represented in the Garrett collection. The three specimens at hand agree very closely with Garrett's description as well as with his specimens. Several Samoan specimens of *M. zebras* are in the Garrett collection in Bernice P. Bishop Museum.

Morula chaidea (Duclos).

Ricinula (*Sistrum*) *chaidea* Duclos: Tryon, Man. Conch., vol. 2, p. 187, pl. 58, figs. 241, 247, 1880.
Hufagalupe, wave bench, on rocks, several; Haakama and Houma, wave benches, several. None were seen on the leeward shore of Tongatabu.

Tryon states that this species may be only a depauperate variety of *M. ochrostoma* Blainville, but that the short ventricose form is very characteristic.

Morula fiscellum (Chemnitz).

Murex fiscellum Chemnitz: Martini and Chemnitz, Conch.-Cab., *Murex*, Küster, p. 95, pl. 33, figs. 10, 11, 1844.
Ricinula (*Sistrum*) *fiscellum* Chemnitz: Tryon, Man. Conch., vol. 2, p. 188, pl. 58, figs. 251-257, 1880.
Nukualofa, outer zone of fringing reef, under hurricane blocks, 3; 2 miles east of Nukualofa, near shore, on rocks, 2; 3 miles east of Nukualofa, near shore, on rock, 1.

As pointed out in the notes on *Morula undata, Ricinula fiscellum* of Chemnitz is *Morula undata,* and his *Murex fiscellum* is the true *Morula fiscellum.* The example that he describes and figures is unusually large and might easily be included with the genus *Murex.*

Morula fiscellum fusco-nigra (Dunker).

Ricinula (Sistrum) fiscellum fusco-nigra Dunker: Tryon, Man. Conch., vol. 2, p. 189, pl. 59, fig. 258, 1880.

Nukualofa, on loose stone by pier, 1; 2 miles east of Nukualofa, near shore, on rocky bottom, several; 3.5 miles east of Nukualofa, 1.

Tryon's description of this variety is very brief and I have no access to the author's description. It appears that its principal difference from other forms of *M. fiscellum* is its short anterior canal.

Morula morus (Lamarck).

Ricinula morus Lamarck: Animaux s. Vert., 2d ed., vol. 10, p. 51, 1844.

Ricinula morus Lamarck: Tryon, Man. Conch., vol. 2, p. 185, pl. 57, figs. 213, 214, 1880.

Ricinula morus Lamarck: Martini and Chemnitz, Conch.-Cab., *Ricinula,* Küster, p. 10, pl. 2, fig. 8, 1862.

Hufagalupe, wave bench, in sand pockets, several specimens.

This species has a wide Indo-Pacific distribution with several well-marked varieties. The Tongan form resembles closely that of Hawaii.

Morula morus aspera (Lamarck).

Ricinula aspera Lamarck: Animaux s. Vert., 2d ed., vol. 10, p. 51, 1844.

Ricinula (Sistrum) morus aspera Lamarck: Man. Conch., vol. 2, p. 185, pl. 57, figs. 215, 216, 1880.

Ricinula aspera Lamarck: Reeve, Conch. Icon., vol. 3, sp. 13, 1846.

Nukualofa, outer zone of fringing reef, under hurricane blocks, several.

Differs from the type chiefly in having white revolving knobs instead of black.

Morula morus striatus (Pease).

Ricinula (Sistrum) morus striatus Pease: Tryon, Man. Conch., vol. 2, p. 185, pl. 57, fig. 217, 1880.

Nukualofa, 2d zone of fringing reef, 2 specimens (1 juvenile), both considerably eroded.

Morula ochrostoma (Blainville).

Ricinula (Sistrum) ochrostoma Blainville: Tryon, Man. Conch., vol. 2, p. 187, pl. 57, fig. 230, 1880.

Ricinula ochrostoma Blainville: Reeve, Conch. Icon., vol. 3, sp. 31, 1846.

Nukualofa, 2d zone of fringing reef, on rocks, several.

The Tongan form is very similar to that of Oahu, Hawaii.

Morula ochrostoma elata (Blainville).

Ricinula (Sistrum) ochrostoma Blainville: Tryon, Man. Conch., vol. 2, p. 187, pl. 57, fig. 223, 1880.

Ricinula elata Blainville: Reeve, Conch. Icon., vol. 3, sp. 27, 1846.

Nukualofa, outer zone of fringing reef, under hurricane blocks, common, majority immature; Nukualofa, shore rocks, 2 immature shells.

I have no access to Blainville's description, but the shells from Nukualofa agree closely with the description of Reeve, Tryon, and Martini and Chemnitz, differing only in being thinner and having a more elevated spire.

Morula ochrostoma spectrum (Reeve).

Ricinula spectrum Reeve, Conch. Icon., vol. 3, sp. 19, 1846.

Ricinula (Sistrum) ochrostoma Blainville: Tryon, Man. Conch., vol. 2, p. 187, pl. 57, fig. 224, 1880.

Nukualofa, outer zone of fringing reef, under hurricane blocks, 20; Hufagalupe, wave bench, on rocks, 3.

Tryon treats this large, stout form as a synonym of *M. ochrostoma.* In Hawaii it is common, as is also a small yellow-mouthed form, the typical *M. ochrostoma* of Blainville. The two are so strikingly distinct that they appear to be widely separated species. Reeve's name should be retained as a variety.

Morula tuberculata (Blainville).

Ricinula (Sistrum) tuberculata Blainville: Tryon, Man. Conch., vol. 2, p. 186, pl. 57, figs. 218, 220, 1880.

Ricinula tuberculata Blainville: Martini and Chemnitz, Conch.-Cab., *Ricinula,* Küster, p. 9, pl. 2, figs. 6, 7, 1869.

Nukualofa, outer zone of fringing reef, under hurricane blocks, fairly common; Nukualofa, on shore rocks, several; Nukualofa, on loose stones by pier, common; a few miles east of Nukualofa, on rocks near shore, several; Hufagalupe, wave bench, openly exposed, common; Houma and Haakama, on wave bench, openly exposed, several.

Most of the specimens at Hufagalupe are larger than those found elsewhere; those from the pier at Nukualofa are the smallest of all. This species, common on both leeward and windward shores of Tongatabu, differs from the Hawaiian form in its larger size and more globular shape.

Morula undata (Chemnitz).

Ricinula (Sistrum) undata Chemnitz: Tryon, Man. Conch., vol. 2, p. 189, pl. 59, figs. 259-268, 270, 271, 1880.

Ricinula fiscellum Chemnitz: Martini and Chemnitz, Conch.-Cab., *Ricinula,* Küster, p. 20, pl. 4, fig. 1, 1862.

Murex undata Chemnitz: Martini and Chemnitz, Conch.-Cab., *Murex,* etc., Küster, p. 121, pl. 36, figs. 7, 8, 1844.

Nukualofa, 2d zone of fringing reef, on rocks, several; Nukualofa, on rocks by pier, 1; 2 miles east of Nukualofa, on rocks near shore, 1; 3 miles east of Nukualofa, on rocks near shore, 2.

As Tryon points out, much confusion has occurred in the synonymy of *Morula fiscellum. Murex undata* and *Ricinula fiscellum* of Chemnitz are synonymous. *Ricinula fiscellum* Chemnitz (Reeve, Conch. Icon., vol. 3, sp. 28, 1846) is also a form of *Morula undata.* The Tongan specimens show more variation in form than those collected on the shore bar about a mile east of Suva, Fiji, where the species was common.

Murex adustus Lamarck.

Murex adustus Lamarck, Animaux s. Vert., 2d ed., vol. 9, p. 573, 1843.
Murex adustus Lamarck: Kiener, Icon. Coq. Viv., p. 38, pl. 33, fig. 1.
Murex adustus Lamarck: Tryon, Man. Conch., vol. 2, p. 90, pl. 15, figs. 148, 149, 1880.

Two shells found on the reef of Makahaa were of a much lighter color than those collected on the shore bar, a mile east of Suva, Fiji, in which locality it was common. This species varies considerably in size, color, and development of fronds. It appears, however, to be sufficiently distinct in all its variations to be separated from others. Tryon figures several variations in size, form, and color.

Murex ramosus Linnaeus.

Murex ramosus Linnaeus: Syst. Nat., 10th ed., p. 747, 1758.
Murex ramosus Linnaeus: Tryon, Man. Conch., vol. 2, p. 95, pl. 1, figs. 1, 2, 1880.
Leeward Tongatabu, Makahaa, on reef, 1, collected by Tongan fisherman; Fafa Island, 2 living specimens, collected by Tongan fisherman.

This large, conspicuous *Murex* of the Indo-Pacific is easily distinguished from others by its flaring canal and pink lips.

Murex tripterus Born.

Murex tripterus Born: Tryon, Man. Conch., vol. 2, p. 87, pl. 41, fig. 531, 1880.
Murex tripterus Born: Martini and Chemnitz, Conch.-Cab., *Murex, Ranella,* etc., Küster, p. 98, pl. 34, fig. 1, 1844.
Hufagalupe, on wave bench, 1.

I have seen no specimens of this species and base my determination entirely upon literature. According to Martini and Chemnitz, it is related to *M. pellucidus* and *M. pinnatus* but is entirely distinct from them.

Nassa arcularia (Linnaeus).

Buccinum arcularia Linnaeus, Syst. Nat., 10th ed., p. 737, 1758.
Nassa (Arcularia) arcularia (Linnaeus): Tryon, Man. Conch., vol. 4, p. 24, pl. 7, figs. 9, 10, 1882.
Nassa arcularia Lamarck: Reeve, Conch. Icon., vol. 8, sp. 25, figs. 25, *a, b,* 1853.
Nukualofa, inner zone of fringing reef, in sandy mud, openly exposed, several.

This species may be readily recognized by its sculpturing and form.

Nassa concinna Powis.

Nassa (Hima) concinna Powis: Tryon, Man. Conch., vol. 4, p. 48, pl. 15, figs. 256, 258, 259, 1882.
Nassa concinna Powis: Reeve, Conch. Icon., vol. 8, sp. 82, 1853.
Nukualofa, inner zone of fringing reef, 2 dead shells.

The fine sculpturing of this species appears to be unique.

Nassa crassa Koch.

Nassa (Phrontis) crassa Koch: Tryon, Man. Conch., vol. 4, p. 42, pl. 13, figs. 188-190, 1882.
Nukualofa, fringing reef, 1 dead and 1 living shell.

This very solid little shell seems to be distinct from all other species.

Nassa glans (Linnaeus).

Buccinum glans Linnaeus, Syst. Nat., 10th ed., p. 737, 1758.
Nassa (Alectrion) glans Linnaeus: Tryon, Man. Conch., vol. 4, p. 27, pl. 8, figs. 45-49, 52-54, 1882.
Three miles east of Nukualofa, reef, 1 dead shell.

This is the largest species of the genus; some varieties of it are comparatively small.

Nassa monile Kiener.

Nassa (Alectrion) monile Kiener: Tryon, Man. Conch., vol. 4, p. 28, pl. 9, figs. 60-68, 1882.
Nassa monile Kiener: Reeve, Conch. Icon., vol. 8, sp. 38, 1853.
Nukualofa, inner zone of fringing reef, on bottom of sandy mud, several; 2 miles east of Nukualofa, on sand near shore, 1; 3 miles east of Nukualofa, on sand near shore, 2.

This species appears to be closest to *N. hirta* Kiener, and is known by many varieties.

Natica marochiensis (Gmelin)

Nerita marochiensis Gmelin: Linnaeus, Syst. Nat. (Gmel. ed.), vol. 1, p. 3673, 1788.
Natica marochiensis (Gmelin): Tryon, Man. Conch., vol. 8, p. 22, pl. 5, figs. 74-96, 1886.
Nukualofa, inner reef zone, 1 living and 5 dead specimens.

This species has a great range in size and coloration and is remarkable for its wide distribution. Tryon reports it from the following localities: West Africa, West Indies, Panama to Mazatlan, Society and Philippine Islands, Australia. It is also common in Hawaii.

Nerita albicilla Linnaeus.

Nerita albicilla Linnaeus, Syst. Nat., 10th ed., p. 778, 1758.
Nerita albicilla Linnaeus: Tryon and Pilsbry, Man. Conch., vol. 10, p. 19, pl. 2, figs. 21-26, 1888.
Nukualofa, at high water mark along pier, on loose stones, abundant; Nukualofa, 2d zone of fringing reef, on rocks, 2; 3 miles east of Nukualofa, 2d zone of fringing reef, on rocks; common; Monu reef, common.

A well-defined species and constant in form.

Nerita plicata Linnaeus.

Nerita plicata Linnaeus: Syst. Nat., 10th ed., p. 779, 1758.
Nerita plicata Linnaeus: Tryon and Pilsbry, Man. Conch., vol. 10, p. 27, pl. 5, figs. 81-83, 1888.
Nukualofa, along shore at high water mark, on imported basaltic rocks, several; Nukualofa, outer zone of fringing reef, under hurricane block, 1; windward Tongatabu, Haakama, sea cliff above wave bench, common, shells larger than in other parts of Tongatabu; Houma, sea cliffs above wave bench, 2.

Nerita reticulata Karsten.

Nerita reticulata Karsten: Tryon and Pilsbry, Man. Conch., vol. 10, p. 21, pl. 3, figs. 49, 50, 1888.

Nerita reticulata fragum Reeve: Martini and Chemnitz, Conch.-Cab., *Nerita* and *Neritopsis*, Martens, p. 109, pl. 13, figs. 21, 22, 1889.
Nukualofa, along shore at high water mark, on imported basaltic rocks, abundant.

The specimens here are of a much lighter color than a lot collected on the shore rocks about 4 miles west of Suva, Fiji. The columellar blotch is constant in the numerous specimens collected in Tonga and Fiji and appears to be the chief distinguishing character of the species.

Nerita undata Linnaeus.

Nerita undata Linnaeus: Syst: Nat., 10th ed., p. 779, 1758.
Nerita undata Linnaeus: Tryon and Pilsbry, Man. Conch., vol. 10, p. 28, pl. 5, fig. 91, 1888.
Nerita chrysostoma Reclus: Reeve, Conch. Icon., vol. 9, sp. 18, figs. 18, *a, b*, 1855.
Three miles east of Nukualofa, near shore, 1 shell dead but fresh.

This is considered by Tryon and Pilsbry an exceedingly variable species of which they have recognized many varieties. A good example of the same form from Fiji in the Garrett collection, Bernice P. Bishop Museum, is labeled *Nerita maxima* Gmelin. I do not see how this error could have been made.

Nerita undata striata Burrow.

Nerita undata striata Burrow: Tryon and Pilsbry, Man. Conch., vol. 10, p. 28, figs. 91-94, 1888.
Nerita striata Burrow: Martini and Chemnitz, Conch.-Cab., *Nerita* and *Neritopsis*, Marten, p. 37, pl. 7, figs. 1-5, 1889.
One mile from Nukualofa, on shore rocks of lagoon, 3.

These specimens from Nukualofa agree very closely with some collected on the shore rocks about four miles west of Suva, Fiji, which show great variation in color and columellar dentition.

Ovula ovum (Linnaeus).

Bulla ovum Linnaeus: Syst. Nat., 10th ed., p. 725, 1758.
Ovula ovum (Linnaeus): Tryon, Man. Conch., vol. 7, p. 246, pl. 1, figs. 11, 12, 1885.
Makahaa, outer margin of reef, 2 living shells, collected by natives; Nukualofa, Ualagalalo reef, 1 living shell, collected by native fisherman.

Both foot and mantle of this unique and well-known species are black and produce a strong color contrast to the glistening white surface of the shell.

Peristernia nassatula (Lamarck).

Turbinella nassatula Lamarck: Animaux s. Vert., 2d ed., vol. 9, p. 387, 1843.
Turbinella nassatula Lamarck: Reeve, Conch. Icon., vol. 4, sp. 45, figs. 45*a*, 45*b*, 1847.
Peristernia nassatula (Lamarck): Tryon, Man. Conch., vol. 3, p. 80, pl. 64, figs. 44-51, 52, 58, 1881.
Hufagalupe, wave bench, on rocks, 1.

Peristernia spinosa (Martyn).

Peristernia spinosa (Martyn): Tryon, Man. Conch., vol 3, p. 80, pl. 64, figs. 48-50, 1881.

Turbinella spinosa Martyn: Martini and Chemnitz, Conch.-Cab., *Turbinella* and *Fasciolaria*, Küster and Kobelt, p. 39, pl. 10, figs. 4, 5, 1876.

Nukualofa, outer zone of fringing reef, under hurricane blocks, several; 2 miles east of Nukualofa, near shore, on rocks, 1; 3 miles east of Nukualofa, near shore, on rocks, 1.

Some Tongan specimens are encircled by brown bands; specimens collected near Suva, Fiji, lack the brown bands.

Peristernia subincarnata Garrett.

Nukualofa, outer zone of fringing reef, under hurricane block, 1 specimen.

This shell agrees closely with one from the barrier reef off Apia, Samoa. Determination has been based entirely upon a comparison with four specimens from Fiji in the Garrett collection in Bernice P. Bishop Museum. I have no access to Garrett's description or to any reference to it.

Planaxis sulcata Born.

Planaxis sulcatus Born: Tryon, Man. Conch., vol. 9, p. 276, pl. 52, figs. 22-27, 1887.

Nukualofa, fringing reef near shore, several dead specimens.

The shells collected are much larger than those collected in living state on the shore bar near Suva, Fiji.

Pisania ignea (Gmelin).

Buccinum igneum Gmelin: Syst. Nat. (Gmel. ed.), vol. 1, p. 3494, 1788.

Pisania ignea (Gmelin): Tryon, Man. Conch., vol. 3, p. 145, pl. 71, figs. 190-194, 1881.

Buccinum pictum Reeve: Conch. Icon., vol. 3, sp. 74, 1846.

Nukualofa, outer zone of fringing reef, under hurricane blocks, several; Vavau, Neiafu limestone quarry, 1 fossil, Hoffmeister and Ostergaard.

This species is represented by several varieties which differ in size, form, and color. The Tongan form seems typical of the species and is like that found in Hawaii. *Buccinum pictum* Reeve is a synonym that represents the typical form well.

Polinices candidissima (Le Guillon).

Natica candidissima Le Guillon: Tryon, Man. Conch., vol. 8, p. 46, pl. 16, fig. 49; pl. 19, fig. 95, 1886.

Natica jukesii Reeve: Conch. Icon., vol. 9, sp. 84, figs. 84 *a, b*, 1855.

Nukualofa, inner zone of fringing reef, sandy mud, several dead shells.

Distinguished from *P. flemingiana* Recluz by its greatly reduced and depressed spire.

Polinices melanostoma (Gmelin).

Nerita melanostoma Gmelin: Linnaeus, Syst. Nat. (Gmel. ed.), vol, 1, p. 3674, 1788.

Natica melanostoma (Gmelin): Tryon, Man. Conch., vol. 8, p. 50, pl. 21, figs. 13-18, 1886.

Nukualofa, inner zone of fringing reef, in sandy mud, several; 2 miles east of Nukualofa, inner zone of fringing reef, in sandy mud, 1.

The species may easily be recognized by its light brown bands and blackish columellar lip.

Pterocera lambis (Linnaeus).

Strombus lambis Linnaeus: Syst. Nat., 10th ed., p. 743, 1758.
Pterocera lambis (Linnaeus): Tryon, Man. Conch., vol. 7, p. 124, pl. 8, figs. 1-3, 1885.
Makahaa, among rocks, openly exposed in sandy places, 2.

This common Indo-Pacific species varies much in size and proportionate length and curvature of its digitations, but is very distinct from all other known species.

Pyramidella sulcata A. Adams.

Pyramidella sulcata A. Adams: Tryon, Man. Conch., vol. 8, p. 301, pl. 72, figs. 79-83, 1886.
Nukualofa, inner zone of fringing reef, in sandy mud, 2.

The specimens from Nukualofa agree closely with one found at Suva, Fiji, and with those of Hawaii, where it is very common.

Solida sulcata (Gmelin).

Solida sulcata Gmelin: Tryon and Pilsbry, Man. Conch., vol. 15, p. 143, pl. *20A*, figs. 39, 46-48, 1893.
Nukualofa, inner zone of fringing reef, 4 dead shells; 3 miles east of Nukualofa, near shore, in shallow water, 2 dead shells.

Tryon and Pilsbry state that this species is subject to great mutation in form, size, and color.

Strombus dentatus rugosus Sowerby.

Strombus dentatus rugosus Sowerby: Tryon, Man. Conch., vol. 7, p. 119, fig. 72, 1885.
Strombus rugosus Sowerby: Reeve, Conch. Icon., vol. 6, sp. 16, 1850.
Three miles east of Nukualofa, fringing reef near shore, in sand pockets on rocky bottom, several dead, perfectly preserved shells; Nukualofa, reef, 1 dead shell.

Strombus dentatus Linnaeus has many varieties. Tryon included *S. rugosus* Sowerby, and I have included it, though with doubt.

Strombus floridus Lamarck.

Strombus floridus Lamarck, Animaux s. Vert., 2d ed., vol. 9, p. 707, 1843.
Strombus floridus Lamarck: Tryon, Man. Conch., vol. 7, p. 119, pl. 7, figs. 73-76, 80, 83, 1885.
Nukualofa, 2d zone of fringing reef, openly exposed on rocks, several; Makahaa, on reef, 2; windward Tongatabu, Houma, Haakama, and Hufagalupe, on wave bench, several. At Suva, Fiji, numerous hermit crab specimens were seen on the shore bar.

Although this species varies greatly in coloration and considerably in form, it is sufficiently distinct from all others to be readily recognized.

Strombus gibberulus Linnaeus.

Strombus gibberulus Linnaeus: Syst. Nat., 10th ed., p. 744, 1758.
Strombus gibberulus Linnaeus: Tryon, Man. Conch., vol. 7, p. 121, pl. 8, fig. 85, 1885.
Strombus gibberulus Linnaeus: Reeve, Conch. Icon., vol. 6, sp. 15, figs. 15, *a*, *b*, 1850.
Two miles east of Nukualofa, fringing reef, near shore, sandy mud, openly exposed, several colonies with numerous individuals; Nukualofa, inner zone of fringing reef, several.

This very common and well-defined Indo-Pacific species inhabits the shallow waters of sheltered sandy and muddy beaches.

Terebra cerithina Lamarck.

Terebra cerethina Lamarck: Tryon, Man. Conch., vol. 7, p. 12, pl. 2, figs. 30, 14, 1885.
Terebra cerithina Lamarck: Martini and Chemnitz, Conch.-Cab., *Volutacea,* Menke and Küster, p. 17, pl. 4, fig. 6, 1841.
Pagaimotu, near shore, sandy mud, 1 dead shell.

This species, which also occurs in Hawaii, is sufficiently distinct to be determined with assurance.

Terebra subulata (Linnaeus).

Buccinum subulatum Linnaeus: Syst. Nat. (Gmel. ed.), vol. 1, p. 3499, 1788.
Terebra subulata (Linnaeus): Tryon, Man. Conch., vol. 7, p. 10, pl. 1, fig. 3, pl. 3, fig. 35, 1885.
Three miles east of Nukualofa, sand bar, 1 dead shell.

Not uncommon in Hawaii. Usually recognized by revolving square brown spots and faint groove below the suture.

Thais hippocastanum (Lamarck).

Purpura hippocastanum Lamarck: Animaux s. Vert., 2d ed., vol. 10, p. 64, 1844.
Purpura hippocastanum Lamarck: Tryon, Man. Conch., vol. 2, p. 162, pl. 45, figs. 36-43, 1880.
Purpura hippocastanum Linnaeus: Reeve, vol. 3, sp. 34, figs. 34, *a-c,* 1846.
Haakama, undercut cliff along wave bench, common in several stages; Hufagalupe, wave bench, 1 living and 1 dead; Nukualofa, along pier at high water mark, on loose stones, 2.

Tryon includes several varieties with this species. It appears to me that specimens from Tongatabu are too near the type of the species to be considered a variety.

Thais hippocastanum distinguenda (Dunker).

Purpura hippocastanum distinguenda Dunker: Tryon, Man. Conch., vol. 2, p. 162, pl. 45, fig. 37, 1880.
Purpura hippocastanum Lamarck: Kiener, Icon. des Coqu. Viv., p. 52, pl. 13, figs. 36, *a,* variété.
Haakama, wave bench, on undercut sea cliff and lower part of sea cliff, several, found with *T. hippocastanum,* though entirely distinct from them; Hufagalupe, on wave bench, 2.

This is a well-pronounced variety. All specimens collected at Tongatabu differ from the type of the species in form and coloration.

Thais hippocastanum intermedia (Kiener).

Purpura hippocastanum intermedia Kiener: Tryon, Man. Conch., vol. 2, p. 162, pl. 45, fig. 41, 1880.
Purpura intermedia Kiener: Reeve, Conch. Icon., vol. 3, sp. 38, 1846.
Hufagalupe, wave bench, 1 dead shell.

I do not know whether this form has been found to intergrade with *T. hippocastaneum* or any of its varieties. In Hawaii this is the only form of the species known.

Thais pica (Blainville).

Purpura pica Blainville: Tryon, Man. Conch., vol. 2, p. 163, pl. 46, figs. 46, 47, 52, 53, 1880.

Purpura pica Blainville: Reeve, Conch. Icon., vol. 3, sp. 36, 1846.

Hufagalupe, wave bench, 3 dead and 1 living; Nukualofa, on loose stones by pier, 1; Makahaa, reef, 1.

This very solid species seems entirely distinct from all others in the genus.

Tonna olearium (Bruguière).

Dolium olearium Bruguière: Tryon, Man. Conch., vol. 7, p. 262, pl. 2, fig. 8, 1885.

Dolium olearium Bruguière: Martini and Chemnitz, Conch.-Cab., *Cassis, Oniscia, Dolium,* etc., Küster, p. 68, pl. 61, fig. 1, 1857.

Leeward Tongatabu, Pagaimotu, beach, 1 dead, collected by native.

Tryon figures and describes three varieties of this species.

Tonna perdix (Linnaeus).

Buccinum perdix Linnaeus: Syst. Nat., 10th ed., p. 734, 1758.

Dolium perdix (Linnaeus): Tryon, Man. Conch., vol. 7, p. 264, pl. 3, fig. 15; pl. 4, figs. 23-25, 1885.

Dolium perdix (Linnaeus): Martini and Chemnitz, Conch.-Cab., *Cassis, Oniscia, Dolium,* etc., Küster, p. 69, pl. 61, fig. 2, 1857.

Eua, beach, 1 shell, Parks.

This well-known species offers little difficulty of identification owing to the distinctive features of its shell. It is also remarkable for its circumterrestrial distribution. Martini and Chemnitz make the following remark: "Wie in der Form, so bietet diese Art auch in der Verbreitung eine Ausnahme von den Übrigen, meist auf eine bestimmte Gegend beschkränkten Arten. Man findet sie auf beiden Halbkugeln, am Senegal, in West- und Ostindien und im stillen Meer."

Trochus calcaratus Souverbie.

Trochus calcaratus Souverbie: Tryon and Pilsbry, Man. Conch., vol. 11, p. 30, pl. 2, fig. 15; pl. 8, figs. 83, 84, 1889.

Nukualofa, outer zone of fringing reef, under hurricane blocks, 2.

Tryon and Pilsbry state that this form, like *T. tubiferus* Kiener, is principally distinguished by the fistulous or perforated peripheral tubercles.

Trochus incrassatus creniferus Kiener.

Trochus incrassatus creniferus Kiener: Tryon and Pilsbry, Man. Conch., vol. 11, p. 27, pl. 7, figs. 67, 68, 1889.

Hufagalupe, wave bench, foot of sea cliff, several dead shells; Houma, wave bench, 1 dead; Houma, sea cliff, several fossils.

Among these few examples a considerable difference is seen in the height of the shell compared to width, which would show that such a difference is only an individual variation. The Tongan specimens possess some characters that belong to *T. incrassatus* and some that belong to variety *creniferus,* but appear to be closer to the latter. A number of specimens collected by T. T. Dranga and L. A. Thurston on Tutuila, Samoa, agree closely to the Tongan form.

Trochus obeliscus Gmelin.

Trochus obeliscus Gmelin: Linnaeus, Syst. Nat. (Gmel. ed.), vol. 1, p. 3579, 1788.
Trochus obeliscus Gmelin: Tryon and Pilsbry, Man. Conch., vol. 11, p. 19, pl. 2, figs. 13, 14, 1889.
Leeward Tongatabu, Monu reef, shallow water with moderate surf, several; Makahaa, reef, 2; Houma, sea cliff, several fossils.

Tryon states, "I believe that this is *T. pyramis* of Born, but since there is some doubt about it, I have followed the precedent of Dr. Fisher in adopting Gmelin's name." I believe it is safe to agree with this conclusion.

Trochus tubiferus Kiener.

Trochus tubiferus Kiener: Tryon and Pilsbry, Man. Conch., vol. 11, p. 31, pl. 6, figs. 62, 63, 1889.
Nukualofa, outer zone of fringing reef, under hurricane blocks, several; Houma, sea cliff, several fossils; Holoipepe quarry, 1 fossil.

The carinated and spinose periphery of this species appears to be one of its distinctive characters.

Turbo argyrostomus Linnaeus.

Turbo argyrostomus Linnaeus: Syst. Nat., 10th ed., p. 764, 1758.
Turbo argyrostomus Linnaeus: Tryon and Pilsbry, Man. Conch., vol. 10, p. 197, pl. 40, fig. 18, 1888.
Makahaa, reef, 2; Hufagalupe, wave bench, 2 dead shells; Houma, sea cliff, many fossil shells and opercula; Haakama, sea cliff, 1 fossil; Nukualofa quarry, several fossils, Hoffmeister.

There is no doubt that there are several geographical races or varieties of this species that might be considered distinct species, if it were not for the series of intergradations linking them. *T. margaritaceus* Linnaeus, according to the author's description, differs very little from his *T. argyrostomus.* It is a question whether *T. intercostalis* Menke should not also be considered a variety.

Turbo chrysostomus Linnaeus.

Turbo chrysostomus Linnaeus: Syst. Nat., 10th ed., p. 762, 1758.
Turbo chrysostomus Linnaeus: Tryon and Pilsbry, Man. Conch., vol. 10, p. 200, pl. 40, fig. 19, 1888.
Nukualofa, outer zone of fringing reef, under hurricane blocks, fairly common; 2 and 3 miles east of Nukualofa, fringing reef, under loose stones, several; Nukualofa, pier, at high water mark on loose stones, 3.

Tryon and Pilsbry state that the golden-orange color of the throat is diagnostic of this species.

Turbo crassus Wood.

Turbo crassus Wood: Tryon and Pilsbry, Man. Conch., vol. 10, p. 194, pl. 47, fig. 20, 1888.

Houma, on wave bench, foot of sea cliff, 1; Houma, sea cliff, 2 fossils; Eua, beach, 1 operculum, Parks.

This ponderous *Turbo* is so distinct in form and sculpturing that its identification involves little difficulty.

Turbo setosus Gmelin.

Turbo setosus Gmelin: Linnaeus, Syst. Nat. (Gmel. ed.), vol. 1, p. 3594, 1788.
Turbo setosus Gmelin: Tryon and Pilsbry, Man. Conch., vol. 10, p. 195, pl. 63, fig. 32, 1888.
Turbo setosus Gmelin: Reeve, Conch. Icon., vol. 4, sp. 37, 1848.

Hufagalupe, wave bench, on rocks, several; Haakama, on wave bench, several.

A combination of characters that is present seems to exclude this species from all others.

Turbo petholatus Linnaeus.

Turbo petholatus Linnaeus: Syst. Nat., 10th ed., p. 762, 1758.
Turbo petholatus Linnaeus: Tryon and Pilsbry, Man. Conch., vol. 10, p. 193, pl. 40, fig. 14, 1888.
Turbo petholatus Linnaeus: Reeve, Conch. Icon., vol. 4, sp. 12, 1848.

Nukualofa, fringing reef, 1 dead shell; Nukualofa, limestone quarry, 1 fossil, Hoffmeister; Eua, on beach, 1, Parks.

This beautiful species, including *T. militaris* Reeve (which Tryon considers a synonym) and the varieties *reevei* Philippi and *variabilis* Reeve, seems well defined and is characterized by its smooth, glossy shell and shiny, highly colored operculum.

Vasum ceramicum (Linnaeus).

Voluta ceramica Linnaeus: Syst. Nat. (Gmel. ed.), vol. 1, p. 3462, 1788.
Turbinella, ceramica (Linnaeus): Reeve, Conch. Icon., vol. 4, sp. 46, 1847.
Vasum ceramicum (Linnaeus): Tryon, Man. Conch., vol. 4, p. 72, pl. 20, fig. 10, pl. 21, figs. 15, 18, 1882.

Hufagalupe, wave bench, 2 dead specimens occupied by hermit crabs.

Vexillum nodosum (Swainson).

Turricula nodosa (Swainson): Tryon, Man. Conch., vol. 4, p. 193, pl. 56, figs. 638-641, 1882.
Mitra nodosa Swainson: Reeve, Conch. Icon., vol. 2, sp. 196, figs. 196*a*, 196*b*, 1844.

Hufagalupe, wave bench, in sand pockets, several.

This species may easily be recognized by its rounded tubercles.

PELECYPODA

Antigona puerpera (Linnaeus).

Venus puerpera Linnaeus: Syst. Nat. (Gmel. ed.), vol. 1, p. 3276, 1788.
Venus puerpera Linnaeus: Martini and Chemnitz, Conch.-Cab., *Veneracea,* Pfeiffer, p. 145, pl. 10, figs. 4, 5, 1869.
Venus puerpera Linnaeus: Reeve, Conch. Icon., vol. 14, sp. 10, 1863.

Separate valves of this species occur in considerable number along the beach and close to the shore of leeward Tongatabu. I saw no living specimens of it. Similarly, on the shore bar near Suva, Fiji, dead shells were also found, a number of them with the two valves united. Reeve comments that "the rust-stained coloring of this well-known species is not an unimportant character."

Antigona reticulata (Linnaeus).

Venus reticulata Linnaeus: Syst. Nat. 10th ed., p. 687, 1758.
Venus reticulata Linnaeus: Martini and Chemnitz, Conch.-Cab., *Veneracea,* Pfeiffer, p. 143, pl. 10, figs. 1, 2, 1869.
Houma, sea cliff, 1 fossil.

No living specimens were seen in Tonga. A few were found on the barrier reef at Apia, Samoa. In Hawaii it is not uncommon in the living state, and as a fossil it is abundant in the limestone of Oahu.

Arca antiquata Linnaeus.

Arca antiquata Linnaeus: Syst. Nat., 10th ed., p. 694, 1758.
Arca antiquata Linnaeus: Reeve, Conch. Icon., vol. 2, sp. 60, 1844.
Makahaa, rocky bottom on reef, 2.

Shells of this species litter the beach of leeward Tongatabu for miles and are probably derived from native refuse heaps. They are brought in from outlying reefs, as they have an important food value. The species appear to be common in Fiji as well as in Tonga. I believe that this identification is correct.

Arca divaricata (Sowerby).

Arca divaricata (Sowerby): Martini and Chemnitz, Conch.-Cab., *Arca,* Kobelt, p. 111, pl. 29, figs. 6-9, 1891.
Arca divaricata (Sowerby): Reeve, Conch. Icon., vol. 2, sp. 108, 1844.
Holoipepe quarry, 1 fossil.

No living specimens were seen in Tonga. An elongated form from the Tuamotus is in the Garrett collection. The species may be identified best by its divaricated ribs on the concave posterior area.

Arca fusca Bruguière.

Arca fusca Bruguière: Martini and Chemnitz, Conch.-Cab., *Arca,* Kobelt, p. 18, pl. 4, fig. 2; pl. 6, figs. 5, 6, 1891.
Arca fusca Bruguière: Reeve, Conch. Icon., vol. 2, sp. 82, 1844.

Nukualofa, outer zone of fringing reef, several, attached by their byssus to hurricane blocks; leeward Tongatabu, Monu reef, common, attached by their byssus to under side of hurricane blocks; Makahaa reef, exposed on rocks, 2; Nukualofa quarry, several fossils; Holoipepe quarry, 1 fossil, Hoffmeister; Vavau, Neiafu, limestone excavation, 2 fossils.

Arca maculata Reeve.

Arca maculata Reeve: Conch. Icon., vol. 2, sp. 71, 1844.
Arca maculata Sowerby: Martini and Chemnitz, Conch.-Cab., *Arca,* Kobelt, p. 76, pl. 21, figs. 7-10, 1891.
Nukualofa, in outer zone of fringing reef, 2.

This small species is conspicuous for its sharply marked-off posterior area.

Cardita variegata Bruguière.

Cardita variegata Bruguière: Martini and Chemnitz, Conch.-Cab., *Carditaceen,* Clessin, p. 23, pl. 3, figs. 8, 9; pl. 11, figs. 5, 6, 1888.
Cardita variegata Bruguière: Reeve. Conch.-Cab., vol. 1, sp. 3, 1843.
Nukualofa, on fringing reef, 1; Nukualofa quarry, 1 fossil, Hoffmeister.

This species may be distinguished from *C. calyculata* Linnaeus by a much less anteromedian curvation of the umbo region and by its much more strongly imbricated posterior ribs. *C. calyculata* Linnaeus is reported from the Mediterranean and the Portuguese coast.

Cardium fragum Linnaeus.

Cardium fragum Linnaeus: Syst. Nat., 10th ed., p. 679, 1758.
Cardium fragum Linnaeus: Martini and Chemnitz, Conch.-Cab., *Cardiacea,* Eduard Römer, p. 105, pl. 4, figs. 9, 10, 1869.
Nukualofa, inner zone of fringing reef, in sandy mud, 2.

This species is readily distinguished from *C. hemicardium,* to which it is probably most closely related, by a much more obtuse anterolateral angle, a bluntly rounded longitudinal keel, and much closer approximation of umbones.

Cardium lyratum Sowerby.

Cardium lyratum Sowerby: Martini and Chemnitz, Conch.-Cab., *Cardiacea,* Römer, p. 96, pl. 14, figs. 4, 5, 6, 1869.
Cardium lyratum Sowerby: Reeve, Conch. Icon., vol. 2, sp. 12, 1844.
Pagaimotu, on sandy and muddy beach, 1 dead shell.

Reeve states: "The *Cardium lyratum* may be distinguished from the *Cardium pectinatum* (*C. aeolicum* Born), to which it is so closely allied, by its having no smooth area on its posterior side."

Cardium maculosum Wood.

Cardium maculosum Wood: Reeve, Conch. Icon., vol. 2, sp. 76, 1845.
Nukualofa, limestone quarry, 1 fossil, Hoffmeister.

This small species is characterized by its very fine ribs.

Cardium orbita Broderip and Sowerby.

Cardium orbita Broderip and Sowerby: Zool. Soc., Proc., p. 83, 1833.
Cardium orbita Broderip and Sowerby: Reeve, Conch. Icon., vol. 2, sp. 85, 1845.
Holoipepe quarry, 2 fossils, Hoffmeister and Ostergaard; Mua Road quarry, 1 fossil, Hoffmeister.

This species is common in living state in Hawaii. Reeve remarks: "The sculpture of this species is well characterized by oblique alternately diverging minute scales which ornament the middle ribs."

Cardium unedo Linnaeus.

Cardium unedo Linnaeus: Syst. Nat., 10th ed., p. 680, 1758.
Cardium unedo Linnaeus: Martini and Chemnitz, Conch.-Cab., *Cardiacea,* Eduard Römer, p. 101, pl. 4, figs. 11, 12, 1869.
Cardium unedo Linnaeus: Reeve, Conch. Icon., vol. 2, sp. 13, 1844.
Nukualofa, inner zone of fringing reef, exposed or concealed in sandy mud, several; 3 miles east of Nukualofa, near shore, in shallow water on sandy bottom, 1 dead shell. May not be uncommon in the sandy mud of the inner zone of the fringing reef, as many separate valves are seen along the shore.

This *Cardium* seems to be quite distinct, and I know no other species that could be confused with it.

Chama iostoma Conrad.

Chama iostoma Conrad: Martini and Chemnitz: Conch.-Cab., Chamiden, Clessin, p. 19, pl. 7, fig. 4, 1889.
Eua, beach, 2 upper valves, Parks.

Chione lamarckii Gray.

Nukualofa, inner zone of fringing reef, exposed or buried in sandy mud, several.

The only source of identification of this species was comparison with specimens in the Garrett collection in Bernice P. Bishop Museum.

Chlamys pallium (Linnaeus).

Ostrea pallium Linnaeus: Syst. Nat., 10th ed., p. 697, 1758.
Pecten pallium (Linnaeus): Reeve, Conch. Icon., vol. 8, sp. 63, figs. 63, *a-c,* 1853.
Nukualofa, 2d and 4th zones of fringing reef, several, attached by their byssus to rocks; Makahaa, reef, several; Haakama, sea cliff, 2 fossils, Hoffmeister.

This species shows considerable range of coloration. Color variety 63, *a,* of Reeve agrees very closely with the Tongan form.

Chlamys radula (Linnaeus).

Ostrea radula Linnaeus: Syst. Nat., 10th ed., p. 697, 1758.
Pecten radula (Linnaeus): Martini and Chemnitz, Conch.-Cab., *Spondylus* and *Pecten,* Küster and Kobelt, p. 54, pl. 15, figs. 1, 2, 1888.
Pecten radula (Linnaeus): Reeve, Conch. Icon., vol. 8, sp. 83, 1853.
Three miles east of Nukualofa, fringing reef, on rocks, 4.

This species is peculiarly distinct.

Chlamys squamosus (Gmelin).

Ostrea squamosa Gmelin: Linnaeus, Syst. Nat. (Gmel. ed.), vol. 1, p. 3319, 1788.
Pecten hybridus (Gmelin): Martini and Chemnitz, Conch.-Cab., *Spondylus* and *Pecten*, Küster and Kobelt, p. 86, pl. 19, figs. 7, 8; pl. 22, figs. 5, 7, 10, 1888.
Pecten squamosus (Gmelin): Reeve, Conch. Icon., vol. 8, sp. 65, 1853.
Makahaa, reef, in rocky places, several; Nukualofa, in outer zone of fringing reef, 1.

I do not believe with Martini and Chemnitz that Gmelin's *Ostrea hybrida* is synonymous with his *O. squamosa*. Gmelin reports *O. hybrida* from Norwegian waters and does not mention the scaly ribs which characterize *O. squamosa*. This species has a wide range of color forms.

Circe dispar (Chemnitz).

Cytherea dispar Chemnitz: Martini and Chemnitz, Conch.-Cab., *Veneracea*, Pfeiffer, p. 32, pl. 11, figs. 5, 6, 1869.
Nukualofa, inner zone of fringing reef, in sandy mud, several (majority dead).

Circe gibbia (Lamarck).

Cytherea gibbia Lamarck, Animaux s. Vert., 2d ed., vol. 6, p. 323, 1835.
Cytherea gibbia Lamarck: Martini and Chemnitz, Conch.-Cab., *Veneracea*, Pfeiffer, p. 51, pl. 18, figs. 7-9, 1869.
Nukualofa, fringing reef, 1; leeward Tongatabu, beach, several separate valves.

Large specimens from Samoa and Fiji are in Bernice P. Bishop Museum.

Circe transversaria (Deshayes).

Nukualofa, fringing reef, 1; 3 miles east of Nukualofa, fringing reef, 1.

I have seen no literature on this species and have been obliged to base my determination upon specimens in the Garrett collection.

Codakia interrupta (Lamarck).

Cytherea interrupta Lamarck: Animaux s. Vert., 2d ed., vol. 6, p. 318, 1835.
Cytherea interrupta Lamarck: Martini and Chemnitz, Conch.-Cab., *Veneracea*, Pfeiffer, p. 261, 1869.
Lucina interrupta (Lamarck): Reeve, Conch. Icon., vol. 6, sp. 5, figs. 5, *a*, *b*, 1850.
Three miles east of Nukualofa, fringing reef, near shore, in sandy mud, several dead shells with valves united; Nukualofa, 1st zone of fringing reef, on sandy bottom, 1 dead shell.

This species may be distinguished from *Codakia punctata* Linnaeus by its much finer striations, but specimens from Tonga differ also in this respect, so that the relationship between the two species seems still closer. Martini and Chemnitz include it as a synonym with *Lucina tigerina* Linnaeus. This does not seem to hold, as *L. tigerina* has distinctly crenulated sculpturing.

Codakia punctata (Linnaeus).

Venus punctata Linnaeus: Syst. Nat., 10th ed., p. 688, 1758.
Lucina punctata (Linnaeus): Martini and Chemnitz, Conch.-Cab., *Veneracea*, Pfeiffer, p. 262, pl. 19, figs. 8, 9, 1869.
Lucina punctata (Linnaeus): Reeve, Conch. Icon., vol. 6, sp. 2, 1850.
Nukualofa, near shore, in sandy mud, 1.

This species appears to be closely related to *C. interrupta Lamarck* and may be found to intergrade with it.

Codakia ramulosa (Gould).

Lucina ramulosa Gould, U. S. Expl. Exp., vol. 12, p. 415, pl. 36, figs. 523, a, b, 1856.
Nukualofa, fringing reef, 1.

This is no doubt one of the several forms of Reeve's *Lucina fibula.*

Codakia tigerina (Linnaeus).

Venus tigerina Linnaeus: Syst. Nat., 10th ed., p. 688, 1758.
Lucina tigerina (Linnaeus): Reeve, Conch. Icon., vol. 6, sp. 3, 1850.
Nukualofa, inner zone of fringing reef, in sandy mud, 1; Nukualofa quarry, 1 large fossil, Hoffmeister.

I believe that Reeve's *Lucina exasperata* should be treated as a synonym, not even as a variety. His distinction between sculpturs and presence or absence of a rose margin apparently does not hold. The species is remarkable for its reported universal distribution in the tropics.

Corbis fimbriata (Linnaeus).

Venus fimbriata Linnaeus: Syst. Nat., 10th ed., p. 687, 1758.
Fimbria fimbriata (Linnaeus): Martini and Chemnitz, Conch.-Cab., *Veneracea,* Pfeiffer, p. 278, pl. 21, figs. 1, 2, 1869.
Nukualofa, inner zone of fringing reef, in sandy mud, several; about 3 miles east of Nukualofa, near shore, in sandy mud, 2.

I know of but one species included in this genus. The examples from Tonga are of much smaller size than those described in the literature and those in the Garrett collection of Bernice P. Bishop Museum.

Cytherea castrensis (Linnaeus).

Venus castrensis Linnaeus: Syst. Nat., 10th ed., p. 687, 1758.
Cytherea castrensis (Linnaeus): Martini and Chemnitz, Conch.-Cab., *Veneracea,* Pfeiffer, p. 37, pl. 12, figs. 3-6, 1869.
Nukualofa, fringing reef, 1 single valve.

Martini and Chemnitz figure considerable variation of the brown waves which characterize the outer surface of this species. Their figures are most typical.

Lima fragilis Chemnitz.

Lima fragilis Chemnitz: Reeve, Conch. Icon., vol. 18, sp. 18, figs. 18, *a, b,* 1872.
Three miles east of Nukualofa, near shore, in sandy mud, several.

Of this species Reeve says: "The South Sea variety, fig. *a* may be a little less oblique and more ventricose than the Philippine one, fig. *b,* but there seems to be no essential difference between them." On the reef at Suva, Fiji, I observed a specimen swimming by a flopping movement of its valves.

Lima squamosa Lamarck.

Lima squamosa Lamarck: Animaux s. Vert., 2d ed., vol. 7, p. 115, 1836.
Lima squamosa Lamarck: Reeve, Conch. Icon., vol. 18, sp. 10, 1872.
Ostrea lima Linnaeus: Syst. Nat., 10th ed., p. 699, 1758.
Mua Road quarry, Holoipepe quarry, and Nukualofa quarry, several fossils, Hoffmeister.

Reeve's figure and description agree very closely with these shells, some of which are in a very good state of preservation. No living specimens were seen in Tonga.

Lithophaga corrugata (Philippi).

Lithodomus corrugatus (Philippi): Reeve, Conch. Icon., vol. 10, sp. 1, 1858.
Nukualofa quarry, 37, Hoffmeister; Holoipepe quarry, 15, Hoffmeister and Ostergaard; Mua Road quarry, 5, Hoffmeister. Seen in Tonga in fossil state only.

Most of the fossils of this rock-boring bivalve are represented by internal moulds, and as its form is closely approached by at least three other South Pacific species, considerable difficulty would have arisen in indentifying it if it were not for one specimen which had a portion of both valves clinging to the mould near its posterior end. The faint undulating corrugated lines present on these shell fragments are the chief diagnostic characters of this species (pl. 1, *C*).

Lucina vesicula Gould.

Lucina vesicula Gould: U. S. Expl. Exped., vol. 12, p. 414, pl. 36, figs. 525, *a, b,* 1856.
Nukualofa, inner zone of fringing reef, 2 entire shells.

Modiolus lignea Reeve.

Modiola lignea Reeve: Conch. Icon., vol. 10, sp. 58, fig. 71, 1858.
Nukualofa, inner zone of fringing reef, 1 dead shell with two united valves.

This is a rather solid ventricose shell which seems quite distinct from all other species.

Modiolus metcalfei Hanly.

Modiola metcalfei Hanly: Reeve, Conch. Icon., vol. 10, sp. 16, figs. 16, *a, b,* 1857.
Houma, wave bench, a few separate valves.

This species may be distinguished from all others by its form and coloration.

Modiolus plumescens Dunker.

Nukualofa, beach, 1 fresh specimen with valves separated and animal removed. The exact habitat is uncertain as this shell might have been brought in by natives from distant reefs for food.

The only source of identification found is the Garrett collection of Bernice P. Bishop Museum.

Pinctada cumingii (Reeve).

Avicula cumingii Reeve: Conch. Icon., vol. 10, sp. 6, 1857.
Avicula (Meleagrima) cumingii Reeve: Martini and Chemnitz, Conch.-Cab., *Avicula,* Dunker, p. 22, pl. 6, fig. 3, 1872.
Makahaa, reef, immature, 2 juveniles.

A closely related species of this fine pearl oyster, *Pinctada galtsoffi* Bartsch, has been described recently from Hawaii.

Pteria castanea (Reeve).

Avicula castanea Reeve: Conch. Icon., vol. 10, sp. 49, 1857.
Avicula castanea Reeve: Martini and Chemnitz, Conch.-Cab., *Avicula,* Dunker, p. 61, pl. 21, fig. 7, 1872.
Makahaa, reef, 1.

The anterior process from the umbo is longer and narrower than in the form described by Reeve, but I know of no other form approaching it more closely.

Tellina cruciata Spengler.

Nukualofa, inner zone of fringing reef, in sandy mud, 1 dead specimen with united valves; Mua Road quarry, fossil, Hoffmeister.

I can find no literature on this species and base my conclusion solely on three specimens in the Garrett collection of Bernice P. Bishop Museum. This *Tellina* may prove synonymous with *T. staurella* Lamarck.

Tellina scobinata Linnaeus.

Tellina scobinata Linnaeus: Syst. Nat., 10th ed., p. 676, 1758.
Tellina scobinata Linnaeus: Martini and Chemnitz, Conch.-Cab., *Tellina,* Martini, p. 73, pl. 20, figs. 5-8, 1774.
Eua, 2 valves of a beach shell, Parks.

Martini points out the diagnostic features of this species: "Diese Telline wird durch ihren grossen, fast kreisförmig, hinten allein durch eine kleine Ein-und Ausbiegung gestörten Umriss von allen kenntlich gemacht." The species appears to be very closely related to *T. elizabethae* Pilsbry, the Hawaiian species, in which the characteristic semilunar scales are finer.

Trapezium oblongum (Linnaeus).

Chama oblonga Linnaeus: Syst. Nat., 10th ed., p. 692, 1758.
Cypricardia oblonga (Linnaeus): Reeve, Conch. Icon., vol. 1, sp. 4, 1843.
Nukualofa quarry, in fossil state, Hoffmeister and Ostergaard; Holoipepe quarry, in fossil state.

The species is found in Oahu as fossil and in living state is distributed among the Hawaiian islands. It appears to be synonymous with *T. duperreyi* Deshayes.

Tridacna gigas Lamarck.

Tridacna gigas Lamarck: Animaux s. Vert., 2d ed., vol. 7, p. 8, 1836.
Tridacna gigas Lamarck: Martini and Chemnitz, Conch.-Cab., *Tridacna, Hippopus*, Küster, p. 3, pl. 1, fig. 5, 1868.
Monu reef, common in many stages of growth; Nukualofa quarry, 2 fossils, Hoffmeister; Nukualofa, in reefs and shoal waters, brought to Nukualofa in large quantities by native fishermen for food.

This mollusk attains by far the greatest size of all bivalves. It is easily distinguished in adult form from other species and usually without much difficulty in young stages.

SUMMARY

Of the 38 species of fossil marine mollusks collected in Tonga and identified, 27 were found living in the surrounding waters and the remaining 11 have been reported as living in the South Pacific or Central Pacific, several of them in Tonga. None were found to be extinct.

Some of the species found only in fossil state seem to thrive in the warmer waters of the Pacific, and others found common as fossils but rare in the living state are known to be common in the warmer waters of Samoa. From this the inference might be drawn that the Tongan waters had a temperature when the fossiliferous limestone of Tongatabu was being deposited higher than that existing at the present time.

The conditions of deposition of the Tongan limestone have a close parallelism in the emergent limestone of Oahu.[3] The resemblance between the two formations is seen to be closer still when the evidence available for determining the geological ages of the limestones of the two regions is considered. The absence of extinct forms in Tongatabu as compared with 3 presumably extinct species, 2 of them oysters, among the 82 fossil forms of Oahu, indicates corresponding age, especially in view of the fact that in local extinction of species the two regions agree also closely.

I believe the geological age of the limestone of Tongatabu, like that of Oahu, is late Pleistocene; and it seems that a warmer temperature existed in both regions during their formations. The observed conditions are explained by referring the deposition of the limestones to the so-called third interglacial epoch, the close of which Osborn[4] places at about 50,000 years ago. During that epoch it is assumed that a southern as well as a northern expansion of the tropics took place and a higher level of the sea, due to the conversion into water of vast ice accumulations, submerged the limestones then in process of formation. This assumption, of course, implies that the sea has again been rising as a result of the retreating glaciers of the fourth or last glacial

[3] Ostergaard, J. M., Fossil marine mollusks of Oahu; B. P. Bishop Mus., Bull. 51, p. 32, 1928.
[4] Osborn, H. F., Man of the old stone age, p. 108, 1916.

period. That such changes of water level correspond to glacial and interglacial periods is, however, difficult to demonstrate, because of local movements of the earth's crust. Only by extensive study and comparisons of the emergent shore lines could substantial data be gathered.

As the island of Tongatabu, Tonga, lies almost exactly the same distance south of the equator as the island of Oahu, Hawaii, lies north of it, and as each island is surrounded by a vast expanse of ocean, a similarity in the marine fauna might be expected. Although there is no close similarity in species between the marine mollusks of the two regions, a few gastropods, such as *Cypraea caput-serpentis* and *Conus ebraeus,* are abundant in both regions but seem to be much less common in the warmer seas of Fiji and Samoa. On the other hand, many species that are rare in Hawaii are common on the shores of Tongatabu. Four species of Cypraea—*lynx, tigris, virtellus, erosa*—which appear to be almost extinct in Hawaii are common in southern Tonga. *Cypraea erosa* is common, however, as fossil in the limestone of Oahu. It is probable that the principal cause of this difference is a temperature of the sea in southern Tonga during the warmer part of the year higher than that in Hawaii during the corresponding season. Observations in Hawaii tend to show that most of the marine mollusks spawn when the water temperature is highest. If the minimum temperature for spawning in a species is infrequently reached, there would be a decrease in the number of individuals which might approach or reach extinction.

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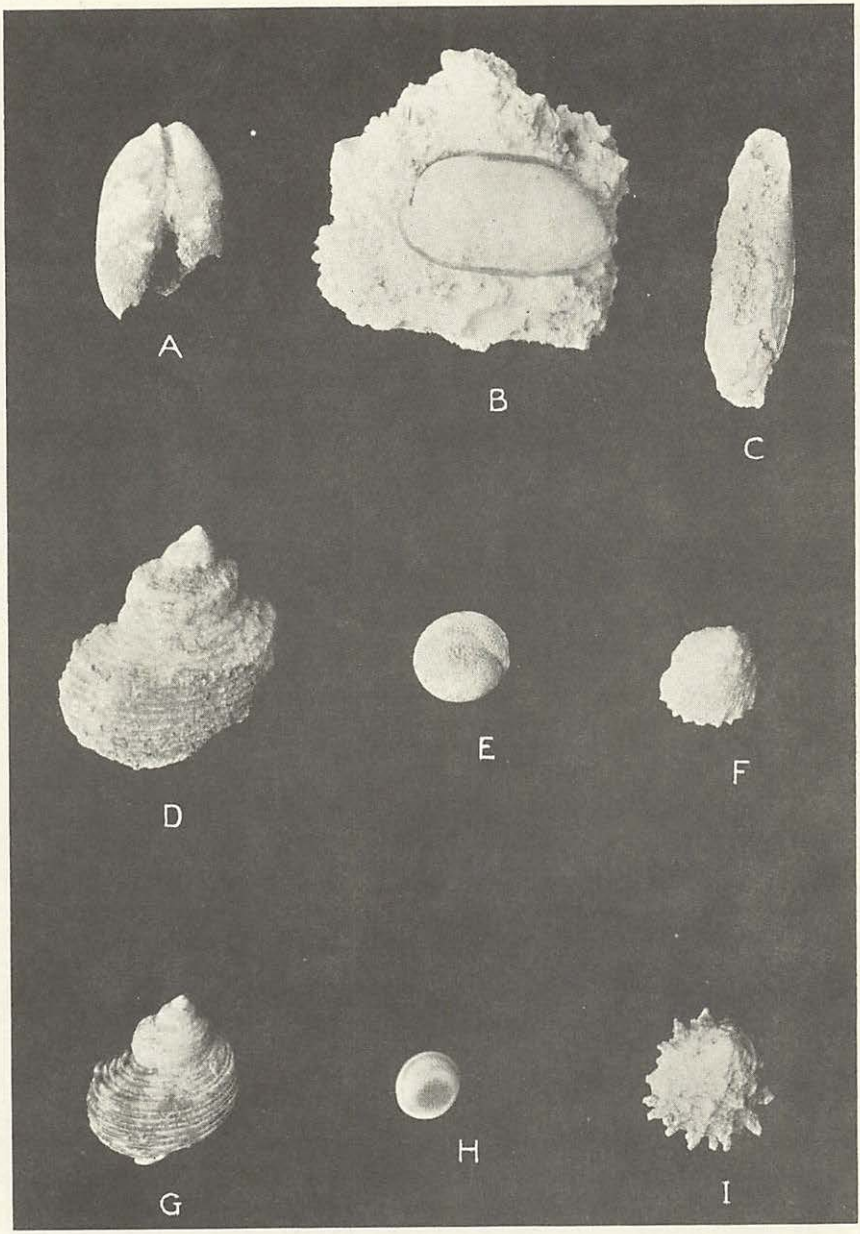
PELECYPODA



TONGAN MOLLUSKS (*A-F*, FOSSILS; *G-I*, LIVING): *A*, *CYPRAEA ARGUS* WITH HALF OF SHELL PRESERVED AND THE OTHER HALF REMOVED BY EROSION; *B*, *CYPRAEA ARGUS*, INTERNAL AND PART OF EXTERNAL MOULDS; *C*, *LITHOPHAGA CORRUGATA*, INTERNAL MOULD WITH PORTION OF SHELL SHOWING SCULPTURING; *D*, *TURBO ARGYROSTOMUS*; *E*, OPERCULUM OF *TURBO ARGYROSTOMUS*; *F*, *ASTRALIUM PETROSUM VIRESCENS*; *G*, *TURBO ARGYROSTOMUS*; *H*, OPERCULUM OF *TURBO ARGYROSTOMUS*; *I*, *ASTRALIUM PETROSUM*. (ONE HALF NATURAL SIZE.)