# Cenozoic Fossil Mollusks From Western Pacific Islands; Gastropods (Turritellidae Through Strombidae)

GEOLOGICAL SURVEY PROFESSIONAL PAPER 532

# Cenozoic Fossil Mollusks From Western Pacific Islands; Gastropods (Turritellidae Through Strombidae)

*By* HARRY S. LADD

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*Descriptions or citations of 174 representatives of 18 gastropod families from seven island groups*


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# CONTENTS


| | Page |
|---|---|
| Abstract | 1 |
| Introduction | 1 |
| Acknowledgments | 1 |
| Geology | 3 |
| Stratigraphy and correlation | 3 |
| Paleontology | 3 |
| Fossils from drill holes | 3 |
| Geographic and geologic distribution of species | 3 |
| Paleoecology | 3 |
| Faunal relations | 11 |
| Systematic paleontology | 13 |
| Additional species in families covered in Ladd (1966) | 13 |
| Families covered in the present paper | 14 |
| Turritellidae | 14 |
| Mathildidae | 17 |
| Architectonicidae | 18 |
| Vermetidae | 20 |
| Thiaridae | 21 |
| Paleontology—Continued | |
| Systematic paleontology—Continued | |
| Families covered in the present paper—Continued | |
| Caecidae | 22 |
| Modulidae | 24 |
| Potamididae | 24 |
| Diastomidae | 27 |
| Cerithiidae | 29 |
| Cerithiopsidae | 43 |
| Triphoridae | 45 |
| Epitoniidae | 51 |
| Vanikoridae | 52 |
| Hipponicidae | 52 |
| Capulidae | 54 |
| Xenophoridae | 55 |
| Strombidae | 56 |
| Localities | 63 |
| References cited | 69 |
| Index | 73 |


# ILLUSTRATIONS

[Plates follow index]


PLATE 1. Turritellidae.
2. Turritellidae and Architectonicidae.
3. Architectonicidae and Vermetidae.
4. Thiaridae, Littorinidae, Turbinidae, and Cerithiidae.
5. Caecidae and Modulidae.
6. Potamididae and Diastomidae.
7. Diastomidae and Cerithiidae.
8–10. Cerithiidae.
11. Cerithiidae, Cerithiopsidae, and Triphoridae.
12. Triphoridae.
13. Triphoridae, Epitoniidae, Vanikoridae, and Hipponicidae.
14. Hipponicidae, Capulidae, and Xenophoridae.
15–20. Strombidae.

| | Page |
|---|---|
| FIGURE 1. Index map showing location of island groups | 2 |
| 2–12. Maps showing fossil localities on— | |
| 2. Goikul peninsula, Babelthuap, Palau | 63 |
| 3. Guam, Mariana Islands | 65 |

Page

FIGURE 4. Saipan, Mariana Islands ---- 66
5. Maewo and Pentecost, New Hebrides ---- 67
6. Viti Levu, Fiji ---- 67
7. Vanua Levu, Fiji ---- 67
8. Fulanga, Lau, Fiji ---- 68
9. Lakemba, Lau, Fiji ---- 68
10. Oneata, Lau, Fiji ---- 68
11. Eua, Tonga ---- 69

## TABLES

Page

TABLE 1. Correlation chart of Cenozoic units in the island area ---- 4
2. Geographic distribution of Cenozoic fossil mollusk species in the island area ---- 5
3. Geologic distribution of Cenozoic mollusk species in the island area ---- 8
4. Living Indo-Pacific mollusks that also occur in the upper Tertiary sedimentary rocks of the island area ---- 12

# CENOZOIC FOSSIL MOLLUSKS FROM WESTERN PACIFIC ISLANDS; GASTROPODS (TURRITELLIDAE THROUGH STROMBIDAE)

By HARRY S. LADD

ABSTRACT

Descriptions and identifications of Cenozoic fossil mollusks from seven island groups in the western Pacific, which were started in U.S. Geological Survey Professional Paper 531, are continued in the present paper. The 174 species and subspecies treated represent 18 gastropod families (Turritellidae through Strombidae). Thirty-two new species and one new subspecies are described.

Half the named forms are from Eniwetok drill holes; a fourth are from those of Bikini. As in the families covered in U.S. Geological Survey Professional Paper 531, the number of identifications for each of two stages of the Miocene (Tertiary *f* and *g*) exceed those recorded for other divisions of the Cenozoic. Seventeen identifications are from the upper Eocene (Tertiary *b*): one of these is from the section beneath Eniwetok; the others are from Eua, Tonga. The number of still-living species is greater than the number of species listed for any other individual epoch.

Most of the mollusks appear to be reef associated; many are from lagoonal beds. Some species from Palau occur in beds that accumulated on a tidal flat, and a few species from Fiji lived in fresh or brackish waters. The Eocene mollusks from Eua, Tonga, and Pliocene mollusks from Vanua Levu, Fiji, are from off-reef beds that probably accumulated at depths of 100 fathoms or more.

The mollusks are clearly Indo-Pacific in general aspect. The ties to Indonesia and northern Australia are a little closer than those to the Ryukyus and Japan and appreciably stronger than those to the southern part of Australia.

## INTRODUCTION

The descriptions of fossil mollusks from seven island groups in the western Pacific begun by Ladd (1966) are continued in the present report. The island groups form a broad and somewhat irregular belt spreading 4,000 miles across the tropical latitudes of the western Pacific, from the Mariana Islands and Palau on the northwest to Fiji and Tonga on the southeast (fig. 1). A total of 174 species and subspecies, representing 18 families of gastropods, are described or recorded; they range in age from late Eocene to Holocene.

The following references containing identifications or descriptions of fossil mollusks supplement those listed on pages 3–5 of Ladd (1966):

1965. Hirst, J. A., Geology of east and north-east Viti Levu: Fiji Geol. Survey Bull. 12, 51 p., geol. maps. Includes references (p. 27–28) to mollusks from Matainananu identified by H. S. Ladd.

1966. Rickard, M. J., Reconnaissance geology of Vanua Levu: Fiji Geol. Survey Mem. 2, 81 p., geol. map. Includes brief reference (p. 77) to mollusks identified by H. S. Ladd.

1968. Ladd, H. S., Fossil land snail from Funafuti, Ellice Islands: Jour. Paleontology, v. 42, no. 3, pt. 1, p. 857. A species of *Ptychodon* is described from a depth of 170 feet in a drill hole.

1970. Ladd, H. S., Eocene mollusks from Eua, Tonga: U.S. Geol. Survey Prof. Paper 640–C. p. C1–C12. Twenty-five mollusks are described from off-reef tuffaceous limestone.

### ACKNOWLEDGMENTS

I am indebted to Mr. F. Gautier of the Museum National d'Histoire Naturelle, France, for the loan of fossil material from the New Hebrides described by Professor René Abrard and to Dr. D. I. J. Mallick and Mr. K. A. Liggett of the New Hebrides Geological Survey for fossils collected in those islands. Mr. William Ponder of the Australian Museum loaned type of species from Funafuti and Australia described by Charles Hedley.

In 1964 and 1966 I visited Fiji, spending some days in the field with members of the Geological Survey of Fiji on the two largest islands, Viti Levu and Vanua Levu. For field discussions during these times and for assistance in the collection of fossils, I am particularly indebted to Dr. Peter Ibbotson and Messrs. Frank Coulson and John Hirst. Other members of the Geological Survey of Fiji who submitted fossils for identification include R. B. Band, William Hindle, M. J. Rickard, Peter Rodda and Joeli Romanu.

Mr. Warren Blow of the U.S. Geological Survey aided in the preparation of much of the material. Some of the photographs were taken by W. M. Briggs, Jr., while a member of the U.S. Geological Survey; the

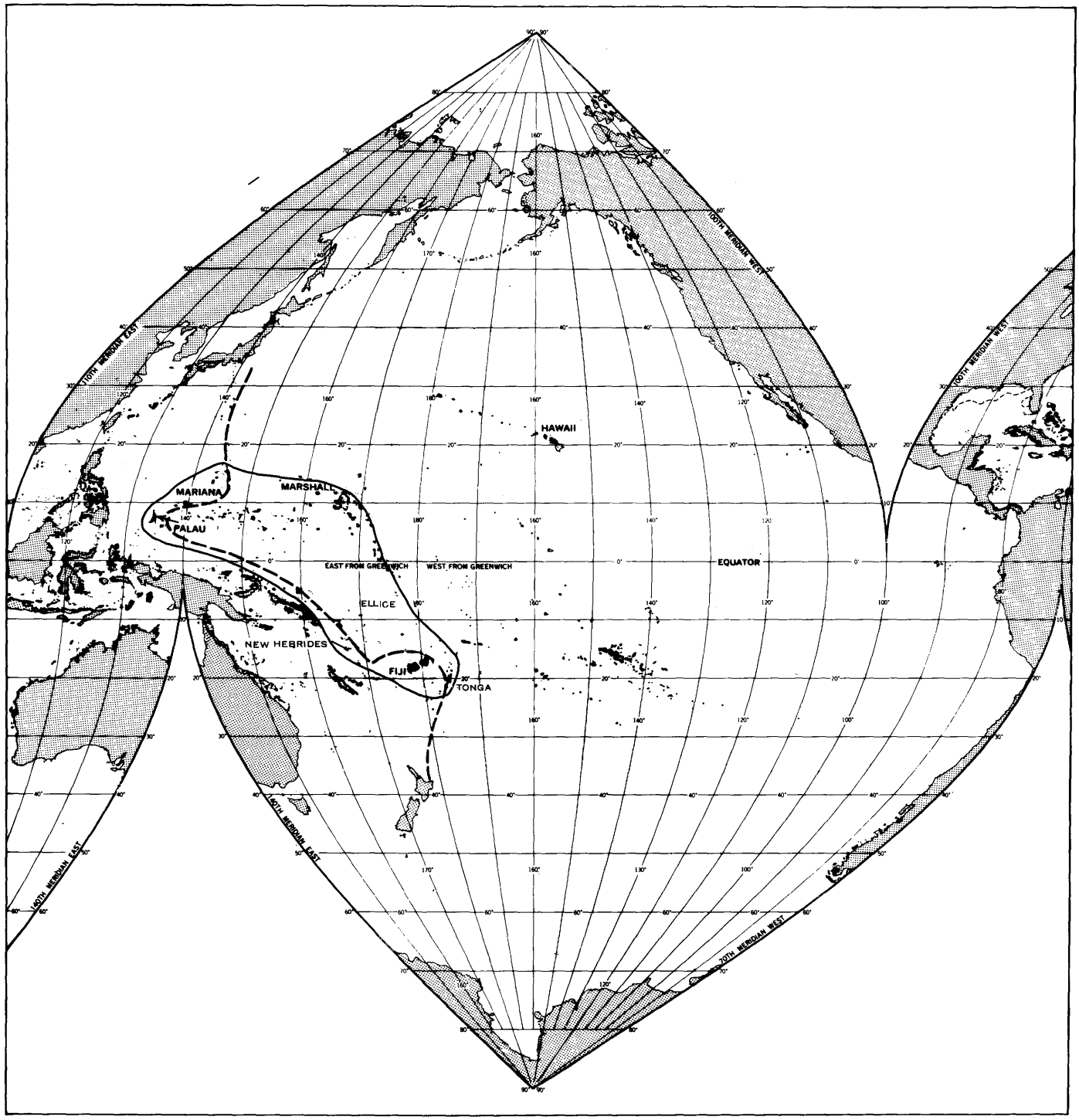


FIGURE 1.—Location of island groups from which fossil mollusks have been obtained. Dashed line marks structural boundary of Pacific basin (andesite line). Islands shown include the surrounding reefs.

rest by Robert H. McKinney, David H. Massie, and Page Valentine, Jr., all of the U.S. Geological Survey. A few of the photographs have been retouched by Mrs. Elinor Stromberg of the U.S. Geological Survey.

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U.S. Geological Survey Professional Paper 531, has benefited from critical reviews by W. P. Woodring of the Smithsonian Institution and Dr. R. Tucker Abbott, now of the Delaware Museum of Natural History.

## GEOLOGY

### STRATIGRAPHY AND CORRELATION

During the past 5 years, fieldwork in Fiji and the New Hebrides has been actively continued by the Geological Surveys of those areas. Priority has been given to geologic mapping on a 1:50,000 scale. For Fiji, 92 percent of the total land area of the colony has been covered (Fiji Geological Survey Department, 1969, Annual Report for 1968); and for the New Hebrides, the ratio is only a little lower (Mallick, 1970). Elsewhere in the island area, little geological fieldwork has been done. Except for Fiji and the New Hebrides, the Cenozoic units shown in table 1 are the same as those given by Ladd (1966).

## PALEONTOLOGY

### FOSSILS FROM DRILL HOLES

Many of the mollusks described in the present report were obtained from drill holes that penetrate existing reefs. Samples were collected from the surface downward, starting at a level only a few feet above the sea. That the collections were made from recently formed material raises questions involving age and nomenclature. Are all the mollusks obtained from such drill holes to be considered fossils?

Ordinarily a fossil has been defined as the remains of an organism that lived before Holocene time or as direct evidence (mold, cast, track, or trail) of its existence. The definition is a logical attempt to exclude from the category of fossils the shells, leaves, and other organic materials that are buried daily in streams and oceans. Actually, in most nonglaciated areas, the boundary between Pleistocene and Holocene beds is not sharp, particularly in tropical marine areas, where conditions did not change greatly at the close of the Ice Age. Improved isotopic age determinations are changing this situation, and eventually it will be possible to recognize the exact boundaries of the Pleistocene in many stratigraphic sections. At the present time paleontologists recognize that a few Pleistocene mollusks appear to have become extinct before the end of that epoch, but these mollusks are too few to have any meaning in terms of Lyellian percentages. Mollusk shells of still-living species may be recognized as Pleistocene forms if they occur in or on elevated terraces that on physiographic grounds appear to be Pleistocene, but the shells themselves do not always indicate their age.

To identify the top of the Pleistocene in a drill hole is particularly difficult, even where the core is nearly continuous. In the present study, samples from drill holes are the only types of samples available in the Marshall and Ellice Islands (Eniwetok, Bikini, and Funafuti). In these areas any shell that is recovered from below the surface is considered to be a fossil. In the other island groups, shells from consolidated limestones and from clays above sea level are considered to be fossils. Mollusks contained in exposed beach rock, beach sands, and boulder ramparts are not regarded as fossils.

Small Holocene species such as *Obtortio pyrrhacme* and *Diala ludens* occur in many drill samples taken close to the surface and are also found in numerous others collected downward into the lower Miocene. Fresh shells from near-surface beds retain characteristic coloration—a dark-brown apex in the case of *Obtortio*, discontinuous spiral brown lines in *Diala*. Tertiary examples of both species are uniformly tan in color. Any pure white shells—with or without traces of color pattern—that are recovered from Tertiary levels have probably been carried downward by circulating mud.

### GEOGRAPHIC AND GEOLOGIC DISTRIBUTION OF SPECIES

The geographic distribution of all the species is shown in table 2. As was true for the faunas covered by Ladd (1966), the Marshall Island faunas are the richest, a reflection of the abundance of well-preserved microfossils in drill cores and cuttings. Half of all the named forms are from Eniwetok, a fourth, from Bikini. Guam has been more intensively collected than Fiji, but the total of named forms from Guam is less than the total from Fiji, partly because of the better preservation of the Fijian shells.

The geologic distribution of species is shown in table 3. As with the families covered in Ladd (1966) the number of identifications for each of two stages of the Miocene (Tertiary *f* and *g*) exceed the number recorded for other divisions of the Cenozoic. The number of living species is greater than the number listed for any earlier epoch.

### PALEOECOLOGY

As noted by Ladd (1966), most fossiliferous sediments that crop out on the islands or that have been reached in the drill holes below sea level are reef associated; that is, they accumulated on reefs or in adjacent lagoons.

**TABLE 1.—*Correlation of Cenozoic units in the island area***

**[Vertical ruling indicates hiatus; blank areas show unknown parts of section]**

| SYSTEM | EPOCH | | LETTER CLASSIFICATION | MARSHALL | | ELLICE | PALAU | MARIANA | | | NEW HEBRIDES | FIJI | | | | TONGA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | ENIWETOK | BIKINI | FUNAFUTI | | SAIPAN | TINIAN | GUAM | | Age | VITI LEVU[3] Group | LAU | VANUA LEVU | |
| QUATERNARY | Holocene | | | Reef complex, chiefly lagoonal and forereef | Reef limestone, chiefly lagoonal beds | Reef limestone | Beach deposits | Raised beaches | Raised-beach sand and gravel | Beach deposits | Reef limestones | Holocene | Alluvium | Mango Odinite | Alluvium and other deposits | Reef limestone |
| | Pleistocene | | | | | | Peleliu Limestone | Tanapag Limestone | Mariana Limestone | Mariana Limestone | | Pliocene-Pleistocene | Thuvu / Verata | Fulanga Limestone | Mbua Group ? | Reef limestone |
| UPPER TERTIARY | Pliocene | | *h* | | | ? | Palau Limestone | Mariana Limestone ? Terrace deposits ? | | ? Alifan Limestone Janum Fm. Barrigada Limestone | Reef limestones | | Mba | Ndalithoni Limestone | Tuatua Limestone Undu Group ? | Reef limestone |
| | Miocene | Late | *g* | | | | | | | | | Miocene-Pliocene | Koroimavua | | | |
| | | Early | *f* | | | | Airal clay and lignite | | | | Water-laid tuffs and limestones | | Navosa | Koro Mbasanga Volcanics | Natewa Group | Tuff |
| | | | *e* | | | | | Tagpochau Limestone | Tagpochau Limestone | Umatac Formation | | | Nandi | Futuna Limestone | | |
| LOWER TERTIARY | Oligocene | Late | *d* | ? | ? | | ? ? Ngeremiengui Formation | Fina-sisu Formation | | | ? | | Mendrausuthu | Lau Volcanics | | |
| | | | *c* | ? | ? | | | | | Alutom Formation | | Eocene-Miocene | Ra / Savura / Singatoka / Wainimala | | ? | |
| | Eocene | Early | *b* | Reef complex | ? | | ? ? Aimelik Formation | Matansa Limestone / Densinyama Fm. / Hagman Formation | Pyroclastic rocks | | Limestone(?)[2] | | Intrusive rocks | | | Limestone and tuffaceous limestone |
| | | | *a* | | Globigerina ooze[1] | | ? Babelthuap Formation ? | | | | | Tertiary Early Late | Younger intrusive rocks / Tholo Plutonics | | | ? |

1 Occurrence on Sylvania Guyot adjoining Bikini (Hamilton and Rex, 1959).
2 Larger Foraminifera from cobbles in conglomerate on Maewo (Coleman, 1969).
3 This is a generalized section from Rodda's map of 1967. In this and other reports (Phillips, 1965, 1966, Rodda and Band, 1967, Band, 1968) the Geological Survey of Fiji recognizes volcanic groups, sedimentary groups, and undifferentiated units that cannot, at present, be accurately integrated.

TABLE 2.—*Geographic distribution of Cenozoic fossil mollusk species in the island area*

| Species | Palau | Guam | Saipan | Eniwetok | Bikini | Funafuti | New Hebrides | Fiji | Tonga |
|---|---|---|---|---|---|---|---|---|---|
| **Additions to families covered in Ladd (1966)** | | | | | | | | | |
| Scissurellidae: | | | | | | | | | |
| *Scissurella (Anatoma) tongaensis* Ladd | | | | | | | | | × |
| *Sinezona kondoi* Ladd | | | | | | | | | × |
| Trochidae: | | | | | | | | | |
| *Basilissa (Ansistrobasis) pacifica* Ladd | | | | | | | | | × |
| *Bathybembix*? sp | | | | | | | | | × |
| *Turcica (Perrinia) blowi* Ladd | | | | | | | | | × |
| *Astele (Callistele)* sp | | | | | | | | | × |
| Turbinidae: | | | | | | | | | |
| *Pareuchelus*? sp | | | | | | | | | × |
| *Astraea (Bolma) stearnsi* Ladd | | | | | | | | | × |
| sp. F | | × | | | | | | | |
| Littorinidae: | | | | | | | | | |
| *Littorina scabra* Linnaeus | | | | | | | × | | |
| Adeorbidae: | | | | | | | | | |
| *Daronia (Daronia) hoffmeisteri* Ladd | | | | | | | | | × |
| *Munditiella euaensis* Ladd | | | | | | | | | × |
| *Lydiphnis vainganaensis* Ladd | | | | | | | | | × |
| **Families covered in this report** | | | | | | | | | |
| Turritellidae: | | | | | | | | | |
| *Turritella* aff. *T. cingulifera* Sowerby | | | | × | | | | | |
| cf. *T. javana* Martin | | | × | | | | | | |
| aff. *T. sedanensis* Martin | | | × | | | | | | |
| aff. *T. spolongensis* Martin | | | × | | | | | | |
| sp. A | | × | | | | | | × | |
| sp. B | | | | | × | | | | |
| (*Kurosioia*) *fileola* Yokoyama | | × | | | | | × | × | |
| aff. *T. fascialis* Menke | | × | | | | | | | |
| (*Torcula*?) sp. C | | | | | | | | × | |
| *Tenagodus (Tenagodus)* sp | | | | | | | | × | |
| (*Agathirses*) cf. *T. australis* (Quoy and Gaimard) | | | | | | | | × | |
| *Vermicularia* sp. A | | | | × | × | | | | |
| Mathildidae: | | | | | | | | | |
| *Mathilda (Fimbriatella*?) sp | | | | | | | | | × |
| *Gegania whipplei* Ladd | | | | | | | | | × |
| Architectonicidae: | | | | | | | | | |
| *Climacopoma*? sp. A | | | | × | | | | | |
| *Architectonica (Architectonica) perspectiva* (Linnaeus) | | | | | | | | × | |
| (*Pseudotorinia*) *corwini* Ladd, n. sp | × | | | × | × | | | | |
| *Philippia (Psilaxis) radiata* (Röding) | | | | × | | | | | |
| *Heliacus variegatus* (Gmelin) | | | | × | | | | × | |
| Vermetidae: | | | | | | | | | |
| *Petaloconchus (Macrophragma) merkana* Ladd, n. sp | × | | | × | × | | | | × |
| (*Macrophragma*?) *lamellosus* Ladd, n. sp | | | | × | × | | | | |
| *Serpulorbis* cf. *S. javanus* (Martin) | | | | × | | | | | |
| sp | | | | | | | | × | |
| Thiaridae: | | | | | | | | | |
| *Melanatria vitiensis* Ladd, n. sp | | | | | | | | × | |
| *Thiara (Setaeara) morrisoni* Ladd, n. sp | | | | | | | | × | |
| *Melanoides (Melanoides)* cf. *M. tuberculatus* (Müller) | | | | | | | | × | |
| Caecidae: | | | | | | | | | |
| *Caecum vertebrale* Hedley | | | | × | | | | | × |
| *berberense* Ladd, n. sp | | | | × | × | | | × | |
| *parryensis* Ladd, n. sp | | | | × | | | | | |
| *Micranellum schlangeri* Ladd, n. sp | | | | × | | × | | | |
| *Elephantanellum* sp. A | | | | × | | | | | |
| *Fartulum* aff. *F. amputatum* (Hedley) | | | | × | | | | | |
| sp. A | | | | × | | | | | |
| Modulidae: | | | | | | | | | |
| *Modulus tectum* (Gmelin) | | × | | | | | | | |
| *preangerensis* Martin | × | | | | | | | | |

TABLE 2.—*Geographic distribution of Cenozoic fossil mollusk species in the island area*—Continued

| Species | Palau | Guam | Saipan | Eniwetok | Bikini | Funafuti | New Hebrides | Fiji | Tonga |
|---|---|---|---|---|---|---|---|---|---|
| Potamididae: | | | | | | | | | |
| *Potamides tayamaia* Ladd, n. sp | × | | | | | | | | |
| *wardi* Ladd, n. sp | | × | | × | | | | | |
| sp. A | | | | × | | | | | |
| sp. B | | | | × | | | | | |
| *Tympanotonos berberkirianus* (Martin) | × | | | | | | | | |
| *Vicarya* sp | | | | × | | | | | |
| *Cerithidae* cf. *C. obtusa* (Lamarck) | | | × | | | | | | |
| *Terebralia sulcata* (Born) | | | | × | | | | | |
| *Batillaria* (*Zeacumantus*) *rickardi* Ladd, n. sp | | | | | | | | × | |
| Diastomidae: | | | | | | | | | |
| *Obtortio pyrrhacme* (Melvill and Standen) | | | | × | × | | | | |
| *failingi* Ladd, n. sp | | | | × | × | | | | |
| *dancei* Ladd, n. sp | | | | × | | | | | |
| sp. A | | | | × | | | | | |
| Cerithiidae: | | | | | | | | | |
| *Diala ludens* Melvill and Standen | | | | × | × | × | | | × |
| *stricta* Habe | | | | × | × | | | | |
| *sulcifera* A. Adams | | | | × | | | | | |
| *Bittium impendens* (Hedley) | | | | × | | | | | |
| *sergentum* (Jousseaume) | | | | × | × | × | | | |
| *ianthinum* (Gould) | | | | × | | | | | |
| *eniwetokensis* Ladd, n. sp | | | | × | | | | | |
| (*Bittiolum*) *toddae* Ladd, n. sp | | | | × | | | | | |
| *Colina* (*Ischnocerithium*) *rostrata* (Sowerby) | | | | × | × | | | | |
| *Ataxocerithium eniwetokensis* Ladd, n. sp | | | | × | | | | | |
| *Rhinoclavis* (*Rhinoclavis*) *vertagus* (Linnaeus) | | | | | × | | × | | |
| (*Rhinoclavis*) *articulata* (Adams and Reeve) | | | × | | | | | | |
| *procera* (Kiener) | | × | × | | | | | × | |
| *aspera* (Linnaeus) | | × | × | × | | | | | |
| *sinensis* (Gmelin) | | | | | | | × | | |
| aff. *R. sinensis* (Gmelin) | | | | × | | | | | |
| *marshallensis* Ladd, n. sp | | | | × | × | | | | |
| *powelli* Ladd, n. sp | | | | × | | | | | |
| *jonkeri* (Martin) | | × | | | | | | | |
| (*Proclava*) *sordidula* (Gould) | | × | | | | | × | | |
| (*Pseudovertagus*) *eniwetokensis* Ladd, n. sp | | | | × | | | | | |
| *lowae* Ladd, n. sp | | | | × | × | | | | |
| *floraensis* Ladd, n. sp | | × | | × | × | | | | |
| *Cerithium* (*Thericium*) *mutatum* Sowerby | | | | × | | | | | |
| (*Thericium*) *alveolus* Hombron and Jacquinot | | | × | × | | | | | |
| *salebrosum* Sowerby | | | | × | × | | | | |
| *schmidti* Ladd, n. sp | | | × | | | | | | |
| *tenellum* Sowerby | | | | × | × | | | | |
| *ruppelli* Philippi | | | | | | | × | | |
| (*Cerithium*) *nodulosum* Bruguière | × | × | | | × | | | × | |
| *columna* Sowerby | | × | | | | | | | |
| aff. *C. columna* Sowerby | | | | × | | | | | |
| *tuberculatum* (Linnaeus) | | × | | | | | | | |
| (*Conocerithium*) *egenum* Gould | | | | × | × | | | | |
| aff. *C. egenum* Gould | | | | × | | | | | |
| *Clypeomorus verbeeki* (Woodward) | | | | × | | | | | |
| *wainingoli* Ladd, n. sp | | | | | | | | × | |
| *Liocerithium kayae* Ladd, n. sp | × | | | × | × | | | | |
| *Plesiotrochus luteus* (Gould) | | | | × | × | | | | |
| *pagodiformis* Hedley | | | | × | × | | | | |
| *talinana* Ladd, n. sp | | | | × | | | | | |
| *marshallensis* Ladd, n. sp | | | | × | × | | | | |
| *whitmorei* Ladd, n. sp | | | | × | × | | | | |
| sp. A | | | | × | | | | | |
| Cerithiopsidae: | | | | | | | | | |
| *Cyrbasia* (*Joculator*) *tribulationis* (Hedley) | | | | × | | | | | |
| (*Joculator*) *semipicta* Gould | | | | × | | | | | |
| *sumangi* Ladd, n. sp | × | | | × | | | | | |
| aff. *C. ovata* (Laseron) | | | | × | × | | | | |
| *Cerithiopsis* sp | | | | | | | | | × |
| *Seila* (*Notoseila*) *waluensis* Ladd, n. sp | | | | × | | | | × | |
| Triphoridae: | | | | | | | | | |
| *Triphora* (*Triphora*) *pallida* (Pease) | | | | × | | | | | |
| (*Triphora*) *otsuensis* (Yokoyama) | | | | × | | | | | |

TABLE 2.—*Geographic distribution of Cenozoic fossil mollusk species in the island area*—Continued

| Species | Palau | Guam | Saipan | Eniwetok | Bikini | Funafuti | New Hebrides | Fiji | Tonga |
|---|---|---|---|---|---|---|---|---|---|
| Triphoridae—Continued | | | | | | | | | |
| *Triphora*—Continued | | | | | | | | | |
| (*Inella*) *pyramidalis* (Adams and Reeve) | × | | | × | × | | | | |
| *roddai* Ladd, n. sp | | | | | | | | × | |
| *maharatai* Beets | | | | × | × | | | | |
| sp. A | × | | | | | | | | |
| (*Inforis*) *albogranosa* Kosuge | | | | × | | | | | |
| *ofuensis* Baker and Spicer | | | | × | × | × | | | |
| sp. B | | | | | × | | | | |
| (*Mastonia*) *cingulifera* (Pease) | | | × | × | | | | | |
| *cingulifera goikulensis* Ladd, n. subsp | × | | | | | | | | |
| *clavata* (Pease) | | | | | × | | | | |
| *squamosa* (Kosuge) | | | | × | | | | | |
| *intermissa* (Laseron) | | | | × | × | | | × | |
| *auberti* (Abrard) | | | | | | | × | | |
| *Cautotriphora hervieri* (Kosuge) | | | | | × | | | | |
| *Viriola pagoda* (Hinds) | | | | × | | | | | |
| *incisa* (Pease) | | | | × | | | | | |
| *cancellata* (Hinds) | | | | × | × | | | | |
| *elegans* (Hinds) | | | | × | | | | | |
| Epitoniidae: | | | | | | | | | |
| *Epitonium* (*Gyroscala*) *perplexum* (Pease) | | | | × | | | | | |
| (*Cycloscala*) *revolutum* (Hedley) | × | | | | | | | | |
| (*Boreoscala*?) sp | | | | | | | | | × |
| (*Clathrus*) sp. A | | | | | | | | × | |
| Vanikoridae: | | | | | | | | | |
| *Vanikoro cancellata* (Lamarck) | | | | × | | | | | |
| *gueriniana* (Récluz) | | | | × | | | | × | |
| aff. *V. kanakarum* Pilsbry | | | | × | | | | | |
| Hipponicidae: | | | | | | | | | |
| *Cheilea equestris* (Linnaeus) | | | | × | | | × | × | |
| *Hipponix* (*Malluvium*) cf. *H. badius* (Dunker) | | | | | | | | × | |
| (*Antisabia*) *foliaceus* Quoy and Gaimard | | | | × | | | | × | |
| (*Sabia*) *conicus* (Schumacher) | | × | | × | × | | | × | |
| (*Pilosabia*) *revellei* Ladd, n. sp | | | | × | × | | | | |
| Capulidae: | | | | | | | | | |
| *Capulus* (*Krebsia*) aff. *C. liberatus* Pease | | | | | × | | | | |
| (*Krebsia*) sp. A | | | | × | | | | × | |
| sp. B | | | | × | × | | | | |
| Xenophoridae: | | | | | | | | | |
| *Xenophora* sp. A | | | | | | | | | × |
| sp. B | | | × | | | | | | |
| *Tugurium exutum* (Reeve) | | | | | | | | × | |
| Strombidae: | | | | | | | | | |
| *Varicospira* aff. *V. crispata* (Sowerby) | × | | | | | | | | |
| *Tibia* (*Tibia*) *powisii modesta* (Martin) | | | | | | | | × | |
| *Terebellum* (*Terebellum*) *terebellum* (Linnaeus) | | | × | | | | | | |
| *Strombus* (*Laevistrombus*) *canarium* Linnaeus | | | | | | | × | | |
| (*Tricornis*) *maximus* Martin | × | | | | | | | | |
| aff. *S. thersites* Swainson | | | | | | | | × | |
| cf. *S. sinuatus* Lightfoot | | | | | | | × | | |
| sp. A | × | × | | | | | | | |
| (*Canarium*) *urceus* Linnaeus | | | | | | | × | | |
| *mutabilis* Swainson | | × | × | × | | | × | × | |
| *erythrinus* Dillwyn | | | | | × | | | | |
| cf. *S. fragilis* (Röding) | | | | | × | | | | |
| sp. B | | | | | | | | × | |
| (*Dolomena*) *plicatus pulchellus* Reeve | | | | | | | × | × | |
| *variabilis athenius* Duclos | | × | | | | | | | |
| *minimus minor* Abrard | | | | | | | × | | |
| (*Lentigo*) *micklei* Ladd, n. sp | | | | × | × | | | | |
| cf. *S. preoccupatus* Finlay | | × | | | | | | | |
| sp. C | | | | × | × | | | | |
| (*Euprotomus*) *vomer hawaiiensis* Pilsbry | | | | | | | | × | |
| (*Conomurex*) *luhuanus* Linnaeus | | × | | | × | | × | | |
| (*Gibberulus*) *gibberulus gibbosus* (Röding) | | × | × | × | × | | × | | |
| *pregibberulus* Abrard | | | | | | | × | | |
| *Lambis* (*Lambis*) *lambis* (Linnaeus) | | | | | | | × | | |
| (*Lambis*) cf. *L. lambis* (Linnaeus) | | | | | | | | × | |
| Total of 174 species | 15 | 21 | 14 | 89 | 44 | 4 | 18 | 34 | 19 |

TABLE 3.—*Geologic distribution of Cenozoic mollusk species in the island area*

[×, present; question mark indicates uncertain identification]

| Species | Tertiary | | | | | Quaternary | | |
|---|---|---|---|---|---|---|---|---|
| | Late Eocene | Early Miocene | | Late Miocene | Pliocene | Pleistocene | Holocene | Living |
| | *b* | *e* | *f* | *g* | *h* | | | |
| **Additions to families covered in Ladd (1966)** | | | | | | | | |
| Scissurellidae: | | | | | | | | |
| *Scissurella* (*Anatoma*) *tongaensis* Ladd | × | | | | | | | |
| *Sinezona kondoi* Ladd | × | | | | | | | |
| Trochidae: | | | | | | | | |
| *Basilissa* (*Ansistrobasis*) *pacifica* Ladd | × | | | | | | | |
| *Bathybembix*? sp | × | | | | | | | |
| *Turcica* (*Perrinia*) *blowi* Ladd | × | | | | | | | |
| *Astele* (*Callistele*) sp | × | | | | | | | |
| Turbinidae: | | | | | | | | |
| *Pareuchelus*? sp | × | | | | | | | |
| *Astraea* (*Bolma*) *stearnsi* Ladd | × | | | | | | | |
| sp. F | | | | | ×? | | | |
| Littorinidae: | | | | | | | | |
| *Littorina scabra* Linnaeus | | | | | | × | | × |
| Adeorbidae: | | | | | | | | |
| *Daronia* (*Daronia*) *hoffmeisteri* Ladd | × | | | | | | | |
| *Munditiella euaensis* Ladd | × | | | | | | | |
| *Lydiphnis vainganaensis* Ladd | × | | | | | | | |
| **Families covered in this report** | | | | | | | | |
| Turritellidae: | | | | | | | | |
| *Turritella* aff. *T. cingulifera* Sowerby | × | × | | | | | | |
| cf. *T. javana* Martin | | | × | | | | | |
| aff. *T. sedanensis* Martin | | | × | | | | | |
| aff. *T. spolongensis* Martin | | | × | | | | | |
| sp. A | | | | | × | × | | |
| sp. B | | | | | × | | | |
| (*Kurosioia*) *fileola* Yokoyama | | | | × | × | × | | |
| aff. *T. fascialis* Menke | | | | ×? | ×? | | | |
| (*Torcula*?) sp. C | | | × | | | | | |
| *Tenagodus* (*Tenagodus*) sp | | | | | × | | | |
| (*Agathirses*) cf. *T. australis* (Quoy and Gaimard) | | | × | | | | | |
| *Vermicularia* sp. A | | × | | | | | | |
| Mathildidae: | | | | | | | | |
| *Mathilda* (*Fimbriatella*?) sp | × | | | | | | | |
| *Gegania whipplei* Ladd | × | | | | | | | |
| Architectonicidae: | | | | | | | | |
| *Climacopoma*? sp. A | | × | | | | | | |
| *Architectonica* (*Architectonica*) *perspectiva* (Linnaeus) | | | | | × | × | | × |
| (*Pseudotorinia*) *corwini* Ladd, n. sp | | | × | × | | | | |
| *Philippia* (*Psilaxis*) *radiata* (Röding) | | | × | × | | | | × |
| *Heliacus variegatus* (Gmelin) | | | × | × | | × | | × |
| Vermetidae: | | | | | | | | |
| *Petaloconchus* (*Macrophragma*) *merkana* Ladd, n. sp | | × | × | × | × | × | × | × |
| (*Macrophragma*?) *lamellosus* Ladd, n. sp | | | | × | | | × | × |
| *Serpulorbis* cf. *S. javanus* (Martin) | | | | × | | | | |
| sp | | | | | × | | | |
| Thiaridae: | | | | | | | | |
| *Melanatria vitiensis* Ladd, n. sp | | | × | | | | | |
| *Thiara* (*Sataeara*) *morrisoni* Ladd, n. sp | | | | ×? | ×? | | | |
| *Melanoides* (*Melanoides*) cf. *M. tuberculatus* (Müller) | | | × | | | | | |

TABLE 3.—*Geologic distribution of Cenozoic mollusk species in the island area*—Continued

| Species | Tertiary | | | | | Quaternary | | |
|---|---|---|---|---|---|---|---|---|
| | Late Eocene | Early Miocene | | Late Miocene | Pliocene | Pleistocene | Holocene | Living |
| | *b* | *e* | *f* | *g* | *h* | | | |
| Caecidae: | | | | | | | | |
| *Caecum vertebrale* Hedley | | | | | | × | × | × |
| *berberense* Ladd, n. sp | | × | × | × | × | | | |
| *parryensis* Ladd, n. sp | | × | | | | | | |
| *Micranellum schlangeri* Ladd, n. sp | | | × | × | | | × | |
| *Elephantanellum* sp. A | | | | | ×? | | | |
| *Fartulum* aff. *F. amputatum* (Hedley) | | | × | | | | | |
| sp. A | | | | | ×? | | | |
| Modulidae: | | | | | | | | |
| *Modulus tectum* (Gmelin) | | | | | | × | | × |
| *preangerensis* Martin | | | | × | | | | |
| Potamididae: | | | | | | | | |
| *Potamides tayamaia* Ladd, n. sp | | | | × | | | | |
| *wardi* Ladd, n. sp | | | ×? | × | ×? | | | |
| sp. A | | | | × | | | | |
| sp. B | | | | × | | | | |
| *Tympanotonos berberkirianus* (Martin) | | | | × | | | | |
| *Vicarya* sp. | | × | | | | | | |
| *Cerithidea* cf. *C. obtusa* (Lamarck) | | ×? | | | | | | |
| *Terebralia sulcata* (Born) | | | | × | | | | × |
| *Batillaria* (*Zeacumantus*) *rickardi* Ladd, n. sp | | | × | | | | | |
| Diastomidae: | | | | | | | | |
| *Obtortio pyrrhacme* (Melvill and Standen) | | × | × | × | × | × | × | × |
| *failingi* Ladd, n. sp | | × | | | | | | |
| *dancei* Ladd, n. sp | | × | | | | | | |
| sp. A | | × | | | | | | |
| Cerithiidae: | | | | | | | | |
| *Diala ludens* Melvill and Standen | | × | × | × | × | × | × | × |
| *stricta* Habe | | × | × | | | ×? | × | × |
| *sulcifera* A. Adams | | | | | | | × | × |
| *Bittium impendens* (Hedley) | | | | | | | × | × |
| *sergentum* (Jousseaume) | | ×? | × | × | × | × | × | × |
| *ianthinum* (Gould) | | | | | | | × | × |
| *eniwetokensis* Ladd, n. sp | | | × | | | | | |
| (*Bittiolum*) *toddae* Ladd, n. sp | | × | | × | | | | |
| *Colina* (*Ischnocerithium*) *rostrata* (Sowerby) | | | | × | × | × | × | × |
| *Ataxocerithium eniwetokensis* Ladd, n. sp | | | | | | | × | |
| *Rhinoclavis* (*Rhinoclavis*) *vertagus* (Linnaeus) | | | | | ×? | ×? | × | × |
| (*Rhinoclavis*) *articulata* (Adams and Reeve) | | | | | | | × | × |
| *procera* (Kiener) | | | × | | ×? | ×? | | × |
| *aspera* (Linnaeus) | | | | × | × | × | × | × |
| *sinensis* (Gmelin) | | | | | | × | ×? | × |
| aff. *R. sinensis* (Gmelin) | | | | × | | | | |
| *marshallensis* Ladd, n. sp | | | × | × | | | | |
| *powelli* Ladd, n. sp | | | | × | | | | |
| *jonkeri* (Martin) | | | | | × | × | | |
| (*Proclava*) *sordidula* (Gould) | | | | | × | × | | × |
| (*Pseudovertagus*) *eniwetokensis* Ladd, n. sp | | | × | × | | | | |
| *lowae* Ladd, n. sp | | | × | | | | | |
| *floraensis* Ladd, n. sp | | × | × | × | × | ×? | | |
| *Cerithium* (*Thericium*) *mutatum* Sowerby | | | | | | | × | × |
| (*Thericium*) *alveolus* Hombron and Jacquinot | | | | | | × | × | × |
| *salebrosum* Sowerby | | | | | × | × | × | × |
| *schmidti* Ladd, n. sp | | | | ×? | | | | |
| *tenellum* Sowerby | | | | | | × | × | × |
| *ruppelli* Philippi | | | | | | × | | × |
| (*Cerithium*) *nodulosum* Bruguière | | | × | × | ×? | | | × |
| *columna* Sowerby | | | | | ×? | ×? | | × |
| aff. *C. columna* Sowerby | | | | | | | × | |
| *tuberculatum* (Linnaeus) | | | | | × | ×? | | × |
| (*Conocerithium*) *egenum* Gould | | | | | | | × | × |
| aff. *C. egenum* Gould | | | | × | | | | |
| *Clypeomorus verbeeki* (Woodward) | | | | × | | | | |
| *wainingoli* Ladd, n. sp | | | | | × | | | |
| *Liocerithium kayae* Ladd, n. sp | | × | × | × | | | | |

TABLE 3.—*Geologic distribution of Cenozoic mollusk species in the island area*—Continued

| Species | Tertiary | | | | | Quaternary | | |
|---|---|---|---|---|---|---|---|---|
| | Late Eocene | Early Miocene | | Late Miocene | Pliocene | Pleistocene | Holocene | Living |
| | *b* | *e* | *f* | *g* | *h* | | | |
| Cerithiidae—Continued | | | | | | | | |
| *Plesiotrochus luteus* (Gould) | | | × | × | × | × | × | × |
| *pagodiformis* Hedley | | | × | | × | × | × | × |
| *talinana* Ladd, n. sp | | × | | | | | | |
| *marshallensis* Ladd, n. sp | | × | × | × | | | | |
| *whitmorei* Ladd, n. sp | | | × | × | | | | |
| sp. A | | | | | × | | | |
| Cerithiopsidae: | | | | | | | | |
| *Cyrbasia* (*Joculator*) *tribulationis* (Hedley) | | | | × | | | × | × |
| (*Joculator*) *semipicta* Gould | | | | × | × | × | × | × |
| *sumangi* Ladd, n. sp | | | | × | | | | |
| aff. *C. ovata* (Laseron) | | | × | | | | × | |
| *Cerithiopsis* sp. | × | | | | | | | |
| *Seila* (*Notoseila*) *waluensis* Ladd, n. sp | | | × | × | | | | |
| Triphoridae: | | | | | | | | |
| *Triphora* (*Triphora*) *pallida* (Pease) | | | | | | | × | × |
| (*Triphora*) *otsuensis* (Yokoyama) | | | × | | | | | × |
| (*Inella*) *pyramidalis* (Adams and Reeve) | | × | × | × | | | × | × |
| *roddai* Ladd, n. sp | | | | | × | | | |
| *maharatai* Beets | | | × | × | | | | |
| sp. A | | | | × | | | | |
| (*Inforis*) *albogranosa* Kosuge | | | | | | | × | × |
| *ofuensis* Baker and Spicer | | | | | | | × | × |
| sp. B | | × | | | | | | |
| (*Mastonia*) *cingulifera* (Pease) | | | | | | | × | × |
| *cingulifera goikulensis* Ladd n. subsp | | | | × | | | | |
| *clavata* (Pease) | | | | | | | × | × |
| *squamosa* (Kosuge) | | | | | | | × | × |
| *intermissa* (Laseron) | | | × | × | | | × | × |
| *auberti* (Abrard) | | | | × | | | | |
| *Cautotriphora hervieri* (Kosuge) | | | | | × | × | | × |
| *Viriola pagoda* (Hinds) | | | | | | | × | × |
| *incisa* (Pease) | | | | | × | | × | × |
| *cancellata* (Hinds) | | × | | × | × | | | × |
| *elegans* (Hinds) | | | | | | | × | × |
| Epitoniidae: | | | | | | | | |
| *Epitonium* (*Gyroscala*) *perplexum* (Pease) | | | | | | | × | × |
| (*Cycloscala*) *revolutum* (Hedley) | | | | × | | | | × |
| (*Boreoscala*?) sp. | × | | | | | | | |
| (*Clathrus*) sp. A | | | × | | | | | |
| Vanikoridae: | | | | | | | | |
| *Vanikoro cancellata* (Lamarck) | | ×? | | | | | × | × |
| *gueriniana* (Récluz) | | × | × | × | × | × | × | × |
| aff. *V. kanakarum* Pilsbry | | | | | | | | |
| Hipponicidae: | | | | | | | | |
| *Cheilea equestris* (Linnaeus) | | | × | | × | × | × | × |
| *Hipponix* (*Malluvium*) cf. *H. badius* (Dunker) | | | | | × | | | |
| (*Antisabia*) *foliaceus* Quoy and Gaimard | | | × | × | × | | | × |
| (*Sabia*) *conicus* (Schumacher) | | | × | × | × | × | × | × |
| (*Pilosabia*) *revellei* Ladd, n. sp | | × | × | × | × | | | |
| Capulidae: | | | | | | | | |
| *Capulus* (*Krebsia*) aff. *C. liberatus* Pease | | × | | | | | | |
| (*Krebsia*) sp. A | | | × | ×? | | | | |
| sp. B | | | | × | | | | |
| Xenophoridae: | | | | | | | | |
| *Xenophora* sp. A | × | | | | | | | |
| sp. B | | × | ×? | × | | | | |
| *Tugurium exutum* (Reeve) | | | | | × | | | × |

TABLE 3.—*Geologic distribution of Cenozoic mollusk species in the island area*—Continued

| Species | Tertiary | | | | | Quaternary | | |
|---|---|---|---|---|---|---|---|---|
| | Late Eocene | Early Miocene | | Late Miocene | Pliocene | Pleistocene | Holocene | Living |
| | *b* | *e* | *f* | *g* | *h* | | | |
| Strombidae: | | | | | | | | |
| *Varicospira* aff. *V. crispata* (Sowerby) | | | | ×? | | | | |
| *Tibia* (*Tibia*) *powisii modesta* (Martin) | | | | | × | | | |
| *Terebellum* (*Terebellum*) *terebellum* (Linnaeus) | | | ×? | | | | | × |
| *Strombus* (*Laevistrombus*) *canarium* Linnaeus | | | | | | × | | × |
| (*Tricornis*) *maximus* Martin | | | | × | | | | |
| aff. *S. thersites* Swainson | | | × | | | | | |
| aff. *S. sinuatus* Lightfoot | | | | | | × | | |
| sp. A | | | | ×? | × | | | |
| (*Canarium*) *urceus* Linnaeus | | | | | × | | | × |
| *mutabilis* Swainson | | | | | × | × | × | × |
| *erythrinus* Dillwyn | | | | | | × | | × |
| cf. *S. fragilis* (Röding) | | | | × | | | | |
| sp. B | | | × | | | | | |
| (*Dolomena*) *plicatus pulchellus* Reeve | | | | | ×? | ×? | | × |
| *variabilis athenius* Duclos | | | | | ×? | | | × |
| *minimus minor* Abrard | | | | | × | | | |
| (*Lentigo*) *micklei* Ladd, n. sp | | | | × | | | | |
| cf. *S. preoccupatus* Finlay | | | | ×? | ×? | | | |
| sp. C | | | | × | | | | |
| (*Euprotomus*) *vomer hawaiiensis* Pilsbry | | | | ×? | | | | × |
| (*Conomurex*) *luhuanus* Linnaeus | | | | | × | | | × |
| (*Gibberulus*) *gibberulus gibbosus* (Röding) | | | | ×? | × | × | × | × |
| *pregibberulus* Abrard | | | | | × | | | |
| *Lambis* (*Lambis*) *lambis* (Linnaeus) | | | | | | × | | × |
| (*Lambis*) cf. *L. lambis* (Linnaeus) | | | × | | | | | |
| Total of 174 species | 17 | 28 | 50 | 65 | 55 | 40 | 47 | 69 |

Off-reef deposits of Eocene age whose fossils suggest a depth of 100 fathoms or more have been recognized on Saipan (Todd, 1957, p. 271) and in the deepest Eniwetok drill hole (Todd and Low, 1960, p. 812–815; Schlanger, 1963, p. 999–1002). Two additional occurrences may now be added to the deeper water off-reef groups: (1) the richly fossiliferous upper Eocene limestone from Eua, Tonga (Todd, 1970; Ladd, 1970) and (2) certain upper Tertiary fossiliferous marls from Vanua Levu, Fiji. The varied faunas from both areas are being actively studied by a number of paleontologists. Suggested depths of deposition, in Eua, Tonga, range from about 200 feet to more than 600 feet; in Vanua Levu, Fiji, they range from about 300 feet to more than 600 feet. The almost complete absence of typical reef organisms and the abundance of deeper water types of Foraminifera, corals, ostracodes, and mollusks strongly support the off-reef interpretation. More detailed analysis will be possible when present studies are completed.

In the earlier unit of the present study (Ladd 1966, p. 15), brief reference was made to late Tertiary fresh- and brackish-water mollusks collected on Viti Levu, Fiji. These mollusks included *Clithon corona* (Linnaeus), the river snail, and *Melanoides* cf. *M. tuberculatus* (Müller). To these may now be added another Tertiary thiarid—*Thiara* (*Setaeara*) *morrisoni* Ladd, n. sp. Single specimens were recovered from marine beds about 70 miles apart on opposite sides of the island of Viti Levu. One specimen was obtained from an outcrop of the Waindina Sandstone of the Verata Group at Nanduruloulou, the other from the Vatukoro Greywacke of the Mba Group a few miles southeast of Lautoka. The Nanduruloulou outcrop contained a varied fauna of benthonic and planktonic smaller Foraminifera; the Lautoka beds, pteropods and other small gastropods. The beds at both places probably are Pliocene.

## FAUNAL RELATIONS

The group of mollusks here described, like the group covered in Ladd (1966), is clearly Indo-Pacific in general aspect. The ties to Indonesia and northern Australia are a little closer than those to the Ryukyus and Japan and appreciably stronger than the ties to the southern part of Australia. Many mollusk species that live in the island area today have been represented there since Tertiary time. Forty such species are recorded in table 4; 28 of these were recovered from

Marshall Island drill holes. Some of the 28 are also listed from other island groups. Table 4 also records the distribution of eight Indo-Pacific species that apparently no longer live in the island area, though they were present there during the Tertiary.

Among the species identified from the Tertiary of the island area are eight that were originally described from the Tertiary of other areas. These are

*Turritella (Kurosioia) fileola* Yokoyama
*Modulus preangerensis* Martin
*Tympanotonos berberkirianus* (Martin)
*Rhinoclavis (Rhinoclavis) jonkeri* (Martin)
*Clypeomorus verbeeki* (Woodward)
*Triphora (Inella) maharatai* Beets
*Tibia (Tibia) powisii modesta* (Martin)
*Strombus (Tricornis) maximus* Martin

The first on the list, *Turritella fileola*, was described from Taiwan; the other seven were described from Indonesia.

Post-Tertiary species that lived in the island area were also recovered from the Quaternary reef sections drilled on Midway Atoll in Hawaii. When the Midway drilling was undertaken, it was hoped that the drill might penetrate unaltered richly fossiliferous beds of Miocene age (Tertiary *g* and *f*) comparable with those drilled beneath atolls in the Marshall Islands. Regrettably, as the drill demonstrated, Midway Atoll was emergent during much of the indicated interval: limestones of Tertiary *g* age were found to rest directly on limestones of Tertiary *e* age. Furthermore, the limestones of both Tertiary *g* and *e* age are leached and

TABLE 4.—*Living Indo-Pacific mollusks that also occur in the upper Tertiary* sedimentary *rocks of the island area*

[×, present; question mark indicates uncertain identification]

| Species | Living | | | | Upper Tertiary | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Indian Ocean | Indonesia and N. Australia | Ryuku and Japan | Island Area | Palau | New Hebrides | Fiji | Mariana Islands | Marshall Islands |
| *Architectonica (Architectonica) perspectiva* (Linnaeus) | × | × | × | × | | | × | | |
| *Philippia (Psilaxis) radiata* (Röding) | × | × | × | × | | | | | × |
| *Heliacus variegatus* (Gmelin) | × | × | × | × | | | × | | × |
| *Petaloconchus (Macrophragma) merkana* Ladd, n. sp | | | | × | × | | | | × |
| *(Macrophragma?) lamellosus* Ladd, n. sp | | | | × | | | | | × |
| *Terebralia sulcata* (Born) | | × | × | × | | | | | × |
| *Obtortio pyrrhacme* (Melvill and Standen) | | | | × | | | | | × |
| *Diala ludens* Melvill and Standen | | | | × | | | | | × |
| *stricta* Habe | | | × | | | | | | × |
| *Bittium sergentum* (Jousseaume) | | | | × | | | | | × |
| *Colina (Ischnocerithium) rostrata* (Sowerby) | × | × | × | × | | | | | × |
| *Rhinoclavis (Rhinoclavis) procera* (Kiener) | × | × | | × | | | × | ×? | |
| *(Rhinoclavis) aspera* (Linnaeus) | × | × | × | × | | | | × | × |
| *(Proclava) sordidula* (Gould) | | × | × | | | × | | ×? | |
| *Cerithium (Thericium) salebrosum* Sowerby | | | | × | | | | | × |
| *(Cerithium) nodulosum* Bruguière | × | × | × | × | × | | × | ×? | × |
| *Plesiotrochus luteus* (Gould) | | | | × | | | | | × |
| *pagodiformis* Hedley | | × | | | | | | | × |
| *Cyrbasia (Joculator) tribulationis* (Hedley) | | × | | | | | | | × |
| *(Joculator) semipicta* (Gould) | | × | | × | | | | | × |
| *Triphora (Triphora) otsuensis* (Yokoyama) | | | × | | | | | | × |
| *(Inella) pyramidalis* (Adams and Reeve) | | × | × | × | × | | | | × |
| *(Mastonia) intermissa* (Laseron) | | × | | | | | × | | × |
| *Cautotriphora hervieri* (Kosuge) | | × | × | × | | | | | × |
| *Viriola incisa* (Pease) | × | × | × | × | | | | | × |
| *cancellata* (Hinds) | × | × | × | × | | | | | × |
| *Epitonium (Cycloscala) revolutum* (Hedley) | | | | × | × | | | | |
| *Vanikoro cancellata* (Lamarck) | × | × | | | | | | | × |
| *gueriniana* (Récluz) | | | × | × | | | × | | × |
| *Cheilea equestris* (Linnaeus) | | | × | × | | | × | | × |
| *Hipponix (Antisabia) foliaceus* Quoy and Gaimard | | × | × | × | | | × | | × |
| *(Sabia) conicus* (Schumacher) | × | × | × | × | | | × | × | × |
| *Tugurium exutum* (Reeve) | | | × | | | | × | | |
| *Terebellum (Terebellum) terebellum* (Linnaeus) | × | × | × | × | | | | × | |
| *Strombus (Canarium) urceus* Linnaeus | | × | × | × | | × | | | |
| *(Canarium) mutabilis* Swainson | × | × | × | × | | ×? | × | × | |
| *(Dolomena) plicatus pulchellus* Reeve | | × | × | × | | × | × | | |
| *variabilis athenius* Duclos | | × | | × | | | | ×? | |
| *(Conomurex) luhuanus* Linnaeus | | × | × | × | | | | × | |
| *(Gibberulus) gibberulus gibbosus* (Röding) | | × | × | × | | | | × | |
| Total of 40 species | 13 | 27 | 25 | 32 | 4 | 4 | 12 | 10 | 28 |

recrystallized rendering most mollusks unidentifiable to species (Ladd and others, 1970). I still believe (Ladd, 1961) that many of the Miocene mollusks found in the Marshalls may also have been living in Hawaii during that time, but convincing evidence for this has not been found.

## SYSTEMATIC PALEONTOLOGY

Thirty-two new species and one new subspecies are described. Nine of the new forms are represented by only one or two specimens. Five of these poorly represented forms are from the drill holes in the Marshall Islands.

Although mollusks from the upper Eocene of Tonga are cited in the systematic section and are included in the faunal lists, none of them are described or figured in the present report, as they have been dealt with in Ladd's (1970) report.

Some of the fossil mollusks from Lau described by Ladd (in Ladd and others, 1945; Ladd, 1966) and in the present report, bear University of Rochester, Museum of Natural History, specimen numbers. Following the closing of the Museum at the University of Rochester, all fossil mollusks from Lau were given to the U.S. National Museum (J. Edward Hoffmeister, written commun., Dec. 8, 1959).

### ADDITIONAL SPECIES IN FAMILIES COVERED IN LADD (1966)

#### Family SCISSURELLIDAE

**Genus SCISSURELLA d'Orbigny (see Ladd, 1966, p. 26)**

**Subgenus ANATOMA Woodward (see Ladd, 1966, p. 27)**

*Scissurella (Anatoma) tongaensis* Ladd, 1970, U.S. Geol. Survey Prof. Paper 640–C, p. C2, pl. 2, figs. 1–4. Late Eocene (Tertiary *b*) ; Eua, Tonga.

#### Genus SINEZONA Finlay

Finlay, 1926, New Zealand Inst. Trans., v. 57, p. 341.

*Type* (by original designation).—*Schismope brevis* Hedley. Living, New Zealand.

*Sinezona kondoi* Ladd, 1970, U.S. Geol. Survey Prof. Paper 640–C, p. C2–C3, pl. 2, figs. 5–8. Late Eocene (Tertiary *b*) ; Eua, Tonga.

#### Family TROCHIDAE

#### Genus BASILISSA Watson

Watson, 1879, Linnaean Soc. London Jour., v. 14, p. 593.

*Type* (by subsequent designation, Cossmann, 1888, Catalogue illustre des coquilles fossiles de l'Eocene*** de Paris: Brussels, Soc. Royale Malacologique de Belgique, v. 3, p. 68).—*Basilissa superba* Watson. Holocene, Australia.

#### Subgenus ANCISTROBASIS Dall

Dall, 1889, Mus. Comp. Zoology Harvard Bull., v. 18, p. 32, 384.

*Type* (by monotypy).—*Basilissa costulata* Watson. Holocene, Caribbean.

*Basilissa (Ancistrobasis) pacifica* Ladd, 1970, U.S. Geol. Survey Prof. Paper 640–C, p. C3, pl. 2, figs. 9–11. Late Eocene (Tertiary *b*) ; Eua, Tonga.

#### Genus BATHYBEMBIX Crosse

Crosse, 1892, Jour. Conchyliologie, v. 40, p. 288–292.

*Type* (by original designation).—*Bembix aeola* Watson. Holocene, Japan.

*Bathybembix*? sp. Ladd, 1970, U.S. Geol. Survey Prof. Paper 640–C, p. C3, pl. 2, figs. 12, 13. Late Eocene (Tertiary *b*) ; Eua, Tonga.

#### Genus TURCICA A. Adams (see Ladd, 1966, p. 35)

#### Subgenus PERRINIA H. and A. Adams (see Ladd, 1966, p. 36)

*Turcica (Perrinia) blowi* Ladd, 1970, U.S. Geol. Survey Prof. Paper 640–C, p. C3–C4, pl. 2, figs. 14–17. Late Eocene (Tertiary *b*) ; Eua, Tonga.

#### Genus ASTELE Swainson (see Ladd, 1966, p. 37)

#### Subgenus CALLISTELE Cotton and Godfrey (see Ladd, 1966, p. 37)

*Astele (Callistele)* sp. Ladd, 1970, U.S. Geol. Survey Prof. Paper 640–C, p. C4, pl. 3, figs. 1–3. Late Eocene (Tertiary *b*) ; Eua, Tonga.

#### Family TURBINIDAE

#### Genus PAREUCHELUS O. Boettger

Boettger, O., 1907, Verhandlungen und Mitteilungen des siebenbürgischen vereins für Naturwissenschaften zu Hermannstadt: Hermannstadt, Jos. Drotleff, v. 55, p. 187.

*Type* (by original designation).—*Euchelus excellens* O. Boettger. Miocene, Hungary.

*Pareuchelus*? sp. Ladd, 1970, U.S. Geol. Survey Prof. Paper 640–C, p. C5, pl. 3, figs 8–10. Late Eocene (Tertiary *b*) ; Eua, Tonga.

#### Genus ASTRAEA Röding (see Ladd, 1966, p. 43)

#### Subgenus BOLMA Risso

Risso, 1826, Histoire naturelle des principales productions de l'Europe méridonale: Paris, F. G. Levrault, v. 4, p. 117.

*Type* (by monotypy).—*Turbo rugosa* Linnaeus. Holocene, Mediterranean and eastern Atlantic.

*Astraea (Bolma) stearnsi* Ladd, 1970, U.S. Geol. Survey Prof. Paper 640–C, p. C4, pl. 3, figs. 6, 7. Late Eocene (Tertiary *b*) ; Eua, Tonga.

#### Genus ASTRAEA sensu lat

#### Subgenus undescribed(?)

#### Astraea sp. F

Plate 4, figure 6

Medium in size; trochoid; whorls slightly inflated. Sculpture consisting of strong close-set oblique axial

ribs; two rows on each whorl, separated by a spiral groove located just above the midpoint; suture deep.

The figured specimen, a latex cast from an incomplete mold, USNM 650580, measures diameter 13 mm, height 10 mm.

In shape and sculpture this form resembles certain astraeids, though there is no trace of a peripheral ridge or of peripheral spines. The oblique axial ribs are sharper, more numerous, and more regular than the beaded folds on specimens of *Astraea* (*Cookia*). The Guam species may represent an undescribed subgenus, but the material is too incomplete for full diagnosis.

*Occurrence.*—Two incomplete molds from the Mariana Limestone of Guam, at USGS locs. 20739 (figured specimen) and 20869 that lie 3 to more than 3½ miles northwest of the head of Talofofo Bay; age, Pliocene or Pleistocene.

### Family LITTORINIDAE (see Ladd, 1966, p. 59)

### Genus LITTORINA Férussac

Férussac, 1822, Tableaux systématiques, des animaux mollusques: London, J. B. Sowerby, p. XI.

*Type* (by subsequent designation, Blainville, 1828, Dictionaire des sciences naturelles: (Paris, Le Normant, v. 56, p. 98).—*Turbo littoreus* Linnaeus. Holocene, western Europe.

#### Littorina scabra Linnaeus

Plate 4, figure 5

*Littorina scabra* Linnaeus. Tryon, 1887, Manual Conchology, v. 9, p. 243, pl. 42, figs. 18–20.

Demond, 1957, Pacific Sci., v. 11, no. 3, p. 289.

A small specimen of this widely distributed living Indo-Pacific species shows the characteristic spiral sculpture and traces of the original irregular axial color bands.

Measurements of the figured specimen, USNM 650582: height 11.5 mm, diameter 7.6 mm.

*Occurrence.*—From a boulder of Waisia Limestone, probably derived from base of Matamaute Group, inland from Lauwauwage Bay, Maewo, New Hebrides; age, Pleistocene.

### Family ADEORBIDAE (TORNIDAE)

### Genus DARONIA A. Adams

Adams, 1861, Annals and Mag. Nat. History, 3d ser., v. 8, p. 244.

*Type* (by original designation).—*Cyclostrema spirula* A. Adams. Holocene, southwest Pacific.

#### Subgenus DARONIA sensu stricto

*Daronia* (*Daronia*) *hoffmeisteri* Ladd, 1970, U.S. Geol. Survey Prof. Paper 640–C, p. C5, pl. 3, figs. 11–13. Late Eocene (Tertiary *b*); Eua, Tonga.

### Genus MUNDITIELLA Kuroda and Habe

Kuroda and Habe, 1954, Venus, v. 18, no. 2, p. 86, 90–91.

*Type* (by original designation).—*Cyclostrema ammonoceras* A. Adams. Holocene, Japan.

*Munditiella euaensis* Ladd, 1970, U.S. Geol. Survey Prof. Paper 640–C, p. C5, pl. 3, figs. 14–16; pl. 4. figs. 1–3. Late Eocene (Tertiary *b*); Eua, Tonga.

### Genus LYDIPHNIS Melvill (see Ladd, 1966, p. 79)

*Lydiphnis vainganaensis* Ladd, 1970, U.S. Geol. Survey Prof. Paper 640–C, p. C5–C6, pl. 4, figs. 4–6. Late Eocene (Tertiary *b*); Eua, Tonga.

## FAMILIES COVERED IN THE PRESENT PAPER

### Family TURRITELLIDAE

### Genus TURRITELLA Lamarck

Lamarck, 1799, Soc. Histoire Nat. Paris Mém., p. 74.

*Type* (by monotypy).—*Turbo terebra* Linnaeus. Holocene, western Pacific.

#### Turritella aff. T. cingulifera Sowerby

Plate 1, figure 1

A slender form with a deep suture; upper part of whorls flattened, rounded below; each whorl bearing four to five low beaded spirals, with faint secondary spirals in the intervening spaces.

Measurements of the figured specimen, USNM 648481 from drill hole E–1, Eniwetok, depth of 2,740–2,750 feet: length (five and a half whorls) 9.9 mm, diameter 3.9 mm.

The sculptural features of the Eniwetok fossils are similar to those of *Turritella cingulifera* but are much more subdued. The fossils resemble *T. fileola*, but that species has three strong beaded spirals.

*Occurrence.* — Thirty-one fragmentary specimens from drill hole E–1 on Eniwetok at depths of 2,660–2,820 feet; age, late Eocene (Tertiary *b*) to early Miocene (Tertiary *e*).

Sowerby (1825, p. xiv) described *Turritella cingulifera* from Holocene shells collected in the East Indies; it has since been reported from northern Australia (Rippingale and McMichael, 1961, p. 51), and Holocene specimens from Japan are in the Hirase Collection in the U.S. National Museum. The species has been reported from the Pliocene of various parts of Indonesia (Altena, 1938, p. 304), and Beets (1950, p. 330) recorded it from the lower Micoene Rembang beds of Java.

#### Turritella cf. T. javana Martin

Plate 1, figure 2

*Turritella* cf. *T. javana* Martin. Gardner *in* Cloud and others, 1956, U.S. Geol. Survey Prof. Paper 280–A, p. 66.

Incomplete external molds that may represent the somewhat variable species described by Martin from

the Miocene of Java (Martin, 1883, p. 233, pl. 11, fig. 27; 1905, p. 227, pl. 34, figs. 521–531) occur in the Tagpochau Limestone (Miocene) of Saipan USGS locs. 17728, marly facies, and 18288, inequigranular facies).

The figured cast from USGS loc. 18288, USNM 648482, measures: length (incomplete) 18 mm, diameter 6 mm.

The Saipan specimens are smaller than shells from Java, and most of them have whorls that are slightly less convex. According to van der Vlerk (1931, p. 253), *Turritella javana* is known also from the Pliocene of Java.

#### Turritella aff. T. sedanensis Martin

Plate 1, figure 3

*Turritella sedanensis* Martin. Gardner *in* Cloud and others, 1956, U.S. Geol. Survey Prof. Paper 280–A, p. 66.

Medium in size; flattened whorls have four sharp equally spaced primary spirals, the lower two being slightly larger than those above; weak secondary spirals occur between the primaries.

Measurements of the figured cast, USNM 648483, length 20 mm, width 6 mm.

The species closely resembles *Turritella sedanensis* described by Martin (1905, p. 234, pl. 35, figs. 554, 554a) from the lower Miocene of Java, but that species has five primary spirals. It is referred to as a variety of *T. subulata* Martin by Beets (1941, p. 28, pl. 9, fig. 347).

*Occurrence.*—External molds in the tuffaceous facies of the Tagpochau Limestone (Miocene) at USGS loc. 17689, Saipan.

#### Turritella aff. T. spolongensis Martin

Plate 1, figure 4

*Turritella* cf. *T. spolongensis* Martin. Gardner *in* Cloud and others, 1956, U.S. Geol. Survey Prof. Paper 280–A, p. 66.

Incomplete molds of a flat-sided *Turritella* show a prominent spiral ridge near the middle of each whorl and an almost equally prominent spiral on the lower part of the whorl close to the suture; remainder of whorl has secondary spirals, the highest one of which, near the suture, is larger than the others.

The sculpture of the species closely resembles that of *Turritella spolongensis* described by Martin (1916, p. 256, pl. 3, figs. 73, 73a) from the lower Miocene of Java, but the whorls of that species are more convex than those of the Saipan fossil here described. Martin compared his Java fossil with the Holocene *T. vittulata* Adams and Reeve from the China Sea, a species whose whorls are also distinctly convex.

Measurements of the figured specimen, a latex cast from specimen USNM 648484: length (incomplete) 14 mm, diameter 4 mm.

*Occurrence.*—Three incomplete molds from the inequigranular facies of the Tagpochau Limestone (Miocene) of Saipan (USGS loc. 17942).

#### Turritella sp. A

Plate 1, figures 5, 6

Represented by two incomplete shells from Viti Levu, Fiji (station MR–20). The adult whorls appear flat sided, but the middle part of each whorl is slightly concave. The most striking feature is the prominence of one or two spirals immediately above the impressed suture; a few secondary spirals occur on the remainder of the whorl.

Measurements of the figured specimen from Fiji, USNM 648485: height (four and a half whorls) 23.3 mm, diameter 11.1 mm.

Two incomplete and finely recrystallized molds from Guam probably represent the same species. The figured specimen, a latex cast, shows parts of 13 whorls that are nearly flat in profile. A single strong spiral lies immediately above the suture, and traces of widely spaced finer spirals are found on the later whorls, the lowest one on each whorl being stronger than the others.

Measurements of the figured specimen from Guam, USNM 648486: height 24.2 mm, diameter 5.3 mm.

The sculptural features of the fossils from Fiji and Guam resemble those of shells assigned to *Turritella bifastigata* Nelson, a Miocene species first described from Peru and also known from Ecuador (Olsson, 1964, p. 189) and Panama (Woodring, 1957, p. 111), but *T. bifastigata* is a larger form and has a wider apical angle.

*Occurrences.*—Mba Group, station MR–20, Viti Levu, Fiji; age, probably Pliocene (Tertiary *h*). USGS loc. 21434, Guam, in the molluscan facies of the Mariana Limestone; age, Pliocene-Pleistocene.

#### Turritella sp. B

Plate 1, figure 7

Apical whorls gently convex, bearing three strong unbeaded spirals, the lowest one slightly larger than the others; suture deeply impressed. The single specimen does not closely resemble any other fossil *Turritella* from the island area, but it is identical with apical tips dredged from Bikini lagoon at a depth of 25 fathoms (USNM 586704).

Measurements of the figured specimen, USNM 648487: height (incomplete) 3.2 mm., diameter 1.0 mm.

*Occurrence.*—Drill hole 2A, Bikini, at depth of 279–284½ feet; age, post-Miocene, possibly Pliocene (Tertiary *h*).

### Subgenus KUROSIOIA Ida

Ida, 1952, Japan Geol. Survey Rept. 150, p. 43.

*Type* (by original designation).—*Turritella kurosio* Ida. Pleistocene, Japan.

### Turritella (Kurosioia) fileola Yokoyama

Plate 1, figures 8–14

*Turritella fileola* Yokoyama, 1928, Japan Imp. Geol. Survey Rept. 101, p. 57, pl. 4, fig. 7.

Nomura, 1935, Tohoku Imp. Univ. Sci. Repts., 2d ser. (Geol.), v. 18, no. 2, p. 189.

Otuka, 1938, Venus, v. 8, no. 1, p. 39, fig. 13.

*Turritella* (*Kurosioia*) *filiora* Ida (=*T. fileola* Yokoyama, 1928), 1952, Japan Geol. Survey Rept. 150, p. 44, pl. 1, figs. 5, 9; pl. 7, fig. 7.

*Turritella* (*Kurosioia*) *fileola* Yokoyama. Kotaka, 1959, Tōhoku Univ. Sci. Repts., 2d ser. (Geol.), v. 31, no. 2, p. 85, pl. 11, figs. 1, 3.

*Turritella* (*Haustator*) *fileola* Yokoyama. MacNeil, 1961 [imprint 1960], U.S. Geol. Survey Prof. Paper 339, p. 36, pl. 1, fig. 20; pl. 11, figs. 22–26.

A small slender species whose flattish whorls bear three strong equally distant spiral ridges and numerous secondary and tertiary spirals; spirals beaded by incremental lines; suture impressed; aperture subquadrate.

Measurements of the figured specimens (pl. 1, figs. 8–10, 13) from USGS loc. 17446, Guam—all rubber casts from incomplete external molds—are:

| Specimen (USNM) | Length (mm) | Diameter (mm) |
|---|---|---|
| 648488 | 18.0 | 3.9 |
| 648489 | 16.1 | 4.5 |
| 648490 | 19.7 | 4.8 |
| 648491 | 25.5 | 6.3 |

Measurements of the figured specimen from station C–89, Viti Levu, Fiji, USNM 648494: (pl. 1, fig. 11) length (incomplete) 8.1 mm, diameter 2.1 mm. Measurements of the figured specimens (pl. 1, figs. 12, 14) from USGS loc. 21031, Espiritu Santo, New Hebrides; USNM 648492—length 14 mm, diameter 4 mm; USNM 648493—length (incomplete) 5.7 mm, diameter 3.2 mm.

*Occurrence.*—Abundant at three stations on Guam (USGS locs. 17446, 20648, 21630); less abundant at 11 other stations on the same island (USGS locs. 20560, 20586, 20587, 20590, 20600, 20611, 20674, 20969, 20993, 21626, 21631). All specimens are from the Mariana Limestone (Pliocene and Pleistocene) (most from Agana Argillaceous Member, several from the detrital facies). A single specimen from USGS loc. 20724 is from an area mapped as the Talisay Member of the Alifan Limestone (upper Tertiary).

Known from three stations on Viti Levu, Fiji: stations C–89 (seven specimens) and MR–20 (one specimen) in beds referred to the Mba Group (?); station 344 near Singatoka (one specimen) in Thuvu Formation. All these occurrences are probably Pliocene.

Abundant in rounded cobbles from gravel bar in Sarakata River, USGS loc. 21031, Espiritu Santo, New Hebrides. Age, unknown.

The species was originally described from the Pliocene of Taiwan (Boritzu beds). It has been identified from the Pliocene of Japan (Kotaka, 1959, p. 86) and the Miocene (Yonabaru Clay Member of Shimajiri Formation) and Pliocene (Nakoshi Sand and Chinen Sand and Naha Limestone) of Okinawa (MacNeil, 1960, p. 36).

### Turritella (Kurosioia) aff. T. fascialis Menke

Plate 1, figure 15

*Turritella* aff. *T. fascialis* Menke. MacNeil, 1961 [imprint 1960], U.S. Geol. Survey Prof. Paper 339, p. 36, pl. 11, fig. 28.

A single external mold from the Barrigada Limestone (Tertiary *g* or *h*) in the Dededo Well on Guam (USGS loc. 24795) at a depth of 120 feet appears to be conspecific with the specimen figured by MacNeil (1960) from the Chinen Sand (Pliocene) on Okinawa (USNM 562908). The incomplete Guam mold has a wide flattened band both above and below the suture; between these flattened areas the surface of each whorl is gently convex and bears three low primary spirals; between the primary spirals and on the flattened areas near the suture are fine secondary spirals.

Measurements of the figured mold, from specimen USNM 648495: length (incomplete) 7 mm, diameter 3 mm.

*Turritella fascialis*, the Holocene species described by Menke (1828, p. 83), was discussed at some length by Kotaka (1959, p. 86). Otuka (1938, p. 38) noted that the species occurs in the Pleistocene of Japan. The single Guam fossil may well represent the Japanese species. *T. fascialis* is probably conspecific with *T. gracillima* Gould (1861, p. 386). Gould's types are in the U.S. National Museum (USNM 2027 and 24143); they appear to be more uniformly sculptured than the fossils from Guam and Okinawa. MacNeil (1960) recognized that the Okinawa fossils could be merely a variant of *T. fileola* but noted that none of many specimens of that species from other localities closely resembled the specimen he was comparing with *T. fascialis*; this statement also holds true for the Guam fossil figured here.

### Subgenus TORCULA Gray

Gray, 1847, Zool. Soc. London Proc., pt. 15, p. 155.

*Type* (by original designation).—*Turbo exoletus* Linnaeus. Holocene, West Indies and Florida.

#### Turritella (Torcula?) sp. C

Plate 1, figure 16

Medium in size, stout, bearing two large coarse spiral ribs on the lower part of each whorl, the one closer to the suture being less prominent than the other; a third heavy spiral lies immediately below the suture; the broad central area between the spirals is strongly concave with traces of three secondary spirals; base concave. Though worn and incomplete the single fossil retains lines of yellowish-brown spots immediately above and below the suture.

Measurements of the figured specimen, USNM 648496: height (2½ whorls) 17.1 mm, diameter 8.9 mm.

The Fiji fossil appears to be related to the Holocene subgenotype, a West Indian species. On the Holocene shell only the body whorl has a double spiral at the base of the whorl, but on the fossil such double spirals are present on younger whorls also. The fossil probably represents a distinct species, but a name is withheld pending the finding of better type material.

*Occurrence.*—Station 160, Walu Bay, Viti Levu, Fiji; age, early Miocene (Tertiary *f*).

### Genus TENAGODUS Guettard

Guettard, 1770, Mémoires sur differentes parties des Sciences et Arts, 3, Paris, p. 129.

*Type* (by subsequent designation, Cossmann, 1912, Essais de paléoconchologie comparée: Paris, v. 9, p. 146).—*Serpula anguinus* Linnaeus. Holocene, Indian Ocean.

#### Tenagodus (Tenagodus) sp.

Plate 1, figures 17, 18

*Siliquaria* sp. Ladd *in* Ladd and others, 1945, Bernice P. Bishop Mus. Bull. 181, p. 361, pl. 51, figs. H, I.

No additional material obtained. Known only from the Ndalithoni Limestone (age, probably Tertiary *h*) of Vanua Mbalavu (station 110B) in eastern Fiji.

### Subgenus AGATHIRSES Montfort

Montfort, 1808, Conchyliologie Systématique, v. 1, p. 399.

*Type* (by subsequent designation, Cossmann, 1912, [*Agathyrsus*] Essais de paléoconchologie comparée: Paris, v. 9, p. 148).—*Siliquaria spinosa* Lamarck. Eocene, France.

#### Tenagodus (Agathirses) cf. T. australis (Quoy and Gaimard)

Plate 2, figures 1–4

A loosely coiled thick tubular shell with a prominent slit. Near the apex the slit has undulating edges, and more anteriorly the slit is pierced by open holes. Above the slit the surface bears fine spiral striae; below, the surface is cut by closely set transverse fissures.

Measurements of the incomplete figured specimens: USNM 650414—height 6.6 mm, diameter of tube 4.2 mm, USNM 650415—height 5.8 mm, diameter of tube 1.8 mm.

The two Fiji fossils are too incomplete for positive identification.

*Occurrence.*—Two specimens from the conglomerate in the Suva Formation near Suva, Fiji (station 160); age, early Miocene (Tertiary *f*). The Holocene *Tenagodus australis* lives off the coast of South Australia and Tasmania.

### Genus VERMICULARIA Lamarck

Lamarck, 1799, Soc. Histoire Nat. Paris Mém., p. 78.

*Type* (by monotypy).—*Serpula lumbricalis* Linnaeus. Holocene, western Pacific.

#### Vermicularia sp. A

Plate 2, figures 5–7

The 24 specimens available consist of parts of a *Turritella*-like spire, none showing the whorls of the protoconch or the adult part of the shell. Spire consists of at least eight whorls bearing a strong median spiral above and below which the whorl is flattened; the median spiral is rounded on early whorls but becomes sharper on later whorls, and on some specimens may be indistinctly beaded; some specimens show two or three secondary ribs on later whorls both above and below the median spiral, the ribs next to the suture being more prominent than the others. The prominence of the median spiral and of the ribs next to the suture varies considerably. On one specimen growth lines are present.

Measurements of the figured specimens: USNM 648497—length 6.4 mm, diameter 2.0 mm; USNM 648498—length (incomplete) 5.2 mm, diameter 2.1 mm; USNM 648499—length (incomplete) 6.5 mm, diameter 2.6 mm.

*Occurrence.*—Nine specimens from drill hole E–1 on Eniwetok at depths of 1,835–2,720 feet; 15 specimens from drill hole 2B on Bikini at depths of 1,545–2,102 feet. All specimens were found in beds referred to the lower Miocene (Tertiary *e*).

## Family MATHILDIDAE

### Genus MATHILDA Semper

Semper, 1865, Jour. Conchyliologie, v. 13, p. 330.

*Type* (by subsequent designation, Cossmann, 1888, Catalogue illustre des coquilles fossiles de l'Eocene*** de Paris: Brussels, Soc. Royale Malacologique de Belgique, v. 3, p. 68.).—*Turbo quadricarinatus* Brocchi. Pliocene, Sicily.

### Subgenus FIMBRIATELLA Sacco

Sacco, 1895, I Molluschi dei terreni terziarii del Piemonte e della Liguria: Torino, Italy, Carlo Clausen, pt. 19, p. 36.

*Type* (by original designation).—*Cerithium fimbriatum* Michelloti. Late Miocene, Italy.

#### Mathilda (Fimbriatella?) sp.

*Mathilda* (*Fimbriatella*?) sp. Ladd, 1970, U.S. Geol. Survey Prof. Paper 640–C, p. C6, pl. 4, fig. 7. Late Eocene (Tertiary *b*); Eua, Tonga.

### Genus GEGANIA Jeffreys

Jeffreys, 1884, Zool. Soc. London Proc., p. 365, pl. 27, fig. 10.

*Type* (by monotypy).—*Gegania pinquis* Jeffreys. Holocene, Atlantic.

#### Gegania whipplei Ladd

*Gegania whipplei* Ladd, 1970, U.S. Geol. Survey Prof. Paper 640–C, p. C6, pl. 4, figs. 8–11. Late Eocene (Tertiary *b*); Eua, Tonga.

## Family ARCHITECTONICIDAE

### Genus CLIMACOPOMA Fischer

Fischer, 1885, Manual Conchology, p. 714.

*Type* (by original designation).—*Solarium patula* Lamarck. Eocene, Paris Basin.

#### Climacopoma? sp. A

Plate 2, figures 8–10

Small, discoidal, with a rounded peripheral keel that is regularly scalloped. Protoconch depressed. Sculpture of the flattened dorsal surface consisting of spirals, the peripheral one being the largest; on ventral surface a rounded spiral lies next to the peripheral keel; umbilicus moderately wide, its margin puckered, the grooves extending to the marginal spirals; aperture ovate.

Represented by a single specimen, USNM 648500, that is worn and probably immature and that measures: height 0.8 mm, diameter 2.9 mm.

The serrate periphery of this unusual architectonicid suggest that it is a *Climacopoma*, though its umbilicus is narrower than that of the genotype and of late Tertiary and Holocene species referred to the genus (MacNeil, 1960, p. 37).

*Occurrence.*—Drill hole E–1, Eniwetok at a depth of 2,650–2,660 feet. Age, early Miocene (Tertiary *e*).

### Genus ARCHITECTONICA Röding

Röding, 1798, Mus. Boltenianum: Hamburg, Johan Christi, pt. 2, p. 78.

#### Subgenus ARCHITECTONICA sensu stricto

*Type* (by subsequent designation, Gray, 1847, Zool. Soc. London Proc., pt. 15, p. 151. "*Architectoma*").—*Trochus perspectivus* Linnaeus. Holocene, Indo-Pacific.

#### Architectonica (Architectonica) perspectiva (Linnaeus)

Plate 2, figures 11–13

*Trochus perspectivus* Linnaeus, 1758, Systema naturae [10th ed.], p. 757.

*Solarium perspectivum* (Linnaeus). Marshall, 1887, Manual Conchology, v. 9, p. 8, pl. 2, figs. 18–21.

*Architectonica* (*Architectonica*) *perspectiva* (Linnaeus). Ladd [new subspecies?] 1934, Bernice P. Bishop Mus. Bull. 119, p. 214, pl. 38, figs. 2–4.

*Architectonica perspectiva* (Linnaeus). Altena, 1938, Leidse Geol. Meded., v. 10, no. 2, p. 310. (See for additional citations.)

MacNeil, 1961 [imprint 1960], U.S. Geol. Survey Prof. Paper 339, p. 38, pl. 1, figs. 18, 22, 26; pl. 12, figs. 1, 7, 11.

*Architectonica* (*Architectonica*) *perspectiva* (Linnaeus). Wissema, 1947, Young Tertiary and Quaternary Gastropoda from the Island of Nias***: Rijksuniversiteit, Leiden, doctor's thesis, p. 35.

Shuto, 1969, Kyushu Univ. Fac. Sci. Mem., ser. D, Geol., v. 19, no. 1, p. 96, pl. 1, figs. 4, 8, 15, text fig. 16.

A single specimen recently collected from Vanua Levu, Fiji, closely resembles the single fossil previously described from Viti Levu. Each is a small, probably immature, shell with a low spire, convex base, and extended peripheral spiral.

Measurements of the Vanua Levu specimen, USNM 648501: height 5.3 mm, diameter 13.4 mm.

*Occurrence.*—In Fiji at stations 165 and C–89 on Viti Levu and at station 817 on Vanua Levu; age of all three occurrences probably Pliocene (Tertiary *h*).

The species has been reported from upper Tertiary beds in many localities in Melanesia, India, Formosa, Okinawa, and Japan and from the Pleistocene in Melanesia and the Ryukyu Islands. Living examples inhabit wide areas of the Indo-Pacific region. The Fiji fossils cannot be distinguished from Holocene specimens collected in Fiji.

#### Subgenus PSEUDOTORINIA Sacco

Sacco, 1892, I Molluschi dei terreni terziarii del Piemonte e della Liguria: Torino, Italy, Carlo Clausen, pt. 12, p. 66.

*Type* (by original designation).—*Solarium obtusum* Bronn. Miocene and Pliocene, Italy.

#### Architectonica (Pseudotorinia) corwini Ladd, n. sp.

Plate 2, figures 14–18

Small, low, whorls flattened; protoconch smooth, slightly more than one whorl visible on dorsal side. Dorsal surface covered by four strongly beaded spiral cords, the one at the periphery being slightly larger than the others; beads on adjacent cords connected by rounded oblique axial threads. Umbilicus moderately wide, bordered by a coarse, strongly beaded rib which is separated by a deep groove from a series of beaded spiral cords that cover the remainder of the ventral

surface; spiral cords vary in size, the coarser ones lying near the umbilicus, fine threads tending to alternate with cords nearer the periphery. Aperture subcircular, crenulated by spiral sculpture.

Measurements of the holotype, USNM 648502 from USGS loc. 21304 (type locality) in Palau: Height 3.7 mm, diameter 6.6 mm. Paratype A, USNM 648503, an incomplete shell from the type locality showing protoconch and early whorls: height 0.7 mm, diameter 2.3 mm. Paratype B, USNM 648504, from Bikini: height 3.7 mm, diameter 6.7 mm.

On the Bikini specimen the axials connecting the beads of the spirals are more prominent than on Palau shells; a single specimen from Eniwetok resembles the Bikini specimen in this respect but has five spiral cords per whorl dorsally rather than four.

The species resembles *Architectonica euprepes* Woodring from the middle Miocene of Jamaica (Woodring, 1928, p. 357, pl. 27, figs. 15–17), but that species has a lower spire, a wider umbilicus.

The species is named for Dr. Gilbert Corwin, Chief of the U.S. Geological Survey's mapping party in Palau.

*Occurrence.*—Seven specimens from Palau, USGS locs. 21301 and 21304; one specimen from drill hole 2A, Bikini, at depth 925–936 feet; age, late Miocene (Tertiary *g*). A single specimen from drill hole F–1, Eniwetok at depth 960–970 feet may be slightly older, Tertiary *f*.

### Genus PHILIPPIA Gray

Gray, 1847, Zool. Soc. London Proc., pt. 15, p. 146.

*Type* (by original designation).—*Solarium luteum* Lamarck. Holocene, Australia.

### Subgenus PSILAXIS Woodring

Woodring, 1928, Carnegie Inst. Washington Pub. 385, p. 355.

*Type* (by original designation).—*Architectonica* (*Philippia*) *krebsii* Mörch. Holocene, West Indies and Florida.

#### Philippia (Psilaxis) radiata (Röding)

Plate 2, figures 19–21

*Architectonica radiata* Röding, 1798, Mus. Boltenianum: Hamburg, Johan Christi, pt. 2, p. 79.

*Philippia* (*Psilaxis*) *radiata* (Röding). Robertson, 1970, Pacific Sci., v. 24, p. 66–83. (See for additional citations.)

Shell small, spire low, whorls flattened. Protoconch consisting of one large rounded whorl; on the dorsal surface of succeeding whorls is a strong peripheral cord, next to which is a much weaker cord. Ventral surface has a strongly beaded umbilical cord bounded by a smaller beaded cord whose beading is extended by slight swellings on adjoining shell surface; next to the peripheral cord is a weak cord.

Measurements of the figured specimen, USNM 648505, from drill hole F–1, Eniwetok, at depth 700–710 feet: height 3.2 mm, diameter 6.5 mm. A smaller specimen from drill hole K–1B, Eniwetok, at depth 957–976 feet, USNM 648506, measures: height 0.6 mm, diameter 1.7 mm.

On both the fossil specimens the spire is low but neither shell is fully adult. The dorsal surfaces of the specimens are more flattened than those on most Holocene shells. The ventral surface of the figured specimen bears a rather sharp median elevation which appears to be the attachment scar of an earlier whorl.

*Occurrence.*—Figured specimen from drill hole F–1, Eniwetok, at depth 700–710 feet is late Miocene (Tertiary *g*) in age. The smaller specimen from drill hole K–1B, Eniwetok, at depth 957–968 is from early Miocene (Tertiary *f*) beds, but this specimen is worn and may have been derived from a younger horizon.

In his paper Robertson (1970, fig. 5) included a map showing the distribution of *Philippia* (*Psilaxis*) *radiata* in the existing oceans. Museum specimens and literature records cover the entire Indo-Pacific, from the Marquesas to South Africa and the Red Sea, from Japan to southern Australia.

### Genus HELIACUS d'Orbigny

d'Orbigny, 1842, *in* Sagra, Ramón de la, Histoire physique, politique et naturelle de l'îsle de Cuba, Mollusques: Paris, Arthus Bertrand, v. 2, p. 68.

*Type* (by monotypy).—*Solarium heberti* Deshayes. Holocene, West Indies.

#### Heliacus variegatus (Gmelin)

Plate 3, figures 1–3

*Trochus variegatus* Gmelin, 1791, Systema naturae [13th ed.], p. 3,575.

*Torinia variegatus* (Gmelin). Marshall, 1887, Manual Conchology, v. 9, p. 16, pl. 5, figs. 75–79; pl. 1, figs. 14–16.

*Heliacus* sp. Ladd, 1934, Bernice P. Bishop Mus. Bull. 119, p. 215, pl. 38, figs. 5–7.

*Heliacus* cf. *variegatus planulatus* (Hanley). Ladd *in* Ladd and others, 1945, Bernice P. Bishop Mus. Bull. 181, p. 360.

*Heliacus variegatus* (Gmelin). Kira, 1962, Shells of the western Pacific in color: Osaka, Japan, Hoikusha Pub. Co., v. 1, p. 24, pl. 13, fig. 4.

The following description is based on the fossil material:

Shell small, solid; spire low to moderately high, its sides gently convex; suture inconspicuous; base nearly flat; aperture subcircular, its inner lip crenulated by surface spirals. Sculpture consisting of two strong peripheral cords, the upper one being slightly larger than the lower; on the dorsal surface, three cords present between periphery and suture; dorsal spirals obliquely beaded by close-set axials; on the base a

strong beaded spiral encircles the umbilicus, and four or five flattened spirals occur between the umbilical and peripheral spirals; on some specimens the cord next to the peripheral spiral is appreciably weaker than the others.

Measurements of the figured specimen, USNM 648507, from Eniwetok: height 4.6 mm, diameter 7.5 mm.

The fossil examples fall within the range of variation exhibited by Holocene shells.

*Occurrence.*—Single specimens from drill hole F–1, Eniwetok, at depth 700–710 feet (upper Miocene, Tertiary *g*); at station 160, Walu Bay, Viti Levu, Fiji (lower Miocene, Tertiary *f*); and at station L–10, Fulanga, Fiji (probably Pleistocene). Living individuals have been collected widely throughout the Indo-Pacific region, from East Africa to Hawaii.

### Family VERMETIDAE
### Genus PETALOCONCHUS Lea

Lea, 1843, Am. Philos. Soc. Proc., v. 3, p. 162.

*Type* (by monotypy).—*Petaloconchus sculpturatus* Lea. Miocene, Virginia.

#### Subgenus MACROPHRAGMA Carpenter

Carpenter, 1857, Catalogue of the collection of Mazatlan shells in the British Museum, London, p. 308.

*Type* (by original designation).—*Petaloconchus macrophragma* Carpenter. Holocene, Pacific coast of Mexico.

**Petaloconchus (Macrophragma) merkana Ladd, n. sp.**

Plate 3, figures 4–12

Small tubes coiled irregularly to form flattened cylindrical or conical masses; all whorls attached except the last; aperture circular. Sculpture consisting of strong, regularly spaced, rounded axial ribs, except on the erect last section, which may be nearly smooth; longitudinal sculpture varying from strong ribs to obscure broad elevations, on some shells absent entirely.

Measurements of the types and of other specimens selected to illustrate the variation in longitudinal sculpture follow:

| Specimen (USNM) | Type | Locality | Age | Length of coil (mm) | Diameter of tube (mm) |
|---|---|---|---|---|---|
| 650416 | Holotype | Palau | late Miocene | 7.5 | 1.0 |
| 650417 | Paratype A | Drill hole E–1, Eniwetok, 620–630 ft. | do | 6.2 | .9 |
| 650418 | Paratype B | Drill hole K–1B, Eniwetok, 831–842 ft. | do | 3.0 | .7 |
| 586680 | | Bikini lagoon | Holocene | 6.1 | 1.0 |
| 650419 | Paratype C | Drill hole 2A, Bikini, 925–936 ft. | late Miocene | 8.1 | 1.7 |
| 341315 | | Pearl Harbor, Hawaii. | Holocene | 13.9 | 1.7 |
| 362370 | | Midway Atoll, Hawaii. | do | 7.3 | .8 |

Plate 3, figures 6–8 illustrate the internal lamellae shown by many specimens, both fossil and living. The species is characterized particularly by the strong axial ribs.

*Occurrence.*—Holotype and 17 less complete specimens from USGS loc. 21304, Palau; five specimens from USGS loc. 21301, Palau; age, late Miocene (Tertiary *g*). In Eniwetok drill holes, numerous specimens from depths of 55 to 1,746 feet; age, early Miocene (Tertiary *e*) to Holocene. In drill hole 2A, Bikini, many specimens from depths of 105 to 946 feet; age, late Miocene (Tertiary *g*) to Holocene. An incomplete specimen from station 202720, Tonga, is probably Pleistocene in age. Living specimens have been collected from Bikini's lagoon and from Pearl Harbor, Oahu, and Midway Atoll in Hawaii.

**Petaloconchus (Macrophragma?) lamellosus Ladd, n. sp.**

Plate 3, figure 13

Small, short, flat-coiled tubes with circular aperture; sculpture consists of strong close-set, imbricating lamellae, best developed on the upper surface; no trace of longitudinal markings. Internal lamellae not observable on three fossil specimens from the Marshall Islands but are present in a group of adhered Holocene specimens from Hawaii.

Measurements of the holotype, USNM 650421: maximum diameter 5.1 mm, diameter of tube 1.5 mm.

The well-developed lamellate sculpture of this species distinguishes it from other known species of the genus.

*Occurrence.*—Two single specimens from Eniwetok drill holes: the holotype from E–1 at depth of 670–680 feet, the other specimen from E–1 at depth of 780–790 feet; these two specimens are late Miocene (Tertiary *g*) in age. A third fossil from drill hole 2A on Bikini at depth of 195 feet is Holocene. Several shells of dead individuals were collected in drift material on two Bikini islets (USNM 585972 and 586967). An adherent group of Holocene specimens from Laysan Island, Hawaii in the U.S. National Museum collections (USNM 333098) were recognized by W. H. Dall (unpub. data) as an undescribed form.

### Genus SERPULORBIS Sassi

Sassi, 1827 Giornale Ligustico di Scienze, Lettere, ed Arti, pt. 5, p. 483.

*Type* (by monotypy).—*Serpulorbis polyphragma* Sassi (=*Serpula arenaria* Linnaeus). Holocene, Mediterranean Sea.

**Serpulorbis cf. S. javanus (Martin)**

Plate 3, figures 14, 15

Tube irregularly coiled near attachment area; later parts nearly straight; aperture circular; tube divided

by thin partitions that are concave forward. Sculpture consisting of coarse longitudinal ridges that may be scaly or that may be smoothly beaded; one to three fine threads are present between larger ridges.

The Eniwetok specimens closely resemble and may be identical with the Java species described by Martin (1879–80). The nearly straight section of the Eniwetok fossil is less strongly beaded by transverse swellings than is that section of the Java form; the longitudinal ridges of the Eniwetok forms are nearly parallel to the axis, whereas Martin noted that the ridges on the Java specimens are commonly oblique to the axis.

Measurements of the figured specimens: coiled specimen, USNM 650422—maximum diameter 13.1 mm, diameter of tube 4.2 mm; uncoiled segment, USNM 650423—length 15.0 mm, diameter of anterior end of tube 4.1 mm.

*Occurrence.*—Represented by two specimens from drill hole F–1, Eniwetok at a depth of 790–800 feet and by a single specimen from a depth of 810–820 feet in same hole: age, late Miocene (Tertiary *g*).

*Serpulorbis javanus*, with which the Eniwetok specimens are compared, was described as *Vermetus javanus* by Martin (1879–80, p. 77, pl. 14, fig. 13.) from the Tertiary of Java. It has since been recognized from the Miocene, Pliocene, and later beds in Java; from the Miocene of East Borneo and other parts of Indonesia; and from the Pliocene of Timor and Taiwan (Beets, 1941, p. 34).

#### Serpulorbis sp.

Plate 3, figure 16

*Lemintina* sp. Ladd *in* Ladd and others, 1945, Bernice P. Bishop Mus. Bull. 181, p. 360, pl. 51, fig. G.

No additional specimens of this weakly sculptured form have been obtained. Known only from the Ndalithoni Limestone (age, probably Pliocene, Tertiary *h*) of Vanua Mbalavu (station 110B) in eastern Fiji.

### Family THIARIDAE

### Genus MELANATRIA Bowdich

Bowdich, 1822, Elements of conchology, p. 27–28, pl. 6, fig. 20.

*Type* (by monotypy).—*Melania pyrene* Lamarck. Holocene, Madagascar.

#### Melanatria vitiensis Ladd, n. sp.

Plates 4, figure 1

*Pyrazus* (*Pyrazus*) sp. Ladd, 1934, Bernice P. Bishop Mus. Bull. 119, p. 215, pl. 38, fig. 8.

Shell large; spire high and flat sided; younger whorls slightly more convex than older whorls. Aperture channeled anteriorly and posteriorly; inner lip callused. Sculpture consisting of strong regularly spaced axial plications, alternating, on the younger whorls, with poorly developed secondary plications; all whorls bearing flattened spiral ribs, 10 ribs present on the penultimate whorl; on body whorl last axial plication stronger than others, and in front of it suture descends; growth lines indistinct over most of the shell. Traces of original color present as narrow orange bands near the aperture.

Measurements of the holotype and only specimen (Bernice P. Bishop Mus., Geol. No. 1187): height 78.4 mm, diameter 26.3 mm.

The axial plications on the younger whorls of the fossil shell do not become spinose as they do on the shells, of *Melanatria fluminea*, a living species, the type of the genus. Also, the spiral ribs of *M. vitiensis* are fewer and more flat topped than these of *M. fluminea*.

*Occurrence.*—In the conglomerate at the base of the limestone section (station 160) on Walu Bay, Viti Levu, Fiji; age, early Miocene (Tertiary *f*).

### Genus THIARA Röding

Röding, 1798, Mus. Boltenianum: Hamburg, Johan Cristi, pt. 2, p. 77.

*Type* (by subsequent designation, Brot, 1874, *in* Martini, Systematisches Conchylien Cabinet, v. 1, pt. 24, p. 7).—*Helix amarula* Linnaeus. Holocene, Indo-Pacific.

### Subgenus SETAEARA Morrison

Morrison, 1952, Am. Malacological Union Bull. and Ann. Rept. 1951, p. 8.

*Type* (by monotypy).—*Thiara cancellata* Röding. Holocene, Indonesia.

#### Thiara (Setaeara) morrisoni Ladd, n. sp.

Plate 4, figures 2, 3

Shell ovate with a large inflated body whorl and a short truncated spire. High on each whorl is a distinct shoulder; immediately above the shoulder is a shallow depression followed by an inflated zone; suture distinct; aperture lenticular, outer lip sharp, inner lip covered by a thin callus. Sculpture consisting of narrow flattened spiral bands, separated by interspaces nearly as wide as the bands themselves; these interspaces narrow to fine grooves on the upper part of the whorl; spiral bands crossed by low slightly oblique axial ridges that are expanded at the shoulder to form nodes; above the shoulder the ribs are twisted into a slightly sigmoid curve.

Measurements of the holotype, USNM 650581: height (apex missing) 6.8 mm, diameter 4.5 mm.

The nodes along the shoulder appear to have been spines opening to the left and may have supported cuticular setae of the type described by Morrison in defining the subgenus. *Thiara* (*Setaeara*) *morrisoni* is

closely related to *T. cancellata* Röding, a larger and more strongly shouldered fresh-water species living in the Philippines and various parts of Indonesia.

This species is named for Dr. J. P. E. Morrison who has worked out the relationships of Melanians (a group that includes *Thiara*) round the world.

*Occurrence.*—Known from two specimens, one collected from the Waindina Sandstone of the Verata Group, station C–831, at Nanduruloulou, the other from the base of the Vatukoro Greywacke of the Mba Group, station C–1134 near Ambatha, Viti Levu, Fiji; age of both specimens, late Miocene or early Pliocene.

### Genus MELANOIDES Olivier

Olivier, 1804, Voyage dans l'empire Othoman, l'Egypte, et la Perse: Paris, v. 3, p. 69.

*Type* (by monotypy).—*Melanoides fasciolata* Olivier (=*Nerita tuberculata* O. F. Müller). Holocene, Coromandel, India.

#### Melanoides (Melanoides) cf. M. tuberculatus (Müller)

Plate 4, figure 4

*Melanoides* (*Melanoides*) cf. *M. tuberculatus* (Müller). Ladd, 1965, Malacologia, v. 2, no. 2, p. 192, pl. 1, fig. 5.

Small, slender; whorls moderately convex, somewhat flattened immediately below impressed suture; aperture elongate-oval, angular above, rounded below; imperforate; peristome incomplete. Sculpture consisting of spiral cords, four to seven on penultimate whorl; on some shells the spirals are crossed by weak or moderately developed axials that give the shell a clathrate appearance, with the intersections beaded in some specimens; in a few shells the axials are developed into strong curved ridges (pl. 4, fig. 4).

Measurements of the figured specimen, USNM 648447: height (incomplete) 3.9 mm.; diameter (body whorl incomplete) 1.4 mm.

The Fiji fossils almost certainly represent the exceedingly variable and widely distributed *Melanoides tuberculatus*, but on none of the numerous fossils is the apex or the aperture complete or well preserved. The fossils, which have been compared with Holocene shells from many areas, are smaller than most Holocene shells, and most of the fossil shells show a well-developed flattened area immediately below the suture. An area of this sort is found on some Holocene shells.

*Occurrence.*—Abundant at station C–136, a boulder in Nasaranga Creek west of Rewasau and about 3 miles southwest of Nasongo, Viti Levu, Fiji; age, probably late Tertiary. *Melanoides tuberculatus* was originally described as a Holocene shell from Coromandel, India. The species has been widely reported from Africa; from Asia Minor through southern China, Indonesia, and north Australia; and from a number of Pacific islands, including Fiji (Germain, 1932, p. 55). Fossil *M. tuberculatus* shells have been reported from the upper Miocene (Martin, 1905, p. 238), Pliocene, and Pleistocene of Java (Benthem Jutting, 1956, p. 416).

According to Mrs. van Benthem Jutting (1956, p. 415; 1958, p. 325), who described Holocene shells from Java and other Indonesian islands, *Melanoides tuberculatus* generally is found in fresh water but occasionally in brackish waters. It seems to prefer slowly running water but has been found living in stagnant, even polluted, waters; it also occurs in swamps.

## Family CAECIDAE

### Genus CAECUM Fleming

Fleming, 1813, Brewster's Edinburgh Encyclopedia, v. 7, p. 67.

*Type* (by subsequent designation, Gray, 1847, Zool. Soc. London Proc., pt. 15, p. 203).—*Dentalium trachaea* Montagu. Holocene, seas of Europe.

Small, curved tubes, apical end closed by a septum; sculpture consists of strong well-spaced axial rings.

#### Caecum vertebrale Hedley

Plate 5, figures 8–10

*Caecum* sp. de Folin, 1886, Zoology, *Challenger* Rept., 15, p. 684, pl. 2, fig. 12.

*Caecum vertebrale* Hedley, 1899, Australian Mus. Mem. 3, pt. 7, p. 425, fig. 15.

Shell minute, moderately curved, slightly tapering. Sculpture consists of 22–30 moderately strong rounded rings separated by hollows of approximately the same width. Aperture circular, slightly oblique, separated from the first ring by a convex area; posterior end closed by a strongly convex septum.

Measurements of the figured specimens: USNM 650425 from drill hole F–14–C, Eniwetok, at depth 33–36 feet—length 2.8 mm, diameter 0.6 mm; USNM 650426 from drill hole F–1, Eniwetok, at depth 260–270 feet—length 2.6 mm, diameter 0.7 mm; Bernice P. Bishop Mus. Geol. No. 1341 from Bernice P. Bishop Mus. Cat. station 202980, Tonga—length 1.8 mm, diameter 0.4 mm.

The two figured specimens from Eniwetok were compared with one of Hedley's Holocene types (Australian Museum, Paratype C5917).

*Occurrence.*—Four specimens in four drill holes on Eniwetok at depths from 19 to 270 feet; age Pleistocene to Holocene. Six specimens from Bernice P. Bishop Mus. Cat. station 202980, Tongatapu, Tonga; age, probably Pleistocene.

#### Caecum berberense Ladd, n. sp.

Plate 5, figures 11, 12

Minute, moderately curved, slightly tapering. Sculpture consisting of 21–26 strong, sharply elevated rings

separated by wider interspaces. Aperture circular, septum gently convex.

Measurements of the holotype from drill hole E–1, Eniwetok, depth 1,260–1,270 feet, USNM 650429: length 2.9 mm, diameter 1.5 mm. Paratype from drill hole F–1, Eniwetok, depth 910–920 feet, USNM 650428: length 2.3 mm diameter 0.5 mm.

*Caecum berberense* closely resembles *C. vertebrale* but has stronger and more sharply elevated rings and a less convex septum.

*Occurrence.*—More than 40 specimens from three deep holes on Eniwetok at levels ranging from 230 to 1,394 feet; age, early Miocene (Tertiary *e*) to Pliocene (Tertiary *h*) or younger beds. Bikini drill holes yielded three specimens of comparable ages at depths 447–453, 1,240–1,251 and 1,734–1,755 feet. Sixteen incomplete shells from station 160, Viti Levu, Fiji, probably represent the same species; age early Miocene (Tertiary *f*).

#### Caecum parryensis Ladd, n. sp.

Plate 5, figures 1–7

Minute, moderately arcuate and slightly twisted, has a plug that is flattened at the edges but that rises to a spur near the convex side of the shell; spur pinched at right angles to the main plane of curvature. Anterior third of shell distinctly flared. Sculpture consisting of fine close-set growth rings; rim of aperture slightly thickened.

Measurements of the single specimen, USNM 648518 (holotype): length 2.1 mm, apertural diameter 0.7 mm.

*Caecum parryensis* has the twisting and the fine sculpture characteristic of *Strebloceras*, *Parastrophia*, and *Watsonia* but differs from these in being decollate, the apex being closed by septum and spur. The single specimen may not be mature.

*Occurrence.*—Drill hole E–1 on Parry Island, Eniwetok, at depth of 1,260–1,270 feet. Age, early Miocene (Tertiary *e*).

### Genus MICRANELLUM Bartsch

Bartsch, 1920, Washington Acad. Sci. Jour., v. 10, no. 20, p. 568.

*Type* (by original designation).—*Caecum crebricinctum* Carpenter. Holocene, California.

Shape as in *Caecum* but with numerous fine axial rings.

#### Micranellum schlangeri Ladd, n. sp.

Plate 5, figures 13, 14

Small, elongate, inflated, slightly curved shells; maximum inflation and curvature in anterior third of shell; posterior end filled by a plug that rises to a moderately sharp projecting spur close to the convex side of the tube; aperture constricted, oblique. Sculpture consists of faint close-set ringlets that are clearly visible only under high magnification.

Measurements of the holotype, USNM 650430 from drill hole E–1, Eniwetok, at depth 940–950 feet: length 2.8 mm, diameter 0.7 mm. A paratype, Mus. Comparative Zoology 29022, from Funafuti at depth 65 feet, measures: length 2.9 mm, diameter 0.7 mm.

The amount of constriction of the anterior end of the tube is a variable feature. The fossils are smaller, more slender, and more tapered anteriorly than *Micranellum catalinense*, a Holocene species described by Bartsch (1920, p. 569) from California. In general form the fossils closely resemble Holocene shells described by de Folin (1881, p. 17, pl. 1, fig. 9) as *Meioceras elongatum* from the China Sea, but the plug of the fossils protrudes more sharply than that of the smooth shell described and figured by de Folin.

This species is named for Dr. S. O. Schlanger, who studied and interpreted drill samples from Eniwetok.

*Occurrence.*—Four specimens from drill holes K–1B and E–1, Eniwetok, at depths 873–950 feet; age, early Miocene (Tertiary *f*); two specimens from same holes at higher levels, 820–840 feet; age, late Miocene (Tertiary *g*). One specimen from drill hole F–6–C, Eniwetok, at depth 14–17 feet is Holocene as are three specimens from the Funafuti drill hole at depths 65–70 feet.

### Genus ELEPHANTANELLUM Bartsch

Bartsch, 1920, Washington Acad. Sci. Jour., v. 10, no. 20, p. 567.

*Type* (by original designation).—*Caecum hexagonum* Carpenter. Holocene, Mazatlan.

Shape as in *Caecum* but with axial rings and longitudinal ridges or riblets.

#### Elephantanellum sp. A

Plate 5, figure 15

Shell small, nearly straight posteriorly, gently curved near aperture; circular in section, lip thin; septum strongly convex. Sculpture consists of fine close-set growth lines that become prominent anteriorly to form six distinct rings; extremely fine longitudinal threads can be distinguished under high magnification; threads are slightly more conspicuous in hollows between anterior rings than elsewhere.

Measurements of the only specimen, USNM 650431: length 3.6 mm, diameter 0.6 mm.

The presence of fine longitudinal sculpture disguishes this species from other fossil caecids from the island area.

*Occurrence.*—The single specimen was recovered from drill hole E–1, Eniwetok, at depth of 540–550 feet. Age, post-Miocene, probably Pliocene.

### Genus FARTULUM Carpenter

Carpenter, 1857, Catalogue of the collection of Mazatlan shells in the British Museum, London, p. 325.

*Type* (by original designation).—*Caecum laeve* C. B. Adams. Holocene, Panama to Mazatlan.

Small decollate caecids with no sculpture other than lines of growth.

#### Fartulum aff. F. amputatum (Hedley)

Plate 5, figures 16, 17

Small, elongate, circular in section; apical end slightly constricted in some specimens; apertural end has a heavy collar, beveled below to a thin edge; aperture slightly oblique. Sculpture consisting of numerous fine lines of growth.

Measurements of figured specimen from drill hole K–1B, Eniwetok, USNM 650432: length 2.7 mm, diameter 0.7 mm. A specimen from drill hole E–1, Eniwetok, USNM 650433: length 2.1 mm, diameter 0.5 mm.

Closely resembles *Fartulum amputatum* described by Hedley (1893) from Sydney Harbor, Australia, but that form lacks the heavy, beveled apertural collar. Hedley's description and figure indicate a bulge near the aperture, but an examination of the type shows that the bulge is much less conspicuous than the collar described here. A smaller and more slender Holocene species, *Caecum gulosum*, from the lagoon beach at Funafuti, also described by Hedley (1899, p. 426, fig. 16), is collarless.

*Occurrence.*—Six specimens from drill hole K–1B, Eniwetok, depth 862–884 feet; and six specimens from drill hole E–1, Eniwetok, depth 960–1,010 feet. Age, early Miocene (Tertiary *f*).

#### Fartulum sp. A

Plate 5, figure 18

Shell small, inflated, smooth, straightened posteriorly, slightly constricted posteriorly, more strongly constricted anteriorly; plug projecting to a broadly rounded, centrally located point; aperture circular, oblique.

Measurements of the single specimen, USNM 650434: length 2.5 mm, diameter 0.6 mm.

*Fartulum* sp. A is more straightened posteriorly and more constricted anteriorly than the type species, *F. laeve* (C. B. Adams).

*Occurrence.*—Drill hole F–1, Eniwetok, at depth 280–290 feet. Age, post-Miocene, possibly Pliocene (Tertiary *h*).

### Family MODULIDAE

### Genus MODULUS Gray

Gray, 1847, Zool. Soc. London, Proc. pt. 15, p. 150.

*Type* (by original designation).—*Trochus modulus* Linnaeus. Holocene, West Indies.

#### Modulus tectum (Gmelin)

*Trochus tectum* Gmelin, 1791, Systema Naturae [13th ed.], v. 1, p. 3,569.

*Modulus tectum* (Gmelin). Tryon, 1887, Manual Conchology, v. 9, p. 260, pl. 48, figs. 87–89.

A single specimen of this widespread Holocene Indo-Pacific species was collected from the Mariana Limestone on Cabras Island, Guam (USGS loc. 21591). Age, probably Pleistocene. According to Beets (1941, p. 37), the species has also been reported from the Pleistocene of the Red Sea area and the Quaternary of Celebes.

#### Modulus preangerensis Martin

Plate 5, figures 19–21

*Modulus preangerensis* Martin, 1895, Die fossilien von Java, Geol. Reichs-Mus. Leiden Samml., new ser., v. 1, p. 221, pl. 41, fig. 671.

Medium in size, biconic, solid; whorls about six; protoconch smooth; whorls of spire shouldered; periphery rounded, suture lightly impressed, not descending at aperture; aperture elongate-oval, oblique; outer lip strongly lirate within, inner lip callused: columella with a heavy basal tooth that is deeply excavated below; umbilicus moderately wide and deep. Sculpture consisting of strong spiral cords that are crossed and weakly beaded by oblique axial riblets; above the periphery, obscure axial folds are present; the rounded periphery of the body whorl bears two spirals larger than the two enclosed between them and the spirals that lie above and below; the base bears 10 subequal spirals.

Measurements of the figured specimen, USNM 648450: height 10.9 mm, diameter 9.5 mm.

*Occurrence.*—Three specimens from the marls at the base of the Palau Limestone in the Goikul area (USGS loc. 21304), Palau; age, late Miocene (Tertiary *g*). Martin (1895) described the species from the upper Miocene of Java; van der Vlerk (1931, p. 252) reported it also from the lower Miocene.

### Family POTAMIDIDAE

The Potamididae include many brackish-water forms that live in great abundance on intertidal flats and in mangrove swamps.

### Genus POTAMIDES Brongniart

Brongniart, 1810, Mus. Histoire Nat. Paris Annals, v. 15, p. 367–368

*Type* (by monotypy).—*Potamides lamarckii* Brongniart. Oligocene, France.

#### Potamides tayamaia Ladd, n. sp.

Plate 6, figures 1–3

Medium to large, stout; spire composed of about 13 flattened whorls, each bearing four to five primary

spirals that are distinctly beaded where they cross the numerous slightly curved axial ribs (21–28 on penultimate whorl); five to six secondary spirals present between primary ribs on each whorl, not distinctly beaded where they cross the axials. A varix is present on the body whorl opposite the aperture, and other varicis are present on the spire at irregular intervals on some specimens; suture shallow. Aperture lenticular, outer lip thin, flaring and crenulated. Inside the outer lip back at least half a whorl are four to five elongate nodes that are variable in size and distribution. Inner lip heavily callused, its edge erect; columella has one prominent and several smaller spiral ridges; anterior channel moderately long, slightly recurved; posterior channel shallow.

Measurements of the types: Holotype, USNM 650500—height (incomplete) 22.0 mm. diameter 8.8 mm; paratype A, USNM 650499—height 31.7 mm, diameter (aperture incomplete) 11.1 mm; paratype B, USNM 650501—height (incomplete) 23.0 mm, diameter (aperture incomplete) 8.5 mm.

*Potamides tayamaia* is very closely related to *P. herklotsi* (Martin), a species found in the lower and upper Miocene of Java. Both the Palau and the Java species are represented by numerous specimens. Martin (1879–80, p. 64; 1899, p. 214) pointed out that the Java species is exceedingly variable; the numerous Palau shells are less variable. The complex sculpture of early whorls of the two species is so similar that they are indistinguishable, but the later whorls of *P. herklotsi* commonly lose most of their spiral sculpture; this change is not seen in any of the numerous specimens of *P. tayamaia.*

The Palau fossils closely resemble Holocene shells that are common on tidal flats around Airai Bay west of the Goikul Peninsula; however, the Holocene shells consistently have only three principal spirals, whereas the Goikul fossils have four or five.

This species is named for the late Professor Risaburo Tayama of Sendai, Japan, who was a pioneer in the study of the geology of Palau.

*Occurrence.*—The most abundant of the larger mollusks in the Goikul Marl exposures north of Goikul village (USGS locs. 21301 and 21304); also collected at USGS loc. 21310 east of the village, Babelthuap, Palau; an incomplete mold from the Palau Limestone at USGS loc. 17718 on "Aulopsehal" (Auluptagel) Island probably represents the same species; age, late Miocene (Tertiary *g*).

### Potamides wardi Ladd, n. sp.

Plate 6, figures 4, 5

Medium in size, slender; spire composed of 10 or more gently convex whorls, each having three primary spirals that are strongly beaded where they cross the axial ribs (10 on penultimate whorl); two or three threadlike secondary spirals lie between each two primaries; secondaries not beaded in crossing the axials; a low varix is present opposite the aperture; suture wide, hollow. Aperture lenticular, outer lip not complete in any specimen but inside the broken edges are three low nodes, the posterior one of which is the largest; inner lip heavily callused, its edge erect; columella with one prominent and several indistinct spiral ridges; anterior canal moderately long and recurved.

Measurements of the incomplete holotype from Guam, USNM 650498: height 18.5 mm, diameter 6.8 mm. A paratype, USNM 650511 from drill hole F–1, Eniwetok, 770–780 feet, measures: height (incomplete) 16.0 mm., diameter 6.2 mm.

In general form and in details of sculpture this species is very similar to *Rhinoclavis* (*Proclavia*) *sordidula* (Gould) (=*Cerithium pfefferi* Dunker = *C. turritum* Sowerby), a Holocene species known from Japan to the Philippines and from Pliocene and younger rocks from parts of the same area, but that species does not have nodes inside the outer lip.

This species is named for Porter Ward of the U.S. Geological Survey, long a student of hydrology on Guam.

*Occurrence.*—Holotype and four other nearly complete specimens, together with numerous fragments, from USGS loc. 20535 on Guam, from the Talisay Member of the Alifan Limestone; age, late Tertiary (Tertiary *g* or *h*). Paratype and five other specimens from drill hole F–1, Eniwetok, at depths 770–790 feet; age, Miocene (Tertiary *f–g*).

### Potamides sp. A

Plate 6, figure 6

Small, slender; spire consists of about 10 whorls; on the upper six whorls of the spire the lower half of each whorl bears two prominent spiral threads that are beaded where they cross rounded axial plications; finer spiral threads cover the remainder of each whorl, but these are not beaded in crossing the axials; lower whorls of spire flatter than those of apical part, and the two primary spiral threads on these whorls are less conspicuous than those on the apical part; suture distinct, wavy; a low varix is present opposite the aperture; similar but even less prominent varices occur at irregular intervals on the spire. Aperture elongate-oval, extended anteriorly into a narrow recurved canal bordered by a basal columellar fold; inner lip smooth, heavily callused; margin of outer lip not preserved, but lip is lirate within.

Measurements of the figured specimen. USNM 650520: height 11.1 mm, diameter 3.6 mm.

*Occurrence.*—Two incomplete specimens from drill hole K–1B, Eniwetok, at depth of 747–758 feet; age, late Miocene (Tertiary *g*).

#### Potamides sp. B

Plate 6, figure 7

Like *Potamides* species A, this species is small and slender; its spire composed of about nine whorls that are flattened above and strongly convex below. Whorls of the apex have strong spiral ribs, later whorls are covered by smaller spirals, the one immediately above the suture being larger than the others; large rounded axial plications occur over the entire shell; base covered by spirals that alternate in size, the larger ones beaded. Apertural features, including internal lirations, similar to those in *Potamides* sp. A.

Measurements of the figured specimen, USNM 650521, height 7.7 mm, diameter 2.6 mm.

*Occurrence.*—Figured specimen from drill hole K–1B, Eniwetok, 778–790 feet; age, late Miocene (Tertiary *g*).

### Genus TYMPANOTONOS Schumacher

Schumacher, 1817, Essai d'un nouveau système des habitations des vers testacés: Copenhagen, p. 211.

*Type* (by monotypy).—*T. fluviatilis* Schumacher (= *Murex fuscatus* Linnaeus). Holocene, Indo-Pacific.

#### Tympanotonos berberkirianus (Martin)

Plate 6, figures 8–10

*Potamides* (*Tympanotomus*) *berberkirianus* Martin, 1899, Geol. Reichs-Mus. Leiden Samml., v. 1, nos. 6–8, p. 209, pl. 32, figs. 472–477.

Martin, 1922, Geol. Reichs-Mus. Leiden Samml., v. 1, 2d sec., no. 4, p. 472, pl. 60, fig. 71.

Medium in size with a high spire consisting of about 10 intricately sculptured, turreted whorls. Protoconch missing on all four available specimens. Aperture elongate-oval; outer lip incomplete but with one or two heavy rounded nodes within; columella with one or more low spiral folds near and above the midpoint; posterior canal shallow but distinct, anterior canal twisted. Sculpture consisting of several sets of spiral ribs that are noded or beaded by less prominent axial ridges. The largest spiral lies near the top of each whorl; below it are two somewhat less prominent spirals; between the three primary spirals are sets of fine and very fine spirals, all somewhat beaded by axial riblets; several fine beaded spirals also occur between the largest primary spiral and the inconspicuous suture; a strong varix is developed opposite the aperture and similar but less well developed structures occur on earlier whorls.

Measurements of the figured specimens from USGS loc. 21301, Palau: USNM 650456—height 29.9 mm, diameter 12.2 mm; USNM 650457—height (incomplete) 20.4 mm, diameter 7.9 mm.

*Occurrence.*—Three specimens from USGS loc. 21301 and one from USGS loc. 21304—both localities in marls at base of Palau Limestone, Goikul peninsula, Babelthuap, Palau; age, late Miocene (Tertiary *g*). Martin described the species from the Miocene and Pliocene of Java.

### Genus VICARYA d'Archiac and Haime

d'Archiac and Haime, 1854, Description des animaux fossiles du group nummulitique de l'Inde: Paris, p. 298, pl. 28, fig. 4.

*Type* (by monotypy).—*Nerinea? vernuili* d'Archiac. Miocene, India.

#### Vicarya sp.

Plate 6, figure 11

A fragment, consisting of parts of three whorls, shows the unusual sculpture that characterizes *Vicarya*. Immediately below the suture each whorl bears a row of prominent tubercles that are flattened in a plane at right angles to the axis of coiling. Below the row of tubercles the remainder of the whorl is concave in profile and bears five regularly spaced spiral threads; suture inconspicuous; internally a central columnar fold is visable. Traces of yellowish axial bands are preserved between the rows of tubercles.

Measurements of the figured specimen, USNM 650493; height (incomplete) 9.2 mm, diameter 6.3 mm. The Eniwetok fossil is smaller than the species described as *Vicarya? callosa* by Jenkins (1864, p. 57, pl. 7, fig. 5) from the Miocene of Java and lacks the distinct spiral groove that runs over the tops of the tubercles in that species.

In reviewing occurrences of species of *Vicarya*, Takeyama (1933, p. 140) noted that they appear to have inhabited brackish waters.

*Occurrence.*—Single fragment from drill hole E–1, Eniwetok, at depth 2,700–2,710 feet; age, early Miocene (Tertiary *e*).

### Genus CERITHIDEA Swainson

Swainson, 1840, Treatise on malacology: London, Longman, Orme, Brown, Greene, and Longmans, p. 342.

*Type* (by subsequent designation, Pilsbry and Harbison, 1933, Acad. Nat. Sci. Philadelphia Proc., v. 85, p. 115).—*Melania lineolata* Griffith and Pidgeon (= *Cerithium obtusum* Lamarck). Holocene, Indian Ocean and Indonesia.

### Cerithidea cf. C. obtusa (Lamarck)

Plate 6, figure 12

Five incomplete specimens from the Miocene of Saipan are smaller than Holocene shells from Pacific islands but seem to be similar in all other observable features. Measurements of the figured specimen, USNM 650497: height 19.3 mm, diameter 10.7.

*Occurrence.*—USGS loc. 21408, Saipan, in the tuffaceous facies of the Tagpochau Limestone; age, Miocene. Holocene shells of *Cerithidea obtusa* have been collected from India through Indonesia to the Pacific islands.

### Genus TEREBRALIA Swainson

Swainson, 1840, Treatise on malacology: London, Longman, Orme, Brown, Green, and Longmans, p. 342.

*Type* (by subsequent designation, Sacco, 1895, I Molluschi dei terreni terziarii del Piemonte e della Liguria: Torino, Italy Carlo Clausen pt. 17, p. 51.).—*Strombus palustris* Linnaeus. Holocene, Indo-Pacific.

### Terebralia sulcata (Born)

Plate 6, figure 13

*Murex sulcatus* Born, 1778, Index Rerum Naturatium Musei Caesarei Vindobonensis: Vienna, Krausiana, p. 324.

*Pyrazus sulcatus* (Born). Reeve, 1865, Conchologica Iconica, v. 15, *Pyrazus* sp. 1.

*Potamides* (*Terebralia*) *sulcatus* (Born). Tryon, 1887, Manual Conchology, v. 9, p. 160, pl. 32, figs. 46, 47.

Martin, 1895, Die fossilien von Java, Geol. Reichs-Mus. Leiden Samml., v. 1, no. 2, p. 211.

Medium in size; cerithid in form; whorls of spire flat; penultimate and body whorl gently convex; aperture lenticular; columella with a strong plication above and a weaker one below, these structures matched by two heavy rounded nodes on inside of outer lip; anterior canal short and curved; sculpture consisting of strong regularly spaced axial ribs (about 15 on body whorl) crossed by four straplike spirals, the two spirals adjacent to the incised suture being larger than the other two; areas between spirals sharply excavated; axials beaded where crossed by spirals. A broad varix is present close behind outer lip, and other varices occur on earlier whorls.

Measurements of the figured specimen USNM 650445; height (incomplete) 20.0 mm, diameter 8.6 mm.

*Occurrence.*—Single specimen from drill hole E–1, Eniwetock, at depth 640–650 feet; age, late Miocene (Tertiary *g*). Living specimens inhabit an area from the Caroline Islands, Indonesia, northern Australia, Okinawa, to the Philippines. The species has also been reported from the upper Miocene of Java and the Pliocene of Sumatra and Timor (van der Vlerk, 1931, p. 251).

### Genus BATILLARIA Benson

Benson, 1842, *in* Cantor, Annals and Mag. Nat. History, v. 9, p. 488.

*Type* (by monotypy).—*Cerithium zonalis* Bruguière. Holocene, China coast.

### Subgenus ZEACUMANTUS Finlay

Finlay, 1926, New Zealand Inst. Trans., v. 57, p. 380.

*Type* (by original designation).—*Cerithium subcarinata* Sowerby. Holocene, New Zealand.

### Batillaria (Zeacumantus) rickardi Ladd, n. sp.

Plate 6, figure 14

Medium in size, high spired; upper whorls straight sided, later whorls gently convex; suture wide and deep. Sculpture consists of wide flattened spiral ribs (four on each whorl of the spire) and strong axial plications (seven to nine per whorl), those of one whorl imperfectly alined with those of adjoining whorls; spiral ribs slightly swollen where they cross the axial plications.

The strong regular sculpture and the deep suture distinguish the fossil from described Holocene species of *Zeacumantus*.

Measurements of the holotype, USNM 650436: height (incomplete) 25.2 mm, diameter 12.2 mm.

This species is named for Dr. M. J. Rickard, who collected the type specimen during the course of a long and productive study of Fijian geology.

*Occurrence.*—Holotype and one other specimen from conglomerate at base of limestone section (station 160) on Walu Bay, Viti Levu, Fiji; age, early Miocene (Tertiary *f*).

### Family DIASTOMIDAE

### Genus OBTORTIO Hedley

Hedley, 1899, Australian Mus. Mem. 3, pt. 7, p. 413, fig. 6.

*Type* (by original designation).—*Rissoia pyrrhacme* Melvill and Standen, Holocene, Loyalty Islands.

When Hedley (1899, p. 412), proposed the genus *Obtortio*, he placed in it some shells that he had collected from the lagoon beach of Funafuti in the Ellice Islands. As type of his new genus, he chose *Rissoia pyrrhacme*, which was described by Melvill and Standen (1896, p. 310, pl. 11, fig. 70) from the Loyalty Islands. Hedley expressed the opinion that the shell described from the Loyalty Islands was identical with a common New Caledonian shell that he had collected at Panie, New Caledonia, only "a day's sail" from the type locality of *R. pyrrhacme*. Because the figure published by Melvill and Standen was too small to give

details of the apex, Hedley prepared an enlargement to show characteristics that he considered of generic importance. This figure shows axial ribs on the whorls of the protoconch, but these ribs are not mentioned in the accompanying description.

Later workers (for example, Wenz, 1940, p. 750) have followed Hedley's figure and have stated that the protoconch of *Obtortio* has ribbed whorls, differing in this respect from *Alabina* (Dall, 1902). Numerous fossil and Holocene shells from the Marshall Islands have most of the features described by Hedley for *Obtortio*, but the whorls of their protoconchs are smooth. In an attempt to determine the type of protoconch possessed by the Loyalty Island shell named as type of *Obtortio*, I asked S. P. Dance, then at the Manchester Museum, to examine the shells of *Rissoia pyrrhacme* described by Melvill and Standen. He stated (written commun., Apr. 3, 1967) that an examination of the (potential) lectotype and of the few paratypes that retain the protoconch showed the protoconch to be quite smooth (pl. 7, fig. 3). Hedley also mentioned that the shells he referred to *O. pyrrhacme* had an aperture that was grooved within. The Marshall Island shells appear to be grooved within, but a close examination reveals that this is the effect of the outside spirals showing through. Mr. Dance reported that the types of *R. pyrrhacme* are also smooth within.

It appears that *Alabina* Dall is a synonym of *Obtortio* Hedley.

### Obtortio pyrrhacme (Melvill and Standen)

Plate 6, figures 15, 16; plate 7, figures 1–3

*Rissoia pyrrhacme* Melvill and Standen, 1896, Jour. Conchology (Leeds), v. 8, pt. 9, p. 310, pl. 11, fig. 70.

*Obtortio pyrrhacme* (Melvill and Standen). Hedley, 1899, Australian Mus. Mem. 3, pt. 7, p. 413, fig. 6.

Shell small, stout, with sharp apex; early whorls of spire turreted, later whorls broadly convex. Protoconch consisting of two to three smooth convex whorls, followed by seven to eight sculptured whorls. Aperture elongate-oval; slightly effuse anteriorly; columella thickened below; outer lip smooth within. First four whorls of spire with two to three strong spiral ribs that become beaded as the larger whorls are approached; larger whorls have numerous (six or more) spiral ribs with obscure minute riblets in the interstices; spiral ribs of larger whorls beaded by numerous low axial plications that disappear on the lower part of the body whorl.

Many fossils from shallow depths in the Marshall Island drill holes retain traces of brown color on the apex that characterizes the shells of living specimens.

Measurements of the figured specimens are:

| Specimen (USNM) | Island | Drill hole | Depth (feet) | Height (mm) | Diameter (mm) |
|---|---|---|---|---|---|
| 650461 | Eniwetok | F–1 | 20–45 | 2.8 | 1.3 |
| 650462 | do | K–1 | 201–211.5 | 3.5 | 1.4 |
| 650463 | do | F–1 | 860–870 | 4.7 | 1.8 |
| 650464 | Bikini | 2B | 1,345.5–1,356 | 3.7 | 1.3 |

Hedley noted a considerable variation in the outline (proportion) of the shells he examined. This same variation is exhibited by the Marshall Island shells. The difference in outline may be a sexual feature, as suggested by Hedley. Smaller spiral lirae in the interstices of some of the larger lirae can be observed on some of the Marshall Island shells, but on many specimens these smaller lirae cannot be seen even under high magnification. Another variable feature is the development of the axial plications. On some shells they are low and indistinct, on others sharp and more prominent.

*Occurrence.*—In all the deep holes and many of the shallow holes on Eniwetok and Bikini; more than 100 lots from near the surface to a depth of 2,039 feet; age, early Miocene (Tertiary *e*) to Holocene. As mentioned earlier, the species was described from Holocene shells collected in the Loyalty Islands; Hedley's shells from New Caledonia and from the lagoon beach at Funafuti in the Ellice Islands probably represent the same species, but I could not find any fossils in samples from the drill hole on Funafuti.

### Obtortio failingi Ladd, n. sp.

Plate 7, figures 4, 5

Small, stout, pupoid, polished. Protoconch consists of two to three glassy convex whorls followed by about five sculptured whorls that make up the spire; first two whorls slightly flattened on upper part and bearing low regularly spaced axial plications that are canceled by two to three low spiral ribs; spirals persist on all later whorls, but axial plications become more widely spaced and indistinct; suture impressed. Aperture ovate, slightly effuse; columella with a pad of callus that is sharply defined.

The sculpture varies considerably; on some shells the plications are fairly well developed even on the body whorl (pl. 7, fig. 5).

Measurements of the figured specimens: holotype, USNM 650465—(2B, Bikini, 2,070–2,081 feet) height 2.4 mm, diameter 0.9 mm; a paratype, USNM 650466—(E–1, Eniwetok, 1,746–1,777 feet) height 2.1 mm, diameter 0.9 mm.

This species is named for the late George E. Failing, who furnished the drill used during Operation Crossroads.

*Occurrence.*—Thirty-three specimens (14 lots) in drill hole 2B, Bikini, at depths 1,492–2,112 feet; 40

specimens (9 lots) in drill hole E–1, Eniwetok, at depths 1,280–1,985 feet; age of all occurrences, early Miocene (Tertiary *e*).

### Obtortio dancei Ladd, n. sp.

Plate 7, figure 6

Shell minute, stout, turreted; protoconch consists of about two smooth glassy whorls followed by five to six sculptured whorls; suture prominent. Aperture broadly lenticular, slightly expanded anteriorly; inner lip sharply set off, outer lip thin. Sculpture consisting of spiral ribs, about five to the whorl; two peripheral ribs are larger than the others and add to the turreted appearance; peripheral spirals noded by broad axials; nodes less prominent on body whorl; base has about five distinct subequal spiral ribs.

Measurements of the holotype, USNM 650545: height 1.6 mm, diameter 0.5 mm.

*Obtortio dancei* is named for S. P. Dance, English malacologist. It is very closely related to a living species in Hawaii and is possibly identical with that species. The fossil shell appears to be more strongly turreted and more strongly noded than the shells of the living species (USNM 339456, three specimens collected off Waikiki, Oahu, at 35–50 fathoms).

*Occurrence.*—More than 40 specimens from drill hole E–1 on Eniwetok at depth of 1,746–1,777 feet; age, early Miocene (Tertiary *e*).

### Obtortio sp. A

Plate 7, figure 7

A single specimen of a slender *Obtortio* from drill hole E–1 on Eniwetok appears to be distinct from *O. failingi*, which occurs in the same drill hole both above and below. The protoconch consists of two glassy whorls as does the protoconch of *O. failingi*, but the shell lacks the pupoid outline of *O. failingi* and shows stronger axial and spiral sculpture. It is more slender than *O. pyrrhacme*, which occurs at higher levels, and does not have an acicular point.

Measurements of the single specimen, USNM 650467: height 1.7 mm, diameter 0.5 mm.

The shell probably represents an undescribed species, but because the single specimen may be an immature form, a new name seems unwarranted.

*Occurrence.*—Drill hole E–1, Eniwetok at depth 1,350–1,365 feet; age, early Miocene (Tertiary *e*).

## Family CERITHIIDAE

### Genus DIALA A. Adams

Adams, A. 1861, Annals and Mag. Nat. History, v. 8, p. 242.

*Type* (by subsequent designation, Dall, 1921, Nautilus, v. 35, p. 84).—*Diala varia* A. Adams (= *Rissoia semistriata* Philippi). Holocene, Japan and China coasts, Red Sea.

### Diala ludens Melvill and Standen

Plate 7, figures 8–12

*Diala ludens* Melvill and Standen, 1895, Jour. Conchology (Leeds), v. 8, p. 118, pl. 2, fig. 9.

Small, elongate-conical, with blunted apex; whorls gently convex, numbering about seven; suture sharply impressed; aperture broadly ovate; on some large adult shells the body whorl is slightly inflated. Sculpture consisting of fine spiral grooves most prominent on the base but discernible at high magnification over the entire spire; on some specimens the grooves on the base are close set but with a spacing that results in fine riblike spirals alternating with coarser spirals.

The color pattern is exceedingly variable. Most well-preserved shells have narrow red-brown spiral bands, six commonly present on each whorl; the lowest two or four may be unbroken, but the highest one shows regular gaps; on some shells the gaps cut all spiral bands and the open spaces form wide axial bands of white. On some shells the apex is red brown.

Measurements of the figured specimens are:

| Specimen (USNM) | Drill hole | Depth (ft) | Height (mm) | Diameter (mm) |
|---|---|---|---|---|
| 650447 | F–7–C | 16.67–19.17 | 4.1 | 2.0 |
| 650448 | Mu–4 | 40.5–41 | 1.8 | 0.9 |
| 650449 | E–1 | 940–950 | 1.6 | 0.8 |
| 650450 | F–1 | 1,040–1,050 | 2.4 | 1.2 |
| 650451 | 2B | 1,471.5–1,482 | 2.9 | 1.3 |

The largest fossil shells are about the same size as the Holocene shells described by Melvill and Standen, but the average size fossils appear to be smaller.

In general form and in color pattern *Diala ludens* resembles the type of the genus, *D. varia* A. Adams (= *D. semistriata* (Philippi), a Holocene species widely distributed in the Indo-Pacific, from the Japanese coast to the Red Sea, but on shells of that species the spiral grooves are limited to the base. *D. lauta* A. Adams (1862, p. 298) and *D. albugo* (Watson) (1886, p. 568, pl. 42, fig. 3), both Holocene Australian shells, likewise have the spirals limited to the base; they appear to be synonyms of *D. varia*.

*Occurrence.*—One of the most abundant and long ranging species in the drill holes of Eniwetok and Bikini. More than 200 lots have been collected, some of them containing numerous specimens. The Marshall Island specimens range from early Miocene (Tertiary *e*) to Holocene. A single specimen from Tonga station 202980 is probably Pleistocene. Two specimens from the Funafuti drill hole at a depth of 90–100 feet are probably Holocene. Surprisingly, Hedley (1899) did not report the species among the lagoon and beach shells that he described from Funafuti.

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Melville and Standen described the species from Uvea in the Loyalty Islands. The species is abundant in the northern Marshall Islands today.

### Diala stricta Habe

Plate 7, figure 13

*Diala stricta* Habe, 1960, Seto Marine Biol. Lab. Pub., v. 8, no. 2, p. 296, fig. 2.

Habe, 1964, Shells of the western Pacific in color. Osaka, Japan, Hoikusha Pub. Co., v. 2, p. 40, pl. 12, fig. 9.

Small, elongate-conical; about eight flat-sided whorls separated by a deeply incised suture; aperture broadly ovate. Earliest three whorls of spires on unworn specimens bear weak spiral ribs; remainder of spire smooth, except the base which is marked by seven to eight spiral ribs. The boundary between the ribbed base and the rest of the whorl is usually rounded but may be subangular.

Measurements of the figured specimen, USNM 650452 from drill hole 2B, Bikini, at depth of 1,587–1,598 feet: height 3.5 mm, diameter 1.3 mm.

The fossils are smaller than the Holocene shells from Japan but do not seem to differ in other important features. The ribbing of the apical whorls is not mentioned by Habe, but traces of it are present on unworn shells from Japan.

*Occurrence.*—Twenty-one specimens from three deep holes on Eniwetok at depths from 211 to 998 feet; age, early Miocene (Tertiary *f*) and Quaternary (no examples from Tertiary *g* or *h*). In drill hole 2B on Bikini, one specimen from 1,471 to 1,482 feet, another from 1,587 to 1,598 feet; age, early Miocene (Tertiary *e*).

### Diala sulcifera A. Adams

Plate 7, figure 14

*Alba* (*Diala*) *sulcifera* A. Adams, 1862, Annals and Mag. Nat. History, v. 10, 3d ser., p. 298.

Small, elongate-conical, slightly inflated; whorls about six; suture conspicuously channeled; aperture broadly ovate, slightly effuse below. Sculpture consisting of spiral grooves that separate flattened riblike elevations; six grooves are present on the penultimate whorl.

Measurements of the figured specimen from drill hole F–A, Eniwetok, USNM 650453: height 2.5 mm, diameter 1.3 mm.

This species is more strongly sculptured than other species of *Diala*; the widespread *Diala ludens* has the same sort of markings, but they are much weaker.

*Occurrence.*—Represented by a single slightly worn fossil from drill hole F–A, Eniwetok, at a depth of 1–5 feet; age, Holocene. A single specimen was dredged from Bikini's lagoon at a depth of 25 fathoms, 3 miles off Bikini Island (USNM 582877). Adams described the species from Holocene shells collected in Japan but did not figure them. The two Marshall Island shells appear to be identical with specimens from Japan in the U.S. National Museum.

## Genus BITTIUM Leach

Leach, Oct. 1847, Annals and Mag. Nat. History, v. 20, p. 270.

*Type* (by subsequent designation, Gray, Nov. 1847, Zool. Soc. London Proc., pt. 15, p. 154).—*Murex reticulatus* Montagu. Holocene, seas of Europe.

### Bittium impendens (Hedley)

Plate 7, figure 15

*Cerithium impendens* Hedley, 1899, Australian Mus. Mem. 3, pt. 7, p. 434, fig. 23.

Shell strong, stout, characterized particularly by a carina close above the suture on the whorls of the spire and by strong and regular axial plications. Plications overridden by close-set spiral threads; a prominent varix is present on the body whorl opposite the aperture. Aperture sublenticular, anterior canal broad and short.

Measurements of the figured specimen, USNM 650479: height 4.7 mm, diameter 2.1 mm.

The shells of *Bittium impendens* are larger and stouter than those of *B. parcum* Gould, a Holocene species described from the Ryukyu Islands and known to occur widely in Hawaii.

*Occurrence.*—Six specimens from five drill holes on Eniwetok at depths of less than 80 feet; age, Holocene. These shells and others dredged from Bikini's lagoon were found to be identical with Hedley's paratype from the lagoon beach at Funafuti. The species also occurs in Hawaii where, according to Dr. Alison Kay, of the University of Hawaii (written commun., 1969), shells are found in 30 to 60 feet of water off Oahu and Hawaii and, more rarely, are found in beach drift on Oahu.

### Bittium sergentum (Jousseaume)

Plate 7, figures 16–20

*Cerithium lineatum* Tryon, 1887, Manual Conchology, v. 9, p. 143, pl. 27, figs. 27, 28 (not *C. lineatum* Lamarck, 1816).

*Cerithium sergentum* Jousseaume, 1930, Jour. Conchyliologie, v. 74, p. 284.

Small, stout; spire consisting of eight to nine flattened whorls, each with four subequal spiral ribs that are strongly beaded by axials to give the shell a clathrate appearance; suture wide and deep; on later whorls the suture carries a fine spiral riblet; a low varix is present opposite the aperture; base has five to six moderately strong spiral ribs, the upper ones of which alternate with finer riblets. Aperture broadly

ovate, entire; anterior canal broad and short; posterior canal shallow. Inner lip callused; outer lip thin, slightly flaring, smooth within. Shell white or cream colored, bearing two or more narrow, usually continuous spiral bands of orange on the lower part of each whorl.

All the fossil shells from above a depth of 310 feet and one shell from a depth of 2,154–2,165 feet (drill hole 2B, Bikini) retain traces of the orange color bands that are so conspicuous on Holocene shells. Other shells from deeper horizons have no trace of color.

Measurements of five specimens selected to illustrate variation in size, sculpture, and coloration:

| Specimen (USNM) | Type | Drill hole | Depth (ft) | Height (mm) | Diameter (mm) |
|---|---|---|---|---|---|
| 650477 | Holotype | 2 | 126 | 7.1 | 3.0 |
| 650481 | Paratype A | Holocene | Surface | 5.7 | 2.5 |
| 650482 | Paratype B | E–1 | 540–550 | 4.2 | 1.9 |
| 650483 | Paratype C | F–1 | 760–770 | 5.5 | 2.6 |
| 650484 | Paratype D | E–1 | 940–950 | 3.0 | 1.4 |

| Specimen (USNM) | Type | Number of spiral ribs | Secondary spiral in suture | Beading | Color bands |
|---|---|---|---|---|---|
| 650477 | Holotype | 4 | Present | Strong | Present. |
| 650481 | Paratype A | 4 | do | do | Do. |
| 650482 | Paratype B | 6± | do | Weak | Absent. |
| 650483 | Paratype C | 6 | do | do | Do. |
| 650484 | Paratype D | 4 | Absent | Strong | Do. |

*Occurrence.*—Tryon's four type specimens (Acad. Nat. Sci. Philadelphia, 17730) were collected in Fiji. Wray Harris found specimens (USNM 380953) at Ofu Island, Samoa, under coral blocks and in pieces of dead coral collected at low tide level. On Bikini, specimens were collected on the reef at about low tide (USNM 583597).

Thirty-one fossil shells were recovered from three drill holes on Bikini (drill holes 1, 2, 2A), from near the surface to a depth of 232 feet; age, Pleistocene and (or) Holocene; a single specimen from drill hole 2B, Bikini, at a depth of 2,154–2,165 could be early Miocene (Tertiary *e*) but it retains traces of original color and probably was derived from a higher horizon. More than 30 specimens from three drill holes on Eniwetok at depths 40–950 feet; age, early Miocene (Tertiary *f*) to Holocene. Two incomplete specimens from Funafuti's first bore hole at depth of 90–100 feet probably represent this species; age, Holocene.

### Bittium ianthinum (Gould)

Plate 7, figures 21, 22

*Cerithium ianthinum* Gould, 1849, Boston Soc. Nat. History Proc., v. 3, p. 121.

Gould, 1862, Otia Conchologica, p. 63.

Tryon, 1887, Manual Conchology, v. 9, p. 137, pl. 25, figs. 71, 72.

*Cerithium janthinum* Gould, 1852, U.S. Explor. Exped., Mollusca, v. 12, p. 152, pl. 10, figs. 173, 173a, b.

Johnson, 1964, U.S. Natl. Mus. Bull. 239, p. 95.

Small, stout; spire consisting of seven to eight gently convex whorls covered by close-set raised spiral lines that tend to alternate in size and are beaded by weak axials; a prominent varix is present opposite the aperture, and varices are also present on several earlier whorls. Aperture broadly ovate; anterior canal wide, short.

Measurements of the figured specimens: USNM 650486—height 7.0 mm, diameter 2.6; the type, USNM 5573—height 8.3, diameter 3.8 mm.

In describing this species Gould noted that the whorls of the apex were angulated by an elevated, nodular central thread. This feature is not apparent in the figures published by Gould in 1852, but the type specimen clearly shows it (pl. 7, fig. 21). The type specimen, however, seems to be the only shell to show this angulated apex, as none of the Holocene shells in large collections from Samoa, Society Islands, and New Caledonia have this feature, nor do the Eniwetok fossil shells. On the other hand, the postapical whorls of all these other shells are more strongly beaded than are those of the type specimen.

*Occurrence.*—Thirteen specimens from two drill holes on Eniwetok at depths to 40 feet; age, Holocene. The type specimen, a Holocene shell, is from the Tuamotu Islands; also known from Samoa, Society Islands, Cook Islands, and New Caledonia.

### Bittium eniwetokensis Ladd, n. sp.

Plate 4, figure 13

Small, stout; two smooth, glassy, convex nuclear whorls followed by six gently convex sculptured whorls. Sculpture consisting of close-set axial ribs that are crossed and beaded by spiral riblets (six on penultimate whorl); base has seven spiral riblets that decrease progressively in size below; no varices present; suture channeled to give the spire a slightly turreted appearance; aperture broadly lenticular; outer lip thickened, inner lip callused; anterior canal short, moderately deep.

Measurements of the holotype, USNM 650514: height 4.6 mm, diameter 1.7 mm.

The numerous spirals and the regularity of the reticulate sculpture differentiate this species from other members of the genus known from the island area.

*Occurrence.*—Two specimens from deep drill holes on Eniwetok (drill holes F–1, 930–940 feet; E–1, 970–980 feet); age, early Miocene (Tertiary *f*).

### Subgenus BITTIOLUM Cossmann

Cossman, 1906, Essais de paléoconchologie comparée: Paris, v. 7, p. 139.

*Type* (by original designation).—*Bittium podagrinum* Dall. Holocene, Pliocene, Florida.

#### Bittium (Bittiolum) toddae Ladd, n. sp.

Plate 4, figures 14–16

Small, stout, flat sided with a sharply impressed suture. Protoconch consists of about two smooth convex whorls, followed by about eight flattened whorls that make up the spire; first two to three whorls of spire each have two strong slightly beaded spiral ribs; remaining whorls have close-set axial ribs, better developed on some shells than in others; axials usually weak on body whorl and absent entirely on base; fine close-set spiral grooves may be conspicuous between axial ribs on spire; spiral sculpture dominant on base, the grooves may be slightly narrower than the intervening areas that stand out as flattened ribs. Aperture broadly ovate; anterior canal short and wide; posterior canal narrow and shallow; inner lip heavily callused; outer lip slightly flaring, beveled within. A broad varix is present on the body whorl opposite the aperture; in front of this varix the axial sculpture is greatly reduced.

Measurements of the types: Holotype, USNM 650512—K–1B, Eniwetok, 778–790 ft, height 5.5 mm, diameter 2.3 mm; paratype, USNM 650513—E–1, Eniwetok, 1,746–1,776 ft., height 5.0 mm, diameter 2.1 mm.

The Eniwetok species resembles the type of *Bittiolum, B. podagrinum*, from the Pliocene of Florida (Dall, 1892, p. 274, pl. 21, fig. 12), but *B. toddae* is more slender and has stronger spiral sculpture on the early whorls and weaker spirals on the remainder of the shell. *B. fretense* from the Pliocene of Trinidad (Jung, 1969, p. 448, pl. 45, figs. 12, 13) is shorter and much more strongly reticulate than the Eniwetok fossil. *B. varium* Pfeiffer, a species that lives along the west Atlantic coast and in the Caribbean, is more slender, has more-convex whorls, and is more strongly reticulate than *B. toddae*.

The species is named for Ruth Todd of the U.S. Geological Survey, whose studies of smaller Foraminifera from the western Pacific have been of great value in stratigraphic and ecologic work in the area.

*Occurrence.*—Holotype and three other specimens from drill hole K–1B, Eniwetok, at depth of 778–790 feet; age, late Miocene (Tertiary *g*). Figured paratype and 22 other specimens from drill hole E–1, Eniwetok, at depth 1,746–1,776 feet; age, early Miocene (Tertiary *e*).

### Genus COLINA H. and A. Adams

Adams, H. and A., 1854, Genera of Recent Mollusca: London, John van Voorst, v. 1, p. 286.

*Type* (by original designation).—*Cerithium macrostoma* Hinds. Holocene, Indonesia.

### Subgenus ISCHNOCERITHIUM Thiele

Thiele, 1929, Handbuch der systematischen weichtierkunde: Jena, von Gustav Fischer, v. 1, p. 212.

*Type* (by monotypy).—*Cerithium rostratum* Sowerby. Holocene, central and western Pacific.

#### Colina (Ischnocerithium) rostrata (Sowerby)

Plate 4, figure 17

*Cerithium rostratum* Sowerby, 1855, Monograph of genus *Cerithium, in* Thésaurus Conchyliorum, p. 861, pl. 180, fig. 104.

Tryon, 1887, Manual Conchology, v. 9, p. 130, pl. 23, figs. 90, 91.

*Colina (Ischnocerithium) rostrata* (Sowerby). Thiele, 1929, Handbuch der systematischen weichtierkunde: Jena, von Gustav Fischer, v. 1, p. 212.

This widely distributed Holocene species is slender and has strong axial plications that are crossed by fine granulose spiral ribs. The aperture is broadly ovate; the outer lip varicose; the anterior canal produced; the tip of the canal is dark brown to nearly black in shells of living animals, and traces of this color are retained in well-preserved fossils.

Measurements of the figured specimen, USNM 650480: height 9.9 mm, diameter 3.7 mm.

*Occurrence.*—Numerous specimens from eight drill holes on Eniwetok from near the surface to depth of 280 feet; age, Pleistocene to Holocene; a single specimen from a depth of 750–760 feet in drill hole F–1 is late Miocene (Tertiary *g*). In Bikini drill holes, two specimens from drill hole 1 at depths 5–59 feet are Holocene; a single specimen from drill hole 2B at a depth of 621–631.5 is probably Pliocene (Tertiary *h*). The species lives today in many island groups from the Philippines to Hawaii and in the Indian Ocean.

### Genus ATAXOCERITHIUM Tate

Tate, 1894, Royal Soc. New South Wales Jour., v. 27, p. 179.

*Type* (by original designation).—*Cerithium serotinum* A. Adams. Holocene, Tasmania.

#### Ataxocerithium eniwetokensis Ladd, n. sp.

Plate 4, figure 18; plate 8, figure 1

Shell small, spire wide and gently inflated, its height about three times that of the aperture; whorls of spire about nine; base flattened, bearing smooth, close-set spirals; aperture broadly ovate, posterior canal deep and sharply defined; anterior canal extended below, bent backward and slightly to left, almost closed by

reflected basal lip of aperture; columellar lip free. Sculpture consists of three beaded spirals to each whorl of spire; a fine thread is present between the upper two spirals, and on the penultimate and body whorl a thread is also present between the lower two spirals.

Measurements of the holotype, USNM 650454: height (incomplete) 11.1 mm, diameter 5.4 mm.

*Ataxocerithium eniwetokensis* is much more swollen near the middle of the spire than is *A. serotinum*, type of the genus.

*Occurrence.*—In drill hole E–1, Eniwetok Atoll, at depth of 40–50 feet; age, Holocene. The species also was found in the Sand Island drill hole on Midway, Hawaii, at a depth of 137–138 feet; age, Holocene.

### Genus RHINOCLAVIS Swainson

Swainson, 1840, Treatise on malacology: London, Longman, Orme, Brown, Green, and Longmans, p. 315.

### Subgenus RHINOCLAVIS sensu stricto

*Type* (by subsequent designation, Herrmannsen, 1848, Indicis generum malacozoorum: Cassellis, Theodori Fischeri, v. 2, p. 392).—*Murex vertagus* Linnaeus. Holocene, western Pacific.

#### Rhinoclavis (Rhinoclavis) vertagus (Linnaeus)

Plate 8, figures 2–4

*Murex vertagus* Linnaeus, 1767, Systema naturae [12th ed.], p. 1,225.

*Cerithium (Vertagus) vertagus* (Linnaeus). Tryon, 1887, Manual Conchology, v. 9, p. 149, pl. 29, figs. 69, 70.

*Rhinoclavis vertagus* (Linnaeus). Demond, 1957, Pacific Sci., v. 11, no. 3, p. 291.

Characterized particularly by axial plaits below the suture; plaits well developed on earlier whorls, becoming all but obsolescent on later whorls.

Measurements of the figured specimen from Bikini, USNM 650458: height 41.8 mm, diameter 12.0 mm. Measurements of two specimens from Maewo, New Hebrides (pl. 8, figs. 3, 4): USNM 650618—height 37.0 mm, diameter 14.9 mm; USNM 650619—height 39.9 mm, diameter 7.3 mm.

The axial plaits on the figured fossil specimen from Bikini are more distinctly beaded than they are on most Holocene shells, but a second fossil that was found with the first is not strongly beaded.

*Occurrence.*—Two specimens from top of core No. 2 in drill hole 2 on Bikini, depth 180–185 feet; age, probably Pleistocene. Numerous specimens from Maewo and Pentecost Islands, New Hebrides; age, Pliocene-Pleistocene. Holocene shells have been collected from the Indian Ocean and many parts of the western tropical Pacific, as far east as Palau and Yap and, to the south, in the Solomon Islands. Not found living in the Marshall Islands.

#### Rhinoclavis (Rhinoclavis) articulata (Adams and Reeve)

Plate 8, figures 5, 6

*Cerithium articulatum* Adams and Reeve, 1850, Mollusca, *in* Voyage of H.M.S. *Samarang* [Rept.]: London, Reeve and Benham, p. 43, pl. 10, fig. 14.

*Cerithium gemmatum* Hinds. Tryon [part], 1887, Manual Conchology, v. 9, p. 146, pl. 28, fig. 45.

*Vertagus articulatus* (Adams and Reeve). Dautzenberg and Bouge, 1933, Jour. Conchyliologie, v. 77, no. 2, p. 316.

The following description is based on the fossil material: Shell medium in size, robust. Sculpture of later whorls consisting of two rows of prickly spirals separated by a sharply incised groove and, directly below the suture, a third spiral with rounded nodes that are more closely spaced than the prickly nodes below; between the rounded nodes in several places traces of brown color have been retained. Suture appressed and difficult to follow; base gently convex, cut by incised lines into six strong cords that are obscurely beaded near aperture. Body whorl has a bulging varix above the posterior end of the canal. Aperture lenticular, passing anteriorly into a short canal that lies at right angles to the axis of the shell; outer lip flaring and slightly reflected, smooth within; inner lip heavily callused with a narrow groove posteriorly; columella has two low parallel folds.

Measurements of the figured specimen, USNM 650459: height (incomplete) 22.6 mm, diameter 9.4 mm.

Large collections of Holocene shells show that the sculpture of the species is quite variable; on many shells the highest of the three rows of spirals is set off as a very distinct band.

*Occurrence.*—Three specimens from the Tanapag Limestone on Saipan (USGS loc. 17891); age, Pleistocene. Shells of this species were first described from the coast of Borneo and the China Sea, but they have since been collected from a number of island groups in the western Pacific, including the Marianas.

#### Rhinoclavis (Rhinoclavis) procera (Kiener)

Plate 8, figure 7

*Cerithium procerum* Kiener, 1841, Coquille vivantes comprenant la collection du Muséum d'Histoire Naturelle de Paris***, pt. 1, p. 22, pl. 18, fig. 1, 1a.

*Cerithium fasciatum* Brugière. Tryon, 1887, Manual Conchology, v. 9, p. 149, pl. 29, fig. 67.

Characteristically long and slender with 12 or more flattened whorls; sculpture consisting of strong, rounded close-set axial ribs crossed by fine spiral grooves.

Measursements of the figured specimen from Saipan, USNM 650460: height (incomplete) 31.8 mm, diameter 7.7 mm.

All the fossils are smaller than Holocene shells from the Marshall Islands and Hawaii.

*Occurrence.*—Eight specimens from the Tanapag Limestone of Saipan (USGS loc. 17891); age, Pleistocene. Twenty-seven incomplete specimens from the Mariana Limestone of Guam (USGS locs. 20607, 20637, 21377); age, Pliocene-Pleistocene. Nine incomplete specimens from station 160, Viti Levu, Fiji; age, early Miocene (Tertiary *f*). Holocene shells have been widely reported from Hawaii, the western Pacific, and the Indian Ocean.

**Rhinoclavis (Rhinoclavis) aspera (Linnaeus)**

Plate 8, figures 8, 9

*Murex asper* Linnaeus, 1758, Systema naturae [10th ed.], p. 756.

*Cerithium (Vertagus) asper* (Linnaeus). Tryon, 1887, Manual Conchology, v. 9, p. 148, pl. 28, figs. 62, 63.

*Rhinoclavis aspera* (Linnaeus). Hirase and Taki, 1951, Hand-Bunkyōkaku, pl. 83, fig. 1.
book of illustrated shells in natural colors: Tokyo,

Demond, 1957, Pacific Sci., v. 11, no. 3, p. 290.

*Cerithium asperum* (Linnaeus). MacNeil, 1961 [imprint 1960], U.S. Geol. Survey Prof. Paper 339, p. 41, pl. 18, fig. 27.

Fossil examples of this widely distributed Holocene Indo-Pacific species were found on Saipan and Guam and in the drill holes of Eniwetok. Measurements of the figured specimens: drill hole F–15–C, Eniwetok, USNM 650468—(pl. 8, fig. 8), height 27.0 mm, diameter 9.4 mm; station 17897, Saipan, USNM 650469—(pl. 8, fig. 9) height (incomplete) 31.0 mm, diameter 12.1 mm.

*Occurrence.*—Four specimens from three drill holes on Eniwetok at depths from 14 to 150 feet; age, Holocene. A fifth specimen from drill hole F–1, Eniwetok, at a depth of 800–810 feet is unusually slender but probably represents the same species; age, late Miocene (Tertiary *g*). Five specimens were collected from USGS locs. 20555, 20560, and 20743, Guam, from the Agana Argillaceous Member of the Mariana Limestone (age, Pliocene and Pleistocene), and several specimens from USGS locs. 20605 and 20691 in the detrital lagoonal limestone of the same formation. Numerous specimens from the Alifan Limestone at USGS loc. 17750 are much smaller than other fossils from Guam; age, Tertiary *g* or *h*. Two specimens were collected on Saipan (USGS locs. 17897, 21407), both from the Tanapag Limestone; age, Pleistocene. MacNeil (1960) reported the species from the Yontan Limestone (Pleistocene) of Okinawa.

Holocene shells have been collected from many localities in the western Pacific and in the Indian Ocean, but the species has not been reported from Hawaii.

**Rhinoclavis (Rhinoclavis) sinensis (Gmelin)**

Plate 8, figure 10

*Murex sinensis* Gmelin, 1791, Systema naturae, 13th ed., v. 1, pt. 6, p. 3542, no. 54.

*Cerithium obeliscus* Bruguière, 1792, Encyclopédie méthodique histoire naturelle des vers: Paris, Panckoucke, p. 472, pl. 443, figs. 4a, b.

*Vertagus obeliscus* (Bruguière). Reeve, 1865, Conchologica Iconica, v. 15, *Vertagus*, pl. 2, figs. 7 a, b.

*Cerithium (Vertagus) obeliscus* Bruguière. Tryon, 1887, Manual Conchology, v. 9, p. 146, pl. 27, figs. 39, 40.

Martin, 1899, Geol. Reichs.-Mus. Leiden Samml., new ser., v. 1, nos. 6–8, p. 206.

*Rhinoclavis sinensis* (Gmelin). Demond, 1957, Pacific Sci., v. 11, p. 290.

Represented by six specimens in the post-Tertiary beds of Espiritu Santo, New Hebrides (USGS loc. 21028). The fossils are incomplete and are partly encrusted with carbonate but seem clearly to represent this wide-ranging and somewhat variable Holocene species. On the whorls of the spire only two beaded spiral ribs are well developed below the prominent spiral that lies below the suture.

Measurements of the figured specimen, USNM 650502: height 57.2 mm, diameter 21.8 mm.

Holocene shells have been collected in Indonesia and from many island groups from Hawaii to the south and west. Martin (1899) noted the species in the Pliocene of Java.

**Rhinoclavis (Rhinoclavis) aff. R. sinensis (Gmelin)**

Plate 8, figure 11

A single incomplete specimen from upper Miocene (Tertiary *g*) beds in a drill hole on Eniwetok closely resembles the Holocene shell. Both the fossil and the Holocene shells are characterized particularly by a row of strong tubercles that form a slight shoulder at the top of each whorl and by lines of smaller tubercles of varying strength that cover the remainder of the shell.

The fossil appears smaller than the average Holocene examples of *Rhinoclavis sinensis* from Eniwetok, and more slender and more delicately sculptured. It may represent a distinct species, but until more material is available, its status cannot be determined.

Measurements of the figured specimen, USNM 650490: height (incomplete) 18.2 mm, diameter 7.0 mm.

*Occurrence.*—Single specimen from drill hole F–1, Eniwetok, at depth 840–850 feet; age, late Miocene (Tertiary *g*).

**Rhinoclavis (Rhinoclavis) marshallensis Ladd, n. sp.**

Plate 8, figures 12, 13

Small to medium in size, stout; spire of nine to 11 flat or gently convex whorls; suture wide, moderately

deep; aperture lenticular, posterior canal narrow, deep, extended by the slight rise of the outer lip; outer lip thick and varicose, furrowed within; inner lip heavily callused, anterior canal broad and short. Sculpture consisting of strongly beaded spiral bands, four to each whorl; fine spiral threads alternate with the beaded spirals, and one occurs between the lowest beaded spiral and the suture. A low varix is present opposite the aperture, and other varices are found on earlier whorls; on some shells the varices are aligned. On the base, strong spirals alternate with weak ones, the stronger ones being indistinctly beaded.

Measurements of the holotype, USNM 650491: height 15.4 mm, diameter 5.8 mm.

The sculpture of this species suggests that found in the subgenus *Ochetoclava*, but the outer lip is not strongly ascending as in that group nor is the inner lip detached anteriorly. I have not been able to locate a close relative, either living or fossil.

*Occurrence.*—Numerous specimens from three drill holes on Eniwetok at depths 690–947 feet; two specimens from drill hole 2A, Bikini, at depths 940–1,046 feet. Age, Miocene (Tertiary *f–g*).

#### Rhinoclavis (Rhinoclavis) powelli Ladd, n. sp.

Plate 8, figures 14, 15

Shell large, slender; spire gently convex. Sculpture consisting of close-set spiral ridges, some of which bear rows of sharp nodes that are directed upward; on early whorls there are three equally strong rows of prickly nodes; on later whorls there are five rows, but the lower two are less conspicuous; nodes are imperfectly alined to form axial ridges; entire shell has slightly curved growth lines. Suture indistinct; aperture elongate; inner lip heavily callused; columella has a strong fold that continues inside the shell; one or two low secondary folds also present; anterior and posterior canals well developed. Edge of outer lip not preserved, but inside, below the site of a low varix that is present opposite the aperture, there are three low rounded mounds. These mounds are suggestive of the more prominent knobs that characterize many potamidids, but *R. vertagus*, type of *Rhinoclavis*, has similar but even less conspicuous internal elevations.

Measurements of the holotype, USNM 650503: height (incomplete) 32.0 mm, diameter 11.5 mm. The fragmentary paratype, USNM 650504, measures: height 27.6 mm, diameter 15.3 mm.

*Rhinoclavis* (*Rhinoclavis*) *powelli* bears a superficial resemblance to *Terebripirena javana* (Martin), a Miocene species that was referred to *Cerithium* until Cossmann (1912, p. 162) made it the monotype of *Terebripirena; T. javana*, however, is distinctly dimorphous and has only a single spiral row of pointed nodes.

Named for A. W. B. Powell of New Zealand, long a student of Pacific mollusks and their biogeography.

*Occurrence.*—Represented by only two specimens, both from drill hole F–1, Eniwetok, from depths of 790–840 feet; age, late Miocene (Tertiary *g*).

#### Rhinoclavis (Rhinoclavis) jonkeri (Martin)

Plate 8, figure 16

*Cerithium* (*Vertagus*) *jonkeri* Martin, 1884, Geol. Reichs-Mus. Leiden Samml., ser. 1, v. 3, p. 148, pl. 8, fig. 146.

*Cerithium jonkeri* Martin. Altena, 1941, Leidse Geol. Meded., v. 12, p. 20, fig. 3.

*Clava* (*Clava*) *jonkeri* (Martin). Wissema, 1947, Young Tertiary and Quaternary Gastropoda from the island of Nias***: Rijksuniversiteit, Leiden, doctor's thesis, p. 54, pl. 2, figs. 42–55.

Two external molds that appear to represent this Indonesian species were obtained from the Mariana Limestone of Guam, USGS locs. 20870 and 20966. Casts of the specimens show a sharply pointed spire made up of about 12 flattened whorls; the upper part of the spire bears a series of close-set axial ribs that are overridden and beaded by spiral ribs (three or four to the whorl) between which are spiral threads; the lowest two or more whorls are nearly smooth, showing only faint indications of axial and spiral sculpture; low varices occur at intervals over the sculptured part of the spire on one of the specimens; suture distinct; upper edges of smooth whorls broadly rounded adjacent to the suture; aperture not preserved.

Measurements of the figured cast, USNM 650516 from USGS loc. 20870: height (incomplete) 31 mm, diameter 10 mm.

Wissema (1947), from large collections available to him, described and figured the great variability of this species. The Guam specimens clearly show features within the limits of those described.

*Occurrence.*—The species is known from the Pliocene of Java and other islands in Indonesia and from the Pleistocene of Java; the Guam occurrences in the Mariana Limestone are Pliocene or Pleistocene.

### Subgenus PROCLAVA Thiele

Thiele, 1929, Handbuch der systematischen weichtierkunde: Jena, von Gustav Fischer, v. 1, p. 212.

*Type* (by monotypy).—*Cerithium pfefferi* Dunker (= *C. turritum* Sowerby = *C. sordidulum* Gould).

#### Rhinoclavis (Proclava) sordidula (Gould)

Plate 8, figures 17, 18

*Cerithium sordidulum* Gould, 1849, Boston Soc. Nat. History Proc., v. 3, p. 119.

Gould, 1852, U.S. Explor. Exped., Mollusca, v. 12, p. 145, pl. 10, figs. 170, a–b.

Gould, 1862, Otia Conchologica, p. 61.

Johnson, 1964, U.S. Natl. Mus. Bull. 239, p. 151.

*Cerithium turritum* Sowerby, 1855, Monograph of genus *Cerithium*, *in* Thésaurus Conchyliorum, p. 860, pl. 180, fig. 101.

*Vertagus pfefferi* Dunker, 1882, Molluscorum Maris Japonica: Kassel, Theodor Fischer, p. 108, pl. 4, figs. 12–14.

*Cerithium* (*Vertagus*) *turritum* Sowerby. Abrard, 1946, Annales de paléontologie, v. 32, p. 57, pl. 4, fig. 22.

*Clava* (*Proclava*) *pfefferi* (Dunker). Wissema, 1947, Young Tertiary and Quaternary Gastropoda from the island of Nias***: Rijksuniversiteit, Leiden, doctor's thesis, p. 50.

*Cerithium* (*Proclava*) *turritum* Sowerby. MacNeil, 1961 [imprint 1960], U.S. Geol. Survey Prof. Paper 339, p. 41, pl. 12, fig. 3.

A medium-sized slender form with a sharply pointed apex; whorls 11 or more, each bearing three strong spiral ribs that are conspicuously beaded where they cross regularly spaced axial ribs; spiral threads occur between the spiral ribs; suture widely excavated.

Measurements of the figured cast, USNM 650505: height 11.2 mm, diameter 4.6 mm.

*Occurrence.*—Represented by numerous molds from the Mariana Limestone (USGS locs. 20516, 20610, 20653) on Guam; age, Pliocene (Tertiary *h*) or Pleistocene. Abrard (1946) reported the species from the Pliocene of the New Hebrides. A new view of his figured specimen is given on plate 8, figure 18. Holocene shells have been reported from Indonesia and Japan; MacNeil (1960) cited the occurrence of the species (as *C. turritum*) in the Pliocene of Okinawa.

### Subgenus PSEUDOVERTAGUS Vignal

Vignal, 1904, Mus. Histoire Nat. Paris Bull. 10, p. 358.

*Type* (by original designation).—*Murex aluco* Linnaeus. Holocene, Philippines.

#### Rhinoclavis (Pseudovertagus) eniwetokensis Ladd, n. sp.

Plate 9, figures 1, 2

Medium in size, stout; protoconch smooth, followed by nine to 10 sculptured whorls, each with a median, spiral, sharp-crested ridge bearing strong, regularly spaced, pointed nodes, eight to nine on each whorl; surface of shell covered by inconspicuous axial lines of growth; spiral threads best developed on upper parts of whorls and on base. On lower part of each whorl, between the median nodes, there is a group of dark slightly wavy axial lines; similar lines appear inside the aperture on the inner lip where they are covered near the aperture by the heavy callus; on a few shells the axial lines of color extend over the upper part of the whorl. A prominent varix is opposite the aperture; anterior canal long and curved.

Measurements of the types: holotype, USNM 650487—height 24.8 mm, diameter 9.7 mm; paratype, USNM 650488—height (incomplete) 17.5 mm, diameter 9.3 mm.

The Eniwetok fossil bears a general resemblance to the Holocene type species *Rhinoclavis* (*Pseudovertagus*) *aluco* (Linnaeus) but is smaller, has fewer whorls, and its apical whorls are not spirally ribbed and cancelled as they are on the type.

*Occurrence.*—Thirty-two somewhat worn and broken specimens from three deep holes on Eniwetok at depths 780–960 feet; age, Miocene (Tertiary *f* and *g*).

#### Rhinoclavis (Pseudovertagus) lowae Ladd, n. sp.

Plate 9, figure 3

Medium in size, slender; spire consisting of nine or more gently convex whorls, those forming the apical half of the spire bear strong close-set axial ribs that are expanded at irregular intervals to varix proportions; whorls of anterior half of spire bear a spiral row of sharply pointed knobs, nine to 10 on each whorl; row is near middle of whorl, and knobs are slightly inclined posteriorly. A spiral row of secondary knobs is located immediately below the suture. Fine spiral riblets present over the entire shell, but particularly conspicuous on the base where alternate riblets are larger. Aperture elongate-oval, extended into curved anterior canal.

Measurements of the holotype, USNM 650489: height (tip of apex missing) 15.9 mm, diameter 6.2 mm.

The apical sculpture of *Rhinoclavis* (*Pseudovertagus*) *lowae* differs strikingly from that of *R.* (*P.*) *aluco*, type of *Pseudovertagus*, and from that of *R.* (*P.*) *eniwetokensis*, the fossil species previously described. Possibly the two fossils represent new subgenera, but because they are incomplete, they are here referred to *Pseudovertagus*.

This species is named for Doris Low of the U.S. Geological Survey who has collaborated with Ruth Todd in studies of Pacific smaller Foraminifera, fossil and living.

*Occurrence.*—Holotype and two other specimens from drill hole F–1, Eniwetok, at depth of 880–890 feet; one specimen at 890–900 feet. A single specimen from drill hole 2B, Bikini, at 1,020–1,100 feet probably represents the same species. Age of all specimens, early Miocene (Tertiary *f*).

#### Rhinoclavis (Pseudovertagus) floraensis Ladd, n. sp.

Plate 9, figures 4, 5

Medium in size, stout; spire, consisting of about nine sculptured whorls, is gently convex in outline. Aperture lenticular; anterior canal long, deep, and curved; inner

lip heavily callused, ascending at aperture; outer lip not preserved. Sculpture consisting of a spiral row of large rounded tubercles near the middle of the whorl (nine on penultimate whorl) and two rows of smaller and more numerous tubercles, one immediately above the suture, the other immediately below; suture wavy, inconspicuous; surface of shell between tubercles covered by close-set spiral threads and fine axial lines of growth; a low varix is present opposite the aperture. The primary tubercles are a darker brown in color than the remainder of the shell.

Measurements of the types: Holotype, USNM 650495—height 25.2 mm, diameter 9.7 mm; paratype, USNM 650496—height 14.5 mm, diameter 6.2 mm.

*Occurrence.*—Seventeen specimens from three drill holes on Eniwetok at depths of 700–1,715 feet; age, Miocene (Tertiary *e*, *f*, and *g*). Two specimens from drill hole 2A, Bikini, at depths 1,030–1,062 feet; age, early Miocene (Tertiary *f*). Two external molds from Guam represent the same species: USGS loc. 20863, Alifan Limestone (Tertiary *g* and *h*) and USGS loc. 20702, Mariana Limestone (Pliocene and Pleistocene).

### Genus CERITHIUM Bruguière

Bruguière, 1789, Encyclopédie méthodique histoire naturelle des vers: Paris, Panckoucke, v. 1, p. xv.

*Type* (by virtual tautonymy).—*Cerithium adansonii* Bruguière. Holocene, Red Sea.

### Subgenus THERICIUM Monterosato

Monterosato, 1890, Naturalista Siciliano, year 9, no. 7, p. 163.

*Type* (by original designation).—*Cerithium vulgatum* Bruguière. Holocene, Mediterranean Sea.

### Cerithium (Thericium) mutatum Sowerby

Plate 9, figure 6

*Cerithium mutatum* Sowerby, 1834, The genera of recent and fossil shells***: London, *Cerithium*, fig. 6.

Reeve, 1842, Conchyliologie Systématique, v. 2, p. 179, pl. 127, fig. 6.

This well-known species with its spiral heavily noded ribs and its discontinuous brown axial lines is widely distributed today in the open Pacific, including the Marshall Islands and Hawaii. The incomplete figured specimen, USNM 650427, was obtained from drill hole F–18–A on Eniwetok at a depth of 33–36 feet; age, Holocene. It measures: height (incomplete) 30.3 mm, diameter 11.9 mm.

### Cerithium (Thericium) alveolus Hombron and Jacquinot

Plate 9, figures 7, 8

*Cerithium alveolus* Hombron and Jacquinot, 1854, Voyage au Pole Sud et dans l'océanie, Zoologie: Paris, p. 105, pl. 24, figs. 28, 29.

Demond, 1957, Pacific Sci., v. 11, no. 3, p. 291, fig. 7.

*Cerithium piperitum* Sowerby, 1855, Monograph of genus *Cerithium*, *in* Thésaurus Conchyliorum, p. 867, pl. 181, figs. 136, 137.

Tryon, 1887, Manual Conchology, v. 9, p. 144, pl. 27, figs. 31, 32.

A small, stout species whose sculpture consists of low, rounded spiral ribs that alternate with one or more fine threads; low axial plications occur at fairly regular intervals and, on many specimens, the whorls are slightly angled near the middle.

Measurements of the figured specimen, USNM 650474: height 12.3 mm, diameter 6.0 mm.

*Occurrence.*—Figured specimen and two others from Saipan at USGS loc. 17897; Tanapag Limestone; age, Pleistocene. A single worn specimen from drill hole E–1 on Eniwetok at a depth of 30–40 feet probably represents the same species; age, Holocene. Living specimens were collected from many localities on the windward ocean reef flats of Bikini and Eniwetok (Demond, 1957). The rarity of the shell in the Marshall Island drill holes is not altogether surprising as the beds drilled, for the most part, are thought to represent lagoon deposits.

### Cerithium (Thericium) salebrosum Sowerby

Plate 9, figure 12

*Cerithium salebrosum* Sowerby, 1855, Monograph of genus *Cerithium*, *in* Thésaurus Conchyliorum, p. 862, pl. 181, figs. 114, 115.

Tryon, 1887, Manual Conchology, v. 9, p. 131, pl. 23, figs. 100, 1.

Demond, 1957, Pacific Sci. v. 11, p. 292, fig. 9.

Shell small; smooth whorls of protoconch followed by nine to 10 moderately convex subsequent whorls; suture impressed; aperture broadly ovate; posterior canal narrow and deep; anterior canal elongate and slightly recurved; outer lip scalloped by spiral ribs; inner lip heavily callused with broad elevations both anteriorly and posteriorly. Sculpture consisting of strong spiral ribs with spiral threads of one or two sizes in the intervening areas; primary spirals beaded at intersections with regular fairly heavy axial plications, giving the shell a rough appearance; lowest two spirals on body whorl are larger than others; a low varix is developed on the body whorl at the left side opposite the aperture.

Measurements of the figured specimen from Eniwetok, USNM 650473: height 21.8 mm, diameter 8.0 mm.

*Occurrence.*—Six fossil specimens from four drill holes on Eniwetok at depths from 22 to 490 feet; one specimen from drill hole 2, Bikini, at depth 115 feet; age, Pliocene to Holocene. Type locality Marutea (Lord Hood Island) in the Tuamotu group but reported living in the Marshall, Gilbert, and Caroline Islands.

### Cerithium (Thericium) schmidti Ladd, n. sp.

Plate 9, figures 13, 14

Shell small, stout; protoconch not preserved; whorls of spire flattened or slightly turreted because of the relative prominence of the posterior spiral; suture impressed. Sculpture consisting of axial plications and spiral ribs. Plications fairly regular in strength, 11 present on penultimate whorl; plication to left of aperture commonly varicose; primary spirals rounded and fairly regularly spaced, the posterior one commonly the largest; secondary ribs in groups of three between the primaries, the middle secondary of each group a little stronger than the one on either side; strong spirals present on base, with or without intermediate secondaries; all spirals noded or beaded where they cross the axial plications. Aperture lenticular; outer lip flaring and varicose; anterior canal short and slightly twisted.

Measurements of the holotype, USNM 650470: height (apex incomplete) 13.9 mm, diameter 5.6 mm. A paratype, USNM 650420, shows the tip of the shell (pl. 9, fig. 14).

The late Julia Gardner recognized this cerithid as an undescribed species and desired to name it for Robert G. Schmidt in recognition of his perserverance in collecting numerous specimens on Saipan where fossil mollusks are rare.

Miss Gardner noted that, like many other species of its group, *Cerithium* (*T.*) *schmidti* shows a wide variation in outline and in the details of sculpture pattern. Some individuals are slender, others almost pupiform. Most of the shells are tabulated to some degree, but in a few the whorls are evenly rounded. The axial pattern is usually fairly strong and regular, but a few individuals have little more than a series of nodes at the intersections of the axials and the spirals. The variation range is similar to that of *Cerithium* (*T.*) *salebrosum* Sowerby previously described. The Holocene shells of *C.* (*T.*) *salesbrosum* average about 20 mm in height instead of slightly more than 15 mm, the average height of *C.* (*T.*) *schmidti*. The sculpture pattern of *C.* (*T.*) *salebrosum*, as befits the name, is more rough and uneven than that of *C.* (*T.*) *schmidti*. The Holocene species *C.* (*T.*) *salebrosum* is abundant at Bikini and has been reported from Saipan.

*Occurrence.*—Forty-eight specimens from USGS loc. 17893 on Saipan. Inequigranular facies of Tagpochau Limestone; age, Miocene.

### Cerithium (Thericium) tenellum Sowerby

Plate 9, figure 15

*Cerithium tenellum* Sowerby, 1855, Monograph of genus *Cerithium*, *in* Thésaurus Conchyliorum, p. 857, pl. 180, figs. 88–90.

Tryon, 1887, Manual Conchology, v. 9, p. 132, pl. 23, figs. 10, 11.

A variable species that is distinguished with some difficulty from *Cerithium* (*T.*) *salebrosum*. On *C.* (*T.*) *tenellum* the beading is coarser, the beads are more smoothly rounded, and the anterior canal is more strongly recurved than on *C.* (*T.*) *salebrosum*.

Measurements of the figured specimen from Eniwetok, USNM 650485: height 17.4 mm, diameter 6.1 mm.

*Occurrence.*—One specimen from drill hole K–1B, Eniwetok, at depth 232–243 feet; three specimens from drill hole 2A, Bikini, at depths 200–274 feet; ages, Pleistocene and Holocene. The species was described by Sowerby from the Philippines. It occurs in great abundance on the reefs and in the lagoons of Bikini and Eniwetok.

### Cerithium (Thericium) ruppelli Philippi

Plate 9, figure 16

*Cerithium ruppelli* Philippi, 1849, Zeitschr. Malakozoologie, for 1848, p. 22.

Philippi, 1851, Abbildungen und Beschreibungen neuer oder wenig gekannter Conchylien, v. 3, *Cerithium*, p. 13, pl. 1, fig. 1.

Tryon, 1887, Manual Conchology, v. 9, p. 124, pl. 20, figs. 28, 29.

Medium in size, slender; whorls convex, slightly shouldered; suture distinct; aperture broadly lenticular; posterior canal deep; anterior canal short; outer lip thickened, slightly flaring, denticulate within. Sculpture consisting of strong spiral ribs, three to each whorl, that override close-set axial folds and tend to bead them where they cross; three fine spiral threads lie between each two spiral ribs.

Measurements of the figured specimen, USNM 650586: height 33.9 mm, diameter 11.4 mm.

*Occurrence.*—Two specimens from boulders of Waisia Limestone on the island of Maewo, New Hebrides (USGS loc. 24794); age, Pleistocene.

*Cerithium ruppelli* was described from the Red Sea and also occurs abundantly in the Gulf of Aden. It is an exceedingly variable species, and related, if not identical, forms have been collected in Fiji and Samoa.

### Subgenus CERITHIUM sensu stricto

### Cerithium (Cerithium) nodulosum Bruguière

Plate 9, figure 17

*Cerithium nodulosum* Bruguière, 1792, Encyclopédie méthodique histoire naturelle des vers: Paris, Panckoucke, v. 1, pl. 442, fig. 3.

Tryon, 1887, Manual Conchology, v. 9, p. 122, pl. 19, figs. 13, 14; pl. 20, fig. 20.

Demond, 1957, Pacific Sci., v. 11, p. 292.

An incomplete but characteristically sculptured shell of this widely distributed Holocene Indo-Pacific species was recovered from drill hole 2A, Bikini, at a depth of 925–936 feet; age, late Miocene (Tertiary *g*). The specimen, USNM 650492, measures: height (incomplete) 25.4 mm, diameter 14.0 mm.

Three incomplete molds from the Palau Limestone on Auluptagel, Palau, at USGS loc. 18316; age, Neogene. Incomplete molds from Mariana Limestone of Guam at USGS locs. 20567, 20576, 20591; age, Pliocene-Pleistocene. Six small and incomplete specimens from the Suva Formation at station 160, Viti Levu, Fiji; age, early Miocene (Tertiary *f*).

#### Cerithium (Cerithium) columna Sowerby

Plate 10, figure 1

*Cerithium columna* Sowerby, 1834, The genera of recent and fossil shells, London, *Cerithium*, fig. 7.

Tryon, 1887, Manual Conchology, v. 9, p. 123, pl. 20, figs. 17–19.

Demond, 1957, Pacific Sci., v. 11, p. 291.

Tinker, 1958, Pacific sea shells, Rutland, Vt., Charles E. Tuttle, 3 figs. on p. 33.

A single mold of this widely distributed (Mauritius to Hawaii) Indo-Pacific Holocene species was recovered from the Mariana Limestone at USGS loc. 20702 on Guam; age, Pliocene-Pleistocene.

The incomplete mold, USNM 650517, measures: height 26 mm, diameter 10 mm.

#### Cerithium (Cerithium) aff. C. columna Sowerby

Plate 10, figure 2

A single specimen from a drill hole on Eniwetok differs from other Holocene Marshall Island shells in that two prominent spirals produce a saddle in the shell's profile where they cross the radial plications; the varix opposite the aperture is less prominent and less oblique than in living shells.

Measurements of the fossil specimen, USNM 650478: height 20.4 mm, diameter 8.6 mm.

*Occurrence.*—Drill hole Mu–4, Eniwetok at depth of 35.5–36 feet; age, Holocene.

#### Cerithium (Cerithium) tuberculatum (Linnaeus)

Plate 10, figures 3, 4

*Strombus tuberculatus* Linnaeus, 1791, Systema naturae [13th ed.], p. 3,521.

*Cerithium petrosum* Wood, 1828, Index Testaceologicus, Suppl.: London, p. 34, pl. 4, fig. 9.

*Cerithium tuberculatum* (Linnaeus). Tryon, 1887, Manual Conchology, v. 9, p. 133, pl. 24, figs. 25–28.

Medium in size, short, stout, each whorl bearing several rows of prominent nodes, one of which may be larger than the others. Between the nodes are fine spiral threads. The most characteristic feature is a strong oblique varix on the back of the body whorl. Two of the fossils retain traces of reddish-brown spots near the aperture.

Measurements of the figured specimen, USNM 650494; height 20.6 mm, diameter 10.4 mm.

*Occurrence.*—Four fossil specimens that probably represent this variable and widely distributed Holocene species were collected at USGS loc. 21591, Cabras Island, Guam, from the Mariana Limestone; age, Pliocene or Pleistocene. Martin (1899, p. 202, pl. 31, fig. 463) described an unnamed variety from the Pliocene Sondé-beds of Java. Living specimens have been collected from the Mariana and Loyalty Islands, from Fiji, Indonesia, and Aqaba.

### Subgenus CONOCERITHIUM Sacco

Sacco, 1895, I Molluschi dei terreni terziarii del Piemonte e della Liguria, Torino, Italy, Carol Clausen, pt. 17, p. 22, pl. 2, fig. 18.

*Type* (by original designation).—*Cerithium tauroconicum* Sacco. Miocene, Europe.

#### Cerithium (Conocerithium) egenum Gould

Plate 9, figures 9, 10

*Cerithium egenum* Gould, 1849, Boston Soc. Nat. History Proc., v. 3, p. 121.

Gould, 1852, U.S. Explor. Exped., Mollusca, v. 12, p. 151, pl. 10, fig. 171.

Gould, 1862, Otia Conchologica, p. 62.

Tryon 1887, Manual Conchology, v. 9, p. 137, pl. 25, fig. 70.

Johnson, 1964, U.S. Natl. Mus. Bull. 239, p. 71.

Small, stout; whorls flattened; sculpture consisting of about five primary spiral ribs, the one near the middle of the whorl being larger than the others and on most shells distinctly nodose; rib immediately below suture larger than remaining primaries; two to three fine secondary spirals occur between each two of the larger ribs; a prominent varix is present on the body whorl opposite the aperture. Aperture oval; anterior canal short. Traces of original color in the form of pennant-shaped brown spots directed upward are preserved near the base.

Measurements of the figured specimen from drill hole E–1, Eniwetok, depth 30–40 feet, USNM 650475: height 6.6 mm, diameter 3.0 mm.

The type of *C. egenum* (USNM 5571) is a worn shell from Ifaluk Atoll (Wilson Island) in the Carolines; the type is smoother than most shells from Ifaluk, but it seems to fall within the observed range of variation and retains traces of the original color pattern. A well-preserved Holocene shell from Ifaluk is shown on plate 9, figure 10; this specimen, USNM 650476, measures: height 6.4 mm, diameter 2.8 mm.

*Occurrence.*—Thirteen specimens from four drill holes on Eniwetok at depths above 40 feet; three specimens from two drill holes on Bikini at depth of 27–253 feet; all specimens probably Holocene.

At Ifaluk Atoll in the Caroline Islands, the type locality of the species, D. P. Abbott collected numerous specimens from the reefs at intertidal levels and from shallow depths in the lagoon; similar occurrences were found in the Marshall Islands.

#### Cerithium (Conocerithium) aff. C. egenum Gould

Plate 9, figure 11

A single specimen of a medium-sized stout cerithid from the upper Miocene of Eniwetok (drill hole F–1, depth 750–760 feet) appears to be closely related to *Cerithium egenum*, a small species that, as noted previously, lives in the Marshall Islands today and has been recovered at shallow depths from drill holes on Eniwetok and Bikini. The late Miocene fossil, USNM 650510, measures 14.3 mm in height and 7.8 mm in diameter and thus is more than twice the size of the Holocene shells and proportionately thicker. The outline of the spire of the fossil is more convex, but the sculpture and the apertural features are very similar to those of the Holocene shells. The fossil probably represents a distinct species, but because the single example, though complete, is somewhat worn, a specific name is withheld.

### Genus CLYPEOMORUS Jousseaume

Jousseaume, 1888, Soc. Zool. France Mém. 1, p. 171–173.

*Type* (by original designation).—*Clypeomorus clypeomorus* Jousseaume. Holocene, Red Sea area.

#### Clypeomorus verbeeki (Woodward)

Plate 10, figure 5

*Cerithium verbeeki* Woodward, 1879, Geol. Mag., v. 6, p. 540, pl. 14, figs. 9a, b.

Martin, 1883, Geol. Reichs-Mus. Leiden Samml., v. 3, p. 152, pl. 8, fig. 149.

Martin 1899, Geol. Reichs-Mus. Leiden Samml., v. 1, nos. 6–8, p. 199, pl. 31, figs. 457–459.

Shell medium in size, stout; spire consisting of about 10 flattened whorls separated by a prominent suture. Sculpture consisting of spiral ribs, about four to each whorl, that are distinctly beaded where they cross close-set, slightly curved axial ribs; fine threads are present between primary spirals. Aperture broadly ovate; columella concave; outer lip thickened, slightly flaring and denticulate within; inner lip heavily callused, with a distinct margin; posterior canal narrow and deep; anterior canal wide, short, straight. A low varix is present on the body whorl opposite the aperture; similar but less conspicuous varices irregularly distributed on spire.

Measurements of the figured specimen, USNM 650518: height 15.6 mm, diameter 6.5 mm.

*Occurrence.*—Represented by three specimens from two deep holes on Eniwetok at depths 710–758 feet; age, late Miocene (Tertiary *g*). Described originally from the Miocene of Sumatra; also reported from the lower and upper Miocene of Java and the Pliocene of Timor.

#### Clypeomorus wainingoli Ladd, n. sp.

Plate 10, figures 6, 7

Shell small, inflated; spire consists of about eight gently convex whorls, separated by a distinct suture. Sculpture consisting of two sets of spirals: primary spirals, about six per whorl, those on the lower half of each whorl being slightly larger than those above; two or more threadlike spirals between each two primary spirals; primary spirals slightly swollen where they cross low axial elevations on the spire, these swellings becoming beadlike on the body whorl. Aperture ovate; columella concave; outer lip slightly thickened and crenulate within; inner lip thickly callused, distinctly margined; posterior canal narrow and deep; anterior canal wide, moderately long. A low varix opposite the aperture is slightly oblique; other varices on the spire are indistinct.

Measurements of the holotype, USNM 650515: height 12.4 mm, diameter 6.3 mm.

*Clypeomorus wainingoli* appears to be most closely related to *C. morus* (Lamarck), a Holocene species widely distributed in the Indo-Pacific (Mauritius to Hawaii), including Fiji; but the fossil shells are much smaller than the Holocene shells, and the primary spirals of the fossil are smaller and more numerous than those of the Holocene shell.

The species is named for the late William Wainingolo, unusually competent guide during fieldwork in the Exploring Isles in eastern Fiji.

*Occurrence.*—Three specimens from the Ndalithoni Limestone, station 110B, Vanua Mbalavu, Fiji; age, probably Pliocene (Tertiary *h*).

### Genus LIOCERITHIUM Tryon

Tryon, 1887, Manual Conchology, v. 9, p. 113.

*Type* (by monotypy).—*Cerithium incisum* Sowerby. Holocene, Pacific.

#### Liocerithium kayae Ladd, n. sp.

Plate 4, figures 7–12

Shell small, elongate conical. Protoconch of two smooth rounded whorls followed by eight to nine flattened sculptured whorls, each with numerous (five to 12, usually about six) sharply elevated ribbonlike

spirals, the lowest overhanging a wide, deep suture that may bear one or two finer spirals; broad axial folds, 10 or more to the whorl, are present but are inconspicuous on most shells; a prominent varix lies opposite the aperture on the body whorl. Aperture broadly ovate; outer lip ascending slightly posteriorly, its edge (broken on most specimens) crenulated by the spirals; inner lip thinly callused posteriorly, thickly callused anteriorly, its margin sharp; posterior canal shallow, anterior canal broad, deep and recurved; base bearing about 10 subequal spiral ribs.

Measurements of the types:

| Specimen (USNM) | Type | Island | Locality | Height (mm) | Diameter (mm) |
|---|---|---|---|---|---|
| 650506 | Holotype | Babelthuap | USGS loc. 21308 | 7.5 | 2.5 |
| 650507 | Paratype A | do | USGS loc. 21304 | 6.3 | 1.9 |
| 650508 | Paratype B | Eniwetok | Drill hole K–1B, 841–853 ft | 5.3 | 1.8 |
| 650509 | Paratype C | do | Drill hole E–1, 860–870 ft | 7.4 | 2.6 |
| 650519 | Paratype D | Bikini | Drill hole 2B, 1,020–1,100 ft | 9.8 | 3.6 |

*Liocerithium kayae* is distinguished from other cerithids known from the island area by its dominant spiral sculpture and its regular and sharply elevated ribbonlike spirals. *L. incisum*, the type of the genus, is a large shell that has two prominent spirals below the suture. Its numerous spirals are similar to those of *L. kayae* but its anterior canal is shorter.

This species is named for Dr. Alison Kay of the University of Hawaii, who has contributed much to our knowledge of living Pacific island mollusks.

*Occurrence.*—Numerous specimens from four localities (USGS locs. 21301, 21304, 21308, and 21310) on the Goikul peninsula, Babelthuap, Palau; marls at the base of the Palau Limestone; age, late Miocene (Tertiary *g*). More than 50 specimens from various levels in three deep holes on Eniwetok, from depths of 799 to 1,249 feet; age, Miocene (Tertiary *e*, *f*, and *g*). Fifteen specimens from two deep holes on Bikini at depths 925–1,072; age, Miocene (Tertiary *f* and *g*).

### Genus PLESIOTROCHUS Fischer

Fischer, P., 1878, Jour. Conchyliologie, v. 18, no. 1, p. 212.

*Type* (by monotypy).—*Plesiotrochus souverbianus* P. Fischer (= *Tectarius euteus* Gould). Holocene, Indo-Pacific.

### Plesiotrochus luteus (Gould)

Plate 10, figures 8, 9

*Tectarius luteus* Gould, 1861, Boston Soc. Nat. History Proc., v. 8, p. 14.

Johnson, 1964, U.S. Natl. Mus. Bull. 239, p. 106, pl. 17, fig. 4.

*Trochus exilis* Pease, 1868, Am. Jour. Conchology, v. 3, p. 286, pl. 24, fig. 7.

*Plesiotrochus souverbianus* P. Fischer, 1878, Jour. Conchyliologie, v. 26, p. 212.

P. Fischer, 1879, Jour. Conchyliologie, v. 27, p. 29, pl. 3, fig. 4.

*Plesiotrochus luteus* (Gould). Yen, 1944, California Acad. Sci. Proc., v. 23, no. 38, p. 566, pl. 50, figs. 42, 43.

Small, elongate-conical; flattened whorls are slightly convex in profile; base convex, imperforate; aperture obliquely subquadrate; inner lip callused; outer lip thin, its anterior edge descending slightly below the periphery of the whorl. Sculpture consisting of a prominent spiral rib at the base of each whorl; rib may be scalloped, and the high points may be extended across the whorl as obscure axial plications; fine axial lines visible under high magnification; above the main spiral rib, whorls are covered by fine close-set spiral riblets that vary slightly in size.

Fossil shells from shallow depths on Bikini and Eniwetok retain traces of spots or narrow axial stripes of brown color.

Measurements of the figured Bikini specimens: USNM 650437 from drill hole 1 at depth 40 feet—height 4.0 mm, diameter 2.5 mm; USNM 650438 from drill hole 2B at depth 1,324.5–1,335 feet—height 4.1 mm, diameter 2.5 mm.

*Occurrence.*—In numerous shallow drill holes on Eniwetok from near the surface to depth of nearly 100 feet; in three deep holes at depths 201–737 feet; age, late Miocene (Tertiary *g*) to Holocene. At Bikini, five specimens from depths 20 to 184 feet; age Holocene. Two additional specimens from drill hole 2B on Bikini from depths of 1,324 to 1,944 feet indicate an age of early Miocene (Tertiary *e* and *f*), but these two specimens may have been derived from higher horizons.

The species is abundant in the Marshall Islands today; Gould's specimens came from Lifu in the Loyalty Islands, Pease's shells from Paumotu (Tuamotu). The species is abundant at Midway, in Hawaii.

### Plesiotrochus pagodiformis Hedley

Plate 10, figure 10

*Plesiotrochus pagodiformis* Hedley, 1907, Linnaean Soc. New South Wales Proc., v. 32, p. 498, pl. 17, fig. 16.

Small, elongate-conical; whorls flattened. On the periphery of the body whorl are two strong spiral ribs that enclose a wide and deep groove, the lower of the two ribs being covered on earlier whorls. Broad low axial plications cross the whorls at fairly regular intervals (eight on last whorl) and cause broad scallops in the main spiral rib; sides of whorls and base covered by close-set spiral riblets, some of which are finer than others; obscure very fine axials are also

present. Suture only faintly impressed; aperture broadly ovate; anterior canal short, wide, deep.

Measurements of the figured specimen, USNM 650439: height 3.4 mm, diameter 2.2 mm.

The fossils appear to be identical with Holocene shells from the type locality, Masthead Reef, Queensland, comparisons having been made with the type (Australian Museum C–18837) and with cotypes (USNM 201415).

*Occurrence.*—Three specimens from Eniwetok drill holes (Mu–4, 35.5 ft; K–1, 211–222 ft; and F–1, 300–310 ft) in post-Miocene beds. A single specimen from drill hole 2A, Bikini, at depth 998–1,009 feet is early Miocene (Tertiary *f*); it has sharper axial sculpture but is believed to be the same species.

**Plesiotrochus talinana Ladd, n. sp.**
**Plate 10, figures 11, 12**

Small, high spired, slender; whorls flattened; suture impressed; aperture ovate, constricted anteriorly into a wide and deep canal. Protoconch consisting of two smooth whorls, followed by about seven sculptured whorls. Two prominent spiral ribs are present on the periphery of each whorl, the upper being the larger. Regularly spaced axial plications are present on all sculptured whorls, those of one whorl tending to aline with plications on adjoining whorls; plications indistinct near suture but become prominent as they approach the periphery, giving rise to rounded nodes where they cross the larger peripheral spiral rib. Surface of whorls, including the deep groove between the peripheral ribs and the base, are covered by close-set spiral riblets.

Measurements of the holotype and only specimen, USNM 650440: height 4.3 mm, diameter 1.8 mm.

*Plesiotrochus talinana* is more slender than *P. pagodiformis*, and there are differences in sculpture: on *P. talinana* the lower of the two peripheral spiral ribs is not covered on the whorls of the spire; the axial plications are larger, more numerous, and more regularly spaced than on *P. pagodiformis*; and axial plications on adjoining whorls of *P. talinana* tend to be alined; both on *P. talinana* and on *P. pagodiformis* all the spiral riblets are subequal in size. *P. talinana* appears to be the oldest *Plesiotrochus* yet reported; it may be ancestral to *P. pagodiformis*, which occurs at higher levels in the Marshall Island drill holes and still lives in Queensland, Australia.

*Occurrence.*—Drill hole E–1, Eniwetok, at depth 1,955–1,985 feet. Age, early Miocene (Tertiary *e*).

**Plesiotrochus marshallensis Ladd, n. sp.**
**Plate 10, figures 13–15**

Small, broadly conical; whorls nearly flat; suture lightly impressed; base bently convex; aperture subquadrate with a broad, slightly curved anterior canal. Sculpture variable; the strong spiral ridge on the base of each whorl that characterizes *Plesiotrochus* may be weak (pl. 10, fig. 15) or may be scalloped into strong rounded nodes (pl. 10, fig. 14); on some shells the low nodes of the basal ridge are extended upward as obscure axial plications (pl. 10, fig. 13). Whorls, including base, covered by fine close-set spiral riblets—three to four on prominent basal spiral ridge, as many as 10 on the remainder of the whorl. Base has numerous low axial ridges that are overridden by the spiral riblets.

Measurements of the types: Holotype, USNM 650441—height 7.7 mm, diameter 5.4 mm; paratype A, USNM 650442—height 5.4 mm, diameter 3.0 mm; paratype B, USNM 650443—height 4.2 mm, diameter 2.5 mm.

*Occurrence.*—A total of 15 specimens (seven lots) from three drill holes on Eniwetok at depths 760–1,569 feet. Age, Miocene (Tertiary *e–f–g*). A single specimen from drill hole 2A, Bikini, at depth of 967–978 feet; age, late Miocene (Tertiary *g*).

**Plesiotrochus whitmorei Ladd, n. sp.**
**Plate 11, figures 2, 3**

Small, biconic, diameter nearly equaling height. Protoconch smooth, followed by about six flattened sculptured whorls; suture slightly impressed; anterior canal short, wide. Periphery has an inconspicuous rib only slightly larger than the fine close-set riblets covering the balance of each whorl; base also covered by spiral riblets, one or more fine riblets included between others that are slightly coarser.

Measurements of the types: Holotype, USNM 650445—height 3.4 mm, diameter 2.9 mm; paratype, USNM 650446—height 2.6 mm, diameter 2.3 mm.

*Plesiotrochus whitmorei* differs from the other plesiotrochids found in the island area in having a relatively inconspicuous peripheral rib.

This species is named for Dr. Frank C. Whitmore, who administered the U.S. Geological Survey's program covering the Pacific Islands.

*Occurrence.*—Eleven specimens from three Marshall Island drill holes: nine from drill holes F–1 and K–1B on Eniwetok at depths 810–926 feet—age, Miocene (Tertiary *f* and *g*); two specimens from drill hole 2A on Bikini at depth 1,046–1057 feet—age, early Miocene (Tertiary *f*).

**Plesiotrochus sp. A**
**Plate 11, figure 1**

Small, elongate-conical; spire consists of eight flattened whorls, the lower parts of which are inflated and

rise prominently above the top of the succeeding whorl; suture impressed; base gently convex; aperture subquadrate with a broad anterior canal. Sculpture consists of strong, slightly oblique axial plications, 10 on the penultimate whorl, that are prominent on the lower part of the whorl but grow weaker above; whorls covered by fine close-set spiral riblets, several occurring on the inflated lower edge of the whorl; on the base larger spirals tend to alternate with the finer riblets, and both are crossed by obscure axials.

Measurements of the only specimen, USNM 650444: height 4.2 mm, diameter 2.7 mm.

*Plesiotrochus* sp. A has stronger and more regular axial plications than *P. marshallensis*, from which it may have evolved.

*Occurrence.*—Drill hole E–1, Eniwetok, at a depth of 520–530 feet. Age, probably Pliocene (Tertiary *h*).

### Family CERITHIOPSIDAE

### Genus CYRBASIA Harris and Burrows (=TIARELLA Cossmann, 1889)

Harris and Burrows, 1891, The Eocene and Oligocene beds of the Paris basin, Geologist's Assoc., London, p. 112.

*Type* (by monotypy).—*Cerithium pupina* Deshayes. Eocene, Europe.

### Subgenus JOCULATOR Hedley

Hedley, 1909, Linnaean Soc. New South Wales Proc., v. 34, pt. 3, p. 442.

*Type* (by original designation).—*Cerithiopsis ridicula* Watson. Holocene, northeast Australia.

Includes small ovate or bulbous shells with a smooth, subulate, many whorled protoconch; whorls of spire have beaded spirals.

#### Cyrbasia (Joculator) tribulationis (Hedley)

Plate 11, figure 4

*Cerithiopsis (Joculator) tribulationis* Hedley, 1909, Linnaean Soc. New South Wales Proc., v. 34, pt. 3, p. 441, pl. 40, fig. 57.

Minute, elongate-conic, slightly narrowed anteriorly. Protoconch subulate, slightly crooked, consisting of three and a half smooth whorls; five subsequent whorls, each with three strongly beaded spirals; the beads on each spiral are tied to those of adjacent spirals by low axial elevations, giving the shell a cancellated appearance. Body whorl has four beaded spirals; base has a single unbeaded ridge; aperture subquadrate; anterior canal short.

Measurements of the figured specimen, USNM 650544: length 2.0 mm, diameter 0.6 mm.

In describing this species Hedley stated that the uppermost spiral on each whorl was somewhat larger than the others, but this is not true of the fossil specimens.

*Occurrence.*—Drill hole F–1, Eniwetok, at depth of 55–60 feet; age, Holocene. A second specimen from drill hole E–1, Eniwetok, at depth of 730–740 feet is late Miocene (Tertiary *g*) in age; it has an incomplete protoconch but is not a Holocene specimen carried downward in the hole, for it has the light-brown color that is characteristic of the Miocene fossils of Eniwetok. Hedley described the species from shells collected from the Great Barrier Reef of Australia at depths of 5–10 fathoms. The species has not previously been reported as a fossil.

#### Cyrbasia (Joculator) semipicta (Gould)

Plate 11, figures 5, 6

*Cerithiopsis semipicta* Gould, 1861, Boston Soc. Nat. History Proc., v. 7, p. 388.

Gould, 1862, Otia Conchologica, p. 143.

*Cerithiopsis balteata* Watson, 1881, Linnaean Soc. London Jour., v. 15, p. 124.

Watson, 1886, *Challenger*, Zoology, Rept., v. 15, p. 526, pl. 30, fig. 1.

*Joculator semipictus* (Gould). Yen, 1944, California Acad. Sci. Proc., v. 23, p. 570, pl. 50, figs. 28, 29.

Shell minute, pupoid; protoconch of smooth whorls (incompletely preserved); whorls of spire about six; suture in deep furrow; aperture small, lenticular; inner lip thick, detached. Sculpture consisting of two spiral rows of coarse tubercles that are slightly elongated axially, the tubercles in the upper row being larger than those in lower row; the two rows are separated by a deep furrow; on the body whorl the upper row of tubercles may be divided by a shallow spiral furrow, and there is a third row of tubercles at the base. On one well-preserved fossil, the lower of the two rows of tubercles retains traces of the brown color that characterizes living specimens.

Measurements of the figured specimens: Plate 11, figure 5 from drill hole F–7–A, Eniwetok, USNM 650587—height 1.9 mm, diameter 0.9 mm; plate 11, figure 6 from drill hole F–1, Eniwetok, USNM 650588—height 1.6 mm, diameter 0.7 mm.

*Cyrbasia semipicta* resembles *Cerithiopsis pinea*, described by Hedley (1909, p. 440, pl. 40, fig. 55) from the Great Barrier Reef of Australia, but in *C. pinea* the tubercles are more elongated axially.

*Occurrence.*—Figured specimen from drill hole F–7–A, Eniwetok, at depth of 10–12 feet (pl. 11, fig. 5) is Holocene in age; specimen from drill hole F–1, Eniwetok, at depth 630–640 feet (pl. 11, fig. 6) is late Miocene (Tertiary *g*); four other specimens from Eniwetok drill holes at depths of 40–710 feet represent the same age span (Tertiary *g* to Holocene). Gould's type came from the "China Seas"; Watson's (1881,

1886) specimens of *C. balteata* were collected from Fiji at a depth of 12 fathoms.

#### Cyrbasia (Joculator) sumangi Ladd, n. sp.

Plate 11, figures 7–11

Shell small, slender, spindle shaped. Protoconch coiled at a slight angle to the axis of the shell, consisting of approximately two smooth convex whorls plus a buttonlike tip, followed by six to eight sculptured whorls; suture distinct. Sculpture consisting of three spiral rows of well-rounded beads linked by a spiral thread. A fourth spiral that is only weakly beaded occurs below the others on the body whorl, and below it one or two smaller unbeaded spirals may be present; aperture broadly ovate; inner lip thick, its edge detached.

Measurements of the types:

| Specimen (USNM) | Type | Locality | Height (mm) | Diameter (mm) |
|---|---|---|---|---|
| 650591 | Holotype | Palau, USGS loc. 21301 | 3.3 | 0.7 |
| 650589 | Paratype A | do | 2.4 | .7 |
| 650590 | Paratype B | do | 1.5 | .5 |
| 650593 | Paratype C | Eniwetok, drill hole F–1, 710–720 ft. | 1.5 | .5 |
| 650594 | Paratype D | Eniwetok, drill hole E–1, 770–780 ft. | 3.5 | 1.0 |

This species is named for Sumang Yachaderchemai, who served as guide and field assistant during my stay in Palau.

*Occurrence.*—Present in abundance at USGS locs. 21301 and 21304, and a few were found at USGS loc. 21308, all on Goikul Peninsula, Babelthuap Island, Palau; from marl at base of Palau Limestone. A single specimen was recovered from drill hole F–1 on Eniwetok at depth of 710–720 feet; another from drill hole E–1 at depth of 770–780 feet. Age of all specimens, late Miocene (Tertiary *g*).

#### Cyrbasia (Joculator) aff. C. ovata (Laseron)

Plate 11, figure 12

Minute, broadly lenticular in outline, diameter nearly equaling half the height. Protoconch not preserved; spire consisting of five whorls, the penultimate the largest, each with three spiral rows of well-rounded close-set beads; a fourth beaded spiral is present below the others on the body whorl, and below it is a narrow nearly smooth spiral; suture distinct; aperture narrowly ovate; inner lip thick, its margin slightly elevated; columella expanded into a large plait.

Measurements of the figured specimen, USNM 650592: height 1.5 mm, diameter 0.6 mm.

The highly inflated Marshall Islands fossils bear a striking resemblance to a living Great Barrier Reef species described as *Joculator ovata* by Laseron (1956, p. 170, fig. 33). The fossils are more regularly beaded than the present-day shells, and most of the fossils are slightly narrower.

*Occurrence.*—One specimen from drill hole E–1, Eniwetok, at depth of 870–880 feet; another at depth 970–980 feet; age, early Miocene (Tertiary *f*). A third specimen from drill hole 2, Bikini, at depth of 105 feet is Holocene.

### Genus CERITHIOPSIS Forbes and Hanley

Forbes and Hanley, 1853, History of British Mollusca: London, John van Voorst, v. 3, p. 364.

*Type* (by monotypy).—*Murex tubercularis* Montagu. Holocene, Seas of Europe.

### CERITHIOPSIS sensu lato

#### Cerithiopsis sp.

*Cerithiopsis* sp. Ladd, 1970, U.S. Geol. Survey Prof. Paper 640–C, p. C6, pl. 4, fig. 12. Late Eocene (Tertiary *b*); Eua, Tonga.

### Genus SEILA A. Adams

Adams, A. 1861, Annals and Mag. Nat. History, 3d ser., v. 7, p. 131.

*Type* (by original designation).—*Triphoris dextroversa* Adams and Reeve. Holocene, China seas.

#### Subgenus NOTOSEILA Finlay

Finlay, 1926, New Zealand Inst. Trans., v. 57, p. 382.

*Type* (by original designation).—*Cerithium terebelloides* Martens. Holocene, New Zealand.

#### Seila (Notoseila) waluensis Ladd, n. sp.

Plate 11, figure 13

Shell small, slender; whorls flattened. Protoconch consisting of three smooth rounded whorls with mammillate tip. Whorls of spire bearing three strong smooth spiral keels, the middle one smaller than the other two; interstices between keels have close-set axial growth lines; base flat; aperture subcircular.

Measurements of the types from station 160, Viti Levu, Fiji: Holotype, an incomplete shell that retains the protoconch, USNM 650584—height 1.8 mm, diameter 0.7 mm; paratype (incomplete shell), USNM 650585, measures 1.3 mm in diameter.

*Seila waluensis* closely resembles *S. terebelloides*, the type of *Notoseila*, but on that species the three spiral keels are equal in size and the protoconch consists of four whorls. The Fiji fossil also resembles *S. attenuisima* Marshall and Murdock (1920, p. 129, pl. 6, fig. 2) from the Tertiary of New Zealand, but on that shell the lowest of the three spirals is slightly larger than the other two.

*Occurrence.*—Three specimens from station 160 on Walu Bay, Viti Levu, Fiji; age, early Miocene (Tertiary *f*). Three fragments from drill hole K–1B on Eniwetok at depths 810 and 874 feet do not show the protoconch, but the sculpture of the whorls of the spire is identical with the Fiji specimens. The Eniwetok specimens are Miocene—two from Tertiary *f* and one from Tertiary *g*.

### Family TRIPHORIDAE

### Genus TRIPHORA Blainville

Blainville, 1828, Dictionnaire des sciences naturelle: Paris, LeNormant, v. 55, p. 344.

*Type* (by monotypy).—*Triphora gemmata* Blainville. Holocene, Mauritius.

#### Subgenus TRIPHORA sensu stricto

Includes slender acuminate shells whose whorls bear beaded spiral ribs. Anterior canal is a narrow groove; the posterior canal is short and narrow.

#### Triphora (Triphora) pallida (Pease)

Plate 11, figure 14

*Triphoris pallidus* Pease, 1870, Zool. Soc. London Proc., p. 774.

Shell medium in size, slender; sides gently convex. Sculpture consisting of two prominent beaded spiral ridges; between the two a third slightly beaded spiral becomes increasingly prominent on later whorls. Body whorl has four subequal beaded spirals; base has two small unbeaded spirals; suture obscure; aperture subquadrate; anterior canal thick, turned backward; posterior canal short, narrow.

Measurements of the figured specimen, USNM 650539: length (apex incomplete) 5.3 mm, diameter 1.3 mm.

In describing this species Pease (1870) aptly commented: "A slender species without any particular character."

*Occurrence.*—Single specimen from drill hole E–1, Eniwetok, at depth of 30–40 feet; age, Holocene. The type locality is Hawaii. As the species is also known from the Mariana and Philippine Islands, its appearance in the Holocene sediments of the Marshalls is not surprising.

#### Triphora (Triphora) otsuensis (Yokoyama)

Plate 11, figure 15

*Triforis otsuensis* Yokoyama, 1920, College Sci. Jour., Tokyo Imp. Univ., v. 39, p. 69, pl. 4, fig. 11.

*Notosinister otsuensis* (Yokoyama). Kosuge, 1962, Tokyo Nat. Sci. and Mus. Bull., v. 6, no. 2, p. 89, pl. 10, fig. 2.

Kosuge, 1963, Venus, v. 22, no. 3, p. 242, pl. 15, fig. 16.

*Triphora otsuensis* (Yokoyama). Kosuge, 1966, Malacologia, v. 4, no. 2, p. 316, pl. 1, fig. 12.

A medium-sized, stout, flat-sided shell characterized by three subequal spiral rows of coarse beads and a wide deep suture bearing a fine spiral thread. Body whorl has four spirals, the lowest unbeaded; base flattened, with three unbeaded spirals; aperture ovate; margin of inner lip distinct.

Measurements of the figured specimen, USNM 650452: length (apex incomplete) 3.9 mm, diameter 1.4 mm.

On the shells of living specimens the low elevations that connect the beads of one spiral to those of another are more distinct than on the fossil.

*Occurrence.*—Single specimen from drill hole F–1, Eniwetok, at depth 880–890 feet; age, early Miocene (Tertiary *f*). Described by Yokoyama from fossil specimens collected from Pliocene or Pleistocene beds at Otsu, Yokosuka City, Japan; the species is known to be living in the Amami Islands of Japan and the Philippines.

#### Subgenus INELLA Bayle

Bayle, 1878, Jour. Conchyliologie v. 27, p. 35.

*Type* (by subsequent designation, Jousseaume, 1884, Soc. Malacologique France Bull., v. 1, p. 230).—*Triphoris gigas* Hinds. Holocene, New Guinea.

A group of large acuminate shells that have numerous whorls, bearing three rows of beads connected by spiral cords.

#### Triphora (Inella) pyramidalis (Adams and Reeve)

Plate 11, figures 16, 17

*Triphoris pyramidalis* Adams and Reeve, 1850, Mollusca, *in* Voyage of H.M.S. *Samarang* [Rept.]: London, Reeve and Benham, p. 46, figs. 36a, b.

*Inella pyramidalis* (Adams and Reeve). Kosuge, 1962, Venus, v. 22, no. 2, p. 119.

The following description is based on the fossil material:

Shell large, slender, flat sided; protoconch smooth, inflated, consisting of about one and a half whorls; spire made up of 21 whorls. Sculpture consisting of four regularly spaced spirals of varying strength; the lowest and the third from the bottom are smooth or weakly beaded cords, and between them lies the most prominent spiral, a heavy beaded keel whose surface descends steeply below but more gently above. The fourth spiral is a smooth keel lying immediately below the suture; it is weaker than the beaded keel; inconspicuous oblique axial ridges extend upward from the beads of the major keel. Aperture subquadrate; outer lip incomplete; inner lip heavily callused; anterior canal wide, deep, recurved, not covered over; base has two strong spiral keels that are beaded by axial ridges.

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A specimen from drill hole K–1B, Eniwetok, at depth 642–653 feet, retains traces of brown color on the keel below the suture.

Measurements of the figured specimen from Palau, USNM 650523: length 19.4 mm, diameter (outer lip incomplete) 3.6 mm. Figured specimen from Eniwetok, USNM 650543, measures: length (incomplete) 10.7 mm, diameter 2.5 mm.

*Occurrence.*—Represented by seven specimens from near Goikul, Babelthuap, Palau, USGS locs. 21301 and 21304, from marls at the base of the Palau Limestone; age, late Miocene (Tertiary *g*). Seventeen incomplete specimens from three drill holes on Eniwetok at depths 642–1,569 feet; age, Miocene (Tertiary *e–g*). From Bikini, two incomplete specimens: one from drill hole 2A at depth 925–936 feet, late Miocene (Tertiary *g*); the other from drill hole 1 at depth 40 feet, Holocene. The type, a Holocene shell described by Adams and Reeve, came from the China Sea; also known from the Marshall, Philippine, and Amami Islands.

### Triphora (Inella) roddai Ladd, n. sp.

Plate 11, figure 18

Shell large, acuminate; apical angle is 8°; spire composed of numerous (more than 15) whorls. Aperture subquadrate; posterior canal short, deep; anterior canal deep and recurved but not closed over; inner lip heavily callused; base has five smooth spirals, the upper two larger than the others. Sculpture of spire consisting of broad axial ribs that are beaded, the beads connected by spirals; on body whorl, four strong spirals are present (the lowest the strongest), with two secondary spirals, one above and one below the next-to-lowest primary; on earlier whorls, only three spirals are prominent.

Measurements of the holotype, USNM 650522: length (apex incomplete) 24.5 mm, diameter 4.7 mm.

This fossil species appears to be most closely related to *Triphora* (*Inella*) *pyramidalis* (Adams and Reeve), which lives in the China Sea, the Amami Islands, the Marshalls, and the Philippines and which is known from Miocene beds in the Marshalls and Palau. The Fiji fossil has coarser sculpture and is less sharply beaded than *T.* (*I.*) *pyramidalis*.

This species is named for Peter Rodda of the Geological Survey of Fiji, who collected the type specimen and many other fossils in Fiji.

*Occurrence.*—Holotype from the marls of the Mba Group on Korotambua Creek, south of Mba, station C–89, Viti Levu, Fiji; an incomplete specimen was collected from the Ndalithoni Limestone on Vanua Mbalavu (station 110B); age of both specimens, Pliocene (Tertiary *h*).

### Triphora (Inella) maharatai Beets

Plate 12, figure 1

*Triphora* (*Inella*) *maharatai* Beets, 1941, Nederland en Kolonien Geol.-Mijnb. genoot. Verh., Geol. Ser., v. 13, pt. 1, p. 62, pl. 4, figs. 145–146.

Shell acuminate with nearly flat sides. Each whorl bears four spiral ridges as follows: an anterior strongly noded ridge and a weaker posterior ridge that is nearly smooth; in the concave space between these two major spirals is a fine nearly smooth spiral; and the fourth spiral, fine and nearly smooth, lies immediately above the suture. Traces of still finer spirals can be distinguished under high magnification on some specimens. The nodes of the most prominent spiral are extended axially to form poorly defined ribs. Aperture subquadrate, inner lip distinct; anterior canal well developed, twisted. On the figured specimen, the part of each whorl above the noded spiral is darker than the area below.

Measurements of the figured specimen, USNM 650526: height (incomplete) 10.2 mm, diameter 3.0 mm.

*Occurrence.*—Figured specimen from drill hole 2A, Bikini, at depth 925–935.5 feet; age, late Miocene (Tertiary *g*); two specimens from drill hole F–1, Eniwetok, at depth 780–790 feet; age, late Miocene (Tertiary *g*); a single incomplete specimen from drill hole E–1, Eniwetok, at depth 990–1,000 feet; age, early Miocene (Tertiary *f*). Described by Beets (1941) from the upper Miocene of east Borneo.

### Triphora (Inella) sp. A

Plate 12, figure 2

A single incomplete shell from the upper Miocene marls of Palau differs from other island species assigned to *Inella* in sculpture and color pattern. Each whorl of the spire bears two prominent beaded spirals that enclose a weaker beaded spiral between them; the beads are extended axially to form slightly oblique axial ribs; on the body whorl the three beaded spirals are equal in size. Each whorl retains a spiral band of pinkish-brown color between the major rows of beaded spirals.

Measurements of the figured specimen, USNM 650527; height 2.5 mm, diameter 1.1 mm.

*Occurrence.*—Marls at the base of the Palau Limestone in the Goikul area, Babelthuap, Palau (USGS loc. 21304); age, late Miocene (Tertiary *g*).

### Subgenus INFORIS Jousseaume

Jousseaume, 1884, Soc. Malacologique France Bull., v. 1, p. 235.

*Type* (by original designation).—*Inforis malvaceus* Jousseaume. Holocene, New Caledonia.

Includes shells that have an acuminate apex whose sculpture consists of two to three spiral rows of beads; in adult shells both anterior and posterior canals are tubular and are completely closed over (three-mouthed aperture).

### Triphora (Inforis) albogranosa Kosuge

Plate 12, figures 3–5

*Triphora (Inforis) albogranosa* Kosuge, 1961, Venus, v. 21, no. 3, p. 313, pl. 19, fig. 7, text-figs. 5, 7.

*Inforis albogranosa* (Kosuge). Kosuge, 1966, Malacologia, v. 4, no. 2, p. 298, 314, pl. 1, fig. 6.

Medium in size, slender, slightly tapering anteriorly; apex acuminate. Protoconch bearing close-set normal or slightly oblique axial ribs; whorls of spire about 13, each having two rows of beads, the lower row of which has the larger ones; beads in each row connected by a spiral ribbon; a wavy spiral thread lies between the two rows of beads. Aperture circular in outline, extended, bearing two beaded spirals. Anterior and posterior canals long and tubular, encircled by concentric rings.

Measurements of figured specimens from drill hole E–1, Eniwetok, at depth of 30–40 feet: Plate 12, figures 3, 4, USNM 650529 (with normal three openings)—height 5.2 mm, maximum diameter of spire 1.3 mm; plate 12, figure 5, USNM 650530 (an unusual specimen with two posterior tubes, one located two whorls above the body whorl)—height 5.5 mm, maximum diameter of spire 1.2 mm.

*Occurrence.*—Eleven specimens from drill hole E–1, Eniwetok, at depth 30–45 feet; age, Holocene. Kosuge (1961, 1966) based his description on Holocene shells collected in the Amami Islands. The species is also known from Hawaii, Samoa, Fiji, and the Philippine Islands.

### Triphora (Inforis) ofuensis Baker and Spicer

Plate 12, figures 8–12

*Triphora ofuensis* Baker and Spicer, 1935, San Diego Soc. Nat. History Trans., v. 8, no. 7, p. 38, pl. 5, fig. 3.

Shell small, spindle shaped; apex acuminate; protoconch consisting of about five whorls, each of the last three to four bearing a strong spiral cord crossed by close-set sharp axial ribs; mature whorls about nine. Sculpture consisting of two spiral rows of rounded beads, the beads in the anterior row larger except on the body whorl where the order is reversed; suture inconspicuous; base has three spiral cords, the upper two beaded. Aperture subcircular, extended; anterior canal short, conical; posterior canal thin, tubular, erect, inclined posteriorly.

Measurements of the figured specimen from drill hole F–1, Eniwetok, at depth 20–45 feet, USNM 650531: height 3.6 mm, maximum diameter of spire 1.2 mm. Measurements of the figured specimens from Funafuti: (1) British Museum 1970, 0.24, from sample 90 at a depth of 75 feet (pl. 12, fig. 10)—height 3.2 mm, diameter 0.9 mm; (2) British Museum 1970, 0.25 from a depth of 65–74 feet (pl. 12, figs. 11, 12)—height 2.2 mm, diameter 0.8 mm.

*Triphora ofuensis* is probably the species referred doubtfully by Hedley (1899, p. 439, fig. 27) to *Triforis aegle* Jousseaume. Hedley collected his specimen from Funafuti lagoon, noting that it was the commonest *Triforis* on the atoll.

*Occurrence.*—Thirteen specimens from three drill holes on Eniwetok at depths 20 to 145 feet; one specimen from drill hole 1 on Bikini at depth of 59 feet; six specimens from Funafuti drill hole at depths 65 to 95 feet. Age of all fossils, Holocene. Described from living specimens collected in Samoa; also known from Hawaii.

### Triphora (Inforis) sp. B

Plate 12, figures 6, 7

Shell medium in size; slender; sides of spire flat. Mature whorls about nine, each with two spiral rows of beads, those of the lower row much larger than those above; beads of each row linked by a spiral ribbon; beads on lower spiral slope steeply below, more gently above. Aperture circular, extended, bearing weak spirals; anterior canal tubular, projecting; posterior canal a narrow curved tube extending outward and upward from a base nearly opposite the aperture.

Measurements of the figured specimen, USNM 650528: height 6.0 mm, maximum diameter of spire 1.3 mm.

This species is assigned to *Inforis* because of its general resemblance to *T. (Inforis) albogranosa*. The apex of the single specimen is not preserved, and the species may be referable to *Epiforis*, a group in which the protoconch is mammillate. *Triphora* sp. B differs from *T. alborgranosa* in having a smoother apertural tube and smoother anterior and posterior canals; it may represent an undescribed form.

*Occurrence.*—A single specimen from drill hole 2B, Bikini, at depth of 1,377–1,388 feet; age, early Miocene (Tertiary *e*).

### Subgenus MASTONIA Hinds

Hinds, 1843, Annals and Mag. Nat. History, v. 11, p. 19.

*Type* (*fide* Wenz, 1940, Handbuch der Paläozoologie; Gastropoda: Berlin, Gebrüder Borntraeger, p. 786).—*Triphoris vulpinus* Hinds. Holocene, New Ireland.

Includes spindle-shaped shells whose whorls bear beaded spiral ribs. Posterior canal narrow, not completely closed over.

### Triphora (Mastonia) cingulifera (Pease)

Plate 12, figure 13

*Triphoris cingulifera* Pease, 1860, Zool. Soc. London Proc., p. 434.

Langkavel, 1871, Donum Bismarkianum: Berlin, von Ferdinand Berggold, p. 38, pl. 2, fig. 8.

*Notosinister cingulifera* (Pease). Kosuge, 1962, Tokyo Nat. Sci. and Mus. Bull., v. 6, no. 2, p. 88, pl. 9, fig. 6.

Shell small, spindle shaped; sides of spire gently convex. Whorls of protoconch bear fine axial riblets; whorls of spire bear two strongly beaded spirals with a spiral thread above, close to the suture; body whorl has three beaded spirals; on the base, three slightly beaded spirals. Aperture subcircular, its margin slightly expanded; anterior canal strong, bent backward, not completely closed over; posterior canal an open groove.

Measurements of the figured specimen, USNM 650532: height 3.1 mm, diameter 1.3 mm.

On the shells of living animals, both the lower of the two beaded spirals on the spire and the spirals on the base are brown. Traces of this color pattern are preserved on the figured specimen.

*Occurrence.*—Five specimens from three drill holes on Eniwetok at depths from 10 to 222 feet; age, Holocene. A single specimen from USGS loc. 17891 on Saipan; Tanapag Limestone; age, probably Holocene. The species was originally described from Hawaii; also known from the Amami Islands and the Philippines.

### Triphora (Mastonia) cingulifera goikulensis Ladd, n. subsp.

Plate 12, figure 14

Medium in size, slender; sides gently convex; aperture subquadrate, inner lip heavily callused, outer lip thin; posterior canal short, open; anterior canal recurved and nearly closed. Sculpture consisting of two primary beaded spirals with a fine spiral thread between; base rounded, bearing three spirals, the uppermost one slightly beaded.

Measurements of the holotype, USNM 650524, from USGS loc. 21304: height 9.2 mm, diameter 2.5 mm.

The Palau fossils are very closely related to the Holocene shells described by Pease (1860b, p. 434) from Hawaii. Comparisons have also been made with Quaternary fossils from the Midway drill holes and with Holocene shells from the Philippines and Borneo. The Palau fossils average larger, have straighter sides, and consequently are less spindle shaped than the others. On all Holocene shells and in the Midway fossils the lower of the two major spirals is dark purplish brown; no trace of this striking color pattern is preserved in the Palau fossils.

*Occurrence.*—Fifteen specimens from the marls at the base of the Palau Limestone on Goikul peninsula, Babelthuap Island, Palau (USGS loc. 21301, 21304); age, late Miocene (Tertiary *g*).

### Triphora (Mastonia) clavata (Pease)

Plate 12, figure 15

*Triphoris clavata* Pease, 1860, Zool. Soc. London Proc., pt. 3, p. 434.

Shell medium in size, acuminate, slightly tapered anteriorly. Whorls of protoconch about five, the upper three bearing a single spiral each and the lower two having two spirals each; on all five whorls the spirals are cancellated by close-set axials. Whorls of spire about 10, each of which has two strong beaded spirals; on lower whorls a secondary unbeaded spiral is present between the two primary spirals, and there are traces of still finer wavy spiral threads; body whorl has four primary spirals, the lowest two somewhat smaller than the others. Aperture subquadrate; posterior canal a narrow slit leading to circular opening; anterior canal strongly recurved. The single fossil has a brown protoconch, as do the shells of the living form, and it retains faint traces of the brown color present in the sutures of shells of living specimens.

Measurements of the figured specimen, USNM 650537: height 4.2 mm, diameter 1.4 mm.

*Occurrence.*—A single specimen from drill hole 1, Bikini, at depth of 100 feet; age, probably Holocene. Described by Pease from Holocene shells from Hawaii, where the species is abundant. Also occurs on many island groups in western Pacific, including the Marshall Islands.

### Triphora (Mastonia) squamosa (Kosuge)

Plate 12, figure 16

*Mastonia squamosa* Kosuge, 1962, Venus, v. 22, no. 2, p. 125, pl. 8, fig. 15, text-figs. 10, 11.

Shell medium in size, stout; apical area acuminate; shell tapered slightly below. Sculpture consisting of two rows of strongly beaded spirals, the upper row a little smaller; between the major spirals a wavy unbeaded secondary spiral lies closer to the upper major spiral; above and below the spirals the shell is covered

by minute spiral threads that, under high magnification, appear to be beaded, giving the shell a scaly appearance. Protoconch not preserved in single fossil available. The specimen, however, retains traces of original color; the upper spiral, brownish; the lower one, white.

Measurements of the figured specimen, USNM 650538: height (incomplete) 6.8 mm, diameter 2.7 mm.

*Occurrence.*—Single specimen from drill hole E–1, Eniwetok, at depth 35–40 feet; age, Holocene. Described from living specimens from Amami Islands; also known from Samoa.

#### Triphora (Mastonia) intermissa (Laseron)

Plate 12, figures 17, 18

*Coriophora intermissa* Laseron, 1958, Australian Jour. Marine and Freshwater Research, v. 9, no. 4, p. 605, figs. 105–107.

Small to medium in size and varying considerably in shape; small shells are obese and greatly constricted anteriorly; large shells are more slender and are only slightly narrowed anteriorly. Protoconch has a tilted, bulbous nucleus that is partly buried in the succeeding two whorls that bear a prominent spiral keel above and below. Whorls of the spire each with two strong beaded spirals that, on some specimens, are connected by low axial elevations from bead to bead; later whorls of the spire have a third spiral that appears between the other two; on penultimate whorl the third spiral is nearly as large as the others and is beaded; suture distinct; body whorl has five spirals, the lowest and smallest of which is unbeaded (or weakly beaded); aperture subquadrate; anterior canal large and tubular; posterior canal little more than a notch. Some fossil specimens retain traces of the original color: the whorls of protoconch are gray; the spire is light brown with a darker shade of brown between the beads on the spiral ribs.

Measurements of the figured specimens: USNM 650540 from drill hole En–3, Eniwetok, at depth 20 feet—height 3.4 mm, diameter 1.1 mm; USNM 650541 from drill hole E–1, Eniwetok, at depth 110–120 feet—height 2.5 mm, diameter 1.2 mm.

*Occurrence.*—Eleven specimens from four drill holes on Eniwetok at depths 20–842 feet; age, late Miocene (Tertiary *g*) and Holocene; a questionable specimen from drill hole E–1, depth 890–900 feet, is early Miocene (Tertiary *f*) in age. Two specimens from two drill holes on Bikini at depths 27–205 feet; age, Holocene. One specimen from station 160, Viti Levu, Fiji; age, early Miocene (Tertiary *f*). Laseron described the species from Holocene shells obtained in the Capricorn Group of the Great Barrier Reef, Australia. The U.S. National Museum collections contain many lots from Hawaii and the Philippines and single specimens from the Loyalty Islands and the Straits of Malacca.

#### Triphora (Mastonia) auberti (Abrard)

Plate 12, figure 19

*Triforis (Mastonia) auberti* Abrard, 1946, Annales de Paléontologie, v. 32, p. 57, pl. 4, figs. 21, 21a.

Small, slightly inflated, tapering near the base; spire composed of eight or nine whorls; suture inconspicuous; aperture small, compressed; canal short, strongly reflected over base. Sculpture consisting of two spiral rows of strongly beaded granules with a fine spiral thread between them.

Measurements of the holotype (Museum National d'Histoire Naturelle, Paris): height (incomplete) 6.5 mm, diameter 2.3 mm.

As pointed out by Abrard, the sculpture of *Triphora auberti* is similar to that of *T. perlatus* Issel, a species living in the Red Sea. On *T. perlatus* the canal is much less turned down than on *T. auberti*.

*Occurrence.*—Bay of Foreland, island of Epi, New Hebrides; age, late Miocene.

### Genus CAUTOTRIPHORA Laws

Laws, 1940, Royal Soc. New Zealand Trans., v. 70, pt. 1, p. 51.

*Type* (by original designation).—*Cautotriphora simulans* Laws. Pliocene, New Zealand.

Includes shells that have three subequal beaded spirals, the beads connected axially by weak ridges.

#### Cautotriphora hervieri (Kosuge)

Plate 12, figure 20

*Notosinister hervieri* Kosuge, 1962, Tokyo Nat. Sci. and Mus. Bull., v. 6, no. 2, p. 81, pl. 10, fig. 1, text-figs. 15, 18.

*Cautotriphora hervieri* (Kosuge). Kosuge, 1966, Malacologia, v. 4, no. 2, p. 316, pl. 1, fig. 11.

Represented by two small subulate shells. Sides of spire gently convex, cut by well-impressed suture; each whorl has three subequal beaded spiral ridges, the beads of which are connected axially by low ridges that are much weaker than the spirals. Aperture subquadrate; anterior canal large, strongly recurved backward; base has two spirals.

Measurements of the figured specimen from drill hole 2A, Bikini, at depth 447–453 feet, USNM 650536: height 3.5 mm, diameter 1.0 mm.

*Occurrence.*—One specimen from drill hole 2A, Bikini, at depth 447–453 feet; age, probably Pliocene (Tertiary *h*). Single specimen from drill hole 2, Bikini, at depth 184 feet; age, probably Pleistocene.

Described by Kosuge from Holocene shells from the Amami Islands; also reported from Japan, the Philippines, and Loyalty and Marshall Islands.

### Genus VIRIOLA Jousseaume

Jousseaume, 1884, Soc. Malacologique France Bull., v. 1, p. 238.

*Type* (by original designation).—*Viriola bayani* Jousseaume. Holocene, New Caledonia.

A small group of species characterized by strong, generally smooth, spiral ridges.

#### Viriola pagoda (Hinds)

Plate 12, figure 21

*Triphoris (Ino) pagodus* Hinds, 1843, Zool. Soc. London Proc., pt. 11, p. 22.

*Viriola pagoda* (Hinds). Kosuge, 1961, Venus, v. 21, no. 4, p. 413, pl. 22, fig. 2.

Kosuge, 1962, Tokyo Nat. Sci. and Mus. Bull., v. 6, no. 2, p. 86.

Shell large, slender, made up of numerous whorls each with three smooth spiral ridges, the lowest being the largest, the middle one the smallest; suture inconspicuous; aperture subquadrate.

Measurements of the figured specimen, USNM 650525: height (incomplete) 9.2 mm; diameter 3.0 mm.

The simplicity of the spiral sculpture appears to distinguish this species from all others.

*Occurrence.*—The single fossil specimen is from drill hole E–1, Eniwetok, at a depth of 35–40 feet; age, Holocene. Hinds described the species from a single dead Holocene shell collected in the Philippines. The species is also known from Okinawa, Amami Islands and Japan. Two specimens in the U.S. National Museum collections (USNM 91166) were collected in Samoa.

#### Viriola incisa (Pease)

Plate 12, figure 22

*Triphoris incisa* Pease, 1860, Zool. Soc. London Proc., p. 434.
Tryon, 1887, Manual Conchology, v. 9, p. 190, pl. 39, fig. 65.
Hedley, 1899, Australian Mus. Mem. 3, pt. 7, p. 447, fig. 33.

*Viriola incisa* (Pease). Kosuge, 1961, Venus, v. 21, no. 4, p. 414, pl. 22, fig. 9.

Shell small, made up of a dozen or more whorls, sides of spire gently convex; sculpture consisting of three prominent smooth ridges, the center one smaller than the other two; fine spiral threads occur between the ridges.

Measurements of the figured specimen, USNM 650533, from Eniwetok: height (decollated) 7.3 mm, diameter 2.1 mm.

*Occurrence.*—Eight specimens from drill hole E–1, Eniwetok, at depths 10–600 feet; age, Pliocene (Tertiary *h*) and Holocene. Pease described the species from Holocene shells collected in Hawaii; since reported from the Marshall Islands, Samoa, Philippines, Formosa, Ryukyu Islands, Japan, Indonesia, and the Cocos-Keeling Islands in the Indian Ocean.

#### Viriola cancellata (Hinds)

Plate 13, figure 1

*Triphoris (Ino) cancellatus* Hinds, 1843, Annals and Mag. Nat. History, v. 11, p. 18.

*Triphoris (Viriola) cancellatus* Hinds. Tryon, 1887, Manual Conchology, v. 9, p. 189, pl. 39, fig. 64.

*Viriola cancellata* (Hinds). Kosuge, 1961, Venus, v. 21, no. 4, p. 413, pl. 22, fig. 1.

Kosuge, 1962, Tokyo Nat. Sci. and Mus. Bull., v. 6, no. 2, p. 86.

Maes, 1967, Acad. Nat. Sci. Philadelphia Proc., v. 119, no. 4, p. 116, pl. 7, fig. J.

This widely distributed species is characterized particularly by two strong rounded spiral ribs. The area between the ribs is cancellated by axial threads that are beaded in crossing a fine spiral riblet. The cancellated area is dark brown, and traces of this color pattern are preserved on all three of the fossils.

Measurements of the figured specimen, USNM 650534: height (decollated) 8.4 mm, diameter 2.6 mm.

*Occurrence.*—Single specimen from drill hole 2B, Bikini, at depth 1,503–1,514; age, early Miocene (Tertiary *e*). A fragment from drill hole F–1, Eniwetok, at depth 760–770 feet; age, late Miocene (Tertiary *g*). An incomplete specimen from drill hole E–1, Eniwetok, depth 270–280 feet; age, probably Pliocene. Described by Hinds from Holocene shells collected from the Straits of Malacca; later reported Holocene from the Marshall, Philippine, Ryukyu, and Amami Islands, also Japan and the Cocos-Keeling Islands.

#### Viriola elegans (Hinds)

Plate 13, figure 2

*Triphoris elegans* Hinds, 1843, Annals and Mag. Nat. History, v. 11, p. 18.

*Triforis (Viriola) elegans* (Hinds). Tryon, 1887, Manual Conchology, v. 9, p. 189, pl. 39, fig. 62.

Shell medium in size; sides of spire gently convex. Sculpture consisting of four carinae that tend to alternate in size: the lowest is the smallest, a thread lying next to the suture; the second, the next above, is the strongest of the series, a prominent beaded carina; the third lies near the middle of the whorl and is slightly larger than the thread near the suture; the fourth is larger than the third but is not as prominent as the beaded carina. Aperture subcircular; anterior canal strong and straight; posterior canal an inconspicuous shallow groove.

Measurements of the figured specimen, USNM 650535: height 6.5 mm, diameter 2.4 mm.

*Occurrence.*—A single fossil from drill hole Mu–4, Eniwetok, at depth of 21–22 feet; age, Holocene. Originally described from Holocene shells from the

Straits of Malacca. Collections in the U.S. National Museum include shells from Hawaii, the Marshall, Ellice, Samoan, Loyalty and Philippine Islands and Japan.

### Family EPITONIIDAE

#### Genus EPITONIUM Röding

Röding, 1798, Mus. Boltenianum: Hamburg, Johan Christi, pt. 2, p. 91.

*Type* (by subsequent designation, Suter, 1913, Manual New Zealand Mollusca, p. 319).—*Turbo scalaris* Linnaeus. Holocene, western Pacific.

#### Subgenus GYROSCALA de Boury

de Boury, 1887, Étude sur les sous genres de Scalidae du Bassin de Paris: Paris, Vigny, p. 15.

*Type* (by original designation).—*Scala commutata* Monterosato. Holocene, Mediterranean Sea.

#### Epitonium (Gyroscala) perplexum (Pease)

Plate 13, figure 3

*Scalaria perplexa* Pease, 1868, Am. Jour. Conchology, v. 3, no. 4, p. 288.

*Scalaria lamellosa* Lamarck. Tryon, 1887, Manual Conchology, v. 9, p. 74, pl. 15, fig. 83.

*Gyroscala perplexa* (Pease). Kira, 1962, Shells of the western Pacific in color: Osaka, Japan, Hoikusha Pub. Co., p. 30, pl. 14, fig. 19.

Small, stout; bearing prominent, continuous, bladelike varices, seven to the whorl; aperture oval, imperforate; body whorl has an inconspicuous spiral cord near its base. Traces of brownish color occur immediately below the prominent suture.

Measurements of the figured specimen, USNM 650607: height 7.3 mm, diameter 3.1 mm.

*Occurrence.*—Represented by a single fossil from drill hole E–1, Eniwetok, at depth of 10–20 feet; age, Holocene. Pease described *E. perplexum* from shells collected in Hawaii, and Kira noted the occurrence of the species south of central Japan. The extensive collections of Marshall Island shells in the U.S. National Museum include only three examples of *E. perplexum*; one from Kwajalein, and two from Taka Atoll.

#### Subgenus CYCLOSCALA Dall

Dall, 1889, Mus. Comp. Zoology Harvard Bull., v. 18, p. 316.

*Type* (by subsequent designation, de Boury, 1909, Jour. Conchyliologie v. 57, p. 258).—*Scala dunkeriana* Dall (= *Scalaria echinaticosta* d'Orbigny). Holocene, West Indies.

#### Epitonium (Cycloscala) revolutum (Hedley)

Plate 13, figure 4

*Scala revoluta* Hedley, 1899, Australian Mus. Mem. 3, pt. 7, p. 414.

Shell minute, slender; three whorls of apex smooth and in contact; remaining whorls widely uncoiled; aperture circular. Sculpture consisting of strong axial lamellae, about eight on each of later whorls. Shell surface between lamellae smooth and glossy.

Measurements of the figured specimen, USNM 650435: height (incomplete) 2.1 mm, diameter 1.1 mm.

Hedley noted that his minute shell resembled a larger Holocene Philippine species described by Sowerby as *Scalaria hyalina* (Sowerby 1844a, p. 11; 1844b, pl. 32, figs. 21, 22). In that species, however, the whorls are uncoiled starting at the tip, but the later whorls are not as widely separated as they are in *E. revolutum*.

*Occurrence.*—Two specimens from the marls at the base of the Palau Limestone (USGS loc. 21308) in the Goikul area, Palau. Age, late Miocene (Tertiary *g*).

Hedley's single specimen, a Holocene shell, was collected from the lagoon beach at Funafuti Atoll.

#### Subgenus BOREOSCALA Kobelt

Kobelt, 1905, Iconographie der schalentragenden europäischen Meeresconchylein: Wiesbaden, C.W. Kreidel, v. 3, p. 23.

*Type* (by monotypy).—*Scala groenlandica* Chemnitz (= *Scalaria greenlandicum* Perry). Holocene, circumpolar and south to northern Japan and New York.

#### Epitonium (Boreoscala?) sp.

*Epitonium* (*Boreoscala*?) sp. Ladd, 1970, U.S. Geol. Survey Prof. Paper 640–C, p. C6–C7, pl. 4, fig. 13. Late Eocene (Tertiary *b*); Eua, Tonga.

#### Subgenus CLATHRUS Oken

Oken, 1815, Lehrbuch der Naturgeschichte: Leipzig, H. Reclaus, v. 3, p. 256.

*Type* (by tautonomy.—*Turbo clathrus* Linnaeus. Holocene, seas of Europe

#### Epitonium (Clathrus) sp. A

Plate 13, figure 5

Shell medium in size, stout, consisting of about eight rounded whorls separated by a deep suture; aperture oval. Sculpture consisting of thin varices, about 15 on body whorl, and close-set spiral threads that cover the entire surface of the shell and the posterior slopes of the varices; the spirals tend to alternate in size; surface between varices made finely reticulate by close- and regularly spaced axial threads that are narrower than the larger spirals.

Measurement of the single incomplete fossil, USNM 650608: height 12.0 mm, diameter 5.5 mm.

The fine reticulate sculpture of the fossil is similar to that shown by three species living in Hawaii—

*E. fucatum* (Pease) (1860a, p. 400), *E. decussatum* (Pease) (1868, p. 289, pl. 24a, fig. 10), and *E. kanemoe* Pilsbry (1921, p. 375, fig. 11b)—but these three species have fewer varices than the fossil.

*Occurrence.*—Basal foraminiferal member of Futuna Limestone, station L–466, Oneata, Fiji; age, early Miocene (Tertiary *f*).

### Family VANIKORIDAE

### Genus VANIKORO Quoy and Gaimard

Quoy and Gaimard, 1832, Voyage de l'*Astrolabe*, Zoologie, [Rept.]: Paris, J. Tastu, v. 2, p. 239.

*Type* (by monotypy).—*Sigaretus cancellatus* Lamarck. Holocene, Vanikoro, Santa Cruz Islands.

#### Vanikoro cancellata (Lamarck)

Plate 13, figures 6–8

*Sigaretus cancellatus* Lamarck, 1822, Historie naturelle des animaux sans vertèbres: Paris, Guiradudet, v. 6, pt. 2, p. 208.

*Vanikoro cancellata* (Lamarck). Tryon, 1886, Manual Conchology, v. 8, p. 67, pl. 29, figs. 60, 61.

Smith, 1908, Malacol. Soc. London, Proc., v. 8, no. 2, p. 105.

This large species, type of the genus, was originally collected from Vanikoro in the Santa Cruz Islands but has since been reported from many parts of the Indian Ocean, from Indonesia, the Great Barrier Reef area, and the Philippines. Its occurrence in the Holocene beds drilled on Eniwetok is not surprising in view of the fact that it has also been identified from a depth of 165–170 feet in a drill hole on Midway, in Hawaii. The species is probably the largest of the genus and is characterized particularly by its large aperture, wide umbilicus, and reticulated surface. The sculpture appears to be somewhat variable in both present-day and fossil shells, but the oblique axials in most specimens are coarser and more widely spaced than the spirals; at intersections the two series may be distinctly beaded.

Measurements of the figured specimen, USNM 650598, from drill hole F–3–C, Eniwetok, depth 6–10 feet: height 4.3 mm, diameter 4.2 mm. USNM 650599 from drill hole E–1, Eniwetok, depth 1,688–1,715 feet, measures: height (apex incomplete) 3.0 mm, diameter 3.2 mm.

*Occurrence.*—Three small fossil specimens from Eniwetok: one specimen each from drill holes F–3–C and Mu–4—age, Holocene; a specimen from drill hole E–1, Eniwetok, at depth of 1,688–1,715 is from early Miocene (Tertiary *e*) beds, but the specimen is slightly broken and may have been derived from a higher horizon; in any event, it has the color and preservation that is typical of the Miocene in the Marshalls.

#### Vanikoro gueriniana (Recluz)

Plate 13, figures 9, 10

*Narica gueriniana* Récluz, 1843, Zool. Soc. London Proc., p. 139.

*Vanikoro gueriniana* (Récluz). Sowerby, 1878, Conchologica Iconicas, v. 20, no. 2.

Tryon, 1886, Manual Conchology, v. 8, p. 68, pl. 29, fig. 62.

This widely distributed western Pacific species is characterized particularly by thick, regularly spaced oblique axial ribs that are overriden by close-set spiral threads.

Measurements of the figured specimen, USNM 650595 (drill hole E–1, Eniwetok, 780–790 feet): height 2.8 mm, diameter 3.0 mm.

*Occurrence.*—Described originally from the Philippine Islands but later collected in the Loyalty Islands, Japan, and the Marshall Islands. Rare specimens were found in samples from 22 levels in five Eniwetok drill holes from depths of 2–1,180 feet, from early Miocene (Tertiary *e*) to Holocene in age. Only one shell was found in any one depth interval, and many of the shells are small and apparently immature. A single specimen, likewise small, was found at station 160 on Viti Levu, Fiji, in beds referred to the early Miocene (Tertiary *f*).

#### Vanikoro aff. V. kanakarum Pilsbry

Plate 13, figure 11

Small, globose; apex obtuse: protoconch smooth, followed by two whorls with oblique axial ribs that are crossed by spiral threads; remainder of shell covered by moderately strong spiral threads, between which there are one to three finer threads; axial sculpture absent. Umbilicus wide and deep, slightly plicate within; aperture semilunate.

Measurements of the figured specimen, USNM 650597; height 4.3 mm, diameter (outer lip broken) 4.7 mm.

The Eniwetok specimen has a lower spire than Pilsbry's Holocene type from Kauai in Hawaii (Pilsbry 1921, p. 374).

*Occurrence.*—A single specimen from drill hole E–1, Eniwetok, at depth of 110–120 feet; age, Holocene.

### Family HIPPONICIDAE

### Genus CHEILEA Modeer

Modeer, 1793, Kgl. Svenska Vetenskaps Akademiens Nya Handlingar, v. 14, p. 110, 111.

*Type* (by subsequent designation, Woodring, 1928, Carnegie Inst. Washington Pub. 385, p. 374).—*Patella equestris* Linnaeus. Holocene, Indian Ocean.

#### Cheilea equestris (Linnaeus)

Plate 13, figure 12

*Patella equestris* Linnaeus, 1758, Systema naturae [10th ed.], p. 780.

*Mitrularia equestris* (Linnaeus). Tryon, 1886, Manual Conchology, v. 8, p. 137, pl. 41, figs. 25–32.

*Cheilea equestris* (Linnaeus). Demond, 1957, Pacific Sci., v. 11, p. 294, fig. 12.

Five well-preserved specimens that can confidently be assigned to this variable and widespread Indo-Pacific species were recovered from the three deep drill holes on Eniwetok at depths of 830–990 feet in beds of Miocene (Tertiary *f* and *g*) age. The figured specimen, USNM 650600 from drill hole E–1 at depth 830–840 feet, measures: length 8.6 mm, width 8.5 mm, convexity 3.0 mm. It cannot be separated from the shells of animals found living on the reefs of Eniwetok and Bikini.

In addition to the Miocene specimens, a total of eight small shells of *Cheilea* were recovered in six drill holes on Eniwetok at depths of 10–211 feet; these probably represent *C. equestris*. A large mold that may represent the same species was obtained from USGS loc. 21028 in the New Hebrides; it is probably Pleistocene in age. Molds and a poorly preserved shell from the Ndalithoni Limestone, station 110B on Vanua Mbalavu in Fiji, are Pliocene; two small shells from station 160 and numerous molds from station 158 on Viti Levu are early Miocene (Tertiary *f*). MacNeil (1960, p. 46, pl. 16, fig. 32) described and figured a mold from the Pliocene of Okinawa.

### Genus HIPPONIX Defrance

Defrance, 1819, Jour. Physique, Chimie, Histoire Nat. et Arts, v. 88, p. 217.

*Type* (by subsequent designation, Gray, 1847, Zool. Soc. London Proc., pt. 15, p. 157).—*Patella cornucopia* Lamarck. Eocene, Paris Basin.

### Subgenus MALLUVIUM Melvill

Melvill, 1906, Malacol. Soc. London Proc., v. 7, p. 82.

*Type* (by original designation).—*Capulus lissus* E. A. Smith. Holocene, Bay of Bengal.

#### Hipponix (Malluvium) cf. H. badius (Dunker)

Plate 13, figures 13, 14

*Hipponix badius*, described by Dunker as a *Capulus* (Dunker, 1882, p. 124, pl. 13, figs. 15–17) and still so regarded by some authors (Kuroda and Habe, 1952, p. 44), is probably a *Hipponix* that is closely related to *H. lissus*, type of the subgenus *Malluvium*. Such a relation was suggested by MacNeil (1960, p. 47).

The Fiji fossil shell here compared with *H. badius* is slightly compressed, as are Holocene shells from Japan, the type area, and shows weak radial ribs that are stronger posteriorly than on other parts of the shell.

Measurements of the figured specimen, USNM 650602: length 7.9 mm, width 5.8 mm, convexity 5.4 mm.

*Occurrence.*—A single specimen from station 817 on Vanua Levu, Fiji; age, probably Pliocene (Tertiary *h*).

### Subgenus ANTISABIA Iredale

Iredale, 1937, Australian Zoologist, v. 8, pt. 4, p. 253.

*Type* (by original designation).—*Hipponix foliacea* Quoy and Gaimard. Holocene, western Pacific.

#### Hipponix (Antisabia) foliaceus Quoy and Gaimard

Plate 13, figures 15–21

*Hipponix foliacea* Quoy and Gaimard, 1835, Voyage de l'*Astrolabe*, Zoologie [Rept.]: Paris, J. Tastu, v. 3, pt. 2, p. 439, pl. 72, figs. 41–45.

*Hipponix* sp. Ladd, 1934, Bernice P. Bishop Mus. Bull. 119, p. 214, pl. 37, figs. 4–6.

Ladd *in* Ladd and others, 1945, Bernice P. Bishop Mus. Bull. 181, p. 360.

*Hipponix* (*Antisabia*) *foliaceus* Quoy and Gaimard. MacNeil, 1961 [imprint 1960], U.S. Geol. Survey Prof. Paper 339, p. 47, pl. 18, figs. 10, 16–17.

Exterior of shell covered by concentric, wavy, overlapping lamellae that bear close-set radial threads; height variable; apex posterior; protoconch smooth.

Measurements of the figured specimens: USNM 650603 from drill hole F–1, Eniwetok, 760–770 feet—length 6.3 mm, width 6.2 mm, convexity 3.2 mm; USNM 650604 from drill hole F–1, Eniwetok, 690–700 feet—length 4.0 mm, width 3.4 mm, convexity 1.7 mm; Bernice P. Bishop Mus. Geol. No. 1237 from Vitu Levu, Fiji—length 6.4 mm, width 6.0 mm, convexity 3.1 mm.

*Occurrence.*—Ten specimens from drill holes E–1 and F–1, Eniwetok, at depths ranging from 640 to 900 feet; age, Miocene (Tertiary *f* and *g*). Fourteen specimens from station 160, Viti Levu, Fiji; age, early Miocene (Tertiary *f*); a single specimen from the Ndalithoni Limestone, station 110C, Vanua Mbalavu, Fiji; age, Pliocene (Tertiary *h*). MacNeil reported two specimens from the Yontan Limestone (Pleistocene) of Okinawa. The species was described from Guam and has been found in other island groups in the Pacific (Hawaii, Tuamotu, Samoa, Philippines, Japan) and in Australia. No Holocene specimens were collected in the Marshalls. No fossils were found in the drill holes of Bikini nor above the Miocene in Eniwetok drill holes, but typical shells were recovered from shallow depths in both the holes drilled on Midway, in beds believed to be Pleistocene.

### Subgenus SABIA Gray

Gray, 1847, Zool. Soc. London Proc., pt. 15, p. 157.

*Type* (by original designation).—*Amalthea conica* Schumacher. Holocene, Indo-Pacific.

### Hipponix (Sabia) conicus (Schumacher)

Plate 13, figures 22–27

*Amalthea conica* Schumacher, 1817, Essai d'un noveau Système des habitationes des vers testacés: Copenhagen, p. 181, pl. 21, figs. 4a–c.

*Hipponix (Sabia) conicus* (Schumacher). Demond, 1957, Pacific Sci., v. 11, p. 293, fig. 11.

*Hipponix conicus* (Schumacher). Macpherson and Gabriel, 1962, Marine molluscs of Victoria: Melbourne, Brown, Prior, and Anderson, p. 127, fig. 152.

Cernohorsky, 1968, Veliger, v. 10, no. 3, p. 275, pl. 41.

Fourteen specimens representing this thick conical coarsely ribbed variable Holocene species were recovered from five drill holes on Eniwetok from near the surface to a depth of 960 feet; age, early Miocene (Tertiary *f*) to Holocene. Six specimens from drill hole 2A on Bikini were found at depths of 900–940 feet in beds of late Miocene (Tertiary *g*) age. Two worn specimens were collected at station 160, Viti Levu, Fiji—age, early Miocene (Tertiary *f*); several specimens were recovered from the Ndalithoni Limestone at station 110B on Vanua Mbalavu in eastern Fiji—age, Pliocene. Two molds from upper Tertiary limestone on Guam (USGS loc. 20708) represent the same species. Holocene shells have been reported throughout the Indo-Pacific region.

Measurements of the figured specimens: USNM 650605, from drill hole F–1, Eniwetok, at depth 660–670 feet—length 6.7 mm, width 5.4 mm, convexity 2.8 mm; USNM 650606, from station 110B, Vanua Mbalavu, Fiji—length 10.9 mm, width 10.0 mm, convexity 3.8 mm.

#### Subgenus PILOSABIA Iredale

Iredale, 1929, Queensland Mus. Mem., v. 9, pt. 3, p. 277.

*Type* (by original designation).—*Pileopsis pilosus* Deshayes. Holocene, Australia.

### Hipponix (Pilosabia) revellei Ladd, n. sp.

Plate 14, figures 1–18

Shell small, cap shaped; small shells flattened, large adult shells highly convex with apex projecting well beyond the posterior margin of the shell; aperture broadly ovate; muscle scar horseshoe shaped with swollen ends open anteriorly. Sculpture variable but consisting of radial ribs that are crossed by strong, scaly concentric lamellae. The number and the spacing of the radial ribs vary greatly from specimen to specimen, depending largely on the age of the shell; in young shells the ribs are few and appear only near the margins of the shell, but in some adult shells there may be 20 or 30 close-set regularly spaced ribs that may be beaded by the concentric lamellae. Protoconch, often preserved in younger shells, more rarely in older shells, is a smooth dextral coil.

Measurements of the types are:

| Specimen (USNM) | Type | Drill hole | Depth (ft) | Length (mm) | Width (mm) | Convexity (mm) |
|---|---|---|---|---|---|---|
| 650609 | Holotype | F–1 | 890–900 | 5.4 | 4.6 | 2.5 |
| 650610 | Paratype A | F–1 | 900–910 | 5.9 | 3.9 | 3.1 |
| 650611 | Paratype B | F–1 | 870–880 | 5.0 | 3.4 | 1.3 |
| 650612 | Paratype C | F–1 | 880–890 | 5.1 | 3.8 | 2.4 |
| 650613 | Paratype D | 2B | 1,650–1,661 | 5.1 | 3.8 | 2.3 |
| 650614 | Paratype E | K–1B | 1,008–1,019 | 4.9 | 3.8 | 1.4 |
| 650615 | Paratype F | K–1B | 715–727 | 3.5 | 2.3 | 0.6 |
| 650616 | Paratype G | E–1 | 980–990 | 2.1 | 1.5 | 0.7 |

The Marshall Island fossils bear a general resemblance to Australian examples of *Hipponix pilosus* (Deshayes) and to representatives of this species from other areas, including Hawaii; but the fossil shells are much flatter in early stages and have stronger concentric sculpture.

This species is named for Dr. Roger Revelle, who encouraged and supported plans for deep drilling in the Marshall Islands.

*Occurrence.*—More than 200 specimens from many horizons in all holes drilled into the Tertiary on Eniwetok and Bikini from the Pliocene (Tertiary *h*) to the lower Miocene (Tertiary *e*); in the Eniwetok holes depths range from 530 to 2,040 feet; in the Bikini holes from 726 to 1,661 feet.

## Family CAPULIDAE

### Genus CAPULUS Montfort

Montfort, 1810, Conchyliologie Systématique, v. 2, p. 54.

*Type* (by original designation).—*Patella hungaricus* Linnaeus. Holocene, seas of Europe.

#### Subgenus KREBSIA Mörch

Mörch, 1877, Malakozoologische Blätter, v. 24, p. 97.

*Type* (by original designation).—*Hipponix militaris* Mörch [non Linnaeus] (= *Pileopsis intortus* Lamark). Holocene, West Indies.

Five small capulids that appear to represent the subgenus *Krebsia* were collected in the island area. Three are from the Marshall Island drill holes and two are from Fiji; all are Miocene—the oldest Tertiary *e*, the youngest Tertiary *g*. Three species may actually be represented, but because all specimens appear immature, no specific names have been definitely assigned. No capulids of this type have previously been reported from the Marshalls or from Fiji. All the fossils resemble the Holocene *Capulus liberatus* described by Pease from the Tuamotu (Paumotu) Islands (Pease, 1868, p. 284, pl. 24a, fig. 2). Iredale (1929, p. 277) named *Capulus liberatus* as the type of a new genus *Tenpetasus*, separating it from the West Indian *Krebsia*.

### Capulus (Krebsia) aff. C. liberatus Pease

Plate 14, figures 19, 20

Shell very small, strongly inflated, thick. Protoconch a smooth detached dextral coil; aperture subcircular. Sculpture consisting of strong concentric lamellae, crossed by numerous indistinct radial riblets.

Measurement of the figures specimen, USNM 648451: length 1.7 mm, width 1.5 mm, convexity 1.4 mm.

The radials of the single fossil are not beaded as are those of most Holocene shells assigned to *C. liberatus*. The Holocene shell was described from the Tuamotus and has also been collected from Norfolk Island, from Lifu in New Caledonia, and from Michaelmas Cay on the Australian Great Barrier Reef (Iredale, 1929, p. 277).

*Occurrence.*—Drill hole 2B, Bikini, at depth of 1,891–1,902 feet; age, early Miocene (Tertiary *e*).

### Capulus (Krebsia) sp. A

Plate 14, figure 21

Shell small, thick; apex forming a detached dextral coil; aperture subcircular, its anterior margin wavy. Sculpture consisting of strong, rounded spiral ribs, with fine riblets in the interspaces; ribs crossed by regularly spaced concentric lines that bead the spiral ribs on the younger part of the shell.

Measurements of the figured specimen, USNM 650601: length (incomplete) 6.1 mm, width 4.7 mm, convexity 3 mm.

*Occurrence.*—The figured specimen and two others were recovered from the conglomerate in the Suva Formation at stations F–B20 and 160 on Viti Levu, Fiji; age, early Miocene (Tertiary *f*). A poorly preserved immature specimen from drill hole E–1, Eniwetok, at depth 710–720 feet (age, Tertiary *g*) may represent the same species. The fossils have fewer and coarser ribs than the living *Capulus liberatus* Pease previously referred to.

### Capulus (Krebsia) sp. B

Plate 14, figures 22–24

Shell very small, moderately convex, wider than long. Protoconch a smooth, detached dextral coil; aperture broadly elliptical. Sculpture consisting of prominent, regularly spaced radial ribs with finer close-set riblets between, crossed by coarse regularly spaced concentric lamellae that are beaded at their intersections with the primary radial ribs.

Measurements of the figured specimen, USNM 648452: length 2.0 mm, width 2.3 mm, convexity 0.9 mm.

*Occurrence.*—Figured specimen from drill hole F–1, Eniwetok, at depth of 850–860 feet; a smaller, narrower specimen from Bikini drill hole 2A at depth of 852–857 feet probably represents the same species; both specimens are from beds of late Miocene (Tertiary *g*) age. The Marshall Island fossils have sharper and more regularly spaced sculpture than does *C. liberatus*, the Holocene shell previously referred to. The fossil specimens probably represent an undescribed species.

## Family XENOPHORIDAE

### Genus XENOPHORA Fischer von Waldheim

Fischer von Waldheim, 1807, Muséum Demidoff, ou catalogue systématique et raisonne des curiosités de la nature: Mascou, Paul de Demidoff, v. 3, p. 213.

*Type* (by ruling, Internat. Comm. Zool. Nomenclature, 1964, Bull. Zool. Nomenclature, v. 21, pt. 6, p. 417).—*Trochus conchyliophorus* Born. Holocene, West Indies.

### Xenophora sp. A

*Xenophora* species Ladd, 1970, U.S. Geol. Survey Prof. Paper 640–C, p. C7, pl. 3, figs. 4, 5. Late Eocene (Tertiary *b*); Eua, Tonga.

### Xenophora sp. B

Plate 14, figure 25

Poorly preserved molds of shells of *Xenophora* were collected at two localities on Saipan. Internal molds have prominent peripheral nodes; the base is sculptured with fine, regularly spaced, slightly beaded arcuate threads.

Measurements of the figured mold, USNM 648453: height (incomplete) 5 mm, diameter 18 mm.

*Occurrence.*—Four specimens from the Tagpochau Limestone (Miocene) of Saipan: Three specimens (including figured specimen) from USGS loc. 17728 in the marly facies; one specimen from USGS loc. 17723 in the transitional facies.

The Miocene specimens from Saipan are probably specifically distinct from the minute shell recorded from the Eocene of Tonga, but owing to poor preservation, detailed comparison cannot be made.

### Genus TUGURIUM Fischer

Fischer, 1880, *in* Kiener, Spécies général et iconographie des coquilles vivantes: Paris, J.-B. Baillère et Fils, v. 12, p. 450.

*Type* (*fide* Thiele, 1929, Handbuch der systematischen weichtierkunde: Jena, von Gustav Fischer, v. 1, p. 250).—*Phorus exutus* Reeve. Holocene, China seas.

### Tugurium exutum (Reeve)

Plate 14, figure 26

*Phorus exutus* Reeve, 1843, Conchologica Iconica, v. 1, pl. 2, fig. 7.

*Xenophora* (*Tugurium*) *exuta* (Reeve). Tryon, 1886, Manual Conchology, v. 8, p. 161, pl. 46, figs. 90, 91.

*Tugurium exutum* (Reeve). MacNeil, 1961 [imprint 1960] U.S. Geol Survey Prof. Paper 339, p. 47, pl. 12, fig. 10. (See for additional citations.)

A single shell from the Pliocene beds at station 817 on Vanua Levu, Fiji, USNM 650472, measures: height 8.9 mm, diameter (incomplete) 40.9 mm. It appears to be identical with the specimen from the Nakoshi Sand (Pliocene) of Okinawa figured by MacNeil (1960). As noted by MacNeil, Holocene shells have been reported from the South China Sea, Philippines, Japan and the Ryukyu Islands; fossil occurrences include the Miocene(?) of Japan and the Pliocene of Taiwan.

### Family STROMBIDAE

Representatives of the family are a conspicuous element in all Indo-Pacific faunas today. They include some of the largest and most decorative shells. Fossil representatives are numerous in Tertiary and later sediments, and such species have been found in all the island groups here considered, except Tonga. *Strombus* and *Lambis* include most of the fossils. These two genera have recently been monographed by Abbott (1960, 1961) in Indo-Pacific Mollusca; these excellent reports cover both living and fossil species and include distribution maps and discussions of ecology.

### Genus VARICOSPIRA Eames

Eames, F. E., 1952, Royal Soc. London Philos. Trans., ser. B, v. 236, no. 631, p. 70.

*Type* (by original designation).—*Strombus cancellatus* Lamarck. Holocene, Philippines.

#### Varicospira aff. V. crispata (Sowerby)

Plate 15, figure 1

Represented by a single specimen, an incomplete external mold. On the spire the axial and spiral ribs are equally strong, resulting in uniform cancellation without pronounced beading at the intersections; on the body whorl fine secondary spirals are present between the larger ribs near the suture and likewise over the lower third of the whorl; varices are present at intervals on the spire; lower part of inner lip slightly detached.

Measurements of the figured specimen (rubber cast from external mold, USNM 648454): height 30.5 mm, diameter 10.0 mm.

The fossil resembles the Holocene *V. crispata* described by Sowerby (1842, p. 26, pl. 8, figs. 62, 63) from the Philippines. On the Holocene shells, however, the axial ribs are stronger and more widely spaced than are the overriding spirals.

*Occurrence.*—The single specimen was collected at USGS loc. 17713, Urukthapel, Palau; float from altitude 350 feet; age, possibly Miocene.

### Genus TIBIA Röding

Röding, 1798, Mus. Boltenianum: Hamburg, Johan Christi, pt. 2, p. 123.

#### Subgenus TIBIA sensu stricto

*Type* (by subsequent designation, Dall, 1906, Jour. Conchology (Leeds), v. 11, p. 295).—*Murex fusus* Linnaeus. Holocene, western Pacific.

#### Tibia (Tibia) powisii modesta (Martin)

Plate 15, figures 2, 3

*Rostellaria powisii modesta* Martin, 1899, Geol. Reichs-Mus. Leiden Samml., new ser., v. 1, no. 6–8, p. 191, pl. 30, figs. 443, 444.

Martin, 1919, Geol. Reichs-Mus. Leiden Samml., p. 92.

van der Vlerk, 1931, Leidse Geol. Meded., v. 5, p. 246.

Cernohorsky, 1965, Fiji Mus. Records, v. 1, no. 1, p. 15, pl. 4, fig. 24.

Shuto, 1969, Kyushu Univ. Fac. Sci. Mem., ser. D, Geol., v. 19, no. 1, p. 72, pl. 3, figs. 2–6, text-fig. 20.

*Rostellaria powisii abyssicola* Schepman, 1908, The Prosobranchia of the *Siboga* expedition: Leydon, E. J. Brill, pt. 2, p. 154, pl. 11, fig. 5.

*Rostellaria (Sulcogladius) powisii timorensis* Koperberg, 1931, Jungtertiäre und Quartare Mollusken von Timor, The Hague, Algemeene Landsdrukkerij, p. 127.

*Tibia* cf. *powisii modesta* (Martin). Ladd, 1934, Bernice P. Bishop Mus. Bull. 119, p. 217, pl. 39, figs. 1, 2.

*Tibia (Tibia) powisii* (Petit). Altena [part], 1941, Leidse Geol. Meded., v. 12, pt. 1, p. 45.

The Fiji fossils, now totaling more than 70 specimens, are smaller than shells of the Holocene *Tibia powisii* and on practically all the fossils the sculpture is greatly reduced, if not obsolete, on the early whorls.

Measurements of the figured specimens from station B107 (=817) Vanua Levu, Fiji: USNM 648455—length 31.2 mm, diameter 12.7 mm; USNM 650617—length (incomplete) 19.6 mm, diameter 10.7 mm.

*Occurrence.*—Previously known in Fiji from three localities (stations 165, 304, 306) in north-central and northwest Viti Levu, Fiji (Ladd, 1934, p. 217), has since been collected from four additional stations on Viti Levu (F–238, MR–69, MR–16, and C–89). The species has also been found in great abundance on Vanua Levu at station B–107 (=817) and at nearby localities K–63 and K–138. Age of all Fijian occurrences probably Pliocene (Tertiary *h*).

Martin's type material was collected from the Pliocene (Sondé-beds) of Java. The species has also been recorded from the Pliocene of Sumatra and Timor and from the upper Miocene of Timor and New Guinea (Altena, 1941, p. 46). The Holocene Indonesian shells described and figured by Schepman as *Rostellaria powisii abyssicola* were obtained at a depth of nearly 400 meters and were interpreted as dwarfed forms with obsolete sculpture. I have not seen these specimens.

### Genus TEREBELLUM Röding

Röding, 1798, Mus. Boltenianum: Hamburg, Johan Christi, pt. 2, p. 135.

#### Subgenus TEREBELLUM sensu stricto

*Type* (by tautonymy).—*Terebellum nebulosum* Röding (= *Bulla terrebellum* Linnaeus = *Conus terebellum* Linnaeus). Holocene, western Pacific.

#### Terebellum (Terebellum) terebellum (Linnaeus)

Plate 15, figure 4

*Conus terebellum* Linnaeus, 1758, Systema naturae [10th ed.], p. 718.

*Terebellum (Terebellum) terebellum* (Linnaeus). Jung and Abbott, 1967, Indo-Pacific Mollusca, v. 1, no. 7, p. 445–454. (See for additional citations.)

A single incomplete specimen that seems to represent this widespread and somewhat variable Holocene Indo-Pacific species was collected from the tuffaceous facies of the Tagpochau Limestone (Miocene) on Saipan (USGS loc. 17724).

Measurements of the specimen, USNM 648456: length (incomplete) 35.5 mm, diameter 8.6 mm.

Jung and Abbott (1967, p. 454) list a number of reported fossil occurrences from Miocene and younger beds in various parts of the Indo-Pacific region, chiefly Indonesia.

### Genus STROMBUS Linnaeus

Linnaeus, 1758, Systema naturae [10th ed.], p. 742.

*Type* (by subsequent designation, Montfort, 1810, Conchyliologie Systématique, v. 2, p. 515).—*Strombus pugilis* Linnaeus. Holocene, Caribbean and Florida.

#### Subgenus LAEVISTROMBUS Kira

Kira, 1955, Shells of Japan [1st ed.]: Osaka, p. 31.

*Type* (by subsequent designation, Abbott, 1960, Indo-Pacific Mollusca, v. 1, no. 2, p. 47).—*Strombus canarium* Linnaeus. Holocene, India to Melanesia, north to Japan.

#### Strombus (Laevistrombus) canarium Linnaeus

Plate 15, figures 5, 6

*Strombus canarium* Linnaeus, 1758, Systema naturae [10th ed.], p. 745.

*Strombus isabella* Lamarck. Abrard, 1946, Annales Paléontologie, v. 32, p. 59, pl. 4, fig. 23.

*Strombus (Laevistrombus) canarium* Linnaeus. Abbott, 1960, Indo-Pacific Mollusca, v. 1, no. 2, p. 48, pl. 17, figs. 15, 16, pl. 22, 23. (See for additional citations.)

Shuto, 1969, Kyushu Univ. Fac. Sci. Mem., ser. D, Geol., v. 19, no. 1, p. 73, pl. 3, figs. 1, 10, pl. 4, figs. 2, 3, 7.

Two specimens with characteristically thick smooth shells and wide thickened outer lips were collected from boulders of Waisia Limestone on the island of Maewo, New Hebrides, USGS loc. 24794; age, Pleistocene.

Abrard's (1946) New Hebrides fossils were obtained from the Pliocene of Malekula.

Measurements of the figured specimen, USNM 650583: length 50 mm, diameter 33 mm.

#### Subgenus TRICORNIS Jousseaume

Jousseaume, 1886 Le Naturaliste, Paris, 1st ser., v. 3, no. 28, p. 220.

*Type* (by monotypy).—*Strombus tricornis* Lamarck (= *S. tricornis* Lightfoot). Holocene, Red Sea.

#### Strombus (Tricornis) maximus Martin

Plate 16, figures 1–4

*Strombus maximus* Martin, 1883, Geol. Reichs-Mus. Leiden Samml., 1st ser., v. 1, p. 195, pl. 9, fig. 1.

Martin, 1899, Geol. Reichs-Mus. Leiden Samml., new ser., v. 1. pt. 1, p. 175, pl. 28, fig. 407, pl. 29, fig. 407a.

Abbott, 1960, Indo-Pacific Mollusca, v. 1, no. 2, p. 56, pl. 31, 32.

Shell large, heavy; spire moderately high, with a strong shoulder, bearing a series of prominent knobs; inner lip has a broad axial depression anteriorly and an even wider depression extending obliquely across it from a point above the middle of the aperture; outer lip thick, the thickness greatly increased near the posterior end, which is prominently extended; stromboid notch well developed.

Measurements of the figured specimen, USNM 648457: length (spire incomplete) 200 mm, width 170 mm. A smaller specimen from USGS loc. 21305, USNM 648458, measures: length (incomplete) 118 mm, width 125 mm.

The Palau shells are smaller than those described by Martin from Java, but adult strombids are known to vary considerably in size and this difference is not believed to be significant. The great thickening of the extended upper part of the outer lip characterizes all three of the Palau shells that retain this part of the shell, and this feature is more strongly developed in the Palau shells than in the Java shells. The oblique depression across the inner lip is also more prominent on the Palau shells than on those from Java.

*Occurrence.*—Nearly complete figured specimen and four identifiable fragments from USGS loc. 21290, a 6-foot section of the *Acropora* zone at the base of the Palau Limestone on Auluptagel Island, Palau; a smaller specimen was collected from USGS loc. 21305 in the marl facies that forms the base of the Palau Limestone on the Goikul peninsula on the southeast corner of Babelthuap Island; two incomplete specimens from USGS loc. 18306, also in the Goikul area. All occurrences, upper Miocene (Tertiary *g*).

Martin described the species from the upper Miocene (Tjilanang beds) of Java.

### Strombus (Tricornis) aff. S. thersites Swainson

Plate 15, figure 7

*Strombus* sp. Ladd *in* Ladd and others, 1945, Bernice P. Bishop Mus. Bull. 181, p. 381, pl. 51, fig. J.

*Strombus* aff. *thersites* Swainson. Abbott, 1960, Indo-Pacific Mollusca, v. 1, no. 2, p. 56.

A single incomplete specimen (Univ. Rochester 13,059) from the Futuna Limestone (lower Miocene, Tertiary *f*), station L389, Lakemba, Fiji was described and illustrated by Ladd in 1945: it measures 83.4 mm in length. Abbott examined the specimen later and noted its close resemblance to *S. thersites*. The fossil, however, lacks the large knob on the body whorl opposite the outer lip that characterizes Holocene *S. thersites* shells from a number of Pacific island localities.

### Strombus (Tricornis) cf. S. sinuatus Lightfoot

An incomplete shell, the spire and part of the attached outer lip (USNM 648459, diameter 30 mm), was collected by H. T. Stearns from a coral pit (USGS loc. 21029) on Espiritu Santo Island in the New Hebrides at altitude 215 feet. Though partly covered by recrystallized material, the specimen shows the strong shoulders with rounded knobs crossed by close-set spiral threads that characterize the Holocene *S. sinuatus* shells. The age of the fossil is probably Pleistocene. Holocene shells have been reported from many localities in the western Pacific, from the Marshall Islands to Fiji, from the Ryukyu Islands through Indonesia to northwest Australia. No fossil occurrences have been reported previously, nor has the species been listed from the New Hebrides (Abbott, 1960, p. 61).

### Strombus (Tricornis) sp. A

Plate 17, figures 1, 2

Incomplete molds of a large strombid that has prominent widely spaced axial knobs on the body whorl were collected from the Alifan Limestone at three localities on Guam and from a comparable horizon in Palau. All the specimens are internal molds, some of them are distorted by compression, but they probably represent the same species.

The figured specimen from Guam, USNM 648460, has an apical angle of about 70°; its inner lip is broadly inflated near its base; the specimen measures —length (incomplete) 126 mm, diameter 98 mm.

The species does not appear to be closely related to any living *Strombus*. Superficially the specimens resemble *S. tjilonganensis* Martin described from the Miocene of Java (Martin, 1899, p. 177, pl. 28, figs. 410, 411, pl. 29, fig. 412). The fossils from Guam and Palau are much larger than any of the shells assigned to *S. tjilonganensis*, but the absence of the shell material on the Guam and Palau specimens makes detailed comparison impossible.

*Occurrence.*—USGS locs. 20630, 20722, 20740, and 21592 (figured specimen) on Guam; all from Alifan Limestone of late Miocene and Pliocene age (Tertiary *g* and *h*). Palau specimen from USGS loc. 18310 at base of Palau Limestone on southwest point of Nardueis Island, off southeast coast of Babelthuap; age, late Miocene (Tertiary *g*).

### Subgenus CANARIUM Schumacher

Schumacher, 1817, Essai d'un nouveau système des habitations des vers testacés: Copenhagen, p. 219.

*Type* (by monotypy).—*Canarium ustulatum* Schumacher (= *Strombus urceus* Linnaeus). Holocene, southwest Pacific.

### Strombus (Canarium) urceus Linnaeus

Plate 15, figures 8, 9

*Strombus urceus* Linnaeus, 1758, Systema naturae [10th ed.], p. 745, no. 440.

*Strombus* (*Canarium*) *gendinganensis* Martin. Abrard, 1946, Annales Paléontologie, v. 32, p. 61, pl. 4, fig. 27.

*Strombus* (*Canarium*) *urceus* Linnaeus. Abbott, 1960, Indo-Pacific Mollusca, v. 1, no. 2, p. 63–66. (See for additional citations.)

The specimen from the Nua River, Malekula, New Hebrides, figured by Abrard was borrowed and photographed; length 25.5 mm. Abbott's suggestion that this specimen from the Pliocene of the New Hebrides is referable to *S. urceus* seems to be correct. As Abbott pointed out, the range of the species, which today is found from southeast Asia and the Ryukyu Islands to Australia and Melanesia, extended farther eastward during the Pliocene.

### Strombus (Canarium) mutabilis Swainson

Plate 15, figures 10–15

*Strombus mutabilis* Swainson, 1821, Zoological Illustrations, London, ser. 1, v. 2, pl. 71.

Abbott, 1960, Indo-Pacific Mollusca, v. 1, no. 2, p. 72, pl. 20, figs. 15–17. (See for additional citations.)

Cernohorsky, 1965, Fiji Mus. Records, v. 1, no. 1, p. 4, pl. 3, figs. 17–19.

*Strombus floridus* Lamarck, 1822, Histoire naturelle des animaux sans vertebres: Paris, Guiraudet, v. 7, p. 211.

Abrard, 1946, Annales Paléontologie, v. 32, p. 62.

Abundant (17 specimens) in the Ndalithoni Limestone (stations 110B, 110C) of Vanua Mbalavu, Fiji; age, Pliocene (Tertiary *h*). All the fossil shells from Fiji are smaller than most of the Holocene shells collected in Fiji.

Measurements of the two figured specimens from

station 110B are: USNM 648462—length 11.9 mm, diameter 6.7 mm; USNM 648463—length 13.9 mm, diameter 7.6 mm.

Three well-preserved specimens were collected from the Mariana Limestone on Cabras Island off the west coast of Guam (USGS loc. 21591), and a single incomplete specimen was collected from the Mariana Limestone of Saipan (USGS loc. 17897); age of both occurrences, probably Pleistocene.

Measurements of the figured specimen from Guam, USNM 648461: length 20.3 mm, diameter 19.1 mm. A single specimen from Eniwetok, drill hole EN—4, depth 2 feet in Holocene.

Holocene shells are abundant on the existing reefs of Guam and have been collected from all parts of the Indo-Pacific except Hawaii, the Line Islands, and the Marquesas. Fossil records include the Pliocene of the New Hebrides and Indonesia and the Pleistocene of Hawaii, the Red Sea, and Somalia.

#### Strombus (Canarium) erythrinus Dillwyn

*Strombus erythrinus* "Chemnitz" Dillwyn, 1817, Descriptive catalogue of Recent shells: London, John and Arthur Arch, v. 2, p. 673.

Abbott, 1960, Indo-Pacific Mollusca, v. 1, no. 2, p. 79, pl. 20, figs. 1–5. (See additional citations.)

Cernohorsky, 1965, Fiji Mus. Records, v. 1, no. 1, p. 4, pl. 4, fig. 22.

An incomplete spire from a core in drill hole 2A on Bikini seems to represent this widespread living Indo-Pacific species. The Bikini fossil has a fairly well developed rounded subsutural cord, as do many Holocene specimens from the Marshall Islands.

*Occurrence.*—Drill hole 2A–17–1, Bikini, at depth 242.5–253 feet. Age, probably Pleistocene.

#### Strombus (Canarium) cf. S. fragilis (Röding)

Plate 15, figures 16, 17

A single fragmentary specimen that may represent this Holocene Pacific species was recovered from a core taken in drill hole 2A on Bikini at a depth of 925–936 feet; age, late Miocene (Tertiary *g*). The incomplete shell, USNM 648464, measures: length 19.3 mm, width 10.5 mm. The fossil has a thinner columellar callus than most Holocene shells of *S. fragilis*, and the callus is lirate at its extremities; the anterior end bears several low knobs; the posterior end bears half a dozen sharper and longer lirae. Similar but less well developed lirae are present on a few Holocene shells.

Living shells have been collected widely in the Pacific: from Hawaii to Samoa and Fiji and from Australia to the Ryukyus (Abbott, 1960, p. 86–87). Abbott also noted that the specimens from the Pliocene of the New Hebrides figured by Abrard (1946) as *S. terebellatus* Sowerby represent *S. fragilis*.

#### Strombus (Canarium) sp. B

Plate 16, figures 5–7

Shell small, slender; spire high; whorls strongly convex, shouldered; suture impressed. Sculpture consists of strong spiral ribs that extend over the upper part of the columella; secondary spirals lying immediately below the primary ribs are developed on the upper and lower parts of the body whorl. Broad axial folds are present on the upper parts of each whorl, strong folds tending to alternate with weaker folds.

Measurements of the figured specimen, USNM 648465: length (incomplete) 31.5 mm, diameter 15.0 mm.

Unfortunately, the single fossil is immature and is incomplete anteriorly. It resembles some of the specimens referred by Beets (1941, pl. 3, figs. 121, 122) to *S. unfasciatus* Martin, a Miocene species reported from East Borneo; however, the Fiji fossil is more strongly shouldered than the Borneo shell, and its axial folds are less extended.

*Occurrence.*—Tuffaceous limestone of the Futuna Formation (station L389), Lakemba, Fiji; age, early Miocene (Tertiary *f*).

### Subgenus DOLOMENA Iredale

Iredale, 1931, Australian Mus. Records, v. 18, no. 4, p. 212.

*Type* (by monotypy).—*Strombus pulchellus* Reeve (= *Strombus plicatus pulchellus* Reeve). Holocene, Red Sea.

#### Strombus (Dolomena) plicatus pulchellus Reeve

Plate 17, figures 3–6

*Strombus pulchellus* Reeve, 1851, Conchologica Iconica, *Strombus*, fig. 52.

*Strombus (Gallinula) malekulensis* Abrard, 1946, Annales Paléontologie, v. 32, p. 59, pl. 4, figs. 24, 25.

*Strombus (Dolomena) plicatus pulchellus* Reeve. Abbott, 1960, Indo-Pacific Mollusca, v. 1, no. 2, p. 92, pl. 18, fig. 3, pl. 63, fig. 2.

Cernohorsky, 1965, Fiji Mus. Records, v. 1, no. 1, p. 7, pl. 2, fig. 12.

Shell small; spire incomplete but apparently high; whorls immediately preceding the body whorl rounded, each with 25 or more low axial ribs crossed by about a dozen fine spiral threads; suture impressed, with a distinct spiral cord immediately below it; spiral sculpture almost obliterated on early half of body whorl but conspicuous on later half, where close-set spirals extend to the edge of the expanded outer lip. Aperture wide; outer lip extended posteriorly to form a canal that terminates on the lower part of the penultimate whorl; outer lip thickened, strongly crenulate within; columella lirate, the lirae less conspicuous near the middle than at the extremities. The inside of the outer

lip retains faint traces of light-brown color in the depressions separating the lirae.

The Fiji fossil is larger than most Holocene shells of *Strombus pulchellus* and is larger than the fossils from the New Hebrides. The middle part of the columella on the Fiji fossil is not completely free of lirations, as it is on most Holocene shells.

Measurements of the figured fossil specimen from Fiji, USNM 648466: length (incomplete) 33.6 mm, diameter 21.7 mm.

*Occurrence.*—Single specimen from station 817, Vanua Levu, Fiji; age, Pliocene (Tertiary *h*). The known distribution of Holocene specimens of *Strombus pulchellus* has been mapped by Abbott (1960, p. 91) as a broad area extending southward from Japan to the Philippines, thence southeastward to include Fiji. The single specimen described by Abrard (1946) as *S. malekulensis* from the Pliocene of New Hebrides (figured herein on pl. 17, figs. 3, 4) is more sharply sculptured than the Fiji fossil. An occurrence in the Pliocene of Java has been reported (Altena, 1941, p. 55).

Cernohorsky (1965) reported living specimens from Fiji at depths of 3–16 fathoms on coral rubble and muddy sand.

#### Strombus (Dolomena) variabilis athenius Duclos

Plate 17, figure 7; plate 18, figures 1, 2

*Strombus variabilis* Swainson. Kiener, 1843, Spécies général et iconographie des coquilles vivantes: Paris, Rousseau, v. 4, pl. 21, fig. 2a.

Reeve, 1850, Conchologica Iconica, *Strombus* pl. 10, fig. 21b.

*Strombus athenius* Duclos *in* Chenu, 1844, Illustrations Conchyliologiques, v. 4, p. 7, pl. 11, fig. 2.

*Strombus variabilis athenius* Duclos. Abbott, 1960, Indo-Pacific Mollusca, v. 1, no. 2, p. 104, pl. 14, fig. 20, pl. 79, figs. 3, 4.

In tentatively ranking *Strombus athenius* as a subspecies of *S. variabilis*, Abbott pointed out that it was a small form characterized by a heavier shell, a more rounded apex, and by weakly shouldered apical whorls (Abbott, 1960, p. 104). The two fossil examples from Guam are similarly characterized and are certainly conspecific with many Holocene shells collected in the Marshall Islands. Other Holocene shells from the Marshalls, however, exhibit considerable variation, particularly as regards the development of the shoulder on the earlier whorls. Abbott (1960) stated that available material was insufficient for a complete understanding of *S. athenius*, recognizing that it might possibly be a stunted ecological form. The rare fossils from Guam merely show that the small form was living in the Mariana Islands in Pliocene-Pleistocene time.

Measurements of the figured specimen, USNM 648467: length (incomplete) 38.5 mm, diameter 24.5 mm.

*Occurrence.*—Three specimens from USGS loc. 20537 on Guam in the Mariana Limestone; age, Pliocene (Tertiary *h*) or Pleistocene. Holocene shells have been collected from New Guinea and the Marshall Islands to Fiji and Samoa (Abbott 1960, p. 104–105). The species has not previously been reported as a fossil.

#### Strombus (Dolomena) minimus minor Abrard

Plate 18, figures 3, 4

*Strombus (Gallinula) minimus minor* Abrard, 1946, Annales Paléontologie, v. 32, p. 60, pl. 4, fig. 26.

?*Strombus (Dolomena) plicatus pulchellus* Reeve. Abbott, 1960, Indo-Pacific Mollusca, v. 1, no. 2, p. 92.

An examination of the type shows this species to be closely related to the living *S. minimus*, but the Holocene shells have a smooth columella and an outer lip that is smooth within except for a few lirae at the base; in the New Hebrides fossil the columella is lirate and the inner wall of the outer lip is strongly lirate throughout its length.

Measurements of the figured type, Mus. Nationale d'Histoire Naturelle, Paris: length 28 mm, diameter 18 mm.

*Occurrence.*—Nua River, Malekula, New Hebrides. Age, Pliocene.

#### Subgenus LENTIGO Jousseaume

Jousseaume, 1886, Le Naturaliste, Paris, 1st ser., v. 3, no. 28, p. 220.

*Type* (by monotypy).—*Strombus lentiginosus* Linnaeus. Holocene, Indo-Pacific.

#### Strombus (Lentigo) micklei Ladd, n. sp.

Plate 18, figures 5–8

Medium in size, spindle shaped, heavy; whorls about nine; protoconch smooth; suture excavated; outer lip thickened, smooth within; stromboid notch widely U-shaped; anterior canal short, straight; suture ascending near aperture; posterior canal short and narrow; inner lip smooth, callused. Sculpture consisting of several strong spiral ridges with low nodes; secondary spirals occur between the main ridges and both types bear fine tertiary spirals. Two specimens from Eniwetok, drill hole F–1, depth 680–690 feet show traces of dark spiral bands of color on body whorl—a broad band on the shoulder, three narrower bands below.

Measurements of the holotype, USNM 648468: length (incomplete) 35.5 mm, diameter 29.2 mm. Paratype, USNM 648469, measures: length 44.5 mm, diameter (incomplete) 21.3 mm.

The features of the aperture, the short straight anterior canal, and the absence of a posterior projection of the outer lip seem to place this species in the subgenus *Lentigo* rather than in *Euprotomus*, a group that

has sculpture much like that of *S. micklei*. The fossils are closely related to *Strombus* (*Lentigo*) *fasciatus* Born, a species living in the Red Sea and in the Philippines, *S. fasciatus* is a high-spired species that lacks the close-set spirals of *S. micklei* but that does have spiral ridges with nodes.

This species is named for the late V. C. Mickle, who aided in planning all of the Marshall Island drilling and who supervised most of the work.

*Occurrence.*—A dozen specimens, including the types, from core in drill hole 2A, Bikini, at depth of 925–935.5 feet. More than 50 fragmentary and immature specimens from drill holes E–1 and F–1 on Eniwetok at depths ranging from 640 to 750 feet. All occurrences in beds referred to the upper Miocene (Tertiary *g*).

#### Strombus (Lentigo) cf. S. preoccupatus Finlay

Plate 18, figure 9; plate 19, figure 1

A single incomplete specimen of a large, heavy, prominently knobbed *Strombus* collected on Guam may represent this species known from the Miocene of Java and Borneo. The specimen consists of eight whorls, but the apex is worn and the largest whorl incomplete. The axial and spiral riblets of the early whorls are almost obliterated by erosion, but on later whorls the spiral sculpture is well developed, about 11 threads per whorl.

Measurements of the incomplete figured specimen, USNM 648471: length 90.6 mm, diameter 52.3 mm.

The Guam fossil appears to be closely related to *Strombus preoccupatus* and may be identical with it. Martin (1881, p. 122; 1899, p. 176; 1921, p. 468) described the species from the Miocene of Java as *Strombus spinosus*. In 1926, Finlay (p. 502) gave it the name *preoccupatus*, for Linnaeus (1767, p. 1,212) had applied the name *spinosus* to a French Eocene Volute. In 1941, Beets (p. 67) described *S. preoccupatus* from the upper Miocene of East Borneo. The Guam specimen is larger than any of the Borneo shells but compares favorably in size with the specimens figured by Martin in 1899 (pl. 28, figs. 408, 409).

*Occurrence.*—The single Guam specimen was collected from the Talisay Member of the Alifan Limestone of late Miocene age (Tertiary *g*) at USGS loc. 20535.

#### Strombus (Lentigo) sp. C

Plate 18, figures 10, 11

Associated with the numerous specimens of *Strombus micklei* n. sp. in the upper Miocene beds drilled on Bikini and Eniwetok are five incomplete shells, each with an outer lip that is strongly lirate within. The other features that are preserved appear to be similar to, if not identical, with those of *S. micklei*. These specimens apparently represent a distinct species, but a name is withheld pending the recovery of a more complete shell. The incomplete figured specimen, USNM 648470, measures: length 22.6 mm, width 19.5 mm.

*Occurrence.*—Figured specimen and one other from core in drill hole 2A on Bikini at depth of 925–935.5 feet; four specimens (parts of outer lip only) from drill holes F–1 and E–1 on Eniwetok at depths 640–830 feet. Age of all specimens, late Miocene (Tertiary *g*).

### Subgenus EUPROTOMUS Gill

Gill, T., 1870, Am. Jour. Conchology, v. 5, p. 131.

*Type* (by monotypy).—*Strombus aurisdianae* Linnaeus. Holocene, Indo-Pacific.

#### Strombus (Euprotomus) vomer hawaiensis Pilsbry

Plate 18, figures 12–14

*Strombus hawaiensis* Pilsbry, 1917, Acad. Nat. Sci. Philadelphia Proc., v. 69, p. 329, pl. 22, figs. 1, 2.

*Strombus vomer hawaiensis* Pilsbry. Abbott, 1960, Indo-Pacific Mollusca, v. 1, no. 2, p. 132, pl. 109, figs. 1, 2.

Body whorl has prominent nodes immediately below the periphry; surface covered by closely spaced spiral cords that are weaker and slightly beaded above the nodes; aperture striate, the striae above and below being stronger than those in the middle; striae near the middle of the inner lip obliterated by callus.

Measurements of the figured specimen, USNM 648472: length (spire missing) 32.3 mm, diameter 23.6 mm.

R. T. Abbott, who examined this specimen when preparing his monograph on Indo-Pacific *Strombus*, noted its close resemblance to *S. hawaiensis* (Abbott, 1960, p. 132). The fossil is proportionately wider anteriorly than the tapered holotype (Abbott, 1960, p. 132, pl. 109), but the shell proportions do not differ from other Hawaiian specimens of this species.

*Occurrence.*—Represented by a single incomplete specimen from a conglomerate block on a landslide area (station F–238) west of Nasongo, Viti Levu, Fiji; age, probably Miocene. Pilsbry's type was a living specimen from Pearl and Hermes Reef, Hawaii.

### Subgenus CONOMUREX Fischer

Fischer, 1884, Manual Conchyliologie, pt. 7, p. 670.

*Type* (by monotypy).—*Strombus luhuanus* Linnaeus. Holocene, western Pacific.

#### Strombus (Conomurex) luhuanus Linnaeus

Plate 19, figures 2, 3

*Strombus luhuanus* Linnaeus, 1758, Systema naturae [10th ed.], p. 744, no. 432.

*Strombus* (*Conomurex*) *luhuanus* Linnaeus. Fischer, 1884, Manual Conchyliologie, pt. 7, p. 670.

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Abrard, 1946, Annales Paléontologie, v. 32, p. 64, pl. 4, fig. 33.

Abbott, 1960, Indo-Pacific Mollusca, v. 1, no. 2, p. 135, pl. 14, fig. 15, pl. 110. (See for additional citations.)

Cernohorsky, 1965, Fiji Mus. Records, v. 1, no. 1, p. 11, pl. 2, fig. 10.

Eight incomplete specimens of this widely distributed western Pacific species were collected from three localities on the west coast of Guam. Three specimens are from the Alifan Limestone (USGS locs. 20730, 21380, both upper Tertiary), and the others are from the Mariana Limestone (USGS loc. 20626); age, Pliocene or Pleistocene. All the Guam specimens are worn, and no traces of axial sculpture remain. Measurements of the incomplete figured specimen, USNM 648473: length 41.4 mm, diameter 30.0 mm.

A single incomplete shell from a core in drill hole 2 on Bikini at a depth of 180–185 feet probably is Pleistocene. The shell, although badly worn, shows the typical heavy spire and its suture, and the columella retains traces of the characteristic deep-brown coloration. Measurements of the incomplete shell are: height 43.8 mm, diameter 23.5 mm. Two slender immature shells from drill hole E–1 on Eniwetok at a depth of 200–210 feet show traces of brown color on their columellas; age, probably Pleistocene.

The species has been reported from the Pliocene or Pleistocene of Indonesia and the Pliocene of the New Hebrides and Taiwan (Abbott 1960, p. 137; Schmid and Walther, 1962). The distribution of the living shells has been shown on a sketch map by Abbott (1960, pl. 111).

### Subgenus GIBBERULUS Jousseaume

Jousseaume, 1888, Soc. Zool. France Mém. 1, p. 174.

*Type* (by monotypy).—*Strombus gibberulus* Linnaeus. Holocene, Indian Ocean.

### Strombus (Gibberulus) gibberulus gibbosus (Röding)

Plate 19, figure 9; plate 20, figures 1–3

*Lambis gibbosa* Röding, 1798, Mus. Boltenianum: Hamburg, Johan Christi, pt. 2, p. 62, no. 786.

*Strombus gibberulus* Linnaeus. Sowerby, 1842, Thésaurus Conchyliorum, v. 1, pl. 6, figs. 24–26.

Demond, 1957, Pacific Sci., v. 2, no. 3, p. 295, fig. 14.

*Strombus* (*Canarium*) *gibberulus* Linnaeus. Abrard, 1946, Annales Paléontologie, v. 32, p. 63.

*Strombus* (*Gibberulus*) *gibberulus gibbosus* (Röding). Abbott, 1960, Indo-Pacific Mollusca, v. 1, no. 2, p. 143, pl. 14, fig. 26, pl. 114, figs. 1–4. (See for additional citations.)

Cernohorsky, 1965, Fiji Mus. Records, v. 1, no. 1, p. 11, pl. 2, fig. 9.

As noted by Abbott (1960), this subspecies is smaller than typical *Strombus gibberulus*, and the spiral threads over the varix on the last whorl are weak or absent. On a figured specimen from drill hole A–1 on Eniwetok (pl. 19, fig. 9; pl. 20, fig. 1) the spirals are absent, but on the other Eniwetok fossil specimens the spirals are weakly developed. On a specimen from Bikini drill hole 2, depth 180–185 feet, the spiral threads are developed on the varix opposite the aperture as well as on the outer lip near the aperture. The spiral threads are weakly developed on the figured specimen from Guam (pl. 20, figs. 2, 3) but are more strongly developed on other fossil specimens from that island.

Measurements of the figured specimen from Eniwetok, USNM 648474: length 28.8 mm, diameter 15.1 mm. The figured specimen from Guam, USNM 648476, measures: length 49.8 mm, diameter 25.9 mm.

*Occurrence.*—A single specimen from the Mariana Limestone (USGS loc. 17893) and two from the Tanapag Limestone (USGS loc. 17897) of Saipan; age of all three specimens, Pleistocene. Numerous specimens from the Agana Argillaceous Member of the Mariana Limestone of Guam (USGS locs. 20526, 20730, 21377, 21378); age, Pliocene or Pleistocene. One specimen from the Alifan Limestone (USGS loc. 20723); age, Tertiary *g* or *h*. Four specimens from Eniwetok drill holes (A–1, depth 136–138 ft; Mu–4, depth 40–41 ft; F–7–C, depth 16–19 ft); all occurrences probably Holocene. Three specimens from core of drill hole 2 on Bikini (Core 2–11–1), depth 180 feet; age, probably Holocene.

Abbott (1960, p. 142) has mapped known occurrences of the living specimens. They inhabit Indonesia and most of the western Pacific islands except Hawaii, the Line Islands, and the Marquesas. Fossil shells thought to be Pleistocene were dredged from Honolulu Harbor (Ostergaard, 1928, p. 27) and were collected from an elevated terrace on Lanai (USNM 496370) by Harold T. Stearns, of the U.S. Geological Survey. Fossil specimens have also been reported from the Pliocene and Quaternary of Indonesia and the New Hebrides.

### Strombus (Gibberulus) praegibberulus Abrard

Plate 19, figures 4–8

*Strombus* (*Canarium*) *praegibberulus* Abrard, 1946, Annales Paléontologie, v. 32, p. 63, pl. 4, figs. 30–31.

*Strombus* (*Gibberulus*) *gibberulus gibbosus* (Röding). Abbott, 1960, Indo-Pacific Mollusca, v. 1, no. 2, p. 143, pl. 117.

This comparatively high-spired form (length 35 mm, diameter 17 mm) of the New Hebrides (Nua River, Island of Malekula; age, Pliocene) was believed by Abrard (1946) to be ancestral to *Strombus gibberulus*. Abbott (1960) referred it questionably to the living form. After examining the types, I follow Abrard in recognizing it as a distinct species.

### Genus LAMBIS Röding

Röding, 1798, Mus. Boltenianum: Hamburg, Johan Christi, pt. 2, p. 61.

*Type* (by absolute tautonomy).—*Strombus lambis* Linnaeus. Holocene, Indo-Pacific.

### Subgenus LAMBIS sensu stricto

### Lambis (Lambis) lambis (Linnaeus)

Plate 19, figure 10; plate 20, figure 4

*Strombus lambis* Linnaeus, 1758, Systema naturae [10th ed.], p. 743, no. 425.

*Lambis lambis* Gmelin, Röding, 1798, Mus. Boltenianum: Hamburg, Johan Christi, pt. 2, p. 66, no. 844.

Abbott, 1961, Indo-Pacific Mollusca, v. 1, no. 3, p. 151, pl. 121, fig. 4, pl. 118, pl. 123, figs. 1–3. (See for additional references.)

A single large and well-preserved example of this widely distributed Indo-Pacific species was collected by H. T. Stearns, of the U.S. Geological Survey, from a limestone pit (USGS loc. 21028) on Espiritu Santo Island in the New Hebrides at an altitude of 240 feet. The large heavy shell with its thickened outer lip is an adult, and the long high knob on the shoulder of the body whorl and the upturned bases of the anterior spines indicate that it is the shell of a female (Abbott, 1961, p. 148). Measurements of the specimen, USNM 648477: length 155 mm, diameter 103 mm.

The limestone at USGS loc. 21028 is probably not older than Pleistocene. The species has also been reported from Quaternary beds in Kenya, Tanganyika, Sudan, and Indonesia (Abbott, 1961, p. 154).

### Lambis (Lambis) cf. L. lambis (Linnaeus)

Plate 20, figures 5, 6

A single incomplete specimen of *Lambis* was recovered from an outcrop of the tuffaceous Futuna Limestone close to sea level on the west coast of Lakembe (station L–493) in eastern Fiji. The limestones that contained the shell clearly are lower Miocene (Tertiary *f*), as indicated by associated mollusks and larger Foraminifera. The part of the *Lambis* shell that is preserved closely resembles the shells of living specimens collected from the reefs of Fiji, but all essential features are not present and hence the specific identity is questioned. The fossil, however, is definitely a *Lambis* and is the oldest occurrence of the genus thus far discovered. Measurements of the incomplete shell, USNM 648478: length 92.1 mm, diameter 37.8 mm.

## LOCALITIES

Fossils described in the present report were collected from many localities not listed or shown on maps in Ladd (1966) and from five islands not covered in that report. The five islands are Maewo and Pentecost in the New Hebrides (fig. 5); Vanua Levu and Oneata in Fiji (figs. 7, 10); and Eua in Tonga (fig. 11). The locality data given below supplements that given by Ladd (1966, p. 81–89).

**PALAU**

[Babelthuap localities shown in fig. 2]

| *Island* | *U.S. Geological Survey Cenozoic locality No.* | *Locality and collector* |
|---|---|---|
| Urukthapel | 17713 | Road to lighthouse, altitude 350 ft; Arnold Mason and P. E. Cloud, 1948. (Same as USGS loc. 18322.) |
| Do | 18316 | Palau Limestone, near west end at altitude 10 ft; Arnold Mason, 1948. |
| Auluptagel | 17718 | 500 ft west of entrance to large bay near south coast of island; exposure in cave 5 ft above sea level; P. E. Cloud and Arnold Mason, 1948. |
| Babelthuap | 18306 | ¼ mile north of Goikul village; Arnold Mason, 1948. |
| Do | 21305 | Marl facies at base of Palau Limestone, Goikul peninsula. (Same as USGS loc. 21301.) H. S. Ladd, 1958. |
| Nardueis | 18310 | Palau Limestone, southwest point, altitude 10 ft; Arnold Mason, 1948. |

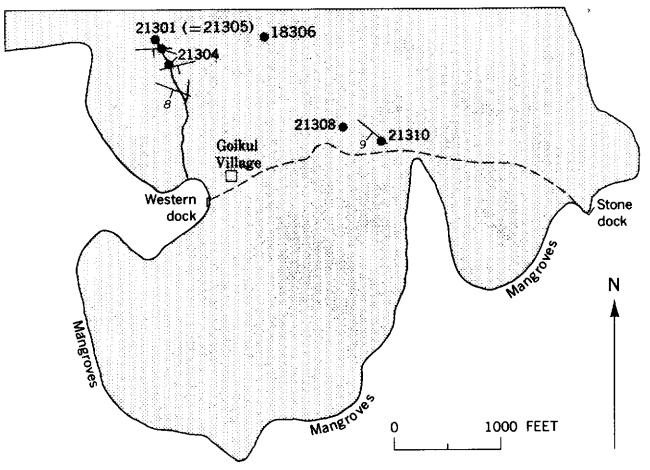


FIGURE 2.—Sketch map of Goikul peninsula showing U.S. Geological Survey fossil localities and attitude of marl beds, Babelthuap, Palau. Localities shown here but not described in the present report are described by Ladd (1966, p. 81).

## MARIANA ISLANDS

[Guam localities shown in fig. 3; Saipan localities in fig. 4]

| Island | U.S. Geological Survey Cenozoic locality No. | Locality and collector (Collector, Pacific Island Engineers, 1946–50, unless otherwise indicated) |
|---|---|---|
| Guam | 17750 | About 200 ft above limestone-volcanic rock contact at middle level of Naval Ammunition Depot quarry 3,000 ft east-northeast of summit of Mount Alifan. P. E. Cloud and R. G. Schmidt, 1948. |
| Do | 20516 | About 2 miles north-northwest of Fadian Point, waist of island. |
| Do | 20535 | 4,300 ft south-by-east of Mount Alifan, southern part of island. |
| Do | 20537 | 6,000 ft east of Ordot, waist of island. |
| Do | 20567 | 4,000 ft northwest of Sinajana, waist of island. |
| Do | 20576 | 2,100 ft southeast of Sinajana, waist of island. |
| Do | 20586 | 1.4 miles northwest of Fadian Point, waist of island. |
| Do | 20587 | 2 miles north-northwest of Fadian Point, waist of island. |
| Do | 20591 | About 2¼ miles northwest of Fadian Point, waist of island. |
| Do | 20605 | About ¾ mile east of Barrigada Hill. |
| Do | 20607 | 3,500 feet northwest of Taogam Point, waist of island. |
| Do | 20610 | 2.1 miles north-northwest of Fadian Point, waist of island. |
| Do | 20611 | About 2,000 ft east of Barrigada, waist of island. |
| Do | 20626 | 1,000 ft south of Agana, waist of island. |
| Do | 20630 | About 4¼ miles northwest of head of Talofofo Bay. |
| Do | 20637 | 1 mile south of Sinajana, waist of island. |
| Do | 20648 | 2 miles west-southwest of Ylig Point. |
| Do | 20674 | 2 miles east of Ordot, waist of island. |
| Do | 20691 | 1,150 ft southeast of Sinajana, waist of island. |
| Do | 20702 | 3,900 ft southeast of Sinajana, waist of island. |
| Do | 20708 | 1 mile southeast of Mount Alifan. |
| Do | 20722 | 4,050 ft north of Mount Almagosa, southern part of island. |
| Do | 20723 | 1,600 ft southeast of landward end of drydock causeway that extends into Apra Harbor, waist of island. |
| Do | 20724 | 1,200 ft east and slightly south of landward end of drydock causeway that extends into Apra Harbor. |
| Do | 20730 | 3,000 ft northeast of landward end of drydock causeway that extends into Apra Harbor. |
| Do | 20739 | 3.7 miles northwest of head of Talofofo Bay. |
| Do | 20740 | About 5¼ miles northwest of the head of Talofofo Bay. |
| Do | 20743 | 4,500 ft southeast of Toto, waist of island. |
| Do | 20863 | About 1,600 ft southeast of Mount Lamlam. |
| Do | 20870 | About 2 2/3 miles west-northwest of head of Talofofo Bay. |
| Do | 20966 | About 1¼ miles northwest of Talofofo. D. B. Doan, 1953. |
| Do | 20969 | ¾ mile southwest of Barrigada village road junction. H. G. May, 1953. |
| Do | 20993 | Rise of ridge north of Talofofo River at point 1.1 miles approximately northwest of river bridge. P. E. Cloud and H. G. May. |
| Do | 21378 | About 1/3 mile S. 5° W. of main road fork southwest of Mangalao, waist of island. H. S. Ladd, 1958. |
| Do | 21380 | Same as USGS loc. 20723. H. S. Ladd, 1958. |
| Do | 21434 | 1 mile north of Mataguac Hill, northern lobe of island. F. S. MacNeil, 1952. |
| Do | 21592 | New cascaja pit on Fena Road above Agat Reservoir, H. T. Stearns, July 1937. (Agat Reservoir is catchment basin of Santa Rita Springs, immediately south of town now called Santa Rita.) |
| Do | 21626 | North of lake, Martinez pasture, about 2 miles north-northwest of head of Pauliluc Bay, southern lobe of island. J. T. Stark, 1953. |
| Do | 21630 | Small road-metal quarry on west side of Camp Witek, on Cross Island Road. J. I. Tracey and Ernest Bishop, 1954. |
| Do | 21631 | About 3,000 ft west of Siciliano's Ranch. 1½ miles west-southwest of head of Talofofo Bay, southern lobe of island. J. T. Stark, 1953. |

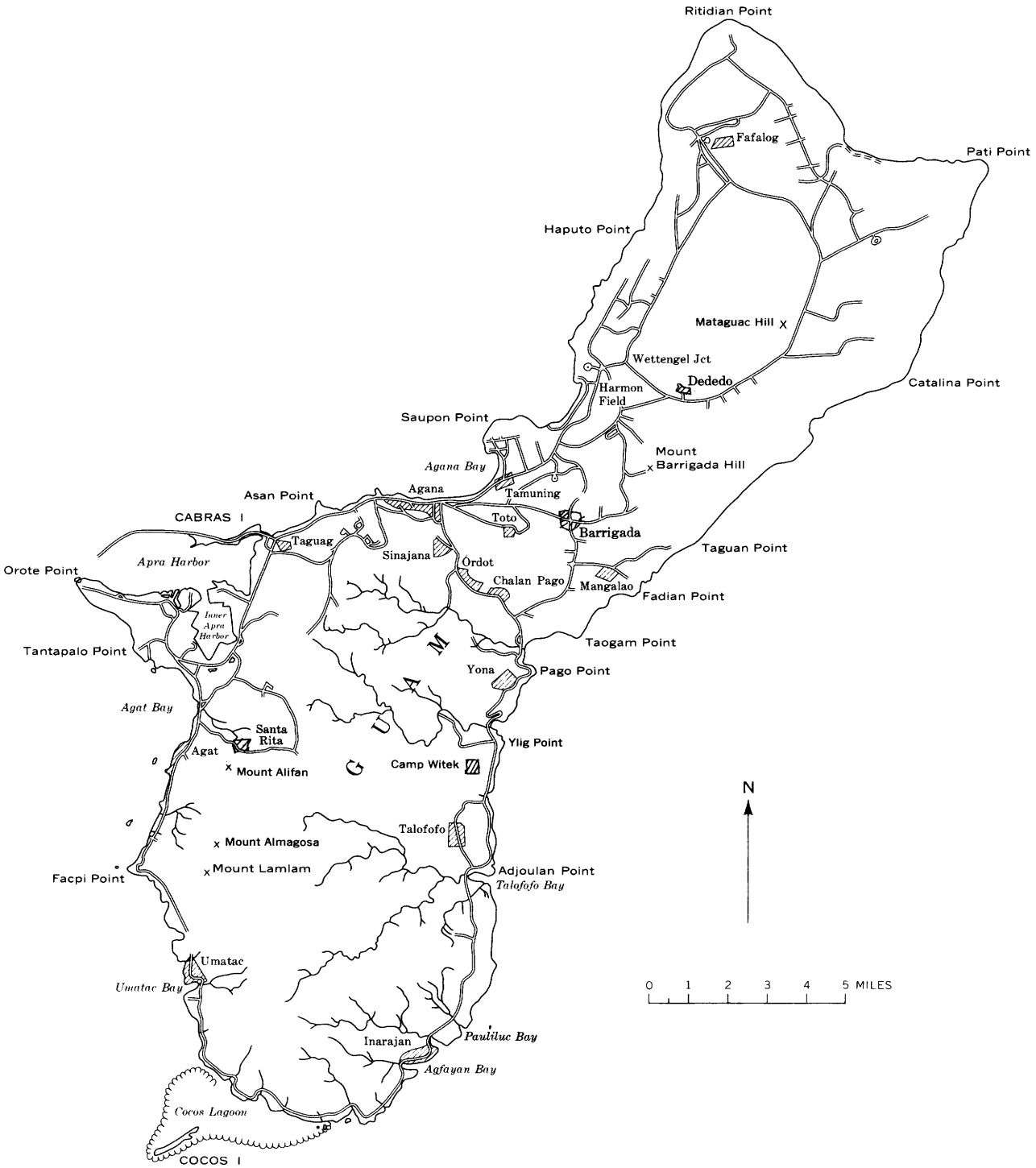


FIGURE 3.—Sketch map of Guam, Mariana Islands, showing villages and physiographic features used in identifying U.S. Geological Survey fossil localities.

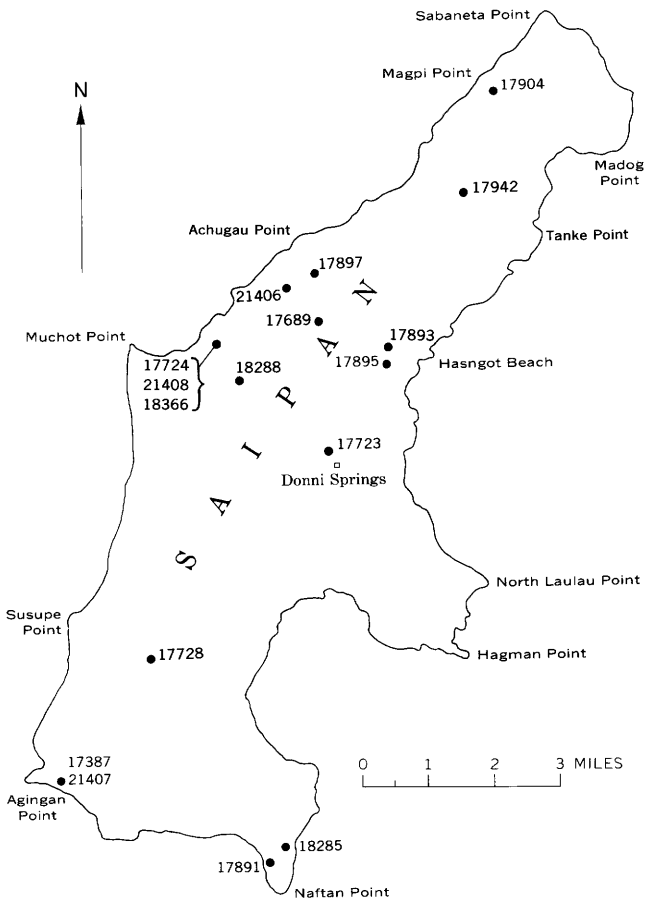


FIGURE 4.—Sketch map showing U.S. Geological Survey fossil localities on Saipan, Mariana Islands. Localities shown here but not described in this report are described by Ladd (1966, p. 83).

MARIANA ISLANDS—CONTINUED

| Island | U.S. Geological Survey Cenozoic locality No. | Locality and collector (Collector, Pacific Island Engineers, 1946–50, unless otherwise indicated) |
|---|---|---|
| Do | 24795 | Well near Dededo village, northern lobe of island. |
| Saipan | 17689 | About 1 1/3 miles south-southeast of Achugau Point. R. G. Schmidt and P. E. Cloud, 1948. |
| Do | 17724 | About 1½ miles east-northeast of Muchot Point. H. W. Burke. |
| Do | 17728 | About 1½ miles southeast of Susupe Point. P. E. Cloud, 1949. |
| Do | 17893 | 2,500 ft west-northwest of Hasngot Beach. P. E. Cloud and R. G. Schmidt, 1949. |
| Do | 17897 | About 3,000 ft south-southeast of Achugau Point. R. G. Schmidt and P. E. Cloud, 1949. |
| Do | 17942 | 7,200 ft northwest of Tanke Point. H. W. Burke, P. E. Cloud, and R. G. Schmidt, 1948. |

MARIANA ISLANDS—CONTINUED

| Island | U.S. Geological Survey Cenozoic locality No. | Locality and collector (Collector, Pacific Island Engineers, 1946–50, unless otherwise indicated) |
|---|---|---|
| Do | 18288 | About 1½ miles east-southeast of Muchot Point. H. W. Burke, 1949. |
| Do | 18366 | Same as USGS loc. 17724. R. G. Schmidt. |
| Do | 21406 | North end of limestone quarry at south end of abandoned Navy Fuel Farm, 600 ft east of West Coast Highway. H. S. Ladd, 1958. (Same as USGS loc. 18366.) |
| Do | 21408 | Same as USGS loc. 17724; H. S. Ladd, 1958. |

MARSHALL ISLANDS

[See Ladd (1966, figs. 5 and 6) for maps showing location of fossil locality]

| Atoll | Island | Drill hole | Total depth (ft) | Location, driller and date |
|---|---|---|---|---|
| Eniwetok | Engebi | En–3 | 48 | 2,175 ft N. 40° W. of drill hole En–9. Shown in figure 6 (Ladd, 1966). Atomic Energy Commission, 1950. |

NEW HEBRIDES

[Fossil localities shown in fig. 5]

| Island | U.S. Geological Survey Cenozoic locality No. | Station | Locality and collector |
|---|---|---|---|
| Pentecost | 24793 | PM–259a | On River Baravet; altitude about 100 meters; long 168° 10′ 3″ E., lat 15° 49′ 58″ S. D. I. J. Mallick, 1969. |
| Maewo | 24794 | ---------- | Inland from Lauwauwage Bay. Kelvin Liggett, 1969. |

FIJI

| Island | Station | Figure showing locality | Locality and collector |
|---|---|---|---|
| Viti Levu | 158 | 6 | 6¼ miles from Suva on Princes Road to Nausori; altitude about 555 ft. H. S. Ladd, 1928. |
| Do | 304 | 6 | About 5½ miles southeast of Mba. H. S. Ladd, 1928. |
| Do | 306 | 6 | Right bank Mba River about 2¼ miles south of Mba. H. S. Ladd, 1928. |
| Do | 344 | 6 | About ¾ mile northwest of Singatoka. H. S. Ladd, 1928. |
| Do | F–238 | 6 | Right bank of Wailoa River about 1 mile west of Na- |

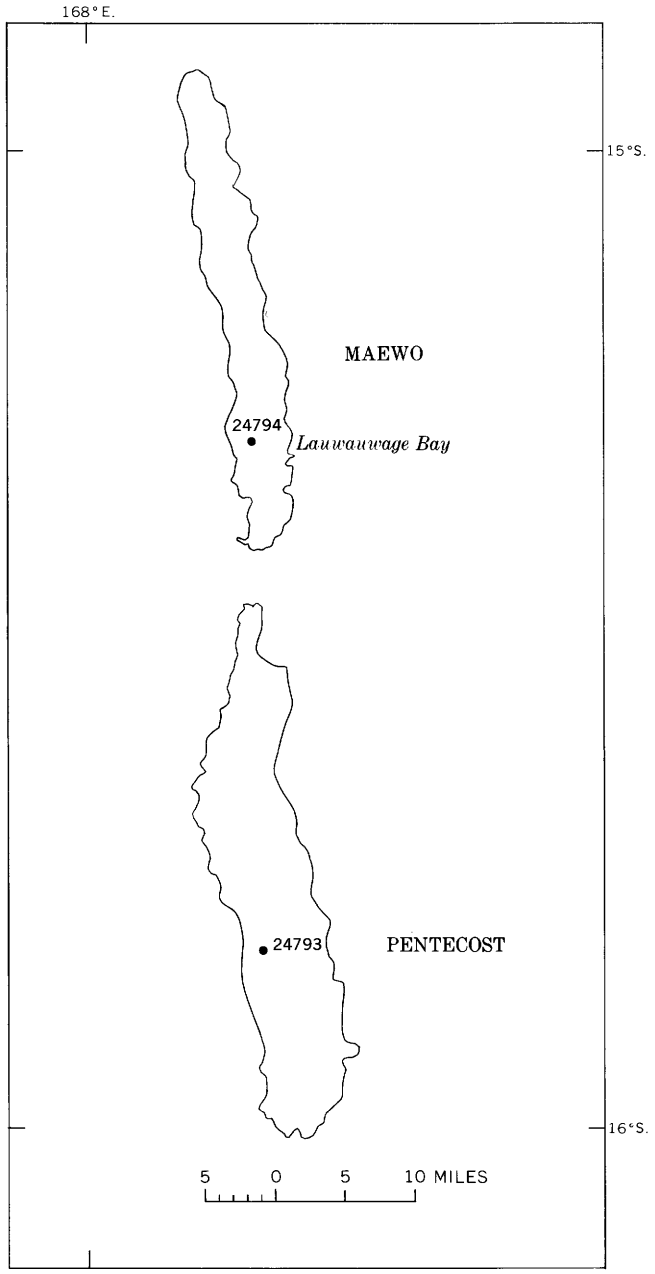


FIGURE 5.—Sketch map showing fossil localities on Maewo and Pentecost, New Hebrides.

FIJI—CONTINUED

| Island | Station | Figure showing locality | Locality and collector |
|---|---|---|---|
| | | | songo; float. H. S. Ladd, 1934. |
| Do | C–89 | 6 | Korotambua Creek, 450 yards southwest of end of railroad spur, Mbalevuto area. Peter Rodda. (Same as MR–20.) |
| Do | C–136 | 6 | Nasaranga Creek west of Rewasau. Peter Rodda. |
| Do | C–831 | 6 | Nanduruloulou; lat 17° 58.9′ S., long 178° 31.6′ E. Peter Rodda. |
| Do | C–1134 | 6 | Southeast of Lautoka on road to Ambatha; lat 17° 39.6′ S., long 177° 29.4′ E. Peter Rodda. |
| Do | MR–16 | 6 | Left bank of Nandrou Greek, 1¼ miles south of Nasolo, Mbalevuto area. M. J. Rickard, 1960–61; P. Ibbotson and H. S. Ladd, 1964. |
| Do | MR–69 | 6 | Rove Creek, ¼ mile south of Tambungguto, Mbalevuto area. M. J. Rickard, 1960–61. |
| Vanua Levu | B–107 | 7 | Roadcut 1 mile west of Nasarowangga River bridge, |

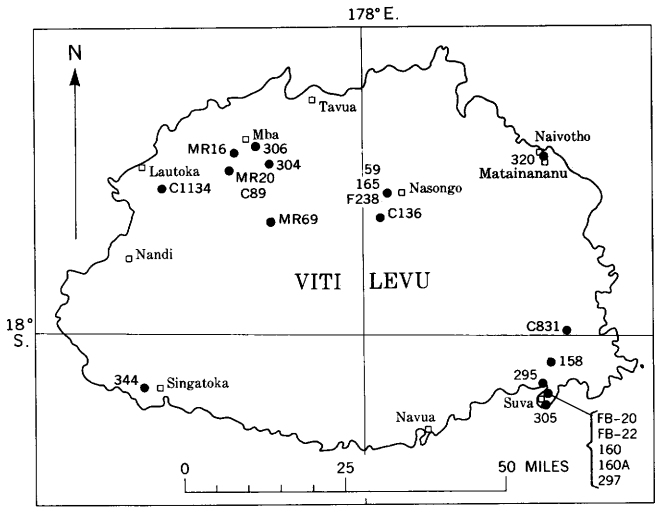


FIGURE 6.—Fossil localities on Viti Levu, Fiji. Localities shown here but not described in this report are described by Ladd (1966, p. 86).

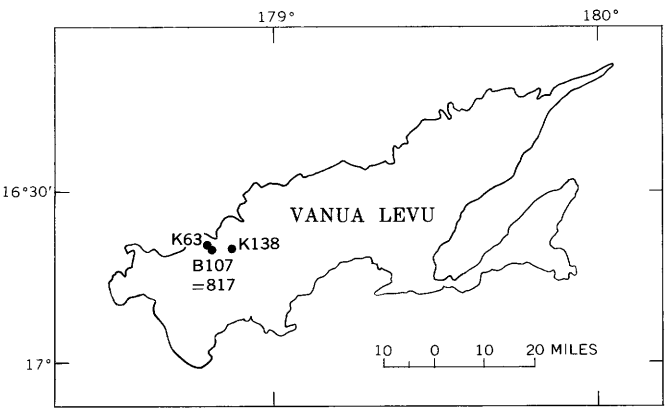


FIGURE 7.—Fossil localities on Vanua Levu, Fiji.

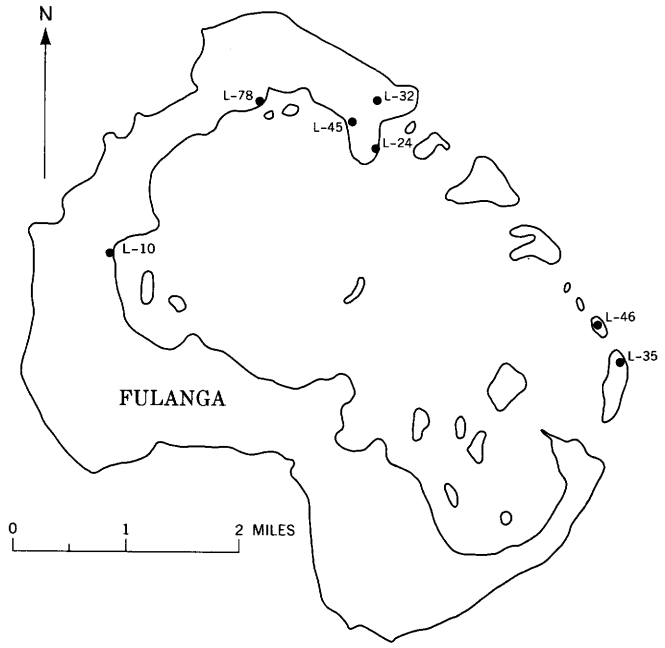


FIGURE 8.—Fossil localities on Fulanga, Lau, Fiji. Localities shown here but not described in this report are described by Ladd (1966, p. 86).

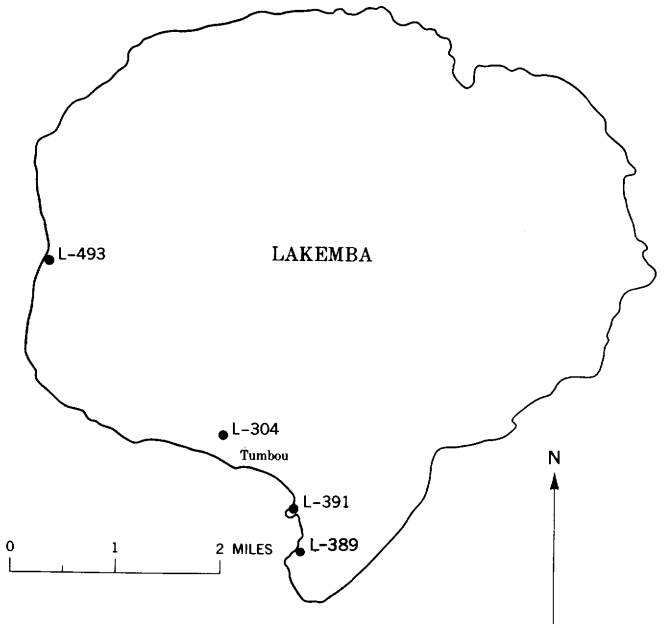


FIGURE 9.—Fossil localities on Lakemba, Lau, Fiji. Localities shown here but not described in this report are described by Ladd (1966, p. 86).

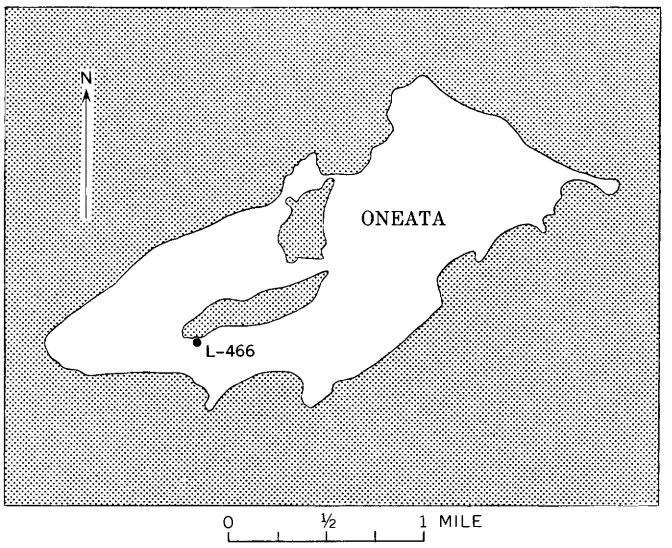


FIGURE 10.—Fossil locality on Oneata, Lau, Fiji.

**FIJI—CONTINUED**

| *Island* | *Station* | *Figure showing locality* | *Locality and collector* |
|---|---|---|---|
| | | | Mbua. M. J. Rickard. (Same as station 817.) |
| Do | K–63 | 7 | ½ mile west and 200 yards north of station 817, Mbau. W. H. Hindle. |
| Do | K–138 | 7 | Nakakawandawa Creek, about 3 miles due east of station 817, Mbua. W. H. Hindle. |
| Do | 817 | 7 | Roadcut 1 mile west of Nasarowangga River bridge, Mbua. P. Ibbotson, W. H. Hindle, and others. (Same as station B–107). |
| Fulanga | L–10 | 8 | Limestone, western shore of inner lagoon; altitude 0–2 ft. H. S. Ladd, 1934. |
| Lakemba | L–389 | 9 | Tuffaceous limestone on coast between Tumbou and Tarakua-wai; altitude 0–3 ft. H. S. Ladd, 1934. |
| Oneata | L–466 | 10 | Basal foraminiferal limestone, near western end of western lake; altitude about 15 ft. H. S. Ladd, 1934. |

**TONGA**

[Fossil locality shown in fig. 11]

| *Island* | *U.S. Geological Survey Cenozoic locality No.* | *Locality and collector* |
|---|---|---|
| Eua | 24686 | About ¼ mile north of Vaingana, altitude 400 ft. Yoshio Kondo, 1967. |

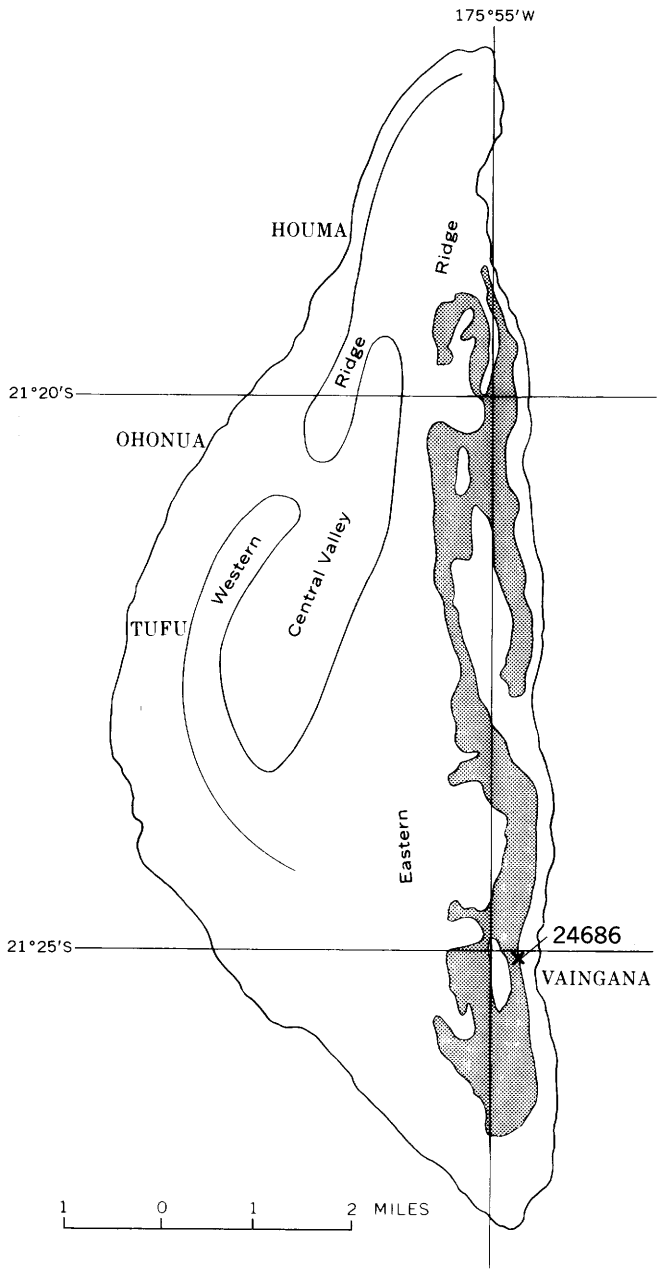


FIGURE 11.—Map of Eua, Tonga, showing location of outcrop of fossil-bearing bed (USGS loc. 24686) and the main mass of Eocene limestone (patterned area) on the east side of the island, as mapped by Hoffmeister (1932).

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# INDEX

[Italic page numbers indicate major references and descriptions]


A

Page

*abyssicola, Rostellaria powisii* ____ 56
*Acropora* ____ 57
*adansonii, Cerithium* ____ 37
Adeorbidae (Tornidae) ____5, 8, *14*
*aegle, Triforis* ____ 47
*aeola, Bembix* ____ 13
*(Agathirses), Tenagodus* ____ 17
*Alabina* ____ 28
*Alba (Diala) sulcifera* ____ 30
*albogranosa, Inforis* ____ 47
*Triphora (Inforis)* ____7, 10, *47* ; pl. 12
*albugo, Diala* ____ 29
*aluco, Murex* ____ 36
*Rhinoclavis (Pseudovertagus)* __ 36
*alveolus, Cerithium* ____ 37
*Cerithium (Thericium)* ____6, 9, *37* ; pl. 9
*Amalthea conica* ____ 53, 54
*amarula, Helix* ____ 21
*ammonoceras, Cyclostrema* ____ 14
*amputatum, Fartulum* ____5, 9, *24* ; pl. 5
*(Anatoma), Scissurella* ____ 13
*tongaensis, Scissurella* ____5, 8, 13
*(Ancistrobasis), Basilissa* ____ 13
*pacifica, Basilissa* ____5, 8, 13
*anguinus, Serpula* ____ 17
*(Antisabia), Hipponix* ____ 53
*foliaceus, Hipponix* ____7, 10,12, *53* ; pl. 13
*Architectonica* ____ *18*
*euprepes* ____ 19
*perspectiva* ____ 18
*radiata* ____ 19
*(Architectonica)* ____ *18*
*perspectiva* ____5, 8, 12, *18* ; pl. 2
*(Philippia) krebsii* ____ 19
*(Pseudotorinia)* ____ *18*
*corwini* ____5, 8, *18* ; pl. 2
*(Architectonica), Architectonica* ___ *18*
*perspectiva, Architectonica* ____ 5, 8, 12, *18* ; pl. 2
Architectonicidae ____5, 8, *18*
*arenaria, Serpula* ____ 20
*articulata, Rhinoclavis (Rhinoclavis)* 6, 9, *33* ; pl. 8
*articulatum, Cerithium* ____ 33
*articulatus, Vertagus* ____ 33
*asper, Cerithium (Vertagus)* ____ 34
*Murex* ____ 34
*aspera, Rhinoclavis* ____ 34
*Rhinoclavis (Rhinoclavis)* ____ 6, 9, 12, *34* ; pl. 8
*asperum, Cerithium* ____ 34
*Astele* ____ 13
*Callistele* ____ 13
*(Callistele)* sp ____5, 8, 13
*Astraea* ____ 13
sp. F ____5, 8, *13* ; pl. 4
*(Bolma)* ____ 13

Page

*Astraea*—Continued
*(Bolma) stearnsi* ____5, 8, 13
*(Cookia)* ____ 14
*Ataxocerithium* ____ *32*
*eniwetokensis* ____6, 9, *32* ; pl. 4, 8
*serotinum* ____ 32
*athenius, Strombus* ____ 60
*Strombus variabilis* ____ 60
*Strombus (Dolomena) variabilis* 7, 11, 12, *60* ; pl. 17, 18
*attenuissima, Seila* ____ 44
*auberti, Triforis (Mastonia)* ____ 49
*auberti, Triphora (Mastonia)* ____ 7, 10, *49* ; pl. 12
*aurisdianae, Strombus* ____ 61
*australis, Tenagodus* ____5, 8, *17* ; pl. 2

B

*badius, Capulus* ____ 53
*Hipponix* ____7, 10, *53* ; pl. 13
*balteata, Cerithiopsis* ____ 43, 44
*Basilissa* ____ 13
*costulata* ____ 13
*superba* ____ 13
*(Ancistrobasis)* ____ 13
*pacifica* ____5, 8, 13
*Bathybembix* ____ 13
sp ____5, 8, 13
*Batillaria* ____ *27*
*(Zeacumantus)* ____ *27*
*rickardi* ____6, 9, *27* ; pl. 6
*bayani, Viriola* ____ 50
*Bembix aeola* ____ 13
*berberense, Caecum* ____5, 9, *22* ; pl. 5
*berberkirianus, Potamides*
*(Tympanotonos)* ____ 26
*Tympanotonos* ____6, 9, 12, *26* ; pl. 6
*bifastigata, Turritella* ____ 15
*(Bittiolum), Bittium* ____ *32*
*toddae, Bittium* ____6, 9, *32* ; pl. 4
*Bittium* ____ *30*
*eniwetokensis* ____6, 9, *31* ; pl. 4
*fretense* ____ 32
*ianthinum* ____6, 9, *31* ; pl. 7
*impendens* ____6, 9, *30* ; pl. 7
*parcum* ____ 30
*podagrinum* ____ 32
*sergentum* ____6, 9, 12, *30* ; pl. 7
*varium* ____ 32
*(Bittiolum)* ____ 32
*toddae* ____6, 9, *32* ; pl. 4
*blowi, Turcica (Perrinia)* ____5, 8, 13
*(Bolma), Astraea* ____ 13
*stearnsi, Astraea* ____5, 8, 13
*(Boreoscala), Epitonium* ____ *51*
*(Boreoscala?)* sp., *Epitonium* ____7, 10, *51*
*brevis, Schismope* ____ 13
*Bulla terrebellum* ____ 57

C

Caecidae ____5, 9, *22*

Page

*Caecum* ____ *22*, 23
*berberense* ____5, 9, *22* ; pl. 5
*crebricinctum* ____ 23
*gulosum* ____ 24
*hexagonum* ____ 23
*laeve* ____ 24
*parryensis* ____5, 9, *23* ; pl. 5
*vertebrale* ____5, 9, *22*, 23 ; pl. 5
sp ____ 22
*(Callistele), Astele* ____ 13
sp., *Astele* ____5, 8, 13
*callosa, Vicarya* ____ 26
*canarium, Strombus* ____ 57
*Strombus (Laevistrombus)* __7, 11, *57* ; pl. 15
*Canarium ustulatum* ____ 58
*(Canarium), Strombus* ____ *58*
*erythrinus, Strombus* ____7, 11, *59*
*gendinganensis, Strombus* ____ 58
*gibberulus, Strombus* ____ 62
*mutabilis, Strombus* ____7, 11, 12, *58* ; pl. 15
*praegibberulus, Strombus* ____ 62
*urceus, Strombus* ____7, 11, 12, *58* ; pl. 15
sp. B, *Strombus* ____7, 11, *59* ; pl. 16
*cancellata, Thiara* ____ 21
*Vanikoro* ____7, 10, 12, *52* ; pl. 13
*Viriola* ____7, 10, 12, *50* ; pl. 13
*cancellatus, Sigaretus* ____ 52
*Strombus* ____ 56
*Triphoris (Ino)* ____ 50
*Triphoris (Viriola)* ____ 50
Capulidae ____7, 10, *54*
*Capulus* ____ *54*
*badius* ____ 53
*liberatus* ____7, 10, 54, *55* ; pl. 14
*lissus* ____ 53
*(Krebsia)* ____ *54*
sp. A ____7, 10, *55* ; pl. 14
sp. B ____7, 10 *55* ; pl. 14
*catalinense, Micranellum* ____ 23
*Cautotriphora* ____ *49*
*hervieri* ____7, 10, 12, *49* ; pl. 12
*simulans* ____ 49
*Cerithidea* ____ *26*
*obtusa* ____6, 9, *27* ; pl. 6
Cerithiidae ____6, 9, *29*
Cerithiopsidae ____6, 10, *43*
*Cerithiopsis* ____ *44*
*balteata* ____ 43, 44
*pinea* ____ 43
*ridicula* ____ 43
*semipicta* ____ 43
sp ____6, 10, *44*
*(Joculator) tribulationis* ____ 43
*Cerithium* ____ 35, *37*
*adansonii* ____ 37
*alveolus* ____ 37
*articulatum* ____ 33
*asperum* ____ 34
*columna* ____ *39* ; pl.10
*egenum* ____ *40* ; pl. 9
*fasciatum* ____ 33
*fimbriatum* ____ 18

Page

*Cerithium*—Continued
*gemmatum* 33
*ianthinum* 31
*impendens* 30
*incisum* 40
*janthinum* 31
*jonkeri* 35
*lineatum* 30
*macrostoma* 32
*mutatum* 37
*nodulosum* 38
*obeliscus* 34
*obtusum* 26
*petrosum* 39
*pfefferi* 25, 35
*piperitum* 37
*procerum* 33
*pupina* 43
*rostratum* 32
*ruppelli* 38
*salebrosum* 37
*sergentum* 30
*serotinum* 32
*sordidulum* 35
*subcarinata* 27
*tauroconicum* 39
*terebelloides* 44
*tuberculatum* 39
*turritum* 25, 35, 36, 38
*verbeeki* 40
*vulgatum* 37
*zonalis* 27
(*Cerithium*) *38*
*columna* 6, 9, *39*; pl. 10
*nodulosum* 6, 9, 12, *38*; pl. 9
*tuberculatum* 6, 9, *39*; pl. 10
(*Conocerithium*) *39*
*egenum* 6, 9, *39*, 40; pl. 9
(*Proclava*) *turritum* 36
(*Thericium*) *37*
*alveolus* 6, 9, *37*; pl. 9
*mutatum* 6, 9, *37*; pl. 9
*ruppelli* 6, 9, *38*; pl. 9
*salebrosum* 6, 9, 12, *37*, 38; pl. 9
*schmidti* 6, 9, *38*; pl. 9
*tenellum* 6, 9, *38*; pl. 9
(*Vertagus*) *asper* 34
*jonkeri* 35
*obeliscus* 34
*turritum* 36
*vertagus* 33
(*Cerithium*), *Cerithium* *38*
*columna*, *Cerithium* 6, 9, *39*; pl. 10
*nodulosum*, *Cerithium* 6, 9, 12, *38*; pl. 9
*tuberculatum*, *Cerithium* 6, 9, *39*; pl. 10
*Cheilea* *52*, 53
*equestris* 7, 10, 12, *52*; pl. 13
*cingulifera*, *Notosinister* 48
*Triphora* (*Mastonia*) 7, 10, *48*; pl. 12
*Triphoris* 48
*Turritella* 5, 8, *14*; pl. 1
*goikulensis*, *Triphora* (*Mastonia*) 7, 10, *48*; pl. 12
*clathrus*, *Turbo* 51
(*Clathrus*), *Epitonium* 51
sp. A, *Epitonium* 7, 10, *51*; pl. 13
*Clava* (*Clava*) *jonkeri* 35
(*Proclava*) *pfefferi* 36
(*Clava*) *jonkeri*, *Clava* 35
*clavata*, *Triphora* (*Mastonia*) 7, 10, *48*; pl. 12
*Triphoris* 48
*Climacopoma* *18*

Page

sp. A 5, 8, *18*; pl. 2
*Clithon corona* 11
*clypeomorus*, *Clypeomorus* 40
*Clypeomorus* *40*
*clypeomorus* 40
*morus* 40
*verbeeki* 6, 9, 12, *40*; pl. 10
*wainingoli* 6, 9, *40*; pl. 10
*Colina* *32*
(*Ischnocerithium*) *32*
*rostrata* 6, 9, 12, *32*; pl. 4
*columna*, *Cerithium* 39; pl. 10
*Cerithium* (*Cerithium*) 6, 9, *39*; pl. 10
*commutata*, *Scala* 51
*conchyliophorus*, *Trochus* 55
*conica*, *Amalthea* 53, 54
*conicus*, *Hipponix* 54
*Hipponix* (*Sabia*) 7, 10, 12, *54*; pl. 13
(*Conocerithium*), *Cerithium* 39
*egenum*, *Cerithium* 6, 9, *39*, 40; pl. 9
(*Conomurex*), *Strombus* *61*
*luhuanus*, *Strombus* 7, 11, 12, *61*; pl. 19
*Conus terebellum* 57
(*Cookia*), *Astraea* 14
*Coriophora intermissa* 49
*cornucopia*, *Patella* 53
*corona*, *Clithon* 11
*corwini*, *Architectonica* (*Pseudotorinia*) 5, 8, *18*; pl. 2
*costulata*, *Basilissa* 13
*crebricinctum*, *Caecum* 23
*crispata*, *Varicospira* 7, 11, *56*; pl. 15
(*Cycloscala*), *Epitonium* *51*
*revolutum*, *Epitonium* 7, 10, 12, *51*; pl. 13
*Cyclostrema ammonoceras* 14
*spirula* 14
*Cyrbasia* *43*
*ovata* 6, 10, *44*; pl. 11
(*Joculator*) *43*
*semipicta* 6, 10, 12, *43*; pl. 11
*sumangi* 6, 10, *44*; pl. 11
*tribulationis* 6, 10, 12, *43*; pl. 11

D

*dancei*, *Obtortio* 6, 9, *29*; pl. 7
*Daronia* 14
(*Daronia*) 14
*hoffmeisteri* 5, 8, 14
(*Daronia*), *Daronia* 14
*hoffmeisteri*, *Daronia* 5, 8, 14
*decussatum*, *Epitonium* 52
*Dentalium trachaea* 22
*dextroversa*, *Triphoris* 44
*Diala* 3, *29*, 30
*albugo* 29
*lauta* 29
*ludens* 3, 6, 9, 12, *29*, 30; pl. 7
*semistriata* 29
*stricta* 6, 9, 12, *30*; pl. 7
*sulcifera* 6, 9, *30*; pl. 7
*varia* 29
(*Diala*) *sulcifera*, *Alba* 30
*Diastomidae* 6, 9, *27*
(*Dolomena*), *Strombus* *59*
*minimus minor*, *Strombus* 7, 11, *60*; pl. 18
*plicatus pulchellus*, *Strombus* 7, 11, 12, *59*; pl. 17
*variabilis athenius*, *Strombus* 7, 11, 12, *60*; pl. 17, 18

E

Page

*dunkeriana*, *Scala* 51
*echinaticosta*, *Scalaria* 51
*egenum*, *Cerithium* *40*; pl. 9
*Cerithium* (*Conocerithium*) 6, 9, *39*, 40; pl. 9
*elegans*, *Triforis* (*Viriola*) 50
*Triphoris* 50
*Viriola* 7, 10, *50*; pl. 13
*Elephantanellum* *23*
sp. A 5, 9, *23*; pl. 5
*elongatum*, *Meioceras* 23
*eniwetokensis*, *Ataxocerithium* 6, 9, *32*; pl. 4, 8
*Bittium* 6, 9, *31*; pl. 4
*Rhinoclavis* (*Pseudovertagus*) 6, 9, *36*; pl. 9
*Epiforis* 47
Epitoniidae 7, 10, *51*
*Epitonium* *51*
*decussatum* 52
*fucatum* 52
*kanemoe* 52
(*Boreoscala*) *51*
(*Boreoscala*?) sp 7, 10, *51*
(*Clathrus*) *51*
(*Clathrus*) sp. A 7, 10, *51*; pl. 13
(*Cycloscala*) *51*
*revolutum* 7, 10, 12, *51*; pl. 13
(*Gyroscala*) *51*
*perplexum* 7, 10, *51*; pl. 13
*equestris*, *Cheilea* 7, 10, 12, *52*; pl. 13
*Mitrularia* 53
*Patella* 52
*erythrinus*, *Strombus* 59
*Strombus* (*Canarium*) 7, 11, *59*
*euaensis*, *Munditiella* 5, 8, 14
*Euchelus excellens* 13
*euprepes*, *Architectonica* 19
(*Euprotomus*), *Strombus* 60, *61*
*vomer hawaiensis*, *Strombus* 7, 11, *61*; pl. 18
*excellens*, *Euchelus* 13
*exilis*, *Trochus* 41
*exoletus*, *Turbo* 16
*exuta*, *Xenophora* (*Tugurium*) 55
*exutum*, *Tugurium* 7, 10, 12, *55*; pl. 14
*exutus*, *Phorus* 55

F

*failingi*, *Obtortio* 6, 9, *28*, 29; pl. 7
*Fartulum* *24*
*amputatum* 5, 9, *24*; pl. 5
*laeve* 24
sp. A 5, 9, *24*; pl. 5
*fascialis*, *Turritella* 5, 8, *16*; pl. 1
*fasciatum*, *Cerithium* 33
*fasciatus*, *Strombus* (*Lentigo*) 61
*fasciolata*, *Melanoides* 22
*fileola*, *Turritella* 12, 14, 16
*Turritella* (*Haustator*) 16
*Turritella* (*Kurosioia*) 5, 8, 12, *16*; pl. 1
(*Fimbriatella*), *Mathilda* *18*
(*Fimbriatella*?) sp., *Mathilda* 5, 8, *18*
*fimbriatum*, *Cerithium* 18
*floraensis*, *Rhinoclavis* (*Pseudovertagus*) 6, 9, *36*; pl. 9
*floridus*, *Strombus* 58
*fluminea*, *Melanatria* 21
*fluviatilis*, *Tympanotonos* 26
*foliacea*, *Hipponix* 53
*foliaceus*, *Hipponix* (*Antisabia*) 7, 10, 12, *53*; pl. 13
*fragilis*, *Strombus* 7, 11, *59*; pl. 15
*fretense*, *Bittium* 32
*fucatum*, *Epitonium* 52

Page

*fuscatus, Murex* ---------- 26
*fusus, Murex* ---------- 56

G

*(Gallinula) malekulensis, Strombus* ---------- 59
*minimus minor, Strombus* ---- 60
*Gegania* ---------- *18*
*pinquis* ---------- 18
*whipplei* ----------5, 8, *18*
*gemmata, Triphora* ---------- 45
*gemmatum, Cerithium* ---------- 33
*gendinganensis, Strombus (Canarium)* ---------- 58
*gibberulus, Strombus* ---------- 62
*Strombus (Canarium)* ---------- 62
*gibbosus, Strombus (Gibberulus)* 7, 11, 12, *62* ; pl. 19, 20
*(Gibberulus), Strombus* ---------- 62
*gibberulus gibbosus, Strombus* 7, 11, *62* ; pl. 19, 20
*praegibberulus, Strombus* ---7, 11, *62* ; pl. 19
*gibbosa, Lambis* ---------- 62
*gibbosus, Strombus (Gibberulus) gibberulus* --7, 11, 12, *62* ; pl. 19, 20
*gigas, Triphoris* ---------- 45
*goikulensis, Triphora (Mastonia) cingulifera* ----------7, 10, *48* ; pl. 12
*gracillima, Turritella* ---------- 16
*greenlandicum, Scalaria* ---------- 51
*groenlandica, Scala* ---------- 51
*gueriniana, Vanikoro* --7, 10, 12, *52* ; pl. 13
*gulosum, Caecum* ---------- 24
*Gyroscala perplexa* ---------- 51
*(Gyroscala), Epitonium* ---------- *51*
*perplexum, Epitonium* ------7, 10, *51* ; pl. 13

H

*(Haustator) fileola, Turritella* ---- 16
*hawaiensis, Strombus* ---------- 61
*Strombus vomer* ---------- 61
*Strombus (Euprotomus) vomer* 7, 11, *61* ; pl. 18
*heberti, Solarium* ---------- 19
*Heliacus* ---------- *19*
*variegatus* ----------5, 8, 12, *19* ; pl. 3
*variegatus planulatus* --------- 19
sp ---------- 19
*Helix amarula* ---------- 21
*herklotsi, Potamides* ---------- 25
*hervieri, Cautotriphora* -7, 10, 12, *49* ; pl. 12
*Notosinister* ---------- 49
*hexagonum, Caecum* ---------- 23
*Hipponicidae* ----------7, 10, *52*
*Hipponix* ---------- *53*
*badius* ----------7, 10, *53* ; pl. 13
*conicus* ---------- 54
*foliacea* ---------- 53
*lissus* ---------- 53
*militaris* ---------- 54
*pilosus* ---------- 54
sp ---------- 53
*(Antisabia)* ---------- *53*
*foliaceus* -----7, 10, 12, *53* ; pl. 13
*(Malluvium)* ---------- *53*
*lissus* ---------- 53
*(Pilosabia)* ---------- *54*
*revelli* ----------7, 10, *54* ; pl. 14
*(Sabia)* ---------- *53*
*conicus* ------7, 10, 12, *54* ; pl. 13
*hoffmeisteri, Daronia (Daronia)* --5, 8, 14
*hungaricus, Patella* ---------- 54

I

Page

*hyalina, Scalaria* ---------- 51
*ianthinum, Bittium* --------6, 9, *31* ; pl. 7
*Cerithium* ---------- 31
*impendens, Bittium* --------6, 9, *30* ; pl. 7
*Cerithium* ---------- 30
*incisa, Triphoris* ---------- 50
*Viriola* ----------7, 10, 12, *50* ; pl. 12
*incisum, Cerithium* ---------- 40
*Liocerithium* ---------- 41
*Inella pyramidalis* ---------- 45
*(Inella), Triphora* ---------- *45*, 46
*maharatai, Triphora* ----7, 10,12, *46* ; pl. 12
*pyramidalis, Triphora* -------- 7, 10, 12, *45*, 46 ; pl. 11
*roddai, Triphora* ------7, 10, *46* ; pl. 11
sp. A, *Triphora* ----------7, 10, *46*
*Inforis albogranosa* ---------- 47
*malvaceus* ---------- 47
*(Inforis), Triphora* ---------- *47*
*albogranosa, Triphora* -----7, 10, *47* ; pl. 12
*ofuensis, Triphora* ----7, 10, *47* ; pl. 12
sp. B, *Triphora* ------7, 10, *47* ; pl. 12
*(Ino) cancellatus, Triphoris* ------ 50
*pagodus, Triphoris* ---------- 50
*intermissa, Coriophora* ---------- 49
*Triphora (Mastonia)* ----7, 10, 12, *49* ; pl. 12
*intortus, Pileopsis* ---------- 54
*isabella, Strombus* ---------- 57
*(Ischnocerithium), Colina* -------- *32*
*rostrata, Colina* ----6, 9, 12, *32* ; pl. 4

J

*janthinum, Cerithium* ---------- 31
*javana, Terebripirena* ---------- 35
*Turritella* ----------5, 8, *14* ; pl. 1
*javanus, Serpulorbis* --------5, 8, *20* ; pl. 3
*Vermetus* ---------- 21
*Joculator ovata* ---------- 44
*semipictus* ---------- 43
*(Joculator), Cyrbasia* ---------- *43*
*semipicta, Cyrbasia* -----6, 10, 12, *43* ; pl. 11
*sumangi, Cyrbasia* ----6, 10, *44* ; pl. 11
*tribulationis, Cerithiopsis* ---- 6, 10, *43* ; pl. 11
*tribulationis, Cyrbasia* -------- 6, 10, 12, *43* ; pl. 11
*jonkeri, Cerithium* ---------- 35
*Cerithium (Vertagus)* -------- 35
*Clava (Clava)* ---------- 35
*Rhinoclavis (Rhinoclavis)* ---- 6, 9, 12, *35* ; pl. 8

K

*kanakarum, Vanikoro* ----7, 10, *52* ; pl. 13
*kanemoe, Epitonium* ---------- 52
*kayae, Liocerithium* --------6, 9, *40* ; pl. 4
*kondoi, Sinezona* ----------5, 8, 13
*(Krebsia), Capulus* ---------- *54*
sp. A, *Capulus* -------7, 10, *55* ; pl. 14
sp. B, *Capulus* ------7, 10, *55* ; pl. 14
*krebsii, Architectonica (Philippia)* - 19
*kurosio, Turritella* ---------- 16
*(Kurosioia), Turritella* ---------- *15*
*fascialis, Turritella* ---------- 16
*fileola, Turritella* ----5, 8, 12, *16* ; pl. 1

L

*laeve, Caecum* ---------- 24
*Fartulum* ---------- 24
*(Laevistrombus), Strombus* ------- *57*
*canarium, Strombus* --7, 11, *57* ; pl. 15

Page

*lamarckii, Potamides* ---------- 24
*lambis, Lambis* ----------7, 11, *63* ; pl. 20
*Strombus* ---------- 63
*Lambis (Lambis)* --7, 11, *63* ; pl. 19, 20
*Lambis* ---------- 56, 63
*gibbosa* ---------- 62
*lambis* ----------7, *63* ; pl. 20
*(Lambis)* ---------- *63*
*lambis* -------7, 11, *63* ; pl. 19, 20
*(Lambis), Lambis* ---------- *63*
*lambis, Lambis* ----7, 11, *63* ; pl. 19, 20
*lamellosa, Scalaria* ---------- 51
*lamellosus, Petaloconchus (Macrophragma?)* -------- 5, 8, 12, *20* ; pl. 3
*lauta, Diala* ---------- 29
*Lemintina* sp ---------- 21
*lentiginosus, Strombus* ---------- 60
*(Lentigo), Strombus* ---------- *60*
*fasciatus, Strombus* ---------- 61
*micklei, Strombus* ------7, 11, *60*, 61 ; pl. 18
sp. C, *Strombus* ------7, 11, *61* ; pl. 18
*liberatus, Capulus* -----7, 10, 54, *55* ; pl. 14
*lineatum, Cerithium* ---------- 30
*lineolata, Melania* ---------- 26
*Liocerithium* ---------- *40*
*incisum* ---------- 41
*kayae* ----------6, 9, *40* ; pl. 4
*lissus, Capulus* ---------- 53
*Hipponix* ---------- 53
*Hipponix (Malluvium)* -------- 53
*littoreus, Turbo* ---------- 14
*Littorina* ---------- 14
*scabra* ----------5, 8, 14
*Littorinidae* ----------5, 8, *14*
*lowae, Rhinoclavis (Pseudovertagus)*, 6, 9, *36* ; pl. 9
*ludens, Diala* ----------3, 6, 9, 12, *29*, 30 ; pl. 7
*luhuanus, Strombus* ---------- 61
*Strombus (Conomurex)* --7, 11, 12, *61* ; pl. 19
*lumbricalis, Serpula* ---------- 17
*luteum, Solarium* ---------- 19
*luteus, Plesiotrochus* ----6, 9, 12, *41* ; pl. 10
*Tectarius* ---------- 41
*Lydiphnis* ---------- 14
*vainganaensis* ----------5, 8, 14

M

*macrophragma, Petaloconchus* ----- 20
*(Macrophragma), Petaloconchus* --- *20*
*lamellosus, Petaloconchus* ---- 5, 8, 12, *20* ; pl. 3
*merkana, Petaloconchus* --5, 8, 12, *20* ; pl. 3
*macrostoma, Cerithium* ---------- 32
*maharatai, Triphora (Inella)* ----- 7, 10, 12, *46* ; pl. 12
*malekulensis, Strombus* ---------- 60
*Strombus (Gallinula)* -------- 59
*(Malluvium), Hipponix* ---------- *53*
*lissus, Hipponix* ---------- 53
*malvaceus, Inforis* ---------- 47
*marshallensis, Plesiotrochus* --6, 9, *42*, 43 ; pl. 10
*Rhinoclavis (Rhinoclavis)* ---6, 9, *34* ; pl. 8
*Mastonia squamosa* ---------- 48
*(Mastonia), Triphora* ---------- *48*
*auberti, Triforis* ---------- 49
*auberti, Triphora* -----7, 10, *49* ; pl. 12
*cingulifera, Triphora* --7, 10, *48* ; pl. 12
*goikulensis, Triphora* --7, 10, *48* ; pl. 12

Page

(*Mastonia*)—Continued
*clavata, Triphora* ____7, 10, *48* ; pl. 12
*intermissa, Triphora* ____7, 10, 12, *49* ; pl. 12
*squamosa, Triphora* __7, 10, *48* ; pl. 12
*Mathilda* _____ *17*
(*Fimbriatella*) _____ *18*
sp _____5, 8, *18*
Mathildidae _____5, 8, *17*
*maximus, Strombus* _____ 57
*Strombus* (*Tricornis*) ___7, 11, 12, *57* ; pl. 16
*Meioceras elongatum* _____ 23
*Melanatria* _____ *21*
*fluminea* _____ 21
*vitiensis* _____5, 8, *21* ; pl. 4
*Melania lineolata* _____ 26
*pyrene* _____ 21
*Melanoides* _____ *22*
*fasciolata* _____ 22
*tuberculatus* _____5, 8, 11, *22* ; pl. 4
*merkana, Petaloconchus* (*Macrophragma*) _____5, 8, 12, *20* ; pl. 3
*micklei, Strombus* (*Lentigo*) __7, 11, *60*, 61 ; pl. 18
*Micranellum* _____ *23*
*catalinense* _____ 23
*schlangeri* _____5, 9, *23* ; pl. 5
*militaris, Hipponix* _____ 54
*minimus, Strombus* _____ 60
*minor, Strombus* (*Dolomena*) __ 7, 11, *60* ; pl. 18
*Strombus* (*Gallinula*) ____ 60
*minor, Strombus* (*Dolomena*) *minimus* _____7, 11, *60* ; pl. 18
*Strombus* (*Gallinula*) *minimus* 60
*Mitrularia equestris* _____ 53
*modesta, Rostellaria powisii* _____ 56
*Tibia powisii* _____ 56
*Tibia* (*Tibia*) *powisii* __7, 11, 12, *56* ; pl. 15
Modulidae _____5, 9, *24*
*modulus, Trochus* _____ 24
*Modulus* _____ *24*
*preangerensis* _____5, 9, 12, *24* ; pl. 5
*tectum* _____5, 9, *24*
*morrisoni, Thiara* (*Setaeara*) __5, 8, 11, *21* ; pl. 4
*morus, Clypeomorus* _____ 40
*Munditiella* _____ 14
*euaensis* _____5, 8, 14
*Murex aluco* _____ 36
*asper* _____ 34
*fuscatus* _____ 26
*fusus* _____ 56
*reticulatus* _____ 30
*sinensis* _____ 34
*sulcatus* _____ 27
*tubercularis* _____ 44
*vertagus* _____ 33
*mutabilis, Strombus* _____ 58
*Strombus* (*Canarium*) __7, 11, 12, *58* ; pl. 15
*mutatum, Cerithium* _____ 37
*Cerithium* (*Thericium*) __6, 9, *37* ; pl. 9

N

*Narica queriniana* _____ 52
*nebulosum, Terebellum* _____ 57
*Nerinea vernuili* _____ 26
*Nerita tuberculata* _____ 22
*nodulosum, Cerithium* _____ 38
*Cerithium* (*Cerithium*) __6, 9, 12, *38* ; pl. 9
(*Notoseila*) *Seila* _____ *44*
*waluensis, Seila* _____6, 10, *44* ; pl. 11
*Notosinister cingulifera* _____ 48

O

Page

*hervieri* _____ 49
*otsuensis* _____ 45
*obeliscus, Cerithium* _____ 34
*Cerithium* (*Vertagus*) _____ 34
*Vertagus* _____ 34
*Obtortio* _____ 3, *27*
*dancei* _____6, 9, *29* ; pl. 7
*failingi* _____6, 9, *28*, 29 ; pl. 7
*pyrrhacme* _____3, 6, 9, 12, *28*, 29 ; pl. 6, 7
sp. A _____6, 9, *29* ; pl. 7
*obtusa, Cerithidea* _____6, 9, *27* ; pl. 6
*obtusum, Cerithium* _____ 26
*Solarium* _____ 18
(*Ochetoclava*), *Rhinoclavis* _____ 35
*ofuensis, Triphora* _____ 47
*Triphora* (*Inforis*) ____7, 10, *47* ; pl. 12
*otsuensis, Notosinister* _____ 45
*Triforis* _____ 45
*Triphora* _____ 45
*Triphora* (*Triphora*) ____6, 10, 12, *45* ; pl. 11
*ovata, Cyrbasia* _____6, 10, *44* ; pl. 11
*Joculator* _____ 44

P

*pacifica, Basilissa* (*Ancistrobasis*) __5, 8, 13
*pagoda, Viriola* _____7, 10, *50* ; pl. 12
*pagodiformis, Plesiotrochus* ___6, 9, 12, *41* ; pl. 10
*pagodus, Triphoris* (*Ino*) _____ 50
*pallida, Triphora* (*Triphora*) ____6, 10, *45* ; pl. 11
*pallidus, Triphoris* _____ 45
*palustris, Strombus* _____ 27
*Parastrophia* _____ 23
*parcum, Bittium* _____ 30
*Pareuchlus* _____ 13
sp _____5, 8, 13
*parryensis, Caecum* _____5, 9, *23* ; pl. 5
*Patella cornucopia* _____ 53
*equestris* _____ 52
*hungaricus* _____ 54
*patula, Solarium* _____ 18
*perlatus, Triphora* _____ 49
*perplexa, Gyroscala* _____ 51
*Scalaria* _____ 51
*perplexum, Epitonium* (*Gyroscala*) __ 7, 10, *51* ; pl. 13
(*Perrinia*), *Turcica* _____ 13
*blowi, Turcica* _____5, 8, 13
*perspectiva, Architectonica* _____ 18
*Architectonica* (*Architectonica*) 5, 8, 12, *18* ; pl. 2
*perspectivum, Solarium* _____ 18
*perspectivus, Trochus* _____ 18
*Petaloconchus* _____ *20*
*macrophragma* _____ 20
(*Macrophragma*) _____ *20*
*lamellosus* _____5, 8, 12, *20* ; pl. 3
*merkana* _____5, 8, 12, *20* ; pl. 3
*petrosum, Cerithium* _____ 39
*pfefferi, Cerithium* _____ 25, 35
*Clava* (*Proclava*) _____ 36
*Vertagus* _____ 36
*Philippia* _____ *19*
(*Psilaxis*) _____ *19*
*radiata* _____5, 8, 12, *19* ; pl. 2
(*Philippia*) *krebsii, Architectonica* __ 19
*Phorus exutus* _____ 55
*Pileopsis intortus* _____ 54
*pilosus* _____ 54
(*Pilosabia*), *Hipponix* _____ *54*
*revelli, Hipponix* _____7, 10, *54* ; pl. 14

Page

*pilosus, Hipponix* _____ 54
*Pileopsis* _____ 54
*pinea, Cerithiopsis* _____ 43
*pinquis, Gegania* _____ 18
*piperitum, Cerithium* _____ 37
*planulatus, Heliacus variegatus* ___ 19
*Plesiotrochus* _____ *41*, 42
*luteus* _____6, 9, 12, *41* ; pl. 10
*marshallensis* _____6, 9, *42*, 43 ; pl. 10
*pagodiformis* _____6, 9, 12, *41* ; pl. 10
*souverbianus* _____ 41
*talinana* _____6, 9, *42* ; pl. 10
*whitmorei* _____6, 9, *42* ; pl. 11
sp. A _____6, 9, *42*
*plicatus pulchellus, Strombus* _____ 59
*pulchellus, Strombus* (*Dolomena*) ___7, 11, 12, *59* ; pl. 17
*podagrinum, Bittium* _____ 32
*polyphragma, Serpulorbis* _____ 20
*Potamides* _____ *24*
*herklotsi* _____ 25
*lamarckii* _____ 24
*tayamaia* _____6, 9, *24* ; pl. 6
*wardi* _____6, 9, *25* ; pl. 6
sp. A _____6, 9, *25*, 26 ; pl. 6
sp. B _____6, 9, *26* ; pl. 6
(*Terebralia*) *sulcatus* _____ 27
(*Tympanotonos*) *berberkirianus* 26
Potamididae _____6, 9, *24*
*powelli, Rhinoclavis* (*Rhinoclavis*) 6, 9, *35* ; pl. 8
*powisii, Tibia* _____ 56
*Tibia* (*Tibia*) _____ 56
*abyssicola, Rostellaria* _____ 56
*modesta, Rostellaria* _____ 56
*Tibia* _____ 56
*Tibia* (*Tibia*) _____7, 11, 12, *56* ; pl. 15
*timorensis, Rostellaria* (*Sucogladius*) _____ 56
*praegibberulus, Strombus* (*Canarium*) _____ 62
*Strombus* (*Gibberulus*) ____7, 11, *62* ; pl. 19
*preangerensis, Modulus* __5, 9, 12, *24* ; pl. 5
*preoccupatus, Strombus* _____7, 11, *61* ; pl. 18, 19
*procera, Rhinoclavis* (*Rhinoclavis*) 6, 9, 12, *33* ; pl. 8
*procerum, Cerithium* _____ 33
(*Proclava*), *Rhinoclavis* _____ *35*
*pfefferi, Clava* _____ 36
*sordidula, Rhinoclavis* _____ 6, 9, 12, 25, *35* ; pl. 8
*turritum, Cerithium* _____ 36
(*Pseudotorinia*), *Architectonica* ___ *18*
*corwini, Architectonica* __5, 8, *18* ; pl. 2
(*Pseudovertagus*), *Rhinoclavis* ____ *36*
*aluco, Rhinoclavis* _____ 36
*eniwetokensis, Rhinoclavis* ____ 6, 9, *36* ; pl. 9
*floraensis, Rhinoclavis* __6, 9, *36* ; pl. 9
*lowae, Rhinoclavis* _____6, 9, *36* ; pl. 9
(*Psilaxis*), *Philippia* _____ *19*
*radiata, Philippia* ____5. 8, 12, *19* ; pl. 2
*pugilis, Strombus* _____ 57
*pulchellus, Strombus* _____ 59, 60
*Strombus plicatus* _____ 59
*Strombus* (*Dolomena*) *plicatus* 7, 11, 12, *59* ; pl. 17
*pupina, Cerithium* _____ 43
*pyramidalis, Inella* _____ 45
*Triphora* (*Inella*) ____7, 10, 12, *45*, 46 ; pl. 11
*Triphoris* _____ 45
*Pyrazus* (*Pyrazus*) sp _____ 21
(*Pyrazus*) sp., *Pyrazus* _____ 21
*pyrene, Melania* _____ 21

Page

*pyrrhacme, Obtortio* ____3, 6, 9, 12, *28*, 29; pl. 6, 7
*Rissoia* _____ 27, 28

Q

*quadricarinatus, Turbo* _____ 17
*queriniana, Narica* _____ 52

R

*radiata, Architectonica* _____ 19
*Philippia (Psilaxis)* __5, 8, 12, *19*; pl. 2
*reticulatus, Murex* _____ 30
*revelli, Hipponix (Pilosabia)* ____7, 10, *54*; pl. 14
*revoluta, Scala* _____ 51
*revolutum, Epitonium (Cycloscala)* 7, 10, 12, *51*; pl. 13
*Rhinoclavis* _____ *33*
*aspera* _____ 34
*sinensis* _____6, *34*; pl. 8
*vertagus* _____ 33, 35
*(Ochetoclava)* _____ 35
*(Proclava)* _____ *35*
*sordidula* _____6, 9, 12, 25, *35*; pl. 8
*(Pseudovertagus)* _____ *36*
*aluco* _____ 36
*eniwetokensis* _____6, 9, *36*; pl. 9
*floraensis* _____6, 9, *36*; pl. 9
*lowae* _____6, 9, *36*; pl. 9
*(Rhinoclavis)* _____ *33*, 35
*articulata* _____6, 9, *33*; pl. 8
*aspera* _____6, 9, 12, *34*; pl. 8
*jonkeri* _____6, 9, 12, *35*; pl. 8
*marshallensis* _____6, 9, *34*; pl. 8
*powelli* _____6, 9, *35*; pl. 8
*procera* _____6, 9, 12, *33*; pl. 8
*sinensis* _____6, 9, *34*; pl. 8
*vertagus* _____6, 9, *33*; pl. 8
*(Rhinoclavis), Rhinoclavis* _____ *33*, 35
*articulata, Rhinoclavis* _____6, 9, *33*; pl. 8
*aspera, Rhinoclavis* _____6, 9, 12, *34*; pl. 8
*jonkeri, Rhinoclavis* _____6, 9, 12, *35*; pl. 8
*marshallensis, Rhinoclavis* ___6, 9, *34*; pl. 8
*powelli, Rhinoclavis* ____6, 9, *35*; pl. 8
*procera, Rhinoclavis* _____6, 9, 12, *33*; pl. 8
*sinensis, Rhinoclavis* ____6, 9, *34*; pl. 8
*vertagus, Rhinoclavis* ____6, 9, *33*; pl. 8
*rickardi, Batillaria (Zeacumantus)* 6, 9, *27*; pl. 6
*ridicula, Cerithiopsis* _____ 43
*Rissoia pyrrhacme* _____ 27, 28
*semistriata* _____ 29
*roddai, Triphora (Inella)* __7, 10, *46*; pl. 11
*Rostellaria powisii abyssicola* _____ 56
*powisii modesta* _____ 56
*(Sulcogladius) powisii timorensis* _____ 56
*rostrata, Colina (Ischnocerithium)* 6, 9, 12, *32*; pl. 4
*rostratum, Cerithium* _____ 32
*rugosa, Turbo* _____ 13
*ruppelli, Cerithium* _____ 38
*Cerithium (Thericium)* _____6, 9, *38*; pl. 9

S

*(Sabia), Hipponix* _____ *53*
*conicus, Hipponix* _____7, 10, 12, *54*; pl. 13

Page

*salebrosum, Cerithium* _____ 37
*Cerithium (Thericium)* ___6, 9, 12, *37*; pl. 9
*scabra, Littorina* _____5, 8, 14
*Scala commutata* _____ 51
*dunkeriana* _____ 51
*groenlandica* _____ 51
*revoluta* _____ 51
*Scalaria echinaticosta* _____ 51
*greenlandicum* _____ 51
*hyalina* _____ 51
*lamellosa* _____ 51
*perplexa* _____ 51
*scalaris, Turbo* _____ 51
*Schismope brevis* _____ 13
*schlangeri, Micranellum* _____5, 9, *23*; pl. 5
*schmidti, Cerithium (Thericium)* __6, 9, *38*; pl. 9
*Scissurella* _____ 13
*(Anatoma)* _____ 13
*tongaensis* _____5, 8, 13
*Scissurellidae* _____5, 8, *13*
*sedanensis, Turritella* _____5, 8, *15*; pl. 1
*Seila* _____ *44*
*attenuissima* _____ 44
*waluensis* _____ 44
*(Notoseila)* _____ 44
*waluensis* _____6, 10, *44*; pl. 11
*semipicta, Cerithiopsis* _____ 43
*Cyrbasia (Joculator)* ____6, 10, 12, *43*; pl. 11
*semipictus, Joculator* _____ 43
*semistriata, Diala* _____ 29
*Rissoia* _____ 29
*sergentum, Bittium* _____6, 9, 12, *30*; pl. 7
*Cerithium* _____ 30
*serotinum, Ataxocerithium* _____ 32
*Cerithium* _____ 32
*Serpula anguinus* _____ 17
*arenaria* _____ 20
*lumbricalis* _____ 17
*Serpulorbis* _____ *20*
*javanus* _____5, 8, *20*; pl. 3
*polyphragma* _____ 20
sp _____5, 8, *21*
*(Setaeara), Thiara* _____ *21*
*morrisoni, Thiara* _____5, 8, 11, *21*; pl. 4
*Sigaretus cancellatus* _____ 52
*Siliquaria spinosa* _____ 17
sp _____ 17
*simulans, Cautotriphora* _____ 49
*sinensis, Murex* _____ 34
*Rhinoclavis* _____6, *34*; pl. 8
*Rhinoclavis (Rhinoclavis)* ___6, 9, *34*; pl. 8
*Sinezona* _____ 13
*kondoi* _____5, 8, 13
*sinuatus, Strombus* _____7, 11, *58*
*Solarium heberti* _____ 19
*luteum* _____ 19
*obtusum* _____ 18
*patula* _____ 18
*perspectivum* _____ 18
*sordidula, Rhinoclavis (Proclava)* 6, 9, 12, 25, *35*; pl. 8
*sordidulum, Cerithium* _____ 35
*souverbianus, Plesiotrochus* _____ 41
*spinosa, Siliquaria* _____ 17
*spinosus, Strombus* _____ 61
*spirula, Cyclostrema* _____ 14
*spolongensis, Turritella* _____5, 8, *15*; pl. 1
*squamosa, Mastonia* _____ 48
*Triphora (Mastonia)* _____7, 10, *48*; pl. 12
*stearnsi, Astraea (Bolma)* _____5, 8, 13
*Strebloceras* _____ 23
*stricta, Diala* _____6, 9, 12, *30*; pl. 7

Page

*Strombidae* _____7, 10, *56*
*Strombus* _____56, *57*, 61
*athenius* _____ 60
*aurisdianae* _____ 61
*canarium* _____ 57
*cancellatus* _____ 56
*erythrinus* _____ 59
*floridus* _____ 58
*fragilis* _____7, 11, *59*; pl. 15
*gibberulus* _____ 62
*hawaiensis* _____ 61
*isabella* _____ 57
*lambis* _____ 63
*lentiginosus* _____ 60
*luhuanus* _____ 61
*malekulensis* _____ 60
*maximus* _____ 57
*minimus* _____ 60
*mutabilis* _____ 58
*palustris* _____ 27
*plicatus pulchellus* _____ 59
*preoccupatus* _____7, 11, *61*; pl. 18, 19
*pugilis* _____ 57
*pulchellus* _____ 59, 60
*sinuatus* _____7, 11, *58*
*spinosus* _____ 61
*terebellatus* _____ 59
*thersites* _____7, 11, *58*; pl. 15
*tjilonganensis* _____ 58
*tricornis* _____ 57
*tuberculatus* _____ 39
*unfasciatus* _____ 59
*urceus* _____ 58
*variabilis* _____ 60
*variabilis athenius* _____ 60
*vomer hawaiensis* _____ 61
sp _____ 58
*(Canarium)* _____ *58*
*erythrinus* _____7, 11, *59*
*gendinganensis* _____ 58
*gibberulus* _____ 62
*mutabilis* _____7, 11, 12, *58*; pl. 15
*praegibberulus* _____ 62
*urceus* _____7, 11, 12, *58*; pl. 15
sp. B _____7, 11, *59*; pl. 16
*(Conomurex)* _____ *61*
*luhuanus* _____7, 11, 12, *61*; pl. 19
*Strombus (Dolomena)* _____ *59*
*(Dolomena) minimus minor* __ 7, 11, *60*; pl. 18
*plicatus pulchellus* __7, 11, 12, *59*; pl. 17
*variabilis athenius* __7, 11, 12, *60*; pl. 17, 18
*(Euprotomus)* _____ 60, *61*
*vomer hawaiensis* _____7, 11, *61*; pl. 18
*(Gallinula) malekulensis* _____ 59
*minimus minor* _____ 60
*(Gibberulus)* _____ 62
*gibberulus gibbosus* __7, 11, 12, *62*; pl. 19, 20
*praegibberulus* ___7, 11, *62*; pl. 19
*(Laevistrombus)* _____ *57*
*canarium* _____7, 11, *57*; pl. 15
*(Lentigo)* _____ *60*
*fasciatus* _____ 61
*micklei* _____7, 11, *60*, 61; pl. 18
sp. C _____7, 11, *61*; pl. 18
*(Tricornis)* _____ *57*
*maximus* _____7, 11, 12, *57*; pl. 16
sp. A _____7, 11, *58*; pl. 17
*subcarinata, Cerithium* _____ 27
*subulata, Turritella* _____ 14
*sulcata, Terebralia* _____6, 9, 12, *27*; pl. 6
*sulcatus, Murex* _____ 27
*Potamides (Terebralia)* _____ 27


462-678 O - 72 - 6

Page

*sulcifera, Alba (Diala)* ---------- 30
*Diala* ----------6, 9, *30*; pl. 7
*(Sulcogladius) powisii timorensis, Rostellaria* ---------- 56
*sumangi, Cyrbasia (Joculator)* --6, 10, *44*; pl. 11
*superba, Basilissa* ---------- 13

T

*talinana, Plesiotrochus* -----6, 9, *42*; pl. 10
*tauroconicum, Cerithium* ---------- 39
*tayamaia, Potamides* -------6, 9, *24*; pl. 6
*Tectarius luteus* ---------- 41
*uteus* ---------- 41
*tectum, Modulus* ----------5, 9, *24*
*Trochus* ---------- 24
*Tenagodus* ---------- *17*
*australis* ----------5, 8, *17*; pl. 2
*(Agathirses)* ---------- 17
*(Tenagodus)* sp --------5, 8, *17*; pl. 1
*(Tenagodus)* sp., *Tenagodus* ---5, 8, 17
*tenellum, Cerithium (Thericium)* --6, 9, *38*; pl. 9
*Tenpetasus* ---------- 54
*terebellatus, Strombus* ---------- 59
*terebelloides, Cerithium* ---------- 44
*terebellum, Conus* ---------- 57
*Terebellum (Terebellum)* ----- 7, 11, 12, *57*; pl. 15
*Terebellum* ---------- *57*
*nebulosum* ---------- 57
*(Terebellum)* ---------- *57*
*terebellum* ----------7, 11, 12, *57*; pl. 15
*(Terebellum), Terebellum* -------- *57*
*terebellum, Terebellum* --7, 11, 12, *57*; pl. 15
*terebra, Turbo* ---------- 14
*Terebralia* ---------- *27*
*sulcata* ----------6, 9, 12, *27*; pl. 6
*(Terebralia) sulcatus, Potamides* -- 27
*Terebripirena* ---------- 35
*javana* ---------- 35
*terrebellum, Bulla* ---------- 57
*(Thericium), Cerithium* ---------- *37*
*alveolus, Cerithium* ----6, 9, *37*; pl. 9
*mutatum, Cerithium* ----6, 9, *37*; pl. 9
*ruppelli, Cerithium* -----6, 9, *38*; pl. 9
*salebrosum, Cerithium* -------- 6, 9, 12, *37*, 38; pl. 9
*schmidti, Cerithium* ----6, 9, *38*; pl. 9
*tenellum, Cerithium* ----6, 9, *38*; pl. 9
*thersites, Strombus* ------7, 11, *58*; pl. 15
*Thiara* ---------- *21*, 22
*cancellata* ---------- 21, 22
*(Setaeara)* ---------- *21*
*(Setaeara) morrisoni* ----5, 8, 11, *21*; pl. 4
Thiaridae ----------5, 8, *21*
*Tiarella* ---------- *43*
*Tibia* ---------- *56*
*powisii* ---------- 56
*powisii modesta* ---------- 56
*(Tibia)* ---------- 56
*powisii* ---------- 56
*powisii modesta* ----7, 11, 12, *56*; pl. 15
*(Tibia), Tibia* ---------- 56
*powisii, Tibia* ---------- 56
*modesta, Tibia* -----7, 11, 12, *56*; pl. 15
*timorensis, Rostellaria (Sucogladius) powisii* ---------- 56
*tjilonganensis, Strombus* ---------- 58
*toddae, Bittium (Bittiolum)* -----6, 9, *32*; pl. 4
*tongaensis, Scissurella (Anatoma)* --5, 8, 13

Page

*(Torcula), Turritella* ---------- *16*
sp. C, *Turritella* ----------5, 8, 17
*Torinia variegatus* ---------- 19
(Tornidae), Adeorbidae ---------- 14
*trachaea, Dentalium* ---------- 22
*tribulationis, Cyrbasia (Joculator)* 6, 10, 12, *43*; pl. 11
*tricornis, Strombus* ---------- 57
*(Tricornis), Strombus* ---------- *57*
*maximus, Strombus* ----7, 11, 12, *57*; pl. 16
sp. A, *Strombus* ------7, 11, *58*; pl. 17
*Triforis* ---------- 47
*aegle* ---------- 47
*otsuensis* ---------- 45
*(Mastonia) auberti* ---------- 49
*(Viriola) elegans* ---------- 50
*Triphora* ---------- *45*
*gemmata* ---------- 45
*ofuensis* ---------- 47
*otsuensis* ---------- 45
*perlatus* ---------- 49
*vulpinus* ---------- 48
*(Inella)* ---------- *45*, 46
*maharatai* ----7, 10, 12, *46*; pl. 12
*pyramidalis* -----7, 10, 12, *45*, 46; pl. 11
*roddai* ----------7, 10, *46*; pl. 11
sp. A ----------7, 10, *46*; pl. 12
*(Inforis)* ---------- *47*
*albogranosa* ------7, 10, *47*; pl. 12
*ofuensis* ---------7, 10, *47*; pl. 12
sp. B ----------7, 10, *47*; pl. 12
*(Mastonia)* ---------- *48*
*auberti* ----------7, 10, *49*; pl. 12
*cingulifera* ------7, 10, *48*; pl. 12
*goikulensis* ----7, 10, *48*; pl. 12
*clavata* ---------7, 10, *48*; pl. 12
*intermissa* ----7, 10, 12, *49*; pl. 12
*squamosa* -------7, 10, *48*; pl. 12
*(Triphora)* ---------- *45*
*otsuensis* -----6, 10, 12, *45*; pl. 11
*pallida* ----------6, 10, *45*; pl. 11
*(Triphora), Triphora* ---------- *45*
*otsuensis, Triphora* -----6, 10, 12, *45*; pl. 11
*pallida, Triphora* -----6, 10, *45*; pl. 11
Triphoridae ----------6, 10, *45*
*Triphoris cingulifera* ---------- 48
*clavata* ---------- 48
*dextroversa* ---------- 44
*elegans* ---------- 50
*gigas* ---------- 45
*incisa* ---------- 50
*pallidus* ---------- 45
*pyramidalis* ---------- 45
*(Ino) cancellatus* ---------- 50
*pagodus* ---------- 50
*(Viriola) cancellatus* ---------- 50
Trochidae ----------5, 8, *13*
*Trochus conchyliophorus* ---------- 55
*exilis* ---------- 41
*modulus* ---------- 24
*perspectivus* ---------- 18
*tectum* ---------- 24
*variegatus* ---------- 19
*tuberculatus, Murex* ---------- 44
*tuberculata, Nerita* ---------- 22
*tuberculatum, Cerithium* ---------- 39
*Cerithium (Cerithium)* ------6, 9, *39*; pl. 10
*tuberculatus, Melanoides* -----5, 8, 11, *22*; pl. 4
*Strombus* ---------- 39
*Tugurium* ---------- *55*
*exutum* ----------7, 10, 12, *55*; pl. 14
*(Tugurium) exuta, Xenophora* ---- 55
Turbinidae ----------5, 8, *13*

Page

*Turbo clathrus* ---------- 51
*exoletus* ---------- 16
*littoreus* ---------- 14
*quadricarinatus* ---------- 17
*rugosa* ---------- 13
*scalaris* ---------- 51
*terebra* ---------- 14
*Turcica* ---------- 13
*(Perrinia)* ---------- 13
*blowi* ----------5, 8, 13
*Turritella* ---------- 14, 15
*bifastigata* ---------- 15
*cingulifera* ----------5, 8, *14*; pl. 1
*fascialis* ----------5, 8, *16*; pl. 1
*fileola* ----------12, 14, 16
*gracillima* ---------- 16
*javana* ----------5, 8, *14*; pl. 1
*kurosio* ---------- 16
*sedanensis* ----------5, 8, *15*; pl. 1
*spolongensis* ----------5, 8, *15*; pl. 1
*subulata* ---------- 14
*vittulata* ---------- 15
sp. A ----------5, 8, *15*; pl. 1
sp. B ----------5, 8, *15*; pl. 1
*(Haustator) fileola* ---------- 16
*(Kurosioia)* ---------- *15*
*fileola* ---------5, 8, 12, *16*; pl. 1
*(Torcula)* ---------- *16*
sp. C ----------5, 8, *17*; pl. 1
Turritellidae ----------5, 8, *14*
*turritum, Cerithium* --------25, 35, 36, 38
*Cerithium (Proclava)* -------- 36
*Cerithium (Vertagus)* -------- 36
*Tympanotonos* ---------- *26*
*berberkirianus* ------6, 9, 12, *26*; pl. 6
*fluviatilis* ---------- 26
*(Tympanotonos) berberkirianus, Potamides* ---------- 26

U

*unfasciatus, Strombus* ---------- 59
*urceus, Strombus* ---------- 58
*Strombus (Canarium)* ---7, 10, 12, *58*; pl. 15
*ustulatum, Canarium* ---------- 58
*uteus, Tectarius* ---------- 41

V

*vainganaensis, Lydiphnis* ---------5, 8, 14
Vanikoridae ----------7, 10, *52*
*Vanikoro* ---------- *52*
*cancellata* --------7, 10, 12, *52*; pl. 13
*gueriniana* -------7, 10, 12, *52*; pl. 13
*kanakarum* ----------7, 10, *52*; pl. 13
*varia, Diala* ---------- 29
*variabilis, Strombus* ---------- 60
*athenius, Strombus* ---------- 60
*athenius, Strombus (Dolomena)* 7, 11, 12, *60*; pl. 17, 18
*Varicospira* ---------- *56*
*crispata* ----------7, 11, *56*; pl. 15
*variegatus, Heliacus* ----5, 18, 12, *19*; pl. 3
*Torinia* ---------- 19
*Trochus* ---------- 19
*planulatus, Heliacus* ---------- 19
*varium, Bittium* ---------- 32
*verbeeki, Cerithium* ---------- 40
*Clypeomorus* ------6, 9, 12, *40*; pl. 10
Vermetidae ----------5, 8, *20*
*Vermetus javanus* ---------- 21
*Vermicularia* ---------- *17*
sp. A ----------5, 8, *17*; pl. 2
*vernuili, Nerinea* ---------- 26
*vertagus, Cerithium (Vertagus)* ---- 33
*Murex* ---------- 33
*Rhinoclavis* ---------- 33, 35
*Rhinoclavis (Rhinoclavis)* ---6, 9, *33*; pl. 8

Page

*Vertagus articulatus* ---------- 33
*obeliscus* ---------- 34
*pfefferi* ---------- 36
(*Vertagus*) *asper, Cerithium* ------ 34
*jonkeri, Cerithium* ---------- 35
*obeliscus, Cerithium* ---------- 34
*turritum, Cerithium* ---------- 36
*vertagus, Cerithium* ---------- 33
*vertebrale, Caecum* ------5, 9, *22*, 23 ; pl. 5
*Vicarya* ---------- *26*
*callosa* ---------- 26
sp ----------6, 9, 26 ; pl. 6
*Viriola* ---------- *50*
*bayani* ---------- 50
*cancellata* --------7, 10, 12, *50* ; pl. 13
*elegans* ----------7, 10, *50* ; pl. 13
*incisa* ----------7, 10, 12, *50* ; pl. 12
*pagoda* ----------7, 10, *50* ; pl. 12

Page

(*Viriola*) *cancellatus, Triphoris* ---- 50
*elegans, Triforis* ---------- 50
*vitiensis, Melanatria* -------5, 8, *21* ; pl. 4
*vittulata, Turritella* ---------- 15
*vomer hawaiensis, Strombus* ------ 61
*hawaiensis, Strombus* (*Euprotomus*) -----7, 11, *61* ; pl. 18
*vulgatum, Cerithium* ---------- 37
*vulpinus, Triphora* ---------- 48

W

*wainingoli, Clypeomorus* ----6, 9, *40* ; pl. 10
*Seila* ---------- 44
*Seila* (*Notoseila*) ----6, 10, *44* ; pl. 11
*wardi, Potamides* ----------6, 9, *25* ; pl. 6
*Watsonia* ---------- 23

Page

*whipplei, Gegania* ----------5, 8, *18*
*whitmorei, Plesiotrochus* ---6, 9, *42* ; pl. 11

X

*Xenophora* ---------- *55*
sp ---------- 55
sp. A ----------7, 10, *55*
sp. B ----------7, 10, *55* ; pl. 14
(*Tugurium*) *exuta* ---------- 55
Xenophoridae ----------7, 10, *55* ; pl. 14

Z

(*Zeacumantus*), *Batillaria* -------- 27
*rickardi, Batillaria* -----6, 9, 27 ; pl. 6
*zonalis, Cerithium* ---------- 27


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# PLATES 1–20

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# PLATE 1

FIGURE 1. *Turritella* aff. *T. cingulifera* Sowerby (p. 14).
Length 9.9 mm, X 6. Drill hole E–1, Eniwetok Atoll, depth 2,740–2,750 ft; early Miocene. USNM 648481.

2. *Turritella* cf. *T. javana* Martin (p. 14).
Cast of Saipan specimen, length 18 mm, X 3. USGS loc. 18288, inequigranular facies of Tagpochau Limestone (Miocene). USNM 648482.

3. *Turritella* aff. *T. sedanensis* Martin (p. 15).
Cast of Saipan specimen, length 20 mm, X 3. USGS loc. 17689, tuffaceous facies of Tagpochau Limestone (Miocene). USNM 648483.

4. *Turritella* aff. *T. spolongensis* Martin (p. 15).
Cast of Saipan specimen, length 14.0 mm, X 4. USGS loc. 17942, inequigranular facies of Tagpochau Limestone (Miocene). USNM 648484.

5, 6. *Turritella* sp. A (p. 15).
5. Length 23.3 mm, X 3. Viti Levu, Fiji, station MR–20, probably Pliocene. USNM 648485.
6. Length 24.2 mm, X 3. Guam, USGS loc. 21434, molluscan facies of Mariana Limestone (Pliocene and Pleistocene). USNM 648486.

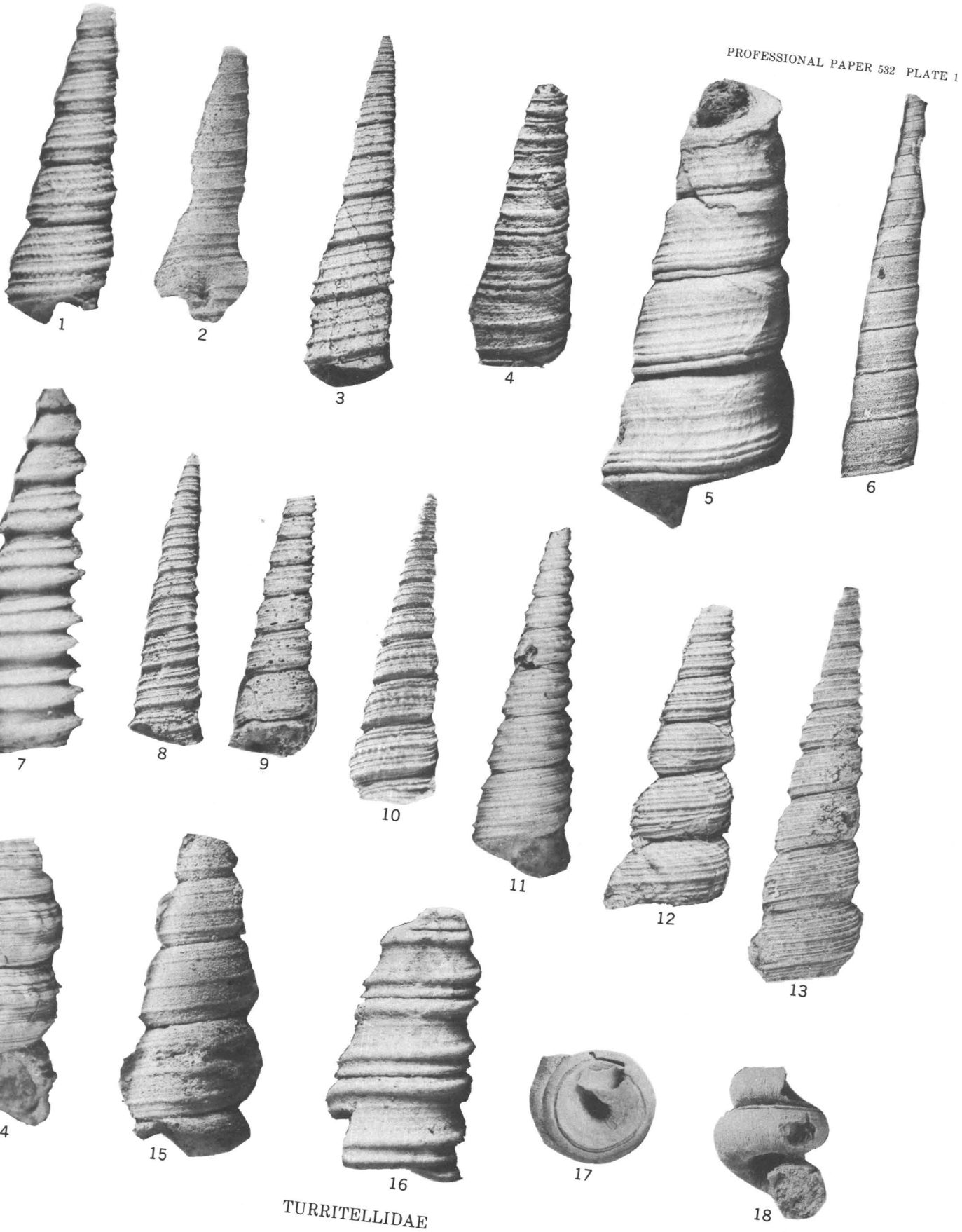
7. *Turritella* sp. B (p. 15).
Height 3.2 mm, X 20. Drill hole 2A, Bikini, depth 279–284½ ft; possibly Pliocene. USNM 648487.

8–14. *Turritella* (*Kurosioia*) *fileola* Yokoyama (p. 16).
8. Cast of Guam specimen, length 18.0 mm, X 3. USGS loc. 17446; Mariana Limestone (Pliocene and Pleistocene). USNM 648488.
9. Cast, length 16.1 mm, X 3. Same as for figure 8. USNM 648489.
10. Cast, length 19.7 mm, X 3. Same as for figure 8. USNM 648490
11. Length 8.1 mm, X 8. Viti Levu, Fiji, station C–89, probably Pliocene. USNM 648494.
12. Length 14 mm, X 4. Espiritu Santo, New Hebrides, USGS loc. 21031; age unknown. USNM 648492.
13. Cast, length 25.5 mm, X 3. Same as for figure 8. USNM 648491.
14. Length 5.7 mm, X 8. Same as for figure 12. USNM 648493.

15. *Turritella* (*Kurosioia*) aff. *T. fascialis* Menke (p. 16).
Cast of Guam specimen, length 7 mm, X 8. USGS loc. 24795. Barrigada Limestone (upper Tertiary). USNM 648495.

16. *Turritella* (*Torcula*?) sp. C (p. 17).
Height 17.1 mm, X 3. Viti Levu, Fiji, station 160, early Miocene. USNM 648496.

17, 18. *Tenagodus* (*Tenagodus*) sp. (p. 17).
Diameter of coil 12.3 mm, X 2. Vanua Mbalavu, Fiji, station 110B, probably Pliocene. Univ. Rochester, Mus. Nat. History Specimen 13058.




TURRITELLIDAE

# PLATE 2

FIGURES 1–4. *Tenagodus* (*Agathirses*) cf. *T. australis* (Quoy and Gaimard) (p. 17).
1, 2. Height 6.6 mm, X 5. Station 160 Viti Levu, Fiji, early Miocene. USNM 650414.
3, 4. Height 5.8 mm, X 5. Same as for figures 1, 2. USNM 650415.

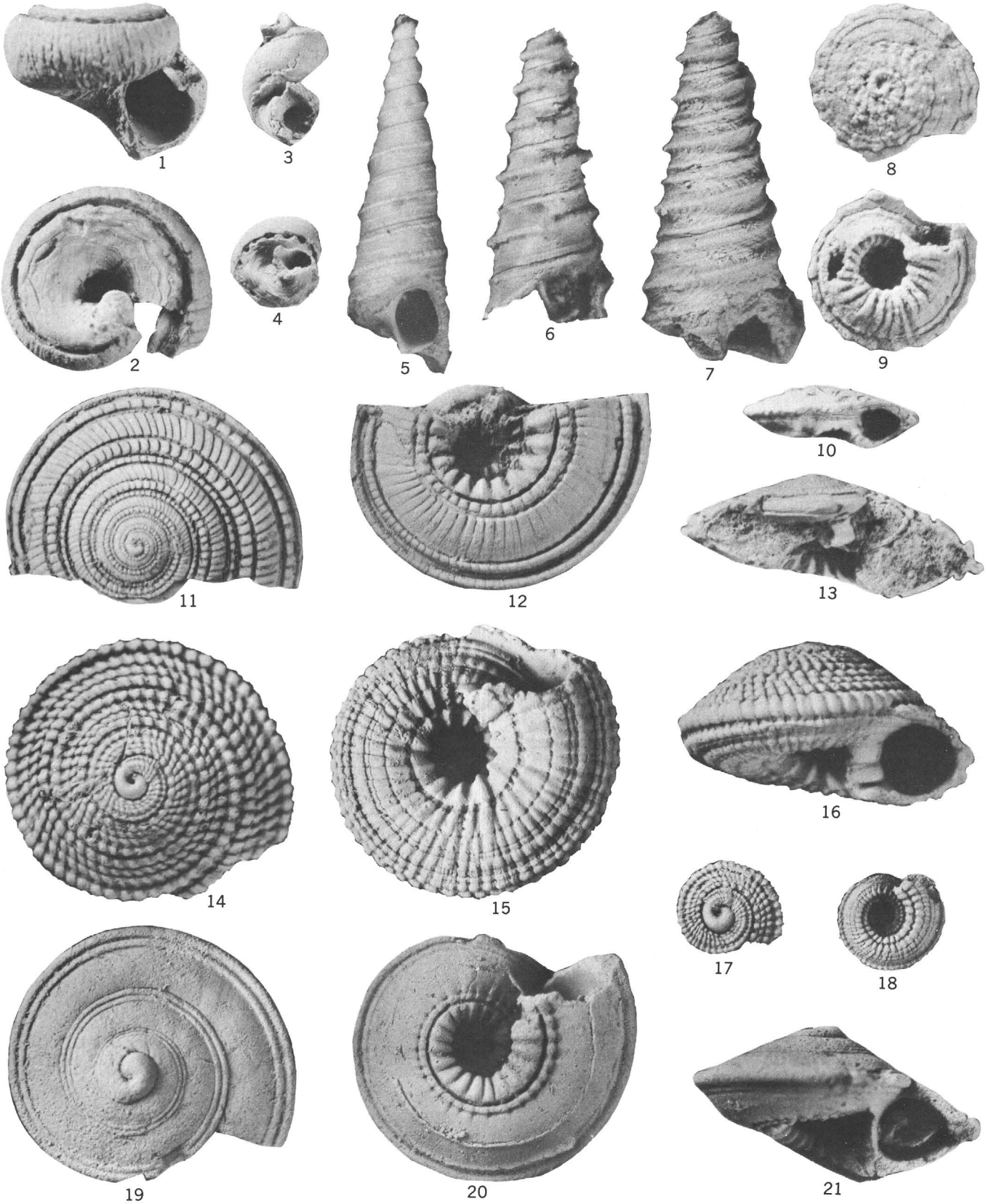
5–7. *Vermicularia* sp. A (p. 17).
5. Length 6.4 mm, X 10. Drill hole E–1, Eniwetok, depth 2,730–2,740 ft; early Miocene (Tertiary *e*). USNM 648497.
6. Length 5.2 mm, X 10. Drill hole 2B, Bikini, depth 2,049–2059½ ft, early Miocene (Tertiary *e*). USNM 648498.
7. Length 6.5 mm, X 10. Drill hole 2B Bikini, depth 1,545–1,555½ ft, early Miocene (Tertiary *e*). USNM 648499.

8–10. *Climacopoma*? sp. A (p. 18).
Diameter 2.9 mm, X 10. Drill hole E–1, Eniwetok, depth 2,650–2,660 ft, early Miocene (Tertiary *e*). USNM 648500.

11–13. *Architectonica* (*Architectonica*) *perspectiva* (Linnaeus) (p. 18).
Diameter 13.4 mm, X 4. Station 817, Vanua Levu, Fiji, probably Pliocene (Tertiary *h*). USNM 648501.

14–18. *Architectonica* (*Pseudotorinia*) *corwini* Ladd, n. sp. (p. 18).
14–16. Holotype, diameter 6.6 mm, X 8. USGS loc. 21304, Goikul peninsula, Babelthuap, Palau; late Miocene (Tertiary *g*). USNM 648502.
17, 18. Paratype A, diameter 2.3 mm, X 8. USGS loc. 21304. Same as for figures 14–16. USNM 648503.

19–21. *Philippia* (*Psilaxis*) *radiata* (Röding) (p. 19).
Diameter 6.5 mm, X 8. Drill hole F–1, Eniwetok, 700–710 ft; late Miocene (Tertiary *g*). USNM 648505.




TURRITELLIDAE AND ARCHITECTONICIDAE

# PLATE 3

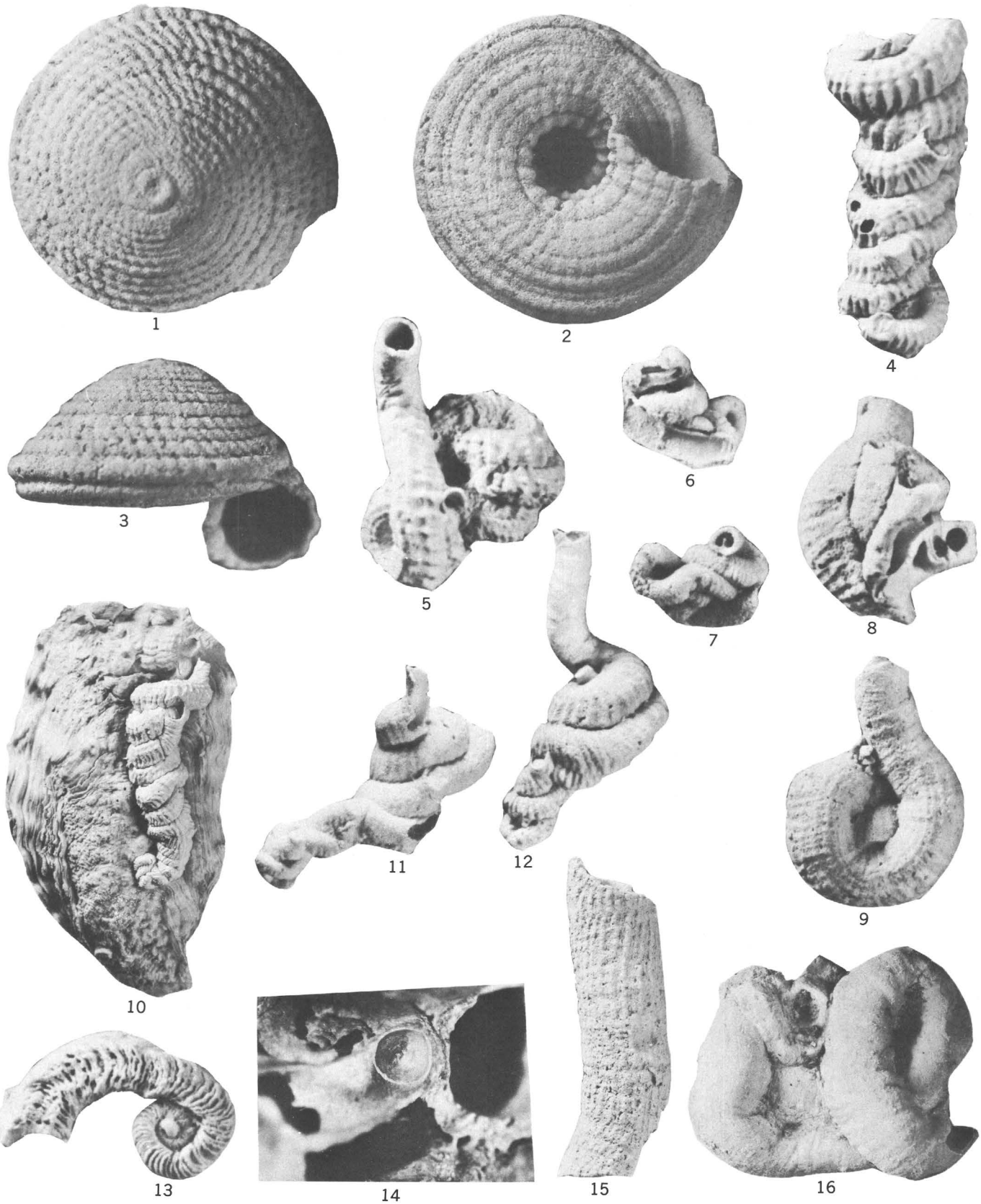
FIGURES 1–3. *Heliacus variegatus* (Gmelin) (p. 19).
Diameter 7.5 mm, X 8. Drill hole F–1, Eniwetok, 700–710 ft; late Miocene (Tertiary *g*). USNM 648507.

4–12. *Petaloconchus* (*Macrophragma*) *merkana* Ladd. n. sp. (p. 20).
4. Holotype, length of coil 7.5 mm, X 8. USGS loc. 21304, Goikul peninsula, Babelthuap, Palau; late Miocene (Tertiary *g*). USNM 650416.
5. Paratype A, length of coil 6.2 mm, X 8. Drill hole E–1, Eniwetok, 620–630 ft; late Miocene (Tertiary *g*). USNM 650417.
6, 7. Paratype B, length of coil 3.0 mm, X 8. Drill hole K–1B, Eniwetok, 831–842 ft; late Miocene (Tertiary *g*). USNM 650418.
8, 9. Paratype C, length of coil 8.1 mm, X 6. Drill hole 2A, Bikini, 925–936 ft; late Miocene (Tertiary *g*). USNM 650419.
10. Shell of living specimen attached to oyster shell, length of coil 13.9 mm, X 3. Pearl Harbor, Oahu, Hawaii. USNM 341315.
11. Holocene specimen, length of coil 6.1 mm, X 8. Bikini lagoon. USNM 586680.
12. Holocene specimen, length of coil 7.3 mm, X 8. Midway Atoll, Hawaii. USNM 362370.

13. *Petaloconchus* (*Macrophragma*?) *lamellosus* Ladd. n. sp. (p. 20).
Holotype, maximum diameter 5.1 mm, X 8. Drill hole E–1, Eniwetok, 670–680 ft; late Miocene (Tertiary *g*). USNM 650421.

14, 15. *Serpulorbis* cf. *S. javanus* (Martin) (p. 20).
Both specimens from drill hole F–1, Eniwetok, 790–800 ft; late Miocene (Tertiary *g*).
14. Part of coiled specimen showing tube partition that is concave forward, X 15. USNM 650422.
15. Nearly straight section of tube, length 15.0 mm, X 4. USNM 650423.

16. *Serpulorbis* sp. (p. 21).
Maximum diameter 26.2 mm, X 2. Station 110B, Ndalithoni Limestone, Vanua Mbalavu, Fiji. Pliocene (Tertiary *h*).




ARCHITECTONICIDAE AND VERMETIDAE

# PLATE 4

FIGURE 1. *Melanatria vitiensis* Ladd, n. sp. (p. 21).
Holotype, height 78.4 mm, X 1. Station 160, Viti Levu, Fiji; early Miocene (Tertiary *f*). Bernice P. Bishop Museum, Geol. No. 1187.

2, 3. *Thiara* (*Setaeara*) *morrisoni* Ladd, n. sp. (p. 21).
Holotype, height 6.8 mm, X 8. Station C–831, at Nanduruloulou, Viti Levu, Fiji; late Miocene or early Pliocene (Tertiary *g* or *h*). USNM 650581.

4. *Melanoides* (*Melanoides*) cf. *M. tuberculatus* (Müller) (p. 22).
Height (incomplete) 3.9 mm, X 15. Station C–136, near Nasongo, Viti Levu, Fiji; probably late Tertiary. USNM 648447.

5. *Littorina scabra* Linnaeus (p. 14).
Height 11.5 mm, X 4. Maewo, New Hebrides; Pleistocene. USNM 650582.

6. *Astraea* sp. F (p. 13).
Cast, height 10 mm, X 4. USGS loc. 20739, Guam; Pliocene or Pleistocene. USNM 650580.

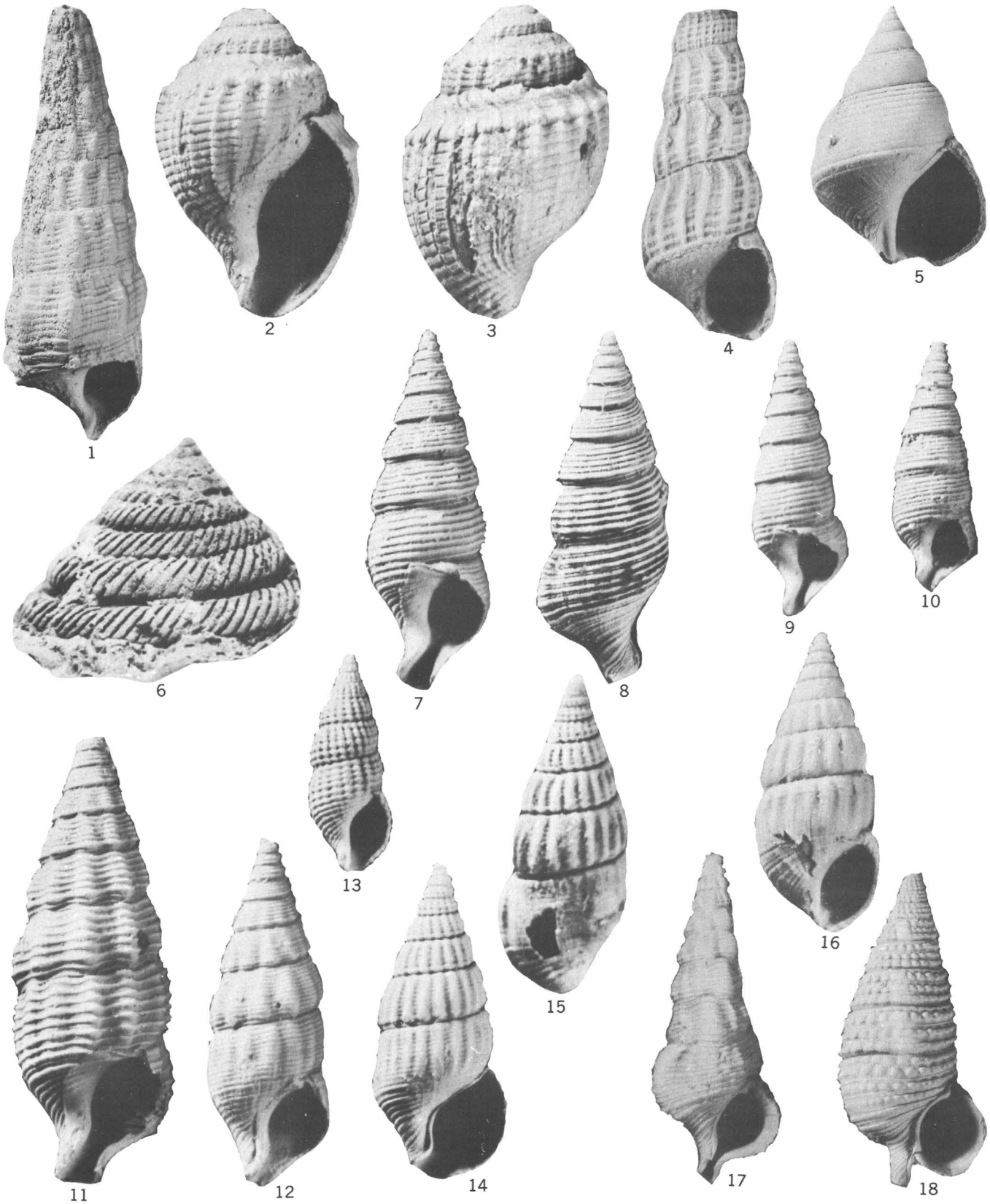
7–12. *Liocerithium kayae* Ladd, n. sp. (p. 40).
7, 8. Holotype, height 7.5 mm, X 8. USGS loc. 21308, Goikul peninsula, Babelthuap, Palau; late Miocene (Tertiary *g*). USNM 650506.
9. Paratype A, height 6.3 mm, X 8. USGS loc. 21304, Goikul peninsula, Babelthuap, Palau; late Miocene (Tertiary *g*). USNM 650507.
10. Paratype B, height 5.3 mm, X 8. Drill hole K–1B, Eniwetok, 841–853 ft; late Miocene (Tertiary *g*). USNM 650508.
11. Paratype D, height 9.8 mm, X 8. Drill hole 2B, Bikini, 1,020–1,100 ft; early Miocene (Tertiary *f*). USNM 650519.
12. Paratype C, height 7.4 mm, X 8. Drill hole E–1, Eniwetok, 860–870 ft; late Miocene (Tertiary *g*). USNM 650509.

13. *Bittium eniwetokensis* Ladd, n. sp. (p. 31).
Holotype, height 4.6 mm, X 8. Drill hole F–1, Eniwetok, 930–940 ft; early Miocene (Tertiary *f*). USNM 650514.

14–16. *Bittium* (*Bittiolum*) *toddae* Ladd, n. sp. (p. 32).
14, 15. Holotype, height 5.5 mm, X 10. Drill hole K–1B, Eniwetok, 778–790 ft; late Miocene (Tertiary *g*). USNM 650512.
16. Paratype, height 5.0 mm, X 10. Drill hole E–1, Eniwetok, 1,746–1,776 ft; early Miocene (Tertiary *e*). USNM 650513.

17. *Colina* (*Ischnocerithium*) *rostrata* (Sowerby) (p. 32).
Height 9.9 mm, X 6. Drill hole Mu–4, Eniwetok, 30.5–36 ft; Holocene. USNM 650480.

18. *Ataxocerithium eniwetokensis* Ladd, n. sp. (p. 32).
Holotype, height 11.1 mm, X 5. Drill hole E–1, Eniwetok, 40–50 ft; Holocene. USNM 650454.




THIARIDAE, LITTORINIDAE, TURBINIDAE, AND CERITHIIDAE

# PLATE 5

FIGURES 1–7. *Caecum parryensis* Ladd, n. sp. (p. 23).
Holotype, length 2.1 mm (figs. 1–4, X 34; figs. 5–7, X 60). Drill hole E–1, Eniwetok, depth 1,260–1,270 ft; early Miocene (Tertiary *e*). USNM 648518

8–10. *Caecum vertebrale* Hedley (p. 22).
8. Length 2.8 mm, X 20. Drill hole F–14–C, Eniwetok, depth 33–36 ft; Holecene. USNM 650425.
9. Length 2.6 mm, X 25. Drill hole F–1, Eniwetok, depth 260–270 ft; Pleistocene. USNM 650426.
10. Length 1.8 mm, X 20. Bernice P. Bishop Mus. Cat No. 202980, Tongatapu, Tonga. Probably Pliestocene. Bernice P. Bishop Mus. Geol. No. 1341.

11, 12. *Caecum berberense* Ladd, n. sp. (p. 22).
11. Holotype, length 2.9 mm, X 20. Drill hole E–1, Eniwetok, depth 1,260–1,270 ft; early Miocene (Tertiary *e*). USNM 650429.
12. Paratype, length 2.3 X 25. Drill hole F–1, Eniwetok, depth 910–920 ft; early Miocene (Tertiary *f*). USNM 650428.

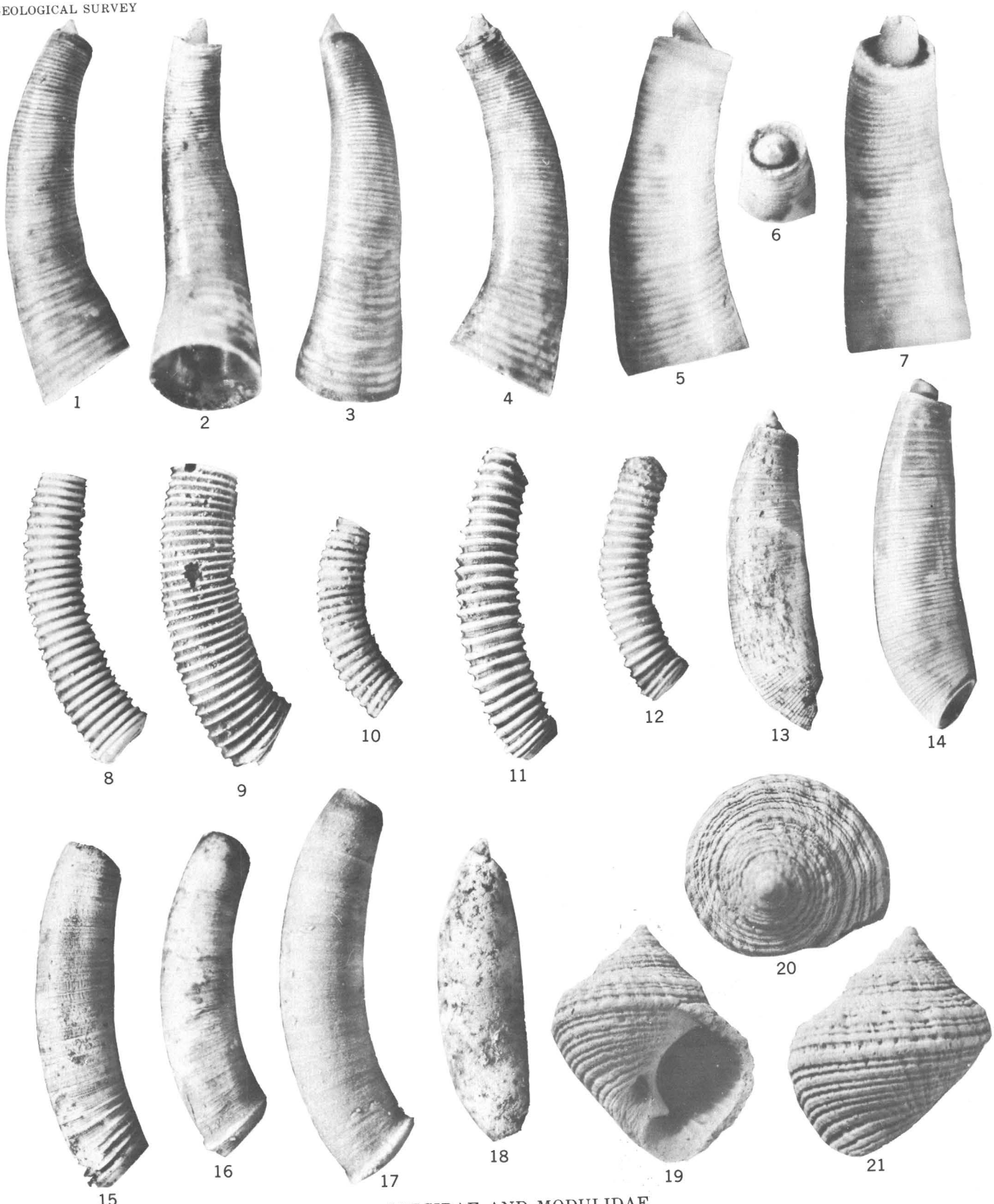
13, 14. *Micranellum schlangeri* Ladd, n. sp. (p. 23).
13. Holotype, length 2.8 mm, X 20. Drill hole E–1, Eniwetok, depth 940–950 ft; early Miocene (Tertiary *f*). USNM 650430.
14. Paratype, length 2.9 mm, X 20. Funafuti, depth 65 ft. Holocene. Museum Comparative Zoology 29022.

15. *Elephantanellum* sp. A (p. 23).
Length 3.6 mm, X 20. Drill hole E–1, Eniwetok, depth 540–550 ft. Probably Pliocene. USNM 650431.

16, 17. *Fartulum* aff. *F. amputatum* (Hedley) (p. 24).
16. Length 2.7 mm, X 22. Drill hole K–1B, Eniwetok, depth 873–884 ft; early Miocene (Tertiary *f*). USNM 650432.
17. Length 2.1 mm, X 30. Drill hole E–1, Eniwetok, depth 960–970 ft; early Miocene (Tertiary *f*). USNM 650433.

18. *Fartulum* sp. A (p. 24).
Length 2.5 mm, X 22. Drill hole F–1, Eniwetok, depth 280–290 ft; possibly Pliocene. USNM 650434.

19–21. *Modulus preangerensis* Martin (p. 24).
Height 10.9 mm, X 4. USGS loc. 21304, Goikul area, Palau. Marl at base of Palau Limestone; late Miocene (Tertiary *g*). USNM 648450.




CAECIDAE AND MODULIDAE

# PLATE 6

FIGURES 1–3. *Potamides tayamaia* Ladd, n. sp. (p. 24).

1. Holotype, height 22.0 mm, X 2. USGS loc. 21301, Goikul peninsula, Babelthuap, Palau; late Miocene (Tertiary *g*). USNM 650500.
2. Paratype A, height 31.7 mm, X 2. USGS 21301, Goikul peninsula, Babelthuap, Palau; late Miocene (Tertiary *g*). USNM 650499.
3. Paratype B, height 23.0 mm, X 3. USGS loc. 21304, Goikul peninsula, Babelthuap, Palau; late Miocene (Tertiary *g*). USNM 650501.

4, 5. *Potamides wardi* Ladd, n. sp. (p. 25).

4. Holotype, 18.5 mm, X 3, USGS loc. 20535, Guam, Talisay Member of Alifan Limestone; late Miocene (Tertiary *g*). USNM 650498.
5. Paratype, height 16.0 mm, X 3. Drill hole F–1, Eniwetok, depth 770–780 ft., late Miocene (Tertiary *g*). USNM 650511.

6. *Potamides* sp. A (p. 25).

Height 11.1 mm, X 5. Drill hole K–1B, Eniwetok, depth 747–758 ft; late Miocene (Tertiary *g*). USNM 650520.

7. *Potamides* sp. B (p. 26).

Height 7.7 mm, X 7. Drill hole K–1B, Eniwetok, depth 778–790 ft; late Miocene (Tertiary *g*). USNM 650521.

8–10. *Tympanotonos berberkirianus* (Martin) (p. 26).

Specimens from USGS loc. 21301, Goikul peninsula, Babelthuap, Palau; late Miocene (Tertiary *g*).

8. Height 29.9 mm, X 3, USNM 650456.
9. Height 20.4 mm, X 3, USNM 650457.
10. Same as last to show nodes in aperture, X 5.

11. *Vicarya* sp. (p. 26).

Diameter 6.3 mm, X 5. Drill hole E–1, Eniwetok, depth 2,700–2,710 ft; early Miocene (Tertiary *e*). USNM 650493.

12. *Cerithidea* cf. *C. obtusa* (Lamarck) (p. 27).

Height 19.3 mm, X 3. USGS loc. 21408, Saipan; tuffaceous facies of Tagpochau Limestone (Miocene). USNM 650497.

13. *Terebralia sulcata* (Born) (p. 27).

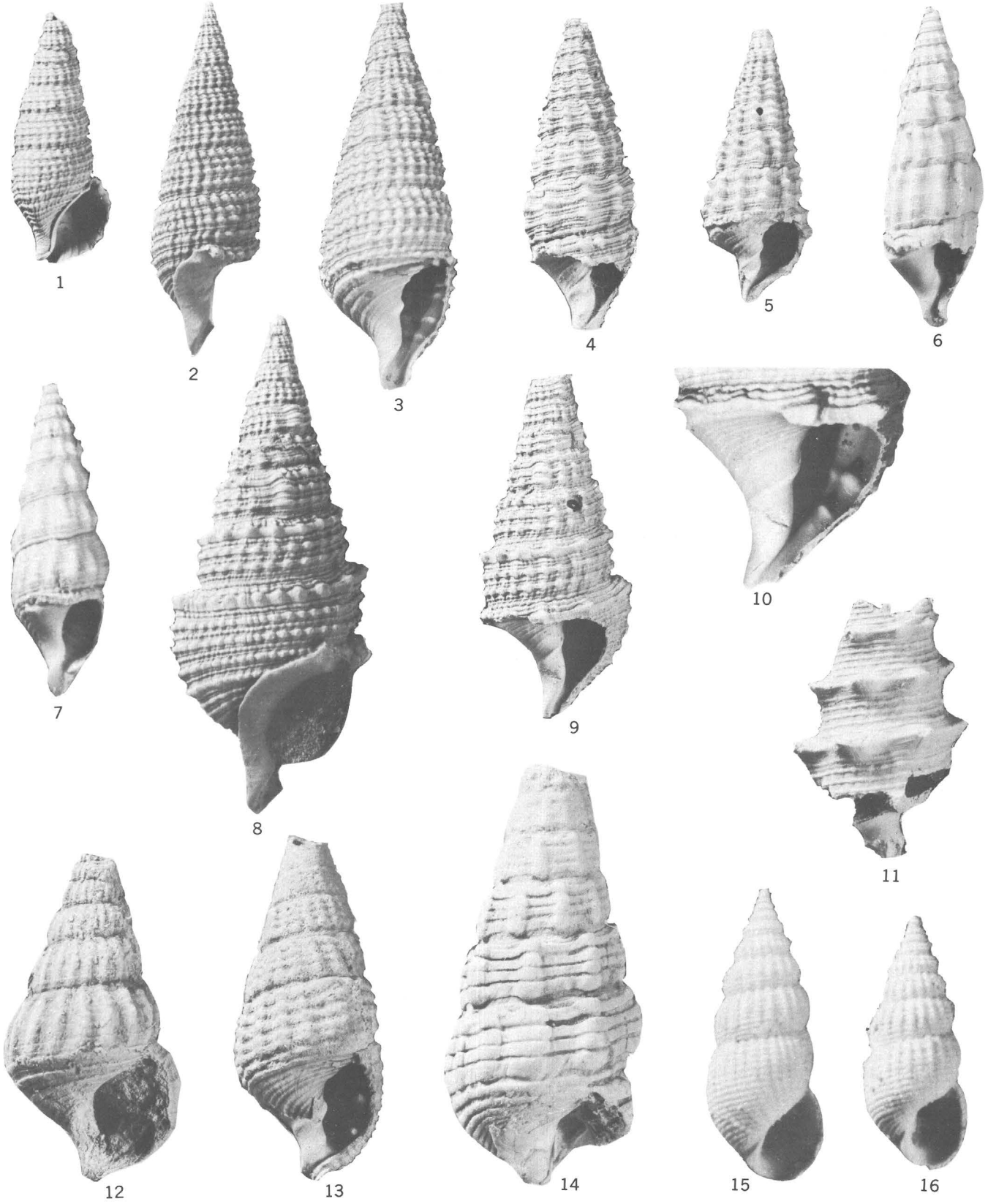
Height 20.0 mm, X 3. Drill hole E–1, Eniwetok, depth 640–650 ft; late Miocene (Tertiary *g*). USNM 650455.

14. *Batillaria* (*Zeacumantus*) *rickardi* Ladd, n. sp. (p. 27).

Height 25.2 mm, X 3. Station 160, Walu Bay, Viti Levu, Fiji; early Miocene (Tertiary *f*). USNM 650436.

15, 16. *Obtortio pyrrhacme* (Melvill and Standen) (p. 28).

15. Height 2.8 mm, X 12. Drill hole F–1, Eniwetok, depth 20–45 ft; Holocene. USNM 650461.
16. Height 3.5 mm, X 12. Drill hole K–1, Eniwetok, depth 201–211.5 ft; Holocene. USNM 650462.




POTAMIDIDAE AND DIASTOMIDAE

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# PLATE 7

FIGURES 1–3. *Obtortio pyrrhacme* (Melvill and Standen) (p. 28).

1. Height 4.7 mm, X 12. Drill hole F–1, Eniwetok, 860–870 ft; early Miocene (Tertiary *f*). USNM 650463.
2. Height 3.7 mm, X 12. Drill hole 2B, Bikini, 1,345.5–1,356 ft; early Miocene (Tertiary *f*). USNM 650464.
3. Apical whorls of Holocene lectotype of *Rissoia pyrrhacme* Melvill and Standen from Loyalty Islands; three smooth whorls above, two keeled below. Drawn by S. P. Dance, April 3, 1967.

4, 5. *Obtortio failingi* Ladd, n. sp. (p. 28).

4. Holotype, height 2.4 mm, X 15. Drill hole 2B, Bikini, 2,070–2,081 ft; early Miocene (Tertiary *e*). USNM 650465.
5. Paratype, height 2.1 mm, X 15. Drill hole E–1, Eniwetok, 1,746–1,777 ft; early Miocene (Tertiary *e*). USNM 650466.

6. *Obtortio dancei* Ladd, n. sp. (p. 29).

Holotype, height 1.6 mm, X 20. Drill hole E–1, Eniwetok, 1,746–1,777 ft; early Miocene Tertiary *e*). USNM 650545.

7. *Obtortio* sp. A (p. 29).

Height 1.7 mm, X 20. Drill hole E–1, Eniwetok, 1,350–1,365 ft; early Miocene (Tertiary *e*). USNM 650467.

8–12. *Diala ludens* Melvill and Standen (p. 29).

8. Height 4.1 mm, X 15. Drill hole F–7–C, Eniwetok, 16.6–19.2 ft; Holocene. USNM 650447.
9. Height 2.9 mm, X 15. Drill hole 2B, Bikini, 1,471.5–1,482 ft; early Miocene (Tertiary *e*). USNM 650451.
10. Height 1.6 mm, X 15. Drill hole E–1, Eniwetok, 940–950 ft; early Miocene (Tertiary *f*). USNM 650449.
11. Height 2.4 mm, X 15. Drill hole F–1, Eniwetok, 1,040–1,050 ft; early Miocene (Tertiary *f*). USNM 650450.
12. Height 1.8 mm, X 15. Drill hole Mu–4, Eniwetok, 40.5–41 ft; Holocene. USNM 650448.

13. *Diala stricta* Habe (p. 30).

Height 3.5 mm, X 15. Drill hole 2B, Bikini, 1,587–1,598 ft; early Miocene (Tertiary *e*). USNM 650452.

14. *Diala sulcifera* A. Adams (p. 30).

Height 2.5 mm, X 15. Drill hole F–A, Eniwetok, 1–5 ft; Holocene. USNM 650453.

15. *Bittium impendens* (Hedley) (p. 30).

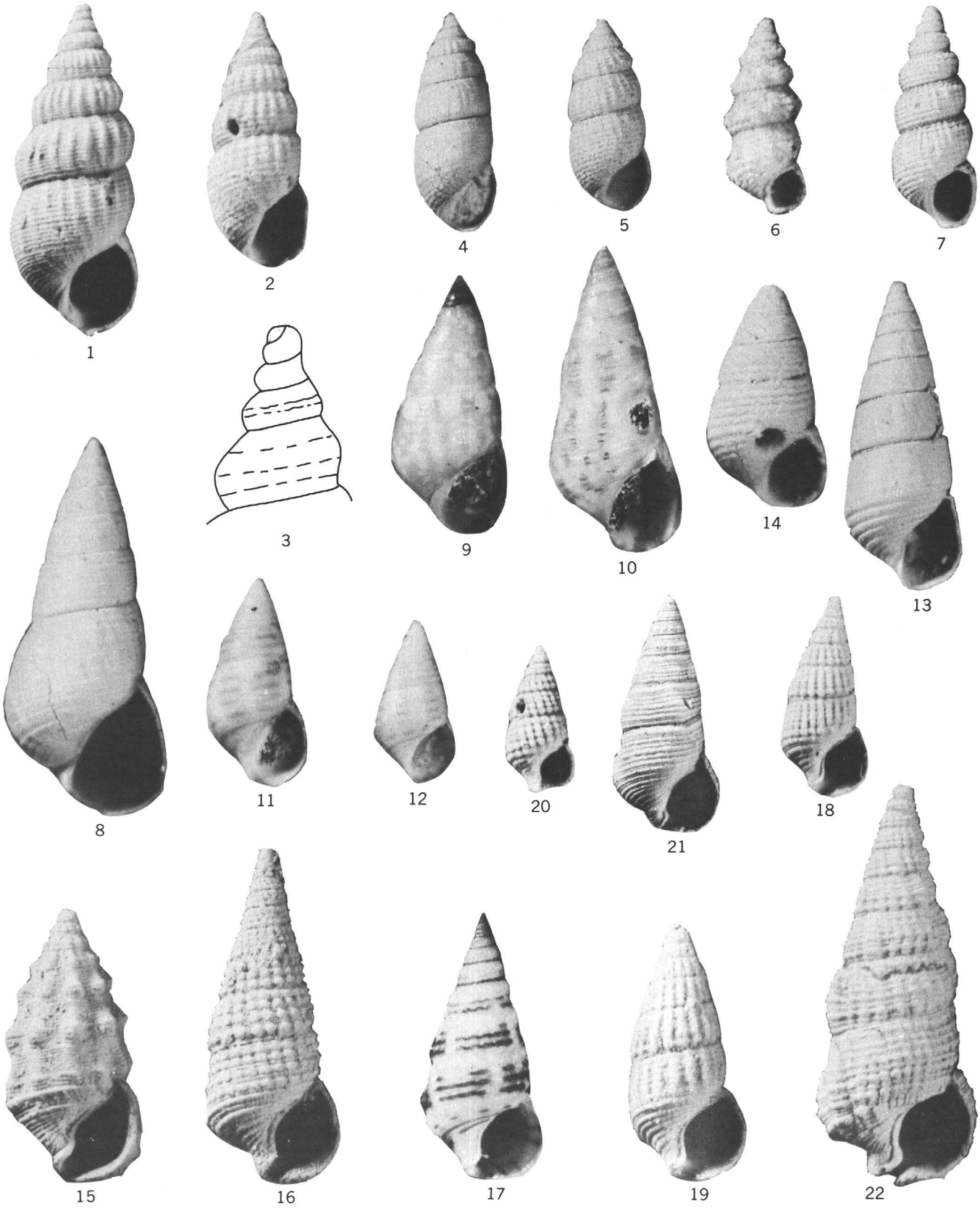
Height 4.7 mm, X 10. Drill hole E–1, Eniwetok, 50–60 ft; Holocene. USNM 650479.

16–20. *Bittium sergentum* (Jousseaume) (p. 30).

16. Height 7.1 mm, X 8. Drill hole 2, Bikini, 126 ft; Holocene. USNM 650477.
17. Height 5.7 mm, X 8. from existing reef of Bikini. USNM 650481.
18. Height 4.2 mm, X 8. Drill hole E–1, Eniwetok, 540–550 ft; probably Pliocene (Tertiary *h*). USNM 650482.
19. Height 5.5 mm, X 8. Drill hole F–1, Eniwetok, 760–770 ft; late Miocene (Tertiary *g*). USNM 650483.
20. Height 3.0 mm, X 8. Drill hole Eniwetok, 940–950 ft; early Miocene (Tertiary *f*). USNM 650484.

21, 22. *Bittium ianthinum* (Gould) (p. 31).

21. Type, height 8.3 mm, X 5. Tuamotu Islands. Holocene. USNM 5573.
22. Height 7.0 mm, X 10. Drill hole E–1, Eniwetok, 30–40 ft; Holocene. USNM 650486.




DIASTOMIDAE AND CERITHIIDAE

# PLATE 8

FIGURE 1. *Ataxocerithium eniwetokensis* Ladd, n. sp. (p. 32).
Holotype, height 11.1 mm, X 5. Drill hole E–1, Eniwetok, 40–50 ft; Holocene. USNM 650454.

2–4. *Rhinoclavis* (*Rhinoclavis*) *vertagus* (Linnaeus) (p. 33).
2. Height 41.8 mm, X 1.5. Drill hole 2, Bikini, 180–185 ft: probably Pleistocene. USNM 650458.
3, 4. Height 37.0 and 39.9 mm, X 1.5. Maewo, New Hebrides; probably Pleistocene. USNM 650618 and 650619, respectively.

5, 6. *Rhinoclavis* (*Rhinoclavis*) *articulata* (Adams and Reeve) (p. 33).
Height 22.6 mm, X 3. USGS loc. 17891, Saipan; Tanapag Limestone (Pleistocene). USNM 650459.

7. *Rhinoclavis* (*Rhinoclavis*) *procera* (Kiener)
Height 31.8 mm, X 2. USGS loc. 17591, Saipan; Tanapag Limestone (Pleistocene). USNM 650460.

8, 9. *Rhinoclavis* (*Rhinoclavis*) *aspera* (Linnaeus) (p. 34).
8. Height 27.0 mm, X 2. Drill hole F–15–C, Eniwetok, 39–43 ft; Holocene. USNM 650468.
9. Height 31.0 mm, X 2. USGS loc. 17897, Saipan; Tanapag Limestone (Pleistocene). USNM 650469.

10. *Rhinoclavis* (*Rhinoclavis*) *sinensis* (Gmelin) (p. 34).
Height 57.2 mm, X 1. USGS loc. 21028, Espiritu Santo, New Hebrides; Quaternary. USNM 650502.

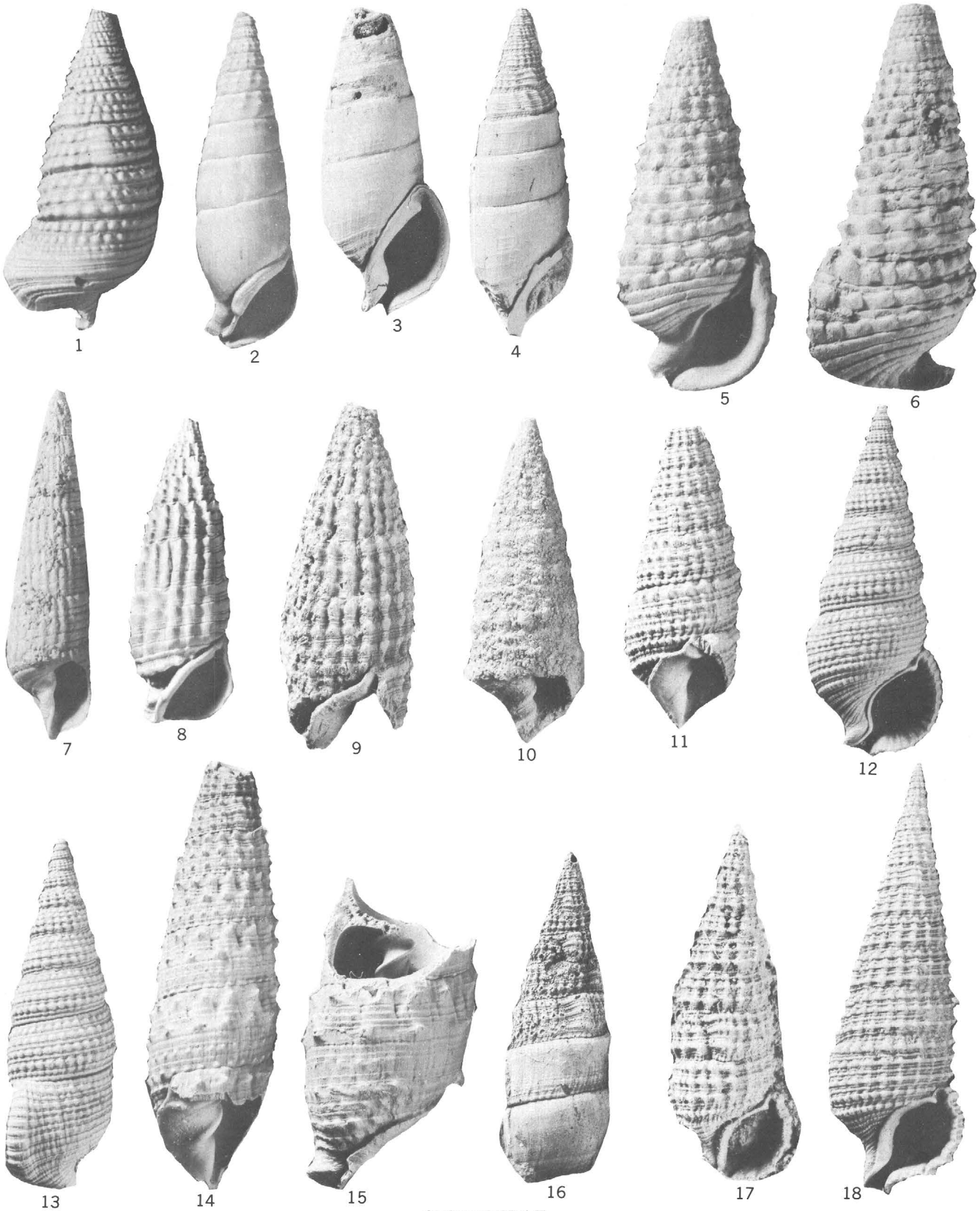
11. *Rhinoclavis* (*Rhinoclavis*) aff. *R. sinensis* (Gmelin) (p. 34).
Height 18.2 mm, X 3. Drill hole F–1, Eniwetok, 840–850 ft; late Miocene (Tertiary *g*). USNM 650490.

12, 13. *Rhinoclavis* (*Rhinoclavis*) *marshallensis* Ladd, n. sp. (p. 34).
Holotype, height 15.4 mm, X 4. Drill hole F–1, Eniwetok, 850–860 ft; late Miocene (Tertiary *g*). USNM 650491.

14, 15. *Rhinoclavis* (*Rhinoclavis*) *powelli* Ladd, n. sp. (p. 35).
14. Holotype, height 32.0 mm, X 2. Drill hole F–1, Eniwetok, 830–840 ft; late Miocene (Tertiary *g*). USNM 650503.
15. Paratype, height 27.6 mm, X 2. Drill hole F–1, Eniwetok, 790–800 ft; late Miocene (Tertiary *g*). USNM 650504.

16. *Rhinoclavis* (*Rhinoclavis*) *jonkeri* (Martin) (p. 35).
Cast, height 31 mm, X 2. USGS loc. 20870, Mariana Limestone of Guam; Pliocene or Pleistocene. USNM 650516.

17, 18. *Rhinoclavis* (*Proclava*) *sordidula* (Gould) (p. 35).
17. Height 11.2 mm, X 4. Cast from Mariana Limestone of Guam; Pliocene or Pleistocene. USNM 650505.
18. Height 19.4 mm, X 4. Malekula, New Hebrides; Pliocene. Specimen described by Abrard (1946).




CERITHIIDAE

# PLATE 9

FIGURES 1, 2. *Rhinoclavis* (*Pseudovertagus*) *eniwetokensis* Ladd n. sp. (p. 36).
1. Holotype, height 24.8 mm, X 3. Drill hole F–1, Eniwetok, 850–860 ft; late Miocene (Tertiary *g*). Uncoated to show color pattern. USNM 650487.
2. Paratype, height 17.5 mm, X 3. Drill hole F–1, Eniwetok, 919–920 ft; early Miocene (Tertiary *f*). Uncoated to show color pattern. USNM 650488.

3. *Rhinoclavis* (*Pseudovertagus*) *lowae* Ladd, n. sp. (p. 36).
Holotype, height 15.9 mm, X 4. Drill hole F–1, Eniwetok 880–890 ft; early Miocene (Tertiary *f*). Uncoated to show color pattern. USNM 650489.

4, 5. *Rhinoclavis* (*Pseudovertagus*) *floraensis* Ladd, n. sp. (p. 36).
4. Holotype, Height 25.2 mm, X 3. Drill hole F–1, Eniwetok, 910–920 ft; early Miocene (Tertiary *f*). USNM 650495.
5. Paratype, height 14.5 mm, X 3. Drill hole F–1, Eniwetok, 750–760 ft; late Miocene (Tertiary *g*). USNM 650496.

6. *Cerithium* (*Thericium*) *mutatum* Sowerby (p. 37).
Height 30.3 mm, X 2. Drill hole F–18–A, Eniwetok, 33–36 ft; Holocene. USNM 650427.

7, 8. *Cerithium* (*Thericium*) *alveolus* Hombron and Jacquinot (p. 37).
Height 12.3 mm, X 5. USGS loc. 17897, Saipan; Tanapag Limestone; Pleistocene. USNM 650474.

9, 10. *Cerithium* (*Conocerithium*) *egenum* Gould (p. 39).
9. Height 6.6 mm, X 6. Drill hole E–1, Eniwetok, 30–40 ft; Holocene. USNM 650475.
10. Height 6.4 mm, X 6. Holocene shell from Ifaluk, Caroline Islands, to show color pattern. USNM 650476.

11. *Cerithium* (*Conocerithium*) aff. *C. egenum* Gould (p. 40).
Height 14.3 mm, X 4. F–1, Eniwetok, 750–760 ft; late Miocene (Tertiary *g*). USNM 650510.

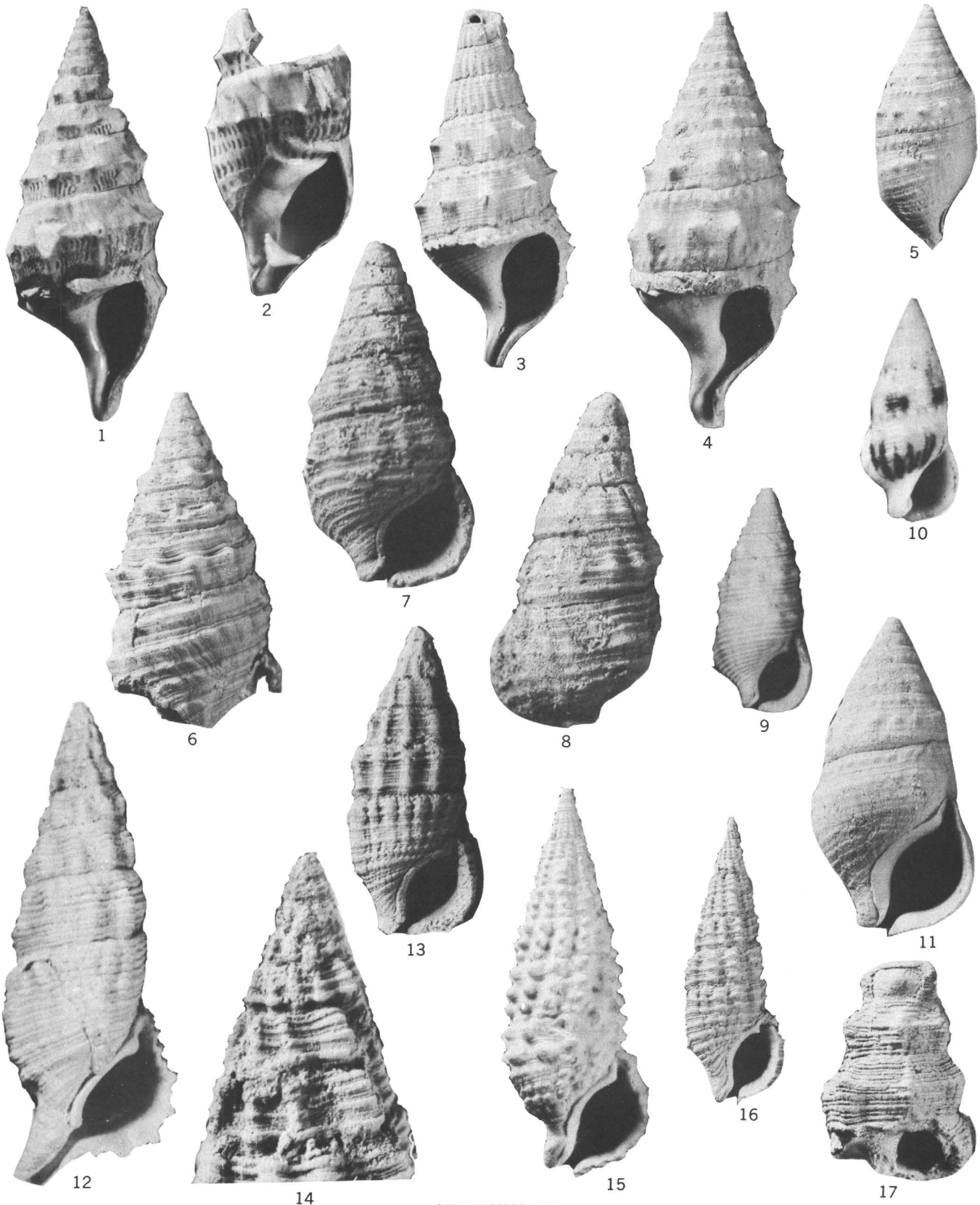
12. *Cerithium* (*Thericium*) *salebrosum* Sowerby (p. 37).
Height 21.8 mm, X 4. Drill hole F–17–C, Eniwetok, 52–54 ft; Holocene USNM 650473.

13, 14. *Cerithium* (*Thericium*) *schmidti* Ladd, n. sp. (p. 38).
13. Holotype, height 13.9 mm, X 4. Saipan, Tagpochau Limestone; Miocene. USNM 650470.
14. Paratype, tip of shell, X 12. Saipan, Tagpochau Limestone; Miocene. USNM 650420.

15. *Cerithium* (*Thericium*) *tenellum* Sowerby (p. 38).
Height 17.4 mm, X 4. Drill hole K–1B, Eniwetok, 232–243 ft; Quaternary. USNM 650485.

16. *Cerithium* (*Thericium*) *ruppelli* Philippi (p. 38).
Height 33.9 mm, X 1.5. USGS loc. 24794, Island of Maewo, New Hebrides; Pleistocene. USNM 650586.

17. *Cerithium* (*Cerithium*) *nodulosum* Bruguière (p. 38).
Height 25.4 mm, X 2. Drill hole 2A, Bikini, 925–936 ft; late Miocene (Tertiary *g*). USNM 650492.




CERITHIIDAE

# PLATE 10

FIGURE 1. *Cerithium* (*Cerithium*) *columna* Sowerby (p. 39).
Height 26 mm, X 3. Cast of specimen from USGS loc. 20702, Guam; Mariana Limestone; Pliocene or Pleistocene. USNM 650517.

2. *Cerithium* (*Cerithium*) aff. *C. columna* Sowerby (p. 39).
Height 20.4 mm, X 4. Drill hole Mu–4, Eniwetok, 35.5–36 ft; Holocene. USNM 650478.

3, 4. *Cerithium* (*Cerithium*) *tuberculatum* (Linnaeus) (p. 39).
Height 20.6 mm, X 3. USGS loc. 21591, Cabras Island, Guam; Mariana Limestone; Pliocene or Pleistocene. USNM 650494.

5. *Clypeomorus verbeeki* (Woodward) (p. 40).
Height 15.6 mm, X 4. Drill hole F–1, Eniwetok, 710–720. ft; late Miocene (Tertiary *g*). USNM 650518.

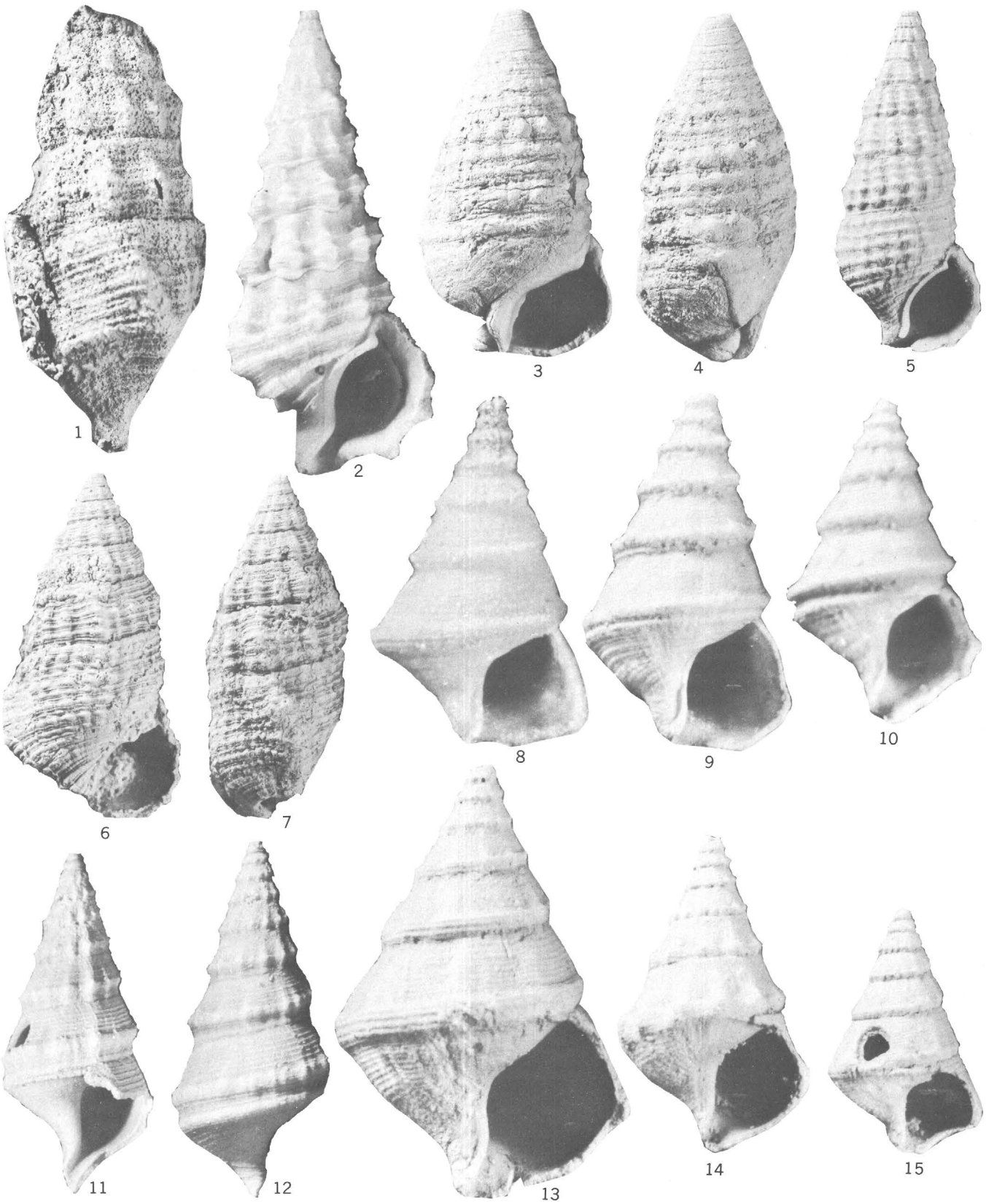
6, 7. *Clypeomorus wainingoli* Ladd, n. sp. (p. 40).
Holotype, height 12.4 mm, X 5. Station 110B, Vanua Mbalavu, Fiji; probably Pliocene. USNM 650515.

8, 9. *Plesiotrochus luteus* (Gould) (p. 41).
8. Height 4.0 mm, X 15. Drill hole 1, Bikini, 40 ft; Holocene. USNM 650437.
9. Height 4.1 mm, X 15. Drill hole 2B, Bikini, 1,324.5–1,335 ft; early Miocene (Tertiary *f*). USNM 650438.

10. *Plesiotrochus pagodiformis* Hedley (p. 41).
Height 3.4 mm, X 15. Drill hole K–1, Eniwetok, 211–222 ft; Holocene. USNM 650439.

11, 12. *Plesiotrochus talinana* Ladd, n. sp. (p. 42).
Holotype, height 4.3 mm, X 15. Drill hole E–1, Eniwetok, 1,955–1,985 ft; early Miocene (Tertiary *e*). USNM 650440.

13–15. *Plesiotrochus marshallensis* Ladd, n. sp. (p. 42).
13. Holotype, height 7.7 mm, X 10. Drill hole F–1, Eniwetok, 780–790 ft; late Miocene (Tertiary *g*). USNM 650441.
14. Paratype A, height 5.4 mm, X 10. Drill hole F–1, Eniwetok, 880–890 ft; early Miocene (Tertiary *f*). USNM 650442.
15. Paratype B, height 4.2 mm, X 10. Drill hole K–1B, Eniwetok, 894–905 ft; early Miocene (Tertiary *f*). USNM 650443.




CERITHIIDAE

# PLATE 11

FIGURE 1. *Plesiotrochus* sp. A (p. 42).
Height 4.2 mm, X 15. Drill hole E–1, Eniwetok, 520–530 ft; probably Pliocene (Tertiary *h*). USNM 650444.

2, 3. *Plesiotrochus whitmorei* Ladd, n. sp. (p. 42).
2. Holotype, height 3.4 mm, X 15. Drill hole K–1B, Eniwetok, 904–915 ft; early Miocene (Tertiary *f*). USNM 650445.
3. Paratype, height 2.6 mm, X 15. Drill hole F–1, Eniwetok, 810–820 ft; late Miocene (Tertiary *g*). USNM 650446.

4. *Cyrbasia* (*Joculator*) *tribulationis* (Hedley) (p. 43).
Length 2.0 mm, X30. Drill hole F–1, Eniwetok, 55–60 ft; Holocene. USNM 650544.

5, 6. *Cyrbasia* (*Joculator*) *semipicta* (Gould) (p. 43).
5. Height 1.9 mm, X 40. Drill hole F–7–A, Eniwetok, 10–12 ft; Holocene. USNM 650587.
6. Height 1.6 mm, X 35. Drill hole F–1, Eniwetok, 630–640 ft; late Miocene (Tertiary *g*). USNM 650588.

7–11. *Cyrbasia* (*Joculator*) *sumangi* Ladd, n. sp. (p. 44).
7. Paratype A, height 2.4 mm, X 25. USGS loc. 21301, Palau; late Miocene (Tertiary *g*). USNM 650589.
8. Paratype B, height 1.5 mm, X 30. USGS loc. 21301, Palau; late Miocene (Tertiary *g*). USNM 650590.
9. Paratype C. height 1.5 mm, X 30. Drill hole F–1, Eniwetok, 710–720 ft; late Miocene (Tertiary *g*). USNM 650593.
10. Holotype, height 3.3 mm, X 25. USGS loc. 21301, Palau; late Miocene (Tertiary *g*). USNM 650591.
11. Paratype D. height 3.5 mm, X 25. Drill hole E–1, Eniwetok, 770–780 ft; late Miocene (Tertiary *g*). USNM 650594.

12. *Cyrbasia* (*Joculator*) aff. *C. ovata* (Laseron) (p. 44).
Height 1.5 mm, X 30. Drill hole E–1, Eniwetok, 870–880 ft; early Miocene (Tertiary *f*). USNM 650592.

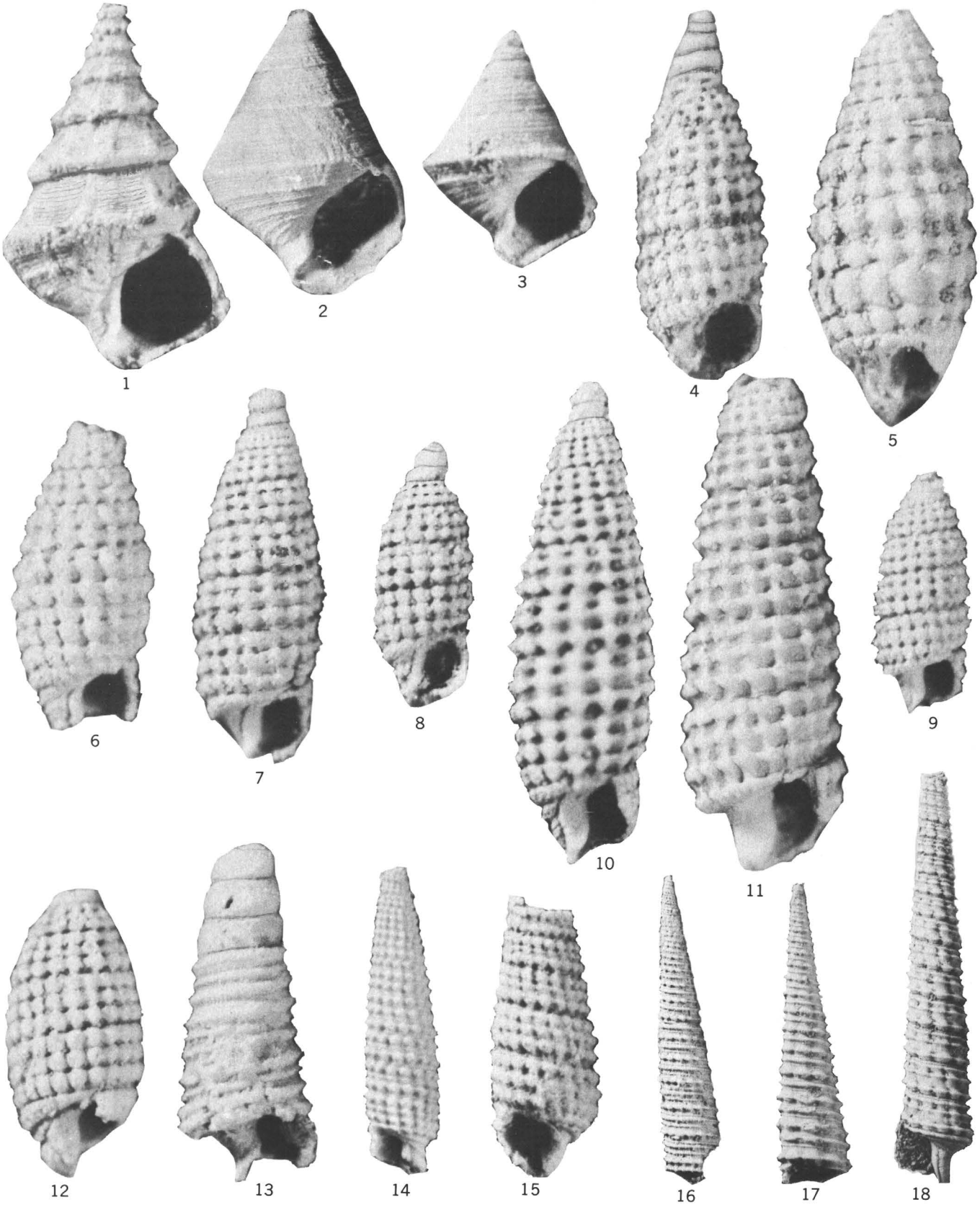
13. *Seila* (*Notoseila*) *waluensis* Ladd, n. sp. (p. 44).
Holotype, height 1.8 mm, X 30. Station 160, Viti Levu, Fiji; early Miocene (Tertiary *f*). USNM 650584.

14. *Triphora* (*Triphora*) *pallida* (Pease) (p. 45).
Length 5.3 mm, X 10. Drill hole E–1 Eniwetok, 30–40 ft; Holocene. USNM 650539.

15. *Triphora* (*Triphora*) *otsuensis* (Yokoyama) (p. 45).
Length 3.9 mm, X 15. Drill hole E–1, Eniwetok, 880–890 ft; early Miocene (Tertiary *f*). USNM 650452.

16, 17. *Triphora* (*Inella*) *pyramidalis* (Adams and Reeve) (p. 45).
16. Palau specimen, length 19.4 mm, X 3. USGS loc. 21301, Goikul peninsula, Babelthuap; late Miocene (Tertiary *g*). USNM 650523.
17. Eniwetok specimen, length 10.7 mm, X 3. Drill hole E–1, 960–970 ft; early Miocene (Tertiary *f*). USNM 650543.

18. *Triphora* (*Inella*) *roddai* Ladd, n. sp. (p. 46).
Holotype, length 24.5 mm, X 3. Station C89, Viti Levu, Fiji; Pliocene (Tertiary *h*). USNM 650522.




CERITHIIDAE, CERITHIOPSIDAE, AND TRIPHORIDAE

# PLATE 12

FIGURE 1. *Triphora* (*Inella*) *maharatai* Beets (p. 46).
Height 10.2 mm, X 6. Drill hole 2A, Bikini, 925–935.5 ft (core 36); late Miocene (Tertiary *g*). USNM 650526.

2. *Triphora* (*Inella*) sp. A (p. 46).
Height 2.5 mm, X 20. USGS loc. 21304, Palau; late Miocene (Tertiary *g*). USNM 650527.

3–5. *Triphora* (*Inforis*) *albogranosa* Kosuge (p. 47).
From drill hole E–1, Eniwetok, 30–40 ft; Holocene.
3,4. Normal three-mouthed specimen; height 5.2 mm, X 12. USNM 650529.
5. Abnormal four-mouthed specimen; height 5.5 mm, X 12. USNM 650530.

6, 7. *Triphora* (*Inforis*) sp. B (p. 47).
Height 6.0 mm, X 9. Drill hole 2B, Bikini, 1,377–1,388 ft; early Miocene (Tertiary *e*). USNM 650528.

8–12. *Triphora* (*Inforis*) *ofuensis* Baker and Spicer (p. 47).
8, 9. Height 3.6 mm, X 16. Drill hole F–1, Eniwetok, 20–45 ft; Holocene. USNM 650531.
10. Height 3.2 mm, X 21. Funafuti drill hole, depth 75 ft (sample 90); Holocene. British Mus. 1970, 0.24.
11, 12. Height 2.2 mm, X 30. Funafuti drill hole, depth 65–74 ft; Holocene. British Mus. 1970, 0.25.

13. *Triphora* (*Mastonia*) *cingulifera* (Pease) (p. 48).
Height 3.1 mm, X 23. Drill hole K–1, Eniwetok, 211–222 ft; Holocene. USNM 650532.

14. *Triphora* (*Mastonia*) *cingulifera goikulensis* Ladd, n. subsp. (p. 48).
Holotype, height 9.2 mm, X 8. USGS loc. 21304, Palau; late Miocene (Tertiary *g*). USNM 650524.

15. *Triphora* (*Mastonia*) *clavata* (Pease) (p. 48).
Height 4.2 mm, X 15. Drill hole 1, Bikini, 100 ft; probably Holocene. USNM 650537.

16. *Triphora* (*Mastonia*) *squamosa* (Kosuge) (p. 48).
Height 6.8 mm, X 10. Drill hole E–1, Eniwetok, 35–40 ft; Holocene. USNM 650538.

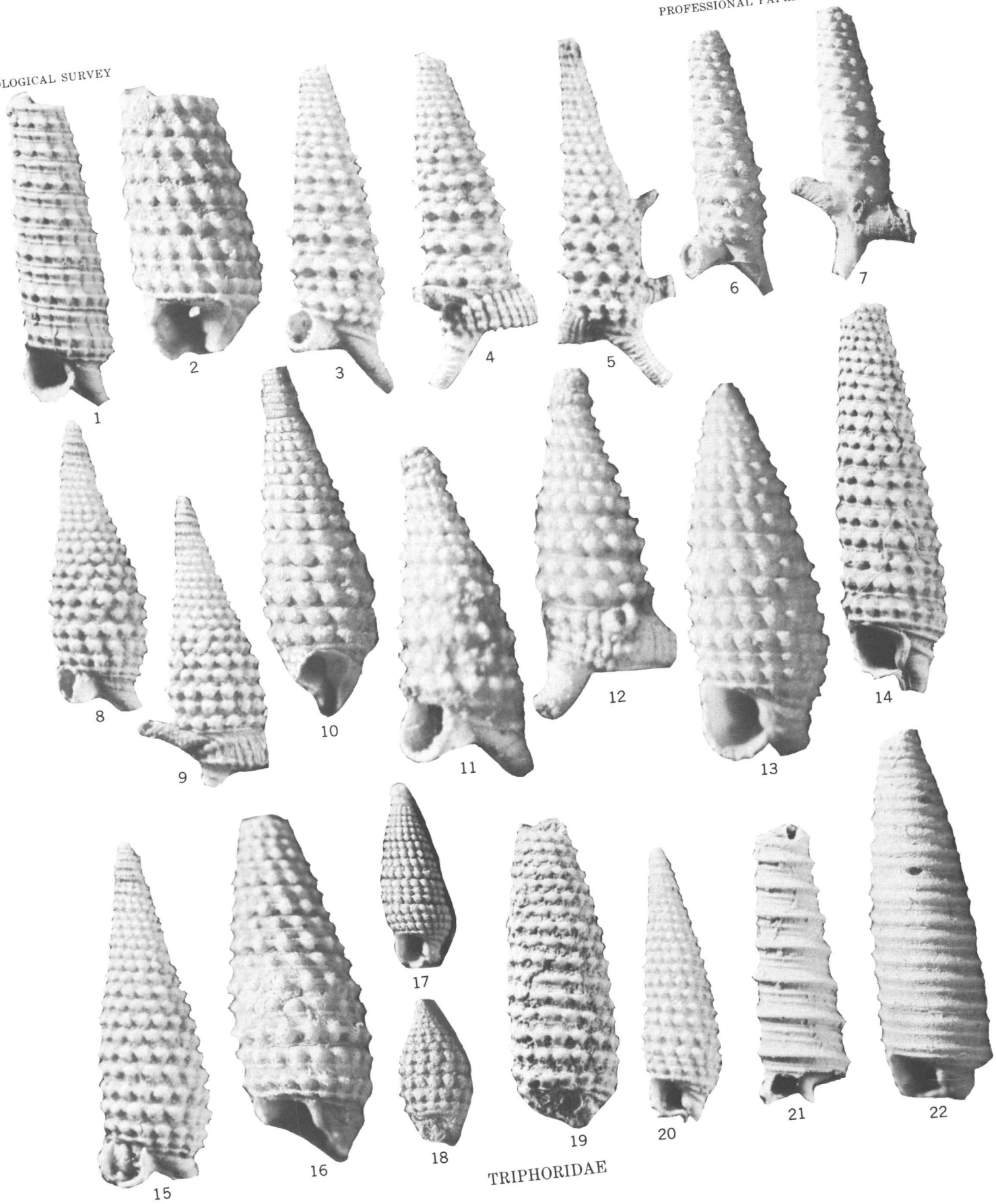
17, 18. *Triphora* (*Mastonia*) *intermissa* (Laseron) (p. 49).
17. Height 3.4 mm, X 10. Drill hole En–3, Eniwetok, 20 ft; Holocene. USNM 650540.
18. Height 2.5 mm, X 10. Drill hole E–1, Eniwetok, 110–120 ft; Holocene. USNM 650541.

19. *Triphora* (*Mastonia*) *auberti* (Abrard) (p. 49).
Holotype, height 6.5 mm, X 9. Island of Epi, New Hebrides; late Miocene. Museum National d'Histoire Naturelle, Paris.

20. *Cautotriphora hervieri* (Kosuge) (p. 49).
Height 3.5 mm, X 15. Drill hole 2A, Bikini, 447–453 ft; probably Pliocene (Tertiary *h*). USNM 650536.

21. *Viriola pagoda* (Hinds) (p. 50).
Height 9.2 mm, X 6. Drill hole E–1, Eniwetok, 35–40 ft; Holocene. USNM 650525.

22. *Viriola incisa* (Pease) (p. 50).
Height 7.3 mm, X 10. Drill hole E–1, Eniwetok, 30–40 ft; Holocene. USNM 650533.




TRIPHORIDAE

# PLATE 13

FIGURE 1. *Viriola cancellata* (Hinds) (p. 50).
Length 8.4 mm, X 6. Drill hole 2B, Bikini, 1,503–1,514 ft; early Miocene (Tertiary *e*). USNM 650534.

2. *Viriola elegans* (Hinds) (p. 50).
Length 6.5 mm, X 8. Drill hole Mu–4, Eniwetok, 21–22 ft; Holocene. USNM 650535.

3. *Epitonium* (*Gyroscala*) *perplexum* (Pease) (p. 51).
Height 7.3 mm, X 8. Drill hole E–1, Eniwetok, 10–20 ft; Holocene. USNM 650607.

4. *Epitonium* (*Cycloscala*) *revolutum* (Hedley) (p. 51).
Height 2.1 mm, X 20. USGS loc. 21308, Palau; late Miocene (Tertiary *g*). USNM 650435.

5. *Epitonium* (*Clathrus*) sp. A (p. 51).
Height 12.0 mm, X 4. Station L466, Oneata, Fiji; early Miocene (Tertiary *f*). USNM 650608.

6–8. *Vanikoro cancellata* (Lamarck) (p. 52).
Height 4.3 mm, X 8. Drill hole F–3–C, Eniwetok, 6–10 ft; Holocene. USNM 650598.

9, 10. *Vanikoro gueriniana* (Récluz) (p. 52).
Height 2.8 mm, X 10. Drill hole E–1, Eniwetok, 780–790 ft; late Miocene (Tertiary *g*). USNM 650595.

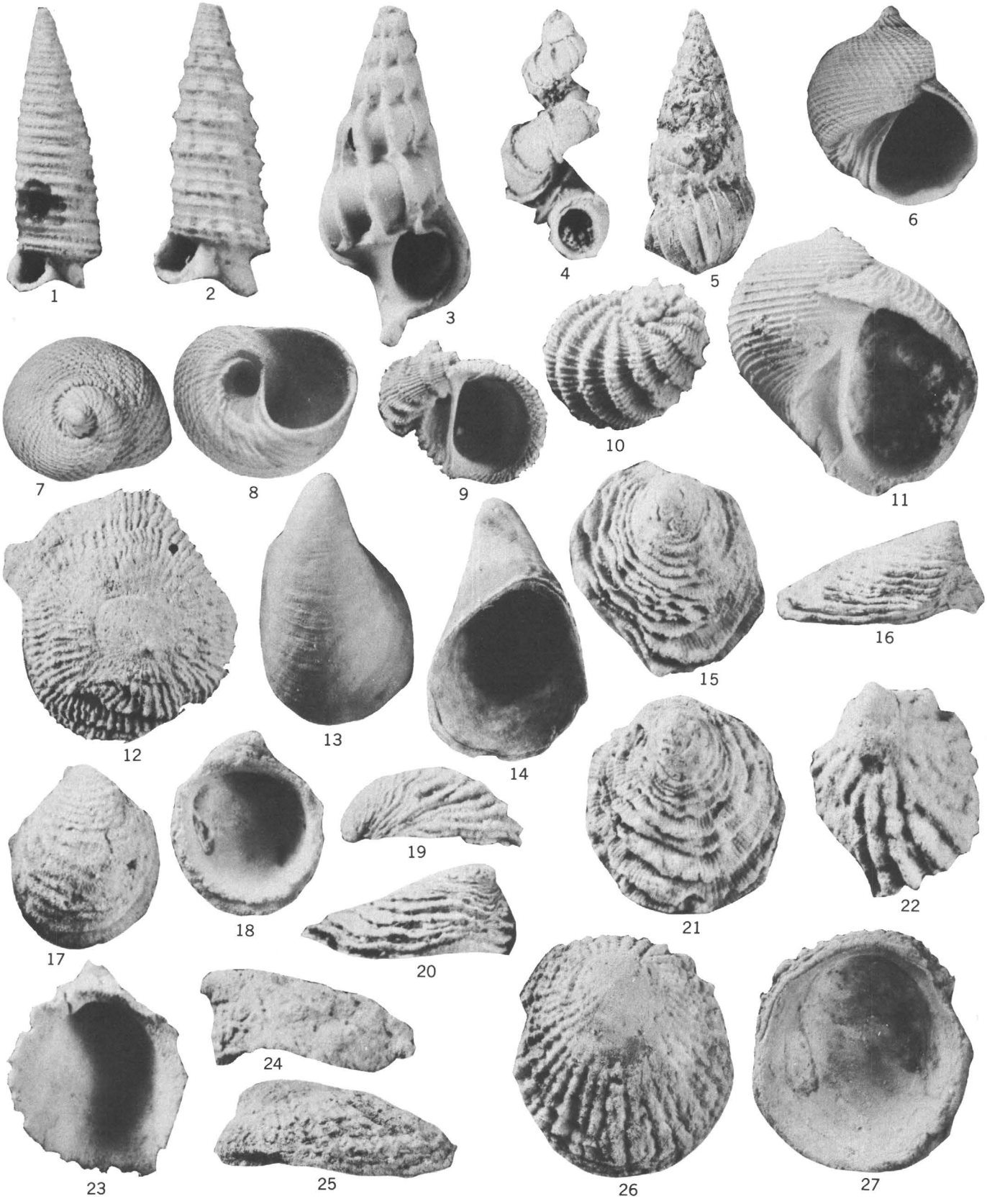
11. *Vanikoro* aff. *V. kanakarum* Pilsbry (p. 52).
Height 4.3 mm, X 10. Drill hole E–1, Eniwetok, 110–120 ft; Holocene. USNM 650597.

12. *Cheilea equestris* (Linnaeus) (p. 52).
Length 8.6 mm, X 5. Drill hole E–1, Eniwetok, 830–840 ft; late Miocene (Tertiary *g*). USNM 650600.

13, 14. *Hipponix* (*Malluvium*) cf. *H. badius* (Dunker) (p. 53).
Length 7.9 mm, X 5. Station 817, Vanua Levu, Fiji; probably Pliocene (Tertiary *h*). USNM 650602.

15–21. *Hipponix* (*Antisabia*) *foliaceus* Quoy and Gaimard (p. 53).
15, 16. Length 6.3 mm, X 6. Drill hole F–1, Eniwetok, 760–770 ft; late Miocene (Tertiary *g*). USNM 650603.
17–19. Length 4.0 mm, X 8. Drill hole F–1, Eniwetok, 690–700 ft; late Miocene (Tertiary *g*). USNM 650604.
20, 21. Length 6.4 mm, X 6. Station 160, Viti Levu, Fiji; early Miocene (Tertiary *f*). Bernice P. Bishop Mus. Geol. No.1237.

22–27. *Hipponix* (*Sabia*) *conicus* (Schumacher) (p. 54).
22–24. Length 6.7 mm, X 6. Drill hole F–1, Eniwetok, 660–670 ft; late Miocene (Tertiary *g*). USNM 650605.
25–27. Length 10.9 mm, X 4. Station 110B, Vanua Mbalavu, Fiji; Pliocene (Tertiary *h*). USNM 650606.




TRIPHORIDAE, EPITONIIDAE, VANIKORIDAE, AND HIPPONICIDAE

# PLATE 14

FIGURES 1–18. *Hipponix* (*Pilosabia*) *revellei* Ladd, n. sp. (p. 54).

1–3. Holotype, length 5.4 mm, X 8. Drill hole F–1, Eniwetok, 890–900 ft; early Miocene (Tertiary *f*). USNM 650609.

4–6. Paratype A, length 5.9 mm, X 8. Drill hole F–1, Eniwetok, 900–910 ft; early Miocene (Tertiary *f*). USNM 650610.

7–9. Paratype B, length 5.0 mm, X 8. Drill hole F–1, Eniwetok, 870–880 ft; early Miocene (Tertiary *f*). USNM 650611.

10–12. Paratype D, length 5.1 mm, X 8. Drill hole 2B, Bikini, 1,650–1,661 ft; early Miocene (Tertiary *e*). USNM 650613.

13, 14. Paratype E, length 4.9 mm, X 8. Drill hole K–1B, Eniwetok, 1,008–1,019 ft; early Miocene (Tertiary *f*). USNM 650614.

15, 16. Paratype F, length 3.5 mm, X 8. Drill hole K–1B, Eniwetok, 715–727 ft; late Miocene (Tertiary *g*). USNM 650615.

17, 18. Paratype G, length 2.1 mm, X 8. Drill hole E–1, Eniwetok, 980–990 ft; early Miocene (Tertiary *f*). USNM 650616.

19, 20. *Capulus* (*Krebsia*) aff. *C. liberatus* Pease (p. 55).

Length 1.7 mm, X 28. Drill hole 2B, Bikini, 1,891–1,902 ft; early Miocene (Tertiary *e*). USNM 648451.

21. *Capulus* (*Krebsia*) sp. A (p. 55).

Length 6.1 mm, X 8. Station FB–20, Viti Levu, Fiji; early Miocene (Tertiary *f*). USNM 650601.

22–24. *Capulus* (*Krebsia*) sp. B (p. 55).

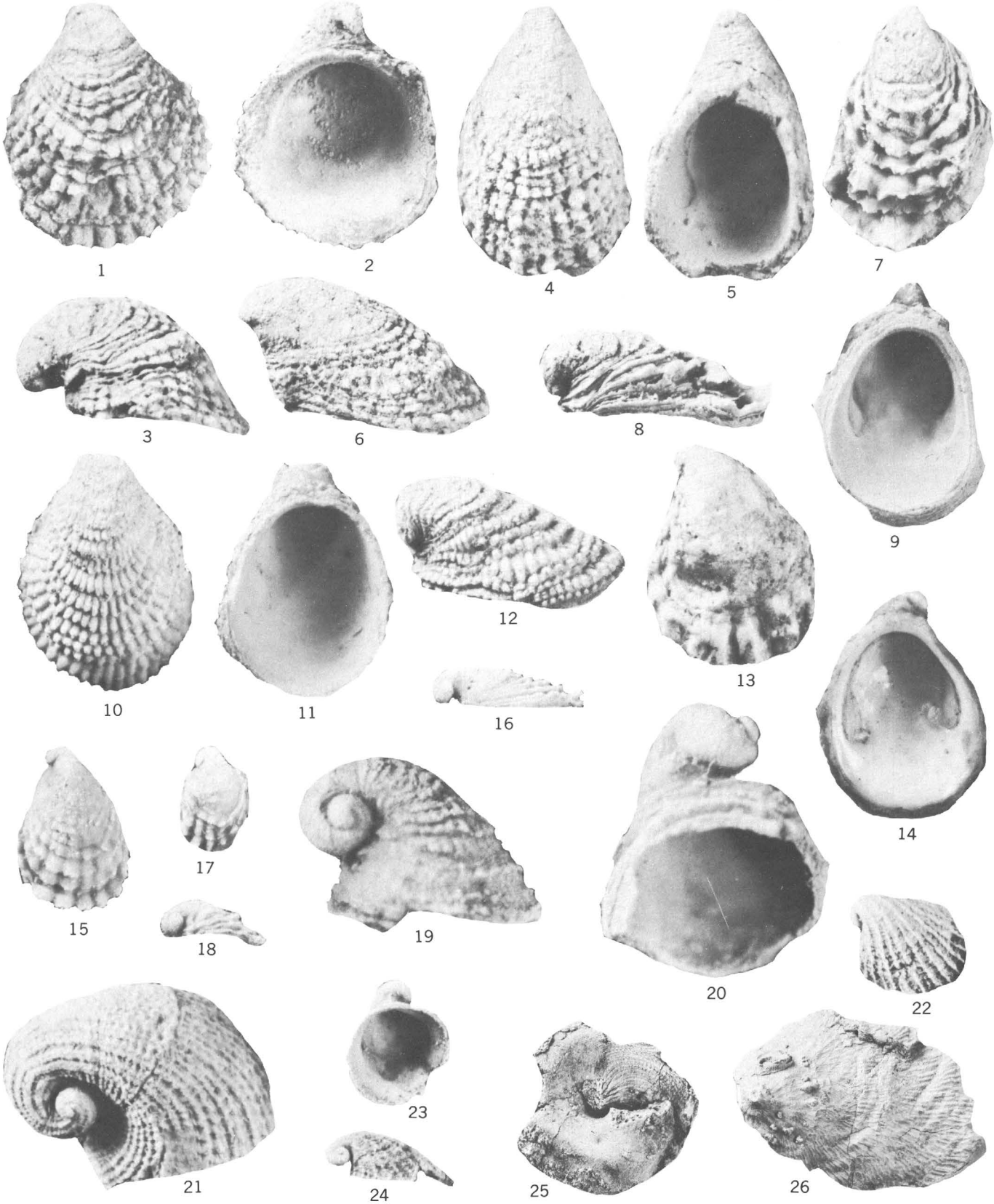
Length 2.0 mm, X 12. Drill hole F–1, Eniwetok, 850–860 ft; late Miocene (Tertiary *g*). USNM 648452.

25. *Xenophora* sp. B (p. 55).

Height 5 mm, X 2. USGS loc. 17728, Saipan; Tagpochau Limestone; Miocene. USNM 648453.

26. *Tugurium exutum* (Reeve) (p. 55).

Diameter 40.9 mm, X 1. Station 817, Vanua Levu, Fiji; Pliocene (Tertiary *h*). USNM 650472.




HIPPONICIDAE, CAPULIDAE, AND XENOPHORIDAE

# PLATE 15

FIGURE 1. *Varicospira* aff. *V. crispata* (Sowerby) (p. 56).
Height 30.5 mm, X 2. USGS loc. 17713, Urukthapel, Palau; possibly Miocene. USNM 648454.

2, 3. *Tibia* (*Tibia*) *powisii modesta* (Martin) (p. 56).
Length 31.2 mm and 19.6 mm, both X 2. Station B–107 (=817), Vanua Levu, Fiji; Pliocene (Tertiary *h*). USNM 648455 and 650617, respectively.

4. *Terebellum* (*Terebellum*) *terebellum* (Linnaeus) (p. 57).
Length 35.5 mm, X 1.5. USGS loc. 17724, Saipan; Tagpochau Limestone (Miocene). USNM 648456.

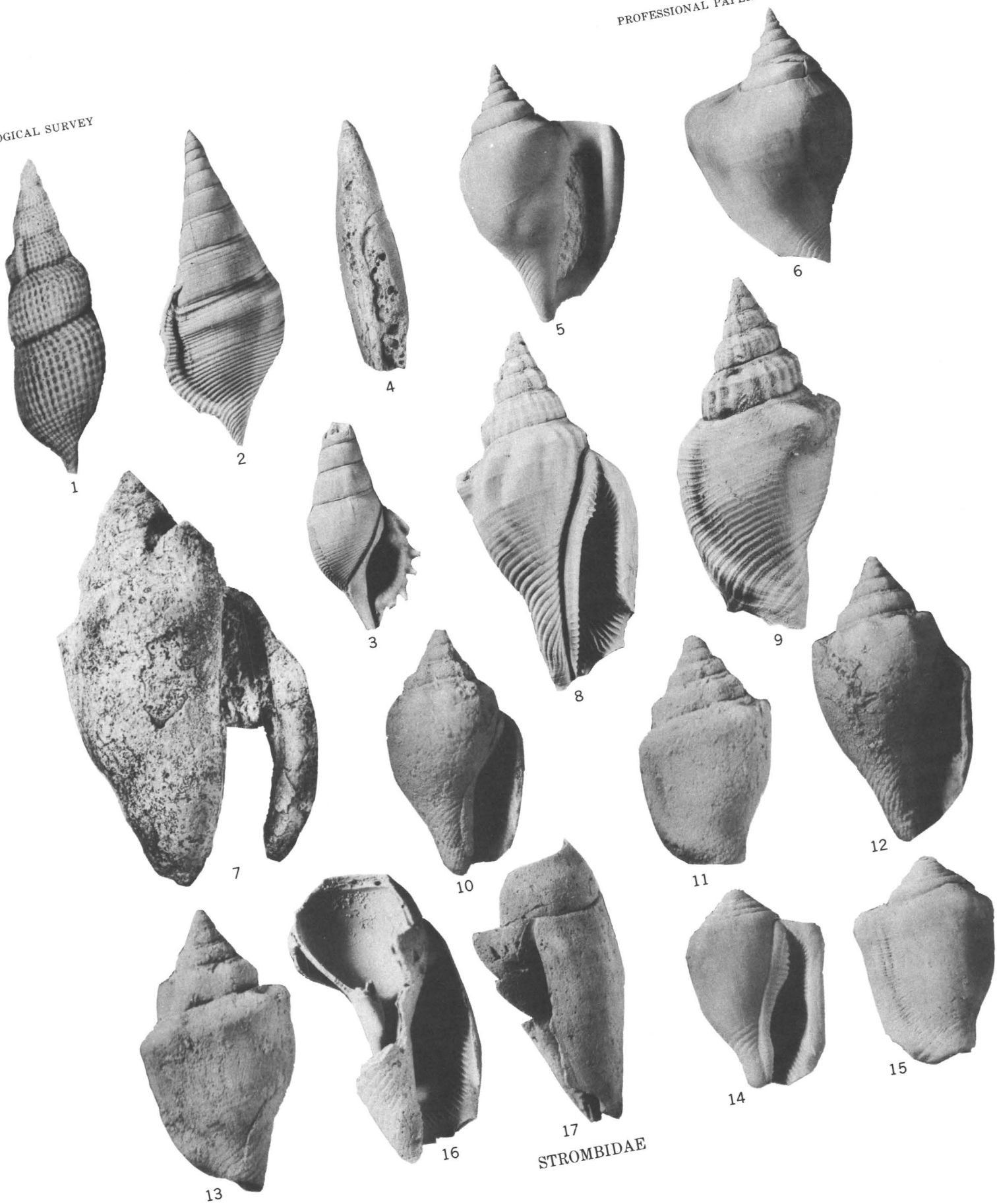
5, 6. *Strombus* (*Laevistrombus*) *canarium* Linnaeus (p. 57).
Length 50.0 mm, X 1. USGS loc. 24794, Maewo, New Hebrides; Pleistocene. USNM 650583.

7. *Strombus* (*Tricornis* ) aff. *S. thersites* Swainson (p. 58).
Length 83.4 mm, X 1. Station L–389, Lakemba, Fiji; Futuna Limestone; early Miocene (Tertiary *f*). Univ. Rochester 13, 059.

8, 9. *Strombus* (*Canarium*) *urceus* Linnaeus (p. 58).
Length 25.5 mm, X 3. Malekula, New Hebrides; Pliocene. René Abrard's specimen.

10–15. *Strombus* (*Canarium*) *mutabilis* Swainson (p. 58).
10, 11. Length 11.9 mm, X 4. Station 110B, Vanua Mbalavu, Fiji; probably Pliocene (Tertiary *h*). USNM 648462.
12, 13. Length 13.9 mm, X 4. Station 110B, Vanua Mbalavu, Fiji; probably Pliocene (Tertiary *h*). USNM 648463.
14, 15. Length 20.3 mm, X 2. Cabras Island, Guam; Mariana Limestone; probably Pleistocene. USNM 648461.

16, 17. *Strombus* (*Canarium*) cf. *S. fragilis* (Röding) (p. 59).
Length 19.3 mm, X 3. Drill hole 2A, Bikini, 925–936 ft; late Miocene (Tertiary *g*). USNM 648464.




STROMBIDAE

# PLATE 16

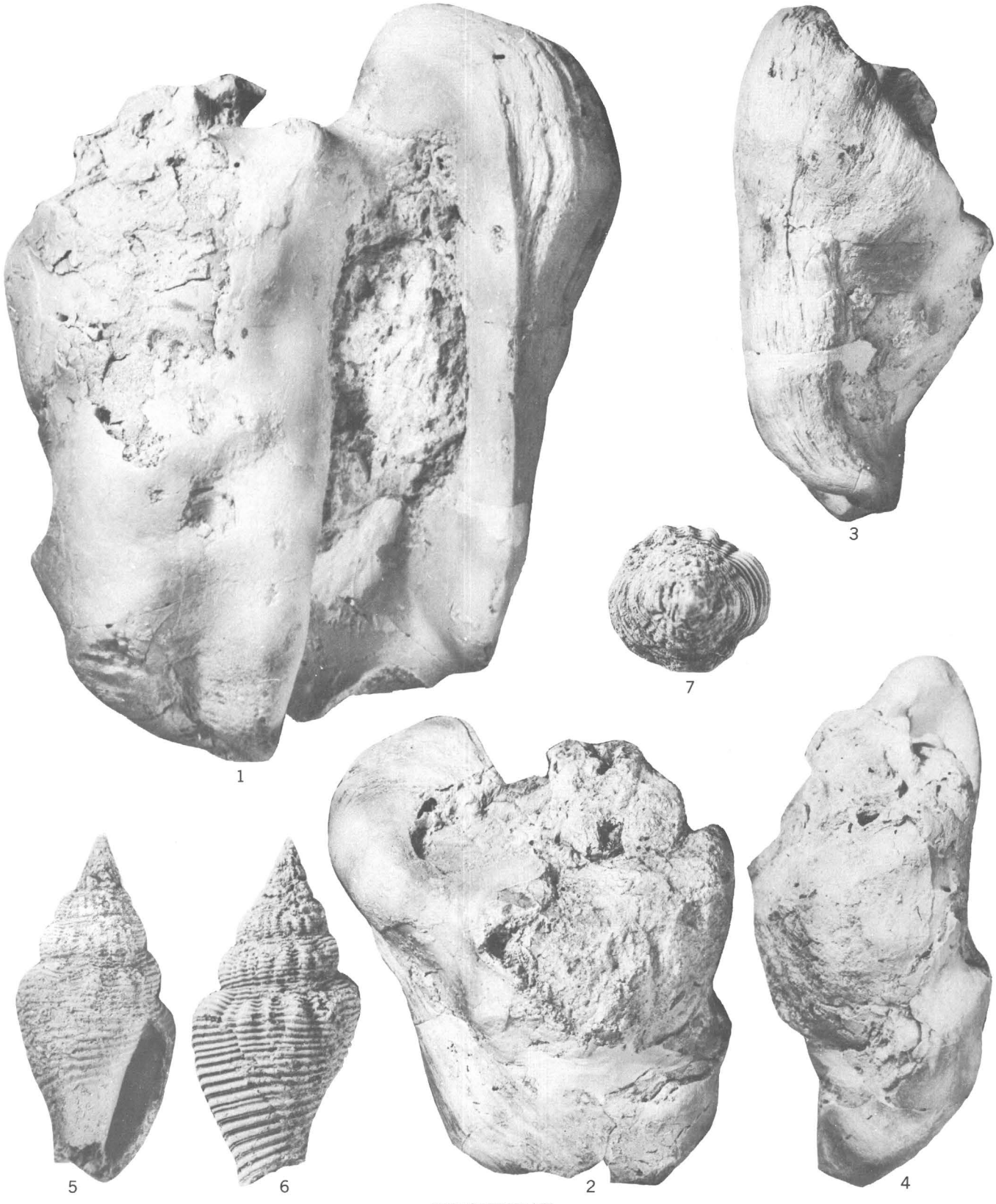
FIGURES 1–4. *Strombus* (*Tricornis*) *maximus* Martin (p. 57).

1. Apertural view. Length 200 mm, X 0.67. USGS loc. 21290, Auluptagel, Palau; late Miocene (Tertiary *g*). USNM 648457.

2–4. Rear and lateral views. About X 0.45.

5–7. *Strombus* (*Canarium*) sp. B (p. 59).

Length 31.5 mm, X 2. Station L–389, Lakemba, Fiji; Futuna Formation; early Miocene (Tertiary *f*). USNM 648465.



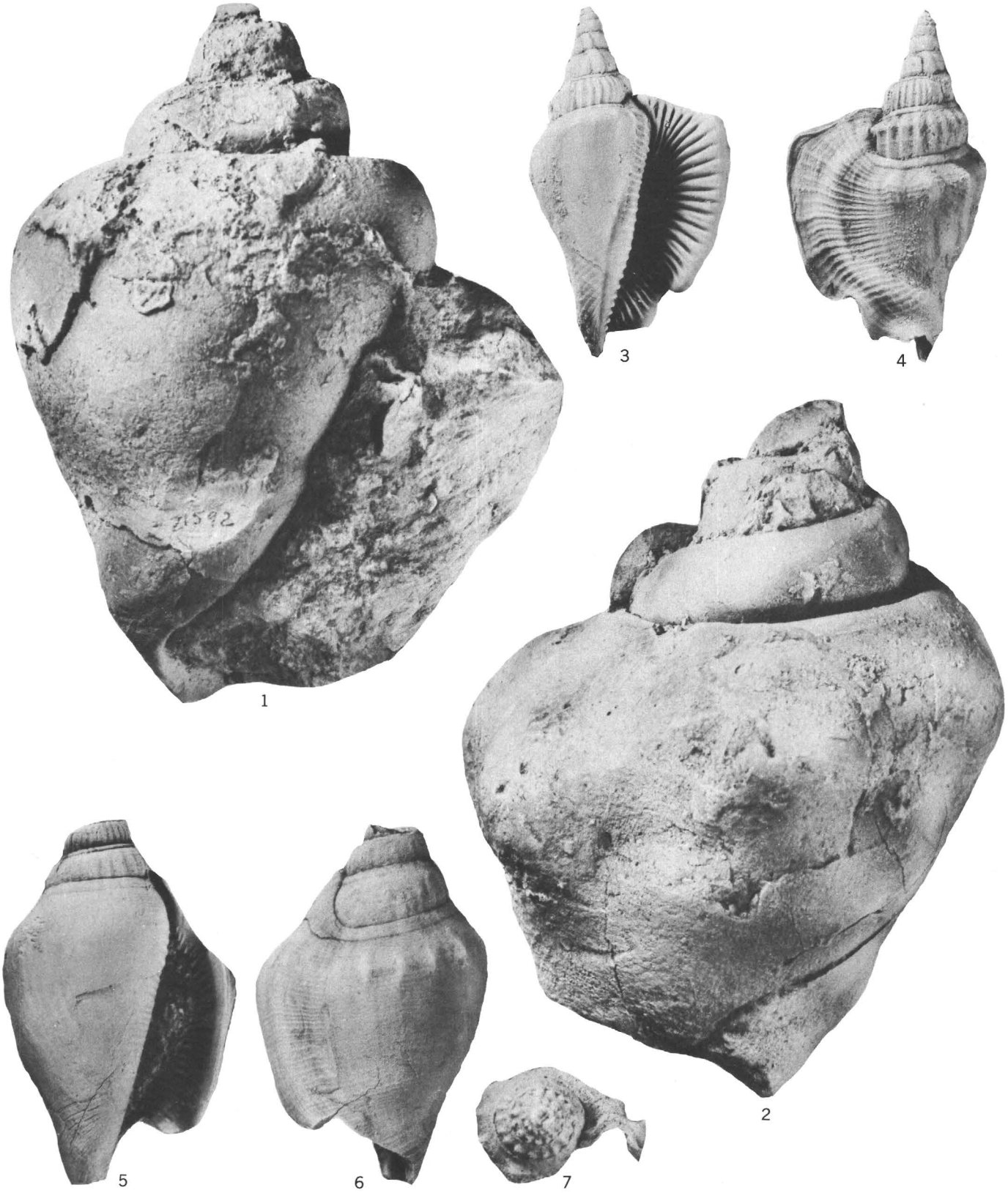

STROMBIDAE

# PLATE 17

FIGURES 1, 2. *Strombus* (*Tricornis*) sp. A (p. 58).
Length 126 mm, X 1. USGS loc. 21592, Guam; Alifan Limestone; late Miocene or Pliocene (Tertiary *g* or *h*). USNM 648460.

3–6. *Strombus* (*Dolomena*) *plicatus pulchellus* Reeve (p. 59).
3, 4. Length 22.5 mm, X 3. René Abrard's specimen; Malekula, New Hebrides; Pliocene.
5, 6. Length 33.6 mm, X 2. Station 817, Vanua Levu, Fiji; Pliocene (Tertiary *h*). USNM 648466.

7. *Strombus* (*Dolomena*) *variabilis athenius* Duclos (p. 60).
Apical view, diameter 24.5 mm, X 1.5. USGS loc. 20537, Guam; Mariana Limestone; Pliocene (Tertiary *h*) or Pleistocene. USNM 648467.




STROMBIDAE

# PLATE 18

FIGURES 1, 2. *Strombus* (*Dolomena*) *variabilis athenius* Duclos (p. 60).
Length 38.5 mm, X 1.5. USGS loc. 20537, Guam; Mariana Limestone; Pliocene (Tertiary *h*). or Pleistocene. USNM 648467.

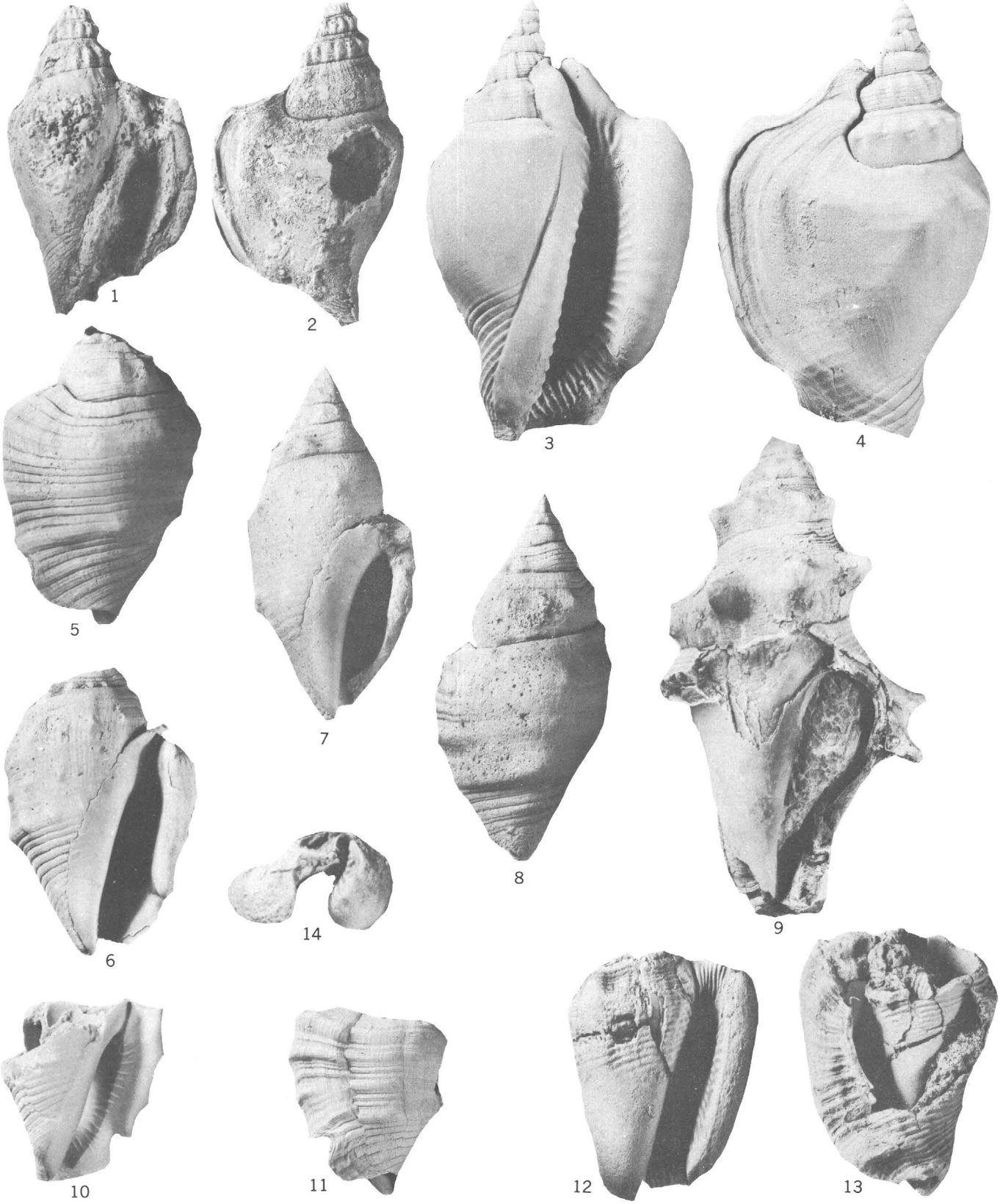
3, 4. *Strombus* (*Dolomena*) *minimus minor* Abrard (p. 60).
Length 28 mm, X 3. René Abrard's type specimen, Malekula, New Hebrides; Pliocene.

5–8. *Strombus* (*Lentigo*) *micklei* Ladd, n. sp. (p. 60).
5, 6. Holotype, length 35.5 mm, X 1.5. Drill hole 2A, Bikini, 925–935.5 ft; late Miocene (Tertiary *g*). USNM 648468.
7, 8. Paratype, length 44.5 mm, X 1.5. From same core and interval as holotype. USNM 648469.

9. *Strombus* (*Lentigo*) cf. *S. preoccupatus* Finlay (p. 61).
Length 90.6 mm, X 1. USGS loc. 20535, Guam, Talisay Member of Alifan Limestone; late Miocene (Tertiary *g*). USNM 648471.

10, 11. *Strombus* (*Lentigo*) sp. C (p. 61).
Length 22.6 mm, X 1.5. Drill hole 2A, Bikini, 925–935.5 ft; late Miocene (Tertiary *g*). USNM 648470.

12–14. *Strombus* (*Euprotomus*) *vomer hawaiensis* Pilsbry (p. 61).
Length 32.3 mm, X 1.5. Station F–238, Viti Levu, Fiji; probably Miocene. USNM 648472.




STROMBIDAE

# PLATE 19

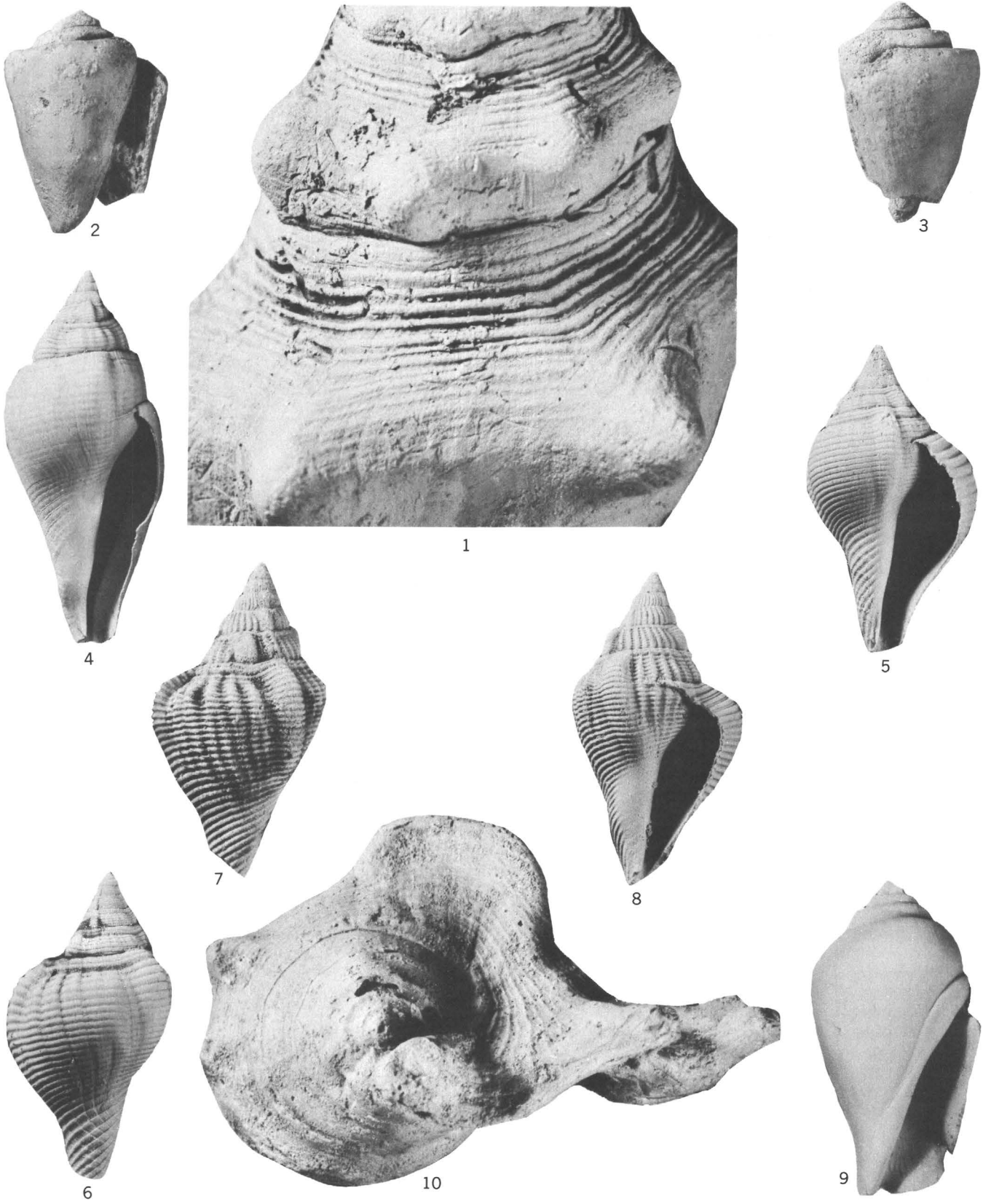
FIGURE 1. *Strombus* (*Lentigo*) cf. *S. preoccupatus* Finlay (p. 61).
Part of spire, X 4. USGS loc. 20535, Guam, Talisay Member of Alifan Formation; late Miocene (Tertiary *g*). USNM 648471.

2, 3. *Strombus* (*Conomurex*) *luhuanus* Linnaeus (p. 61).
Length 41.4 mm, X 1. Guam, USGS loc. 20626; Mariana Limestone; Pliocene (Tertiary *h*) or Pleistocene. USNM 648473.

4–8. *Strombus* (*Gibberulus*) *praegibberulus* Abrard (p. 62).
From Nua River, Island of Malekula, New Hebrides; Pliocene.
4. Type, length 35 mm, X 2.
5–8. Two other specimens, X 4.

9. *Strombus* (*Gibberulus*) *gibberulus gibbosus* (Röding) (p. 62).
Length 28.8 mm, X 2. Drill hole A–1, Eniwetok, 136.5–138 ft; Holocene. USNM 648474.

10. *Lambis* (*Lambis*) *lambis* (Linnaeus) (p. 63).
Diameter 103 mm, X 1. USGS loc. 21028, Espiritu Santo Island, New Hebrides; probably not older than Pleistocene. USNM 648477.



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STROMBIDAE

# PLATE 20

FIGURES 1–3. *Strombus* (*Gibberulus*) *gibberulus gibbosus* (Röding) (p. 62).

1. Length 28.8 mm, X 2. Drill hole A–1, Eniwetok, 136.5–138 ft; Holocene. USNM 648474.

2, 3. Length 49.8 mm, X 2. USGS loc. 20730, Guam; Agana Member of Mariana Limestone; Pliocene or Pleistocene. USNM 648476.

4. *Lambis* (*Lambis*) *lambis* (Linnaeus) (p. 63).

Length 155 mm, X 0.7. USGS loc. 21028, Espiritu Santo, New Hebrides; probably not older than Pleistocene. USNM 648477.

5, 6. *Lambis* (*Lambis*) cf. *L. lambis* (Linnaeus) (p. 63).

Length 92.1 mm, X 1. Station L–493, Lakemba, Fiji; early Miocene (Tertiary *f*). USNM 648478.

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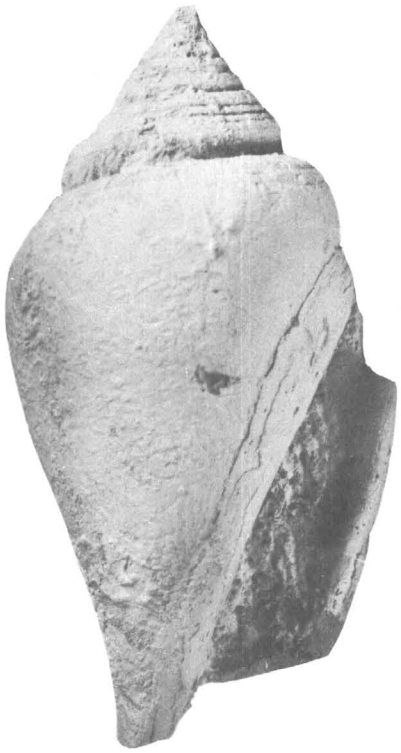

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STROMBIDAE