Cenozoic Fossil Mollusks From Western Pacific Islands; Gastropods (Eratoidae Through Harpidae)

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Cenozoic Fossil Mollusks From Western Pacific Islands; Gastropods (Eratoidae Through Harpidae)

By HARRY S. LADD

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Descriptions or citations of 195 representatives of 21 gastropod families from 7 island groups

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CENOZOIC FOSSIL MOLLUSKS FROM WESTERN PACIFIC ISLANDS; GASTROPODS (ERATOIDAE THROUGH HARPIDAE)

By HARRY S. LADD

ABSTRACT

Descriptions and citations of Cenozoic fossil mollusks from seven island groups in the western Pacific, started in U.S. Geological Survey Professional Papers 531 and 532, are continued in the present report, which deals with 195 species and subspecies. These include representatives of 21 gastropod families—Eratoidae through Harpidae—additions to three families previously covered, and a representative of one family (Cyclophoridae) not previously treated. One new genus, *Nawenia* in the Buccinidae, and 25 new species and 2 new subspecies are described. More than half the new forms were found in Fiji, the rest in the Marshall Islands and Palau. Most of the new forms occur in upper Miocene or Pliocene sediments.

Most of the mollusks described appear to be reef associated. Many are from lagoonal beds, but the most diversified fossil assemblage yet collected in Fiji was obtained from Pliocene marls that accumulated on an offshore shelf at moderate depths. An even richer assemblage of mollusks has recently been found in shallow-water Pleistocene marls on the island of Santo in the New Hebrides.

The mollusks are clearly Indo-Pacific in general aspect and are most closely related to fossil and living forms from tropical Indonesia and northern Australia.

INTRODUCTION

The descriptions of Cenozoic fossil mollusks from seven island groups in the western Pacific started by Ladd (1966, 1972) are continued in the present report. The island groups form a broad and somewhat irregular belt spreading 4,000 miles across the tropical Pacific from the Marianas and Palau on the northwest to Fiji and Tonga on the southeast (fig. 1). In the present report, 195 species and subspecies representing 21 families of gastropods (Eratoidae through Harpidae) are described or recorded along with additions to 3 families previously covered and a representative of one family (Cyclophoridae) not previously reported. The fossils treated range in age from late Eocene to Holocene.

The following references, containing identifications of fossil mollusks, supplement those listed on pages 3–5 of Ladd (1966) and page 1 of Ladd (1972).

1967 Warden, A. J., The geology of the central islands: New Hebrides Condominium Geol. Survey Rept. 5, 108 p. Includes (p. 23) the names of a dozen gastropods identified by Hedley (1905) from beds below the massive limestone at the Foreland on island of Epi; one pelecypod from the overlying reef is cited.

1968 Band, R. B., The geology of southern Viti Levu and Mbengga: Fiji Geol. Survey Dept. Bull. 15, 49 p. Includes (p. 22) the names of three pelecypods from the Lami Limestone determined by H. S. Ladd.

1971 Colley, H., and Ash, R. P., The geology of Erromango: New Hebrides Condominium Geol. Survey Regional Rept., 112 p. Includes (p. 49) the names of 28 mollusks identified by Abrard (1946) in assigning a Quaternary age to limestones from Erromango.

1972 Richards, H. G., Quaternary mollusks from Fiji: Nautilus, v. 86, p. 81–82. Includes the names of 21 mollusks collected from northwestern Viti Levu.

ACKNOWLEDGMENTS

I am indebted to Dr. Derek Green, Director of Mineral Developments, Fiji, for assistance in a continuation of my paleontological studies. Under his direction, I have received samples containing fossil mollusks from several members of the geological staff: Peter Rodda, Senior Geologist, who collected in several parts of Viti Levu and on smaller islands to the west and northwest; F. I. E. Coulson, who found fossils on several supposedly all-volcanic islands in Lomaiviti, who made additional collections in Lau and who accompanied me to Tonga where we

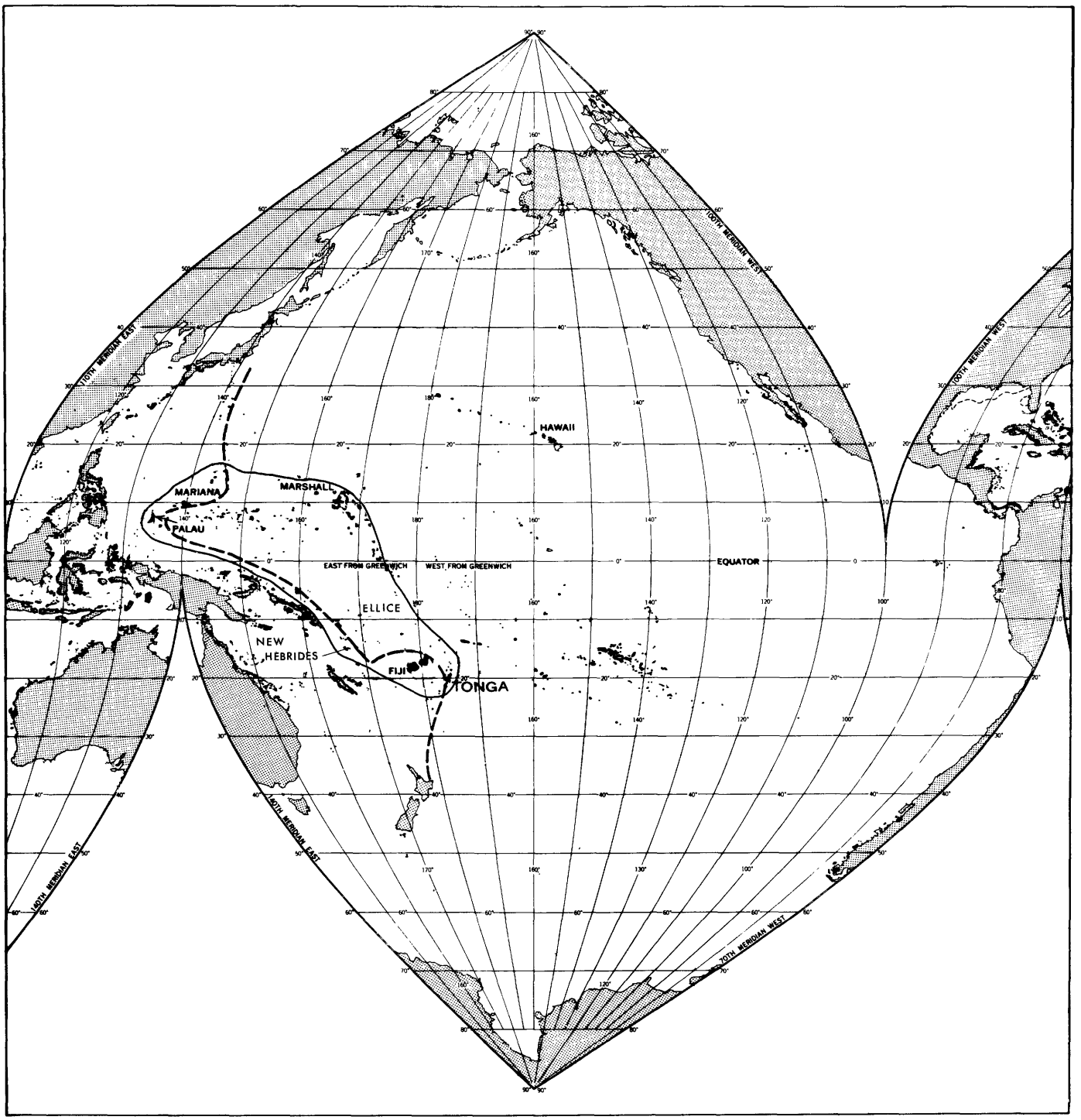

FIGURE 1.—Location of island groups from which fossil mollusks have been obtained. Dashed line marks structural boundary of Pacific basin (andesite line). Islands shown include the surrounding reefs.

collected Eocene mollusks. William Hindle and P. G. Woodrow made additional collections from Vanua Levu and from nearby islands; Andrew Strasfogel, Peace Corps Volunteer Geologist with the Fiji Survey, submitted fossiliferous drill cores from Viti Levu and collected many fossil mollusks on both Viti Levu and Vanua Levu. I am also indebted to Dr. Horace G. Richards of the Academy of Natural Sciences of Philadelphia, who loaned fossils that he and his associates collected in Fiji. Dr. C. P. Nuttall of

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Dr. D. I. J. Mallick, Senior Geologist of the New Hebrides Condominium Geological Survey, and Mr. K. A. Liggett, of the same organization, submitted collections of fossils from several islands in the New Hebrides.

Warren Blow of the U.S. Geological Survey aided in the preparation of much of the material. A few of the photographs were made by W. M. Briggs, Jr., while a member of the U.S. Geological Survey. All the remaining pictures were taken by Robert M. McKinney of the Geological Survey, and several of the photographs have been retouched by Eleanor Stromberg of the Survey.

I am indebted to Drs. H. A. Rehder and J. P. E. Morrison of the National Museum of Natural History, Smithsonian Institution; Druid Wilson of the Geological Survey; Walter O. Cernohorsky of the Auckland Institute and Museum, New Zealand; Dr. Robert Robertson of the Academy of Natural Sciences of Philadelphia; and Dr. Winston Ponder of the Australian Museum for discussions involving the identification of certain fossils. The manuscript has benefited from technical reviews by Dr. R. Tucker Abbott of the Delaware Museum of Natural History and Dr. Peter Jung of Naturhistorisches Museum, Basel.

STRATIGRAPHY AND CORRELATION

The geological mapping programs being carried out by the Surveys of Fiji and the New Hebrides that were mentioned in Ladd (1972, p. 3) are continuing. In Fiji, the mapping has been completed, except on some of the smaller islands. Latest published stratigraphic units in the two island groups are given in table 1.

In other parts of the island area, geologic work on land has been largely restricted to Tonga. Studies dealing primarily with igneous rocks have been carried on by Bryan, Stice, and Ewart (1972) and Ewart and Bryan (1972). Studies of the fossiliferous limestones of Eua continue to appear, the fifth and sixth chapters being reports on the bryozoans by Cheetham (1972) and on the brachiopods by Cooper (1971). A paper on the geologic setting of the deposits by Stearns was published in 1971. During that same year, a consortium of oil companies drilled two deep holes on the nearby island of Tongatapu. According to Durkee (1972, p. 1854; 1973, p. 2116), both wells went to about 5,500 feet. They penetrated Pleistocene to lower Miocene limestone and argillaceous volcanoclastic rocks but did not reach the Eocene limestone.

During recent years, the surface of the entire earth has been studied in the light of plate tectonics, and the island area, as defined in the present report, has been the subject of much interesting speculation. This area includes the island arcs that play an important part in all theories involving mountain building, continental drift, and sea-floor spreading. The several deeps (trenches) that form parts of the island area have been mapped, some have been sampled, and drill holes have been put down in the deep waters near the trenches and between the various groups of islands.

In 1969, during the course of Leg 6 of the cruises of the drilling ship *Glomar Challenger* (California Univ., Scripps Inst. Oceanography, 1971), four holes (nos. 55–58) were drilled on the Caroline Ridge between Palau and the Marshall Islands in water ranging in depth from 2,500 to 4,500 m. Drilled sections were from 130 to more than 560 m, mostly in oozes and chalks of late Oligocene and early Miocene age, resting, in some places at least, on basalt. A hole (no. 59) drilled in the abyssal floor just east of the Mariana Trench in 4,555 m of water passed through a total of more than 1,100 m of Neogene, Eocene, and Paleocene clay and bottomed in Cretaceous clay and lithified ash. A hole (no. 60) on the west wall of the Mariana Trench in 3,717 m of water passed through nearly 350 m of lower Miocene volcanic ash, part of a thick apron of pyroclastic materials extending eastward from Guam.

On Leg 20 of the Deep Sea Drilling Project (California Univ., Scripps Inst. Oceanography, 1973a), a deep hole was put down on the margin of the Caroline Abyssal Plain in 6,090 m of water, finding Mesozoic chalk but not reaching basement. Three other holes drilled on Ita Matai Guyot in the same area in water depths of 1,400–1,500 m found more than 100 m of foraminiferal beds underlain by oolitic limestone and coral debris extending back to the early Eocene.

Latest deep sea drilling in the island area was carried out in 1971 on Leg 21 in the Fiji-Tonga area (California Univ., Scripps Inst. Oceanography, 1973b). On this cruise, one hole was drilled in the Lau Basin (site 203), one in the South Fiji Basin (site 205), and one east of the Tonga Trench (site 204). The Lau Basin hole was drilled in waters 2,720 m deep to a depth of 409 m through nannofossil ooze, clay, and volcanic sand ranging in age from Pliocene to Holocene. The South Fiji Basin hole in 4,320 m of water ended in basaltic pillow lava

TABLE 1.—*Correlation chart of*

PERIOD	EPOCH		LETTER CLASSIFICATION	MARSHALL		ELLICE	PALAU	MARIANA		
				ENIWETOK	BIKINI	FUNAFUTI		SAIPAN	TINIAN	GUAM
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
	Pleistocene						Peleliu Limestone	Tanapag Limestone	Mariana Limestone	Mariana Limestone
LATE TERTIARY	Pliocene		*h*				Palau Limestone; Airal clay and lignite	Mariana Limestone; Terrace deposits		Alifan Limestone; Janum Formation; Barrigada Limestone
	Miocene	Late	*g*			?				
		Early	*f*							Bonya Limestone
			e					Fina-sisu Formation; Tagpochau Limestone	Tagpochau Limestone	Umatac Formation
EARLY TERTIARY	Oligocene	Late	*d*	?	?		? ? Ngeremiengui Formation			? Alutom Limestone
			c		?					
	Eocene	Early	*b*	Reef complex	?		? ? Aimelik Formation	Matansa Limestone; Densinyama Formation; Hagman Formation	Pyroclastic rocks	
			a		Globigerina ooze[1]		? Babelthuap Formation ?			

[1] Occurrence on Sylvania Guyot adjoining Bikini (Hamilton and Rex, 1959).
[2] Robinson (1969).
[3] Reported as Burdigalian—lower Pliocene.
[4] Mitchell (1971).
[5] 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.
[6] Generalized section based on Ibbotson (1969), Rickard (1970) and Coulson (1971).

after passing through 335 m composed mainly of abyssal nannofossil ooze of late Oligocene, Miocene, and early Pliocene age. The hole east of the Tonga Trench in waters 5,354 m deep penetrated 160 m of clay and volcanogenic sediments ranging in age from late Oligocene to Quaternary. The lowest samples contained reworked fossils of Cretaceous age.

The deep-sea drilling to date seems to fit well with the regional pattern of basement ages set forth in 1970 by Fischer and others. Additional drilling will tie known sections more closely together, especially now that chert and other resistant types of sediments can be cored. Some thought is being given to the drilling of deep holes at sites in existing lagoons. Such holes would recover fossil mollusks of great interest to the present study.

The occurrence of lower Eocene (Tertiary *a*) phosphatized *Globigerina* ooze from Sylvania Guyot in the Marshall Islands and the widespread occurrence in the island area of limestones of late Eocene (Tertiary *b*) age have been noted earlier (Ladd, 1966, p. 7–8). The Eocene limestone drilled beneath Eniwetok yielded only one identifiable mollusk, a species of *Turritella* related to a living species that also has been reported from the upper Tertiary of Indonesia (Ladd, 1972, p. 14). A varied assemblage of mollusks was recovered from the base of the Eocene limestone of Eua, Tonga. It was recognized that a few of the shells were shallow-water types, but they were worn and were thought to have been carried in (Ladd, 1970, C1–C2). Reviewers of Ladd (1970) noted the absence of a characteristic "Eocene

Cenozoic units in the island area

Epoch	NEW HEBRIDES: North Santo [2]	NEW HEBRIDES: Northern Malekula [4]	FIJI: Age	FIJI: VITI LEVU [5] Group	FIJI: LAU	FIJI: VANUA LEVU [6]	TONGA
			Holocene	Alluvium	Mango Odinite	Alluvium and other deposits	Reef limestone
Holocene	Alluvium, etc.	Alluvium, etc.	Pliocene and Pleistocene	Thuvu Verata	Fulanga Limestone	Mbua Group Monkey Face Group	Reef limestone
Pleistocene	Papatai Limestone	Tenmaru Limestone		Mba	Ndalithoni Limestone	Tuatua Limestone Undu Group	Reef limestone
Pliocene	Tawoli Calcilutite Tawoli Calcarenite [3] Wounpouko Calcarenite [3]	Malua Formation	Miocene and Pliocene	Koroimavua Navosa Nandi Mendrausuthu Ra	Koro Mbasanga Volcanics Futuna Limestone Lau Volcanics	Natewa Group	Tuff
Miocene	Pailapa Graywacke Ilava Volcanics Peteao Graywacke Ounay Subgraywacke Pelapa Graywacke Mamasa Volcanics Pelowou Limestone Peteao Limestone	Port Sandwich Formation Andesite, etc. Minor intrusive rocks Lambubu Breccia Matanui Group	Eocene and Miocene	Savura Singatoka Wainimala			Limestone and tuffaceous limestone
			Tertiary Late	Intrusive rocks Younger intrusive rocks			
Pre-Miocene	Basement complex	Red mudstone formation	Tertiary Early	Tholo Plutonics			?

look" and speculated that the assemblage might include Miocene or other post-Eocene shells carried seaward to mingle with still unburied late Eocene Foraminifera and other fossils. W. P. Woodring suggested that the possibility be tested by examining the filling of some minute shallow-water shell to see what sort of nannoplankton might be contained in it. None of the available mollusk shells were suitable for this purpose, so five specimens of a small shallow-water brachiopod, *Argyrotheca anomala* Cooper (1971, p. F5), were selected for study. These were sent to M. N. Bramlette who asked David Bukry of the U.S. Geological Survey to check their contents for calcareous nannofossils. Bukry (written commun. 1972) reported as follows:

A probable early Oligocene or possibly latest Eocene age is indicated for the rare nannofossil assemblage recovered by the occurrence of 2 species which become extinct in the early Oligocene (+). An hour of microscope scanning yielded the following species and numbers of specimens:

(+)	*?Bramletteuis serraculoides* Gartner	1
	Coccolithus eopelagicus (Bramlette and Riedel)	3
	C. pelagicus (Wallich)	10
	Cyclicargolithus floridanus (Roth and Hay)	59
(+)	*Cyclococcolithina formosa* (Kamptner)	2
	Dictyococcites bisectus (Hay, Mohler, and Wade)	5
	D. scrippsae Bukry and Percival	12
	Micrantholithus aequalis Sullivan	2
	Reticulofenestra sp	2
*	*Sphenolithus* sp	2

(*) One of the specimens resembles a late variety of late Oligocene *S. distentus* * * *

The above determinations indicate clearly that the Eocene assemblage, though it contains a mixture of shallow- and deep-water forms, is not a mixture of young and old forms. Cheetham (1972), who studied cheilostome Bryozoa from the same deposit, also reported a mixture of shallow and deep-water species.

PALEONTOLOGY

The distribution of the 195 species in the 21 families of gastropods covered in the present paper is shown graphically in table 2. The faunas are mostly reef associated, and it is not surprising to see that the mitrids and the cypraeids are most heavily represented and that the columbellids, naticids, and nassariids are next in abundance. The other 13 families are sparsely represented, two of them, the Ficidae and the Melongenidae, by only one species each. The cypraeids outnumber all others in numbers of specimens, many unidentifiable molds occurring with specifically identifiable material. A few species of the mitrids are represented in abundance, but nearly two-thirds of the species recorded are based on single specimens.

GEOGRAPHIC AND GEOLOGIC DISTRIBUTION OF SPECIES

The geographic distribution of the fossil species from the island area is shown in table 3. The greatest number was obtained from Fiji; Eniwetok was second and Guam, third.

The geologic distribution of the same species is shown in table 4. The numbers are greatest for the late Miocene (Tertiary *g*) and the Pliocene (Tertiary *h*). More than half of the fossil species are still living.

PALEOECOLOGY

FIJI

As mentioned in earlier chapters in the present series (Ladd, 1966, p. 11–15; 1972, p. 3, 11), most of the fossil mollusks collected in the island area are reef associated. In the 1972 paper, a brief reference was made to the upper Tertiary marls of Vanua Levu that were thought to have been deposited in waters 300 to more than 600 feet deep. The beds include the highly fossiliferous sediments exposed near Nasarowangga that were first collected by M. J. Rickard (station B 107) and later by Peter Ibbotson, W. H. Hindle, H. S. Ladd, and others (station 817). The most productive exposure is in a roadcut west of Nasarowangga. It has yielded many types of fossils, including the most abundant and diversified assemblage of mollusks yet collected in Fiji. Its age is now generally recognized as Pliocene (Tertiary *h*), and additional evidence bearing on the environment can now be given.

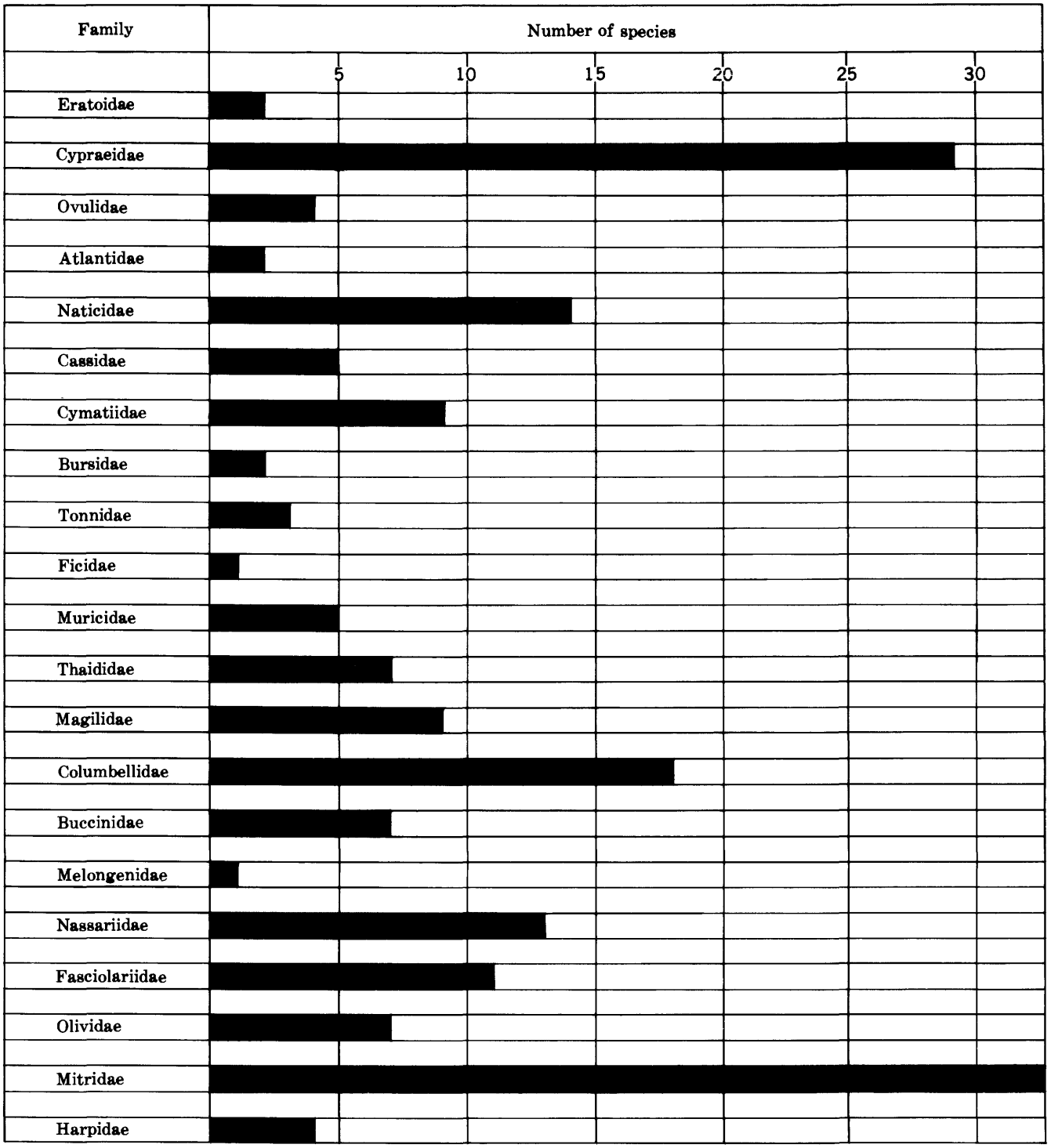
A rich assemblage of planktonic Foraminifera and a restricted assemblage of nannoplankton were obtained from the marls. The nannoplankton, according to David Bukry of the U.S. Geological Survey (written commun., 1973), include no open-ocean forms such as *Ceratolithus* and *Discoaster*. However, present in the marls are planktonic mollusks such as *Atlanta* and the pteropod *Cavolina*. Among the benthonic mollusks are *Phenacovolva nectarea* Iredale, described from shells dredged at 9–12 fathoms, and *Subcancilla abyssicola* Schepman (1911, p. 26), dredged in Indonesia from depths of 247 and 411 m (810 and 1,350 ft). Solitary corals from the marls include many *Carylophyllia* (*Acanthocyathus*) *spinosa* Umbgrove. According to John W. Wells, who made the identification (written commun., 1969), the subgenus *Acanthocyathus* has a bathymetric range of 70 to 750 m (230 to 2,460 ft). William M. Briggs (written commun., 1965), while with the U.S. Geological Survey, recognized more than 40 species of ostracodes, making up a normal marine assemblage that probably lived at depths no greater than 150 m (500 ft). John E. Fitch (written commun., 1973) examined a variety of otoliths recovered from the marls, recognizing several deep-water families of fishes (meso- and bathypelagic types).

All in all, the paleontological evidence seems to suggest accumulation on an offshore shelf at moderate depths rather than on a reef flat or in a shallow lagoon.

The occurrence of the coral-dwelling gastropod, *Magilus antiquus* Montfort, in the lower Miocene conglomerate of station 160, near Suva, Viti Levu, Fiji, is the only fossil occurrence known in the island area; elsewhere, the genus ranges into the Eocene. The single large shall from Fiji was found weathered free, but worn heads of reef corals, some bored by clams (*Coralliophaga* and *Lithophaga*), occur in the same conglomerate (Ladd, 1934, p. 179–181).

A minute land snail, a cyclophorid referable to the genus *Diancta*, was recovered from the marine Pliocene beds at station C1142, northwest Viti Levu, Fiji. The occurrence is interesting, if not particularly significant. The genus is represented on Viti Levu today by several species, some living in the interior, others in the coastal areas, including small islands on

TABLE 2.—*Distribution of species in families*



the reef. Apparently, *Diancta* was also present in Fiji in Pliocene time, and the small shells were washed into the sea. The occurrence is the first fossil record of the genus that lives today in the Mollucas as well as in Fiji.

NEW HEBRIDES

In 1973, during a search for road-surface materials on the island of Santo (formerly Espirtu Santo) in the New Hebrides, D. I. J. Mallick and David Greenbaum of the New Hebrides Geological Survey

TABLE 3.—*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, 1972)									
Neritidae:									
Pisulina adamsiana G. and H. Nevill	--	--	--	×	--	--	--	--	--
Cyclophoridae:									
Diancta aff. *D. macrostoma* Möllendorff	--	--	--	--	--	--	--	×	--
Cerithiidae:									
Argyropeza? suvaensis Ladd, n. sp	--	--	--	--	--	--	--	×	--
Cerithium aff. *C. novaehollandiae* A. Adams	--	--	--	--	--	--	--	×	--
Xenophoridae:									
Xenophora corrugata (Reeve)	--	--	--	--	--	--	--	×	--
konai Habe	--	--	--	--	--	--	×	--	--
calculifera (Reeve)	--	--	--	--	--	--	×	--	--
Tugurium aff. *T. exutum* (Reeve)	--	--	--	--	--	--	--	×	--
Families covered in this report									
Eratoidae:									
Erato hindlei Ladd, n. sp	--	--	--	--	--	--	--	×	--
Trivia (*Trivirostra*) *oryza* (Lamarck)	--	--	--	×	×	--	×	×	--
Cypraeidae:									
Cypraea (*Luria*) *isabella* Linnaeus	--	×	--	×	--	--	--	--	×
lekalekana Ladd	--	--	--	--	--	--	--	×	--
(*Mauritia*) *arabica* Linnaeus	--	--	--	×	--	--	×	--	×
(*Talparia*) *talpa* Linnaeus	--	×	--	--	--	--	--	--	--
(*Cypraea*) cf. *C. tigris* Linnaeus	--	×	--	--	--	--	--	--	--
(*Lyncina*) *lynx* Linnaeus	--	×	×	--	--	--	--	×	×
argus Linnaeus	--	--	--	--	--	--	×	--	×
carneola Linnaeus	--	×	--	--	--	--	×	--	×
lakemba Ladd	--	--	--	--	--	--	--	×	--
porteri Cate	--	--	--	--	--	--	×	--	--
(*Pustularia*) *cicercula* Linnaeus	--	--	--	--	--	--	×	--	--
margarita Dillwyn	--	--	--	--	--	--	--	×	--
globulus Linnaeus	--	×	--	--	--	--	--	--	--
everwijni Martin	--	--	--	--	--	--	--	×	--
childreni Gray	--	×	×	×	--	--	--	×	--
(*Monetaria*) *moneta* Linnaeus	--	×	×	×	--	--	×	×	--
(*Erosaria*) *erosa* Linnaeus	--	×	--	--	--	--	×	--	--
caputserpentis Linnaeus	--	×	--	--	--	--	×	--	--
labrolineata Gaskoin	--	--	--	--	--	--	--	×	--
helvola Linnaeus	--	--	--	×	×	×	--	×	×
cf. *C. miliaris* Gmelin	--	--	--	--	--	--	--	×	--
guttata Gmelin	--	--	--	--	--	--	×	--	--
(*Staphylaea*) *nucleus* Linnaeus	--	--	--	--	--	×	--	×	--
(*Erronea*) *errones* Linnaeus	--	--	--	--	--	--	--	×	--
mbalavuensis Ladd	--	--	--	--	--	--	--	×	--
cylindrica Born	--	--	--	--	--	--	--	×	--
(*Adusta*) aff. *C. kamai* (Beets)	--	--	--	×	--	--	--	--	--
(*Cribraria*) *cribraria* Linnaeus	--	--	--	--	--	--	--	×	--
sp	--	--	--	--	--	--	--	×	--
Ovulidae (Amphiperatidae):									
Pedicularia (*Pediculariona*) *pacifica* Pease	--	--	--	×	--	--	--	--	--
sp	--	--	--	--	--	--	--	--	×
Primovula rhodia (A. Adams)	--	--	--	--	--	--	--	×	--
Phenacovolva nectarea Iredale	--	--	--	--	--	--	--	×	--
Atlantidae:									
Atlanta peronii Lesueur	--	--	--	×	--	--	×	×	--
Oxygyrus levu Ladd, n. sp	--	--	--	--	--	--	--	×	--
Naticidae:									
Ampullina (*Ampullinopsis*) *berauensis* (Beets)	--	--	--	×	--	--	--	--	--
Globularia (*Cernina*) *fijiensis* Ladd	--	--	--	--	--	--	--	×	--
(*Waluia*) *edwardsi* Ladd	--	--	--	--	--	--	--	×	--
Pachycrommium stockwelli Ladd	--	--	--	--	--	--	--	×	--
Pachycrommium? pacificum Ladd	--	--	--	--	--	--	--	×	--
Polinices (*Polinices*) *mammilla* (Linnaeus)	--	×	--	×	--	--	×	×	--
(*Polinices*) *cumingianus madioenensis* Altena	--	--	--	--	--	--	--	×	--
cf. *P. columnaris* (Récluz)	--	--	--	--	--	--	--	×	--
Mammilla melanostoma (Gmelin)	--	--	×	--	--	--	--	×	--
Pliconacca martini Ladd, n. sp	--	--	--	--	--	--	--	×	--
Neverita sp	--	--	--	--	--	--	--	--	×
Sinum sp. A	--	--	--	×	--	--	--	--	--
Naticarius marochiensis (Gmelin) s. 1	×	×	--	×	×	--	×	×	--
onea (Röding)	--	×	--	--	--	--	--	--	--
Cassidae:									
Bathygalea (*Bathygalea*) sp. A	--	×	--	--	--	--	--	--	--
Cassis cf. *C. cornuta* Linnaeus	--	--	×	--	--	--	--	×	--

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

Species	Palau	Guam	Saipan	Eniwetok	Bikini	Funafuti	New Hebrides	Fiji	Tonga
Cassidae:—Continued									
Phalium (Semicassis) bisulcatum (Schubert and Wagner)	--	--	--	--	--	--	×	×	--
(Semicassis) vavakuana (Ladd)	--	--	--	--	--	--	--	×	--
(Casmaria?) sp	--	×	--	--	--	--	--	--	--
Cymatiidae:									
Gyrineum (Gyrineum) bituberculare (Lamarck)	--	--	--	--	--	--	--	×	--
Biplex perca Perry	--	--	--	--	--	--	×	×	--
Cymatium (Lampusia) aquatile (Reeve)	--	--	--	--	--	--	--	×	--
(Cymatriton) rickardi Ladd, n. sp	--	--	--	--	--	--	--	×	--
(Septa) rubecula (Linnaeus)	--	--	--	--	--	--	--	×	--
gemmatum (Reeve)	--	--	--	--	×	--	--	--	--
Distorsio (Distorsio) anus (Linnaeus)	--	--	--	--	--	--	--	×	--
(Rhysema) pusilla Pease	--	--	--	×	--	--	--	--	--
reticulata Röding	--	--	--	--	--	--	×	×	--
Bursidae:									
Bursa (Colubrellina) nobilis (Reeve)	--	--	--	--	--	--	--	×	--
(Colubrellina) margaritula (Deshayes)	--	--	--	--	--	--	×	×	--
Tonnidae:									
Eudolium sp	--	--	--	--	--	--	--	×	--
Quimalea pomum (Linnaeus)	--	--	--	--	--	--	×	--	--
Tonna sulcosa (Born)	--	--	--	--	--	--	--	×	--
Ficidae:									
Ficus variegata Röding	--	--	--	--	--	--	--	×	--
Muricidae:									
Murex (Murex) guppyi Ladd, n. sp	--	--	--	--	--	--	--	×	--
(Murex) nasongoensis Ladd	--	--	--	--	--	--	--	×	--
bantamensis coulsoni Ladd, n. subsp					--	--	--	×	--
cf. *M. multispinosus* G. B. Sowerby	--	--	--	--	--	--	--	×	--
Pterynotus sp	--	--	--	×	--	--	--	--	--
Vitularia miliaris (Gmelin)	--	--	--	--	--	--	--	×	--
Thaididae:									
Drupa (Drupa) ricinus (Linnaeus)	--	×	--	--	--	--	--	--	--
(Morula) granulata (Duclos)	--	--	--	×	--	--	--	--	--
(Cronia) fiscella (Gmelin)	--	--	×	×	--	--	--	--	--
(Drupella) cf. *D. monilifera* (Pease)	--	--	--	×	--	--	--	--	--
Nassa serta (Bruguière)	--	--	--	--	--	--	--	--	×
Thais (Stramonita) sp	--	--	--	--	--	--	--	×	--
(Cymia) aff. *T. carinifera* (Lamarck)	--	--	×	--	--	--	--	--	--
Magilidae:									
Coralliophila (Coralliophila) sp	--	--	--	×	--	--	--	--	--
(Pseudomurex) macneili Ladd, n. sp	--	--	--	×	--	--	--	--	--
bayeri Ladd, n. sp	×	--	--	--	--	--	--	--	--
(Fusomurex) sp. A	--	--	--	×	--	--	--	--	--
sp. B	--	--	--	×	--	--	--	--	--
Latiaxis (Latimurex) inflata (Dunker)	--	--	--	×	--	--	--	--	--
(Latimurex) sp. A	--	--	--	--	×	--	--	--	--
Coralliobia (Quoyula) monodonta (Blainville)	--	--	--	×	--	--	--	--	--
Magilus antiquus Montfort	--	--	--	--	--	--	--	×	--
Columbellidae:									
Columbella pardalina Lamarck	--	--	--	×	--	--	--	×	--
Euplica turturina (Lamarck)	--	--	--	×	×	--	--	--	--
varians (Sowerby)	--	--	--	×	×	--	--	--	--
aff. *E. varians* (Sowerby)	--	--	--	×	--	--	--	--	--
Lavesopus eniwetokensis Ladd, n. sp	--	--	--	×	--	--	--	--	--
Zafrona lifuana (Hervier)	--	--	--	×	--	--	--	--	--
Graphicomassa ligula (Duclos)	--	--	--	--	--	--	--	×	--
sp	--	--	--	--	--	--	--	×	--
Anachis (Costoanachis) winradi Ladd, n. sp	×	--	--	--	×	--	--	--	--
(Costoanachis) rewaensis Ladd, n. sp	--	--	--	--	--	--	--	×	--
lauensis Ladd, n. sp	--	--	--	--	--	--	--	×	--
(Zafra) smithi (Angas)	--	--	--	×	--	--	--	--	--
Pyrene obtusa (Sowerby)	--	--	--	×	--	--	--	--	--
Mitrella sagitta (Gaskoin)	--	--	--	×	×	--	--	--	--
gonzabuensis MacNeil	--	--	--	--	--	--	--	×	--
oweni Ladd, n. sp	×	--	--	--	--	--	--	--	--
sp. A	--	--	--	--	--	--	--	×	--
Zemitrella bikiniensis Ladd, n. sp	--	--	--	--	×	--	--	--	--
Buccinidae:				×					
Siphonalia subspadicea MacNeil	--	--	--	--	--	--	--	×	--
aff. *S. stearnsii* Pilsbry	--	--	--	--	--	--	--	×	--
Searlesia hindlei Ladd, n. sp	--	--	--	--	--	--	--	×	--
Euthria hoffmeisteri Ladd, n. sp	--	--	--	--	--	--	--	×	--
Metula (Metula) ibbotsoni Ladd, n. sp	--	--	--	--	--	--	--	×	--
Cantharus (Pollia?) sp	--	--	×	--	--	--	--	--	--
Nawenia bartholomewi Ladd, n. gen. and n. sp	--	--	--	--	--	--	--	×	--

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

Species	Palau	Guam	Saipan	Eniwetok	Bikini	Funafuti	New Hebrides	Fiji	Tonga
Melongenidae:									
Pugilina (*Mayeria*) *swartzi* Ladd, n. sp	--	--	--	×	--	--	--	--	--
Nassariidae:									
Nassarius (*Phrontis*) *tiarula* (Kiener)	--	--	--	×	--	--	--	--	--
(*Arcularius*) *leptospirus* A. Adams	--	--	--	--	--	--	×	--	--
graniferus (Kiener)	--	--	--	--	×	--	--	--	--
eniwetokensis Ladd, n. sp	--	--	--	×	--	--	--	--	--
(*Arcularius*)? sp	--	×	--	--	--	--	--	--	--
(*Uzita*) *verbeeki* (Martin)	×	--	--	--	--	--	--	×	--
Nassarius (*Uzita*) *mangkalihatensis* Beets	×	--	--	--	--	--	--	--	--
(*Zeuxis*) *concinnus* (Powys)	--	×	--	--	--	--	--	--	--
planicostata (A. Adams)	--	--	--	--	--	--	--	×	--
vitiensis (Hombron and Jaquinot)	--	--	--	--	--	--	×	--	--
(*Niotha*) *fijiensis* (Ladd), new name	--	--	--	--	--	--	--	×	--
ovus (Martin)	--	--	--	--	--	--	--	×	--
marshallensis Ladd, n. sp	--	--	--	×	×	--	--	--	--
Fasciolariidae:									
Latirus sp	--	--	--	--	--	--	--	--	×
craticulatus (Linnaeus)	--	--	--	--	--	--	×	--	--
barclayi (Reeve)	--	×	--	--	--	--	--	--	--
Peristernia nassatula (Lamarck)	--	--	--	×	×	--	--	--	--
incarnata (Kiener)	--	--	--	--	--	--	--	×	--
chlorostoma (Sowerby)	--	--	--	×	--	--	--	--	--
waluensis Ladd, n. sp	--	--	--	--	--	--	--	×	--
eniwetokensis Ladd, n. sp	--	--	--	×	--	--	--	--	--
ustulata (Reeve)	--	×	--	--	--	--	--	--	--
goikulensis Ladd, n. subsp	×	--	--	--	--	--	--	--	--
Fusinus sp	--	--	--	--	--	--	--	×	--
Olividae:									
Belloliva (*Olivellopsis*) *simplex* (Pease)	--	--	--	×	×	--	--	--	--
Oliva carneola (Gmelin)	--	--	--	--	--	--	--	×	--
annulata Gmelin	--	×	--	--	--	--	×	×	--
woolnoughi Ladd	--	--	--	--	--	--	--	×	--
lauensis Ladd	--	--	--	--	--	--	--	×	--
miniacea (Röding)	--	--	--	--	--	--	×	--	--
mustelina Lamarck	--	--	--	--	--	--	--	×	--
Mitridae:									
Mitra (*Mitra*) *eremitarum* Röding	--	--	--	--	--	--	--	×	--
(*Mitra*) *imperialis* Röding	--	--	--	--	--	--	--	×	--
cf. *M. puncticulata* Lamarck	--	--	--	--	×	--	--	--	--
(*Nebularia*) *aurantia* (Gmelin)	--	×	--	--	--	--	--	--	--
coronata Lamarck	--	--	--	--	--	--	×	--	--
crassicostata Sowerby?	--	×	--	--	--	--	--	--	--
fraga Quoy and Gaimard	--	--	--	×	--	--	--	--	--
turgida Reeve	--	--	--	×	--	--	--	--	--
(*Strigatella*) *fastigium* Reeve	--	--	--	--	--	--	--	×	--
Pterygia crenulata (Gmelin)	--	--	×	--	--	--	--	--	--
fenestrata (Lamarck)	--	×	--	--	--	--	--	--	--
Scabricola (*Scabricola*) *desetangsii* (Kiener)	--	×	--	--	--	--	--	--	--
Subcancilla abyssicola (Schepman)	--	--	--	--	--	--	--	×	--
interlirata (Reeve)	--	--	--	--	--	--	--	×	--
malleti (Petit de la Saussaye)	--	×	--	--	--	--	--	--	--
nasongoensis (Ladd)	--	--	--	--	--	--	--	×	--
Cancilla (*Domiporta*) *carnicolor* (Reeve)	--	×	--	--	--	--	--	--	--
Vexillum (*Costellaria*) *amanda* (Reeve)	×	--	--	--	--	--	--	×	--
(*Costellaria*) *cernohorskyi* Ladd, n. sp	--	--	--	×	--	--	--	--	--
deshayesi (Reeve)	--	--	--	×	--	--	--	--	--
aff. *V. discoloria* (Reeve)	--	--	--	--	×	--	--	--	--
festum (Reeve)	--	--	--	×	×	--	--	--	--
leucozonias Deshayes	--	--	--	×	--	--	--	--	--
obeliscus (Reeve)	--	--	--	--	--	--	--	×	--
radius (Reeve)	--	--	--	--	--	--	--	×	--
aff. *V. gembacana* (Martin)	--	--	--	×	×	--	--	--	--
roseum (Broderip)	--	--	--	×	--	--	--	--	--
strasfogeli Ladd, n. sp	--	--	--	--	--	--	--	×	--
stainforthi (Reeve)	--	--	--	--	--	--	×	--	--
aff. *V. zebuense* (Reeve)	--	×	--	--	--	--	--	--	--
(*Pusia*) *approximatum* (Pease)	--	--	--	×	--	--	--	--	--
exquisitum (Garrett)	--	--	--	×	--	--	--	--	--
microzonias (Lamarck)	--	--	--	--	--	--	--	×	--
Harpidae:									
Eocithara? sp. A	--	--	--	--	--	--	--	×	--
sp. B	--	--	--	×	--	--	--	--	--
Harpa amouretta Röding	--	×	--	--	--	--	--	--	--
major (Röding)	--	--	--	--	--	--	×	--	--
Total of 195 species	8	29	9	53	18	2	26	96	9

TABLE 4.—*Geologic distribution of Cenozoic mollusk species in the island area*

[Queries following occurrences show uncertainty as to the exact age of the beds from which the fossils were obtained. The Alifan Limestone of Guam may be Miocene or Pliocene (Tertiary *g* or *h*); the Mariana Limestone of the same island may be Pliocene or Pleistocene]

Species	Tertiary					Quaternary		
	Late Eocene	Early Miocene	Miocene	Late Miocene	Pliocene	Pleistocene	Holocene	Living
	b	*e*	*f*	*g*	*h*			
Additions to families covered in Ladd (1966, 1972)								
Neritidae:								
Pisulina adamsiana G. and H. Nevill	--	--	--	--	--	--	×	×
Cyclophoridae:								
Diancta aff. *D. macrostoma* Möllendorff	--	--	--	--	×	--	--	--
Cerithiidae:								
Argyropeza? *suvaensis* Ladd, n. sp	--	--	×	--	--	--	--	--
Cerithium aff. C. novaehollandiae A. Adams	--	--	--	--	×	--	--	--
Xenophoridae:								
Xenophora corrugata (Reeve)	--	--	--	--	×	--	--	--
konai Habe	--	--	--	--	--	×	--	--
calculifera (Reeve)	--	--	--	--	--	×	--	--
Tugurium aff. *T. exutum* (Reeve)	--	--	--	--	×	--	--	--
Families covered in this report								
Eratoidae:								
Erato hindlei Ladd, n. sp	--	--	--	--	×	--	--	--
Trivia (*Trivirostra*) *oryza* (Lamarck)	--	--	×	×	×	×	×	×
Cypraeidae:								
Cypraea (*Luria*) *isabella* Linnaeus	--	--	--	--	×?	×	×	×
(*Luria*) *isabella lekalekana* Ladd	--	--	×	--	×	--	--	--
(*Mauritia*) *arabica* Linnaeus	--	--	--	--	--	×	×	×
(*Talparia*) *talpa* Linnaeus	--	--	--	--	×?	×?	--	×
(*Cypraea*) cf. *C. tigris* Linnaeus	--	--	--	×?	×?	--	--	--
(*Lyncina lynx* Linnaeus	--	--	×	--	--	×	--	×
argus Linnaeus	--	--	--	--	--	×	--	×
carneola Linnaeus	--	--	--	--	×?	×?	--	×
lakemba Ladd	--	--	×	--	--	--	--	--
porteri Cate	--	--	--	--	--	×	--	×
(*Pustularia*) *cicercula* Linnaeus	--	--	--	--	--	×	--	×
margarita Dillwyn	--	--	--	--	×	--	--	×
globulus Linnaeus	--	--	--	--	×?	×?	--	×
everwijni Martin	--	--	×	--	--	--	--	--
childreni Gray	--	--	×	--	×?	×	×	×
(*Monetaria*) *moneta* Linnaeus	--	--	×	--	×?	×	×	×
(*Erosaria*) *erosa* Linnaeus	--	--	--	--	×?	×	--	×
caputserpentis Linnaeus	--	--	--	--	×?	×	--	×
labrolineata Gaskoin	--	--	--	--	×	--	--	×
helvola Linnaeus	--	--	×	×	×	×	--	×
cf. *C. miliaris* Gmelin	--	--	--	--	--	×	--	×
guttata Gmelin	--	--	--	--	--	×	--	×
(*Staphylaea*) *nucleus* Linnaeus	--	--	--	--	×	--	--	×
(*Erronea*) *errones* Linnaeus	--	--	--	--	×	--	--	×
mbalavuensis Ladd	--	--	--	--	×	--	--	--
cylindrica Born	--	--	--	--	×	--	--	×
(*Adusta*) aff. *C. kamai* (Beets)	--	×	--	--	--	--	--	--
(*Cribraria*) *cribraria* Linnaeus	--	--	--	--	×	--	--	×
sp	--	--	--	--	×	--	--	--
Ovulidae:								
Pedicularia (*Pediculariona*) *pacifica* Pease	--	--	--	--	--	--	×	×
sp	×	--	--	--	--	--	--	--
Primovula rhodia (A. Adams)	--	--	--	--	×	--	--	×
Phenacovola nectarea Iredale	--	--	--	--	×	--	--	×
Atlantidae:								
Atlanta peronii Lesueur	--	--	--	--	×	×	×	×
Oxygyrus levu Ladd, n. sp	--	--	--	--	×	--	--	--
Naticidae:								
Ampullina (*Ampullinopsis*) *berauensis* (Betts)	--	×	--	--	--	--	--	--
Globularia (*Cernina*) *fijiensis* Ladd	--	--	×	--	--	--	--	--
(*Waluia*) *edwardsi* Ladd	--	--	×	--	--	--	--	--
Pachycrommium stockwelli Ladd	--	--	--	--	×	--	--	--
Pachycrommium? *pacificum* Ladd	--	--	×	--	--	--	--	--
Polinices (*Polinices*) *mammilla* (Linnaeus)	--	--	×	×	×	×	--	×
(*Polinices*) *cumingianus madioenensis* Altena	--	--	×	--	×	--	--	--
cf. *P. columnaris* (Récluz)	--	--	--	--	×	--	--	--
Mammilla melanostoma (Gmelin)	--	--	--	--	×	--	×	×
Pliconacca martini Ladd, n. sp	--	--	×	--	--	--	--	--
Neverita sp	×	--	--	--	--	--	--	--
Sinum sp. A	--	--	--	--	--	--	×	--
Naticarius marochiensis (Gmelin) s. l	--	--	×	×	×	--	×	×
onca (Röding)	--	--	--	--	×?	×?	--	×

TABLE 4.—*Geologic distribution of Cenozoic mollusk species in the island area*—Continued

Species	Tertiary					Quaternary		
	Late Eocene	Early Miocene	Miocene	Late Miocene	Pliocene	Pleistocene	Holocene	Living
	b	*e*	*f*	*g*	*h*			
Cassidae:								
Bathygalea (*Bathygalea*) sp. A	--	--	--	--	×?	×?	--	--
Cassis cf. *C. cornuta* Linnaeus	--	--	×	--	--	--	--	--
Phalium (*Semicassis*) *bisulcatum* (Schubert and Wagner)	--	--	--	--	×	×	--	×
(*Semicassis*) *vavakuana* (Ladd)	--	--	--	×	--	--	--	--
(*Casmaria*?) sp	--	--	--	×	--	--	--	--
Cymatiidae:								
Gyrineum (*Gyrineum*) *bituberculare* (Lamarck)	--	--	--	--	×	--	--	×
Biplex perca Perry	--	--	--	--	×	×	--	×
Cymatium (*Lampusia*) *aquatile* (Reeve)	--	--	--	--	×	--	--	×
(*Cymatriton*) *rickardi* Ladd, n. sp	--	--	--	--	×	--	--	--
(*Septa*) *rubecula* (Linnaeus)	--	--	×	--	--	--	--	×
gemmatum (Reeve)	--	--	--	--	--	--	×	×
Distorsio (*Distorsio*) *anus* (Linnaeus)	--	--	--	--	×	--	--	×
(*Rhysema*) *pusilla* Pease	--	--	--	--	--	--	×	×
reticulata Röding	--	--	--	--	×	--	--	×
Bursidae:								
Bursa (*Colubrellina*) *nobilis* (Reeve)	--	--	--	--	×	--	--	×
(*Colubrellina*) *margaritula* (Deshayes)	--	--	--	--	×	×	--	×
Tonnidae:								
Eudolium sp	--	--	×	--	--	--	--	--
Quinalea pomum (Linnaeus)	--	--	--	--	--	×	--	×
Tonna sulcosa (Born)	--	--	--	--	×	--	--	×
Ficidae:								
Ficus variegata Röding	--	--	--	--	×	--	--	×
Muricidae:								
Murex (*Murex*) *guppyi* Ladd, n. sp	--	--	--	--	×	--	--	--
(*Murex*) *nasongoensis* Ladd	--	--	--	×	--	--	--	--
bantamensis coulsoni Ladd, n. subsp	--	--	--	×	×	--	--	--
Murex cf. *M. multispinosus* G. B. Sowerby	--	--	--	--	×	--	--	--
Pterynotus sp	--	--	--	--	--	--	×	--
Vitularia miliaris (Gmelin)	--	--	--	--	×	--	--	×
Thaididae:								
Drupa (*Drupa*) *ricinus* (Linnaeus)	--	--	--	--	×	--	--	×
(*Morula*) *granulata* (Duclos)	--	--	--	--	--	--	×	×
(*Cronia*) *fiscella* (Gmelin)	--	--	--	×	--	×	--	×
(*Drupella*) cf. *D. monilifera* (Pease)	--	--	--	--	--	--	×	--
Nassa serta (Bruguière)	--	--	--	--	--	×	--	×
Thais (*Stramonita*) sp	--	--	--	×	--	--	--	--
(*Cymia*) aff. *T. carnifera* (Lamarck)	--	--	×	--	--	--	--	--
Magilidae:								
Coralliophila (*Coralliophila*) sp	--	--	--	--	--	--	×	--
(*Pseudomurex*) *macneili* Ladd, n. sp	--	--	--	×	--	--	--	--
bayeri Ladd, n. sp	--	--	--	×	--	--	--	--
(*Fusomurex*) sp. A	--	--	×	×	--	--	--	--
sp. B	--	--	×	--	--	--	--	--
Latiaxis (*Latimurex*) *inflata* (Dunker)	--	--	--	×	--	--	--	×
(*Latimurex*) sp. A	--	--	--	×	--	--	--	--
Coralliobia (*Quoyula*) *monodonta* (Blainville)	--	--	--	--	--	--	×	×
Magilus antiquus Montfort	--	--	×	--	--	--	--	×
Columbellidae:								
Columbella pardalina Lamarck	--	--	--	×	×	--	×	×
Euplica turturina (Lamarck)	--	--	--	×?	×?	×	--	×
varians (Sowerby)	--	×	--	--	--	--	×	×
aff. *E. varians* (Sowerby)	--	--	--	×	--	--	--	--
Lavesopus eniwetokensis Ladd, n. sp	--	--	--	--	--	--	×	--
Zafrona lifuana (Hervier)	--	--	--	--	--	--	×	×
Graphiocomassa ligula (Duclos)	--	--	--	--	×	--	--	×
sp	--	--	--	--	×	--	--	--
Anachis (*Costoanachis*) *winradi* Ladd, n. sp	--	×	--	×	--	--	--	--
(*Costoanachis*) *rewaensis* Ladd, n. sp	--	--	--	--	×	--	--	--
lauensis Ladd, n. sp	--	--	--	--	×	--	--	--
(*Zafra*) *smithi* (Angas)	--	--	--	×	×	×	×	×
Pyrene obtusa (Sowerby)	--	--	--	--	--	--	×	×
Mitrella sagitta (Gaskoin)	--	×	×	×	×	×	×	×
gonzabuensis MacNeil	--	--	--	--	×	--	--	--
oweni Ladd, n. sp	--	--	--	×	--	--	--	--
sp. A	--	--	--	--	×	--	--	--
Zemitrella bikiniensis Ladd, n. sp	--	--	--	×	--	--	--	--
Buccinidae:								
Siphonalia subspadicea MacNeil	--	--	--	--	×	×	--	--
aff. *S. stearnsii* Pilsbry	--	--	--	--	×	--	--	--
Searlesia hindlei Ladd, n. sp.	--	--	--	--	×	--	--	--
Euthria hoffmeisteri Ladd, n. sp	--	--	--	--	×	--	--	--
Metula (*Metula*) *ibbotsoni* Ladd, n. sp	--	--	--	--	×	--	--	--
Cantharus (*Pollia*?) sp	--	--	--	×	--	--	--	--
Nawenia bartholomewi Ladd, n. gen. and n. sp	--	--	--	--	×	--	--	--

TABLE 4.—*Geologic distribution of Cenozoic mollusk species in the island area*—Continued

Species	Tertiary					Quaternary		
	Late Eocene	Early Miocene	Miocene	Late Miocene	Pliocene	Pleistocene	Holocene	Living
	b	*e*	*f*	*g*	*h*			
Melongenidae:								
Pugilina (*Mayeria*) *swartzi* Ladd, n. sp	--	--	×	--	--	--	--	--
Nassariidae:								
Nassarius (*Phrontis*) *tiarula* (Kiener)	--	--	--	--	--	--	×	×
(*Arcularius*) *leptospirus* A. A. Adams	--	--	--	--	--	×	--	×
graniferus (Kiener)	--	--	--	--	--	--	×	×
eniwetokensis Ladd, n. sp	--	--	--	×	--	--	--	--
sp	--	--	--	--	×?	×?	--	--
(*Uzita*) *verbeeki* (Martin)	--	--	--	×	×	--	--	--
mangkalihatensis Beets	--	--	--	×	--	--	--	--
(*Zeuxis*) *concinnus* (Powys)	--	--	--	--	×?	×?	--	×
(*Zeuxis*) *planicostata* (A. Adams)	--	--	--	--	×	--	--	×
vitiensis (Hombron and Jaquinot)	--	--	--	--	--	×	--	×
(*Niotha*) *fijiensis* (Ladd), new name	--	--	--	×	×	--	--	--
ovus (Martin)	--	--	--	--	×	--	--	--
marshallensis Ladd, n. sp	--	--	×	×	--	--	--	--
Fasciolariidae:								
Latirus sp	×	--	--	--	--	--	--	--
craticulatus (Linnaeus)	--	--	--	--	--	×	--	×
barclayi (Reeve)	--	--	--	--	×	×	--	×
Peristernia nassatula (Lamarck)	--	--	×	--	--	--	--	×
incarnata (Kiener)	--	--	--	--	--	--	×	×
chlorostoma (Sowerby)	--	--	--	--	--	--	×	×
waluensis Ladd, n. sp	--	--	×	--	--	--	--	--
eniwetokensis Ladd, n. sp	--	--	×	×	--	--	--	--
ustulata (Reeve)	--	--	--	--	×?	×?	--	×
goikulensis Ladd, n. subsp	--	--	--	×	--	--	--	--
Fusinus sp	--	--	×	--	--	--	--	--
Olividae:								
Belloliva (*Olivellopsis*) *simplex* (Pease)	--	×	×	×	×	×	×	×
Oliva carneola (Gmelin)	--	--	×	--	×	--	--	×
annulata Gmelin	--	--	×	--	×	×	--	×
woolnoughi Ladd	--	--	×	×	×	--	--	--
lauensis Ladd	--	--	×	--	--	--	--	--
miniacea (Röding)	--	--	--	--	--	×	--	×
mustelina Lamarck	--	--	--	--	×	×	--	×
Mitridae:								
Mitra (*Mitra*) *eremitarum* Röding	--	--	--	--	×	--	--	×
(*Mitra*) *imperialis* Röding	--	--	--	--	--	×	--	×
cf. *M. puncticulata* Lamarck	--	--	×	--	--	--	--	--
(*Nebularia*) *aurantia* (Gmelin)	--	--	--	--	×	--	--	×
coronata Lamarck	--	--	--	--	--	×	--	×
crassicostata Sowerby?	--	--	--	--	×?	×?	--	×
fraga Quoy and Gaimard	--	--	--	--	--	--	×	×
turgida Reeve	--	--	--	×	--	--	--	×
(*Strigatella*) *fastigium* Reeve	--	--	--	--	×	--	--	×
Pterygia crenulata (Gmelin)	--	--	--	--	--	×	--	×
fenestrata (Lamarck)	--	--	--	--	×?	×?	--	×
Scabricola (*Scabricola*) *desetangsii* (Kiener)	--	--	--	×?	×?	--	--	×
Subcancilla abyssicola (Schepman)	--	--	--	--	×	--	--	×
interlirata (Reeve)	--	--	--	×	×	--	--	×
malleti (Petit de la Saussaye)	--	--	--	--	×?	×?	--	×
nasongoensis (Ladd)	--	--	--	×	--	--	--	--
Cancilla (*Domiporta*) *carnicolor* (Reeve)	--	--	--	--	×?	×?	--	×
Vexillum (*Costellaria*) *amanda* (Reeve)	--	--	--	--	×	--	--	×
(*Costellaria*) *cernohorskyi* Ladd, n. sp	--	--	--	×	--	--	--	--
deshayesi (Reeve)	--	--	--	×	--	--	--	×
aff. *V. discoloria* (Reeve)	--	--	×	--	--	--	--	--
festum (Reeve)	--	--	×	×	--	--	--	×
leucozonias Deshayes	--	--	--	--	--	--	×	×
obeliscus (Reeve)	--	--	--	--	×	--	--	×
radius (Reeve)	--	--	--	×	×	--	--	×
aff. *V. gembacana* (Martin)	--	×	×	×	--	--	--	--
roseum (Broderip)	--	--	--	--	--	×	--	×
strasfogeli Ladd, n. sp	--	--	--	--	×	--	--	--
stainforthi (Reeve)	--	--	--	--	--	×	--	×
aff. *V. zebuense* (Reeve)	--	--	--	--	×?	×?	--	--
(*Pusia*) *approxinatum* (Pease)	--	--	×	--	--	--	--	×
exquisitum (Garrett)	--	--	--	--	--	--	×	×
microzonias (Lamarck)	--	--	--	--	×	--	--	×
Harpidae:								
Eocithara? sp. A	--	--	×	--	--	--	--	--
sp. B	--	--	--	×	--	--	--	--
Harpa amouretta Röding	--	--	--	×?	×?	--	--	×
major Röding	--	--	--	--	--	×	--	×
Total of 195 species	3	7	41	44	99	54	33	107

made extensive collections of mollusks and other fossils from a series of loosely consolidated dark marls (SM242) about 70 m (230 ft) above sea level on the upper Kere River. The assemblage of mollusks is Pleistocene and the shells are exceedingly well preserved; many retain traces of their original color and polish. The total number of molluscan species exceeds 100. It is dominated by forms that live intertidally or at shallow depths. Cones and cowries are abundant and diverse, and the shells collected include some rarities—three incomplete but identifiable shells of *Conus gloriamaris* Chemnitz, a rare living species that has not previously been collected in the New Hebrides; shells of the living, equally rare *Cypraea guttata* Gmelin; and many specimens of *Cypraea porteri* Cate, previously known only from the Holocene type collected in the Phiippines. Some of the less well preserved shells are partly covered by bryozoans, barnacles, and other attached forms; some gastropods have calcareous grains firmly wedged in their apertures, suggesting wave action on a beach or reef flat prior to final deposition. Ruth Todd of the U.S. Geological Survey examined a rich assemblage of smaller Foraminifera, and found typical reef types (oral commun., 1973). Among the unusual fossils from SM242 are two shells of a large barnacle, *Coronula,* a type that lives attached to cetaceans. The genus is known from the Miocene to the present and has a cosmopolitan distribution (Newman and others, 1969, p. R289). The New Hebrides fossils exceed 40 mm in diameter. Such large shells must have been attached to a whale whose body apparently was carried into shallow water.

GUAM

Over most of the northern half of Guam and the coastal areas on the south, the surface rock is the Mariana Limestone. Several facies have been recognized, most of them being composed of reef-associated organisms that lived in fairly shallow waters. The occurrence of an example of the moderately deep to deep-water genus *Bathygalea* in the Mariana is suggestive, but the type of the genus, *B. coronadoi* (Crosse)—to which the Guam species is closely related—has been obtained from depths of only 18–20 fathoms (Abbott, 1968, p. 100–101. The single specimen from Guam was collected by the Pacific Island Engineers north-northwest of Taguan Point from limestone now assigned to the detrital facies of the Pliocene and Pleistocene Mariana (Tracey and others, 1964).

FAUNAL RELATIONS

The broad relationships of the mollusks described in the present paper are similar to those of the groups described earlier (Ladd, 1966, 1972). They are Indo-Pacific in general aspect and are more closely tied to the fossil and (or) living forms of tropical Indonesia and northern Australia than to those of the more temperate waters of southern Australia and New Zealand. Ties with Okinawa, Japan, and areas in the Indian Ocean do not appear to be as close as those with Indonesia.

Among 56 species from the upper Tertiary sections of the island area, 43 still live in parts of the area, and by far the greatest numbers of these were collected in Fiji.

Continued collecting in Fiji has moved that area ahead of the Marshall Islands in numbers of fossil species. Three of the families in the present unit are represented by fossils found only in Fiji.

Of the 27 new species and subspecies described in the present report, more than half (15) were found in Fiji, eight in the Marshall Islands, and four in Palau. Most of the new forms occurred in upper Miocene and Pliocene sediments, seven in lower Miocene sediments, and one in Holocene sediments.

SYSTEMATIC PALEONTOLOGY

ADDITIONAL SPECIES IN FAMILIES COVERED IN LADD (1966, 1972)

Family NERITIDAE

Genus PISULINA Nevill and Nevill

Nevill, G. and Nevill, H., 1869, Asiatic Soc. Bengal Jour., v. 38, pt. 2, no. 2, p. 160, pl. 17, fig. 4.

Type (by monotypy).—*Pisulina adamsiana* G. and H. Nevill, Holocene, Ceylon.

Pisulina adamsiana G. and H. Nevill

Plate 1, figures 1, 2

Pisulina adamsiana G. and H. Nevill, Asiatic Soc. Bengal Jour., v. 38, pt. 2, no. 2, p. 160, pl. 17, fig. 4; Habe, 1963, Venus, v. 22, p. 231, 232 (fig. 1).

Small, globose, spire low; shell smooth, white, glossy; aperture semilunar; outer lip thin, inner lip heavily callused with a large tooth centered below the midpoint and occupying more than one-third of the length of the lip.

Measurements of the figured specimen, USNM 174942: height 4.5 mm, diameter 6.0 mm.

Occurrence.—Two specimens from drill hole E–1, Eniwetok, at depths of 30–40 ft; age, Holocene. The species was also recovered from the Sand Island drill hole on Midway at a depth of 170–175 ft; age,

Quaternary. The species lives today in the Indian Ocean and in the Amami Islands, south of Japan. It has not been found alive in the Marshall Islands or in Hawaii but probably occurs in both areas.

Family CYCLOPHORIDAE

Genus DIANCTA Martens

Martens, 1867, Die Landschnecken, *in* Die Preussiche Exped. nach Ost-Asien: Berlin, pt. 2, p. 164.

Type (by monotypy).—*Diplommatina constricta* Martens. Holocene, Moluccas.

Diancta aff. D. macrostoma Mollendorff

Plate 22, figures 7, 8

Shell small, sinistral, the lower half of the body whorl extended far to left; composed of 5½ whorls, those above the body whorl forming a pupoid spire whose strongly convex whorls are separated by a deep suture; penultimate whorl the largest. Aperture circular, vertical, without trace of tooth, peristome expanded, continuous, with a wide second flange below. Sculpture consisting of slightly oblique axial costae that are more widely spaced on the body whorl than elsewhere.

Measurements of the figured specimen, USNM 175056: height 2.8 mm, diameter 1.7 mm.

A number of Holocene species of *Diancta* have been described from Viti Levu, Fiji, the island that yielded the above-described fossil (Mousson, 1870; Möllendorff, 1897; Kobelt, 1902, p. 419–421), but I have not seen specimens. In general form, the fossil resembles the lectotype of *D. macrostoma* Möllendorff (1897, p. 44) from Viti Levu figured by Zilch (1953, pl 6, fig. 88), but the figure does not show the body whorl.

Occurrence.—A single fossil from station C1142 on Viti Levu, Fiji; age, Pliocene (Tertiary *h*). This appears to be the first fossil record of the genus.

Family CERITHIIDAE

Genus ARGYROPEZA Melvill and Standen

Melvill and Standen, 1901, Zool. Soc. London Proc., p. 371.

Type (by monotypy).—*Argyropeza divina* Melvill and Standen. Holocene, Persian Gulf.

Argyropeza? suvaensis Ladd, n. sp.

Plate 1, figure 3; plate 21, figure 8

Medium in size, slender, flat-sided; each of more than eight whorls bearing two spiral rows of pointed nodules, the nodules in each row connected by a low spiral rib; rows of nodules widely separated, close to the sutures above and below; intervening area gently concave; suture distinct, in the center of a moderately deep excavated area; a spiral riblet lies between the suture and the lower of the two spiral rows of nodules; indistinct axials extend from the nodules of the upper row toward those of lower row; nodules of one whorl not alined with those on whorls above and below; surface of whorls otherwise smooth, except for microscopic retracted growth lines. Aperture of holotype incomplete, on the paratype it appears subcircular; lips incomplete in both specimens; base with several weak spirals, the uppermost the strongest.

Measurements of the holotype, USNM 174966: height (incomplete) 10.6 mm, diameter 2.7 mm; the paratype, USNM 175062: height (incomplete) 10.1 mm, diameter 3.0 mm.

The paratype is more strongly sculptured than the holotype and possibly represents a distinct species; additional and more complete specimens will be needed to resolve this question.

Of the several species of *Argyropeza* known to live in the Indo-Pacific today, *A. suvaensis* is most closely related to *A. melvilli* Schepman (1909, p. 170, pl. 12, fig. 1) described from a single Holocene shell dredged from the Sulu Sea at a depth of 535 m. The two species agree in most observable features, but the spiral ribs connecting the spirally arranged nodules are much stronger on the fossils, whereas the oblique axial ribs are better developed on the living species.

Two other fossil occurrences of *Argyropeza* have been reported, both from Okinawa (MacNeil, 1960, p. 40). One of the Okinawan occurrences is from the Pliocene and is compared with the small Holocene species, *A. divina* Melvill and Standen, the type of the genus. Its two spiral rows of nodules are close together in the middle of the whorl, there being a wide and deep sutural depression. The other fossil occurrence on Okinawa is from the Miocene. It also is a small shell, and MacNeil compared it with the Holocene *A. schepmaniana* Melvill and Standen, a species that bears three spiral rows of nodules.

The Fijian fossils are only tentatively assigned to the genus *Argyropeza*. They appear to be congeneric with *A. melvilli* Schepman, but the author of that species had some questions as to generic reference of his Sulu Sea specimen. MacNeil (1960, p. 43) expressed the opinion that Schepman's specimen was an *Alipta* (Finlay, 1926, type, by original designation, *Cerithiopsis crenistria* Suter) and tentatively assigned a Neogene specimen from Okinawa to that subgenus, naming it *C.* (*A.*) *premelvilli*. Not having seen specimens of *C. crenistria*, MacNeil compared the figured aperture of the type species as shown by

Suter and by Wenz with the aperture of *"Argyropeza" melvilli* shown by Schepman. MacNeil believed that his Okinawan fossil was related to *A. melvilli,* but he recognized that his only specimen was immature and that its apertural features were not necessarily diagnostic. The Fijian fossils here described also appear to be closely related to Schepman's *A. nevelli.* The Fiji shells are adults, but neither shows a complete aperture.

Occurrence.—Both types (the only specimens) collected from the same locality (holotype, station C497; paratype, station FB–13) in Suva, Fiji; age, early Miocene (Tertiary *f*).

Cerithium (Cerithium) aff. C. novaehollandiae A. Adams

Plate 1, figure 4

Medium in size, flat-sided, slightly turreted. Sculpture consisting of strong narrow, slightly curved axial folds that are swollen near the suture, both above and below; body whorl with three slightly beaded spirals that are more prominent than those intervening, the spiral at the periphry the largest; below the periphery, on the base, are several prominent spirals, the one nearest the periphery the largest. A broad varix is present on the body whorl opposite the aperture. Inner lip callused, slightly detached.

Measurements of the figured specimen, British Museum GG13317: height (incomplete) 18.7 mm, diameter 9.4 mm.

The fossil is less strongly turreted than the Holocene *C. novaehollandiae,* has finer spiral sculpture, and narrower axial folds; folds swollen above as well as below the suture.

Occurrence.—A single specimen from station RB44 of R. W. Bartholomew on Viti Levu, Fiji; age, probably Pliocene (Tertiary *h*). *C. novaehollandiae* was described by A. Adams, MS., Sowerby, 1855, p. 864, pl. 178, fig. 54) from Australia.

Family XENOPHORIDAE

Xenophora corrugata (Reeve)

Plate 21, figures 10–12

Phorus corrugatus Reeve, 1842, Zool. Soc. London Proc., p. 163; 1843, Conchologica Iconica, v. 1, *Phorus,* pl. 2, fig. 6.

Xenophora corrugata (Reeve), Cernohorsky, 1972, Marine shells of the Pacific, v. 2, p. 89, pl. 23, fig. 2.

Spire moderately high, broadly convex, bearing strong diagonal wrinkles that, like the suture, are more or less hidden by attached objects; in the two Fijian fossil specimens available, most of the attached objects are rounded pebbles of volcanic rock that have been coated with cream-colored calcareous material. Base deeply concave, its surface covered by close-set spiral ribs that are beaded by low curved radials, resulting in a corrugated surface.

The fossils resemble *X. cerea* (Reeve) (Reeve, 1845, pl. 3, fig. 9), but that species has a less concave base.

Measurements of the figured specimens from Fiji (pl. 21, figs. 10–12) USNM 175049: height (incomplete) 35 mm, diameter 57 mm; a smaller Fijian specimen USNM 175076 from the same bed, measures: height 35 mm, diameter 38.5 mm.

Occurrence.—Two specimens from station C1264, Viti Levu, Fiji, from the Thuvu Group; age, Pliocene (Tertiary *h*). Holocene specimens have been collected from Fiji, Australia, Japan, and the Indian Ocean. The species has not previously been reported as a fossil.

Xenophora konai Habe

Plate 22, figures 1–3

Xenophora konai Habe, 1953, Illustrated catalogue of Japanese shells, no. 23, p. 176, figs. 3–5; 1964, v. 2 *of* Kira and Habe, Shells of the western Pacific in color, p. 57, pl. 16, fig. 5.

The single fossil shows the characteristically convex whorls, deep suture, oblique corrugations, and wavy spiral riblets; lower surface concave, covered with many beaded spirals; umbilicus opening obliquely.

Measurements of the figured specimen, USNM 175090: height 45.7 mm, diameter 54.1 mm.

Occurrence.—Station SM242, Santo, New Hebrides; age, Pleistocene. The species lives today in Japanese waters.

Xenophora calculifera (Reeve)

Plate 22, figures 4–6

Phorus calculiferus Reeve, 1842, Zool. Soc. London Proc., p. 162; 1843, Conchologica Iconica, v. 1, *Phorus,* pl. 1, fig. 1.

Xenophora calculifera (Reeve), Tryon, 1886, Manual Conchology, v. 8, p. 159, pl. 44, figs. 75, 76; Habe, 1964, v. 2 *of* Kira and Habe, Shells of the western Pacific in color, p. 57, pl. 16, fig. 4.

Shell large, convex, whorls covered by close-set, rounded, radial cords. Attachment scars at suture. Base concave; umbilicus wide and deep, encircled by revolving striae; radial cords on the base are strongly beaded near the periphry.

Measurements of the figured specimen: height about 45 mm, diameter 74 mm.

The attachment areas on *X. calculifera* are not limited to the early whorls as they are on shells of *Tugurium exutum* (Reeve).

Occurrence.—A single, nearly complete shell from station SM242 on Santo, New Hebrides. The species lives today in tropical west Pacific waters.

Tugurium aff. T. exutum (Reeve)

Plate 1, figure 5

Two incomplete specimens from the Pliocene beds at station RB44 of R. W. Bartholomew on Viti Levu, Fiji, may represent the Holocene species, *T. exutum*. Both fossils retain patches of their original shell that show the obliquely curved striae and grooves of *T. exutum* and the broad curved axial plicae present on many shells of that species. The fossils, however, show far more numerous attachment scars on the whorls of the spire than could be found on any Holocene shell. The figured specimen retains some parts of the shell on the ventral surface. The narrow band of revolving striae is present, as on shells of *T. exutum*, but between this band and the umbilicus the nearly flat surface is covered by closely set spiral ribs that are beaded by shallow curved radial grooves.

Measurement of the figured specimen, British Museum GG13318, are: height 14 mm, diameter 45.5 mm.

The specimens from western Viti Levu may represent an undescribed species, but additional and more complete specimens will be needed to decide the question. *T. exutum* lives today on islands bordering the South China Sea and northward to Japan. It has been reported from the Pliocene of Vanua Levu, Fiji (Ladd, 1972, p. 56). MacNeil, (1960, p. 47) cited its occurrence in Taiwan and, questionably, from the Miocene of Japan.

FAMILIES COVERED IN THE PRESENT PAPER

Family ERATOIDAE

Genus ERATO Risso

Risso, 1826, Histoire naturelle des principales productions de l'Europe méridionale . . . v. 4, p. 240.

Type (by monotypy).—*Voluta cypraeola* Brocchi. Late Tertiary of Italy.

Erato hindlei Ladd, n. sp.

Plate 1, figures 6–9

Large, stout; protoconch smooth, convex, followed by four whorls that make up the flattened spire; body whorl strongly inflated above, constricted below; outer lip thickened, sharply reflected, bearing 12–14 strong subequal teeth; inner lip concave with a distinct fossula below and with about a dozen teeth that are weaker and less regularly spaced than those of the outer lip; aperture wide, slightly flaring below.

Measurements of the holotype, USNM 650625: length 8.6 mm, lateral diameter 6.0 mm, dorsoventral diameter 4.5 mm. A paratype, USNM 650626, measures: length 6.9 mm, width 4.7 mm, dorsoventral diameter 3.9 mm.

E. hindlei has a wider aperture and coarser teeth than other Pacific species of the genus.

Occurrence.—Holotype from station K138 and paratype from station 817 on Vanua Levu, Fiji; age, Pliocene (Tertiary *h*). A third specimen collected with the paratype at station 817 is incompete but appears to be conspecific. A single specimen from station C1142 on Viti Levu is also probably Pliocene in age.

This species is named for William Hindle of the Fiji Geological Survey who collected the types and many other fossils while he was mapping in western Vanua Levu.

Genus TRIVIA Broderip

Broderip, 1837, Penny Cyclopedia, v. 8, p. 256.

Type (by subsequent designation, Gray, 1847, Zool. Soc. London Proc., p. 15, p. 142).—*Cypraea europaea* Montagu. Holocene, eastern Atlantic.

Subgenus TRIVIROSTRA Jousseaume

Jousseaume, 1884, Soc. Zool. France Bull. 9, p. 100.

Type (by subsequent designation, Roberts, 1885, *in* Tryon Manual Conchology, v. 7, p. 161).—*Trivia scabriuscula* Gray (=*Cypraea oryza* Lamarck). Holocene, Indo-Pacific.

Trivia (Trivirostra) oryza (Lamarck)

Plate 1, figures 10–12

Cypraea oryza Lamarck, 1810, Mus. Histoire Nat. Paris Annales, v. 16, p. 104.

Cypraea scabriuscula Gray, 1828, Zool. Jour., v. 3, p. 365

Trivia oryza (Lamarck), Roberts, 1885, *in* Tryon Manual Conchology, v. 7, p. 200, pl. 21, figs. 82, 83.

Trivia (Trivia) koroensis Ladd, 1934, Bernice P. Bishop Mus. Bull. 119, p. 220, pl. 39, figs. 9, 10.

Trivia (Trivirostra) scabriuscula (Gray), Ladd, 1945, Bernice P. Bishop Mus. Bull. 181, p. 367, pl. 52, figs. T-V.

Trivirostra oryza (Lamarck), Kira, 1962, v. 1 of Kira and Habe, Shells of the western Pacific in color, p. 44, pl. 19, fig. 2.

The examination of additional fossil material from Fiji and the Marshall Islands has led to the conclusion that the Miocene species, *T. koroensis* Ladd, cannot be separated from Holocene shells of *T. oryza* (Lamarck). No additional examples of the Pliocene shells referred by me to *T. scabriuscula* (Gray) have been collected, but that species is now recognized as a synonym of *T. oryza* (Lamarck). The figured specimen, USNM 174983, from drill hole

2A, Bikini, at depth 841–847 ft, measures: length 4.6 mm, lateral diameter 3.3 mm, dorsoventral diameter 2.7 mm.

Occurrence.—Three specimens from the Miocene (Tertiary *f*) Suva Formation (station 160), Viti Levu, Fiji; nine from the Miocene and younger beds of Eniwetok and one from the upper Miocene of Bikini, Marshall Islands; two from the Pliocene Ndalithoni Limestone, Vanua Mbalavu, Fiji; five from the post-Tertiary beds of Eniwetok. The species also occurs in the elevated marls of Santo in the New Hebrides (station SM242); age, Pleistocene. Schepman (1907, p. 185) reported the species from Quaternary beds on Celebes (Sulawesi). The species lives today in the Indian Ocean, Indonesia, and many island groups in the western Pacific, including Fiji and the Marshall Islands where fossils were collected.

Family CYPRAEIDAE

The cowries, originally grouped under the Linnaean genus *Cypraea,* constitute one of the most widely distributed groups of gastropods in the warmer seas. Their polished shells have beautiful patterns in a variety of colors. These patterns, combined with minor variations in shell form, have led some conchologists, both amateur and professional, to recognize 60 genera and hundreds of species and subspecies. Paleontologists, who ordinarily have to deal with shells that lack color patterns, are unable to recognize many of the suggested taxa. Recently Kay (1957, 1960) showed that many of the cowries have little anatomical differentiation. She proposed that all species of the subfamily Cypraeinae be assigned to the genus *Cypraea.* In the present paper, this recommendation has been followed, other generic names being reduced to subgeneric rank.

The cowries today are one of the most abundant and diversified groups of shells to be found on reefs and rocky intertidal flats in the island area. Conditions apparently were similar in the past, and 27 species, representing a dozen subgenera, have been identified as fossils in the present report. As shown on tables 2 and 3, the shells were collected in all island groups except Palau. Actually, fossil cypraeids were found in some abundance in Palau but, with one exception, only in the form of molds that could not be identified specifically. The exception was a shell from the Miocene marls of the Goikul peninsula, but it was too badly crushed for specific identification. No Eocene cypraeids were found and only one species from the oldest Miocene beds (Tertiary *e*). In all younger stages, cypraeids were abundantly represented.

Genus CYPRAEA Linnaeus

Linnaeus, 1758, Systema Naturae 10th ed., p. 718.

Subgenus LURIA Jousseaume

Jousseaume, 1884, Soc. Zool. France Bull., 9, p. 92.

Type (by original designation).—*Cypraea lurida* Linnaeus. Holocene, Mediterranean Sea.

Cypraea (Luria) isabella Linnaeus

Plate 1, figure 13

Cypraea isabella Linnaeus, 1758, Systema Naturae, 10th ed., p. 722; Roberts *in* Tryon, 1885, Manual Conchology, v. 7, p. 165, pl. 1, figs. 6, 7; Ostergaard, 1935, Bernice p. Bishop Mus. Bull. 131, p. 16; Kay, 1961, Malacology Soc. London Proc., v. 34, pt. 4, p. 18.

Two specimens from drill hole E–1 on Eniwetok Atoll at a depth of 60–70 ft are identical with shells collected from the surface of the atoll. One of the fossils, USNM 174960, is figured. It measures: length 16.7 mm, lateral diameter 9.4 mm, dorsoventral diameter 8.2 mm. The fossils are Holocene in age; they retain traces of orange color at the extremities. A single specimen from station 20562 on Guam is from the Mariana Limestone; age, Pliocene or Pleistocene. Ostergaard identified molds of the species from stations 4 and 7 on Tongatapu, Tonga; age, probably Pleistocene.

Cypraea (Luria) isabella lekalekana Ladd

Plate 1, figures 14–19

Cypraea (*Talparia*) *isabella lekalekana* Ladd, 1934, Bernice p. Bishop Mus. Bull. 119, p. 218, pl. 38, figs. 9–12; 1945, Bernice p. Bishop Mus Bull. 181, p. 363, pl. 52, figs. B–D.

Luria (*Basilitrona*) *isabella lekalekana* (Ladd), Schilder and Schilder, 1938, Malacology Soc. London Proc., v. 23, pt. 3, p. 176; 1944, Archiv für Zoologi, v. 36a, no. 2, p. 16.

Cypraea isabella Linnaeus [*Cypraea isabella lekalekana* Ladd], Cernohorsky, 1964, Veliger, v. 6, no. 4, p. 181.

Apparent differences between fossil and Holocene shells were briefly discussed by Ladd in 1945 (Ladd and others, p. 363). The holotype of *L. isabella lekalekana* from the lower Miocene (Tertiary *f*) of western Fiji station 160 (pl. 1, figs. 14–16) is larger, shorter, and thicker than the paratype from the same locality described with it. Three additional specimens were collected from the type locality. Five shells were obtained from the Pliocene (Tertiary *h*) in eastern Fiji, and one of these (Univ. Rochester, Mus. Nat. History, 13061) is figured (pl. 1, figs. 17–19); it measures: length 20.7 mm, lateral diameter 12.6 mm, dorsoventral diameter 9.9 mm. All of the later specimens are smaller and more cylindrical

than the holotype. Further study of Holocene specimens of *L. isabella* from Fiji and many other western Pacific islands indicates the difficulty of separating the fossils from Holocene examples. The fossils as a group are proportionately shorter and thicker than Holocene shells, but the Holocene collections do include rare examples that cannot be easily separated from the fossils.

Subgenus MAURITIA Troschel

Troschel, 1863, Das Gebiss der Schnecken zur Begründung einer natürl. Class., v. 1, p. 208.

Type (by virtual tautonymy).—*Cypraea mauritiana* Linnaeus. Holocene, Indo-Pacific.

Cypraea (Mauritia) arabica Linnaeus

Plate 2, figures 1, 2

Cypraea arabica Linnaeus, 1758; Systema Naturae, 10th ed., p. 718; Roberts, *in* Tryon, 1885, Manual Conchology, v. 7, p. 174, pl. 8, figs. 18, 19, 23, 24; Ostergaard, 1935, Bernice P. Bishop Mus. Bull. 131 p. 27; Cernohorsky, 1964, Veliger, v. 6, no. 4, p. 182, pl. 21, fig. 3.

Seven specimens were recovered from limestone at USGS locality 21028, Santo, New Hebrides; age, Pleistocene. All specimens have the thickly callused margins that characterize the species, and several shells retain traces of brown marginal spots.

Measurements of the figured specimen, USNM 174958: length 51.7 mm, lateral diameter 35.0 mm, dorsoventral diameter 27.6 mm. An incomplete but identifiable internal mold was collected by Ostergaard from Nukualofa quarry (station 7) on Tongatapu in Tonga; age, probably Pleistocene. An unusually large specimen was collected from a pit on Aranit Island, Eniwetok Atoll, at a depth of about 5 ft; age, Holocene.

Subgenus TALPARIA Troschel

Troschel, 1863, Das Gebiss der Schnecken zur Begründung einer natürl. Class., v. 1, p. 206.

Type (by subsequent designation, following virtual tautonymy, Schilder, 1924, Archiv für Naturgeschichte, A 90, no. 4, p. 100).—*Cypraea talpa* Linnaeus. Holocene, Indo-Pacific.

Cypraea (Talparia) talpa Linnaeus

Plate 2, figures 3, 4

Cypraea talpa Linnaeus, 1758, Systema Naturae, 10th ed., p. 720; Roberts *in* Tryon, 1885, Manual Conchology, v. 7, p. 167, pl. 3, figs. 31–33; Kay, 1961, Malocology. Soc. London Proc., v. 34, pt. 4, p. 190.

Cypraea (Talparia) talpa Linnaeus, Demond, 1957, Pacific Sci., v. 11, p. 304.

Three specimens from the Mariana Limestone of Guam at USGS locality 20531; age, Pliocene (Tertiary *h*) or Pleistocene. The figured specimen, USNM 174975, measures: length 52.3 mm., lateral diameter 25.6 mm., dorsoventral diameter 22.4 mm. The species lives today throughout most of the Indo-Pacific region.

Subgenus CYPRAEA s. s.

Type (by subsequent designation, Montfort, 1810, Conchyliologie Systématique, v. 2, p. 631).—*Cypraea tigris* Linnaeus. Holocene, Indo-Pacific.

Cypraea (Cypraea) cf. C. tigris Linnaeus

Plate 2, figure 5

Two specimens that probably represent the widely distributed type species of *Cypraea* were collected on Guam from beds assigned to the upper Tertiary Alifan Limestone (upper Miocene, Tertiary *g*, or Pliocene, Tertiary *h*). The figured specimen (USGS loc. 20730) has a wider and flatter outer lip and a narrower aperture than Holocene specimens from the same area. The fossil USNM 650420 measures: length 75.0 mm, lateral diameter 53.7 mm, dorsoventral diameter 38.7 mm. The second fossil (USGS loc. 20719) also has an unusually narrow aperture and the opening is strongly arched.

C. tigris lives today throughout the Indo-Pacific region. It has also been reported from the upper Miocene of Java and the Quaternary of Celebes (Sulawesi) Vlerk, 1931, p. 245).

Subgenus LYNCINA Troschel

Troschel, 1863, Das Gebiss der Schnecken zur Begründung einer natürl. Class., v. 1, p. 208.

Type (by subsequent designation, Tryon, 1883, Structural and Systematic Conchology v. 2, p. 198).—*Cypraea lynx* Linnaeus; age, Holocene, Indo-Pacific.

Cypraea (Lyncina) lynx Linnaeus

Plate 2, figures 6, 7

Cypraea lynx Linnaeus, 1758, Systema Naturae, 10th ed., p. 721; Ostergaard, 1935, Bernice P. Bishop Mus. Bull. 131, p. 16, 30; Demond, 1957, Pacific Sci., v. 11, no. 3, p. 299; Kay, 1961, Malacology. Soc. London Proc., v. 34, pt. 4, p. 189; Cernohorsky, 1964, Veliger, v. 6, no. 4, p. 185, pl. 24, fig. 20.

Lyncina lynx (Linnaeus), Cernohorsky, 1967, Marine shells of the Pacific, v. 1, p. 66, pl. 8, fig. 36.

Cypraea lynx is one of the most abundant and widespread cowries living in the Pacific today, and fossil occurrences indicate that it has been living in several parts of the island area for a considerable time. On Guam, specimens were collected from the Pliocene and Pleistocene Mariana Limestone on both the east and the west sides of the island (USGS locs.

20534 and 20512). The figured specimen, USNM 174961, from USGS locality 20534, measures: length 46.6 mm, lateral diameter 25.2 mm, dorsoventral diameter 22.9 mm. A single specimen was collected from the Pleistocene and Holocene Tanapag Limestone on Saipan. A shell from USGS locality 21028 on Santo, New Hebrides, retains traces of color; it is probably no older than Pleistocene. In Fiji, the species occurs in rocks believed to be early Miocene (Tertiary *f*) in age at station 160 on Viti Levu and in Holocene beds at station C1640 on Nanuyanuya in the Yasawas. Ostergaard collected a nearly complete fossil specimen from the sea cliff at Houma on Tongatapu in Tonga. Two other specimens were found by J. E. Hoffmeister in the Nukualofa quarry on Tongatapu. Age of all Tongan specimens is probably Pleistocene. According to Vlerk (1931, p. 244), the species has been collected from the Pliocene or Quaternary of Timor and the Quaternary of Celebes (Sulawesi).

Cypraea (Lyncina) argus Linnaeus

Cypraea argus Linnaeus, 1758, Systema Naturae, 10th ed., p. 719; Ostergaard, 1935, Bernice P. Bishop Mus. Bull. 131, p. 16, 27; Abrard, 1946, Annales Paléontologie, 1946-47, p. 46, pl. 4, fig. 34, Demond, 1957, Pacific. Sci., v. 11, p. 304; Cernohorsky, 1964, Veliger, v. 6, no. 4, p. 184, pl. 22, fig. 6.

Lyncina argus (Linnaeus), Cernohorsky, 1967, Marine shells of the Pacific, v. 1, p. 65, pl. 8, fig. 33.

Represented by two internal molds from Nukualofa quarry on Tangatapu, Tonga (B. P. Bishop Mus. cat. 202544) that reveal the characteristic elongate form, anteriorly widened aperture, and fine dentition. Measurements of one of the specimens: length 58.2 mm, lateral diameter 31.0 mm, dorsoventral diameter 26.6 mm. The fossils are probably Pleistocene in age. Abrard reported the species from the elevated reefs of Efate in the New Hebrides, age, probably Quaternary. The species lives today throughout the Indo-Pacific region, from Madagascar to Hawaii.

Cypraea (Lyncina) carneola Linnaeus

Plate 2, figure 8, 9

Cypraea carneola Linnaeus, 1758, Systema Naturae, 10th ed., p. 719; Roberts, *in* Tryon, 1885, Manual Conchology, v. 7, p. 166, pl. 3, figs. 26–30; Ostergaard, 1935, Bernice P. Bishop Mus. Bull. 131, p. 6, 8, 15, 16, 27; Demond, 1957, Pacific Sci. v. 11, no. 3, p. 299; Kay, 1961, Malocolog. Soc. London Proc., v. 34, pt. 4, p. 186.

Lyncina carneola (Linnaeus), Cernohorsky, 1967, Marine shells of the Pacific, v. 1, p. 66, pl. 8, fig. 35.

Two small shells from Santo in the New Hebrides (USGS loc. 21028), probably Pleistocene, represent this species. The larger of the two, USNM 174962, is figured; it measures: length 27.5 mm, lateral diameter 16.0 mm, dorsoventral diameter 14.0 mm. Two specimens from Guam (USGS locs. 20742, 21369) are from the Pliocene and Pleistocene Mariana Limestone.

Ostergaard and W. A. Setchell collected molds of this widely distributed Indo-Pacific species from stations 2, 4, and 7 in the elevated limestones of Tongatapu, Tonga; age, probably Pleistocene. Ostergaard also collected living examples from the shores of Tongatapu. He noted that both the fossils and the living specimens from Tonga were uniformly small and suggested that this might be a racial character.

Shells of living specimens are easily identified by their striking colors—banded orange-brown dorsal surface and purple teeth below. The Holocene shells show some variation in form, but casts made from the Tongan molds collected by Ostergaard clearly fall within this range.

Ostergaard (1928, p. 29) reported many examples from the Pleistocene limestones of Oahu, Hawaii, noting that the fossil shells were consistently smaller than the rare examples found living in Hawaii today.

MacNeil (1960, p. 50, pl. 17, fig. 5) figured a specimen from the Pliocene of Okinawa as *C.* aff. *C. carneola* and referred to occurrences of related fossil forms in Japan, Formosa, and Indonesia.

Cypraea (Lyncina) carneola lakemba Ladd

Plate 2, figures 10, 11

Cypraea (Lyncina) *carneola lakemba* Ladd, 1945, Bernice P. Bishop Mus. Bull. 181, p. 362, pls. 51, figs. K. L; 52, A.

No additional material collected. The figured type (Univ. Rochester, Mus. Nat. History 13060) from the Miocene Futuna Limestone, station L391, Lakemba, Fiji, measures: length (incomplete anteriorly) 42.3 mm, lateral diameter 25.7 mm, dorsoventral diameter 21.6 mm.

The single known specimen from Fiji is much more sharply margined anteriorly than are Holocene shells of *C. carneola* from the same area, but future collecting may show that the Lakemba subspecies should be identified with *C. carneola*.

Cypraea (Lyncina) porteri Cate

Plate 23, figures 4–9

Cypraea (*Lyncina*) *porteri* Cate, 1966, Veliger, v. 8, no. 3, p. 200–201, pl. 29, figs. 1–4; Burgess, 1970, The living cowries, p. 356, pl. 44, fig. A.

Shell medium in size, solid, strongly inflated, margins heavily callused; constricted terminals also thickly callused; aperture narrow, broadly curved,

slightly expanded anteriorly; teeth sharp, numbering 25 or more on each lip but not extending far from the aperture; teeth of inner lip narrower than those on outer lip. Traces of scattered brown spots visible on dorsal surface.

Measurements of the figured specimens: Plate 23, figures 4–6, collection of D. I. J. Mallick: length 43.8 mm, lateral diameter 32.3 mm, dorsoventral diameter 24.7 mm. Plate 23, figures 7–9, USNM 175077: length 38.2 mm, lateral diameter 26.4 mm, dorsoventral diameter 19.6 mm.

The fossil shells are all slightly smaller than the holotype from the Philippines, and the spots on the dorsal surface are less numerous. The spot pattern of the fossils resembles that shown on *Cypraea lynx*, but the shape of the fossil shell is far too bulbous for that species.

Dr. David Greenbaum of the New Hebrides Condominium Geological Survey identified the first fossil specimens. His identification was confirmed by Ladd and later by Crawford Cate.

Occurrence.—Represented by 16 shells from the marls on the Kere River (station SM242 and USGS locs. 25715, 25717), Santo, New Hebrides; age, Pleistocene. Previously known only from the holotype, a shell collected alive in 48 ft of water, Manubul Island, Philippines.

Subgenus PUSTULARIA Swainson

Swainson, 1840, Treatise on Malacology p. 324.

Type (by subsequent designation, Gray, 1847, Zool. Soc. London Proc., v. 15, p. 142).—*Cypraea cicercula* Linnaeus. Holocene, Indo-Pacific.

Cypraea (Pustularia) cicercula Linnaeus

Plate 3, figures 1, 2

Cypraea cicercula Linnaeus, 1758, Systema Naturae, 10th ed., p. 725; Kay, 1961, Malocology Soc. London Proc., v. 34, pt. 4, p. 186.

Pustularia cicercula (Linnaeus), Kira, 1962, Shells of the western Pacific in color, p. 46, pl. 19, fig. 19; Cernohorsky, 1964, Veliger, v. 6, no. 4, p. 187, pl. 26, fig. 53.

A single specimen of the type species was collected from the post-Tertiary limestones of the New Hebrides (USGS loc. 21028, Santo). The shell is highly inflated, its extremities produced and slightly upturned; the granulose dorsal surface bears a shallow central crease.

Measurements, USNM 174956: length 20.3 mm, lateral diameter 13.6 mm, dorsoventral diameter 11.8 mm. The species lives today throughout the western and southwestern Pacific.

Cypraea (Pustularia) margarita Dillwyn

Plate 3, figures 3–5

Cypraea margarita Dillwyn, 1817, Catalogue Recent Shells, v. 1, p. 470; Reeve, 1846, Conchologica Iconica, *Cypraea*, pl. 22, figs. 123a, b.

Cypraea (Pustularia) margarita (Solander) Dillwyn, Ladd, 1945, Bernice P. Bishop Mus. Bull. 181, p. 365, pl. 52, figs. N–P.

Pustularia margarita (Dillwyn), Cernohorsky, 1964, Veliger, v. 6, no. 4, p. 187, pl. 26, fig. 52; Cate, 1969, Veliger, v. 12, no. 1, p. 129, pl. 19, fig. 23.

Cernohorsky, in his 1964 (p. 187) discussion of this species, noted that "Ladd's record of *Cypraea margarita* from Fiji is an indeterminable form of one of the *Pustularia* group." With this comment in mind, I reexamined the single fossil, and it is here refigured. It seems clearly to be a Pliocene representative of *P. margarita* (station 110C, Vanua Mbalavu), but no additional specimens have been collected. The specimen (Univ. Rochester, Mus. Nat. History 13065) measures: length 10.9 mm, lateral diameter 7.2 mm, dorsoventral diameter 6.0 mm.

Occurrence.—The species is widely distributed in Polynesia today.

Cypraea (Pustularia) globulus Linnaeus

Plate 3, figures 6, 7

Cypraea globulus Linnaeus, 1758, Systema Naturae, 10th ed., ed., p. 725; Roberts, *in* Tryon, 1885, Manual Conchology, v. 7, p. 198, pl. 20, figs. 59, 60.

Pustularia globulus (Linnaeus), Cernohorsky, 1967, Marine shells of the Pacific, v. 1, p. 72, pl. 11, fig. 51.

Characterized particularly by its globular form, beaked extremities and nongranular surface.

Measurements of the figured specimen, USNM 174663: length 17.0 mm, lateral diameter 10.1 mm, dorsoventral diameter 9.1 mm.

Occurrence.—A single specimen from the Agana Argillaceous Member of the Mariana Limestone at USGS locality 20730 on Guam, Mariana Islands; age, Pliocene or Pleistocene. The species is widely distributed today, from East Africa to Polynesia.

Cypraea (Pustularia) everwijni Martin

Plate 3, figures 8–10

Cypraea everwijni Martin, 1883–87, Geol. Reichs-Mus. Leiden Samml., ser. 1, v. 3, p. 140, pl. 7, fig. 140.

Cypraea (Pustularia) everwijni Martin, 1916, Geol. Reichs-Mus. Samml., new ser, v. 2, no. 6, p. 244, pl. 2, figs. 44, 45.

Cypraea (Erosaria) agassizi Ladd, 1934, Bernice P. Bishop Mus Bull. 119, p. 219, pl. 39, figs. 3–5.

Since *C. agassizi* was described from Viti Levu, Fiji, a second specimen has been collected from the same locality. These two specimens are identical

with shells described as *C. everwijni* by Martin from the lower Miocene, West Progo beds, in Java.

Measurements of the figured specimen from Fiji (Bernice P. Bishop Mus., Geol. No. 1152): length 13.9 mm, lateral diameter 9.5 mm, dorsoventral diameter 7.8 mm.

Occurrence.—Recorded by Martin from the lower and the upper Miocene of Java. In the island area, two specimens from station 160 on Viti Levu, Fiji; age, early Miocene (Tertiary *f*).

Cypraea (Pustularia) childreni Gray

Plate 3, figures 11–13

Cypraea childreni Gray, 1824, Zool. Jour. 1, p. 518; Kay, 1961, Malocolog. Soc. London Proc., v. 34, pt. 4, p. 186; Cernohorsky, 1964, Veliger, v. 6, no. 4, p. 187, pl. 24, fig. 29.

Cypraea (Ipsa) childreni Gray, Ladd, 1945, Bernice P. Bishop Mus. Bull. 181, p. 366.

Pustularia (Ipsa) childreni (Gray), Cate, 1965; Veliger, v. 8, no. 2, p. 50, pl. 4, figs. 3a, 3b; 1969, Veliger, v. 12, no. 1, p. 129, pl. 20, fig. 25.

The figured Miocene specimen from station 160, Viti Levu, Fiji, USNM 650637, measures: length 22.4 mm, lateral diameter 15.3 mm, dorsoventral diameter 12.1 mm. It is more sharply sculptured than Holocene shells from Fiji and other Pacific islands.

Occurrence.—A single figured specimen from Viti Levu is early Miocene (Tertiary *f*) in age. An internal and external mold that probably represents the species was found in an elevated reef (Fulanga Limestone, station L35) on the island of Fulanga in eastern Fiji; age, probably Pleistocene. A third solitary specimen was collected from the upper Tertiary Alifan Limestone near Apra Harbor on Guam (USGS loc. 20726). A fourth specimen, a broken shell, was collected from the Tanapag Limestone of Saipan (station 17891); age, probably Holocene. In drill hole E–1 on Eniwetok, two well-preserved shells were recovered from 30 to 40 ft; age, Holocene. The species lives today on many island groups—from Mauritius in the Indian Ocean, eastward to Fiji and Hawaii.

Cypraea (Monetaria) moneta Linnaeus

Plate 4, figures 1–5

Cypraea moneta Linnaeus, 1758, Systema Naturae, 10th ed. p. 723; Roberts *in* Tryon, 1885, Manual Conchology, v. 7, p. 177, pl. 10, fig. 46, pl. 11, figs. 51–54, pl. 23, figs. 60–69; Hertlein and Allison, 1960, Veliger, v. 2, no. 4, p. 95, pl. 22; Kay, 1961, Malocolog. Soc. London Proc., v. 34, pt. 4, p. 189.

Cypraea (Monetaria), moneta Linnaeus, Abrard, 1946, Annales paléontologie, v. 32, p. 68, pl. 4, fig. 40; Demond, 1957, Pacific Sci. v. 11, p. 304.

This widely distributed living Indo-Pacific species has a thickened margin that is easily recognizable. Fossil examples were found on Saipan, Guam, Fiji, Eniwetok, and the New Hebrides.

Measurements of the figured specimen from Saipan, USNM 648287: length 23.1 mm, lateral diameter 16.3 mm, dorsoventral diameter 11.5 mm. Figured young specimen from Eniwetok drill hole K–1, USNM 648288: length 14.0 mm, lateral diameter 9.5 mm, dorsoventral diameter 6.5 mm.

Occurrence.—A dozen specimens from the Mariana Limestone on Saipan (USGS loc. 17893); age, probably Pleistocene. Specimens were recovered from 10 localities in the Mariana Limestone of Guam (USGS locs. 20511, 20526, 20534, 20536, 20562, 20626, 21369, 21378, 21379 and 21381); age, Pliocene or Pleistocene. A single specimen from Fiji (USGS loc. 25142) is Miocene; one from Eniwetok (drill hole K–1, 33–44 ft) is Holocene. Abrard described specimens from the Quaternary elevated reefs on Eromanga and Efate in the New Hebrides, and one young specimen was found in Quaternary Limestone at USGS locality 21028 on Santo in the same group.

Holocene shells have been found throughout the Indo-Pacific region from Africa to Hawaii, including such outposts as Clipperton, the Cocos, and Galapagos Islands.

Subgenus EROSARIA Troschel

Troschel, 1863, Das Gebiss der Schnecken zur Begründung einer natürl. Class., v. 1, p. 205, 210.

Type (by subsequent designation, Jousseaume, 1884, Soc. Zool. France Bull., v. 49, p. 96).—*Cypraea erosa* Linnaeus. Holocene, Indo-Pacific.

Cypraea (Erosaria) erosa Linnaeus

Plate 4, figures 6, 7

Cypraea erosa Linnaeus, 1758, Systema Naturae, 10th ed., p. 723; Roberts *in* Tryon, 1885, Manual Conchology, v. 7, p. 192, pl. 18, figs. 1, 90, 100; Ostergaard, 1928, Bernice P. Bishop Mus. Bull. 51, p. 28; Kay, 1961, Malacolog. Soc. London Proc., v. 34, pt. 4, p. 186.

Cypraea (Erosaria) erosa Linnaeus, Abrard, 1946, Annales Paléontologie v. 32, p. 86; Demond, 1957, Pacific Sci., v. 11, p. 302.

Characterized particularly by its thickened and pitted margins. The figured specimen, USNM 174964 from USGS locality 20732 on Guam, measures: length 35.5 mm, lateral diameter 18.4 mm, dorsoventral diameter 15.0 mm.

Occurrence.—Six speciments from USGS localities 20526, 20633, 20636, 20732, 20762, Guam in

the Mariana Limestone; age, Pliocene or Pleistocene. Abrard recorded the species from the elevated Quaternary reefs of Eromanga, New Hebrides. Ostergaard found it abundant in the elevated Pleistocene limestones of Oahu in Hawaii but noted the rarity of living examples in that area today. *C. erosa* lives throughout most of the Indo-Pacific region.

Cypraea (Erosaria) caputserpentis Linnaeus

Plate 4, figures 8–10

Cypraea caputserpentis Linnaeus, 1758, Systema Naturae, 10th ed., p. 720; Tryon, 1885, Manual Conchology, v. 7, p. 173, pl. 6, figs. 98–100; Kay, 1961, Malacolog. Soc. London Proc., v. 34, pt. 4, p. 186.

Cypraea (Erosaria) caputserpentis Linnaeus, Demond, 1957, Pacific Sci., v. 11, p. 302.

Erosaria (Ravitrona) caputserpentis (Linnaeus), MacNeil, 1960, U.S. Geol. Survey Prof. Paper 339, p. 51, pl. 19, figs. 3, 10.

Erosaria (Erosaria) caputserpentis caputserpentis (Linnaeus), Cate, 1969, Veliger, v. 12, no. 1, p. 130, pl. 21, fig. 32.

A single mold of this widely distributed Holocene Indo-Pacific species was collected from the Mariana Limestone on Guam (USGS loc. 20489); age, Pliocene or Pleistocene. Another single specimen was found in a limestone pit (USGS loc. 21028) on Santo Island in the New Hebrides at an altitude of 240 ft; age, probably Pleistocene. The New Hebrides specimen, USNM 650563, measures: length 38.5 mm, lateral diameter 26.8 mm, dorsoventral diameter 16.8 mm.

MacNeil's Okinawan specimen was collected from the Pliocene; as MacNeil notes, the species has also been reported from the Pleistocene of French Somaliland, Hawaii, and Taiwan. An occurrence reported from the Pleistocene of Tonga by Ostergaard (1935, p. 16, 27) is incorrect.

Cypraea (Erosaria) labrolineata Gaskoin

Plate 4, figures 11–13

Cypraea flaveola labro-lineata Gaskoin, 1849, Zool. Soc. London Proc. for 1848, p. 97.

Erosaria (Ravitrona) labrolineata labrolineata (Gaskoin), Cate, 1964, Veliger, v. 7, no. 1, p. 12; 1965, Veliger, v. 8, no. 2, p. 52, pl. 5, figs. 9a, 9b; 1968, Veliger, v. 10, no. 3, p. 228, pl. 27, fig. 34.

Erosaria labrolineata (Gaskoin), Cernohorsky, 1967, Marine shells of the Pacific, v. 1, p. 82, pl. 13, fig. 64.

A single, almost complete, fossil from Pliocene beds at station RB44 and two specimens from the Miocene at USGS locality 25142 on Viti Levu, Fiji, seem to represent this species known to live today in the southwest Pacific from Indonesia to the Tokelau Islands. The figured Pliocene specimen (British Museum GG13319) measures: length 19.4 mm, lateral diameter 11.9 mm, dorsoventral diameter 8.7 mm. The fossils have more widely spaced labial teeth than Holocene shells, but this is a variable feature. Cernohorsky reported the species uncommon in Fiji today.

Cypraea (Erosaria) helvola Linnaeus

Plate 5, figures 1–3

Cypraea helvola Linnaeus, 1758, Systema Naturae, 10th, ed. p. 724; Roberts *in* Tryon, 1885, Manual Conchology, v. 7, p. 194, pl. 19, figs. 8, 9; Ostergaard, 1935, Bernice P. Bishop Mus. Bull. 131, p. 29; Kay, 1961, Malacolog. Soc. London Proc., v. 34, pt. 4, p. 188; Cernohorsky, 1964, Veliger, v. 6, no. 4, p. 189, pl. 25, fig. 39.

Cypraea (Monetaria) annulus sosokoana Ladd; 1934, Bernice P. Bishop Mus. Bull. 119, p. 220, pl. 39, figs. 6–8.

Cypraea (Erosaria) cf. *eburnea* Barnes, Ladd, 1945, Bernice P. Bishop Mus. Bull. 181, p. 364, pl. 52, figs. k–m.

Cypraea (Erosaria) helvola Linnaeus, Demond, 1957, Pacific Sci., v. 11, no. 3, p. 303.

Erosaria helvola (Linnaeus), Kira, 1962, Shells of the western Pacific in color, p. 48, pl. 20, fig. 14.

Erosaria (Erosaria) helvola Linnaeus, Cate, 1969, Veliger, v. 12, no. 1, p. 130, pl. 21, fig. 31.

This variable species ranges today throughout the Indo-Pacfic region from the Red Sea to Hawaii. In Fiji, Miocene (Tertiary *f*) fossils were found in some abundance at station 160 on Walu Bay, and across the bay at USGS locality 25142; a single specimen was recovered from the Miocene of Lakemba (station L391). One shell was found in drill hole 2A on Bikini and two in drill hole F–1 on Eniwetok from the upper Miocene (Tertiary *g*). A half dozen specimens were collected from the Pliocene at stations 110B and 110C on Vanua Mbalavu. The species occurs in the elevated limestones of Tonga (station 4 on Tongatapu) and in the deep hole on Funafuti at depths of 399 and 497 ft and in the elevated marls of Santo in the New Hebrides (station SM242). All three of these occurrences are probably Pleistocene.

The figured specimen from Eniwetok, USNM 648289, measures: length 21.6 mm, lateral diameter 14.7 mm, dorsoventral diameter 10.0 mm.

Cypraea (Erosaria) cf. C. miliaris Gmelin

Plate 6, figure 1

A single specimen that may represent this Holocene species was recovered from the silt-sandstones at USGS locality 24793 on the Island Pentecost, New Hebrides.

Measurements of the specimen, USNM 174995, are: length 27.8 mm, lateral diameter 7.3 mm, dorsoventral diameter 7.1 mm. The specimen closely

resembles *C. miliaris* in shape and sculpture but may possibly represent an usually large and smooth example of *C. helvola* Linnaeus.

Occurrence.—USGS locality 24793, Pentecost, New Hebrides; age, probably Pleistocene. *C. miliaris* Gmelin lives today from Japan to Indonesia and the north coast of Australia (Burgess, 1970, p. 165) but has not been reported as far east as the New Hebrides.

Cypraea (Erosaria) guttata Gmelin

Plate 23, figures 1–3

Cypraea guttata Gmelin, 1791, Systema naturae, 8th ed. p. 3402; Dance, 1969, Rare shells, p. 70, pl. 7, c; Burgess, 1970, The living cowries, p. 158, pl. 11, figs. A, 1A.

Cypraea (Erosaria) guttata Gmelin Woodward, 1963, Jour. Conchology, v. 25, no. 5, p. 180–183, 1 pl. (see for additional citations).

The first fossil occurrence of this rare and beautiful species retains no trace of color pattern, but the deep grooves of the outer lip both above and below identify the shell without question.

Measurements of the figured specimen, USNM 214259: length 56.6 mm, lateral diameter 34.5 mm, dorsoventral diameter 26.6 mm.

Occurrence.—Five specimens from the Pleistocene marls of Santo, New Hebrides; four from station SM242 and USGS locality 25718 on the Kere River, one from USyS locality 25742 on the Navaka River. Living examples have been collected from island groups in the western Pacific, from Japan to the New Hebrides.

Subgenus STAPHYLAEA Jousseaume

Jousseaume, 1884, Soc. Zool. France Bull., v. 9, p. 97.

Type (by original designation).—*Cypraea staphylaea* Linnaeus. Holocene, Indo-Pacific.

Cypraea (Staphylaea) nucleus Linnaeus

Plate 5, figures 4–6

Cypraea nucleus Linnaeus, 1758, Systema Naturae, 10th ed., p. 724; Kay, 1961, Malacolog. Soc. London Proc., v. 34, pt. 4, p. 189; Hedley, 1899, Australian Mus. Mem. 3, p. 454.

Cypraea (Pustularia) nucleus Linnaeus, Ladd, 1945, Bernice P. Bishop Mus. Bull. 181, p. 366, pl. 52, figs. Q–S.

Staphylaea (Nuclearia) nucleus (Linnaeus), MacNeil, 1960, U.S. Geol. Survey Prof. Paper 339, p. 51, pl. 19, figs. 5, 6.

The single Pliocene shell described by me from station 110 Fiji measures 16.3 mm in length, 9.2 mm in lateral diameter and 7.5 mm dorsoventrally. It is less inflated than the Pliocene shell figured by MacNeil from Okinawa and than most Holocene shells. This difference is probably due to the immaturity of the Fijian fossil. An incomplete mold from a depth of 464 ft in the deep hole drilled on Funafuti shows the pustulose sculpture of the species. Hedley (1899, p. 454) reported dead shells occurring frequently on the Funafuti beach. The species has been collected from many island groups in the Indian and Pacific Oceans.

Subgenus ERRONEA Troschel

Troschel, 1863, Das Gebiss der Schnecken zur Begründung einer natürl. Class., v. 1, p. 205, 210.

Type (by subsequent designation, following virtual tautonymy, Schilder, 1924, Archiv für Naturgeschichte, Abt. A, no. 4, p. 202).—*Cypraea errones* Linnaeus. Holocene, Indo-Pacific.

Cypraea (Erronea) errones Linnaeus

Plate 5, figures 10–12

Cypraea errones Linnaeus, 1758, Systema Naturae, 10th ed. p. 723; Roberts, *in* Tryon, 1885, Manual Conchology v. 7, p. 183, pl. 14, figs. 88, 89, 7.

The type of *Erronea* is represented by a single specimen collected from station RB32, Viti Levu, Fiji, by H. G. Richards; age probably Pliocene.

Measurements of the figured specimen (Acad. Nat. Sci. Philadelphia, Geol. 31514): length 18.1 mm, lateral diameter 10.0 mm, dorsoventral diameter 7.9 mm.

Cypraea (Erronea) mbalavuensis Ladd

Cypraea (Erronea) mbalavuensis Ladd, 1945, Bernice P. Bishop Mus. Bull. 181, p. 364, pl. 52, figs. H–J.

Originally described from the Ndalithoni Limestone at station 110, Vanua Mbalavu, Fiji; age, Pliocene (Tertiary *h*). No additional material collected.

Cypraea (Erronea) cylindrica Born

Plate 5, figures 7–9

Cypraea cylndrica Born, 1778, Index Mus. Caesarei Vindobonesis, p. 169; Reeve, 1845, Conchologica Iconica, *Cypraea*, pl. 14, fig. 64; Burgess, 1970, The living cowries, p. 291, pl. 32, figs. B C.

Cypraea (Erronea) cylindrica Born, Abrard, 1946. Annales Paléontologie, v. 32, p. 65, pl. 4, fig. 35.

Characterized particularly by its elongate cylindrical form, flattened base, and sides that are marginated at the extremities. The teeth on the outer lip are large; those on the columella are finer but are extended.

Measurements of the figured specimen, British Museum GG1320: length 31.4 mm, lateral diameter 9.7 mm, dorsoventral diameter 11.6 mm.

On the single fossil, the aperture is less dialated anteriorly than on most Pacific shells and the colum-

ellar teeth are heavier, two of them near the anterior end of the series bifurcating inward.

Occurrence.—The single fossil was collected at station RB44 on Viti Levu, Fiji; age, probably Pliocene (Tertiary *h*). Abrard reported it from the elevated Quaternary reefs of Eromanga, New Hebrides. The species lives today from Guam and Palau south to Australia and westward into the Indian Ocean.

Subgenus ADUSTA Jousseaume

Jousseaume, 1884, Soc. Zool. France Bull., v. 9, p. 93.

Type (by absolute tautonymy).—*Cypraea adusta* Lamarck=*Cypraea onyx* Linnaeus. Holocene, Indo-Pacific.

Cypraea (Adusta) aff. C. kamai (Beets)

Plate 5, figures 13–15

Shell small, ovately biconic, flattened below; aperture moderately wide, expanded anteriorly; umbilicate depression near posterior end; outer lip narrow, bearing 21 strong teeth that extend to the margins except in the midsection; inner lip also with 21 strong teeth that extend to the margin anteriorly and posteriorly but only halfway across in the midsection; shell margined above.

Measurements of the figured specimen, USNM 174971: length 15.3 mm, lateral diameter 8.5 mm, dorsoventral diameter 6.3 mm.

The Eniwetok fossil is smaller and somewhat more inflated than the shells referred by Beets (1941, p. 82, pl. 4, figs. 156–179) to *C. kamai.*

Occurrence.—A single specimen from drill hole E–1 on Eniwetok at a depth of 2,720–2,730 ft; age, early Miocene (Tertiary *e*). Beets described *C. kamai* from the upper Miocene of East Borneo.

Subgenus CRIBRARIA Jousseaume

Jousseaume, 1884, Soc. Zool. France Bull., v. 9, p. 94.

Type (by original designation).—*Cypraea cribraria* Linnaeus. Holocene, Indo-Pacific.

Cypraea (Cribraria) cribraria Linnaeus

Plate 6, figures 2–4

Cypraea cribraria Linnaeus, 1758, Systema Naturae. 10th ed., p. 713; Roberts, 1885, *in* Tryon, Manual Conchology, v. 7, p. 190, pl. 17, figs. 71, 72.

Cribraria cribraria (Linneaus), Cernohorsky, 1967, Marine shells of the Pacific, p. 103, pl. 20, fig. 114; Cate, 1969, Veliger, v. 12, no. 1, p. 129, pl. 25, fig. 57.

A single shell from station 817 on Vanua Levu, Fiji, appears to represent this species that has been reported living from Africa to Hawaii. The fossil, USNM 174957, measures: length 17.0 mm, lateral diameter 9.0 mm, dorsoventral diameter 7.9 mm. The shell is Pliocene in age and is the first reported occurrences of the species as a fossil.

Cypraea (Cribraria) sp.

Cypraea (Cribraria) species Ladd, 1945, Bernice P. Bishop Mus. Bull. 181, p. 363, pl. 52, figs. E–G.

No additional material collected, and the exact identification of the single Pliocene specimen from Fiji (station 110B, Vanua Mbalavu) remains uncertain.

Family OVULIDAE (AMPHIPERATIDAE)

Genus PEDICULARIA Swainson

Swainson, 1840, Treatise on Malacology, p. 245, 357.

Type (by monotypy).—*Pedicularia sicula* Sowerby. Holocene, Mediterranean Sea.

Subgenus PEDICULARIONA Iredale

Iredale, 1935, Australian Zoologist, v. 8, p. 101.

Type (by original designation).—*Pedicularia stylasteris* Hedley. Holocene, Australia.

Pedicularia (Pediculariona) pacifica Pease

Plate 6, figures 5–7

Pedicularia pacifica Pease, 1865, Zool. Soc. London Proc., p. 516; 1868, Am. Jour. Conchology, v. 4, p. 96; Tryon, 1885, Manual Conchology, v. 7, p. 242, pl. 1, figs. 6, 7.

The following is based on two fossils, apparently young shells: Apertural margin lobed, subrectangular to lunate in outline; outer lip irregular, contracted in middle; columella elevated. Exposed spire, consisting of one smooth whorl and at least two beaded whorls. Sculpture of body whorl consisting of closely set spiral striae beaded by finer axial striae.

Measurements of the figured specimen, USNM 648479: length 3.0 mm, width 2.0 mm.

In proposing *Pedicullariona,* Iredale recognized the elevated sculptured spire—buried in adult shells—as distinctive. The fossils possess such a spire and some larger Holocene examples of *P. pacifica* show traces of the spire.

Occurrence.—Drill hole E–1, Eniwetok at depths of 35–45 ft; age, Holocene.

Pedicularia (Pediculariona) sp.

Pedicularia (Pediculariona) species Ladd, 1970, U.S. Geol. Survey Prof. Paper 640–C, p. C7, pl. 4, figs. 4, 5. Eua, Tonga. Late Eocene (Tertiary *b*).

Genus PRIMOVULA Thiele

Thiele, 1925, *in* Kükenthal, W., and Krumback, T., Handbuch der Zoologie, v. 5, p. 88.

Type (by monotypy).—*Amphiperas beckeri* Sowerby. Holocene, South Africa.

Primovula rhodia (A. Adams)

Plate 6, figures 8–10

Amphiperas rhodia A. Adams, 1854, Zool. Soc. London Proc., p. 130, fig. 8.

Ovulum rhodia (Adams), Reeve, 1865, Conchologica Iconica, v. 15, *Ovulum*, pl. 4, no. 18.

Primovula rhodia (A. Adams), Kira, 1962, Shells of western Pacific in color, pl. 19, fig. 6.

Small, elongate, smooth; extended to a point posteriorly, slightly truncated anteriorly; aperture widened anteriorly; inner lip smooth with a conspicuous nodular callus posteriorly and a broad shallow excavation anteriorly; outer lip thickened, dentate within. Measurements of the figured specimen, USNM 650631: height 11.7 mm, diameter 6.2 mm.

Occurrence.—A single fossil from station 817, Vanua Levu, Fiji; age, Pliocene (Tertiary *h*). Holocene shells have been reported from many localities in Japan.

Genus PHENACOVOLVA Iredale

Iredale, 1930, Queensland Mus. Mem., v. 10, pt. 1, p. 85.

Type (by original designation).—*Phenocovolva nectarea* Iredale. Holocene, Queensland, Australia.

Phenacovolva nectarea Iredale

Plate 6, figures 11–13

Phenacovolva nectarea Iredale, 1930, Queensland Mus. Mem., v. 10, p. pt. 1, p. 85.

Medium in size, spindle-shaped, extremities prolonged and recurved; aperture crescentic, wider below; inner lip smooth with a low inconspicuous nodule posteriorly; outer lip thickened and reflected. Sculpture consists of fine striae at the extremities.

Measurements of the figured specimen, USNM 650633: height 18.4 mm, diameter 7.6 mm.

The single fossil is proportionately a little thicker than the type figured by Iredale.

Occurrence.—One specimen from station 817, Vanua Levu, Fiji; age, Pliocene (Tertiary *h*). Iredale described the species from shells dredged from corals at depths of 9–12 fathoms at Port Curtis, Queensland, Australia.

Family ATLANTIDAE

Genus ATLANTA Lesueur

Lesueur, 1817, Jour. Physique, Chimie, Histoire Nat., v. 85, p. 390.

Type (by subsequent designation, Gray, 1847, Zool. Soc. London, Proc. pt. 15, p. 149).—*Atlanta peronii* Lesueur. Holocene, warm and temperate seas.

Atlanta peronii Lesueur

Plate 6, figures 14–20

Atlanta peronii Lesueur, 1817, Jour. Physique, Chimie, Histoire Nat., v. 85, p. 390, pl. 2, figs. 1.1, 1.2; Tesch, 1949, Carlsberg Foundation Dana Rept. no. 34, p. 16, fig. 9.

Shell small, thin, planorboid, compressed. Earliest whorls coiled in a dextral spire; periphery of last whorl extended as a thin keel.

Measurements of the figured specimen from drill hole E–1, Eniwetok, at a depth of 35–40 ft, USNM 174959 (pl. 6 figs. 14, 15): height 0.5 mm, diameter 2.2 mm; figured specimen from Fiji, USNM 650661 (pl. 6 figs. 16, 17): height 0.6 mm, diameter 2.3 mm. Both specimens appear to be immature shells, the last whorl being in contact with the preceding whorl at the aperture. The figured specimen from station SM43 on the island of Santo, New Hebrides (pl. 6, figs. 18–20), USNM 650654: diameter 3.4 mm.

Occurrence.—Two specimens from drill hole E–1, Eniwetok, at depths of 30–40 ft are Holocene in age. The figured specimen from station 817 and two specimens from station B82, both on Vanua Levu, Fiji, are Pliocene (Tertiary *h*): a single specimen from station K671 and four specimens from K755 on Vanua Levu, Fiji and many specimens from Santo, New Hebrides (USGS loc 24918) are Pleistocene in age. The species lives today in the warm waters of both the Pacific and Atlantic Oceans.

Genus OXYGYRUS Benson

Benson, 1835, Asiatic Soc. Bengal Jour., v. 4, no. 39, p. 74.

Type (by monotypy).—*Oxygyrus inflatus* Benson (=*Atlanta keraudrenii* Lesueur). Holocene, South Atlantic and Indian Oceans.

Oxygyrus levu Ladd, n. sp.

Plate 7, figures 1–4.

Shell large, nautiloid, deeply umbilicate on both sides; body whorl large, its periphery unkeeled. Irregularly spaced curved axial lines on the body whorl are variable in strength, but none are prominent. Measurements of the types: holotype, USNM 650659, height 4.7 mm, diameter 11.0 mm; paratype, a mold of a smaller shell, USNM 650660, height 3.2 mm, diameter 9.0 mm.

The species is much larger than the living type of the genus, *O keraudrenii* (Lesueur), and is less inflated than that species. The Fijian fossils more closely resemble an internal mold from the Miocene of Jamaica placed by Woodring (1928, p. 134) under *Atlanta* (*Atlantidea*) *lissa* with the statement that the specimen might represent *Oxygyrus*. The Ja-

maican specimen is too poorly preserved to permit close comparison with the Fijian fossils.

Occurrence.—Represented by two specimens: the holotype from station 817 on Vanua Levu, Fiji, and the paratype, an internal mold from station 1136 on the same island. Age of both specimens probably Pliocene (Tertiary *h*).

Family NATICIDAE

Genus AMPULLINA Bowdich

Bowdich, 1822, Elements of conchology, p. 31, pl. 9, fig. 2.

Type (by monotypy).—*Natica depressa* Lamarck. Eocene, France.

Subgenus AMPULLINOPSIS Conrad

Conrad, 1865, Am. Jour. Conchology, v. 1, p. 27.

Type (by monotypy).—*Natica mississippiensis* Conrad. Oligocene, Mississippi.

Ampullina (Ampullinopsis) berauensis (Beets)

Plate 7, figures 5–7

Globularia (*Megatylotus*) *berauensis* Beets, 1941, Nederland en Koloniers Geol.-Mijnb. Genoot. Vehr., Geol. ser., v. 13, pt. 1, p. 78, pl. 4, figs. 147–152.

Small, strongly inflated, height exceeding width, angle of spire slightly less than 90°; whorls about six, suture deeply impressed; base rounded, aperture lunate, umbilicus open, sheath well developed, bounded by a sharp rim. Sculpture consisting of fairly regularly spaced axial lines of growth and, on the body whorl, fine spiral striations.

Measurements of the figured specimen, USNM 650621, E–1, Eniwetok, 2,760–2,770 ft: height 9.6 mm, diameter 9.0 mm.

Occurrence.—Eight specimens from drill hole E–1, Eniwetok, at depths between 2,710–2,780 ft; age, early Miocene (Tertiary *e*); types from the upper Miocene of East Borneo.

At the writer's request, C. Beets, who named this species, compared the figured Eniwetok specimen with the types in Leiden. He noted (written commun., 1957) that the Eniwetok shell was more juvenile and somewhat smaller (smallest Borneo shell about 1⅓ times the size of the Eniwetok specimen) and that the Eniwetok shell had a slightly higher spire. The five specimens occurring above and below the specimen examined by Beets are immature and even smaller than the one he identified. The shells from Eniwetok, like those from Borneo, show fine spiral striations on the body whorl. The differences between the shells from the two areas seemed minor to Beets; he regarded the two as conspecific.

Genus GLOBULARIA Swainson

Swainson, 1840, Treatise on Malacology, p. 345.

Subgenus GLOBULARIA s. s.

Type (by subsequent designation, Herrmannsen, 1847, Indicis generum malacozoorum, v. 1, p. 480).—*Natica sigaretina* Lamarck. Eocene, Paris basin.

Snbgenus CERNINA Gray

Gray, 1842, Synops. British Mus., 44th ed., p. 60.

Type (by monotypy).—*Natica fluctuosa* Sowerby. Holocene, Philippines.

Globularia (Cernina) fijiensis Ladd

Plate 7, figures 8, 9; plate 8, figures 1, 2

Globularia (*Cernina*) *fijiensis* Ladd, 1945, Bernice P. Bishop Mus. Bull. 181, p. 358, pl. 51, figs. A, B.

The type specimen (Univ. Rochester, Mus. Nat. History 13052) was collected from the Futuna Limestone of Lakemba (station L389) in eastern Fiji. It measures: height 53.9 mm, diameter 47.2 mm. A second specimen that probably represents the species has been found in the limestone of the Suva Formation on Viti Levu (station 295) in western Fiji. Both occurrences are in beds referred to the lower Miocene (Tertiary *f*). The Suva specimen (USNM 650623) is a slightly crushed internal mold. It measures: height 53.8 mm., diameter 57.7 mm.

Globularia fijiensis differs from *G. fluctuosa* (Sowerby), the only living *Cernina*, in the shape of the body whorl; in *G. fluctuosa*, the upper part of the whorl is flattened near the aperture, the suture descending gradually; in *G. fijiensis*, the upper part of the whorl is inflated near the aperture, the suture ascending.

G. nakamurai Otuka (1938, p. 37, pl. 3, figs. 1921) from the Miocene of Japan is considerably larger than *G. fijiensis* and has a shallower suture.

Subgenus WALUIA Ladd

Ladd, 1934, Bernice P. Bishop Mus. Bull. 119, p. 211.

Type (by original designation).—*Globularia edwardsi* Ladd. Miocene, Fiji.

Globularia (Waluia) edwardsi Ladd

Plate 7, figure 10; plate 8, figure 10; plate 9, figures 12, 13

Globularia (*Waluia*) *edwardsi* Ladd, 1934, Bernice P. Bishop Mus. Bull. 119, p. 212, pl. 36, figs. 7, 8; pl. 37, figs. 1, 2; pl. 38, fig. 1; Wenz, 1938, Handbuch de Paläozoologie, v. 6, p. 1022, fig. 2930.

Since *G. edwardsi* was described in 1934, additional material has been obtained from the three localities that yielded the type specimens (stations 160, 295, and 158, Viti Levu, Fiji). There are now

seven nearly complete specimens of the giant snail and half a dozen smaller specimens (immature or incomplete) that probably represent the species. In addition, the Geological Survey of Fiji had a large specimen said to have been collected in 1939 by C. Bucknell from limestone near Korolevu, nearly 50 miles west of the Suva area; this specimen cannot now be located.

Two of the types of *G. edwardsi* are refigured in the present report and, in addition, another specimen that shows the flaring aperture rim more clearly than do the types.

Measurements of the figured specimens.—

	Height (mm)	*Diameter (mm)*
Holotype (B. P. Bishop Mus., Geol. No. 1231)	127	142
Paratype B. (B. P. Bishop Mus., Geol. No. 1223)	170	188
Figured specimen (USNM 174970)	218	205

Subgenus PACHYCROMMIUM Woodring

Woodring, 1928, Carnegie Inst. Washington Pub. 383, p. 391.

Type (by original designation).—*Amaura guppyi* Gabb. Miocene, Dominican Republic.

Pachycrommium stockwelli Ladd

Plate 7, figures 11, 12

Pachycrommium stockwelli Ladd, 1945, Bernice P. Bishop Mus. Bull. 181, p. 359, pl. 51, figs. C, D.

Still represented only by the type specimens. They measure: holotype (Univ. Rochester, Mus. Nat. History, 13053) height 15.0 mm., diameter 10.7 mm; the paratype (Univ. Rochester, Mus. Nat. History, 13054) height 10.9 mm., diameter 8.3 mm. Ndalithoni Limestone, station 110 Vanua Mbalavu, Fiji; age, Pliocene (Tertiary *h*).

According to Cox (1948, p. 19), the species described by Pannekoek in 1936 as *Ampullina* (*Ampullospira*) *harrisi* from the lower Miocene of Java is a *Pachycrommium* that occurs also in the Neogene of Borneo. This species is much larger than the Fiji fossil and is less strongly shouldered.

Pachycrommium? pacificum Ladd

Pachycrommium? pacificum Ladd, 1945, Bernice P. Bishop Mus. Bull. 181, p. 359, pl. 51, figs. E, F.

The generic identity of this species remains uncertain. It is represented by three partly crushed specimens from station L466 on Oneata, Fiji; age, early Miocene (Tertiary *f*).

Genus POLINICES Montfort

Montfort, Conchyliologie Systematique 2, p. 222.

Subgenus POLINICES s. s.

Type (by original designation), *Polinices albus* Montfort (=*Nerita mammilla* Linnaeus).—Holocene, central and southwest Pacific.

Polinices (Polinices) mammilla (Linnaeus)

Plate 8, figure 3

Nerita mammilla Linnaeus, 1758, Systema Naturae 10th ed., p. 776.

Polinices (*Polinices*) *mammilla* (Linnaeus), Ladd, 1934, Bernice P. Bishop Mus. Bull. 119, p. 210, pl. 36, figs. 4, 5.

Natica (*Mamma*) *mamilla* (Linnaeus), Abrard, 1946, Annales Paléontologie, v. 32, p. 53.

Polinices cf. *P. mammilla* (Linnaeus), MacNeil, 1960, U.S. Geol. Survey Prof. Paper 339, p. 54, figs. 17, 21.

Small to medium, thick-shelled, smooth; spire small, low to moderately elevated; body whorl flattened above, greatly expanded below; aperture semilunate; parietal callus thick, entirely covering the umbilicus.

Measurements of the figured specimen (USNM 650624, drill hole 2A–13–A, Bikini, core at depth 200–211 ft) : height 18.6 mm, diameter 13.7 mm.

Occurrence.—Several specimens from the Suva Formation at station 160 (Tertiary *f*) and from RB32 (probably Tertiary *h*) on Viti Levu, collected by H. G. Richards; single Holocene specimen from drill hole K–1, Eniwetok, at depth 222–233 ft, a late Miocene (Tertiary *g*) specimen from drill hole F–1, at depth 670–680 ft. Common in Pliocene and Pleistocene Mariana Limestone at south end of Tinian (USGS loc. 17896); occurring in rocks of same age on Guam (eight specimens from USGS locs. 20541, 20600, 20608, 20626, 20745, 21380). One shell from the Pleistocene marl of Santo, New Hebrides (USGS loc. 25715). MacNeil figured a specimen from the Pliocene Nakoshi Sand of Okinawa. The species has also been reported from the upper Miocene and younger beds of the New Hebrides, the Miocene and Pliocene of Java, the Pliocene of Sumatra and Timor, the Quaternary of Celebes (Sulawesi) and Billiton (Vlerk, 1931, p. 258). Living examples have been reported from many localities in the central and southwest Pacific, Indonesia, and Japan.

Polinices (Polinices) cumingianus madioenensis Altena

Plate 8, figure 4

Natica (*Polinices*) *powisiana* Récluz, Martin, 1905, Geol. Reichs-Mus. Leiden Samml., v. 1, p. 263, pl. 39, figs. 634, 637.

Polinices (*Polinices*) sp. Ladd, 1934, Bernice P. Bishop Mus. Bull. 119, p. 211, pl. 36, fig. 6.

Polinices (*Polinices*) *cumingianus* var. *madioenensis* Altena, 1941, Leidse Geol. Mededel., v. 12, p. 58, fig. 18.

?*Natica* (*Natica*) sp. Ladd, 1945, Bernice P. Bishop Mus. Bull. 181, p. 357.

Polinices cf. *P. cumingianus madioenensis* Altena, MacNeil, 1961, U.S. Geol. Survey Prof. Paper 339, p. 53, pl. 13, fig. 1.

Medium in size, ovate, spire low, broadly pointed, suture lightly impressed; aperture semi-elliptical, outer lip thin; umbilicus large but almost completely filled by a funicle, parietal callus thick, projecting slightly beyond the funicle.

Measurements of the figured specimen, USNM 174969: height 20.5 mm, diameter 20.0 mm.

Authors, including Altena, have stated that two of the species of *Natica, N. cumingianus* and *N powisiana,* described by Récluz (1844, p. 210) are synonymous. In naming his new variety, Altena chose *N. cumingianus* because of page priority.

The Fijian fossils seem to be identical with the shells described by Altena and Martin from the Neogene of Java. When compared with the shells from the Pliocene Nakoshi Sand of Okinawa figured by MacNeil, there appear to be no important differences, the Fijian fossils having a slightly lower spire.

Occurrence.—In 1934, I figured and briefly described a single specimen collected at station 160 on Viti Levu, Fiji. Later collecting at the same locality yielded three more specimens; one of these is figured in the present report; age, early Miocene (Tertiary *f*). A small and somewhat eroded specimen from the Ndalithoni Limestone at station 110B on Vanua Mbalavu may represent this species; age, Pliocene (Tertiary *h*).

Polinices (Polinices) cf. P. columnaris (Recluz)

Plate 8, figure 5

Polinices cf. *P. albumen* (Linnaeus), MacNeil, (pars) U.S. Geol. Survey Prof. Paper 339, p. 53, pl. 2, fig. 23.

Small, obliquely depressed, spire low, aperture semielliptical; umbilicus wide and deep, partly filled by a strong broad funicle; sculpture consisting of curved lines of growth.

Measurements of the figured specimen from station 817, Fiji, USNM 174968: height 10.0 mm, diameter 9.7 mm.

All four Fijian fossils are small and cannot be separated from many young shells of the living *P. columnaris,* nor from the smaller of the Okinawan fossils figured by MacNeil.

Occurrence.—A single fossil from station 817, Vanua Levu, Fiji, and two from station RB44 on Viti Levu; age, Pliocene (Tertiary *h*). An incomplete shell from station L389 on Lakemba, Fiji, may represent the same species; age, early Miocene Tertiary *f*). A shell from the marls of the Kere River, Santo, New Hebrides, is Pleistocene in age. MacNeil's Okinawan shell was collected from the Miocene Yonabaru Clay Member of the Shimajiri Formation. *P. columnaris* lives today in the Philippines and in parts of the Indian Ocean.

Genus MAMMILLA Schumacher

Schumacher, 1817, Essai d'un nouveau système des habitations des vers testacés, p. 190, Copenhagen.

Type (by monotypy).—*Mammillata fasciata* Schumacher (=*Nerita melanostoma* Gmelin). Holocene, Indo-Pacific.

Mammilla melanostoma (Gmelin)

Plate 8, figures 6, 7

Nerita melanostoma Gmelin, 1791, Systema naturae, 13th ed., p. 3674.

Natica (*Mammilla*) *melanostoma* (Gmelin). Tryon, 1886, Manual Conchology, 8, p. 50, pl. 21, figs. 13–18; pl. 22, fig. 21.

Mammilla melanostoma (Gmelin), MacNeil, 1960, U.S. Geol. Survey Prof. Paper 339, p. 54, pl. 8, fig. 1, pl. 12, fig. 19 (see for additional references).

A single large specimen of this widespread Holocene Indo-Pacific species was collected from the Tanapag Limestone on Saipan (USGS loc. 17891); age, probably Holocene.

Measurements of the specimen, USNM 650623 (pl. 8, fig. 7): height 39.1 mm, diameter 38.4 mm. The specimen retains traces of dark color in the columellar area. A smaller specimen was recovered from the Pliocene marls of station 817 on Vanua Levu, Fiji. This shell, USNM 174940, (pl. 8, fig. 6) measures: height 15.5 mm, diameter 13.2 mm.

A single shell was found in the Pleistocene beds of Santo, New Hebrides (SM 242–74A).

As noted by MacNeil, the species has been reported from the Miocene and Pliocene of Java, the Miocene or Pliocene of Okinawa, and the Pleistocene of Java and the Red Sea area.

Genus PLICONACCA (Cossmann and Martin

Cossmann and Martin, 1914, *in* Martin, Geol. Reichs.-Mus. Leiden Samml., v. 2, no. 4, p. 171.

Type (by monotypy).—*Natica trisulcata* Martin. Eocene, Java.

Pliconacca is characterized particularly by the presence of transverse grooves across the umbilical callus. The grooves are shown by the type species from the Eocene of Java and by a comparable species from the Eocene of North America [*Polinices* (*Pliconacca*) *arata* (Gabb), Palmer, 1937, p. 123]

but have not previously been reported from post-Eocene rocks.

Pliconacca martini Ladd, n. sp.

Plate 8, figures 8, 9

Shell small, subglobose, spire moderately high, suture distinct. Aperture ovoid, outer lip thin; umbilicus covered by callus except for a narrow slit below; callus crossed by two or three broad grooves, the areas adjoining the grooves slightly elevated. Oblique plicae prominent on each whorl immediately below the suture; lines of growth thicker near the base of the body whorl than over the middle part of whorl. On all specimens, the apical whorls are partly eroded.

Measurements of the holotype, USNM 174967: height 12.8 mm, diameter 10.8 mm.

P. martini differs from the Eocene species *P. trisulcata* Martin (1914, p. 171) and *P. arata* (Gabb) (Palmer 1937, p. 123) in that it is not widely umbilicate and has more prominent plicae near the suture. The callus grooves on *P. martini* are less prominent than on the Eocene species, but these are somewhat variable features. On two specimens of *P. martini*, one of the elevated areas between grooves is continued as a weak ridge deep inside the shell.

Occurrence.—Represented by a dozen specimens from three stations on Vita Levu: FB13 (holotype), FB7, C497, all in marls of the Suva Formation; age, early Miocene (Tertiary *f*).

This species is named for Dr. K. Martin who monographed the molluscan faunas of the East Indies and established a Tertiary section in that area.

Genus NEVERITA Risso

Risso, 1826, Histoire naturelle des principales productions de l'Europe méridionale, v. 4, p. 149.

Type (by monotypy).—*Neverita josephinia* Risso. Holocene, Mediterranean Sea.

Neverita? sp.

Neverita? sp. Ladd, 1970, U.S. Geol. Survey Prof. Paper 640-C, p. C7, pl. 4, fig. 16.

Eua Tonga. Late Eocene (Tertiary *b*).

Genus SINUM Roding

Röding, 1798, Mus. Boltenianum, v. 2, p. 14.

Type (by subsequent designation, Dall, 1915, U.S. Natl. Mus. Bull. 90, p. 109).—*Helix haliotidea* Linnaeus. Holocene, western Pacific.

Sinum sp. A

Plate 9, figures 1, 2

Minute, spire moderately high, made up of about three rounded whorls; sculpture consisting of fine flattened spiral riblets that vary in size; base smooth.

Measurements of the figured specimen, USNM 174941: height 1.2 mm, diameter 3.2 mm.

The single specimen with its relatively elevated spire does not seem closely related to described species, but the shell is probably immature and a specific name is withheld.

Occurrence.—Drill hole F–1, Eniwetok, at depth of 55–60 ft; age, Holocene.

The only other representative of the genus *Sinum* occurring in the fossil collections from the island area is an unidentifiable internal mold of a small specimen from the reef facies of the Mariana Limestone at USGS locality 20680 on Adelup Point, Guam; age, Pliocene or Pleistocene.

Genus NATICARIUS Dumeril

Duméril, 1806, Zoologie Analytique, p. 164.

Type (by monotypy).—*Nerita canrena* Linnaeus. Holocene, West Indies.

Naticarius marochiensis (Gmelin) s. l.

Plate 9, figures 3–10

Nerita marochiensis Gmelin, 1791, Systema Naturae, 13th ed., p. 3673.

Natica (*Natica*) *marochiensis* (Gmelin), Ladd, 1934, Bernice P. Bishop Mus. Bull. 119, p. 209, pl. 36, figs. 2, 3.

Natica marochiensis (Gmelin), Abrard, 1946, Annales Paléontologie, v. 32, p. 53.

Naticarius (*Naticarius*) *marochiensis* (Gmelin), Wissema, 1947, Young Tertiary and Quaternary Gastropoda from the Island of Nias, Leiden, Rijksuniv., Doctoral thesis, p. 136.

Naticarius marochiensis (Gmelin) s. l., MacNeil, 1960 (1961), U.S. Geol. Survey Prof. Paper 339, p. 55, pl. 15, figs. 21, 22 (see for addtional references).

Many authors have recognized that the shells of living examples of this species are variable in form and in color pattern. Thus broadly defined, *N. marochiensis* has been recognized throughout the Indo-Pacific region, from the east coast of Africa to Hawaii. Reports of fossil occurrences are numerous and are almost equally widespread, the oldest fossil being found in the lower Miocene of Indonesia, Fiji, and Marshall Islands, others in the upper Tertiary (Miocene or Pliocene) in the Philippines, the Pliocene of India, Indonesia, Taiwan, Okinawa, the Pleistocene of Indonesia, Hawaii, the Red Sea area, and East Africa.

N. marochiensis is characterized particularly by low plicae near the suture on later whorls and by a deep umbilicus that is partly, but never completely, filled by funicle. Fossils from the island area average smaller than the shells of living examples.

Measurements of the figured specimens.—

Catalog No.	Locality	Height (mm)	Diameter (mm)
USNM 174951	Fiji, station 817, Vanua Levu.	10.9	10.2
174953	Palau, USGS locality 21301 (operculum: 3.7 mm by 2.2 mm).	5.6	5.0
174955	Guam, USGS locality 20535.	8.8	7.8

Fossil occurrences in the island area.—

In Fiji: age, early Miocene (Tertiary *f*), station 160, Viti Levu. Age, late Miocene (Tertiary *g*), stations F238 and C148, Viti Levu. Age, Pliocene (Tertiary *h*), stations C1142, Viti Levu, and 817 and K700, Vanua Levu.

In the Marshall Islands: in three deep holes on Eniwetok from 211 to 630 ft; age, Miocene (Tertiary *f* and *g*) to Holocene. In two deep holes on Bikini from 1,124 to 192 ft; age, Miocene (Tertiary *f*), Pliocene (Tertiary *h*) and Holocene.

In Palau: from USGS locs. 21301, 21304, 21305, 21308, and 21310 in the marls at the base of the Palau Limestone; age, late Miocene (Tertiary *g*).

In Guam: a single specimen from USGS loc. 20535 in the Talisay Member of the Alifan Limestone; age, Tertiary *g* or *h*.

In the New Hebrides: specimens have been collected from the post-Tertiary beds of Maewo (USGS loc. 24794), Pentecost (USGS loc. 24793) and Santo (station SM242).

The species lives today on reef flats in Fiji. Edmondson (1946, p. 160) cited it as the commonest shore species in Hawaii. The early Miocene occurrences on Viti Levu and on Eniwetok and the late Miocene occurrences in Palau are in shallow-water beds, but during the Pliocene on Vanua Levu, the species lived in somewhat deeper waters.

Naticarius onca (Roding)

Plate 9, figure 11

Cochlis onca Röding, 1798, Mus. Boltenianum, v. 2, p. 147.

Natica chinensis Lamarck, 1816, Hist. nat. animaux sans vertebrae, v. 8, p. 644; Tryon, 1886, Manual Conchology v. 8, p. 20, pl. 3, fig. 53.

Naticarius onca (Röding), Kira, 1962, Shells of western Pacific in color, v. 1, p. 40, pl. 18, fig. 4.

Natica (*Naticarius*) *onca* (Röding), Cernohorsky, 1971, Auckland Inst. and Mus. Rec., v. 8, p. 186, figs. 33–35.

Shells of living examples carry a striking pattern of dark spots arranged in four to five spiral lines. Fossil shells from Guam lack the color pattern but have the globular shape and the wide umbilicus that is nearly filled by a thick callus. The callus is bordered by a narrow groove that ends above in a deep perforation. The suture is slightly impressed, and weak plications are present below the suture.

Measurements of the figured specimen, USNM 174965: height 12.2 mm, diameter 11.5 mm.

Occurrence.—Two specimens from USGS locality 21377 on Guam; two larger shells from USGS localities 20533 and 20607 on Guam probably represent the species. All specimens from the Mariana Limestone of Pliocene and Pleistocene age. The species is widely distributed in the western Pacific today, from Australia and Indonesia north to Japan and eastward through the Philippines and New Caledonia to Fiji, Tonga, and the Wallis islands, but has not previously been reported from the Mariana Islands.

Family CASSIDAE

Genus BATHYGALEA Woodring and Olsson

Woodring and Olsson, 1957, U.S. Geol. Survey Prof. Paper 314–B, p. 22.

Type (by original designation).—*Cassis coronadoi* Crosse. Holocene, north coast of Cuba, off Cape Fear, N.C.

Subgenus BATHYGALEA s. s.

Bathygalea (Bathygalea) sp. A

Plate 10, figures 1, 2

Internal mold very large, globose, spire moderately high, broadly convex in profile, angle slightly less than 100°. Whorls flattened above a rounded shoulder that bears low widely spaced knobs, about five on body whorl; traces of a row of lower knobs occur at about the midpoint of the body whorl. Outer lip reflected.

Measurements of the single specimen, USNM 174982: height 115 mm, diameter 100 mm.

The Guam fossil is poorly preserved but definitely a *Bathygalea*. It appears to be closely related to the type of the genus, *B. coronadoi* (Crosse) and to *B. wyvillei* (Watson). According to Abbott (1968, p. 100–101), *B. coronadoi* has been recovered from depths of 18–20 to 124 fathoms; Bayer (1971, p. 135) described the first live specimens dredged from a depth of 235–280 m (130–155 fathoms). *B. wyvillei* lives today off Japan, the Philippines, Solomon Islands, and Australia at depths from 60–80 to 310 fathoms.

Occurrence.—A single internal mold from the detrital facies of the Mariana Limestone at USGS locality 20598 on Guam; age, Pliocene or Pleistocene.

Genus CASSIS Scopoli

Scopoli, 1777, Introductio ad historiam naturalum * * * * p. 393.

Type (by subsequent designation, Dall, 1909, U.S. Geol. Survey Prof. Paper 59, p. 60).—*Cassis cornuta* Linnaeus. Holocene, Indo-Pacific.

Cassis cf. C. cornuta Linnaeus

Plate 11, figure 1

Cassis species Ladd, 1934, Bernice P. Bishop Mus. Bull. 119, p. 221.

An internal mold of a large cassid from the early Miocene limestone at the head of Walu Bay, Viti Levu, Fiji (near station 295) probably represents this widespread Indo-Pacific species. The mold measures 145 mm in height and has a diameter of 116 mm. It was collected on January 5, 1896, by Sir Henry Berkeley and presented to Professor A. Agassiz. Two incomplete molds from the Miocene Tagpochau Limestone on Saipan (USGS loc. 17890) may represent the same species. Abbott (1968, p. 47–48) has summarized all records of *C. cornuta*. Martin (1879, p. 45, pl. 8, figs. 5 and 5a) reported it from the upper Miocene of Java.

Genus PHALIUM Link

Link, 1807, Beschreibung der Naturalien-Sammlung, Rostock pt. 3, p. 112.

Subgenus PHALIUM s. s.

Type (by subsequent designation, Dall, 1909, U.S. Geol. Survey Prof. Paper 59, p. 62).—*Buccinum glaucum* Linnaeus; Holocene, Indo-Pacific.

Subgenus SEMICASSIS Morch

Mörch, 1852, Catalogus conchyliorum quae reliquit D. Alphonso d'Aguirra et Gadea, Comes de Yoldi, p. 112.

Type (by subsequent designation, G. F. Harris, 1897, Catalogue of Tertiary Mollusca, British Mus., London, p. 198).—*Cassis japonica* Reeve (=*Cassis bisulcata* Schubert and Wagner). Holocene, Indo-Pacific.

Phalium (Semicassis) bisulcatum (Schubert and Wagner)

Plate 10, figures 3–6

Cassis bisulcata Schubert and Wagner, 1829, Conchylien-Cabinet, Nurnberg, v. 12, p. 68, figs. 3081, 3082.

Cassis pila Reeve, 1848, Conchologica Iconica, v. 5, *Cassis*, pl. 9, fig. 23.

Cassis japonica Reeve, 1848, Conchologica Iconica, v. 5, *Cassis*, p. 9, fig. 23.

Semicassis pila (Reeve), MacNeil, 1960, U.S. Geol. Survey Prof. Paper 339, p. 58, pl. 13, figs. 2, 3.

Phalium (*Semicassis*) *bisulcatum* (Schubert and Wagner), Abbott, 1968, Indo-Pacific Mollusca, v. 2, no. 9, p. 126, pl. 8, figs. 13–21, pls. 105–114 (see for additional citations).

This widely distributed Holocene species is present in abundance (37 specimens) in the Pliocene beds at station 817 on Vanua Levu in Fiji. Three other stations on Vanua Levu, where beds of essentially the same age are exposed (K700, K714, and K806), have yielded 10 specimens, and on Viti Levu, one specimen was collected from the Pliocene beds at stations C89 in the Mba area. Two specimens from station 817 are figured: the larger, USNM 174972, measures: height 51.3 mm, diameter 32.0 mm; the smaller, USNM 174973 measures: height 19.9 mm, diameter 9.0 mm. The species also occurs in the dark marls (stations SG80, SM242) of Santo in the New Hebrides; age, Pleistocene.

The specimen figured by MacNeil as *Semicassis pila* (Reeve) from the Shinzato Tuff (Miocene or Pliocene) of Okinawa cannot be distinguished from the Fiji shells. MacNeil cited other fossil occurrences from the Miocene, Pliocene, and Pleistocene of Indonesia. Abbott mapped the distribution of Holocene occurrences from East Africa to the Marshall Islands and Japan to Australia, including Fiji.

Phalium (Semicassis) vavakuana (Ladd)

Plate 10, figures 7, 8

Semicassis (*Semicassis*) *vavakuana* Ladd, 1934, Bernice P. Bishop Mus. Bull. 119, p. 222, pl. 39, fig. 12.

Phalium (*Phalium*) *areola vavakuana* (Ladd), Abbott, 1968, Indo-Pacific Mollusca, v. 2, no. 9, p. 88.

Since this species was described in 1934 from the Miocene of the Nasongo area of Viti Levu (station 59), two additional specimens have been collected. One of these is from the type area near Nasongo (station F238), the other from the Miocene conglomerate at station 160 in the Suva area. Abbott compared the Fijian shells to young specimens of *P. areola*, but the types and the shell from station 160 are fully mature, with heavy detached callus plates on the inner lip. All the shells have the strong spiral sculpture of *P. bisulcatum*, none show the smoothish body whorl of *P. areola*. The holotype, from station 59, Bernice P. Bishop Museum Geology No. 1206, measures: height 35.0 mm, diameter 22.9 mm.

Subgenus CASMARIA H. and A. Adams

H. and A. Adams, 1853, Genera of Recent Mollusca, v. 1, p. 216.

Type (by subsequent designation, G. F. Harris, 1897, Catalogue of Tertiary Mollusca in * * * British, Mus., London, p. 200).—*Buccinum vibex* Linnaeus=*Buccinum erinaceus* Linnaeus. Holocene, Indo-Pacfic.

Phalium (Casmaria?) sp.

Plate 11, figure 2

The extensive fossil collections from the Mariana Islands contain only one cassid, an internal mold of

a medium-sized shell from the Talisay Member of the upper Tertiary Alifan Limestone at USGS locality 20989 on Guam. The specimen, USNM 174974, measures: height 60 mm, diameter 45 mm. The original shell is not present, but color changes in the mold suggest the presence of a strong varix on the body whorl, two others on earlier whorls, and a columellar shield.

The mold may represent *P. (C.) erinaceus;* the spire is high, as in that species, but the body whorl is more inflated and the varices better developed than on most specimens available for comparison.

Family CYMATIIDAE

Genus GYRINEUM Link

Link, 1807, Beschr. der Nat.-Samml. Univ. Rostock, pt. 3, p. 123.

Subgenus GYRINEUM s. s.

Type (by subsequent designation following virtual tautonymy, Dall, 1904, Smithsonian Misc. Colln. v. 47, p. 131).—*Murex gyrinus* Linnaeus. Holocene, southwest Pacific.

Gyrineum (Gyrineum) bituberculare (Lamarck)

Plate 12, figures 7–9

Ranella bitubercularis Lamarck, 1816, Tableau Encyclopédie Méthodique (Vers), pl. 412, fig. 6; 1845, Animaux sans vertèbres, v. 9, p. 548; Reeve, 1843, Conchologica Iconica, *Ranella*, pl. 7, no. 40.

Ranella (Argobuccinum) bitubercularis Lamarck, Tryon, 1881, Manual Conchology, v. 3, p. 42, pl. 23, fig. 44.

Ranella (Apollo) bitubercularis Lamarck, Martin, 1899, Geol. Reichs Mus., Leiden, Samml. v. 1, no. 6, p. 149, pl. 23, figs. 349–351.

Gyrineum (Gyrineum) bituberculare (Lamarck), Altena, 1942, Leidse Geol. Meded., deel 3, afl. 1, p. 96 (see for additional citations); Cox, 1948, Schweizer Palaeont. Abh. v. 66, p. 40, pl. 3, figs. 6a, b.

Gyrineum species Ladd, 1934, Bernice P. Bishop Mus. Bull. 119, p. 222, pl. 39, fig. 13.

Small, biconic in outline, with a continuous varix on each side; aperture broadly lenticular, continued anteriorly as a short, slightly curved canal; inner lip thinly callused, its edge detached; outer lip thin, crenulated within. Sculpture consisting of strongly beaded spiral ribs; between each two of which are two or three fine spiral threads; spiral sculpture overrides prominent axial ribs, giving the shell a cancellate appearance.

Measurements of the figured specimen, from station 817, Vanua Levu, USNM 174976: length 17.5 mm., diameter 10.8 mm.

Occurrence.—Single specimens from station 817 on Vanua Levu and 304 on Viti Levu, Fiji; age, Pliocene (Tertiary *h*). The species lives today from Samoa westward through New Caledonia, Queensland (Australia), the Malay Peninsula, and the Indian Ocean to the Red Sea. Fossil occurrences have been reported from the Miocene and Pliocene of Java and other parts of Indonesia and from the Quaternary of Celebes.

Genus BIPLEX Perry

Perry, 1811, Conchology, pl. 4.

Type (by subsequent designation, Jousseaume, 1879, Le Naturaliste, v. 1, p. 2).—*Biplex perca* Perry. Holocene, western Pacific.

Biplex perca Perry

Plate 11, figures 3, 4

Biplex perca Perry, 1811, Conchology, pl. 4, no. 5; MacNeil, U.S. Geol. Survey Prof. Paper 339, p. 59, pl. 2, fig. 30, pl. 8, fig. 9, pl. 13, fig. 4 (see for additional citations).

Gyrineum (Biplex) perca (Perry), Altena, 1942, Marine Mollusca of Kendeng beds * * * p. 100 (see for additional citations).

Apollon (Biplex) perca (Perry), Wissema, 1947, Young Tertiary and Quaternary Gastropoda from the Island of Nias: Leiden Rijksuniv., Doctoral thesis, p. 145.

A single juvenile shell of this highly decorated type species was collected by R. W. Bartholomew on Vanua Levu (station VL1) and submitted to the British Museum. The specimen, British Museum GG1840, measures: length 14.9 mm, diameter 10.3 mm. Present in abundance in the marls of the Kere River, Santo, New Hebrides.

The species lives today in Indonesia, the Philippines, and north to Japan but has not been found in Fiji.

Reported fossil occurrences include questionable Miocene in India and Java, Miocene and possibly Pliocene in Okinawa, Pliocene in several parts of Indonesia, and Pleistocene in Java. The Fiji occurrence is probably Pliocene. The New Hebrides shells are Pleistocene.

MacNeil (1960) summarized available bathymetric data: Japan 57–163 fathoms: Philippines (*Albatross* collections), more than 50 localities ranging from 80 to 350 fathoms.

Genus CYMATIUM Roding

Röding, 1798, Museum Boltenianium, p. 129.

Type (by subsequent designation, Dall, 1904, Smithsonian Misc. Colln. v. 47, p. 133).—*Murex femorale* Linnaeus. Holocene, West Indies.

Subgenus LAMPUSIA Schumacher

Schumacher, 1817, Essai d'un noveau système des habitations des vers testacés, Copenhagen, p. 250.

Type (by subsequent designation, Herrmannsen, 1847, Indicis Generum, v. 1, p. 575).—*Murex pileare* Linnaeus. Holocene, Philippine Islands.

Cymatium (Lampusia) aquatile (Reeve)

Plate 11, figures 5–7

Triton aquatilis Reeve, 1844, Conchlogica Iconica, v. 2, *Triton*, pl. 7, no. 24.

Two small and incomplete specimens from the Pliocene of Fiji probably represent this Holocene species. The figured specimen, USNM 174996, measures: length 18.4 mm, diameter 17.6 mm. Both fossils have a slightly wider apical angle than Holocene shells and the figured specimen is more sharply sculptured than are shells of living examples. The figured specimen retains two of the groups of stout teeth inside the outer lip that seem to be characteristic of *C. aquatilis*. One of the fossils (figured specimen) was collected from station 817 on Vanua Levu, the other (British Museum specimen) from station RB32 on Viti Levu. The species, originally described from the Philippines, is common on the reefs of Fiji today and has been collected through various island groups to Hawaii. Currently some authors (Cox, 1948, p. 39; Cernohorsky, 1967, p. 50; Keen, 1971, p. 507) place *C. aquatile* in synonymy under the genotype *C. pileare* (Linnaeus), but it appears to me that these two widely distributed species can be separated.

Subgenus CYMATRITON Clench and Turner

Clench and Turner, 1957, Johnsonia, v. 3, no. 36, p. 210.

Type (by original designation).—*Cymatium nicobaricum* Röding. Holocene. western Atlantic and Indo-Pacific.

Cymatium (Cymatriton) rickardi Ladd, n. sp.

Plate 13, figures 10, 11

Shell small, rather slender, with a flat-sided spire, the whorls separated by an intrenched suture. Protoconch consisting of about two convex whorls, followed by seven to eight sculptured whorls. Aperture oval, outer lip with a sharply raised rim, bearing about 10 strong lirae, inner lip heavily callused with strong but rather irregular ridges, posterior canal extended and recurved. Sculpture consisting of several varices, which, on the earlier whorls, are only a little stronger than the axial ribs spaced between. A series of rounded spiral cords overrides all axials; between the cords, fine secondary and tertiary threads occur.

Measurements of the types: holotype, USNM 175030, length 27.0 mm, diameter 14.0 mm. Paratype, USNM 195031, length 22.5 mm, diameter 6.8 mm.

C. rickardi is smaller and proportionately shorter than *C. nicobaricum*, type of *Cymatriton*, and lacks the strong shoulder of that species.

The species is named for Dr. M. J. Rickard who collected many fossils while preparing a reconnaissance map of Vanua Levu for the Fiji Geological Survey.

Occurrence.—On Vanua Levu, Fiji, the types and 21 other specimens from station 817 and two from station K700; on Viti Levu one specimen from station C1142. Age of all specimens Pliocene (Tertiary *h*).

Subgenus SEPTA Perry

Perry, 1810, Arcana, pl. a.

Type (by monotypy.—*Septa scarlatina* Perry (=*Murex rubecula* Linnaeus). Holocene, south Pacific.

Cymatium (Septa) rubecula (Linnaeus)

Plate 11, figure 8

Murex rubecula Linnaeus, 1758, Systema Naturae, 10th ed., p. 749.

Triton rubecula (Linnaeus), Tryon, 1881, Manual Conchology, v. 3, p. 12, pl. 7, fig. 40.

Septa rubecula (Linnaeus), Ladd, new subspecies?, 1934, Bernice P. Bishop Mus. Bull. 119, p. 223, pl. 39, figs. 14, 15.

No additional material. The incomplete specimen (Bernice P. Bishop Mus., Geol. 1210) measures 21.6 mm in diameter. As pointed out in 1934, the fossil from Fiji differs from Holocene shells only in minor features of sculpture. After examining additional Holocene material, I now think it unlikely that the fossil represents a distinct subspecies. *C. rubecula* lives today from the Red Sea to the central Pacific. The Fijian fossil from station 160 on Viti Levu is early Miocene (Tertiary *f*) in age. The species has also been reported from Quaternary rocks on Celebes (Sulawesi).

Cymatium (Septa) gemmatum (Reeve)

Plate 11, figures 9, 10

Triton gemmatus Reeve, 1844, Conchologica Iconica, v. 2, Triton, pl. 15, figs. 60a–b; Tryon, 1881, Manual Conchology, v. 3, p. 13, pl. 7, figs. 41–44.

Cymatium (Septa) gemmatum (Reeve), Clench and Turner, 1957, Johnsonia, v. 3, no. 36, p. 222, pl. 125, figs. 1, 2 (see for discussion of distribution).

A single incomplete specimen of this widely distributed Indo-Pacific western-Atlantic Holocene species was recovered from drill hole 2 on Bikini in core from a depth of 180 ft; age, Quaternary. The

specimen, USNM 650471, measures: length 19.2 mm, diameter 10.3 mm.

Genus DISTORSIO Roding

Röding, 1798, Mus. Boltenianum, p. 133.

Type (by subsequent designation, Gray, 1847, Zool. Soc. London Proc., v. 15, p. 133).—*Murex anus* Linnaeus. Holocene, western Pacific.

Subgenus DISTORSIO s. s.
Distorsio (Distorsio) anus (Linnaeus)

Plate 11, figure 11

Murex anus Linnaeus, 1758, Systema Naturae, 10th ed., p. 750.

Distorsio (Distorsio) anus (Linnaeus), Clench and Turner, 1957, Johsonia, v. 3, no. 36, p. 236; Cernohorsky, 1967, Veliger v. 9, no. 3, p. 323, pl. 45, fig. 23.

An incomplete fossil from station RB44 on Viti Levu preserves a large part of the extensive parietal callus and the basal part of the recurved siphonal canal. Measurements of the figured specimen, British Museum GG19757: length 38.5 mm, diameter 24.9 mm. A smaller incomplete shell was collected at station K700 on Vanua Levu. Both specimens are Pliocene (Tertiary *h*) in age.

D. anus, Holocene type of the genus, lives throughout the Indo-Pacific region.

Subgenus RHYSEMA Clench and Turner

Clench and Turner, 1957, Johnsonia, v 3, no. 36, p. 236.

Type (by original designation).— *Triton clathratum* Linnaeus. Holocene, West Indies.

Distorsio (Rhysema) pusilla Pease

Plate 11, figures 12, 13

Distorsio pusilla Pease, 1860, Zool. Soc. London Proc., p. 397; Tryon, 1881, Manual Conchology, v. 3, p. 35.

Small, biconic; protoconch of one or two smooth whorls followed by about five sculptured whorls; aperture narrowly triangular; anterior canal of moderate length, gently curved; inner lip thinly callused but dentate, its margin free and thickened; outer lip strongly dentate, deeply excavated above. Sculpture consisting of coarse spiral ribs between which are closely set spiral striae; ribs beaded where they cross axial plications. Measurements of the figured specimen, USNM 650634: length 10.6 mm, diameter 4.5 mm.

Occurrence.—Two specimens from drill hole E–1, Eniwetok, at depths of 30–40 ft; age, Holocene. A single Holocene specimen in the USNM collections (337878) was obtained from dredging a channel entering Honolulu Harbor. The specimen described by Pease may have come from the same source. This little species is also known to live in Japan and Fiji.

Distorsio (Rhysema) reticulata Roding

Plate 11, figure 14

Distorsio reticulata Röding, 1798, Mus. Boltenianum, p. 133; Cernohorsky, 1967, Veliger, v. 9, no. 3, p. 324, pl. 45, fig. 24.

Triton decipiens Reeve, 1844, Conchologica Iconica, v. 2, *Triton*, pl. 20, sp. 102.

This species lives today from the Seychelles in the Indian Ocean to Hawaii in the central Pacific. It is characterized particularly by its thin concave outer lip and its deeply excavated columella. The fossils from Fiji are all small. The figured specimen, USNM 650635, measures: length (incomplete) 19 mm, diameter 19.1 mm. Cernohorsky reported that the species is found throughout Fiji today but is moderately rare. All five fossils are from station 817 on Vanua Levu; age, Pliocene (Tertiary *h*). The species has also been collected in large numbers from the elevated marls of Santo in the New Hebrides (station SM242); age, Pleistocene.

Family BURSIDAE

Genus BURSA Roding

Röding, 1798, Mus. Boltenianum, p. 128.

Type (by subsequent designation, Jousseaume, 1881, Soc. Zool. France Bull. v. 6, p. 174).—*Bursa mammata* Röding (=*Murex bufonius* Gmelin). Holocene, western Pacific.

Subgenus COLUBRELLINA Fischer

Fischer, 1884, Manual Conchyliologie, p. 656.

Type (by monotypy).—*Ranella candisata* Lamarck (=*Murex conditus* Gmelin). Holocene, western Pacific.

Bursa (Colubrellina) nobilis (Reeve)

Plate 12, figures 1–3

Ranella nobilis Reeve, 1884, Conchologica Iconica, *Ranella* pl. 4, fig. 16; Martin, 1899, Geol. Reichs-Mus. Leiden Samml., v. 1, no. 6, p. 146, pl. 23, figs. 340–342.

Bursa nobilis (Reeve), Cernohorsky, 1967, Marine shells of the Pacific, p. 46, pl. 2, fig. 6.

The major sculptural features of this highly ornate species are constant, but the strength of the spiral lines of granules that cover the shell surface varies considerably.

Measurements of the figured specimens: USNM 174980 (pl. 12, fig. 1) length 62.0 mm, diameter 36.3 mm; a slightly smaller specimen, USNM 174981 (pl. 12, figs. 2, 3) length 45.5 mm, diameter 33.3 mm.

The five specimens assigned to *B. nobilis* are larger and more ornately sculptured than the two nearly complete shells assigned to *B. margaritula* (Deshayes) that follow.

Occurrence.—Represented by five specimens from station 817, Vanua Levu, Fiji; age, Pliocene (Tertiary *h*). Martin reported the species from the Miocene and Pliocene of Java; it has also been reported (Vlerk, 1931, p. 241) from the upper Miocene of Sumatra and the Pliocene of Timor. Reeve described the Holocene shell from an unknown locality. According to Cernohorsky, (1967) it lives throughout the tropical Pacific but is uncommon. The only specimens in the United States National Museum are two dead shells dredged by Harald Rehder off the island of Ua Pou in the Marquesas. They were recovered from a depth of 40–51 fathoms from a bottom of sand and broken shell.

Bursa (Colubrellina) margaritula (Deshayes)

Plate 12, figures 4–6

Ranella margaritula Deshayes, 1832, *in* C. Bélanger, Voyage Indes Orient, v. 6, p. 424; Reeve, 1844, Conchologica Iconica, *Ranella*, pl. 3, no. 15; Martin, 1899, Geol. Reichs-Mus. Leiden, Samml. v. 1, no. 6–8, p. 146, pl. 23, figs. 337–339.

Medium in size, biconic; varices narrow; whorls with a strong keel, the keel bearing eight prominent tubercles on each whorl; surface of whorls covered by alternately strong and weak spiral ribs. Aperture broadly lenticular; outer lip lirate within; anterior and posterior canals short.

Measurements of the figured specimen, USNM 175075: length 28.7 mm, diameter 19.9 mm.

The peripheral tubercles on the fossils are somewhat worn and do not have the backward upturn shown by the tubercles of many Holocene shells.

Occurrence.—Figured specimen from station F238, Viti Levu, Fiji; two other shells from station C148 in the same area; age, late Miocene (Tertiary *g*). Shells from the Kere River marls, Santo, New Hebrides (USGS loc 25715), are Pleistocene. The species lives today in the Philippines and in parts of the Indian Ocean. Fossil occurrences have been described from the Miocene and Pliocene of Java and other parts of Indonesia.

Family TONNIDAE

Genus EUDOLIUM Dall

Dall, 1889, Mus. Comp. Zoology Bull., v. 29, p. 232.

Type (by original designation).—*Dolium crosseanum* Monterosato. Holocene, Mediterranean Sea.

Eudolium sp.

Plate 12, figure 10

Three incomplete specimens of a relatively high spired pyriform tun, bearing many closely set spiral ribs crossed by fine oblique axial threads, seem to represent a species of *Eudolium*. The incomplete figured specimen, USNM 174986, measures: length 23.9 mm, diameter 17.7 mm. The body whorl bears 34 spiral ribs; secondary spirals are not present.

Occurrence.—Figured specimen and one other from USGS locality 25142; a third specimen from station FB–13; both stations in Suva area, Viti Levu, Fiji; age, early Miocene (Tertiary *f*).

Genus QUIMALEA Iredale

Iredale, 1929, Australian Zoologist, v. 5, pt. 4, p. 345.

Type (by original designation).—*Buccinum pomum* Linnaeus. Holocene, Indo-Pacific.

Quimalea pomum (Linnaeus)

Plate 12, figure 11

Buccinum pomum Linnaeus, 1758, Systema Naturae, 10th ed., p. 735.

Malea pomum (Linnaeus), Demond, 1957, Pacific Sci. v. 11, p. 309.

Malea (*Quimalea*) *pomum* (Linnaeus), Habe, 1964, Shells of the western Pacific in color, v. 2, pl. 24, fig. 7.

Represented by a single specimen from USGS locality 21028, Santo, New Hebrides; age, Pleistocene. The specimen, USNM 174984, is incomplete and is encrusted with tubular growths inside and out but retains the heavy spirals and a part of the strongly toothed outer lip; measurements: length (incomplete). 49.4 mm, diameter 45.5 mm. The species lives today throughout the Indo-Pacific region. It has been reported as a fossil from the Quaternary of Timor (Vlerk, 1931, p. 243).

Genus TONNA Brunnich

Brünnich, 1772, Zoologiae fundamenta praelectionibus academicis accomodata, Hafniae et Lipsiae, p. 248.

Type (fide Suter, 1913, Manual New Zealand Mollusca, p. 314).—*Buccinum galea* Linnaeus. Holocene, Mediterranean Sea.

Tonna sulcosa (Born)

Plate 12, figures 12, 13

Buccinum sulcosum Born, 1778, Index Rerum Natur. Musei Caesarei Vindobonensis, p. 230.

Dolium fasciatum (Bruguière), Lamarck, 1844, Animaux sans vertèbres, v. 10, p. 142; Reeve, 1848, Conchologica Iconica, *Dolium*, pl. 7, fig. 1; Tryon, 1885, Manual Conchology, v. 7, p. 263, pl. 3, fig. 16.

Tonna fasciata (Bruguière), Kira, 1962, Shells of the western Pacific in color, v. 1, pl. 23, fig. 7.

Represented by seven specimens from the Pliocene (Tertiary *h*) beds of Vanua Levu, Fiji. Six of the specimens (two large, four small) are from station 817, the other, a small specimen, from station K700. The figured specimen, USNM 174985, from station 817 measures: length 35.5 mm, diameter 23.4

mm. It retains a part of the outer lip that is dentate within.

The species occurs today in Japan, the China coast, Indonesia, and the Philippines.

Family FICIDAE

Genus FICUS Roding

Röding, 1798, Mus. Boltenianum, p. 148.

Type (by tautonymy and subsequent designation, Winckworth, 1945, Malacolog. Soc. London Proc., v. 26, p. 140).—*Ficus variegatus* Röding (=*Bulla ficus* Gmelin=*Murex ficus* Linnaeus). Holocene, western Pacific.

Ficus variegata Roding

Plate 13, figures 1–3

Ficus variegata Röding, 1798, Mus. Boltenianum, v. 2 p. 148; Cernohorsky, 1972, Marine shells of the Pacific, v. 2, p. 113, pl. 33, fig. 1.

Pyrula ficus Lamarck, 1799, Prodrome d'une nouvelle classification des coquilles * * * Soc. Hist. nat. Paris Mém. 1, p. 73; Martin, 1879 Tertiärschichten auf Java, Leiden, p. 57, pl. 14, fig. 9; Tryon, 1885, Manual conchology, v. 7, p. 266, pl. 5, fig. 29, pl. 6, figs. 36, 37.

Ficula laevigata Reeve, 1847, Conchologica Iconica, *Ficula*, pl. 1, fig. 4.

Shell medium to large, spire low. Protoconch consisting of about 2½ smooth convex whorls; body whorl greatly expanded; columella curved over the anterior half of its length. Sculpture finely reticulate but variable. On most shells, the closely set spirals are strong and flat topped; on others, they alternate with weaker spirals; on juvenile shells, the strong spirtls may alternate with weak ones, neither set being strongly flattened (pl. 13 figs. 2, 3); axials are regularly spaced but usually weaker than the spirals. Such sculptural variation also characterizes the shells of living specimens.

Measurements of the figured specimens: an adult shell, USNM 650628, height (incomplete) 89 mm, diameter 58.4 mm; a juvenile shell, USNM 650629, height 22.4 mm, diameter (incomplete) 12.5 mm.

Occurrence.—Represented by six adult and two juvenile shells, all from station 817, Vanua Levu, Fiji; age, Pliocene (Tertiary *h*). Martin recorded it from the Miocene of Java.

The species is widely distributed today in Indo-Pacific seas, from the Red Sea to Taiwan, but has not been found living in Fiji.

Family MURICIDAE

Genus MUREX Linnaeus

Linnaeus, 1758, Systema Naturae 10th ed., p. 746.

Subgenus MUREX s. s.

Type (by subsequent designation, Montfort, 1810, Conchyliologie Systématique, v. 2, p. 619).—*Murex pecten* (Lightfoot) (=*M. tribulus* Linnaeus). Holocene, western Pacific.

Murex (Murex) guppyi Ladd, n. sp.

Plate 13, figures 6–7

Shell medium in size, spire composed of six or more whorls; each whorl with two strong primary ribs that divide the inflated area into three parts; above the upper rib the whorl is flattened, the remainder of the whorl being moderately convex. Three prominent varices are present but are not alined from whorl to whorl; three or four secondary ribs occur between the primary ribs, and threadlike tertiary ribs are discernible in some areas. On the body whorl, long slightly curved spines are developed where the primary ribs cross the varices, and shorter spines occur on the varices below the lower of the two primary spirals. Aperture oval, outer lip crenulate, inner lip erect, detached. Siphonal canal long, straight, with spines extended at regular intervals.

Measurements of the holotype from station 817, Vanua Levu, Fiji, USNM 175003: length 62.8 mm, diameter (spines omitted) 22.5 mm.

M. guppyi is related to *M. verbeeki* Martin, a Neogene species from Indonesia (Martin, 1895, p. 123, pl. 19, figs. 278–281), but on that species the whorls are more evenly convex and the primary spirals are all nearly equal in size.

This species is named for H. B. Guppy who studied Vanua Levu, Fiji, between 1896 and 1899 and wrote a comprehensive report on its physical and geological features.

Occurrence.—Holotype and three other specimens from station 817 on Vanua Levu, Fiji; age, Pliocene (Tertiary *h*).

Murex (Murex) nasongoensis Ladd, n. sp.

Plate 13, figures 8, 9

Murex (*Murex*) aff. *recurvirostris* Broderip, Ladd, 1934, Bernice P. Bishop Mus. Bull. 119, p. 224, pl. 40, figs. 3, 4 [not fig. 5].

Murex cf. *M. recurvirostris* Broderip, Cernohorsky, 1967, Veliger, v. 10, no. 2, p. 129 [part].

Shell medium in size, globose; whorls inflated, separated by a deep suture. Aperture broadly ovate with a shallow notch posteriorly and a narrow canal anteriorly that is not completely roofed over; both inner and outer lips lirate within, inner lip detached and thickened anteriorly. Each whorl with three varices, those of each whorl aligned with those of

the preceding whorl; low rounded axial ribs are present between varices, five between each two varices on the body whorl; varices and ribs overridden by alternating spiral cords and threads.

Measurements of the holotype and only specimen, Bernice P. Bishop Museum, Geology No. 1208: length 39.1 mm, diameter 30.7 mm.

The Fijian fossil resembles *Murex batamensis* described by Martin (1895, p. 126, pl. 19, figs. 288–290) from the Neogene of Java and recorded by Cox (1948, p. 43, pl. 4, figs. 4a, b, c) from the Neogene of North Borneo, but it has a broader apical angle and is much less spinose than that species.

Occurrence.—Station 59, Viti Levu; age, probably Miocene.

Murex (Murex) bantamensis coulsoni Ladd, n. subsp.

Plate 13, figures 12–15; plate 14, figures 1, 2

Murex (*Murex*) aff. *recurvirostris* Broderip, Ladd, 1934, Bernice P. Bishop Mus. Bull. 119, p. 224, pl. 40, fig. 5 [not figs. 3, 4].

Murex cf. *M. recurvirostris* Broderip, Cernohorsky, 1967, Veliger, v. 10, no. 2, p. 129 [part].

Shell small, whorls strongly inflated, separated by a deep suture. Aperture small, ovate with a thin, erect peristome that is crenulated to form the outer lip that is conspicuously dentate within; inner lip with a smooth margin but internally with several rounded denticles anteriorly; posteriorly, the peristome bears a shallow notch, anteriorly, it is extended as a narrow canal that is almost completely roofed over. Each whorl with three prominent varices which, on the body whorl, converge to the base of the anterior canal; varices of the body whorl alined with those of earlier whorls. Two to four axial ribs are present between each two varices; varices and ribs overridden by alternating primary and secondary spirals, the primary spirals, on some specimens, being extended as short spines.

Measurements of the types:

Holotype, USNM 174997, length 24.3 mm, diameter 15.6 mm.

Paratype A, USNM 174998, length 23.1 mm, diameter 15.0 mm.

Paratype B, USNM 174999, length 19.0 mm, diameter 13.6 mm.

Paratype C, Bishop Mus. Geol. no. 1209, length 30.1 mm, diameter 16.7 mm.

Paratype D, USNM 175001, length 16.3 mm, diameter 9.7 mm.

The above description is based on 13 nearly complete specimens from 4 localities—3 on Viti Levu, the fourth on Vanua Levu, Fiji. The Viti Levu localities furnished one specimen each, the remaining 10 coming from a single station on Vanua Levu. The anterior canal is incomplete on all specimens, and the thin peristome shows evidence of wear.

Paratype C, when originally described, was affiliated with *Murex recurvirostris* Broderip, a variable species living on the west side of Central America and in the Caribbean region, where it has a record dating back to the early Mioceine. Of several forms that have been described from the Americas, the Fijian fossils appear closest to *M. recurvirostris rubidus* F. C. Baker, a living form that is limited to Florida and the Bahamas (Clench and Pérez Farfante, 1945, p. 6, pl. 3, figs. 1–7). The Fijian fossils appear more sharply sculptured, and the intervarical ridges are stronger and more uniform in size than on the Holocene shells.

The Fijian fossils are closely related to *M. bantamensis* Martin and may be identical with that species, known from the Neogene of Java (Martin, 1895, p. 126, pl. 19, figs. 288–290) and of North Borneo (Cox, 1948, p. 43, pl. 4, fig. 4a–c) and the Pliocene of Timor (Tesch, 1915, p. 63, pl. 81, fig. 140). The shells of *M. bantamensis coulsoni* are more strongly sculptured than those of *M. bantamensis* from Indonesia.

The Fijian form is smaller than *M. bantamensis oostinghi*, described by Wissema (1947, p. 172, pl. 6, fig. 148) from the Neogene of Nias and has a broader apical angle. *Murex saplisi* described by MacNeil (1960, p. 63, pl. 8, figs. 14, 15) from the Miocene of Okinawa also has a broader apical angle than the Fijian shells and has weaker spiral sculpture.

The new subspecies is named for Frank I. Coulson, geologist with the Fiji Geological Survey who has made many collections of fossils while mapping in Fiji.

Occurrence.—Holotype, three paratypes, and six other specimens from station 817, Vanua Levu, Fiji; age, Pliocene (Tertiary *h*). One specimen each from stations 59 and 165 on Viti Levu; age, late Miocene (Tertiary *g*) and from C1133; age, Pliocene (Tertiary *h*).

Murex cf. M. multispinosus G. B. Sowerby

Plate 13, figures 4, 5

Medium in size, fusiform, whorls inflated; aperture oval, extended anteriorly as a moderately long canal; margins of aperture free, outer lip denticulate. Each whorl with three prominent varices; surface between varices covered by spiral ribs of several sizes, all more or less beaded, even scaly. Long

slightly curved spines are developed where the largest spiral ribs cross the varices.

Measurements of the figured specimen, USNM 175002: length (incomplete) 54.1 mm, diameter (spines omitted) 31.8 mm.

The fossils may be identical with the Holocene shell that G. B. Sowerby (1904, p. 8, fig. 2) described from the Philippines, but I have not seen a specimen, and the single figure does not show details.

Occurrence.—Figured specimen from station C89, Viti Levu, Fiji; a smaller specimen was found at station 817, Vanua Levu, Fiji; age of both specimens Pliocene (Tertiary *h*).

Genus PTERYNOTUS Swainson

Swainson, 1833, Zoological Illustrations, ser. 2, v. 3, explanation to pl. 100.

Type (by subsequent designation, Swainson, 1833, Zoological Illustrations, ser. 2, v. 3, pl. 122).—*Murex pinnatus* Swainson (=*Purpura alata* Röding). Holocene, Pacific.

Pterynotus sp.

Plate 14, figure 3

A single small immature shell is the only fossil representative of *Pterynotus* yet found in the island area. The specimen shows a smooth rounded protoconch of one whorl followed by 3½ moderately convex whorls carrying three to four low rounded spirals that override three low varices. The aperture is elongate-oval, its outer margin crenulated; anterior canal moderately long, nearly straight, open. The specimen, USNM 175000, measures: length 6.1 mm, diameter 2.6 mm.

Occurrence.—Drill hole E–1, Eniwetok, at depth of 80–90 ft; age, Holocene.

Genus VITULARIA Swainson

Swainson, 1840, Treatise on malacology, p. 297.

Type (by original designation).—*Vitularia tuberculata* Swainson (=*Murex vitulinus* Lamarck=*Murex miliaris* Gmelin). Holocene, eastern Atlantic.

Vitularia miliaris (Gmelin)

Plate 14, figures 4, 5

Murex miliaris Gmelin, 1791, Systema Naturae, 13th ed., p. 3536.

Murex purpura Chemnitz, Reeve, 1845, Conchologica Iconica, v. 3, *Murex*, no. 102, pl. 25, fig. 102.

Murex (*Vitularia*) *miliaris* Gmelin, Tryon, 1880, Manual Conchology, v. 2, p. 133, pl. 35, figs. 393, 397.

Medium in size, biconic, strongly angulated. Above the periphery, the surface of the whorl is smooth, except for broad axial folds that cross the area obliquely; below the periphery, on the body whorl, are six axial folds, each one forming a heavy knob at the angulated shoulder; folds sinuous below the periphery; remnants of spiral sculpture in the form of irregularly distributed elongate pustules occur in front of each fold but are veneered and partly masked on the backside of each fold; in the valleys between folds, no trace of spiral sculpture remains. Aperture elongate-oval; inner lip smooth; outer lip not preserved.

Measurements of the figured specimen, USNM 175011: length (incomplete) 20.6 mm, diameter 13.5 mm.

The single Fijian fossil seems to be well within the range of variation shown by Holocene shels.

Occurrence.—A single specimen from station 817, Vanua Levu, Fiji; age, Pliocene (Tertiary *h*). The species lives today in the Indo-Pacific from Hawaii through parts of Melanesia to Indonesia and northern Australia to Ceylon and the Chagos Islands, but, so far as I can learn, no specimens have been collected in Fiji.

Family THAIDIDAE

Genus DRUPA Roding

Röding, 1798, Mus. Boltenianum v. 2, p. 55.

A review of this genus has recently been published by Emerson and Cernohorsky, 1973, Indo-Pacific Mollusca, v. 3, p. 1–40.

Subgenus DRUPA s. s.

Type (by subsequent designation, Roverto, 1899, Primi ricerche sinonimiche sui generi dei gasteropodi, Atti Soc. ligustica, v. 10, p. 105).—*Drupa morum* Röding.

Drupa (Drupa) ricinus (Linnaeus)

Plate 14, figure 6

Murex ricinus Linnaeus, 1758, Systema Naturae, 10th ed., p. 750.

Drupa ricina (Linnaeus), Hirase and Taki, 1951, Handbook of illust. shells in natural colors, pl. 110, fig. 11; Demond, 1957, Pacific Sci. v. 11, p. 310; Hertlein and Allison, 1960, Veliger, v. 3, no. 1, p. 15.

A single worn specimen of this widely distributed living Indo-Pacific species was collected from the Mariana Limestone on Cabras Island off the west coast of Guam (USGS loc. 21591). The shell, USNM 175005, measures: height 16.0 mm, diameter 14,8 mm. It retains the dark spots of its original color pattern, but the spines have been greatly eroded; age, probably Pleistocene.

Subgenus MORULA Schumacher

Schumacher, 1817, Essai d'un nouveau système des habitations des vers testacés, Copenhagen, p. 227.

Type (by monotypy).—*Ricinula papillosa* Schumacher=*R. morus* Lamarck=*R. uva* Röding. Holocene, western Pacific.

Drupa (Morula) granulata (Duclos)

Plate 14, figure 7

Purpura granulata Duclos, 1832, Annales Sci. Nat., Paris, p. 9, pl. 2, fig. 9.

Purpura tuberculata Blainville, 1832, Nouvelles Annales Mus. d'Histoire Nat., v. 1, p. 204, pl. 9, fig. 3.

Morula granulata (Duclos), Demond 1957, Pacific Sci., v. 11, p. 312; Cernohorsky, 1972, Marine shells of the Pacific, v. 2, p. 127, pl. 36, fig. 2.

Characterized particularly by its large and regularly spaced knobs. Represented in the fossil collections by a single immature shell from drill hole E–1, Eniwetok, at depth of 60–70 ft; age, Holocene. The fossil, USNM 174987, measures: height 7.3 mm, diameter 4.7 mm. A worn shell was found in the Pleistocene marl on the Kere River, Santo, New Hebrides (USGS loc. 25715). The species is common and widespread in the seas today, from Africa to Hawaii.

Subgenus CRONIA H. and A. Adams

Adams, H. and A., 1832, Genera of Recent Mollusca, v. 1, p. 128.

Type (by monotypy).—*Purpura amygdala* Kiener. Holocene, Australia.

Drupa (Cronia) fiscella (Gmelin)

Plate 14, figures 8, 9

Murex fiscellum Gmelin, 1791, Systema Naturae, 13th ed., p. 3552.

Morula fiscella (Gmelin), Demond, 1957, Pacific Sci., v. 11, p. 312.

Cronia fiscillum (Gmelin), Habe, 1964, Shells of the western Pacific in color, v. 2, p. 82, pl. 26, fig. 14.

Morula (*Cronia*) *fiscella* (Gmelin), Cernohorsky, 1972, Marine shells of the Pacific, v. 2, p. 128, pl. 36, fig. 7.

A single, somewhat worn specimen was recovered from drill hole F–1 on Eniwetok at a depth of 690–700 ft; age, late Miocene (Tertiary *g*). The specimen, USNM 174988, measures: length 18.9 mm, diameter 9.7 mm. A larger specimen was collected from USGS locality 17897 on Saipan; age, probably Pleistocene. A single, incomplete shell from Maewo in the New Hebrides (USGS 24794) probably represents the species; age, Pliocene or Pleistocene. The body whorl has seven broad, noded, axial ribs that are overridden by numerous scabrous spiral cords. The outer lip bears seven strong elongate teeth. Measurements of the figured specimen, USNM 175050: height (incomplete) 24.4 mm, diameter 14.5 mm.

The species lives today throughout the Indo-Pacific region, from Africa to Hawaii.

Subgenus DRUPELLA Thiele

Thiele, 1925, Gastropoda der Deutschen Tiefsee—Exped., pt. 2, v. 17, no. 2, p. 137.

Type (by subsequent designation, Thiele, 1929, Handbuch der systematischen Weichtierkunde, teil 1, p. 295).—*Purpura ochrostoma* Blainville. Holocene, western Pacific.

Drupa (Drupella) cf. D. monilifera (Pease)

Shell small, slender, biconic, spire less than half length; whorls strongly shouldered, the part above the periphery smooth except for subdued nodular axial folds and fine oblique axial lines. Sculpture below the periphry consisting of strong spiral ribs that override nodular axial folds. Aperture elongate, posterior canal short, anterior canal long and slightly recurved; inner lip callused, bearing one or two low nodes; outer lip with three prominent nodes.

Measurements of the specimens, both incomplete: USNM 175070, height 6.5 mm, diameter 3.6 mm; USNM 175071, height 6.4 mm, diameter 3.5 mm.

D. monilifera, described by Pease as *Engina monilifera* from Hawaii (1860a, p. 142), also has been collected in the Tuamotu Islands. The two worn shells from Eniwetok appear to be identical with a Holocene specimen from Hawaii, USNM 33303, collected in Kuhio Bay in 3 fathoms of water.

Occurrence.—Two specimens from drill hole E–1, Eniwetok, at depth of 110–120 ft; age, Holocene.

Genus NASSA Roding

Röding, 1798, Mus. Boltenianum, v. 2, p. 132.

Type.—*Nassa picta* Bolten (=*Buccinum sertum* Bruguière). Holocene, Indo-Pacific.

Nassa serta (Bruguiere)

Plate 17, figure 2

Buccinum sertum Bruguière, 1789, Ency. Méthodique Histoire Nat. des Vers, v. 1, p. 262, no. 25; Reeve, 1846, Conchologica Iconica, v. 3, *Buccinum*, pl. 6, no. 42.

Jopas sertum (Bruguière), Tryon, 1880, Manual Conchology, v. 2, p. 180, pl. 55, figs. 181, 188–190.

Isopas sertum (Bruguière), Ostergaard, 1935, Bernice P. Bishop Mus. Bull 131, p. 35.

Nassa serta (Bruguière), MacNeil, 1960, U.S. Geol. Survey Prof. Paper 339, p. 64, pl. 19, fig. 8; Cernohorsky, 1967, Marine shells of the Pacific, v. 1, p. 135, pl. 29, fig. 183.

A single large shell of this widely distributed Indo-Pacific species was collected by J. E. Hoff-

meister from Haloipepe quarry on Tongatapu, Tonga (station 4 of Ostergaard—Bishop Museum Cat. No. 202956). The shell measures 55 mm in height and 28.6 mm in diameter; age, probably Pleistocene. MacNeil (1960) reported it from the Pliocene and Pleistocene of Okinawa. The species lives today from the Red Sea to Hawaii.

Genus THAIS Roding

Röding, 1798, Mus. Boltenianum, pt. 2, p. 54.

Type (by subsequent designation, Iredale, 1915, New Zealand Inst. Trans., v. 47, p. 472).—*Thais neritoides*=*Murex fucus* Gmelin=*Thais lena* Röding. Holocene, Cape Verde and Ascension Islands.

Subgenus STRAMONITA Schumacher

Schumacher, 1817, Essai d'un nouveau système des habitations des vers testacés, Copenhagen, p. 226.

Type (by subsequent designation, Gray, 1847, Zool. Soc. London Proc. pt. 15, p. 138).—*Buccinum haemostoma* Linnaeus. Holocene, eastern Atlantic.

Thais (Stramonita) sp.

"*Thais*" species Ladd, 1934, Bernice P. Bishop Mus. Bull. 119, p. 224, pl. 40, fig. 1, 2.

No additional material collected. The single specimen from the Miocene of Viti Levu (station 59) bears a general resemblance to *Thais* (*Stramonita*) *bitubercularis* Lamarck, a species that lives today in the Philippines and Indonesia. The fossil, however, is too worn to permit specific identification.

Subgenus CYMIA Morch

Mörch, 1861, Malakozoologische Blätter, v. 7, p. 98.

Type (by original designation).—*Cuma tectum* Wood. Holocene, west coast of Central America.

Thais (Cymia) aff. T. carinifera (Lamarck)

Plate 14, figure 10

Two incomplete molds from the Tagpochau Limestone of Saipan show the two revolving rows of prominent slightly uptilted tubercles that characterize *T. carinifera* Lamarck but differ from that species in that one of the secondary spirals between the two rows of the tubercles is larger than the others and is strongly beaded.

Measurements of the incomplete mold, USNM 175004, from which the figured cast was made: height 32 mm, diameter 25 mm.

Occurrence.—Inequigranular facies of the Miocene Tagpochau Limestone at USGS locality 17904, Saipan, Mariana Islands.

The living species, *T.* (*C.*) *carinifera* (Lamarck) has been collected in many western Pacific areas, including the Philippines, Australia, and Indonesia and in the western Indo-Pacific from India and the Red Sea. It has also been reported as a fossil from the Pliocene and Quaternary of Java and the Pliocene of Timor (Vlerk, 1931, p. 238, as *Purpura carinifera* Lamarck).

Family MAGILIDAE

Genus CORALLIOPHILA H. and A. Adams

Adams, H. and A., 1853, Genera of Recent Mollusca, v. 1, p. 135.

Subgenus CORALLIOPHILA s. s.

Type (by subsequent designation, Iredale, 1912, Malacolog. Soc. London Proc., v. 10, p. 221).—*Murex neritoideus* Chemnitz=*Purpura violacea* Kiener. Holocene, Pacific.

Coralliophila (Coralliophila) sp.

Plate 14, figure 11

A single small immature shell has characters that appear to distinguish it from described species. It is biconic in form with strong axial folds that form rounded nodes at the periphery and below; six such nodes present on the periphery of the last whorl. Fine, closely set scaly spiral cords cover the shell surface; narrow discontinuous spiral streaks of brown occur in the low areas between nodes on the axial folds. Aperture elongate-ovate; anterior canal short. Measurements of the figured specimen, USNM 175014: height 6.7 mm, diameter 4.1 mm.

Occurrence.—Drill hole E–1, Eniwetok at a depth of 40–45 ft; age, Holocene.

Subgenus PSEUDOMUREX Monterosato

Monterosato, 1872, Notizie intorno Conchiglie Fossili, p. 15.

Type (fide Wenz, 1938, Handbuch Paläozoologie, v. 6, pt. 1, p. 1131).—*Murex bracteata* Brocchi. Pliocene, Italy.

Coralliophila (Pseudomurex) macneili Ladd, n. sp.

Plate 14, figures 12, 13

Medium in size, biconic; protoconch incomplete, apparently composed of smooth whorls; spire made up of 5½ turreted whorls; aperture lenticular, extended anteriorly into a wide, short canal that is bent backward; aperture and canal combined exceed length of spire; inner lip callused, detached anteriorly where it borders a narrow, shallow groove; outer lip curved inward over a low internal ridge that bears three indistinct transverse elevations posteriorly. Sculpture consists of strong axial folds, 12 on body whorl, that are overridden by strong scaly spiral ribs, best developed below the shoulder where two, stronger than the others, are beaded as they cross the axials; above the shoulder, the spiral ribs

are weaker and more scaly; on the base, the spirals are strong and coarsely scaly.

Measurements of the holotype and only specimen, USNM 175035: height 15.9 mm, diameter 7.7 mm.

C. (P.) macneili, characterized particularly by the scaly areas above the shoulder and on the base, does not appear to be very closely related to other described species. It is named for F. Stearns MacNeil who studied the Cenozoic fossil molluscan faunas of the Ryukyu Islands.

Occurrence.—A single specimen from drill hole F–1 on Eniwetok at a depth of 700–710 ft; age, late Miocene (Tertiary *g*).

Coralliophila (Pseudomurex) bayeri Ladd, n. sp.

Plate 15, figures 1, 2

Medium in size, biconic; protoconch consisting of about three slightly convex smooth whorls, followed by 3½ sculptured whorls; whorls of spire turreted by an elevated band bearing three prominent spiral ribs; above the uppermost of these primary spirals, the surface of the whorl is flattened in profile but made irregular by strongly elevated axial ribs, nine on body whorl, that continue through the belt of primary spirals but become less conspicuous on the lower part of the body whorl; secondary spirals occur between the primary spirals and over the remainder of the shell; all spirals with closely set curved scales. Aperture elongate-ovate, its length exceeding that of the spire; inner lip callused, detached anteriorly where it borders a deep grove; anterior canal slightly bent backward; outer lip constricted, smooth within.

Measurements of the holotype, USNM 175068: height 11.9 mm, diameter 6.2 mm.

C. bayeri is closely related to *C. macneili* described above but is more strongly turreted than that species, has fewer axials, and is more scaly; the anterior canal of *C. bayeri* is less strongly bent backward than that of *C. macneili,* and its outer lip is smooth within.

C. bayeri is named for Dr. F. M. Bayer who collected and studied the living corals and other shallow-water organisms of Palau.

Occurrence.—Five specimens from the marls that lie at the base of the Palau Limestone (USGS locs. 21301 and 21308) on Goikul peninsula, Babelthuap, Palau; age, late Miocene (Tertiary *g*). *C. macneili,* closest relative to *C. bayeri,* occurs in the upper Miocene beds drilled beneath Eniwetok, Marshall Islands.

Subgenus FUSOMUREX Coen

Coen, 1922, Soc. Italiana Sci. Nat., Atti, Pavia, v. 61, p. 69.

Type (by original designation).—*Purpura alucoides* Blainville. Holocene, Mediterranean.

Coralliophila (Fusomurex) sp. A

Plate 15, figure 3

Shell small, biconic, the whorls strongly angulated, suture lightly impressed; aperture ovate, extended anteriorly as a moderately long canal; inner lip detached anteriorly where it is bordered by a deep cleft. Sculpture consisting of broad, slightly retracted axial folds, six on the body whorl, that are covered below the periphry by closely set spiral ribs; above the peripheral angulation, the surface of the whorl is nearly smooth, showing only fine lines of growth and traces of spiral ribs.

Measurement of the figured specimen, USNM 174993; height 12.3 mm, diameter 7.6 mm.

Coralliophila (Fusomurex) sp. A. is characterized by the comparative smoothness of its shell surface and the uniformity of its fine spiral ribbing. The Eniwetok fossils probably represent an undescribed form, but the specimens are somewhat worn, and neither of the two is acceptable as a holotype.

Occurrence.—Figured specimen from drill hole F–1, Eniwetok at depth of 850–860 ft; age, late Miocene (Tertiary *g*). A second slightly smaller shell from drill hole K–1B at depth of 890–905 ft; age, early Miocene (Tertiary *f*).

Coralliophila (Fusomurex) sp. B.

Plate 15, figure 4

Shell small, slender, biconic; protoconch consisting of about three smooth convex whorls, set at a slight angle to the axis of spire. Whorls of spire strongly shouldered; on the exposed body whorl the shoulder is made up of three primary spirals, the middle spiral forming the periphry, and is separated from the primary spiral above by a depression holding a single secondary spiral; the middle primary spiral is separated from the lowest primary by a groove holding two secondary spirals; below, on the base, are three primary spirals and intervening secondary spirals. The part of the whorl above the shoulder is relatively smooth, but the surface is made undulating by eight wide rounded oblique axial folds; traces of secondary spirals and fine oblique growth lines are visible under magnification. Axial folds continue across lower part of whorl. Aperture elongate-ovate, extending anteriorly as a long and slightly reflected canal; at the base of the columella is a deep cleft.

Measurements of the figured specimen, USNM 175069: height 10.2 mm, diameter 5.0 mm.

Coralliophila (*Fusomurex*) sp. B is more slender than *C.* (*F.*) sp. A described above and has an entirely different pattern of spiral sculpture. It bears a general resemblance to *C.* (*F.*) *shimajiriensis* described by MacNeil (1960, p. 65, pl. 3, figs. 6, 12) from the upper Tertiary of Okinawa but is less strongly shouldered. The Eniwetok fossil seems to represent an undescribed species, but the single specimen is immature, somewhat worn, and not suitable as a type.

Occurrence.—Drill hole E–1, Eniwetok at depth of 880–890 ft; age, early Miocene (Tertiary *f*).

Genus LATIAXIS Swainson

Swainson, 1840, Treatise on malacology, p. 306.

Type (by subsequent designation, Gray, 1847, Zool. Soc. London Proc., v. 15, p. 135).—*Pyrula mawae* Gray. Holocene, Indo-Pacific.

Subgenus LATIMUREX Coen

Coen, 1922, Soc. Italiana Sci. Nat. Atti., Pavia, v. 61, p. 70.

Type (by original designation).—*Murex meyendorffii* Calcara. Holocene, Mediterranean.

Latiaxis (Latimurex) inflata (Dunker)

Plate 15, figure 5

Fusus inflatus Dunker, 1847 *in* Philippi, R. A., Abbildungen Conchylien, v. 2, p. 193, pl. 4, fig. 2.

Coralliophila inflata (Dunker), Tryon 1880, Manual Conchology, v. 2, p. 209, pl. 66, fig. 377.

Medium in size, whorls inflated but lacking a distinct peripheral keel, apical angle about 65°, aperture broadly ovate, lirate within; siphonal canal moderately long, bordered by a deep umbilical cleft. Sculpture consisting of closely spaced, erect, scaly spiral ribs that are uniform in size on the spire but less regular on the body whorl where some are larger than others and where a few secondary spirals appear; spiral ribs override broad axial folds of which there are 10 on the body whorl; folds angled anteriorly on the upper part of the whorl. The single fossil is somewhat worn, and the scales of the ribs are preserved only in protected interstices.

Measurements of the specimen, USNM 174992: height 18.8 mm, diameter 12.4 mm.

Occurrence.—A single specimen from drill hole F–1, Eniwetok, at a depth of 690–700 ft; age, late Miocene (Tertiary *g*). The species was described from the sea off Java. The Hirase Collection at the U.S. National Museum contains two specimens (No. 344213) collected from Kii, off Honshu, Japan.

Latiaxis (Latimurex) sp. A

Plate 15, figure 6

Medium in size, fusiform, apical angle slightly more than 40°; whorls strongly convex but without a distinct keel at the periphery. Sculpture consisting of closely spaced, erect scaly spiral ribs, about 15 on the penultimate whorl; traces of spiral threads appear between some of the spiral ribs; broadly rounded axial ridges present on all whorls, 8 on the penultimate whorl; siphonal canal long and slightly recurved.

Measurements of the incomplete figured specimen, USNM 174991: height 30.0 mm, diameter 11.3 mm.

The Bikini fossil appears to be most closely related to *Latiaxis* (*Latimurex*) *costularis* (Lamarck), an Indo-Pacific Holocene species, but is more slender and has more strongly convex whorls and stronger axials than that species. The Bikini shell is smaller than the western Pacific living species *Latiaxis fearnleyi* Emerson and d'Attilio (1965), has stronger axials, more inflated whorls, and lacks the spiny peripheral keel present on that species. *Coralliophila jeffreysii* Smith (1879, p. 213, pl. 20, fig. 98), a living species described from Japan, has coarser sculpture than the Bikini shell and is proportionately much wider.

Occurrence.—The single incomplete fossil was obtained from the base of a core in drill hole 2A, Bikini, at a depth of 935.5 ft; age, late Miocene (Tertiary *g*). The fossil is a well-worn shell, and parts of the exposed inner surface are encrusted with vermetid tubes. The slender shell seems clearly to represent an undescribed species but is too incomplete to be designated a type specimen.

Genus CORALLIOBIA H. and A. Adams

Adams, H. and A., 1853, Genera of Recent Mollusca, v. 1, p. 138.

Type (by monotypy).—*Concholepas fimbriata* A. Adams. Holocene, Philippine Islands.

Subgenus QUOYULA Iredale

Iredale, 1912, Malacolog. Soc. London Proc. v. 10, p. 221.

Type (by original designation).—*Purpura monodonta* Quoy and Gaimard (=*P. monodonta* Blainville). Holocene, Tonga.

Coralliobia (Quoyula) monodonta (Blainville)

Plate 15, figure 7

Purpura monodonta Blainville, 1832, *ex* Quoy and Gaimard Ms., Mus. d'Histoire Nat. Paris, Nouv. Annales, v. 1, p. 241; Quoy and Gaimard, 1833, Voyage de l'Astrolobe, Zoology, v. 2, p. 561, pl. 37, figs. 9, 10.

Quoyula monodonta (Blainville), Demond, 1957, Pacific Sci. v. 11, no. 3, p. 316; Keen. 1971, Sea shells of tropical west America, p. 548, fig. 1072.

Coralliobia (*Quoyula*) *monodonta* (Blainville), Kira, 1962, Shells of the western Pacific in color, v. 1, p. 68, pl. 26, fig. 1.

This species that lives on living coral is represented in the fossil collections by a single small shell, USNM 174990, that measures: height 7.3 mm, diameter 4.7 mm. It shows the characteristic single tooth at the base of the columella.

Occurrence.—Drill hole Mu–4, Eniwetok, at depth of 35.5–36 ft; age, Holocene. The species lives today throughout the Indo-Pacific and eastward to the shore of the Pacific, off Mexico and Panama.

Genus MAGILUS Montfort

Montfort, 1812, Conchyliologie Systématique v. 2, p. 42.

Type (by monotypy).—*Magilus antiquus* Montfort. Holocene, Indian Ocean.

Magilus antiquus Montfort

Plate 15, figures 8–10

Magilus antiquus Montfort, 1810, Conchyliologie Systématique, v. 2, p. 42; Demond, 1957, Pacific Sci., v. 11, no. 3, p. 316, fig. 25.

Medium in size with a low spire and a large globose body whorl; outer lip thin, slightly contracted below; columella sigmoid; inner lip callused below and extended into a short spout-like canal. Sculpture consisting of scaly axial lamellae that are best developed on the lower part of the outer lip where they are erect and wavy, their crenulations giving rise to a rude spiral sculpture.

Measurements of the figured specimen, USNM 650627: height 17.7 mm, diameter 17.2 mm.

The single fossil example of this coral-dwelling snail was found free of coral in a conglomeratic bed that also carried colonies of reef coral.

Occurrence.—Station 160, Walu Bay, Viti Levu, Fiji; age, early Miocene (Tertiary *f*). The species lives in the Indian Ocean (Mauritius, Ceylon, Cocos-Keeling), Indonesia, Japan, northern Australia, New Caledonia, the Marianas and Hawaii. Martin (1879–1880, p. 77) reported the species from the Miocene of Java.

Family COLUMBELLIDAE

Genus COLUMBELLA Lamarck

Lamarck, 1799, Prodrome d'une nouvelle classification des coquilles, Soc. Histoire Nat. Paris Mém., 1, p. 70.

Subgenus COLUMBELLA s. s.

Type (by monotypy).—*Voluta mercatoria* Linnaeus. Holocene, West Indies.

Columbella pardalina Lamarck

Plate 15, figure 11

Columbella pardalina Lamarck, 1822, Animaux sans vertèbres, v. 7, p. 295; Tryon, 1883, Manual Conchology v. 5, p. 108, pl. 44, figs. 59–74; pl. 45, fig. 75.

Pyrene pardalina (Lamarck), Hatai, 1941, Japan Tropical Inst. South Sea Islands, Bull. 7A, p. 138, pl. 28, figs. 4, 7.

Shells of this abundant and widely distributed Indo-Pacific species were found in upper Miocene and younger beds under Eniwetok and in Pliocene limestone in Fiji. The figured specimen, USNM 175012, from F–1, Eniwetok at 740–750 ft, measures: height 11.8 mm, diameter 5.3 mm.

Occurrence.—Ten specimens from drill hole F–1 on Eniwetok at depths of 680–860 ft; age, late Miocene (Tertiary *g*). One specimen in drill hole E–1 at depth of 35–40 ft; age, Holocene. Two specimens from the Ndalithoni Limestone at station 110B, Vanua Mbalavu, Fiji; age, Pliocene (Tertiary *h*). The species lives today throughout the western Pacific, in Indonesia, and in parts of the Indian Ocean.

Genus EUPLICA Dall

Dall, 1889, Mus. Comp. Zoology Bull., v. 18, p. 187.

Type (by original designation).—*Columbella turturina* Duclos=*C. turturina* Lamarck. Holocene, Philippine Islands.

Euplica turturina (Lamarck)

Plate 15, figures 12, 13

Columbella turturina Lamarck, 1822, Animaux sans vertèbres, v. 7, p. 296; Tryon, 1883, Manual Conchology, v. 5, p. 109, pl. 45, figs. 80–82; Demond, 1957, Pacific Sci. v. 11, p. 317, fig. 26.

Columbella (Euplica) turturina Duclos, Dall, 1889, Mus. Comp. Zoology Bull. v. 18, p. 187.

Columbella turturina borealis Pilsbry, 1904, Acad. Nat. Sci. Philadelphia Proc., p. 13.

Seventeen specimens of the heavy-shelled, subglobose type of *Euplica* were recovered from a total of eight drill holes on Bikini and Eniwetok at depths ranging from 12 to 253 ft; all are Quaternary in age. The figured specimen, USNM 175007, from drill hole 2A, Bikini, at a depth of 242–253 ft, measures: height 10.3 mm, diameter 8.2 mm.

Pilsbry, in studying shell collections from Japan, recognized a race that was smaller and less inflated than the typical *C. turturina*. He noted that the Japanese shells also had a narrower aperture. A total of 13 specimens from 3 drill holes on Eniwetok at depths from 21 to 90 ft seem to fall within the limits set by Pilsbry, but the small shells occur with some larger inflated shells that appear to be typical examples of *C. turturina*. One of the smaller shells, USNM 175009, is figured (pl. 15, fig. 13); it measures: height 8.2 mm, diameter 5.1 mm. Pilsbry's subspecies has been placed in synonymy.

Single specimens from the Mariana Limestone at at USGS localities 20732 and 21373 on Guam are Pliocene or Pleistocene in age; a third specimen

from USGS locality 21380 on the same island is from the Alifan Limestone, age, late Miocene (Tertiary *g*) or Pliocene (Tertiary *h*). The species lives today throughout the Indo-Pacific area.

Euplica varians (Sowerby)

Plate 15, figure 14

Columbella varians Sowerby, 1832, Zool. Soc. London Proc., p. 118, Reeve, 1858, Conchologica Iconica, v. 11, *Columbella*, pl. 17, fig. 91; Tryon, 1883, Manual Conchology, v. 5, p. 110, pl. 45, figs. 97–99.

Euplica varians (Sowerby). Habe, 1964, v. 2 *of* Kira and Habe, Shells of the western Pacific in color, p. 89, pl. 28, fig. 32.

Shell small, biconic, thick; aperture narrow, sinuous, longer than the spire, denticulated within; sculpture variable, on most shells, consisting of axial folds that become obsolete below and fine spiral grooves.

Measurements of the figured specimen, USNM 175019, drill hole E–1, Eniwetok, at a depth of 30–40 ft: height 6.6 mm, diameter 3.8 mm.

Occurrence.—Fourteen specimens from five drill holes on Eniwetok at depths of 2–212 ft; age, Holocene. A single specimen from drill hole 2B on Bikini from a depth of 2,461–2,472 feet has an indicated age of early Miocene (Tertiary *e*), but the shell is worn and may have been derived from younger beds. The species was first described from the Galapagos but was later found living in Hawaii and in many parts of the western Pacific, including the Marshall Islands. Some fossils were found in the Quaternary beds drilled on Midway.

Euplica aff. E. varians (Sowerby)

Plate 15, figure 15

A single shell from the upper Miocene beds drilled on Eniwetok differs considerably from the many specimens of *E. varians* obtained from Holocene rocks in Eniwetok drill holes. The Miocene specimen is larger, stouter, and its broad axial folds extend entirely across the body whorl. The specimen, USNM 175060, measures: height 10.1 mm, diameter 6.1 mm. It may represent an undescribed species, but the single specimen is somewhat worn.

Occurrence.—Drill hole F–1, Eniwetok, at a depth of 730–740 ft; age, late Miocene (Tertiary *g*).

Genus LAVESOPUS Iredale

Iredale, 1929, Queensland Mus. Mem., v. 9, pt. 3, p. 289.

Type (by original designation).—*Columbella cumingii* Reeve. Holocene, Philippines.

Lavesopus eniwetokensis Ladd, n. sp.

Plate 16, figure 1

Medium in size, fusiform; protoconch consisting of about two smooth convex whorls, followed by six whorls that make up a flatsided spire; first four whorls of spire bear fine axial ribs; last two whorls smooth and slightly inflated. Aperture lenticular, less than half the length of the shell, notched above and recurved below; outer lip slightly thickened, dentate within; base of body whorl spirally grooved.

Measurements of the holotype, USNM 175013, from drill hole F–15–C, Eniwetok, at a depth of 39–42 ft: height 9.1 mm, diameter 3.2 mm.

L. eniwetokensis closely resembles *L. cumingii*, type of the genus, but is proportionately shorter and has a longer aperture.

Occurrence.—A total of nine specimens from three drill holes on Eniwetok at depths of 30–120 ft; age, Holocene.

Genus ZAFRONA Iredale

Iredale, 1916, Malacolog. Soc. London Proc., v. 12, p. 32.

Type (by original designation).—*Columbella isomella* Duclos. Holocene, western Pacific.

Zafrona lifuana (Hervier)

Plate 16, figure 2

Columbella lifuana Hervier, 1899, Jour. Conchyliologie, v. 47, p. 358, pl. 13, fig. 6.

Zafrona lifuana (Hervier), Habe, 1964, v. 2 *of* Kira and Habe, Shells of the western Pacific in color, p. 87, pl. 28, fig. 17.

Small to medium in size, fusiform, moderately inflated. Protoconch of 3½ smooth whorls followed by 5½ sculptured whorls. Aperture about one-third of length of shell, subrectangular in outline; outer lip thickened, denticulate within; inner lip erect, with a few low denticles inside. Sculpture consisting of many, regularly spaced axial ribs that are overridden by finer closely set spirals.

Measurements of the figured specimen from Eniwetok, USNM 175010: height 9.5 mm., diameter 3.6 mm.

Z. lifuana is more slender than the type of the genus, *Z. isomella* (Duclos) (1840, pl. 9, figs. 7, 8) and has more strongly inflated whorls.

Occurrence.—A single fossil from drill hole E–1, Eniwetok, at a depth of 30–40 ft and a second from drill hole 1, Bikini, at depth of 40 ft; age, Holocene. The species was described from the Loyalty Islands but also lives in Japan.

Genus GRAPHICOMASSA Iredale

Iredale, 1929, Queensland Mus. Mem., v. 9, pt. 3, p. 289.

Type (by original designation).—*Columbella ligula* Duclos. Holocene, western Pacific.

Graphicomassa ligula (Duclos)

Plate 16, figure 3

Columbella ligula Duclos, 1840, Histoire nat. de . . . Coquilles Univalves Marines, Columbelle, pl. 11, figs. 11–16; Tryon, 1883, Manual Conchology, v. 5, p. 119, pl. 47, fig. 55.

Graphicomassa ligula (Duclos), Iredale, 1929 Queensland Mus. Mem., v. 9, pt. 3, p. 289.

Medium in size, spindle-shaped, suture slightly excavated as viewed from above; aperture narrow, elongate, extending for about half the length of the shell; inner lip callused and denticulate, detached below; outer lip thick, crenulate within. Traces of three discontinuous bands of brown are retained on body whorl, only the uppermost band showing on earlier whorls.

Measurements of the figured specimen, Academy of Natural Sciences Philadephia Geology No. 31515: height 17.6 mm, diameter 6.9 mm.

Occurrence.—The single specimen collected by H. G. Richards from station RB32 on Viti Levu, Fiji, appears to be the first fossil occurrence of the genus; age, probably Pliocene (Tertiary *h*). The species lives today in many western Pacific island groups from Australia and Indonesia eastward to Tonga and the Marshall Islands.

Graphicomassa sp.

A single shell from the Pliocene Ndalithoni Limestone on Vanua Mbalavu (station 110B) in Fiji resembles the above-described type species of *Graphicomassa* but is larger, has slightly inflated whorls, and a wider aperture at the posterior end, of which a ridge on the columellar wall faces a tooth on the outer lip to form a channel. Measurements of the specimen, USNM 175018: height 20.0 mm, diameter 8.0 mm.

Genus ANACHIS H. and A. Adams

Adams, H. and A., 1853, Genera of Recent Mollusca, v. 1, p. 184.

Type (by subsequent designation, Tate, 1868, Appendix to second edition of Woodward's Manual of the Mollusca, p. 13).—*Columbella scalarina* Sowerby. Holocene, west coast of Mexico to Panama.

Subgenus COSTOANACHIS Sacco

Sacco, 1890, I Molluschi dei Terreni Terziarii del Piemonte e della Liguria, pt. 6, p. 57.

Type (by subsequent designation, Pace, 1902, Malacolog. Soc. London, Proc., v. 5, p. 43).—*Columbella* (*Anachis*) *turrita* Sacco. Miocene, Italy.

Anachis (Costoanachis) winradi Ladd, n. sp.

Plate 16, figures 4, 5

Shell minute, fusiform; protoconch smooth, globular, slightly more than one whorl, followed by four whorls that make a flatsided spire; suture lightly impressed; aperture elongate, less than half the height of shell, moderately wide, notched posteriorly; columella nearly straight, inner lip callused, erect, dentate within; outer lip thickened posteriorly, extended over the aperture in the midsection, dentate within. Sculpture consisting of strong axial ribs on the posterior half of the body whorl and, on some shells, the anterior part of the penultimate whorl; the younger half of the body whorl and the whorls of the spire are free of axial ribs; strong spiral grooves are present on the lower part of the body whorl.

Measurements of the holotype from Palau, USNM 175023: height 3.5 mm, diameter 1.4 mm. The slightly worn figured specimen from Bikini, USNM 175024 measures: height 2.8 mm, diameter 1.3 mm.

A. winradi does not appear to be closely related to any described species. It bears a general resemblance to the much larger west Atlantic Holocene species, *A. avara* (Say), but there are many differences in sculpture and in apertural features.

This species is named, with syllables reversed, for Dr. George Radwin who has recently completed a comprehensive review of the columbellids of the Western Atlantic.

Occurrence.—Represented by more than 30 specimens from USGS locality 21304 and more than a dozen from USGS locality 21301. Goikul Peninsula, Babelthuap, Palau; age, late Miocene (Tertiary *g*). One specimen from drill hole 2B, Bikini, at a depth of 1,177–1,188 ft, age early Miocene (Tertiary *e*).

Anachis (Costoanachis) rewaensis Ladd, n. sp.

Plate 16, figures 6, 7

Shell small, biconic, stout. Protoconch of three smooth slightly convex whorls coiled at an angle to the axis of the spire, followed by three flattened whorls that bear strong, rounded, slightly oblique axial ribs; ribs become obsolete on body whorl except on the upper part of the whorl near the aperture. Suture incised, aperture wide, subrectangular, less than half of the length of the shell; outer lip thickened, dentate within; anterior canal wide, short.

Measurements of the holotype (only specimen), USNM 175022: height 4.7 mm, diameter 2.2 mm.

A. rewaensis is larger than *A. winradi*, previously described, and the whorls of its spire are ribbed; those of *A. winradi* are smooth.

Occurrence.—Waindina Sandstone of the Suva Group at station C831, Viti Levu, Fiji; age, probably Pliocene (Tertiary *h*).

Anachis (Costoanachis) lauensis Ladd, n. sp.

Plate 16, figure 8

Small, fusiform, stout; protoconch unknown; spire consisting of about five whorls, the first three bearing low, regularly spaced axial ribs; remaining whorls smooth except for strong spiral grooves at the base of the body whorl; suture lightly impressed; aperture as long as remainder of spire; inner lip heavily callused, its margin erect, dentate within; outer lip thickened, dentate within, notched posteriorly.

Measurements of the holotype (only specimen), USNM 175021: height 7.2 mm, diameter 3.2 mm.

Occurrence.—Ndalithoni Limestone, Station 110B, Vanua Mbalavu, Fiji; age, Pliocene (Tertiary *h*).

Subgenus ZAFRA A. Adams

Adams, A., 1860, Annals and Mag. Nat. History, ser. 3, v. 6, p. 331.

Type (by monotypy).—*Zafra mitriformis* A. Adams. Holocene, Japan.

Anachis (Zafra) smithi (Angas)

Plate 16, figure 9

Columbella (*Anachis*) *smithi* Angas, 1877, Zool. Soc. London, Proc., p. 172, pl. 26, fig. 7.

Columbella (*Seminella*) *lentiginosa* Reeve, Tryon, 1883, Manual Conchology, v. 5, p. 170, pl. 57, figs. 22, 23.

Small, ovately fusiform, solid. Whorls six, the first two or three convex and glassy, forming the protoconch; remaining whorls bearing strong axial ribs that may become obsolete on the last part of body whorl; base of body whorl with strong spiral grooves. Aperture, elongate, less than half the height of the shell; outer lip thickened, dentate within; anterior canal short, slightly recurved.

Measurements of the figured specimen, USNM 175016, from drill hole A–1, Eniwetok, at depth 136.5–138 ft: height 3.8 mm, diameter 1.2 mm.

Anachis smithi is closely related to another Holocene species, *A. virginea* (Gould), but that species has a narrower and proportionately longer aperture that is made slightly sinuous by an extension of the midsection of the outer lip. Both species show variation in the ratio of height to diameter and in the tendency to develop a weak shoulder immediately below the suture. Both species still live.

Occurrence.—A dozen specimens from four drill holes on Bikini at depths from 5 to 632 ft; three specimens from three drill holes on Eniwetok at depths of 2 to 840 ft. Age of all fossils, post-Miocene except one specimen from F–1, Eniwetok, at a depth of 830–840 ft which is late Miocene (Tertiary *g*). The species lives today in Australian waters and was found in abundance in Holocene sediments on Midway Atoll in Hawaii.

Genus PYRENE Roding

Röding, 1798, Mus. Boltenianum: Hamburg, Johan Christi, v. 2, p. 134.

Type (by monotypy).—*Pyrene rhombiferum* Röding (=*Buccinum punctatum* Bruguière =*Voluta discors* Gmelin). Holocene western Pacific.

Pyrene obtusa (Sowerby)

Plate 16, figure 10

Columbella obtusa Sowerby, 1832, Zool. Soc. London Proc., p. 117; Reeve, 1858, Conchologica Iconica, v. 11, *Columbella*, pl. 16, fig. 85; Tryon, 1883, Manual Conchology, v. 5, p. 181, pl. 59, figs. 59, 60.

Medium in size, stout, biconic, with an apical angle of about 50°. Acuminate tip of shell made up of a protoconch composed of two smooth convex whorls followed by four whorls, each with a strong spiral rib above and well-developed axial ribs below; remaining whorls of the spire smooth except for spiral ribs at the base of the body whorl. Suture slightly excavated; aperture longer than remainder of whorl; margin of inner lip erect; outer lip notched anteriorly and dentate within.

Measurements of the figured specimen, USNM 175008: height 12.7 mm, diameter 5.9 mm.

Occurrence.—The single fossil is a well-preserved shell from drill hole E–1, Eniwetok, at a depth of 60–70 ft; age, Holocene. The living species was first collected from the Society Islands but has since been found in many western Pacific groups, including the Marshalls and the Marianas.

Genus MITRELLA Risso

Risso, 1826, Histoire naturelle des principales productions de l'Europe méridionale, v. 4, p. 247.

Type (by subsequent designation, Cox, 1927, Neogene and Quaternary Mollusca from the Zansibar Protectorate p. 28). — *Mitrella flamanea* Risso (=*Murex scriptus* Linnaeus). Holocene, eastern and Mediterranean.

Mitrella sagitta (Gaskoin)

Plate 16, figure 11

Columbella sagitta Gaskoin, 1851, Zool. Soc. London Proc., p. 10; Reeve, 1859, Conchologica Iconica, v. 11, *Columbella*, pl. 28, fig. 180; Tryon, 1883, Manual Conchology, v. 5, p. 145, pl. 52, figs. 83, 84.

A small slender shell made up of seven to eight smooth whorls; the first two are slightly convex and

form the small protoconch; whorls of spire nearly flat; suture linear; aperture short; anterior canal wide; outer lip thickened near its margin, dentate within.

Measurements of the figured specimen: USNM 175017 from drill hole F–1, Eniwetok, at a depth of 830–840 ft, height 8.0 mm, diameter 3.4 mm.

A few of the younger fossils retain traces of axial streaks of brown that are similar to patterns shown by some of the shells of living examples.

Occurrence.—A total of 30 specimens from 7 drill holes on Eniwetok at depths ranging from the surface to 947 feet; age, Holocene to early Miocene (Tertiary *f*). Three specimens from three drill holes on Bikini at depths from 115 to 1,100 ft; age, Holocene and Miocene (Tertiary *f* and *e*). The species lives today in Hawaii, the Marshall Islands, and other island groups in the western Pacific.

Mitrella gonzabuensis MacNeil

Plate 16, figure 12

Mitrella gonzabuensis MacNeil, 1960, U.S. Geol. Survey Prof. Paper 339, p. 67, pl. 67, pl. 3, fig. 13.

Well-preserved shells from the Pliocene marls of Fiji are identical with shells described by MacNeil from lithologically similar beds of Miocene age on Okinawa. MacNeil stated "protoconch unknown," but one of his three specimens retains a smooth convex protoconch of about one whorl that appears the same as a protoconch shown by the only Fijian shell that retains the apex. On the largest shell in the Fijian collection, low axials are developed on the lower whorls, especially the penultimate whorl. The trace of a median color band retained on MacNeil's holotype also retains traces of a light subsutural band, and a comparable band occurs on the Fijian shells.

Measurements of the figured specimen, USNM 175026: height 7.3 mm, diameter 2.8 mm.

Occurrence.—Eight specimens from station 817, Vanua Levu, Fiji; age, Pliocene (Tertiary *h*); a worn shell from the Pliocene Ndalithoni Limestone of station 110B, Vanua Mbalavu, Fiji, probably represents the same species. MacNeil's Okinawan specimens came from the Miocene Yonobaru Clay Member of the Shimijiri Formation.

Mitrella oweni Ladd, n. sp.

Plate 16, figure 13

Shell medium in size, biconic, with an acuminate spire made up of about nine whorls; suture impressed; aperture narrow, about equal in length to the spire; outer lip thick, with about a dozen strong denticles and several weaker ones within; columella denticulate below; sculpture consisting of inconspicuous lines of growth and strong spiral grooves at the base of the body whorl. Traces of two series of chevron-shaped brown lines are discernible on the body whorl of some specimens.

Measurements of the holotype, USNM 175048; height 17.3 mm, diameter 7.8 mm.

M. oweni closely resembles *Columbella bandungensis* described by Martin (1880, p. 30, pl. 6, fig. 7; 1895, p. 118, pl. 18 figs. 263–269) from the Miocene and Pliocene of Java, but that species has a much shorter spire. Among living species, *M. oweni* seems closest to *M. yorkensis* (Crosse) from the waters off York Peninsula, Queenland, Australia, but that species has a longer and less acuminate spire and may have fine spiral lines not present on *M. oweni.*

This species is named for Robert O. Owen, staff entomologist in Palau, who was of great help in planning my fieldwork in Palau.

Occurrence.—Represented by many shells from USGS localities 21301, 21304, and 21308; marls at the base of the Palau Limestone; age, late Miocene (Tertiary *g*).

Mitrella sp. A

Plate 16, figure 14

Shell large for the genus, elongate, slender; protoconch of a single convex, smooth whorl followed by 10 smooth flattened whorls, the last two very gently convex; suture lightly impressed; aperture lenticular, less than half the length of shell, extended anteriorly to form a short straight canal; outer lip thickened by a broad varix; base of body whorl with coarse spiral grooves. The shell retains traces of regularly spaced narrow light-colored axial bands.

Measurements of the figured specimen, USNM 175020: height 15.0 mm, diameter 5.2 mm.

This is the largest *Mitrella* in the island fossil collections. It bears a general resemblance to *M. gonzabuensis* MacNeil (1960, p. 67, pl. 3, fig. 13) from the Miocene of Okinawa, but that smaller species has a shorter anterior canal and bears elongate denticles inside the outer lip.

Occurrence.—A single imperfect specimen from station 817, Vanua Levu, Fiji; age, Pliocene (Tertiary *h*).

Genus ZEMITRELLA Finlay

Finlay, 1926, New Zealand Inst. Trans., v. 57, p. 431.

Type (by original designation).—*Lachesis sulcata* Hutton. Holocene, New Zealand.

Zemitrella bikiniensis Ladd, n. sp.

Plate 16, figure 15

Shell minute, fusiform, stout; protoconch consisting of about two smooth convex whorls, followed by four gently convex whorls; suture deeply impressed, giving the whorls a slight shoulder; aperture elongate, slightly sinuous, less than half the length of the shell; outer lip thickened, notched posteriorly, dentate within; inner lip with a moderately heavy callus; anterior canal short; shell smooth except for weak spirals at the base of the body whorl.

Measurements of the holotype, USNM 175025: height 3.7 mm, diameter 1.4 mm.

Z. bikiniensis seems most closely related to *Z. laevigata* (Suter), a Holocene species from New Zealand (Suter, 1913, p. 439; 1915, pl. 19, fig. 24), but *Z. laevigata* has a more lenticular aperture, and the oblique fold at the base of the columella is more prominent.

Occurrence.—Holotype and only specimen from drill hole 2A on Bikini at a depth of 852–857 ft; age, late Miocene (Tertiary *g*).

Family BUCCINIDAE

Genus SIPHONALIA A. Adams

Adams, A., 1863, Annal and Mag. Nat. History, 3d ser., v. 11, p. 202.

Type (by subsequent designation, Cossmann, 1889, Coquilles fossiles de l'Eocene . . . de Paris, v. 4, p. 153).—*Buccinum cassidariaeformis* Reeve. Holocene, Japan.

Siphonalia subspadicea MacNeil

Plate 16, figure 16

Siphonalia subspadicea MacNeil, 1960, U.S. Geol Survey. Prof. Paper 339, p. 69, pl. 13, figs. 15, 16.

A single specimen that lacks the upper whorls of the spire is identical in all important features with the Okinawan species. On the Fijian shell, the spiral lirations, both primary and secondary, are more sharply elevated than on the Okinawan examples.

Measurements of the Fijian fossil, USNM 650630: height (incomplete) 19.3 mm, diameter 12.3 mm.

Occurrence.—Station 817, Vanua Levu, Fiji; age, Pliocene (Tertiary *h*). Two molds from USGS locality 20568 on Guam probably represent this same species: age, Mariana Limestone (Pliocene and Pleistocene). MacNeil's Okinawan specimens were obtained from the Pliocene (Chinen Sand).

Siphonalia aff. S. stearnsii Pilsbry

Plate 16, figure 17

The following description is based on two specimens, neither of which has a complete spire or an unbroken anterior canal.

Shell large, robust; lower whorls strongly shouldered with many axial plications; below the shoulder on the body whorl, the plications become weakened and disappear; surface of whorls covered by sharp-crested, closely set spirals; between each two of which are one or two fine secondary spirals; closely set axial threads that are finer than the secondary spirals are visible between the primary spirals. Aperture semilunar, posterior channel narrow, shallow; inner lip thinly callused above where it fails to conceal the underlying spirals, thicker and smooth below; outer lip lirate within.

Measurements of the figured specimen, USNM 650631: height (incomplete) 33.6 mm, diameter 28.7 mm.

The Fijian fossils are more strongly shouldered and more coarsely sculptured than Holocene examples of *S. stearnsii.* The fossils probably represent an undescribed form, but a decision must await the collection of more complete specimens.

Occurrence.—Two incomplete specimens from station 817, Vanua Levu, Fiji; age, Pliocene (Tertiary *h*). Pilsbry (1894, p. 31) described *S. stearnsii* from Japanese shells. The species has been collected from several localities in that country.

Genus SEARLESIA Harmer

Harmer, 1914, Palaeont Soc. Mon., v. 67, Pliocene Mollusca of Great Britain, v. 1, p. 135, pl. 13, fig. 1.

Type (by original designation).—*Trophon costifer* S. V. Wood. Pliocene, England.

Searlesia hindlei Ladd, n. sp.

Plate 17, figure 1

Shell medium in size, fusiform, slender; protoconch not preserved; spire consisting of seven gently convex whorls; height of body whorl exceeding that of spire. Aperture lenticular; inner lip concave, covered by a thin callus; margin of outer lip not complete, but lip is lirate within; anterior canal long, recurved. Sculpture consisting of strong, rounded axial ribs on the whorls of the spire, the somewhat irregular series becoming all but obsolete before the body whorl; surface of entire shell covered by low flattened spirals, each on later whorls divided by a shallow groove; fine, closely set lines of growth are discernible over most of the shell.

Measurements of the holotype, only specimen, USNM 175028: height 42.4 mm, diameter 20.2 mm, length of aperture 27.2 mm.

S. hindlei is closely related to *S. dira* (Reeve), a species that lives on the west coast of North America from Alaska to California and has been reported from the Pliocene and Pleistocene of California (Grant and Gale, 1931, p. 645). The Fijian fossil is more slender, thinner, and has an aperture and an anterior canal that are proportionately much longer than on *S. dira*.

Gould (1851, p. 141) described *Fusus incisus* as one of the Exploring Expedition shells, but he gave no locality. In 1852, he redescribed the species (1852, p. 232–233) and added "Habitat uncertain; probably New Zealand." Most later writers placed Gould's species in synonymy with *Buccinum dirum* described by Reeve (1846, pl. 12, fig. 92) but omitted reference to the probable New Zealand occurrence. *Fusus incisus* seems not to have been recollected in New Zealand, so the citation remains doubtful. I think Gould's species should be placed with *S. dira*.

This species is named for William Hindle of the Fiji Geological Survey who collected the holotype and only specimen.

Occurrence.—Near station VL1, Vanua Levu, Fiji; age, Pliocene (Tertiary *h*).

Genus EUTHRIA J. E. Gray

Gray, J. E., 1850, *in* M. E. Gray, Figures of molluscous animals, v. 4, p. 67.

Type (by monotypy).—*Fusus lignarius* Lamarck (=*Murex corneus* Linnaeus). Holocene, Mediterranean Sea.

Euthria hoffmeisteri Ladd, n. sp.

Plate 17, figure 3

Shell medium in size, fusiform, spire broadly conical; protoconch incomplete but apparently composed of two or more smooth whorls; whorls of spire flat, forming an apical angle of slightly less than 90°, bearing axial ribs; body whorl has fine spiral threads and intervening still smaller threads, clearly visible only under magnification. Aperture broadly semilunar, equal to nearly four-fifths of the length of the shell, with a shallow channel above and a recurved channel below (incomplete).

Measurements of the holotype, only specimen, USNM 175027: height 20.8 mm, diameter 12.0 mm.

The fossil is placed in *Euthria* with some hesitation. The ratio of body whorl to spire is appreciably greater than in most species in that genus, and the aperture is not constricted below. These features are suggestive of the Volutidae. The outer lip of the fossil is incomplete and partly filled; no internal lirae are visible.

The species is named for Dr. J. Edward Hoffmeister who discovered the type locality while mapping Vanua Mbalavu in eastern Fiji.

Occurrence.—A single specimen from station 110B, Vanua Mbalavu, Fiji; Ndalithoni Limestone of Pliocene (Tertiary *h*) age.

Genus METULA H. and A. Adams

H. and A. Adams, 1853, Genera of Recent Mollusca, v. 1, p. 84.

Type (by hidden tautonymy).—*Buccinum hindsii* H. and A. Adams (=*Buccinum metula* Hinds). Holocene, Pacific coast of Panama.

Metula (Metula) ibbotsoni Ladd, n. sp.

Plate 17, figure 4

Shell small, slender; base of protoconch smooth, remainder not preserved; spire consists of five nearly flat sculptured whorls; suture slightly channeled, aperture elongate-lenticular, longer than spire, anterior canal short and straight; outer lip thickened, crenulate within; inner lip thickly calloused. Sculpture consists of many flattened closely set axial riblets and equally numerous but weaker spiral cords; a narrow, beaded, subsutural band is present on all sculptured whorls.

Measurements of the holotype, USNM 650650: height 18.3 mm, diameter 6.1 mm.

The Fijian fossil appears to be most closely related to an unnamed Holocene species from the Philippines (USNM 237056 and 238079), but on the Holocene shells, the spiral sculpture is nearly as strong as the axial, resulting in a beaded pattern that is best developed on the body whorl. The Fijian shell also closely resembles the specimen described by Jung (1969, p. 515, pl. 55, fig. 1) as *Metula* aff. *cancellata* Gabb from the upper Miocene Melajo Clay Member of the Springvale Formation of Trinidad, but that form has more strongly inflated whorls, coarser sculpture, and a slightly curved anterior canal. On shells of *M. cancellata* Gabb from the Miocene of Santo Domingo, Costa Rica, and Panama (Olsson and Bayer, 1972, p. 911), the upper spiral cords near the suture are larger and more widely spaced than other spirals, but on *M. ibbotsoni*, all spiral cords are of equal size.

This species is named for Dr. Peter Ibbotson who mapped and collected fossils from the Pliocene of western Vanua Levu.

Occurrence.—Two specimens from station 817 on Vanua Levu, Fiji; age, Pliocene (Tertiary *h*).

Genus CANTHARUS Roding

Röding, 1798, Mus. Boltenianum, pt. 2, p. 132.

Type (by subsequent designation, Cossmann, 1889, Soc. Royal Malacolog. Belgique Ann., v. 24, p. 141).—*Cantharus globularis* Röding (=*Buccinum tranquebaricum* Gmelin). Holocene, Indian Ocean.

Subgenus POLLIA Gray

Gray, *in* Sowerby, 1834, Genera Recent Fossil Shells, no. 42, footnote second page of *Purpura*.

Type (by monotypy).—*Buccinum undosum* Linnaeus. Holocene, Indo-Pacific.

Cantharus (Pollia?) sp.

A single incomplete external mold from the Miocene Tagpochau Limestone on Saipan (USGS loc. 17675) may be referable to *Pollia*. The widely spaced axial plications that are overridden by fine spiral ribs suggest the Miocene shell from Java described by Martin (1921, p. 460, pl. 59, fig. 38) as *Tritonidea* (*Cantharus*) *angsanana*. The cast, USNM 650644, measures: height 11 mm, diameter 7 mm.

Genus NAWENIA Ladd, n. gen.

Type.—*Nawenia bartholomewi* Ladd, n. sp. Pliocene (Tertiary *h*), Vanua Levu, Fiji.

Moderately large, inflated. Protoconch consisting of three convex whorls bearing widely spaced spirals and closely set axial threads; early whorls of spire with strong axial ridges that become obsolete on the later whorls; edge of outer lip sharp but thickened and dentate within.

Nawenia bears a general resemblance to several thin-shelled buccinids that live today in higher latitudes, but the protoconch, sculptural features, and color pattern of the fossil are distinctive.

Nawenia bartholomewi Ladd, new gen. and n. sp.

Plate 17, figure 5; plate 21, figure 7

Medium in size, globose; protoconch consisting of about three convex whorls marked with fine widely spaced spiral threads and closely set oblique axial threads that are beaded at the intersections; the five whorls of the spire are gently convex, covered by flattened spiral ribs that tend to alternate in size; the first two whorls of the spire also bear strong axial ridges that become obsolete on later whorls; all whorls of the spire with fine, slightly oblique axial lines of growth. Aperture broadly lenticular; edge of outer lip sharp but thickened and dentate within; non-umbilicate, inner lip lightly callused. The single specimen retains traces of narrow, oblique, widely spaced bands of dark red color on the upper part of the body whorl and the adjoining part of the penultimate whorl.

Measurements of the holotype, British Museum. GG1842; height 34.5 mm, diameter 22.8 mm.

The species is named for Ronald Bartholomew who collected the only specimen in 1957 while mapping on Vanua Levu for the Geological Survey of Fiji.

Occurrence.—Station VL1, roadcut north of Naweni, Vanua Levu, Fiji; age, Pliocene (Tertiary *h*).

Family MELONGENIDAE

Genus PUGILINA Schumacher

Schumacher, 1817, Essai d'un nouveau systéme des habitations des vers testacés, p. 216.

Type (by subsequent designation, Herrmannsen, 1848, Indicis generum malacozoorum primordia, v. 2, p. 354).—*Murex morio* Linnaeus. Holocene, Atlantic.

Subgenus MAYERIA Bellardi

Bellardi, 1872, I Molluschi dei terreni terziari del Piemonte e della Liguria, Torino, v. 1, p. 186.

Type (by monotypy).—*Pyrula acutissima* Bellardi. Miocene, Switzerland.

Pugilina (Mayeria) swartzi Ladd, n. sp.

Plate 17, figures 6–8

Small, pyriform, spire short; body whorl with a strong spiral keel above the midpoint and a less prominent keel a short distance below it; primary keel scalloped by broad axial depressions; entire surface of whorl covered by beaded tertiary spirals that are stronger below the secondary keel than elsewhere; columella smooth, anterior canal long, bordered by a deep umbilical chink.

Measurements of the holotype and only specimen, USNM 174979: length 4.1 mm, diameter 3.7 mm.

The single fossil, which may be immature, is more coarsely ribbed than *P. acutissima*, the type of the subgenus, and the primary keel of that species is not scalloped as in the Eniwetok fossil.

This species is named for the late Dr. Joel H. Swartz who made many geophysical measurements in the deep holes drilled on Eniwetok.

Occurrence.—Drill hole, F–1, Eniwetok, at depth of 870–880 ft; age, early Miocene (Tertiary *f*).

Family NASSARIIDAE

Genus NASSARIUS Dumeril

Duméril, 1806, Zoologie analytique, p. 167 (genus without species).

Type (by monotypy) Froriep, 1806, C. Duméril's analytique zoologie, p. 167; fide Iredale, 1916, Malacolog. Soc. London Proc., v. 12, p. 83).—*Buccinum arcularia* Linnaeus. Holocene, western Pacific.

Subgenus PHRONTIS H. and A. Adams

Adams, H. and A., 1853, Genera of Recent Mollusca, v. 1, p. 117.

Type (by subsequent designation, Cossmann, 1901, Essais de Paléoconchologie comparée, v. 4, p. 207).—*Nassa tiarula* (Kiener). Holocene, Indo-Pacific.

Nassarius (Phrontis) tiarula (Kiener)

Plate 17, figure 9; plate 21, figure 9

Buccinum tiarula Kiener, 1841, Species général . . . coquilles vivantes, *Buccinum*, p. 111, pl. 30, fig. 4.

Nassa tiarula (Kiener), Reeve, 1853, Conchologica Iconica, v. 8, *Nassa*, pl. 14, fig. 92.

Nassa (*Phrontis*) *tiarula* (Kiener), Tryon, 1882, Manual Conchology, v. 4, pl. 12, fig. 174.

This species, widespread today in the Indo-Pacific, is characterized particularly by strong axial ribs that are expanded, immediately below the suture, into prominent rounded nodes. A single specimen was recovered from a core in drill hole A–1 on the island of Aranit, Eniwetok, at a depth of 168.2 to 175.3 ft; age, Holocene. The specimen, USNM 175055, measures: height 12.5 mm, diameter 7.0 mm.

Subgenus ARCULARIUS Link

Link, 1807, Beschreibung der Naturlien-Sammlung der Universität zu Rostock, p. 126.

Type (by subsequent designation, Mörch 1863, Zool. Soc. London Proc. for 1962, p. 227).—*Arcularia coronata* Link=*Buccinum arcularia* Linneaus. Holocene, western Pacific.

Nassarius (Arcularius) leptospira A. Adams

Plate 17, figure 11

Nassa leptospira A. Adams, 1851, Zool. Soc. London Proc., p. 103; Reeve, 1853, Conchologica Iconica v. 8, *Nassa*, pl. 13, fig. 84; Tryon, 1882, Manual Conchology, v. 4, p. 25, pl. 7, figs. 24–28.

Nassa gracilis Pease, 1867, Am. Jour. Conchology, v. 3, p. 273, pl. 23a, fig. 4.

Characterized particularly by its entended callus, strong axial ribs, and its varix-thickened outer lip. The figured specimen, USNM 175037, measures: height 11.2 mm, diameter 7.2 mm.

Occurrence.—A single specimen from USGS locality 24794 on Maewo, New Hebrides; age, Quaternary. The species lives today in the Philippines, New Caledonia, and parts of the Indian Ocean.

Nassarius (Arcularius) graniferus (Kiener)

Plate 17, figures 12, 13

Buccinum graniferum Kiener, 1834, Spécies generale et iconographie coquilles vivantes, Paris, p. 100, pl. 27, fig. 111.

Nassa granifera (Kiener), Reeve, 1853, Conchologica Iconica, v. 8, *Nassa*, pl. 11, fig. 72.

Nassa (*Arcularia*) *granifera* (Kiener), Tryon, 1882, Manual Conchology, v. 4, p. 26, pl. 8, figs. 39–41.

Arcularia (*Plicarcularia*) *granulifera* (Kiener), Habe, 1964, v. 2 *of* Kira and Habe, Shells of the western Pacific in color, p. 99, pl. 32, fig. 12.

Characterized by its large, regularly spaced tubercules, its heavy, widespread callus and thickened outer lip. Two Holocene-specimens were recovered from cores in drill hole 2A, Bikini Atoll. The figured specimen, an adult from a depth of 242.5–253 ft, USNM 175038, measures: height 13.8 mm, diameter 9.1 mm. The second specimen is an immature shell from a depth of 200.5–211 ft. The species lives today in central Polynesia (common at Bikini) and in the western Pacific from the Philippines to the Ryukyu Islands. It is also known from the Indian Ocean—Cocos Keeling Islands and Zanzibar.

Nassarius (Arcularius) eniwetokensis Ladd, n. sp.

Plate 17, figures 14, 15

Shell small, globular; protoconch of about two unmarked whorls, followed by about six rapidly expanding whorls bearing rounded oblique axial folds; folds low and widely spaced on the spire but sharper and more numerous on the greatly expanded body whorl; spiral ridges are developed between the folds on the body whorl, but they do not override the folds except for the prominent spiral next to the suture and the spiral immediately below it. Aperture lenticular, surrounded by a heavy pad of callus that extends well up on the spire and curves around to form a much thickened outer lip that is lirate within. Posterior canal distinct, anteror canal deep; inner lip and its heavy callus covered with irregular denticles.

Measurements of the holotype, USNM 175039; height 7.6 mm, diameter 6.2 mm.

N. eniwetokensis bears a general resemblance to *N. leptospira*, a Holocene Indo-Pacific species, but is proportionately much shorter and has a more highly decorated inner lip.

Occurrence.—Two specimens from drill hole F–1 on Eniwetok at a depth of 680–690 ft; age, late Miocene (Tertiary *g*).

Nassarius (Arcularius?) sp.

Plate 17, figure 16

Incomplete molds of a medium-sized, stout, strongly-ribbed *Nassarius* were collected from the Pliocene and Pleistocene Mariana Limestone at five localities on Guam (USGS locs. 20586, 20653, 20676, 20734, 20969). None of the 12 specimens shows the apertural features, and the subgeneric reference is uncertain. The species has about six whorls that are covered by strong, slightly oblique axial ribs. Spiral sculpture is limited to a single groove below the impressed suture and to a few grooves on the base. Measurements of the figured specimen, USNM 175040 from USGS 20653, are: height 18.5 mm, diameter 12 mm. I have not been able to identify this species with any form now living on Guam.

Subgenus UZITA H. and A. Adams

Adams, H. and A., 1853, Genera of Recent Mollusca, v. 1, p. 120.

Type (by subsequent designation, Cossmann, 1901, Essais de paléoconchologie comparée, pt. 4, p. 205).—*Buccinum migum* Bruguière. Holocene, West Africa.

Nassarius (Uzita) verbeeki (Martin)

Plate 17, figures 17, 18

Nassa (*Hinia*) *verbeeki* Martin, 1895, Die Fossilien von Java, Geol. Reichs-Mus. Leiden Samml., v. 1, no. 2–5, p. 110, pl. 17, figs. 247–255.

Medium in size, stout; protoconch consisting of about three smooth convex whorls, followed by six gently convex whorls that make a flatsided spire, suture moderately to deeply impressed; aperture ovate, inner lip heavily callused, irregularly covered by elongated pustules, lip detached above and below; outer lip thick, lirate within; sculpture consisting of a strongly beaded spiral rib immediately below the suture and flat, less conspicuous spirals below, separated by shallow grooves; spirals interrupted by regularly spaced, slightly curved, rounded axial ribs; anterior canal wide and deep; posterior canal narrow and shallow; axials strongly beaded on lower part of body whorl.

Measurements of figured specimen from Palau, USNM 175032; height 18.9 mm, diameter 10.0 mm. Figured specimen from Fiji, USNM 175033; height 21.5 mm, diameter 13.2 mm.

Occurrence.—Four specimens from USGS locality 21301 and one from 21304 on Goikul Peninsula, Bamelthuap, Palau; late Miocene (Tertiary *g*). Five specimens from station R50 (=MR20) on Viti Levu, eight from station R53 (=817), two from K138, and one from K700 on Vanua Levu, Fiji; age, Pliocene (Tertiary *h*). Present in abundance in the Pleistocene marls of the Kere River, Santo, New Hebrides (USGS loc. 25715).

In Java, the species occurs in the upper Miocene and Pliocene. It has also been reported from the Quaternary beds of Celebes (Schepman, 1907, p. 174).

Nassarius (Uzita) mangkalihatensis Beets

Plate 17, figure 19

Nassarius (*Uzita*) *mangkalithatensis* Beets, 1941, Nederland en Kolonien Geol.-Mijnb. Genoot Vehr., Geol. Ser., v. 13, pt. 1, p. 101, pl. 9, figs. 357–359.

Shell very small, stout; protoconch of two smooth, convex whorls; spire flat-sided, made up of 4½ whorls bearing strong axial ribs that are cancellated by spirals that override the axials and are beaded in the process; suture wide and deep; aperture lenticular, inner lip callused with a moderately strong parietal denticle and, anteriorly, several elongate denticles that appear to reflect the underlying spirals; outer lip thickened by a varixlike structure, lirate within; anterior canal short and deep, siphonal fasciole thick and faintly channeled, set off by a deep groove.

Measurements of the figured specimen, USNM 175057: height 5.3 mm, diameter 3.0 mm.

Occurrence.—The figured specimen and two others from USGS locality 21301; three others from locality 31308 nearby on the Goikul Peninsula, Babelthuap, Palau. All specimens from the marls at the base of the Palau Limestone; age, late Miocene (Tertiary *g*). Beets (1941) described the species from the upper Miocene of East Borneo.

Subgenus ZEUXIS H. and A. Adams

Adams, H. and A., 1853, Genera of Recent Mollusca, v. 1, p. 119.

Type (by subsequent designation, Cossmann, 1901, Essais de paléoconchologie comparée, pt. 4, p. 207).—*Buccinum taenia* Gmelin. Holocene, Indo-Pacific.

Nassarius (Zeuxis) concinnus (Powys)

Plate 17, figure 20

Nassa concinnus Powys, 1835, Zool. Soc. London Proc., p. 95; Tesch. 1915, Paläont. von Timor, p. 61, pl. 81, fig. 136.

Nassa (*Hima*) *concinna* Powys, Tryon, 1882, Manual Conchology, v. 4, p. 48, pl. 15, fig. 256.

Nassarius (*Zeuxis*) *concinnus* (Powys), Cernohorsky, 1972, Indo-Pacific Nassariidae . . ., Auckland Inst. and Mus. Rec. v. 9, p. 177, figs. 132, 133.

A small stout species with gently convex whorls that bear many axial ribs, fine spiral threads, and a groove immediately below the suture that sets off

a spiral row of beads. Represented in the fossil collections by a single incomplete shell, USNM 175059, from USGS locality 20687 on Guam. It measures: height 16.8 mm, diameter 8.7 mm. The fossil is from the Mariana Limestone (Agana Argillaceous Member) and is Pliocene or Pleistocene in age. Tesch reported it from the Pliocene of Timor. The species is widely distributed today in the Indo-Pacific region.

Nassarius (Zeuxis) planicostata (A. Adams)

Plate 17, figure 21; plate 18, figure 1, 2

Nassa planicostata A. Adams, 1851, Zool. Soc. London Proc., p. 108; Reeve, 1853, Conchologica Iconica, v. 8, *Nassa*, pl. 12, no. 76; Tryon, 1882, Manual Conchology, v. 4, p. 34, pl. 10, fig. 112.

Small, 10–25 mm long, stout; protoconch of several convex whorls, followed by four to six sculptured whorls; whorls gently convex, suture distinct but not deeply impressed; aperture lenticular, slightly longer than spire; inner lip with a well-defined border that may be slightly thickened; on adult shells, the inner lip is strongly denticulate and, posteriorly, forms part of narrow canal; outer lip thickened and dentate within; anterior canal deep; sculpture consisting of many narrow slightly curved axial ribs and faint spiral lines; the axial ribs are less conspicuous on the body whorl near the outer lip than elsewhere; strong spiral grooves are developed near the base.

Measurements of the figured specimens: a typical small specimen, USNM 175065, height 10.1 mm, diameter 4.9 mm; an unusually large specimen, USNM 175066, length 23.8 mm, diameter 10.7 mm.

The spirals on the fossil shells are not sufficiently developed to give the lattice effect noted on Holocene examples.

Occurrence.—Nine specimens from station 817 on Vanua Levu, Fiji; age, Pliocene (Tertiary *h*). The species lives today at widely separated localities in the Indo-Pacific but has not been found living in Fiji.

Nassarius (Zeuxis) vitiensis (Hombron and Jaquinot)

Plate 17, figure 10

Nassa vitiensis Hombron and Jaquinot, 1853, Voyage au Pole Sud et dans l'océanie, sur les corvettes l'Astrolabe et la Zélée, atlas, pl. 21, figs. 23–25; 1853, text, v. 5, p. 79.

Nassarius (Zeuxis) vitiensis (Hombron and Jaquinot), Cernohorsky, 1972, Auckland Inst. Mus. Rec., v. 9, p. 175, figs. 127–130, 144.

A heavy medium-sized shell characterized particularly by a thickly callused and toothed aperture and by strong axial ribs. On Holocene shells and most of the fossils, the axial ribs become obsolete in a small area on the back of the body whorl. The figured specimen from Maewo, USNM 175034, measures: height 25.0 mm, diameter 12.6 mm.

Occurrence.—Eleven specimens from post-Miocene beds on Maewo and Pentecost Islands; abundant in the Pleistocene marls on the Kere River (USGS loc. 25715), Santo, New Hebrides. The species lives in Fiji and islands to the west, including the New Hebrides.

Subgenus NIOTHA H. and A. Adams

Adams, H. and A., 1853 Genera of Recent Molusca, v. 1, p. 117.

Type (by subsequent designation, Cossmann, 1901, Essais de paléoconchologie comparée, pt. 4, p. 203).—*Nassa cumingi* Adams. Holocene, western Pacific.

Nassarius (Niotha) fijiensis Ladd, new name

Plate 18, figures 3, 4

Phos vitiensis Ladd, 1934, Bernice P. Bishop Mus. Bull. 119, p. 226, pl. 40, fig. 6.

This species lacks the expanded inner lip of the type, *N. cumingi*, but in other respects, particularly in its striking cancellate sculpture, it seems best referred to *Niotha*. In general shape and most apertural features it resembles *Nassarius* (*Niotha*) *caelatus* (A. Adams), a Holocene species widespread in the western Pacific and also reported to occur in the Pliocene of Okinawa, Taiwan, and Japan and the Pleistocene of Japan (MacNeil, 1960, p. 79). The holotype of *"Phos vitiensis"*, Bernice P. Bishop Museum Geology 1165, is here refigured along with a specimen from station C1142, Viti Levu, Fiji. The latter, USNM 175058, measures: height 16.0 mm, diameter 8.2 mm.

In addition to the type localities, stations 165 and 304, single specimens have been collected on Viti Levu from stations MR69, C89, C1133, and C1142. On Vanua Levu, a dozen specimens have been collected from station 817. All the known occurrences appear to be Pliocene (Tertiary *h*) in age, except 165 on Viti Levu which is late Miocene (Tertiary *g*).

It appears that the specific name *vitiensis* was applied to a species of *Nassarius* in 1854 (*Nassa vitiensis*, Hombroy and Jacquinot, already described). The species that I called *Phos vitiensis* is hereby changed to *Nassarius fijiensis*.

Nassarius (Niotha) ovus (Martin)

Plate 18, figure 5

Nassa (*Niotha*) ovum Martin, 1891, Die Fossilien von Java, v. 1, Gastropoda, p. 108, pl. 17, figs. 242, 243.

Shell small, stout, inflated; protoconch of about two smooth whorls followed by five sculptured

whorls; sculpture consisting of strong, slightly curved axial ribs that are overridden by weaker spirals; a groove immediately below the impressed suture sets off a row of beads. Aperture ovate, less than one-half the total length; inner lip covered by a crenulated callus that is slightly extended to an elevated margin; outer lip thickened and strongly crenulate within; anterior canal short and deep; siphonal fasciole broad. Measurements of the figured specimen from station C89, Viti Levu, Fiji, USNM 175061: height 13.3 mm, diameter 7.4 mm.

The sculpture of the Fijian fossils clearly falls within the range of variation shown by many specimens from the Miocene of Java.

Occurrence.—Two specimens from station C89 and one from station C742, Viti Levu, Fiji; age, Pliocene (Tertiary *h*). Martin described the species from the Miocene of Java, and it has also been identified from the Pliocene of Timor (Tesch, 1915, p. 61, pl. 81, fig. 135).

Nassarius (Niotha) marshallensis Ladd, n. sp.

Plate 18, figure 6, 7

Shell small, biconic, flat-sided; protoconch consisting of three smooth slightly convex whorls, followed by four to six sculptured whorls. Suture lightly impressed; aperture lenticular; outer lip thickened, dentate within, the denticles near the middle larger than those of the extremities; inner lip heavily callused, dentate within, margin thickened; anterior canal narrowed above, wide and deep below; sculpture consisting of strong rounded, slightly curved axial ribs and fine, closely set spirals; on the lower half of the body whorl the spirals override the axials; axial ribs finer on body whorl near margin of outer lip; a prominent groove lies immediately below the suture. The number and strength of the axial ribs is a variable feature; the holotype (pl. 18, fig. 6) is coarsely ribbed as are most specimens; a paratype (pl. 18, fig. 7) shows finer axial sculpture.

Measurements of the types: holotype, USNM 175063 from drill hole F–1, Eniwetok, depth of 870–880 ft: height 7.9 mm, diameter 4.2 mm; a paratype, USNM 175064, from F–1, Eniwetok, at a depth of 880–890 ft: height 5.3 mm, diameter 3.0 mm.

N. marshallensis appears to be closely related to *N. fulleri* MacNeil from the Pliocene of Okinawa (MacNeil, 1960, p. 80, pl. 13, figs. 27, 28) but is smaller, has a less prominent suture, and a smaller parietal callus.

Occurrence.—Twenty-one specimens from three drill holes on Eniwetok at depths ranging from 663 to 1,000 ft; age, Miocene (Tertiary *f* and *g*); two specimens from two drill holes on Bikini at depths of 940–967 ft; age, late Miocene (Tertiary *g*).

Family FASCIOLARIIDAE

Genus LATIRUS Montfort

Montfort, 1810, Conchyliologie Systématique, v. 2, p. 531.

Type (by original designation).—*Latirus aurantiacus* Montfort (=*Murex gibbulus* Gmelin). Holocene, Australia.

Latirus sp.

Latirus sp. Ladd, 1970 U.S. Geol. Survey Prof. Paper 640–C, p. C7, pl. 5, fig. 1, Eua, Tonga. Late Eocene (Tertiary *b*).

Latirus craticulatus (Linnaeus)

Plate 18, figure 8

Murex craticulatus Linnaeus, 1758, Systema Naturae, 10th ed., p. 755.

Latirus craticulatus (Linnaeus), Tryon, 1881, Manual Conchology, v. 3, p. 93, pl. 69, fig. 159; Cernohorsky, 1972, Marine shells of the Pacific, v. 2, p. 156, pl. 46, fig. 5.

A single nearly complete shell of this widespread living Indo-Pacific species was collected from USGS locality 21028 on Santo in the New Hebrides. The specimen, USNM 175051, measures: height (incomplete anteriorly) 33.5 mm, diameter 14.5 mm. The shell shows all diagnostic features, including the scabrous suture, and it retains faint traces of alined but discontinuous orange axial bands. The New Hebrides fossil is probably Pleistocene in age. Schepman (1907, p. 171) reported it fossil in Celebes (Sula wesi), age, Holocene.

Latirus barclayi (Reeve)

Plate 18, figure 9

Turbinella barclayi Reeve, 1847, Conchologica Iconica, v. 4, *Turbonilla*, pl. 4, no. 20.

Latirus polygonus (Gmelin), *barclayi* (Reeve), Tryon, 1881, Manual Conchology, v. 3, p. 88, pl. 67, fig. 110; Cernohorsky, 1972, Marine shells of the Pacific, v. 2, p. 154, pl. 45, fig. 7a.

Latirus barclayi (Reeve), Demond, 1957, Pacific Sci., v. 11, no. 3, p. 320, fig. 32.

A large fusiform species that bears a spiral row of rounded knobs that form a shoulder, above which the surface is concave; a spiral row of secondary knobs is visible on the body whorl; spiral cords and finer spiral threads are present over most of the shell surface.

The species is represented in the fossil collections by two specimens from Guam. Neither is complete, but both clearly represent *L. barclayi*. The figured specimen, USNM 175067, measures: height 43 mm, diameter 29 mm.

Occurrence.—Figured specimen from USGS locality 20730 from the upper Tertiary Alifan Limestone;

an incomplete external mold from the Mariana Limestone at USGS locality 20508; age, Pliocene or Pleistocene. The species lives today from Mauritius in the Indian Ocean, eastward through the Philippines to the Marianas and the Marshalls, but has not been found in Hawaii.

Genus PERISTERNIA Morch

Mörch, 1852, Catalogus conchyliorum quae reliquit D. Alphonso d'Aguirra et Galdea Comes de Yoldi, v. 1, Hafniae, p. 99.

Type (by subsequent designation, Melvill, 1891, Manchester Lit. and Philos. Soc. Mem. and Proc., v. 84, no. 5, p. 378).—*Turbinella nassatula* Lamarck. Holocene, southwest Pacific.

Peristernia nassatula (Lamarck)

Plate 18, figure 10

Turbinella nassatula Lamarck, 1822, Animaux sans vertèbres, v. 7, p. 110.

Peristernia nassatula (Lamarck), Tryon, 1881, Manual Conchology, v. 3, p. 80, pl. 64, figs. 44–47, 51, 52, 58; Demond, 1957, Pacific Sci., v. 11, p. 321; Cernohorsky, 1972, Marine shells of the Pacific, v. 2, p. 158, pl. 47, fig. 3.

Small shells that probably represent this widespread living Indo-Pacific species were recovered from two drill holes on Eniwetok and one on Bikini in beds believed to be early Miocene (Tertiary *f*) in age. The figured specimen, USNM 175072 is unworn but immature; its measurements are: height 5.6 mm, diameter 4.0 mm. It was recovered from drill hole E–1, Eniwetok, at a depth of 970–980 ft. Similar occurrences were in drill hole K1–B, Eniwetok, at a depth of 915–926 ft and in drill hole 2B, Bikini, at a depth of 1,020–1,100 ft. Larger, strongly shouldered shells were collected from the Pleistocene marls on the Kere River (USGS loc. 25715) Santo, New Hebrides.

Peristernia incarnata (Kiener)

Plate 18, figure 11

Turbinella incarnata Deshayes, Kiener, 1841, Species général et Iconographie des coquilles vivantes . . . . p. 45, pl. 18, fig. 3; Tryon, 1881, Manual Conchology, v. 3, p. 81, pl. 65, figs. 63–66, 69–70.

Peristernia incarnata (Kiener), Cernohorsky, 1972, Marine shells of the Pacific, v. 2, p. 161, pl. 47, fig. 5.

A stout shell characterized by deep rectangular pits formed between the spiral cords and the larger, slightly oblique axial ribs. A worn shell, referable to this species, was collected from the volcanic tuff that forms the little island of Matangi, east of Tavenui in Fiji; age, probably Holocene. The specimen, USNM 175046, measures: height 22.8 mm, diameter 9.7 mm.

As noted by Cernohorsky, the *Turbinella incarnata* of Kiener is *not* the *T. incarnata* Deshayes in Laborde and Deshayes (1830), and Kiener's shell may need a new name. The species lives today in many localities in the western Pacific and Indian ocean.

Peristernia chlorostoma (Sowerby)

Plate 18, figure 12

Turbinella chlorostoma Sowerby, 1825, Catalogue shells in collection of . . . Earl of Tankerville, app., p. xv, London.

Peristernia chlorostoma (Sowerby), Tryon, 1881, Manual Conchology, v. 3, p. 83, pl. 65, figs. 75–82, 84, 91; Cernohorsky, Marine shells of the Pacific, v. 2, p. 160, pl. 47, fig. 11.

A small to medium-sized stout shell with strong axial ribs and two sets of spiral cords; aperture lenticular, outer lip lirate within; columella with three low plicae anteriorly. The single fossil is somewhat worn but retains traces of the original color pattern—faint brown spots between axial ribs that form a central band on the body whorl, dark spots immediately above the suture, on the apex, and at the end of the anterior canal.

Measurements of the figured specimen, USNM 175047: height 8.9 mm, diameter 4.9 mm.

Occurrence.—Drill hole Mu–4, Eniwetok, at a depth of 31–31.5 ft; age, Holocene. The species lives today in Hawaii and in many of the islands of the western Pacific. It was found in abundance in a number of the Marshall Islands, including Eniwetok.

Peristernia waluensis Ladd, n. sp.

Plate 18, figure 13

Shell medium in size, slender, biconic; protoconch of about two smooth convex whorls followed by 7 whorls bearing broad, rounded slightly oblique axial ribs, 11 on body whorl. Axials overridden by primary and secondary spirals; primary spirals beaded where they cross the axials; four or five threadlike secondary spirals lie between each two primaries; at the periphry of each whorl, a beaded primary spiral forms a distinct shoulder. Aperture ovate, extended anteriorly into a canal that is slightly reflected; outer lip thin, crenulated; inner lip callused with two indistinct plicae anteriorly.

Measurements of the holotype, USNM 175073: height 16.5 mm, diameter 7.7 mm.

P. waluensis resembles *P. crosseanus* (Souverbie), a Holocene species from New Caledonia, in general form and in the presence of multiple secondary spirals, but *P. crosseanus* lacks the noded shoulder shown on the Fijian shell and has a descending suture.

Occurrence.—A single specimen from station 160 on Walu Bay, Viti Levu, Fiji; age, early Miocene (Tertiary *f*).

Peristernia eniwetokensis Ladd, n. sp.

Plate 18, figures 14, 15

Shell small, biconic; protoconch consisting of two smooth slightly convex whorls followed by four or five sculptured whorls. Each whorl of the spire with strong rounded axial folds, eight on body whorl where they are angled to form a prominent shoulder. Folds crossed by finely sculptured spiral cords and threads, two or three threads between each two cords. Aperture oval, extended anteriorly as a wide and deep canal bent slightly backward; outer lip strongly lirate within, columella with three or four oblique plicae; parietal wall with a rounded tooth.

Measurements of the types: holotype, USNM 175052, height 10.5 mm, diameter 5.1 mm; paratype, USNM 175053, height 9.0 mm, diameter 4.7 mm.

The Eniwetok shells, neither of which appears to be fully adult, resemble *Lathyrus* (*Peristernia*) *beberianus* Martin, described from the lower Miocene of Java (Martin, 1921, p. 456, pl. 19, figs. 31, 32) and East Borneo (Beets, 1941, p. 102, 190), but that larger species is not shouldered and appears to have more uniform spiral sculpture. Among living species, the Eniwetok fossils seem closest to the larger and more coarsely sculptured *P. nassatula* (Lamarck), but that species, like the Indonesian *P. berberiana,* is less strongly shouldered than the Eniwetok shells.

Occurrence.—Holotype from drill hole F–1, Eniwetok, at a depth of 960–970 ft; age, early Miocene (Tertiary *f*); paratype from drill hole E–1, Eniwetok, at a depth of 840–850 ft; age, late Miocene (Tertiary *g*).

Peristernia ustulata (Reeve)

Plate 18, figure 17

Turbinella ustulata Reeve, 1847, Conchologica Iconica, v. 4, *Turbinella*, pl. 12, fig. 62.

Peristernia ustulata (Reeve), Tryon, 1881, Manual Conchology, v. 3, p. 84, pl. 39, fig. 170; Cernohorsky, 1972, Marine shells of the Pacific, v. 2, p. 160, pl. 47, fig. 7.

An incomplete recrystallized specimen from the Mariana Limestone of Guam at USGS locality 20537 probably represents this species that lives today in many parts of the tropical Pacific. The fossil, USNM 175042, measures: height 27.1 mm, diameter 13.2 mm.; age, Pliocene or Pleistocene.

Peristernia ustulata goikulensis Ladd, n. subsp.

Plate 18, figure 16

Shell medium in size, stout; protoconch consisting of about two smooth gently convex whorls, followed by seven sculptured whorls. On the whorls of the spire, broad rounded axial folds, eight on body whorl, are crossed by closely set, alternating coarse and fine spiral threads; suture impressed, and immediately below it the spiral threads are beaded. Aperture lenticular, extended anteriorly as a wide and deep canal slightly reflected backward; outer lip lirate within; anterior half of columella bearing four oblique plicae.

Measurements of the holotype, USNM 175045: height 28.1 mm, diameter 11.8 mm.

The Miocene subspecies here recognized differs from the Holocene shells in invariably having four, rather than a lesser number of, plicae on the columella. *P. ustulata* itself has two, more rarely three, plicae; the variety *P. ustulata luchuana* described by Pilsbry (1901, p. 197) has three plicae. The whorls of the spire of the new subspecies are less convex than on all Holocene shells, the spire being distinctly flattened.

Occurrence.—In Palau, holotype and three other specimens from USGS locality 21304; four other specimens from locality 21301 nearby; Goikul peninsula, Babelthuap; from marls at the base of the Palau Limestone; age, late Miocene (Tertiary *g*). One specimen from drill hole E1, Eniwetok, at a depth of 650–660 ft; age, late Miocene (Tertiary *g*).

Genus FUSINUS Rafinesque

Refinesque, 1815, Analyse de la nature, un tableau de l'univers et des corps organisés, Palermo, p. 145 (emended name for *Fusus* Lamarck).

Type (monotype of *Fusus* Lamarck).—*Murex colus* Linnaeus. Holocene, western Pacific.

Fusinus sp.

Plate 18, figure 18

The genus *Fusinus* is represented in the fossil collections by a single incomplete specimen, an internal mold on which are small areas of a cast of the shell that retain traces of the external sculpture. The spire is composed of strongly convex whorls. Sculpture consists of primary spiral cords, about a dozen on the penultimate whorl, with inconspicuous spiral threads between. Axial ribs apparently present at irregular intervals.

Measurements of the figured specimen, USNM 174989, height (incomplete) 65.5 mm., diameter 31.5 mm.

The poorly preserved fossil bears a general resemblance to *Fusinus* cf. *F. nodoplicatus* (Dunker), described by MacNeil (1960, p. 84, pl. 14, fig. 2) from the Pliocene of Okinawa, but both are poorly preserved, and close comparison is not possible.

Occurrence.—Station L493, Lakemba, Fiji. From the Futuna Limestone; age, early Miocene (Tertiary *f*).

Family OLIVIDAE

Genus BELLOLIVA Peile

Peile, 1922, Malacolog. Soc. London Proc., v. 15, pt. 1, p. 18.

Type (by original designation).—*Olivella brazieri* Angas. Holocene. Australia.

Subgenus OLIVELLOPSIS Thiele

Thiele, 1929, Handbuch der systematischen Weichtierkunde, v. 1, p. 333, fig. 334.

Type (by monotypy).—*Olivella simplex* Pease. Holocene, Paumotu (Tuamotu) Islands.

Belloliva (Olivellopsis) simplex (Pease)

Plate 18, figure 19

Olivella (Callianax) simplex Pease, 1867, Am. Jour. Conchology, v. 3, p. 281, pl. 23a, fig. 24.

Olivella simplex Pease, Tryon, 1883, Manual Conchology, v. 5, p. 72, pl. 17, fig. 47.

Belloliva (Olivellopsis) simplex (Pease), Thiele, 1929, Handbuch der systematischen Weichtierkunde, v. 1, p. 333, fig. 334.

Shell minute, fusiform but with a truncated base; composed of 3½ smooth polished whorls; suture impressed; aperture more than half the length of shell, expanded anteriorly; outer lip smooth within; columella concave, callused.

Measurements of the figured specimen, USNM 175074, Eniwetok, drill hole K1–B, 736–748 ft: length 3.8 mm, diameter 1.8 mm.

Occurrence.—More than 30 specimens from 7 drill holes on Eniwetok from close to the surface to 968 ft; age, Holocene to early Miocene (Tertiary *f*). On Bikini, two specimens: one from drill hole 2A at a depth of 379–384 ft; age, probably Pliocene; one from drill hole 2B at a depth of 1,461–1,472 ft; age, early Miocene (Tertiary *e*). The species lives today in the Marshall and Line Islands, Tuamotu Islands, and Tonga.

Genns OLIVA Bruguiere

Bruguière, 1789, Ency. Méthodique, Histoire Nat. des Vers, v. 1, p. xv (genus without species).

Type (by monotypy and tautonomy, Lamarck, 1799, Soc. Histoire Nat. Paris, Mém., p. 70).—*Voluta oliva* Linnaeus. Holocene, western Pacific.

Oliva carneola (Gmelin)

Plate 18, figure 20

Voluta carneolus Gmelin, 1791, Systema Naturae, 12th ed., p. p. 3443.

Oliva carneola Lamarck, Reeve, 1850, Conchologica, Iconica, v. 6, *Oliva*, pl. 22, no. 60; Ladd, 1934, Bernice P. Bishop Mus. Bull. 119, p. 229, pl. 40, fig. 10; Cernohorsky, 1967, Marine shells of the Pacific, p. 188, pl. 46, fig. 337; Burch and Burch, 1967, Pacific Sci. v. 21, no. 4, 517.

The figured specimen, USNM 650640, from station 817, Vanua Levu, Fiji, measures: length 18.1 mm, diameter 8.8 mm. The fossils, on the average, are a little smaller and are more slender than Holocene shells, but there appear to be no essential differences.

Occurrence.—A single specimen recovered from the Suva Formation at station 160, Viti Levu, Fiji; age, early Miocene (Tertiary *f*). One small specimen from station MR20, Viti Levu; age, Pliocene (Tertiary *h*). Present in great numbers at station 817 on Vanua Levu and present at stations K63, K138, and K700 on the same island. Fiji; age, Pliocene (Tertiary *h*). The species has been reported from the Pliocene of Timor (Tesch, 1915, p. 41, pl. 79, fig. 87) and lives today throughout the tropical Indo-Pacific.

Oliva annulata Gmelin

Plate 18, figures 21, 22

Oliva annulata Gmelin, 1791, Systema Naturae, 13th ed., p. 3441; Burch and Burch, 1967, Pacific Sci., v. 21, p. 516; Cernohorsky, 1967, Marine shells of the Pacific, p. 187, pl. 46, fig. 334.

Oliva guttata Lamarck, 1811, Mus. Histoire Nat. Paris Annales, v. 16, p. 313.

Oliva cf. *guttata* Lamarck, Ladd, 1945, Bernice P. Bishop Mus. Bull. 181, p. 368, pl. 53, fig. C.

This common and widespread Holocene Indo-Pacific species is represented by four specimens from the early Miocene (Tertiary *f*) of Viti Levu, station 160. One of these, USNM 650639, is figured; measurements: length 31.1 mm, diameter 13.1 mm. A single specimen was collected from the Pliocene (Tertiary *h*) of Vanua Mbalavu in eastern Fiji, station 110B. Three recrystallized shells were found on Guam, one from the upper Tertiary Alifan Limestone (USGS loc. 20730) and two from the Pliocene and Pleistocene Mariana Limestone (USGS locs. 20626 and 20742). Two specimens from the elevated reef limestone on Santo in the New Hebrides (USGS locs. 21028 and 21029) are probably no older than Pleistocene.

Oliva woolnoughi Ladd

Oliva woolnoughi Ladd, 1934, Bernice P. Bishop Mus. Bull 119, p. 229, pl. 41, fig. 1.

Oliva makawana Ladd, 1934, Bernice P. Bishop Mus. Bull 119, p. 230, pl. 40, fig. 11.

Characterized particularly by its rectangular outline, low spire, and thick sutural callus. The collection of additional shells from old and new localities on Viti Levu conveys a better idea of the variability shown by this species; the shells described as *O. makawana* from the same general area are now interpreted as a variant of *O. woolnoughi*.

Occurrence.—Stations 59, 165, 303, and F238 in northern Viti Levu, Fiji; age, late Miocene (Tertiary *g*); stations 304 and C148 on Viti Levu are Pliocene (Tertiary *h*). A single specimen from Station 160 in southern Viti Levu may represent this species; age, early Miocene (Tertiary *f*).

Oliva woolnoughi lauensis Ladd

Oliva woolnoughi lauensis Ladd, 1945, Bernice P. Bishop Mus. Bull. 181, p. 368, pl. 53, figs. A, B.

As noted in the above reference, this subspecies is much larger and has a less prominent sutural callus than *O. woolnoughi* from the Suva Formation of Viti Levu. Three additional specimens of the Lau variety have now been identified from station L389 on Lakemba, a locality about half a mile south of station L391 where the types were collected; age, early Miocene (Tertiary *f*).

Oliva miniacea (Roding)

Plate 19, figure 1

Porphyria miniacea Röding, 1798, Mus. Boltenianum: Hamburg, Johan Christi, p. 33, sp. 391.

Oliva miniacea (Röding), Kira, 1962, Shells of the western Pacific in color: Osaka, Japan, Hoikusha Pubs. Co., p. 89, pl. 32, fig. 13; Burch and Burch 1967, Pacific Sci. v. 21, no. 4, p. 506.

A single shell representing this widespread Holocene species was collected from post-Tertiary limestones at USGS locality 21028 on Santo, New Hebrides. The specimen, USNM 650641, measures: length 71.2 mm, diameter 32.6 mm. The shell retains slight traces of its original color pattern.

Holocene shells have been collected from many island groups in the western Pacific, from Indonesia to Japan and eastward to the Marshalls and Samoa.

Oliva mustelina Lamarck

Plate 19, figure 2

Oliva mustelina Lamarck, 1811, Mus. Histoire Nat., Paris Annales, v. 16, p. 316; Tryon, 1883, Manual Conchology, v. 5, p. 78, pl. 22, figs. 6–14; Cernohorsky, 1967, Marine shells of the Pacific, v. 1, p. 190, pl. 48, fig. 343.

A single fossil from the Pliocene of Fiji at station RB44, Viti Levu, represents this somewhat variable Holocene species. It is characterized particularly by a long narrow aperture and a short sharply pointed spire. The fossil, British Museum GG13322, measures: length 31.1 mm, diameter 12.4 mm. The species also occurs in the elevated marls of Santo, New Hebrides (station SM242 and SM259); age, Pleistocene. It lives today in many parts of the tropical Pacific, including Fiji.

Family MITRIDAE

In 1968, Walter Cernohorsky, then engaged in a review of the world's Mitridae, examined and reclassified the extensive collection of Holocene mitrids in the U.S. National Museum. At that time he also examined my collections of fossil mitrids from the islands. Many of the fossils had not then been fully prepared, but he was able to suggest identifications for many of the forms, and most of these identifications have been confirmed. I am most grateful for Cernohorsky's assistance. Since his examination, additional mitrids have been collected, particularly in Fiji. In the fossil collections, the Mitridae are represented by 33 species, a total exceeding that of the next most abundantly represented family, the Cypraeidae, by five.

Genus MITRA Lamarck

Lamarck, 1798, Tableau encyclopedique et methodique, pl. 369.

Subgenus MITRA s. s.

Type (by tautonomy.—*Voluta mitra* Linnaeus. Holocene, Indo-Pacific.

Mitra (Mitra) eremitarum Roding

Plate 19, figure 3

Mitra eremitarum Röding, 1798, Mus. Boltenianum; Hamburg, Johan Christi, p. 136; Cernohorsky, 1965, Veliger, v. 8, no. 2, p. 87, pl. 13, fig. 3.

Mitra adjusta Lamarck, 1811, Mus. Histoire Nat., Paris, Annales, v. 17, p. 201. Represented by a single incomplete specimen (British Museum GG13321) that measures: height 35.9 mm, diameter 12.2 mm.

Occurrence.—Marls at station RB44, Viti Levu, Fiji; age, probably Pliocene (Tertiary *h*). The species lives in the tropical Pacific today, from Indonesia to Hawaii.

Mitra (Mitra) imperialis Roding

Plate 19, figure 4

Mitra imperialis Röding, 1798, Mus. Boltenianum: Hamburg, burg, Johan Christi, v. 2, p. 135; Cernohorsky 1965, Veliger, v. 8, no. 2, p. 90, pl. 14, fig. 11.

Mitra (Mitra) imperalis Röding, Cernohorsky, 1970, Auckland Inst. and Mus. Bull. 7, p. 35.

A single example of this widespread Indo-Pacific species was collected from the Viwa Limestone at station C1640 on Nanuyanuya, an islet near Viwa, Fiji; age, Quaternary. The specimen, USNM 175043, measures: height 19.6 mm, diameter 7.5 mm.

Though very small, the specimen has shallow spiral grooves with punctae that are crossed by shallow axial grooves, resulting in a faint cancellated appearance; the raised areas between the axial grooves are accentuated at the suture to form rounded coronations; the columella bears five prominent oblique folds.

Mitra (Mitra) cf. M. puncticulata Lamarck

Plate 19, figure 5

A single specimen from the early Miocene beds drilled under Bikini may be a juvenile example of *M. puncticulata,* a species that lives today from Africa eastward through the tropical Indo-Pacific to Fiji. The fossil has the shallow spiral grooves and the prominent shoulder nodes that characterize the Holocene shells, but on the fossil, the pits formed in the spiral grooves by the crossing of axial riblets do not form a sharply cancellate pattern as on most Holocene shells.

Measurements of the figured specimen, USNM 650663: height 7.7 mm, diameter 3.7 mm.

Occurrence.—A single specimen from drill hole 2A, Bikini, at a depth of 1,009–1,020 ft; age, early Miocene (Tertiary *f*).

Subgenus NEBULARIA Swainson

Swainson, 1940, Treatise on Malacology: London, Longman, Orme, Brown, Green, and Longmans, p. 319.

Type (by subsequent designation, Herrmannsen, 1847, Indicis Malacozoorum, v. 2, p. 110).—*Mitra contracta* Swainson, Holocene, Indo-Pacific.

Mitra (Nebularia) aurantia (Gmelin)

Plate 19, figure 6

Voluta aurantia Gmelin, 1791, Systema Naturae, 13th ed., p. 3454.

Mitra aurantia (Gmelin), Tryon, 1882, Manual Conchology, v. 4, p. 147, pl. 43, figs. 255, 256.

Mitra (Nebularia) aurantia (Gmelin), Cernohorsky, 1970, Auckland Inst. and Mus. Bull. 8, p. 36.

A single mold (USNM 174948) from the upper Tertiary Barrigada Limestone at USGS locality 20488 on Guam appears to represent this widely distributed Indo-Pacific species. Figured latex cast measurements: height 20 mm, diameter 9 mm.

Mitra (Nebularia) coronata Lamarck

Plate 19, figure 7

Mitra coronata Lamarck, 1811, Mus. Histoire Nat. Paris, Annales, v. 17, p. 214; Cernohorsky 1965, Veliger, v. 8, no. 2, p. 85, pl. 17, figs. 55, 55a–c (see for additional citations).

The single fossil shell retains the crown of light-colored nodules at the suture that characterizes the species.

Measurements of the figured specimen, USNM 650642: height (incomplete) 22.2 mm, diameter 10.1 mm.

Occurrence.—Post-Tertiary limestone at USGS locality 21028, Santo, New Hebrides. The species lives throughout the Indo-Pacific region, from Africa to Hawaii.

Mitra (Nebularia) crassicostata Sowerby?

Plate 19, figure 8

Mitra crassicostata Sowerby, 1874, Theasaurus Conchyliorum, *Mitra*, p. 21, no. 285, fig. 387.

This species, described 100 years ago for an unknown habitat, has, apparently, not been reported since. This single fossil from Guam that probably represents the species was collected from the Mariana Limestone (USGS loc. 20732); age, Pliocene or Pleistocene.

Measurements of the specimen, USNM 650645: height 22.0 mm, diameter 5.6 mm. The fossil bears strong rounded ribs separated by deeply pitted grooves and has the strongly crenulated outer lip that characterizes the Holocene shell. The body whorl of the fossil, however, is less strongly shouldered than the specimen figured by Sowerby.

Mitra (Nebularia) fraga Quoy and Gaimard

Plate 19, figure 9

Mitra fraga Quoy and Gaimard, 1833, Voyage l'Astrolabe, v. 2, p. 660, pl. 45 (bis), figs. 28, 29; Cernohorsky, 1965, Veliger, v. 8, no. 2, p. 89, fig. 42.

Mitra (Nebularia) fraga Quoy and Gaimard, Cernohorsky, 1970, Auckland Inst. and Mus. Bull. 8, p. 36.

A single juvenile shell appears to represent this widespread Indo-Pacific species. The figured specimen, USNM 174950, measures: height 4.6 mm, diameter 2.2 mm. It was recovered from drill hole F–1 on Eniwetok at a depth of 60–70 ft; age, Holocene. The species lives today from Cocos-Keeling in the Indian Ocean to Hawaii in the Pacific. At Eniwetok, specimens have been collected from the reef and in the lagoon.

Mitra (Nebularia) turgida Reeve

Plate 19, figures 10, 11

Mitra turgida Reeve, 1845, Conchologica, Iconica, *Mitra*, pl. 33, no. 273; Tryon, 1882, Manual Conchology v. 4, p. 42, pl. 42, fig. 234; Cernohorsky, 1970, Auckland Inst. and Mus. Bull. 8, p. 36.

Mitra ericea Pease, 1860, Zool. Soc. London, Proc., p. 146.

Mitra indentata Sowerby, 1874, Thesaurus Conchyliorum, *Mitra*, no. 173, fig. 412.

This variable species is especially characterized by its thick midsection and its short flat-sided spire

and tapered body whorl produces a biconic shape. The columella bears three to four strong plaits.

Measurements of the figured specimen from Palau, USNM 650647: height 15.3 mm, diameter 6.6 mm.; specimen from Eniwetok, USNM 650648: height 14.4 mm, diameter 6.9 mm. On most of the fossils, the axial threads in the depressions between the spiral ribs are coarser than on most Holocene shells.

Occurrence.—This species, not previously reported fossil, was collected from the marls at the base of the Palau Limestone in Palau (USGS locs. 21301 and 21304, a total of seven specimens) and from two drill holes on Eniwetok (E–1, 620–630 ft; F–1, 660–730 ft, three specimens). All the fossils are late Miocene (Tertiary *g*) in age. The species is not known to be living in the Marshall Islands today, but it has been collected in many other island groups from Indonesia to Hawaii.

Subgenus STRIGATELLA Swainson

Swainson, 1840, Treatise on malacology: London, Longman, Grave, Brown, Green, and Longmans, p. 130, 131, 319.

Type (by subsequent designation, Gray, 1847, Genera of Recent Mollusca, p. 141).—*Mitra zebra* Lamarck (=*Voluta paupercula* Linnaeus). Holocene, Indo-Pacific.

Mitra (Strigatella) fastigium Reeve

Plate 19, figure 12

Mitra fastigium Reeve, 1845, Conchologica Iconica, *Mitra*, pl. 28, fig. 221; Cernohorsky, 1970, Auckland Inst. and Mus. Bull 8, p. 39.

Shell small, biconic, smooth, columella with four strong plaits.

Measurements of the figured specimen, USNM 650646: height (incomplete) 15.3 mm, diameter 6.6 mm.

Occurrence.—Five specimens from the Ndalithoni Limestone on Vanua Mbalavu, Fiji (station 110B); age, Pliocene (Tertiary *h*); not previously reported fossil. The National Museum collections contain Holocene shells from a dozen Pacific island groups extending from Indonesia to Hawaii, but Fiji, where the fossils were collected, is not represented, nor did Cernohorsky (1965) report the species in his review of Fiji Mitridae.

Genus PTERYGIA Roding

Röding, 1798, Mus. Boltenianum: Hamburg, Johan Christi, p. 51.

Type (by subsequent designation, Dall, 1915, U.S. Nat. Mus. Bull. 90, p. 52).—*Pterygia nucella* Röding (=*Voluta dactylus* Linnaeus). Holocene, Indian Ocean.

Pterygia crenulata (Gmelin)

Plate 19, figure 13

Voluta crenulata Gmelin, 1791, Systema Naturae, 13th ed., p. 3452.

Mitra crenulata Lamarck, Reeve, 1844, Conchologica Iconica, v. 2, *Mitra* pl. 24, no. 190.

Cylindromitra undulosa (Reeve), MacNeil, 1960, U.S. Geol. Survey Prof. Paper 339, p. 95, pl. 17, fig. 19.

Pterygia crenulata (Gmelin), Cernohorsky, 1965, Veliger, v. 8, no. 2, p. 151, pl. 23, fig. 132; 1970, Auckland Inst. and Mus. Bull. 8, p. 41–42.

A single specimen (USNM 650638) of this widely distributed Indo-Pacific species was collected from the Pleistocene and Holocene Tanapag Limestone on Saipan (station 7897). It measures: height 29.4 mm, diameter 13.7 mm. MacNeil reported on a single specimen from the Pliocene Naha Limestone of Okinawa. The species lives today throughout the Indo-Pacific region from the Red Sea to Hawaii.

Pterygia fenestrata (Lamarck)

Plate 19, figure 14

Mitra fenestrata Lamarck, 1811, Mus. Histoire Nat. Paris Annales, v. 17, p. 212.

Pterygia fenestrata (Lamarck), Cernohorsky, 1965, Veliger, v. 8, no. 2, p. 152, pl. 23, fig. 129.

A single worn specimen that appears to represent this widely distributed living Indo-Pacific species was collected from the Pliocene and Pleistocene Mariana Limestone on Guam (USGS loc. 20626). The specimen, USNM 175006, measures: height 23.1 mm, diameter 13.3 mm. The National Museum collection of Holocene shells contains none from Guam or other islands in the Mariana Group, but the species probably lives there.

Genus SCABRICOLA Swainson

Swainson, 1840, Treatise on Malacology: London, Longman, Orune, Brown, Green, and Longmans, p. 130, 319.

Subgenus SCABRICOLA s. s.

Type (by subsequent designation, Gray 1847, Genera of Recent Mollusca, p. 141).—*Mitra serpentina* Lamarck. Holocene, western Pacific.

Scabricola (Scabricola) desetangsii (Kiener)

Plate 19, figure 15

Mitra desetangsii Kiener, 1838–39, Spécies général et iconographie des coquilles vivantes, *Mitra*, p. 98, pl. 29, fig. 94; Liénard, 1869, Jour. Conchyliologie v. 17, p. 226–227; Tryon, 1882, Manual Conchology, v. 4, p. 117, pl. 34, fig. 34.

Mitra variegata Reeve, 1844, Conchologica Iconica, *Mitra*, pl. 15, no. 111.

Scabricola (*Scabricola*) *desetangsii* (Kiener), Cernohorsky, 1970, Auckland Inst. and Mus. Bull. 8, p. 44.

A single fairly well preserved shell that probably represents this species was collected from the upper Tertiary (Tertiary *g* or *h*) Alifan Limestone at USGS locality 20726 on Guam. The specimen, USNM 650649, measures: height 21.2 mm, diameter 10.6 mm. *S. desetangsii* lives today in the western Pacific from Indonesia to Japan and at Mauritius in the Indian Ocean.

Genus SUBCANCILLA Olsson and Harbison

Olsson and Harbison, 1953, Acad. Nat. Sci, Philadelphia Mon. 8, p. 190.

Type (by original designation).—*Mitra sulcata* Swainson. Holocene, coast of Ecuador.

Subcancilla abyssicola (Schepman)

Plate 19, figure 16

Mitra (Scabricula) abyssicola Schepman, 1911, Siboga-Exped. pt. 4, Rachiglossa, p. 26, pl. 19, fig. 1, Leiden.

Mitra (Scabricula) osapiensis Koperberg, 1931, Jungtertiäre und Quartäre Mollusken von Timor, Jaarb, Mijnwezen Ned.-Indië, p. 75, pl. 2, fig. 23.

Subcancilla abyssicola (Schepman), Cernohorsky, 1970. Auckland Inst. and Mus. Bull 8, p. 46.

This elongate fusiform species is characterized particularly by its cancellate surface on which closely set axial ribs are crossed and beaded by stronger spirals; the resulting pits are subquadrate and deep; the columella bears four folds.

Measurements of the figured specimen, USNM 174949; height (apex incomplete) 13.2 mm, diameter 5.3 mm.

Occurrence.—Two specimens from station 817 on western Vanua Levu, Fiji; age, Pliocene (Tertiary *h*). Holocene shells have been collected from the Philippines and Indonesia at depths of 300 to more than 4,000 ft. Miss Koperberg's Timor specimens were from the Pliocene.

Subcancilla interlirata (Reeve)

Plate 19, figure 17

Mitra interlirata Reeve, 1844, Conchologica Iconica, *Mitra*, pl. 10, fig. 70.

Mitra pia Dohrn, 1860, Zool. Soc. London Proc., pt. 28, p. 366.

Mitra (Tiara) fijiensis Ladd, 1934, Bernice P. Bishop Mus. Bull. 119, p. 227, pl. 40, fig. 7.

Mitra (Cancilla) interlirata Reeve, Cernohorsky, 1965, Veliger, v. 8, no. 2, p. 106, pl. 16, figs. 36 36a.

Mitra (Cancilla) pia Dohrn, Cernohorsky, 1965, Veliger, v. 8, no. 2, p. 107, pl. 16, figs. 37 37a.

Subcancilla interlirata (Reeve), Cernohorsky, 1970, Auckland Inst. and Mus. Bull. 8, p. 46.

A sharply ridged species characterized particularly by a low secondary ridge between the primary spirals. Described originally from the Philippines but known to range widely in the Indo-Pacific region from Mauritius and the Persion Gulf in the Indian Ocean to Hawaii in the central Pacific. Living examples are moderately rare in Fiji but cannot be distinguished from late Tertiary examples from both Viti Levu (station 165) and Vanua Levu (station 817). Figured specimen, Bernice P. Bishop Museum, Geology No. 1214, measures: height 19.3 mm, diameter 6.4 mm.

Subcancilla malleti (Petit de la Saussaye)

Plate 19, figure 18

Mitra malleti Petit de la Saussaye, 1852, Jour. Conchyiologie v. 3, p. 58, pl. 2, fig. 1.

Subcancilla malleti (Petit de la Saussaye), Cernohorsky, Auckland Inst. and Mus. Bull. 8, p. 46.

Incomplete external molds that probably represent this Holocene Indo-Pacific species were recovered from the Pliocene and Pleistocene Mariana Limestone at USGS locality 17446 on Guam; a single mold from the same formation at USGS locality 20703 is also tentatively referred to *S. malleti.*

The small fusiform shells bear sharp close-set spiral ridges; between the ridges are many fine axial riblets. Diameter of the figured cast, from a limestone mold, USNM 174946, 4.7 mm. The species lives today on Mauritius in the Indian Ocean and in various parts of the southwestern Pacific as far norts as Fiji and Samoa. It has not previously been recorded as a fossil.

Subcancilla nasongoensis (Ladd)

Plate 20, figure 1

Mitra (Tiara) nasongoensis Ladd, 1934, Bernice P. Bishop Mus. Bull. 119, p. 227, pl. 40, fig. 8.

Subcancilla nasongoensis (Ladd), Cernohorsky, 1970, Auckland Inst. and Mus. Bull. 8, p. 46.

No additional material collected. Known only from the holotype (Bernice P. Bishop Mus. Geol. No. 1215) from station 165 on Viti Levu, Fiji; age, late Miocene (Tertiary *g*).

Measurements: height 18.4 mm, diameter 5.9 mm.

Genus CANCILLA Swainson)

Swainson, 1840, Treatise on Malacology; London, Longman, Orme, Brown, Green, and Longmans, p. 130, 320.

Type (by subsequent designation, Herrmannsen, 1846, Indicis generum malacozoorum primordia, v. 1, p. 168).—*Tiara isabella* Swainson, Holocene, Indo-Pacific.

Subgenus DOMIPORTA Cernohorsky

Cernohorsky, 1970, Auckland Inst. and Mus. Bull. 8, p. 49.

Type (by original designation).—*Voluta filaris* Linnaeus. Holocene, Indo-Pacific.

Cancila (Domiporta) carnicolor (Reeve)

Plate 20, figures 2, 3

Mitra carnicolor Reeve, 1844, Conchologica Iconica, v. 2, *Mitra*, pl. 21, fig. 164.

A single incomplete shell from the Pliocene and Pleistocene Mariana Limestone on Guam (USGS locality 21378) probably represents this Holocene species. The spiral ribs of the fossil show less regular alternation in strength than do most Holocene shells, but this feature appears to be somewhat variable.

Measurements of the figured specimen, USNM 650643: height (incomplete) 22.2 mm, diameter 10.1 mm. Living specimens have been collected from Tahiti and other Pacific Islands.

Genus VEXILLUM Roding

Röding, 1798, Mus. Boltenianum: Hamburg, Johan Christi, pt. 2, p. 138.

Type (by subsequent designation, Woodring, 1928, Carnegie Inst. Washington Pub. 385, p. 244).—*Vexillum plicatum* Röding (=*Voluta plicaria* Linnaeus). Holocene, Indo-Pacific.

Subgenus COSTELLARIA Swainson

Swainson, 1840, Treatise on Malacology: London, Longman, Orme, Brown, Green, and Longmans, p. 320.

Type (by monotypy).—*Mitra rigida* Swainson (=*Mitra semifusciata* Lamarck). Holocene, Indo-Pacific.

Vexillum (Costellaria) amanda (Reeve)

Plate 20, figures 4, 5

Mitra amanda Reeve, 1845, Conchologica Iconica, *Mitra*, pl. 38, no. 318.

Uromitra fulleri MacNeil, 1960 (1961), U.S. Geol. Survey Prof. Paper 339, p. 91, pl. 8, fig. 29.

Vexillum amanda (Reeve), Cernohorsky, 1965, Veliger, v. 8, no. 2, p. 116, pl. 18, fig. 73.

Vexillum (Costellaria) amanda (Reeve), Cernohorsky, 1970, Auckland Inst. and Mus. Bull. 8, p. 54.

Shell medium to large, stout, turreted, with strong, gently curved axial ribs; spiral riblets between the axials produce a cancellated appearance; aperture shorter than spire.

Measurements of the figured specimens from Palau: USNM 174944, a large specimen (pl. 20, fig. 4), height 18.9 mm, diameter 7.0 mm; USNM 174945, average-sized specimen (pl. 20, fig. 5), height 9.2 mm, diameter 3.4 mm.

Occurrence.—Abundant in the marls beneath the Palau Limestone at USGS localities 21301 and 21304 north of Goikul and represented by three specimens from the same marls at locality 21308 east of Goikul, Babelthuap, Palau; age, late Miocene (Tertiary *g*); three specimens from station C89 on Viti Levu, Fiji; age, Pliocene (Tertiary *h*). One large shell (SM242–85A) from the Pleistocene marls on the Kere River, Santo, New Hebrides. The species described as *Uromitra fulleri* by MacNeil from the Shinzato Tuff on Okinawa (age, Miocene or Pliocene) seems to be this species. *V. amanda* was originally described from Holocene shells from the Philippines, where it has been widely collected. The U.S. National Museum collections also contain Holocene specimens from Indonesia, the China Sea, Fiji, and Samoa.

Vexillum (Costellaria) cernohorskyi Ladd, n. sp.

Plate 20, figures 6, 7

Small, slender, fusiform; protoconoch consisting of about two smooth, glassy whorls, followed by about seven sculptured whorls; early whorls of the spire nearly flat, later whorls slightly more convex; suture lightly impressed. Sculpture consisting of broad, rounded, slightly curved, axial ribs that are regularly spaced, 10 or 11 on body whorl; weak spiral striae are present in the depressions between axial ribs. Aperture, elongate, shorter than spire; columella with four inclined folds. Traces of four dark bands of color are discernible on the body whorl, the highest one thinner than the other three.

Measurements of the holotype, USNM 650662: height 8.2 mm, diameter 2.7 mm.

V. cernohorskyi is closely related to the living *V. michaui* (Crosse and Fischer) but is smaller and more slender; it has fewer whorls, and these are not angulated immediately below the suture as are those of the living species. *V. michaui* is widely distributed through the Indo-Pacific from Mauritius in the Indian Ocean to Japan and the Marianas in the northwest Pacific, thence southeast to Fiji and Tonga. It has not been recorded from the Marshall Islands.

This species is named for Walter O. Cernohorsky, who has studied the Mitridae of the world.

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

Vexillum (Costellaria) deshayesi (Reeve)

Plate 20, figure 8

Mitra deshayesi Reeve, 1844, Conchologica Iconica, *Mitra*, pl. 22, no. 170.

Vexillum deshayesi (Reeve), Cernohorsky, 1965, Veliger, v. 8, no. 2, p. 123, pl. 22, figs. 114, 114a (see for additional citations).

Holocene shells of this variable species have been fully described by Cernohorsky. The fossils from Eniwetok have stronger axial sculpture and a less prominent siphonal fasciole than most of the many Holocene shells examined. The figured specimen,

USNM 650652, measures: height 15.1 mm, diameter 5.3 mm.

Occurrence.—Three specimens from drill hole F–1, Eniwetok, at a depth of 850–860 ft; age, late Miocene (Tertiary *g*). The species lives today from Mauritius in the Indian Ocean through Indonesia to Tonga and Samoa in southern Polynesia. The Eniwetok shells are the first reported fossils. The species is not known to be living in the Marshall Islands today.

Vexillum (Costellaria) aff. V. discoloria (Reeve)

Plate 20, figure 9

A single fossil from drill hole 2A, Bikini, at a depth of 1,056–1,063 ft (age, early Miocene, Tertiary *f*) is remarkably similar to Holocene shells from several island groups in the western Pacific. Though the fossil shows the overall tan color that characterized Miocene shells from the Marshall Island drill holes, it still retains traces of the dark bands found on all Holocene shells. The fossil is appreciably more slender than all the many Holocene shells examined, but the importance of this difference cannot be determined from a single specimen. The fossil, USNM 650657, measures: height 7.3 mm, diameter 2.6 mm. *V. discoloria* lives today from the Gulf of Oman through the tropical Pacific to Samoa (Cernohorsky, 1965, p. 122, as *V. cruentatum* (Gmelin)).

Vexillum (Costellaria) festum (Reeve)

Plate 20, figure 10

Mitra festa Reeve, 1845, Conchologica Iconica, *Mitra*, pl. 36, fig. 303.
Turricula bancalanensis Bartsch, 1918, Biol. Soc. Washington Proc., v. 31, p. 186.
Vexillum festum (Reeve), Cernohorsky, 1965, Veliger, v. 8, no. 2, p. 126, pl. 19, fig. 83; 1967, Marine shells of the Pacific, p. 170, pl. 40, fig. 282.
Vexillum (*Costellaria*) *festum* (Reeve) Cernohorsky, 1970, Auckland Inst. and Mus. Bull. 8, p. 55.

A stout shell with strong axial ribs; interstices between ribs cancellated by spiral grooves; columella with four plaits. Measurements of the figured specimen, USNM 174943 from drill hole F–1, Eniwetok, 820–830 ft: height 8.5 mm, diameter 3.1 mm.

The Miocene fossils are smaller and more slender than many Holocene shells, but they are well within the limits of variation shown by today's shells.

Occurrence.—Nine specimens from three deep holes on Eniwetok at depths of 663–978 ft; age, late Miocene (Tertiary *g*). Three specimens from drill hole 2A, Bikini, at depths of 925–1,078 ft; age, Miocene (Tertiary *f* and *g*). The species lives today from the Philippines to Fiji.

Vexillum (Costellaria) leucozonias Deshayes

Plate 20, figure 11

Mitra leucozonias Deshayes, 1830, *in* Laborde and Deshayes, Voyage de L'Arabie Pétrée, p. 66; Cernohorsky, 1970, Auckland Inst. and Mus. Bull. 8, p. 55.
Mitra cinceracea Reeve, 1845, Conchologica Iconica, *Mitra*, pl. 38, no. 311.
Mitra judaeorum Dohrn, 1860, Zool. Soc. London Proc., p. 367.
Mitra moana Cate, 1963, Veliger, v. 6, no. 1, p. 28, pl. 5, figs. 6–10.

The above synonomy follows Cernohorsky and is supported by the USNM collections, which indicate that the species, though rare, lives today in localities scattered from the Red Sea to Hawaii. On Eniwetok, a single fossil was recovered from drill hole Mu–4 at a depth of 21.5 ft. It is Holocene in age and well preserved. The specimen, USNM 650651, measures: height 10.8 mm, diameter 4.1 mm. The Eniwetok fossil is the first reported occurrence from the Marshall Islands. The species lives today on Midway but was not recovered from drill holes into that atoll.

The fossil retains much of its original color. The colored areas are the "faded orange" recorded by Mrs. Cate.

Vexillum (Costellaria) obeliscus (Reeve)

Plate 20, figure 12

Mitra obeliscus Reeve, 1844, Conchologica Iconica, v. 2, *Mitra* pl. 15, fig. 107; Cernohorsky, 1965, Veliger, v. 8, no. 2, p. 131, pl. 19, fig. 80; 1970, Auckland Inst. and Mus. Bull. 8, p. 55.
Turricula (*Costellaria*) *obeliscus* (Reeve), Tesch, 1915, Paläont. von Timor, V. Lieferung, p. 49, pl. 80, fig. 106.
Uromitra aff. *U. obeliscus* (Reeve), MacNeil, 1960, U.S. Geol. Survey Prof. Paper 339, pl. 14, fig. 5.

This is a slender species on which strong axial ribs are overridden by flattened spirals to produce a sharply cancellate appearance. Cernohorsky pointed out that today's shells are extremely variable in sculpture and other morphological features. The Fijian fossils cannot be distinguished from Holocene shells from Fiji and other Pacific islands or from at least one of the specimens from the Pliocene Chinen Sand of Okinawa cited by MacNeil as *Uromitra* aff. *U. obeliscus*. The figured Fijian fossil, USNM 650636, measures: height (incomplete) 22.3 mm, diameter 8.0 mm.

Occurrence.—Two specimens from station 817, Vanua Levu, Fiji; age, Pliocene (Tertiary *h*). Known from the Pliocene of Timor. Holocene shells

were described originally from the Philippine Islands and have since been reported from Mauritius through the tropical Indo-Pacific to Fiji where they have been found on the west and southern coasts of Viti Levu (Cernohorsky, 1965).

Vexillum (Costellaria) radius (Reeve)

Plate 20, figure 13

Mitra radius Reeve, 1845, Conchologica Iconica, pl. 37, no. 309.
Vexillum (*Vexillum*) *gembacana* (Martin), Ladd, 1934, Bernice P. Bishop Mus. Bull. 119, p. 228, pl. 40, fig. 9.
Vexillum radius (Reeve), Cernohorsky, 1965, Veliger, v. 8, no. 2, p. 133, pl. 18, fig. 68.
Vexillum (*Costellaria*) *radius* (Reeve), Cernohorsky, 1970, Auckland Inst. and Mus. Bull. 8, p. 55.

Walter Cernohorsky examined the Fijian fossils referred by me to *V. gembacana* (Martin); he found that they could not be distinguished from *V. radius* (Reeve), an uncommon Holocene species in Fiji, described originally from the Philippine Islands. Having now seen the Holocene shell from Fiji, I agree with Cernohorsky's conclusion. The figured specimen (Bernice P. Bishop Mus., Geol. no. 1193) measures: height 14.6 mm, diameter 4.8 mm.

The late Miocene fossils from Viti Levu, Fiji (stations 59 and 165) that I referred to *V. gembacana* (Martin) are thus shifted to the Holocene species, *V. radius;* a specimen from the Pliocene beds at MR20 on Viti Levu is also placed there. A dozen related specimens recovered from 10 Miocene horizons in drill holes on Eniwetok and Bikini do not appear to be conspecific with *V. radius*. They resemble *V. gembacana,* though smaller than most Java fossils. They are grouped as being affiliated with *V. gembacana.*

Vexillum (Costellaria) aff. V. gembacana (Martin)

Plate 20, figure 14

The Marshall Island Miocene fossils tentatively placed here are much smaller than most Java examples of *V. gembacana* (Martin), but there seem to be no other important differences. The Marshall Island fossils are stouter and have fewer whorls than do the shells of *V. radius* cited above. The two species are, however, closely related. The exact relationship between the Marshall Island fossils and those of *V. gembacana* from Indonesia cannot be determined with certainty from available material.

Measurements of the figured specimen from drill hole F–1, Eniwetok, at a depth of 830–840 ft, USNM 175036: height 7.9 mm, diameter 3.0 mm.

Occurrence.—Eniwetok drill holes E–1, F–1, and K–1B at depths 630–920 ft; age, Miocene (Tertiary *f* and *g*) drill hole 2B, Bikini, 1,671–1,682 ft; age, early Miocene (Tertiary *e*).

Vexillum (Costellaria) roseum (Broderip)

Plate 20, figure 15

Tiara rosea Broderip, 1836, Zool. Soc. London Proc., p. 195.
Turricula (*Costellaria*) *pharaonis* A. Adams, 1872, Zool. Soc. London Proc., p. 9, pl. 3, fig. 1.
Turricula (*Costellaria*) *appellii* Jickeli, 1874, Deutsche Malakozool. Gesell. Jahrb., p. 39.
Mitra breviacaudata Sowerby, 1874, Thesourus Conchyliorum, *Mitra,* no. 359, fig. 410.
Vexillum (*Costellaria*) *roseum* (Broderip), Cernohorsky, 1970, Auckland Inst. and Mus. Bull. 8, p. 55.

Medium in size, slender, fusiform, solid; whorls slightly turreted, suture impressed; aperture less than half the height of shell; columella with four plaits. Sculpture consisting of strong, regularly spaced axial folds, overridden by closely set, flattened spiral ribs.

Measurements of the figured specimen, USNM 650658: height 12.0 mm, diameter 4.6 mm.

The single Eniwetok fossil is less strongly shouldered than the examples figured by Adams and Sowerby.

Occurrence.—Drill hole E–1, Eniwetok, at a depth of 230–240 ft; age, probably Pleistocene. Holocene shells have been recorded from South Marutea (Lord Hood's Island), the Tuamotu Islands, Mauritius, and the Red Sea.

Vexillum (Costellaria) strasfogeli Ladd, n. sp.

Plate 20, figure 16

Small, stout; protoconch incomplete but apparently smooth, followed by about seven sculptured whorls that are nearly flat and slightly angulated at the sutures; aperture less than half the total length; columella with four strong folds. Sculpture consisting of strong, narrow, slightly curved axial ribs, 17–19 on the penultimate whorl, and closely set spiral ribs in the intervening areas, 10–11 on the penultimate whorl; spiral sculpture becomes dominant near the base, the spirals nodose.

Measurements of the holotype, USNM 174947: height 14.8 mm, diameter 5.7 mm.

V. strasfogeli appears to be closely related to the living *V. radix* (Sowerby) but is smaller, has sharper axials, and more numerous spiral ribs. The fossil form may be ancestral to *V. radix,* a species that lives in Fiji today.

This species is named for Andrew L. Strasfogel, Peace Corps Volunteer Geologist with the Fiji Geological Survey, who conducted a training course for

geological assistants, during which many fossils were collected.

Occurrence.—Five specimens from station 817 in western Vanua Levu, Fiji; one questionable specimen from K138, a station about 3 miles to the east; age of all specimens, probably Pliocene (Tertiary *h*).

Vexillum (Costellaria) stainforthi (Reeve)

Plate 20, figure 17

Mitra stainforthii Reeve, 1844, Conchlogica Iconica, v. 2, *Mitra*, pl. 3, no. 13.

Vexillum (Costellaria) stainforthii (Reeve), Cernohorsky, 1970, Auckland Inst. and Mus. Bull. 8, p. 55.

A large shell with strong axial ribs that are crossed by fine, closely set, spiral grooves.

Measurements of the figured specimen, USNM 175054: height (incomplete) 32.5 mm, diameter 10.7 mm.

Occurrence.—Two specimens from USGS locality 25257, west coast of Santo, New Hebrides; age, Quaternary. The species lives today in many parts of the western Pacific.

Vexillum (Costellaria) aff. V. zebuense (Reeve)

Plate 20, figure 18

An incomplete mold (USNM 650653) of a medium-sized, fusiform mitrid shows sculptural features that suggest *V. zebuense* (Reeve). Strong axial ribs with narrow flattened crests are overridden and slightly notched by narrow spiral grooves that separate wide flattened areas. Measurements of the figured cast from USNM 650653: height (incomplete) 11 mm, diameter 7.5 mm.

Occurrence.—A single specimen from the Pliocene and Pleistocene Mariana Limestone of Guam (USGS loc. 20674). The living *V. zebuense* is found in the western Pacific from the Philippines, through Fiji, to Polynesia. (Cernohorsky, 1965, p. 141).

Subgenus PUSIA Swainson

Swainson, 1840, Treatise on Malacology, p. 320.

Type (by monotypy).—*Pusia microzonis* (Lamarck) (=*Mitra microzonias* Lamarck) Holocene, Indo-Pacific.

Vexillum (Pusia) approximatum (Pease)

Plate 20, figure 19

Turricula approximata Pease, 1860, Zool. Soc. London Proc., p. 146.

Mitra dimidiata Sowerby, 1870, Zool. Soc. London Proc., p. 259.

Vexillum xenum Pilsbry, 1920, Acad. Nat. Sci. Philadelphia Proc., p. 317, pl. 12, fig. 25.

Vexillum (Pusia) approximatum (Pease), Cernohorsky, 1970, Auckland Inst. and Mus. Bull. 8, p. 56.

The Eniwetok fossil is smaller than Holocene shells from Hawaii, including a fossil from Midway, but is identical with them in all other respects.

Measurements of the figured specimen, USNM 650656: height (apex incomplete) 12.0 mm, diameter 5.5 mm.

Occurrence.—A single fossil from drill hole K1–B, Eniwetok, at a depth of 925–937 ft; age, early Miocene (Tertiary *f*). The species has been collected only in Hawaii but at several localities from the island of Hawaii on the southeast to Midway on the northwest. At Midway, it was also found in the Sand Island drill hole at a depth of about 147 ft; age, probably Holocene.

Vexillum (Pusia) exquisitum (Garrett)

Plate 21, figure 1

Mitra exquisita Garrett, 1872, Zool. Soc. London Proc., p. 842.

Mitra suavis Souverbie, 1875, Jour. Conchyliologie v. 23, p. 283, pl. 13, fig. 2.

Vexillum equisitum (Garret), Cate, 1963, Veliger, v. 6, p. 33, pl. 6, fig. 23.

Shell small, stout, fusiform; whorls with prominent, rounded shoulders and a series of strong axial ribs; columella with four plaits. The shells of living examples have two dark-brown spiral lines on the body whorl that enclose a milk-white band. Traces of this color pattern are retained on the single fossil.

Measurements of the figured specimen, USNM 650655: height 5.5 mm, diameter 2.3 mm.

Occurrence.—A single specimen from drill hole E–1, Eniwetok, at a depth of 100–110 ft; age, probably Holocene. The species lives today in several island groups from Japan through Fiji and the Tuamotus to Hawaii.

Vexillum (Pusia) microzonias (Lamarck)

Plate 21, figure 2

Mitra microzonias Lamarck, 1811, Mus. Histoire Nat. Paris Annales, 17, p. 218.

Vexillum (Vexillum) vavakuana Ladd, 1945, Bernice P. Bishop Mus. Bull. 181, p. 367, pl. 52, fig. W.

Pusia microzonias (Lamarck), Cernohorsky, 1965, Veliger, v. 8, no. 2, p. 148, pl. 21, figs. 110, 110a.

Vexillum (Pusia) microzonias (Lamarck), Cernohorsky, 1970, Auckland Inst. and Mus. Bull. 8, p. 56.

The only fossil occurrence is the small shell that I described in 1945 as *Vexillum vavakuana*. This specimen (Univ. Rochester Mus. Natl. History 13068) was collected from the Ndalithoni Limestone at station 110B on Vanua Mbalavu, Fiji; age, Pliocene (Tertiary *h*). It measures: height 9.3 mm, diameter 4.1 mm. *V. microzonias* lives today throughout Fiji

and in many other parts of the western Pacific, from Indonesia to the Marshall Islands.

Family HARPIDAE

Fossil representatives of the Harpidae are not abundant in the island area. Only seven specimens have been found to date, and all of these are incomplete. Two are from the Miocene, one from Fiji, the other from Eniwetok; the third is a mold from the upper Tertiary of Guam, and the remaining four are from the Quaternary of the New Hebrides. Before attempting specific identifications, I learned of Harald Rehder's (1973) monographic study of the family in "Indo-Pacific Mollusca" (since published, Rehder, 1973). I turned the island fossils over to him, and he is largely responsible for the descriptions that follow.

Genus EOCITHARA P. Fischer

Fischer, P., 1883, Man. Conch. et de Paléont. Conchyliologique, Paris, p. 601.

Type (by monotypy).—*Harpa mutica* Lamarck. Eocene, France.

Eocithara? sp. A

Plate 21, figure 3

A single fossil, an incomplete shell from the lower Miocene (Tertiary *f*) of Lakemba (station L389) in Fiji, may represent this genus, but the definitive columellar area is not preserved. The upper ends of the axial ribs are not extended by callus as in *Harpa amouretta* Röding, the common living Indo-Pacific harp, but this difference may be largely due to poor preservation.

Measurements of the single fossil specimen, USNM 174977: length (incomplete) 30 mm, diameter 26 mm.

The Fijian shell bears a general resemblance to a smaller species described by Martin from the lower Miocene of Java as *Harpa* (*Eocithara*) *muticaeformis* (Martin, 1916, p. 231, pl. 1, fig. 15).

Eocithara? sp. B

Eocithara species Rehder, (1973), Indo-Pacific Mollusca, v. 3, no. 16, p. 231.

A fragment of a second specimen that may represent the genus *Eocithara* was recovered from drill hole E–1, Eniwetok at a depth of 830–840 ft; age, late Miocene (Tertiary *g*). Harald Rehder, who examined the specimen, stated that the fragment, 15 mm long, consisted of "only the anterior canal and sinus, the lower portion of the columellar lip, and a part of the body whorl comprising three complete ribs from their procurved end to the siphonal fasciole and anterior canal." His assignment to *Eocithara* was

> based on the low, not broadly expanded, procurved end of the ribs and the nature of the siphonal fasciole that is strongly convex on the ventral surface and separated from the lower end of the columellar callus by a deep furrow which suggests a pseudoumbilical chink.
>
> The fairly crowded ribs are low, somewhat flattened in their upper portion, with faint paired color lines visible under magnification. The interspaces show flattened spiral cords, crossed by irregular axial growth striae. The crowded microscopic axial striae present in *Harpa major* Röding are absent, and the aspect of the sculpture is generally distinct from that found in the Recent species of *Harpa*.

Rehder noted that if properly placed in *Eocithara*, the Eniwetok shell is the latest known occurrence of the genus.

Genus HARPA Roding

Röding, 1798, Mus. Boltenianum: Hamburg, Johan Christi, pt. 2, p. 149.

Type (by absolute tautonomy).—*Buccinum harpa* Linnaeus. Holocene, Mauritius.

Harpa amouretta Roding

Plate 21, figure 4

Harpa amouretta Röding, 1798, Mus. Boltenianum: Hamburg, Johan Christi, pt. 2, p. 150; Kira, 1962, Shells of the western Pacific in color, v. 1, p. 90, pl. 32, fig. 16: Rehder, 1973, Indo-Pacific Mollusca, v. 3, no. 16, p. 240, pls. 183, 189, figs. 6–11, pl. 211.

Harpa minor Lamarck, 1822, Animaux sans Vertèbres v. 7, p. 257; Reeve, 1843, Conchologica Iconica, *Harpa* pl. 3, fig. 6.

This widely distributed Indo-Pacific species is represented in the fossil collections by a single mold collected from the Talisay Member of the Alifan Limestone on Guam (USGS loc. 20640); age, Tertiary *g* and *h*. The incomplete mold, USNM 174978, measures 16 mm in diameter.

Harpa major Roding

Plate 21, figures 5, 6

Harpa major Röding, 1798, Mus. Boltenianum: Hamburg, Johan Christi, pt. 2, p. 149, Cernohorsky, 1972, Marine shells of the Pacific, v. 2, p. 168, pl. 1, fig. 8; pl. 50, fig. 1; Rehder, 1973, Indo-Pacific Mollusca, v. 3, no. 16, p. 245, pl. 183; pl. 188, figs. 8–11, pl. 214.

Represented in the collection by three specimens from station SM242 on Santo, New Hebrides. All three shells retain traces of original color. The most nearly complete shell, New Hebrides Geological Survey, station SM242, 55A, is figured. It measures: length 49.5 mm, diameter 32.7 mm. A single incomplete mold collected at USGS locality 21032 on Santo probably represents the same species. *H. major* lives

today throughout the tropical Pacific. Cernohorsky's treatment includes a figure in color of a shell from the New Hebrides. Rehder's account includes colored views of shells and extended soft parts. All the New Hebrides fossils are Pleistocene.

LOCALITIES

Some of the fossils described in the present report were collected from localities not listed or shown on maps in the previous reports (Ladd 1966, 1972) and, in addition, from several small islands in Fiji (Matangi, Lauthala, Ngau, Viwa, Nanuyanuy) not previously reported upon. The locality data given below supplement those given previously by Ladd (1966, p. 81–89; 1972, p. 63–69).

Palau

Island	*U.S. Geological Survey Cenozoic locality*	*Locality and Collector*
Auluptagel	21290	*Acropora* zone at base of Palau Limestone, immediately above contact with underlying volcanic rock, northeast end of island, altitude 0–6 ft. H. S. Ladd, 1958.

Mariana Islands

[Guam localities shown in fig. 2; Saipan localities, in fig. 3]

Island	*U.S. Geological Survey Cenozoic locality*	*Locality and collector* [1]
Guam	20488	1,900 yd north-northwest of Barrigada Hill, waist of island.
Do	20508	1,600 ft southeast of Sinajana, waist of island.
Do	20512	3,500 ft north-northwest of Pago Bay beach, waist of island.
Do	20541	4,800 ft southeast of Ordot, waist of island.
Do	20562	About 2⅓ miles northwest of Taogam Point, waist of island.
Do	20568	3,300 ft northeast of Sinajana, waist of island.
Do	20580	About 1.4 miles north of Taogam Point, waist of island.
Do	20598	About 1⅓ miles north-northwest of Taogam Point, waist of island.
Do	20608	About 2 miles north-northwest of Fadian Point, waist of island.
Do	20633	About 1½ miles southeast of Sinajana, waist of island.

[1] Collector is Pacific Islands Engineers, 1946–50, unless otherwise indicated.

Mariana Islands—Continued

Island	*U.S. Geological Survey Cenozoic locality*	*Locality and collector* [1]
Do	20640	1,600 ft southeast of Mount Almagosa, southern part of island.
Do	20676	About 5,000 ft southeast of Toto, waist of island.
Do	20680	Adelup Point, immediately west of Agana, waist of island.
Do	20681	Asan Point, northwest coast of island.
Do	20703	About 0.7 mile southeast of Sinajana, waist of island.
Do	20726	About 1,900 ft southeast of east end of Drydock Causeway, Apra Harbor area.
Do	20734	4,000 ft south-southwest of Ordot, waist of island.
Do	20742	About 4,500 ft east-southeast of Tantapalo Point, west coast of island.
Do	20745	1¼ miles southeast of Tamuning, waist of island.
Do	20762	About 6,000 ft east-northeast of Ordot, waist of island.
Do	20989	Cascajo pit about 2 miles east of Mount Alifan on west bank of Talisay River, altitude 350 ft. J. T. Alexander.
Do	21378	About 1¼ miles southwest of Pago Point, waist of island.
Do	21381	Along road 1.2 miles south-southeast of Agana, waist of island, west coast. H. S. Ladd, 1958.
Do	21397	About 1 mile north of head of Ylig Bay, east coast of island. H. S. Ladd, 1958.
Do	21591	Cabras Island off west coast of Guam, P. E. Cloud.
Saipan	17675	About 2¾ miles east of Muchot Point, in center of island. R. G. Schmidt and P. E. Cloud, 1948.
Do	17890	About 2½ miles north-northwest of Naftan Point, south end of island. P. E. Cloud, 1949.

Marshall Islands

Eniwetok Atoll	Aranti Island	Sample	S1	Near bottom of trench in northeast quarter of island about three ft above mean tide level. H. S. Ladd, 1971.

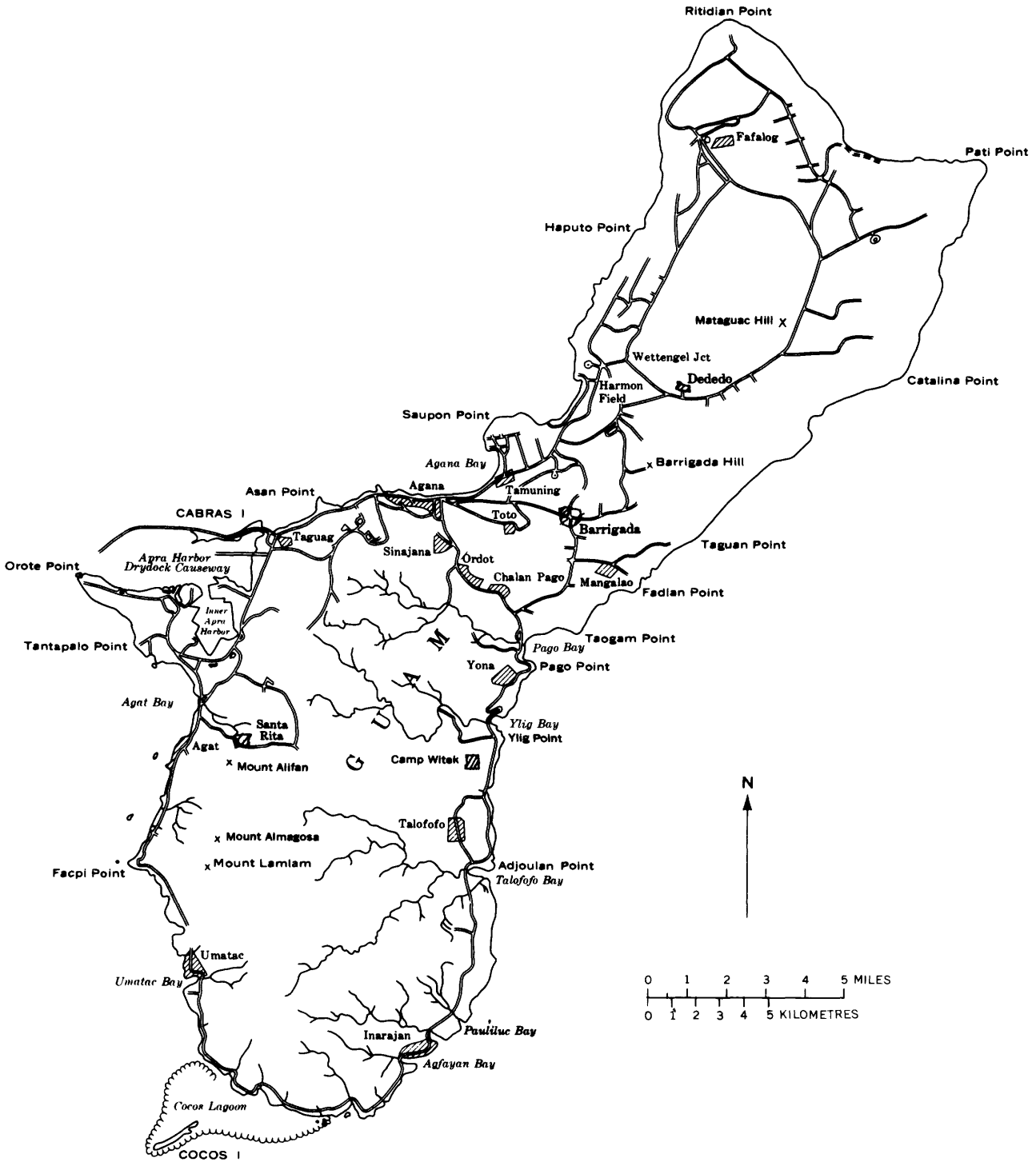


FIGURE 2.—Sketch map of Guam, Mariana, Island, showing villages and physiographic features used in identifying U.S. Geological Survey fossil localities.

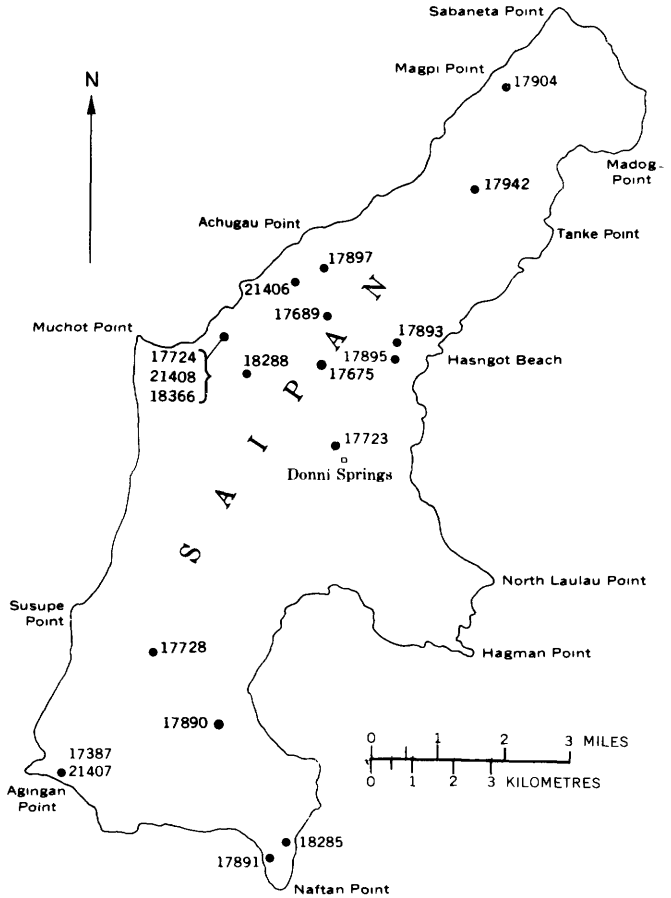


FIGURE 3.—Sketch map of Saipan, Mariana Islands.

New Hebrides

[Fossil localities shown in fig. 4]

Island	*U.S. Geological Survey Cenozoic locality*	*Station*	*Locality and collector*
Santo	21032		Emerged reef north of Segund Channel at altitude of 125 ft. H. T. Stearns, 1943.
Do	24918	SM43	Navaka River section, long 166° 15.04′ E.; lat 15° 36.08′ S.; altitude 165 ft. D. I. J. Mallick.
Do	25257	SM60	West coast; from basal part of reefal limestone. D. I. J. Mallick.
Do	25258	SM236	Navaka River section; calcarenite/calcilutite, below station SM43 in sequence. D. I. J. Mallick.
Do	25259	SM239	Navaka River section; marine band in mainly nonmarine sequence. D. I. J. Mallick.
Do	25379	SM242	Upper Kere River, lat 15° 34′ S; long 166° 56.74′ E.; altitude 70 m (230 ft). D. I. J. Mallick.
Do	25380	SG80	Sankata River, lat 15°26′30″ S., long 167°05′45″ E; altitude 50 m (165 ft) D. I. J. Mallick.
Do		SG84	River debris near station SG80.
Do	25385	SM259	Wambu River; lat 15°28.48′ S.; long 166°58.20′ E.; altitude 260 m (850 ft) D. I. J. Mallick.
Do	25715, 25717, 25718		Kere River about 4 miles inland (same as USGS loc. 25379). T. R. Waller, J. Bolango, W. Blow.
Do	25734, 25742		Navaka River (same as USGS loc. 24918). T. R. Waller, J. Bolango, W. Blow.

Fiji

Island	*Station*	*Figure showing locality*	*Locality and collector*
Vitu Levu	303	5	About 6¼ miles out of Wairuarua en route to Numbumakita. H. S. Ladd, 1928.
Do	C142	5	Ndevondevondrandra Creek, near Rewasau. P. Rodda.
Do	C148	5	Waisere Creek, about 2½ miles northwest of Rewasau. P. Rodda.
Do	C497	5	South-facing cut in marl immediately behind Carlton Brewery on Queen's Road, west side of Walu Bay, Suva. P. Rodda, R. Band, W. Briggs, H. Ladd, and others (same as FB 13 and USGS loc. 25142).
Do	C742	5	Top of southern extremity of central plateau, Waisavu; lat 17°53.4′ S., long 177°58.5′ E. P. Rodda.
Do	C1133	5	Near Lautoka; lat 17°39.5′ S., long 177°26.8′ E. P. Rodda.
Do	C1142	5	Korotambua Creek, 100 to 200 m downstream from bridge on the Marinitawa Rd., lat 17°36.3′ S., long 177°40.9′ E. P. Rodda.

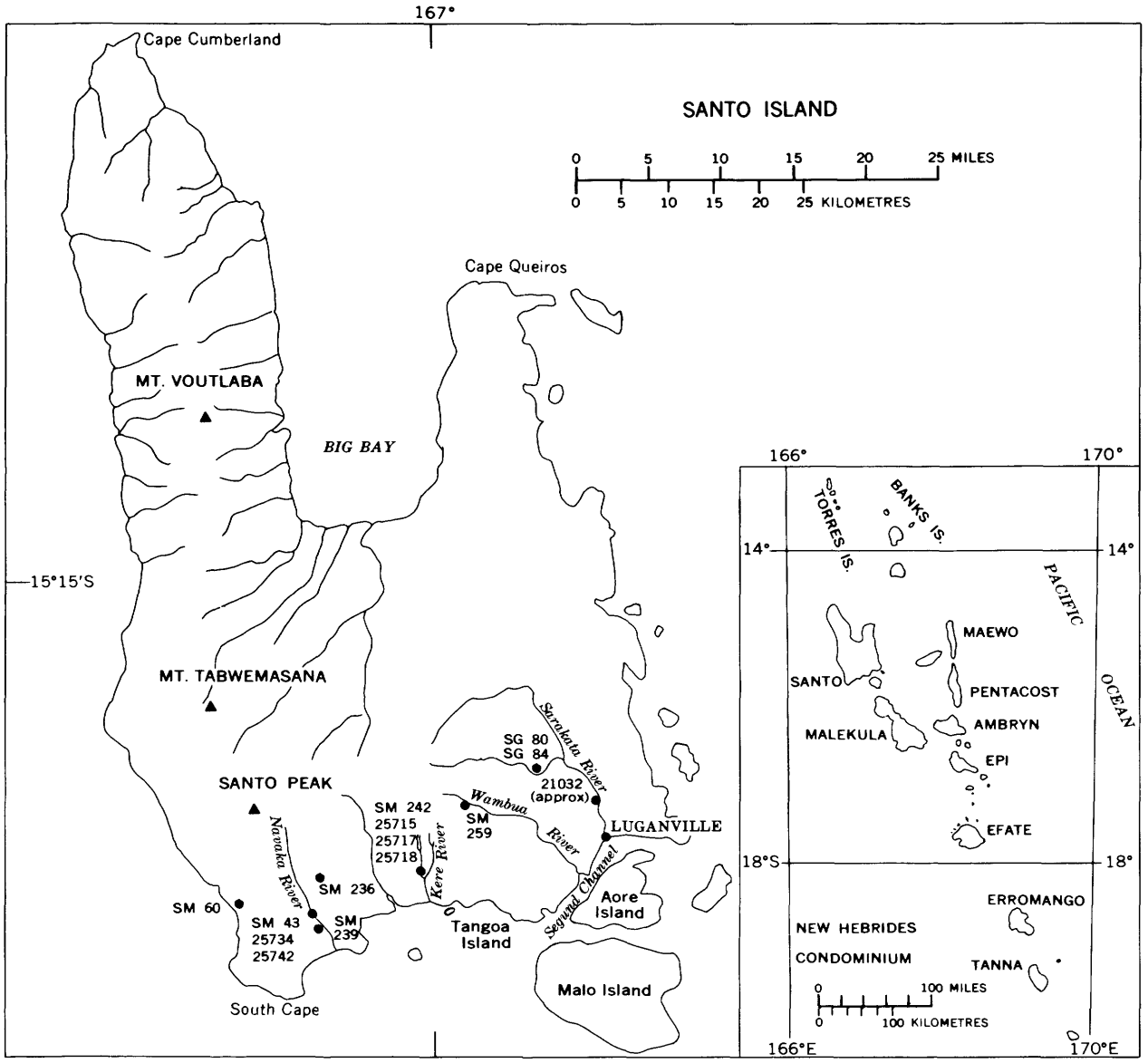


FIGURE 4.—Sketch map showing fossil localities on Santo, New Hebrides.

Fiji—Continued

Island	*Station*	*Figure showing locality*	*Locality and collector*
Nanuyanuya	C1640	-----	Islet near Viwa, northwest of Viti Levu; lat 17°09.2′ S., long 176°54.3′ E. P. Rodda. (Islet not shown in fig. 5.)
Vitu Levu	FB13	5----	Same as C497 and U.S. Geological Survey locality 25142. W. M. Briggs, Jr.
Do	MR89	5----	Mbusa Creek, about 3 miles southwest of Nanoko, Sheet 5 of Fiji Geol. Survey. M. J. Rickard.
Do	RB32	5----	Approximately half a mile northwest of Pilia trigonometric station, which is 3½ miles south of Lautoka. R. W. Bartholomew.
Do	RB44	5----	Approximately 1 mile northeast of Pilia trigonometric station, which is 3½ miles south of Lautoka. R. W. Bartholomew.
Do	25142	5----	Same as C497 and FB13.

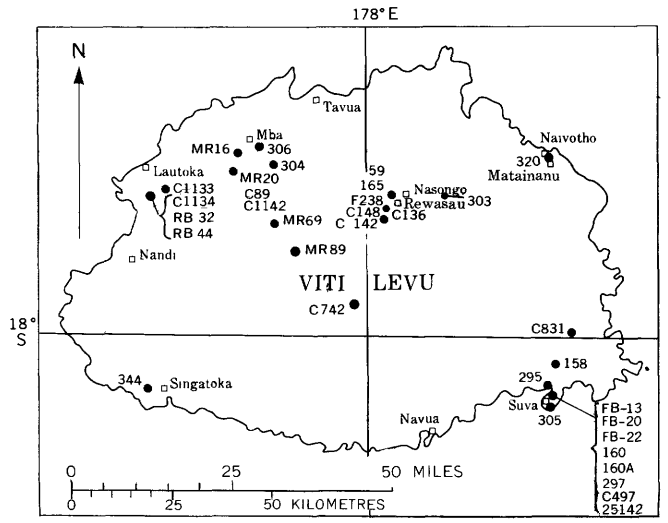


FIGURE 5.—Fossil localities on Viti Levu, Fiji, and nearby islands. Localities shown here but not described in this report have been described by Ladd (1966, p. 86; 1972, p. 66–67).

Fiji—Continued

Island	*Station*	*Figure showing locality*	*Locality and collector*
Vanua Levu__	1136	6____	About one-fourth mile south of Nakambuta trigonometric station, Saivou, Mathuata. P. Ibbotson, 1965.
Do ----------	B82	6____	4½ miles north of mouth of Wainunu River.
Do ----------	K63	6____	About 2,000 ft west and 600 ft north of station 817. William H. Hindle.
Do ----------	K138	6____	Nakakawandawa Creek, about 3 miles due east of station 817. William H. Hindle.
Do ----------	K700	6____	Lower Navilevu River about half a mile above junction with Wainanu River (lat 16°48.0′ S, long 178°53.6′ E). William H. Hindle.
Do ----------	K714	6____	Ndavutu Creek, at crossing with main Nandua-Ndawara track. (lat 16°48.8′ S, long 178°55.35′ E). William H. Hindle.

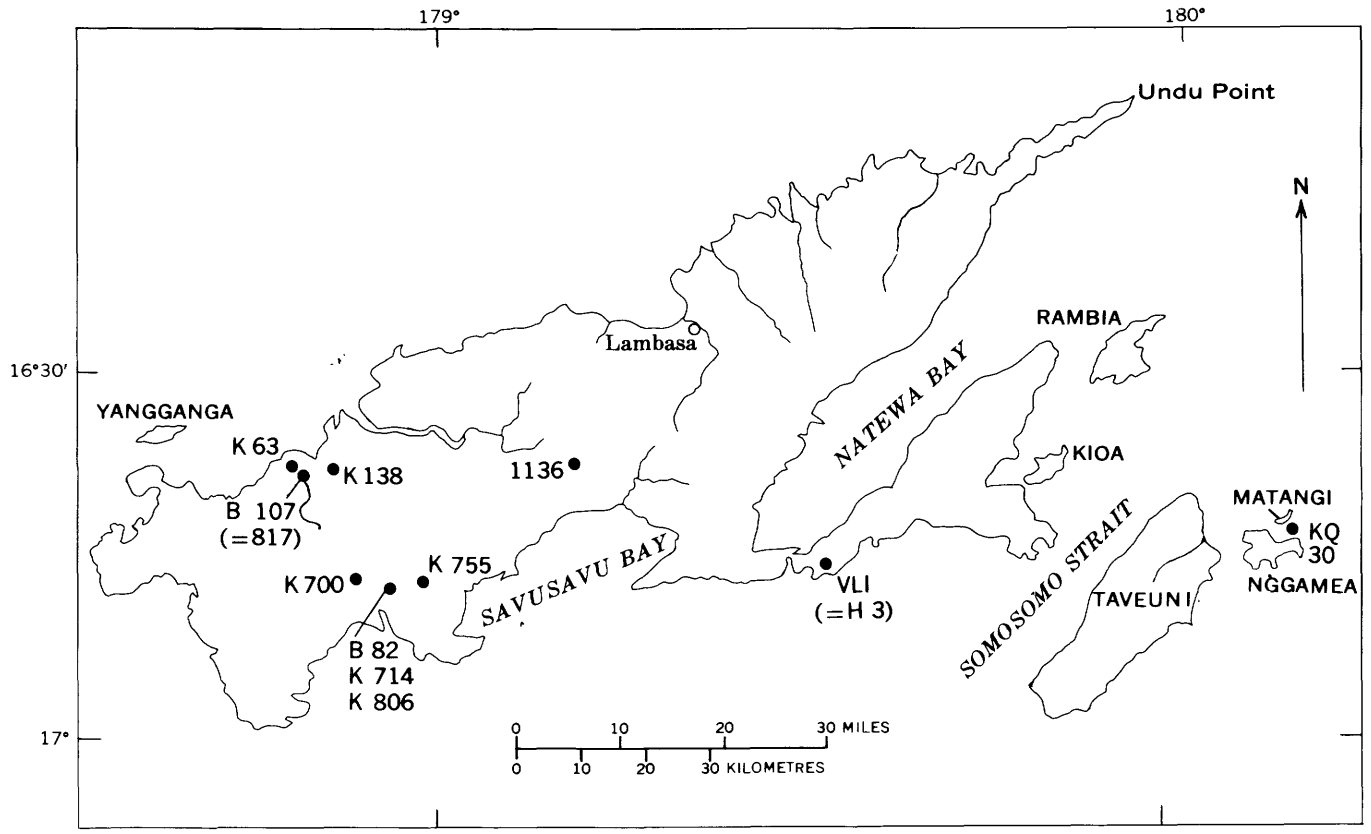


FIGURE 6.—Fossil localities on Vanua Levu, Fiji, and nearby islands.

Fiji—Continued

Island	Station	Figure showing locality	Locality and collector
Do	K755	6	Kilaka River, 200 yds below junction with Mbengga Creek (lat 16°48.8′ S, long 178°59.75′ E). William H. Hindle.
Vanua Levu	K806	6	Ndawandingo Creek, off Wainunu River (approx. lat 16°50.5′ S., long 178°56.2′ E), William H. Hindle.
Do	VL1 (=H3)	6	Breast-cut on south coastal road north of Naweni, 4 miles east of Salt Lake. R. W. Bartholomew 1957; William H. Hindle and others later.
Matangi	KQ30	6	Volcanic tuff on small island east of Tavenui. William H. Hindle.

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PLATES 1-23

Contact photographs of the plates in this report are available, at cost,
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PLATE 1

FIGURES 1, 2. *Pisulina adamsiana* G. and H. Nevill (p. 14).
Diameter 6.0 mm (× 6). Drill Hole E–1, Eniwetok, depth 30–40 ft; Holocene. USNM 174942.

3. *Argyropeza? suvaensis* Ladd, n. sp. (p. 15).
Height 10.6 mm (× 6). Station C497, Suva, Fiji; early Miocene (Tertiary *f*). USNM 174966.

4. *Cerithium* (*Cerithium*) aff. *C. novaehollandiae* A. Adams (p. 16).
Height 18.7 mm (× 3). Station 44 of R. W. Bartholomew, Viti Levu, Fiji, probably Pliocene (Tertiary *h*). British Mus. No. GG13317.

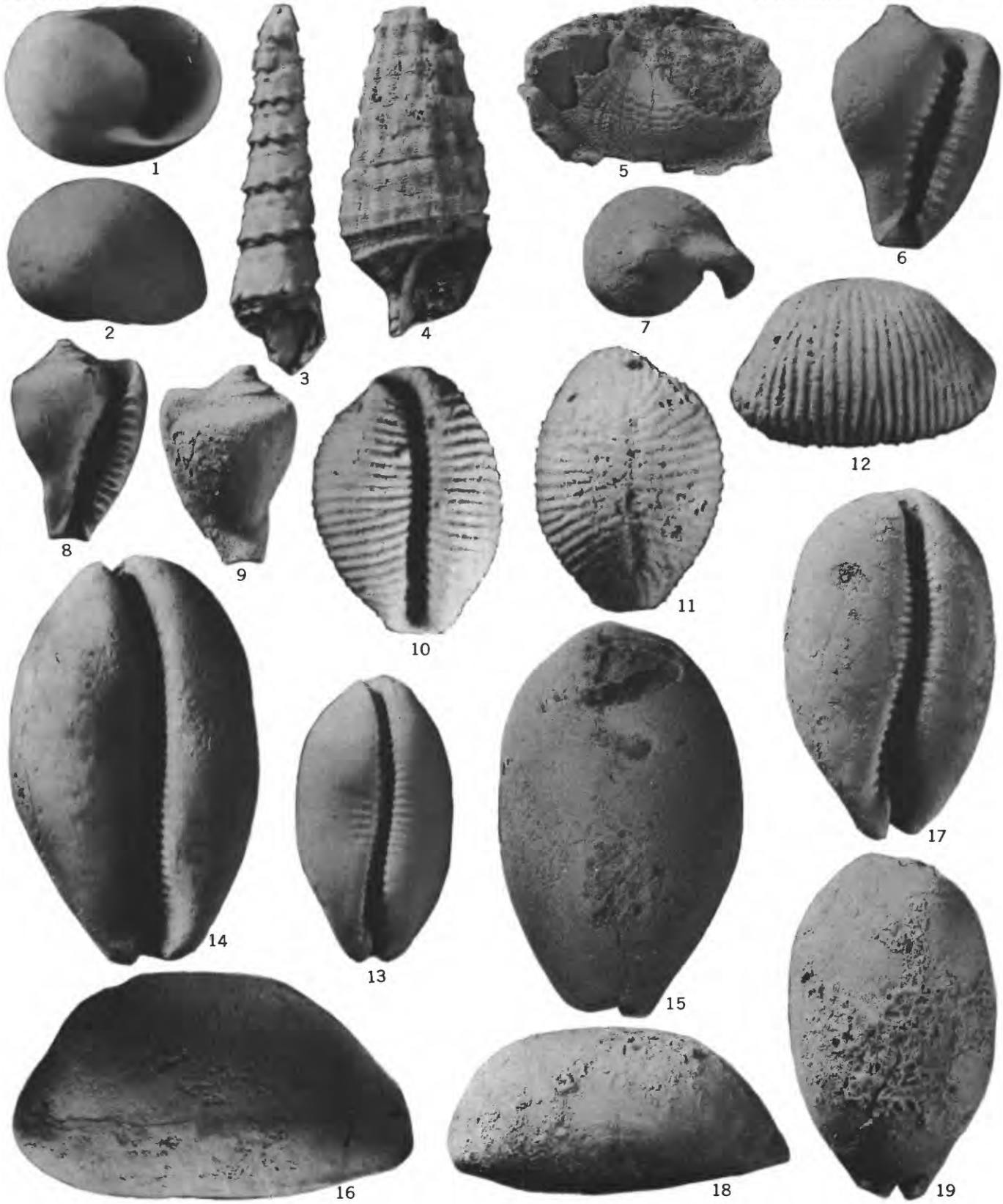
5. *Tugurium* aff. *T. exutum* (Reeve) (p. 17).
Height 14 mm (× 1). Station 44 of R. W. Bartholomew, Viti Levu, Fiji; probably Pliocene (Tertiary *h*). British Mus. No. GG13318.

6–9. *Erato hindlei Ladd,* n. sp. (p. 17).
6, 7. Holotype, length 8.6 mm (× 5). Station K138, Vanua Levu, Fiji; Pliocene (Tertiary *h*). USNM 650625.
8, 9. Paratype, length 6.9 mm (× 5). Station 817, Vanua Levu, Fiji; Pliocene (Tertiary *h*). USNM 650626.

10–12. *Trivia* (*Trivirostra*) *oryza* (Lamarck) (p. 17).
Length 4.6 mm (× 10). Drill hole 2A, Bikini, Marshall Islands, depth 841–847 ft; late Miocene (Tertiary *g*). USNM 174983.

13. *Cypraea* (*Luria*) *isabella* Linnaeus (p. 18).
Length 16.7 mm (× 3). Drill hole E–1, Eniwetok, depth 60–70 ft; Holocene. USNM 174960.

14–19. *Cypraea* (*Luria*) *isabella lekalekana* Ladd (p. 18).
14–16. Holotype, length 37.0 mm (× 2). Station 160, Viti Levu, Fiji; early Miocene (Tertiary *f*). Bernice P. Bishop Mus., Geol. No. 1148.
17–19. Eastern Fiji specimen, length 20.7 mm (× 3). Station 110B, Vanua Mbalavu, Fiji; Pliocene (Tertiary *h*). Univ. Rochester, Mus. Nat. History No. 13061.



NERITIDAE, CERITHIIDAE, XENOPHORIDAE, ERATOIDAE, AND CYPRAEIDAE

PLATE 2

FIGURES 1, 2. *Cypraea* (*Mauritia*) *arabica* Linnaeus (p. 19).
Length 51.7 mm (× 1). USGS loc. 21028, New Hebrides; probably Pleistocene. USNM 174958.

3, 4. *Cypraea* (*Talparia*) *talpa* Linnaeus (p. 19).
Length 52.3 mm (× 1). USGS loc. 20531, Guam; Pliocene or Pleistocene. USNM 174975.

5. *Cypraea* (*Cypraea*) cf. *C. tigris* Linnaeus (p. 19).
Length 75.0 mm (× 1). USGS loc. 20730, Guam; late Miocene (Tertiary *g*) or Pliocene (Tertiary *h*). USNM 650420.

6, 7. *Cypraea* (*Lyncina*) *lynx* Linnaeus (p. 19).
Length 46.6 mm (× 2). USGS loc. 20534, Guam; Pliocene (Tertiary *h*) or Pleistocene. USNM 174961.

8, 9. *Cypraea* (*Lyncina*) *carneola* Linnaeus (p. 20).
Length 27.5 mm (× 3). USGS loc. 21028, New Hebrides; probably Pleistocene. USNM 174962.

10, 11. *Cypraea* (*Lyncina*) *carneola lakemba* Ladd (p. 20).
Holotype, length 42.3 mm (× 2). Station L493 Lakemba, Fiji; early Miocene (Tertiary *f*). Univ. Rochester, Mus. Nat. History No. 13060.

CYPRAEIDAE

PLATE 3

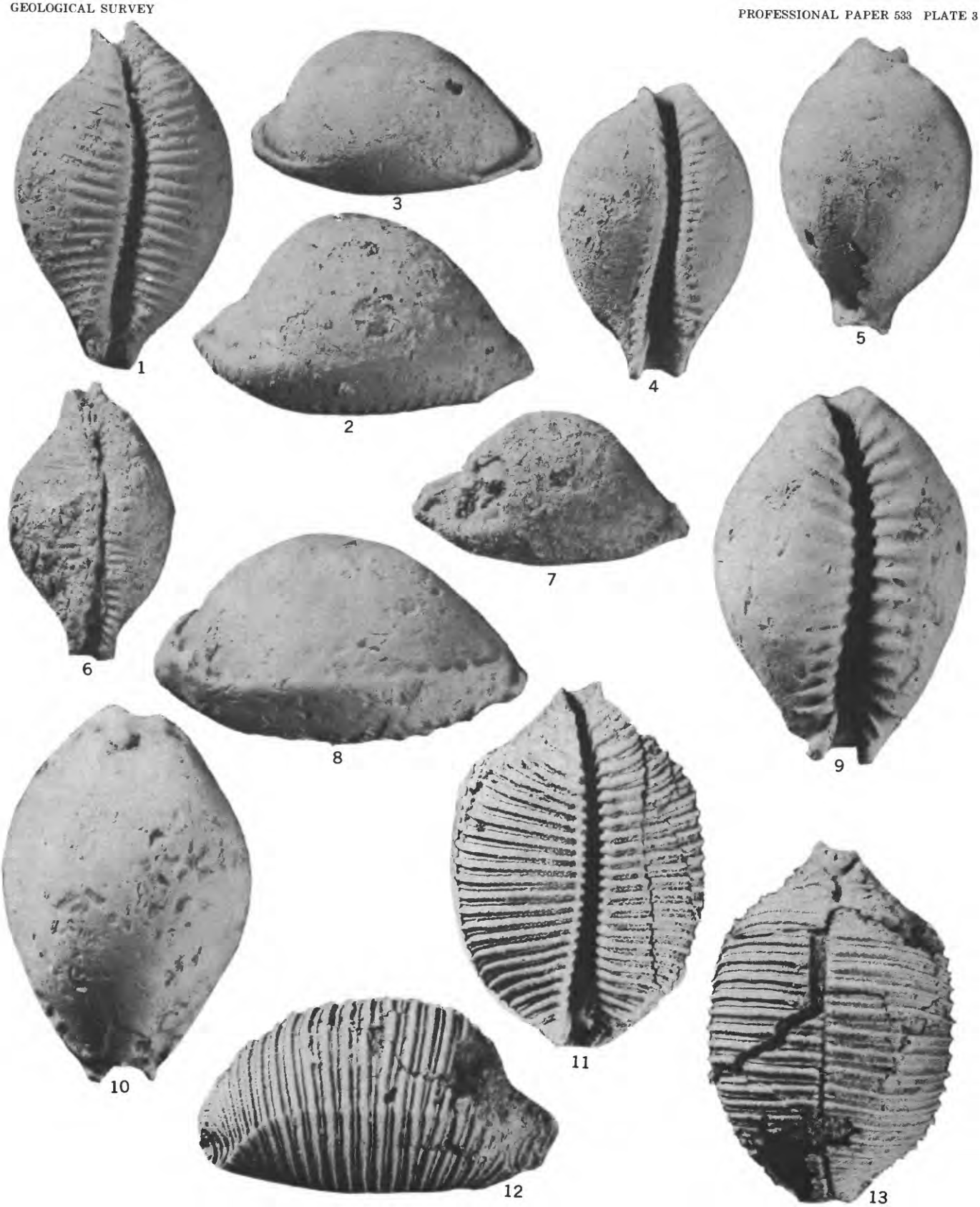
FIGURES 1, 2. *Cypraea* (*Pustularia*) *cicercula* Linnaeus (p. 21).
Length 20.3 mm (× 3). USGS loc. 21028, New Hebrides, probably Pleistocene. USNM 174956.

3–5. *Cypraea* (*Pustularia*) *margarita* Dillwyn (p. 21).
Length 10.9 mm (× 5). Station 110C, Vanua Mbalavu, Fiji; Pliocene (Tertiary *h*). Univ. Rochester, Mus. Nat. History No. 13065.

6, 7. *Cypraea* (*Pustularia*) *globulus* Linnaeus (p. 21).
Length 17.0 mm (× 3). USGS loc. 20730, Guam; Pliocene or Pleistocene. USNM 174663.

8–10. *Cypraea* (*Pustularia*) *everwijni* Martin (p. 21).
Length 13.9 mm (× 5). Station 160, Viti Levu, Fiji; early Miocene (Tertiary *f*). Bernice P. Bishop Mus., Geol. No. 1152.

11–13. *Cypraea* (*Pustularia*) *childreni* Gray (p. 22).
Length 22.4 mm (× 3). Station 160, Viti Levu, Fiji; early Miocene (Tertiary *f*). USNM 650637.



CYPRAEIDAE

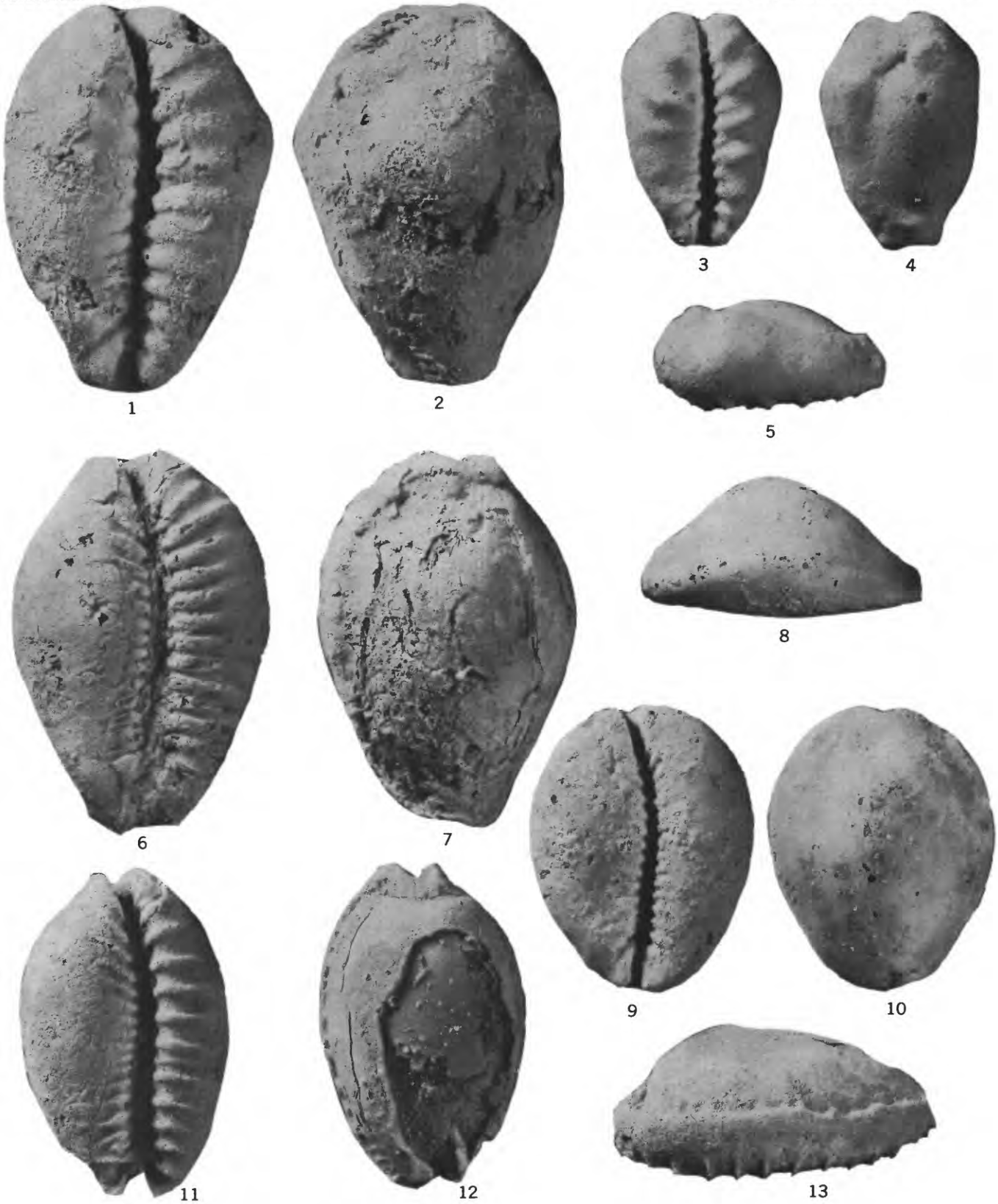
PLATE 4

FIGURES 1–5. *Cypraea* (*Monetaria*) *moneta* Linnaeus (p. 22).
1, 2. Length 23.1 mm (× 3). USGS loc. 17893, Saipan; probably Pleistocene. USNM 648287.
3–5. Length 14.0 mm (× 3). Drill hole K–1, Eniwetok, 33–44 ft; Holocene. USNM 648288.

6, 7. *Cypraea* (*Erosaria*) *erosa* Linnaeus (p. 22).
Length 35.5 mm (× 2). USGS loc. 20732; Pliocene or Pleistocene. USNM 174964.

8–10. *Cypraea* (*Erosaria*) *caputserpentis* Linnaeus (p. 23).
Length 38.5 mm (× 1.5). USGS loc. 21028, New Hebrides, probably Pleistocene. USNM 650563.

11–13. *Cypraea* (*Erosaria*) *labrolineata* (Gaskoin) (p. 23).
Length 19.4 mm (× 3). Station 44, Viti Levu, Fiji; Pliocene (Tertiary *h*). British Mus. No. GG13319.



1 2 3 4 5 6 7 8 9 10 11 12 13

CYPRAEIDAE

PLATE 5

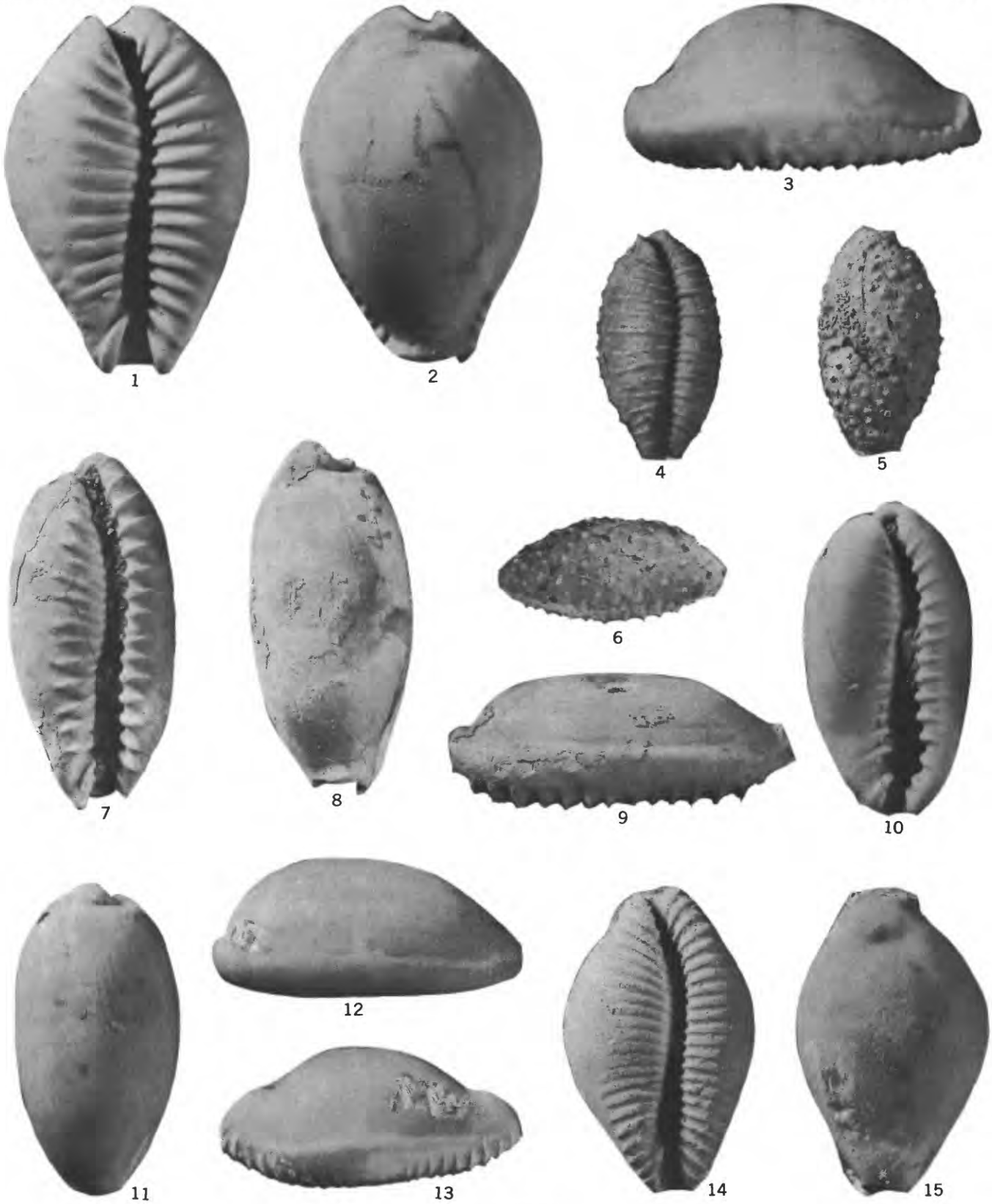
FIGURES 1–3. *Cypraea* (*Erosaria*) *helvola* Linnaeus (p. 23).
Length 21.6 mm (× 3). Drill hole F–1, Eniwetok, depth 830–840 ft; late Miocene (Tertiary *g*). USNM 648289.

4–6. *Cypraea* (*Staphylaea*) *nucleus* Linnaeus (p. 24).
Length 16.3 mm (× 2.5). Station 110C, Vanua Mbalavu, Fiji; Pliocene (Tertiary *h*). Univ. Rochester, Mus. Nat. History No. 13066.

7–9. *Cypraea* (*Erronea*) *cylindrica* Born (p. 24).
Length 31.4 mm (× 2). Station 44, Viti Levu, Fiji; probably Pliocene (Tertiary *h*). British Mus. No. GG1320.

10–12. *Cypraea* (*Erronea*) *errones* Linnaeus (p. 24).
Length 18.1 mm (× 3). Station RB32, Viti Levu, Fiji; probably Pliocene (Tertiary *h*). Acad. Nat. Sci. Philadelphia, Geol. No. 31514.

13–15. *Cypraea* (*Adusta*) aff. *C. kamai* (Beets) (p. 25).
Length 15.3 mm (× 4). Drill hole E–1, Eniwetok, depth 2,720–2,730 ft; early Miocene (Tertiary *e*). USNM 174971.



CYPRAEIDAE

PLATE 6

FIGURE

1. *Cypraea* (*Erosaria*) cf. *C. miliaris* Gmelin (p. 23).
   Length 27.8 mm (× 2). USGS loc. 24793, Pentecost, New Hebrides; probably Pleistocene. USNM 174995.

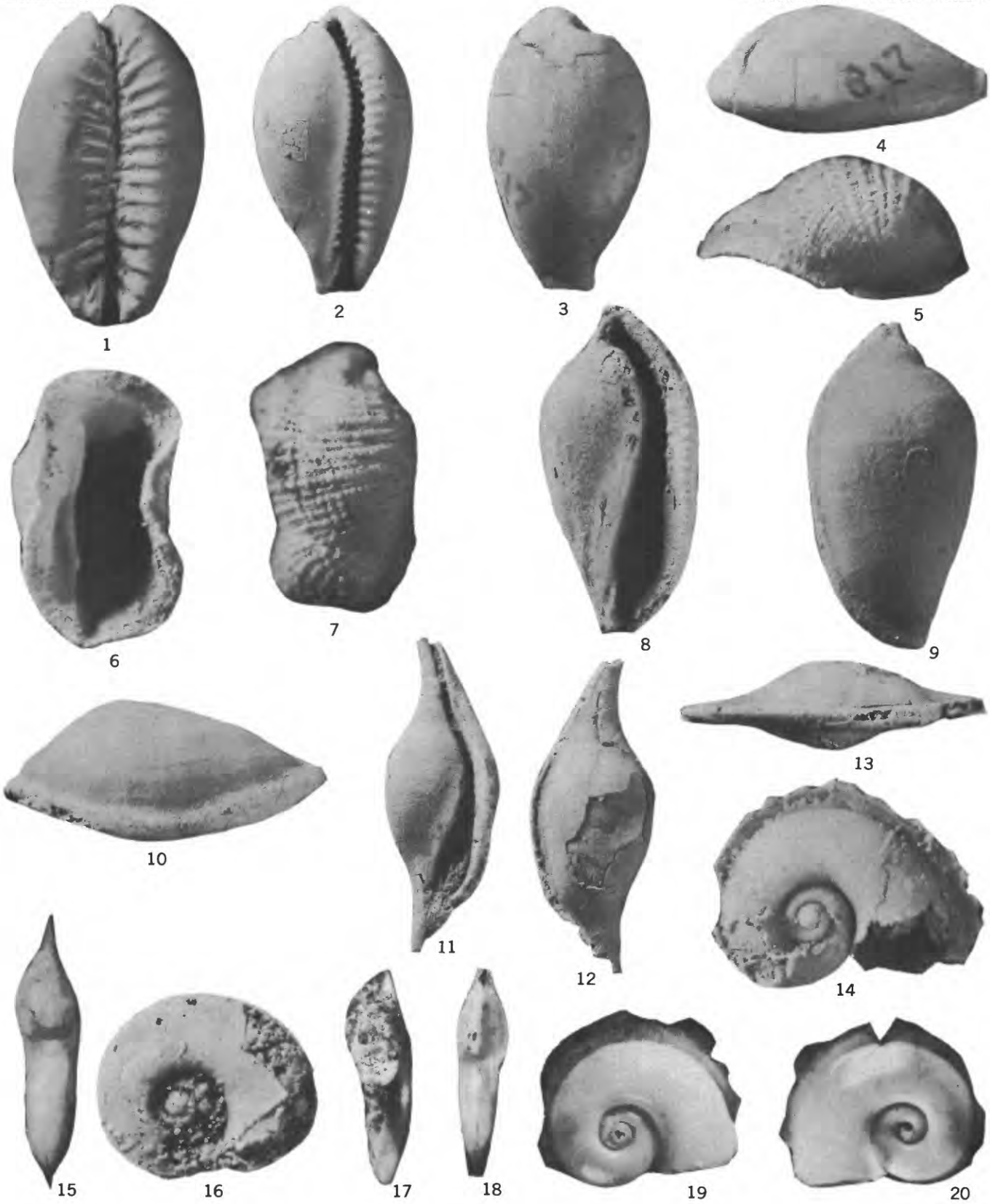
2–4. *Cypraea* (*Cribraria*) *cribraria* Linnaeus (p. 25).
   Length 17.0 mm (× 3). Station 817, Vanua Levu, Fiji; Pliocene (Tertiary *h*). USNM 174957.

5–7. *Pedicularia* (*Pediculariona*) *pacifica* Pease (p. 25).
   Length 3.0 mm (× 15). Drill hole E–1, Eniwetok, 40–45 ft; Holocene. USNM 648479.

8–10. *Primovula rhodia* (A. Adams) (p. 26).
   Height 11.7 mm (× 5). Station 817, Vanua Levu, Fiji; Pliocene (Tertiary *h*). USNM 650631.

11–13. *Phenacovolva nectarea* Iredale (p. 26).
   Height 18.4 mm (× 3). Station 817, Vanua Levu, Fiji; Pliocene (Tertiary *h*). USNM 650633.

14–20. *Atlanta peronii* Lesueur (p. 26).
   14, 15. Diameter 2.2 mm (× 20). Drill hole E–1, Eniwetok, 35–40 ft; Holocene. USNM 174959.
   16, 17. Diameter 2.3 mm (× 20). Station 817, Vanua Levu, Fiji; Pliocene (Tertiary *h*). USNM 650661.
   18–20. Diameter 3.4 mm (× 20). Station SM43, Santo, New Hebrides; Pleistocene. USNM 650654.



CYPRAEIDAE, OVULIDAE, AND ATLANTIDAE

PLATE 7

FIGURES 1–4. *Oxygyrus levu* Ladd, n. sp. (p. 26).

1, 2. Holotype, diameter 11.0 mm (× 5). Station 817, Vanua Levu, Fiji; Pliocene (Tertiary *h*). USNM 650659.

3, 4. Paratype, diameter 9.0 mm (× 5). Station 136, Vanua Levu, Fiji; Pliocene (Tertiary *h*). USNM 650660.

5–7. *Ampullina* (*Ampullinopsis*) *berauensis* (Beets) (p. 27).

Height 9.6 mm (× 4). Drill hole E–1, Eniwetok, depth 2,710–2,780 ft; early Miocene (Tertiary *e*). USNM 650621.

8, 9. *Globularia* (*Cernina*) *fijiensis* Ladd (p. 27).

Holotype, height 53.9 mm (× 1). Station L389, Lakemba, Fiji; Futuna Limestone, early Miocene (Tertiary *f*). Univ. Rochester, Mus. Nat. History No. 13052.

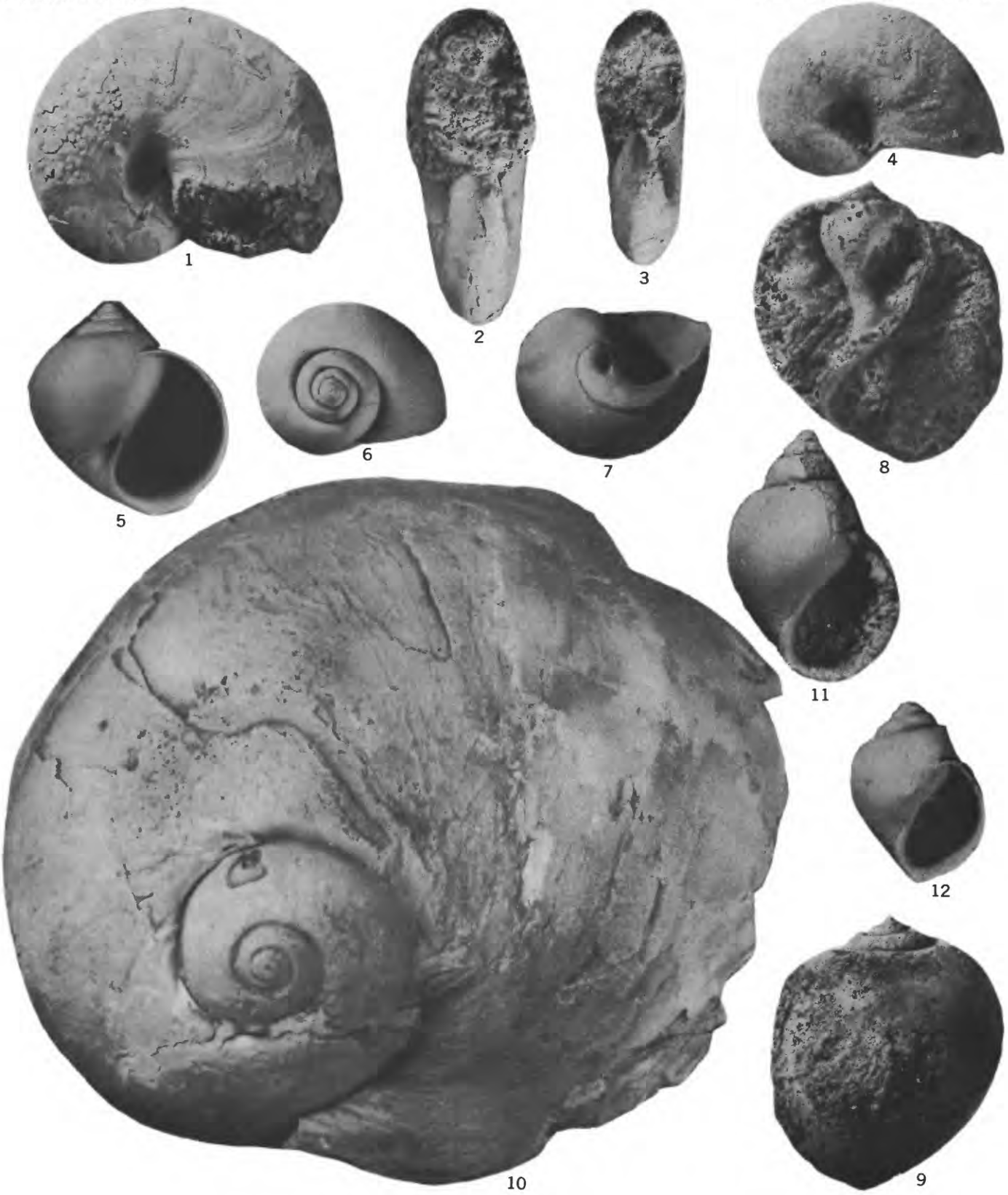
10. *Globularia* (*Waluia*) *edwardsi* Ladd (p. 27).

Holotype, height 127 mm (× 1). Station 160, Viti Levu, Fiji; early Miocene (Tertiary *f*). Bernice P. Bishop Mus., Geol. No. 1231.

11, 12. *Pachycrommium stockwelli* Ladd (p. 28).

11. Holotype, height 15.0 mm (× 3). Station 110C, Vanua Mbalavu, Fiji; Ndalithoni Limestone, Pliocene (Tertiary *h*). Univ. Rochester, Mus. Nat. History No. 13053.

12. Paratype, height 10.9 mm (× 3). Station 110C, Vanua Mbalavu, Fiji; Ndalithoni Limestone, Pliocene (Tertiary *h*). Univ. Rochester, Mus. Nat. History No. 13054.



ATLANTIDAE AND NATICIDAE

PLATE 8

FIGURES 1, 2. *Globularia* (*Cernina*) *fijiensis* Ladd (p. 27).
Height 53.8 mm (× 1). Station 295, Viti Levu, Fiji; early Miocene (Tertiary *f*). USNM 650623.

3. *Polinices* (*Polinices*) *mammilla* (Linnaeus) (p. 28).
Height 18.6 mm (× 3. Drill hole 2A, Bikini, core 13-A, depth 200-211 ft; Holocene. USNM 650624.

4. *Polinices* (*Polinices*) *cumingianus madioensis* Altena (p. 28).
Height 20.5 mm (× 3). Station 160, Viti Levu, Fiji; early Miocene (Tertiary *f*). USNM 174969.

5. *Polinices* (*Polinices*) of *P. columnaris* (Récluz) (p. 29).
Height 10.0 mm (× 3). Station 817, Vanua Levu, Fiji; Pliocene (Tertiary *h*). USNM 174968.

6, 7. *Mammilla melanostoma* (Gmelin) (p. 29).
6. Height 15.5 mm (× 2). Station 817, Vanua Levu, Fiji; Pliocene (Tertiary *h*). USNM 174940.
7. Height 39.1 mm (× 1). USGS loc. 17891, Saipan; Tanapag Limestone; Holocene. USNM 650623.

8, 9. *Pliconacca martini* Ladd, n sp. (p. 30).
Holotype, height 12.8 mm (× 4). Station FB-13; early Miocene (Tertiary *f*). USNM 174967.

10. *Globularia* (*Waluia*) *edwardsi* Ladd (p. 27).
Holotype, height 127 mm (× 1). Station 160, Viti Levu, Fiji; early Miocene (Tertiary *f*). Bernice P. Bishop Mus., Geol. No. 1231.

NATICIDAE

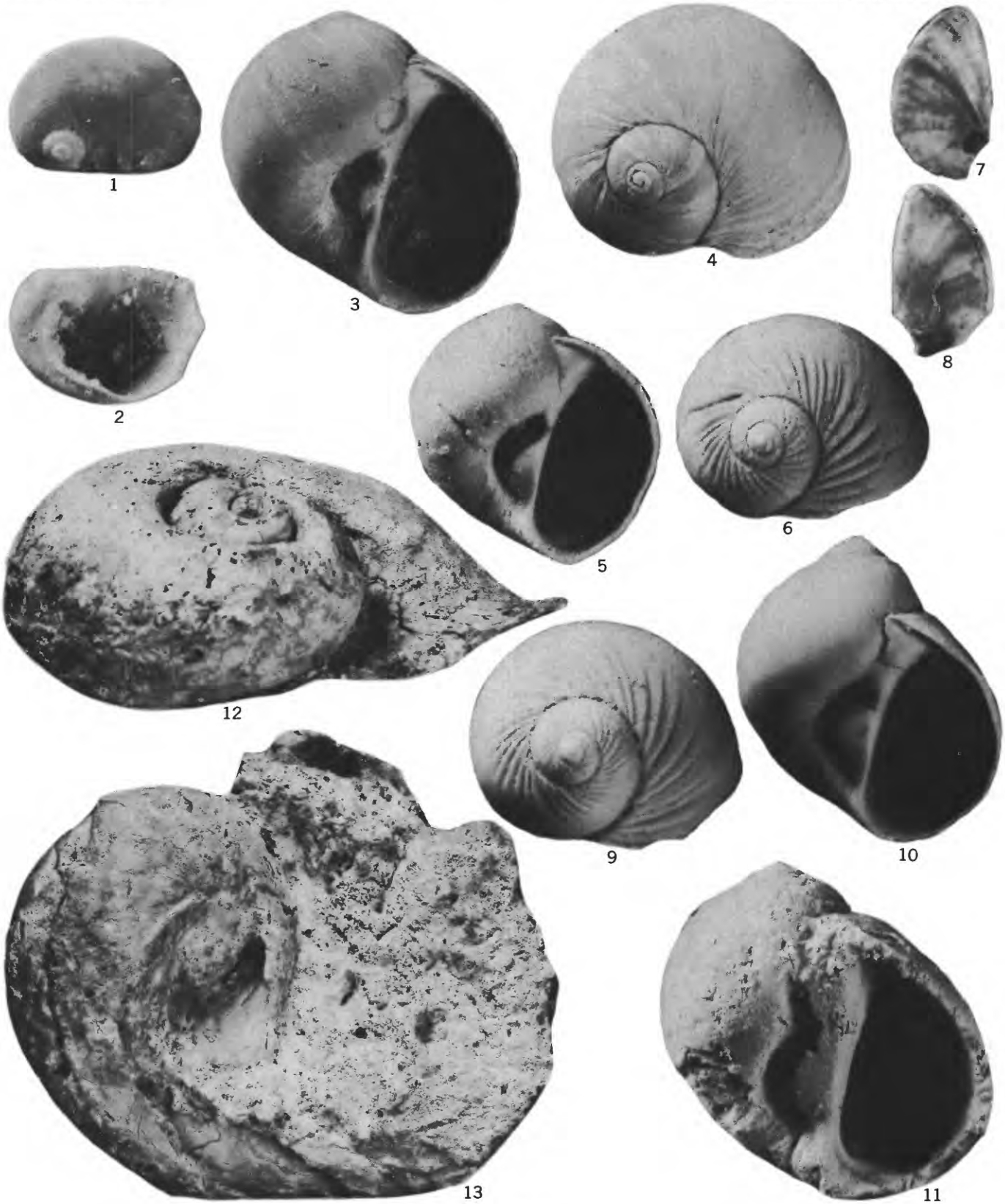
PLATE 9

FIGURES 1, 2. *Sinum* sp. A (p. 30).
Diameter 3.2 mm (× 10). Drill hole F–1, Eniwetok, depth 55–60 ft; Holocene. USNM 174941.

3–10. *Naticarius marochiensis* (Gmelin) (p. 30).
3, 4. Height 10.9 mm (× 5). Station 817, Vanua Levu, Fiji; Pliocene (Tertiary *h*). USNM 174951.
5, 6. Height 5.6 mm (× 8). USGS loc. 21301; Goikul Peninsula, Babelthuap, Palau; marl at base of Palau Limestone; late Miocene (Tertiary *g*). USNM 174953.
7, 8. Operculum belonging to shell shown fig. 5, 6. Measurements 3.7 × 2.2 mm (× 8).
9, 10. Height 8.8 mm (× 6). USGS loc. 20535, Guam; Talisay Member of Alifan Formation; late Tertiary (Tertiary *g* or *h*). USNM 174955.

11. *Naticarius onca* (Röding) (p. 31).
Height 12.2 mm (× 5). USGS loc. 21377, Guam; Mariana Limestone, Pliocene or Pleistocene. USNM 174965.

12, 13. *Globularia* (*Waluia*) *edwardsi* Ladd (p. 27).
12. Specimen no. 2, height 218 mm (× ½). Station 295, Viti Levu, Fiji; early Miocene (Tertiary *f*). USNM 174970.
13. Paratype B. height 170 mm (× ½). Station 158, Viti Levu, Fiji; early Miocene (Tertiary *f*). Bernice P. Bishop Mus., Geol. No. 1223.



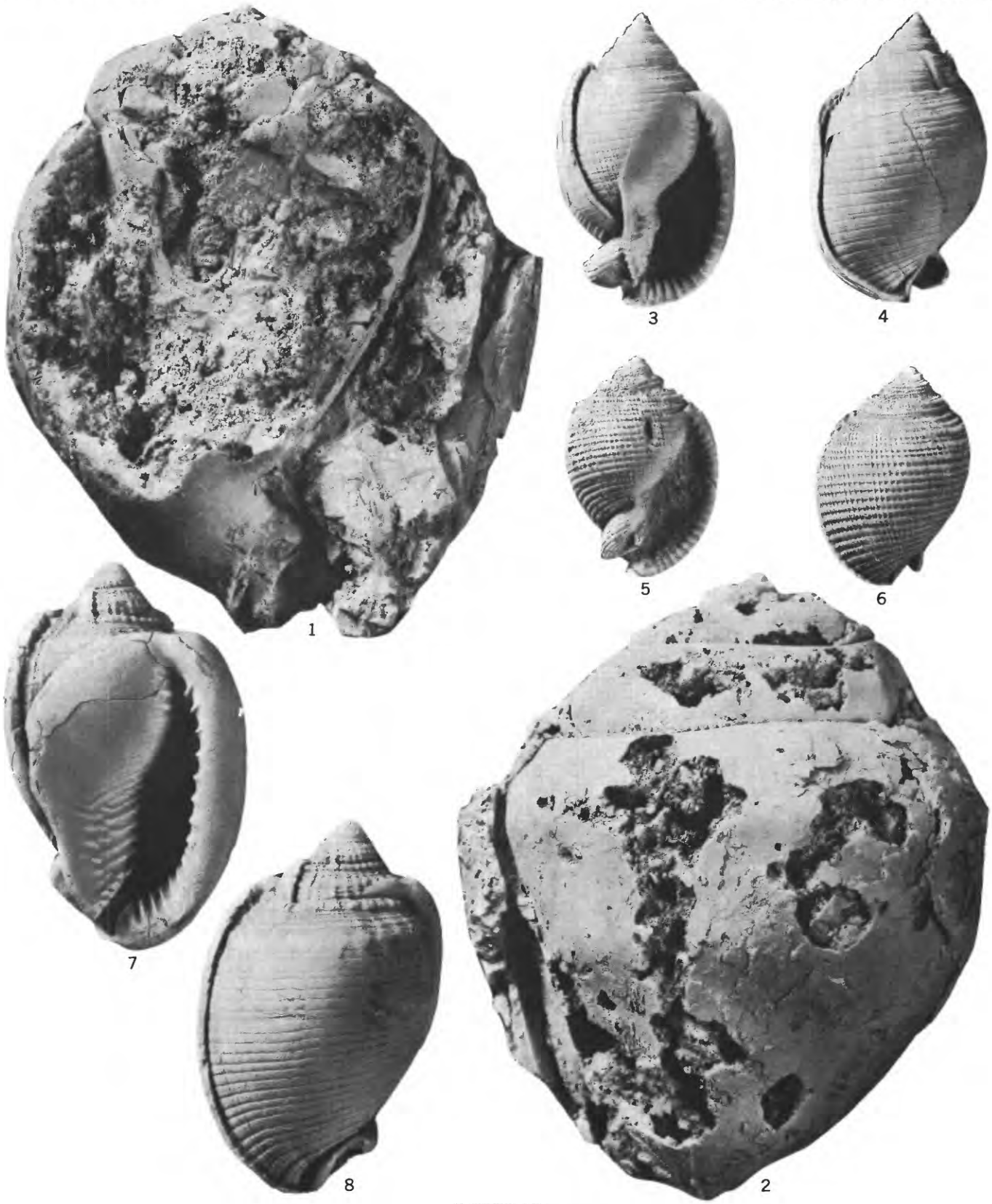
NATICIDAE

PLATE 10

FIGURES 1, 2. *Bathygalea* (*Bathygalea*) sp. A (p. 31).
Length 115 mm (× 1). USGS loc. 20598, Guam; Mariana Limestone, Pliocene or Pleistocene. USNM 174982.

3–6. *Phalium* (*Semicassis*) *bisulcatum* (Schubert and Wagner) (p. 32).
3, 4. Length 51.3 mm (× 1). Station 817, Vanua Levu, Fiji; Pliocene (Tertiary *h*). USNM 174972.
5, 6. Length 19.9 mm (× 2) with last. USNM 174973.

7, 8. *Phalium* (*Semicasis*) *vavakuana* Ladd (p. 32).
Holotype, length 35.0 mm (× 2). Station 59, Viti Levu, Fiji; Miocene. Bernice P. Bishop Mus., Geol. No. 1206.



CASSIDAE

PLATE 11

FIGURE

1. *Cassis* cf. *C. cornuta* Linnaeus (p. 32).
   Height 145 mm (× ½). Limestone at head Walu Bay (near station 295), Viti Levu, Fiji; Miocene.
2. *Phalium* (*Casmaria*?) sp. (p. 32).
   Length 60 mm (× 1). USGS loc. 20989, Guam; Talisay Member of Alifan Limestone, late Tertiary (Tertiary *g* or *h*). USNM 174974.

3, 4. *Biplex perca* Perry (p. 33).
   Height 14.9 mm (× 4). Station VL1, Vanua Levu, Fiji; probably Pliocene. British Mus. No. GG1840.

5–7. *Cymatium* (*Lampusia*) *aquatile* (Reeve) (p. 34).
   5, 6. Length 18.4 mm (× 3). Station 817 Vanua Levu, Fiji; Pliocene (Tertiary *h*). USNM 174996.
   7. Same; enlargement of aperture (× 4).

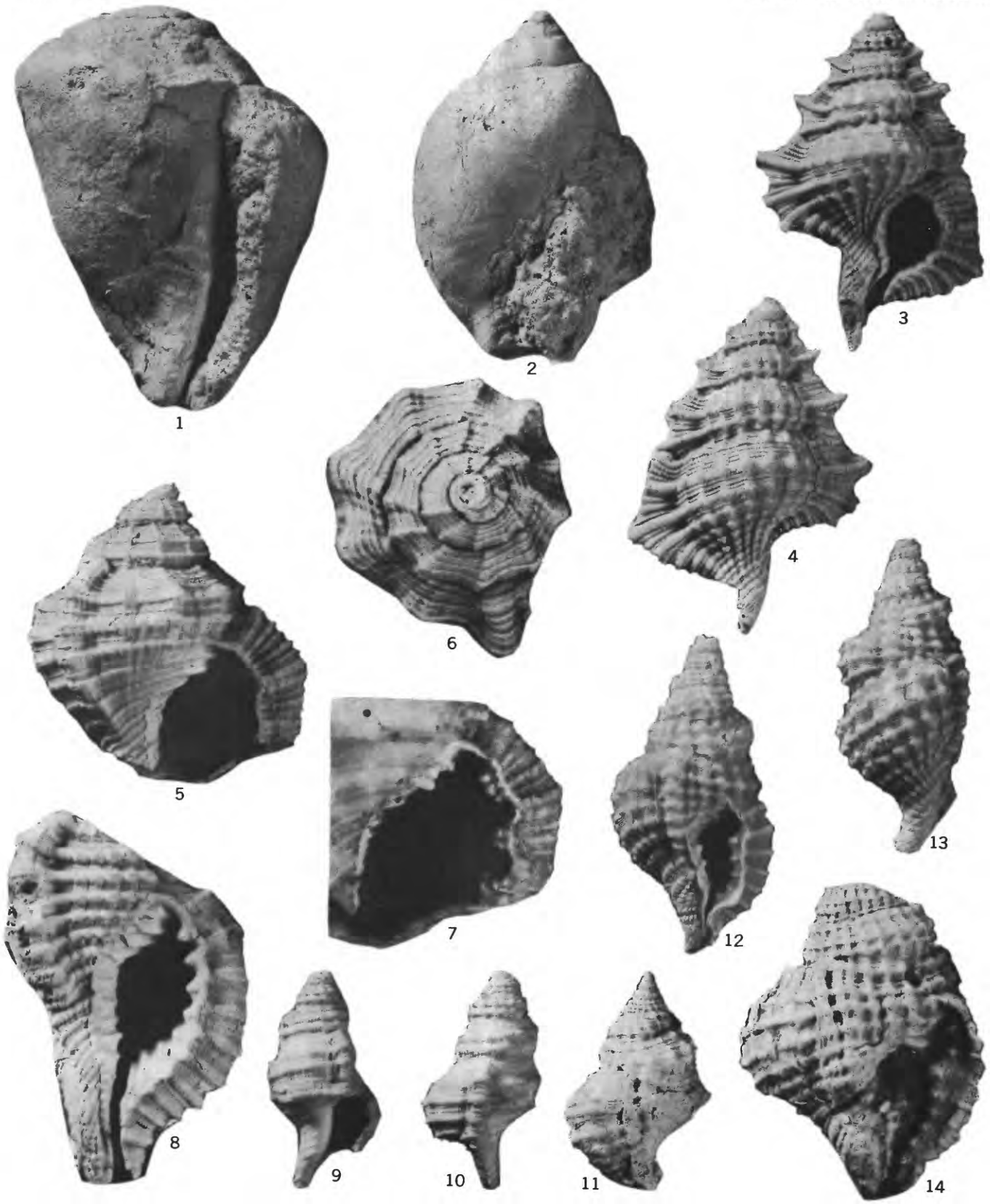
8. *Cymatium* (*Septa*) *rubecula* (Linnaeus) (p. 34).
   Diameter 21.6 mm (× 2). Station 160, Viti Levu, Fiji; early Miocene (Tertiary *f*). Bernice P. Bishop Mus., Geol. No. 1210.

9, 10. *Cymatium* (*Septa*) *gemmatum* (Reeve) (p. 34).
   Length 19.2 mm (× 2). Drill hole 2, Bikini, in core at 180 ft; age, Quaternary. USNM 650471.

11. *Distorsio* (*Distorsio*) *anus* (Linnaeus) (p. 35).
   Length 38.5 mm (× 1). Station 44, Viti Levu, Fiji; Pliocene (Tertiary *h*). British Mus. No. GG19757.

12, 13. *Distorsio* (*Rhysema*) *pusilla* Pease (p. 35).
   Length 10.6 mm (× 5). Drill hole E–1, Eniwetok, depth 30–40 ft; Holocene. USNM 650634.

14. *Distorio* (*Rhysema*) reticulata Röding (p. 35).
   Length (incomplete) 19 mm (× 3). Station 817, Vanua Levu, Fiji; Pliocene (Tertiary *h*). USNM 650635.



CASSIDAE AND CYMATIIDAE

PLATE 12

FIGURES 1–3. *Bursa* (*Colubrellina*) *nobilis* (Reeve) (p. 35).

1. Length 62.0 mm (× 1).

2, 3. Length 45.5 mm (× 1.5). Both specimens station 817, Vanua Levu, Fiji; Pliocene (Tertiary *h*). USNM 174980 and 174981, respectively.

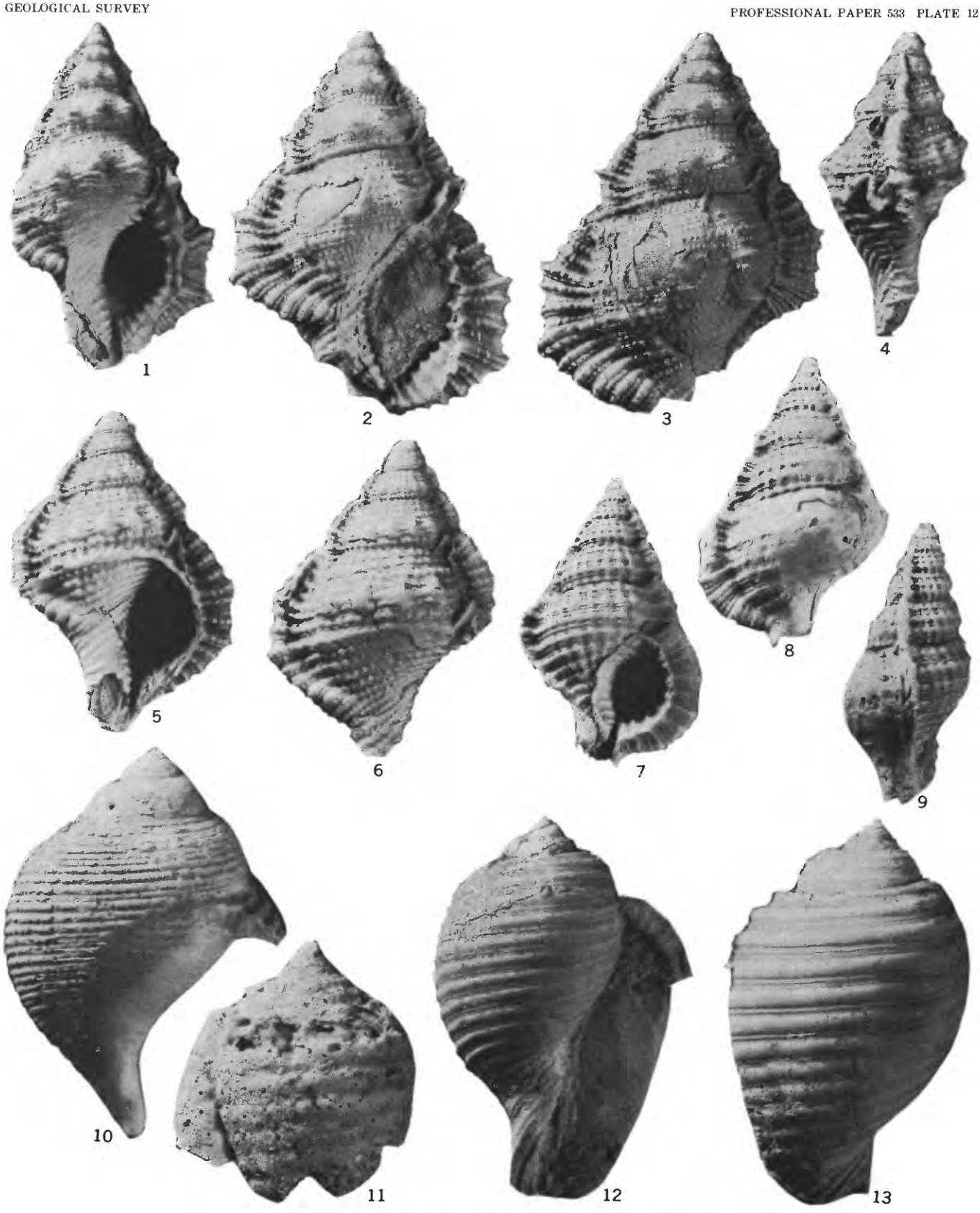
4–6. *Bursa* (*Colubrellina*) *margaritula* (Deshayes) (p. 36).
Length 28.7 mm (× 2). Station F238, Viti Levu, Fiji; late Miocene (Tertiary *g*). USNM 175075.

7–9. *Gyrineum* (*Gyrineum*) *bituberculare* (Lamarck) (p. 33).
Length 17.5 mm (× 3). Station 817, Vanua Levu, Fiji; Pliocene (Tertiary *h*). USNM 174976.

10. *Eudolium* sp. (p. 36).
Length 23.9 mm (× 3). USGS loc. 25142, Viti Levu, Fiji; early Miocene (Tertiary *f*). USNM 174986.

11. *Quimalea pomum* (Linnaeus) (p. 36).
Diameter 45.5 mm (× 1). USGS loc. 21028, Espiritu santo, New Hebrides; probably Pleistocene. USNM 174984.

12, 13. *Tonna sulcosa* (Born) (p. 36).
Length 35.5 mm (× 2). Station 817, Vanua Levu, Fiji; Pliocene (Tertiary *h*). USNM 174985.



CYMATIIDAE, BURSIDAE, AND TONNIDAE

PLATE 13

FIGURES 1–3. *Ficus variegata* Röding (p. 37).

1. Adult shell, height 89 mm (× 1).

2, 3. Juvenile shell, height 22.4 mm (× 3). Both specimens from station 817, Vanua Levu, Fiji; Pliocene (Tertiary *h*). USNM 650628 and 650629 respectively.

4, 5. *Murex* cf. *M. multispinosus* G. B. Sowerby (p. 38).
Length 54.1 mm (× 1). Station C89, Viti Levu, Fiji; Pliocene (Tertiary *h*). USNM 175002.

6, 7. *Murex* (*Murex*) *guppyi* Ladd, n. sp. (p. 37).
Holotype, length 62.8 mm (× 1). Station 817, Vanua Levu, Fiji; Pliocene (Tertiary *h*). USNM 175003.

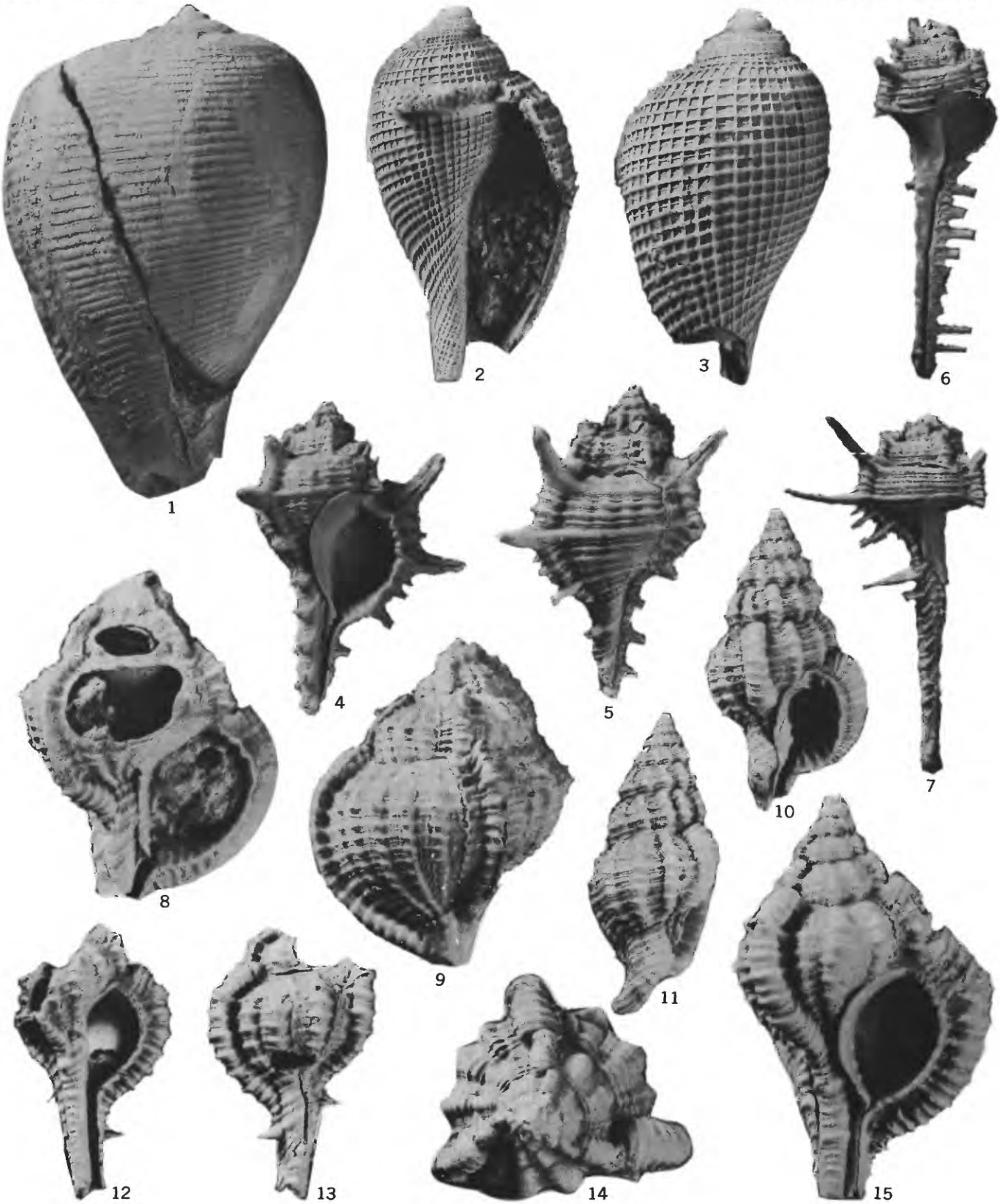
8, 9. *Murex* (*Murex*) *nasongoensis* Ladd, n. sp. (p. 37).
Holotype, length 39.1 mm (× 1½). Station 59, Viti Levu, Fiji; probably Miocene. Bernice P. Bishop Mus., Geol. No. 1208.

10, 11. *Cymatium* (*Cymatriton*) *rickardi* Ladd, n. sp. (p. 34).
Holotype, length 27.0 mm (× 2). Station 817, Vanua Levu, Fiji; Pliocene (Tertiary *h*). USNM 175030.

12–15. *Murex* (*Murex*) *bantamensis coulsoni* Ladd, n. subsp. (p. 38).

12, 13. Paratype D, height 16.3 mm (× 3). Station 817, Vanua Levu, Fiji; Pliocene (Tertiary *h*). USNM 175001.

14, 15. Holotype, length 24.3 mm (× 3). Station 817, Vanua Levu, Fiji; Pliocene (Tertiary *h*). USNM 174997.



FICIDAE, MURICIDAE, AND CYMATIIDAE

PLATE 14

FIGURES 1, 2. *Murex* (*Murex*) *bantamensis coulsoni* Ladd, n. subsp. (p. 38).
1. Paratype C, length 30.1 mm (× 2.5). Station 165, Viti Levu, Fiji; age, possibly Miocene. Bernice P. Bishop Mus., Geol. No. 1209.
2. Paratype B, length 19.0 mm (× 3). Station 817, Vanua Levu, Fiji; Pliocene (Tertiary *h*). USNM 174999.

3. *Pterynotus* sp. (p. 39).
Length 6.1 mm (× 8). Drill hole E–1, Eniwetok, depth 80–90 ft; age, Holocene. USNM 17500.

4, 5. *Vitularia miliaris* (Gmelin) (p. 39).
Length 20.6 mm (× 3). Station 817, Vanua Levu, Fiji; Plicene (Tertiary *h*). USNM 175011.

6. *Drupa* (*Drupa*) *ricinus* (Linneaus) (p. 39).
Height 16.0 mm (× 3). USGS loc. 21591, Cabras Island off Guam. Mariana Limestone; Pliocene or Pleistocene. USNM 175005.

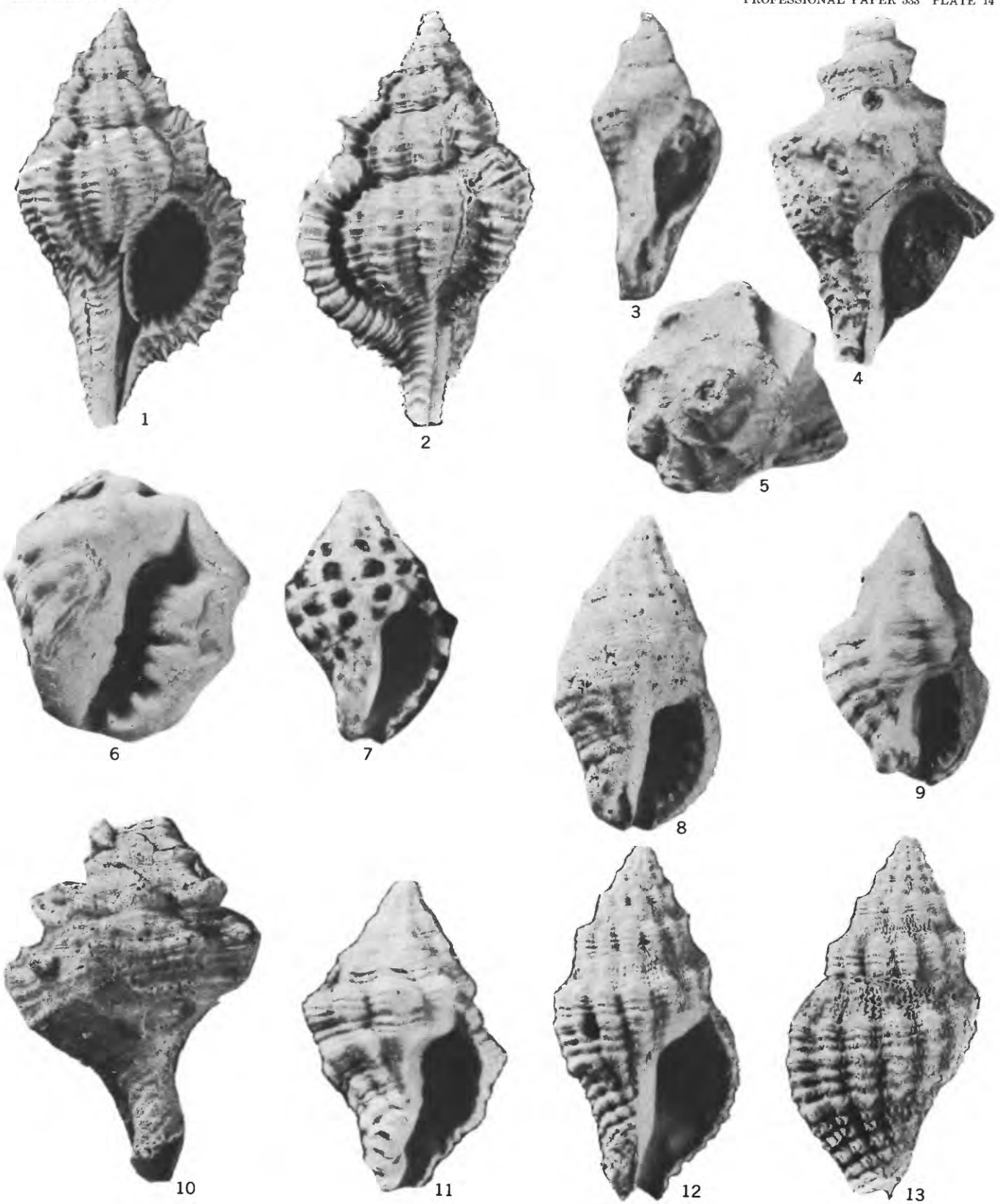
7. *Drupa* (*Morula*) *granulata* (Duclos) (p. 40).
Height 7.3 mm (× 6). Drill hole E–1, Eniwetok, depth 60–70 ft; Holocene. USNM 174987.

8, 9. *Drupa* (*Cronia*) *fiscella* (Gmelin) (p. 40).
8. Length 18.9 mm (× 3). Drill hole F–1, Eniwetok, depth 690–700 ft; age, late Miocene (Tertiary *g*). USNM 174988.
9. Length 24.4 mm (× 2). Maewo, New Hebrides; age, Pliocene or Pleistocene. USNM 175050.

10. *Thais* (*Cymia*) aff. *T. carinifera* (Lamarck) (p. 41).
Cast from incomplete mold, height 32 mm (× 2). USGS loc. 17904; Tagpochau Limestone, Saipan; age, Miocene. USNM 175004.

11. *Coralliophila* (*Coralliophila*) sp. (p. 41).
Height 6.7 mm (× 8). Drill hole E–1, Eniwetok, depth 40–45 ft; Holocene. USNM 175014.

12, 13. *Coralliophila* (*Pseudomurex*) *macneili* Ladd, n. sp. (p. 41).
Holotype, height 15.9 mm (× 4). Drill hole F–1, Eniwetok, depth 700–710 ft; age, late Miocene (Tertiary *g*). USNM 175035.



MURICIDAE, THAIDIDAE, AND MAGILIDAE

PLATE 15

FIGURES 1, 2. *Coralliophila* (*Pseudomurex*) *bayeri* Ladd, n. sp. (p. 42).
Holotype, height 11.9 mm (× 5). USGS loc. 21301, Babelthuap, Palau; marls at base of Palau Limestone; age, late Miocene, (Tertiary *g*). USNM 175068.

3. *Coralliophila* (*Fusomurex*) sp. A (p. 42).
Height 12.3 mm (× 5). Drill hole F–1, Eniwetok, depth 850–860 ft; age, late Miocene (Tertiary *g*). USNM 174993.

4. *Coralliophila* (*Fusomurex*) sp. B (p. 42).
Height 10.2 mm (× 5). Drill hole E–1, Eniwetok, depht 880–890 ft; age, early Miocene (Tertiary *f*). USNM 175069.

5. *Latiaxis* (*Latimurex*) *inflata* (Dunker) (p. 43).
Height 18.8 mm (× 3). Drill hole F–1, Eniwetok, depth 690–700 ft; age, late Miocene (Tertiary *g*). USNM 174992.

6. *Latiaxis* (*Latimurex*) sp. A. (p. 43).
Height 30.0 mm (× 3. Drill hole 2A, Bikini, depth 935.5 ft; age, Miocene (Tertiary *g*). USNM 174991.

7. *Coralliobia* (*Quoyula*) *monodonta* (Blainville) (p. 43).
Height 7.3 mm (× 8). Drill hole Mu–4, Eniwetok, depth 35.5–36 ft; age, Holocene. USNM 174990.

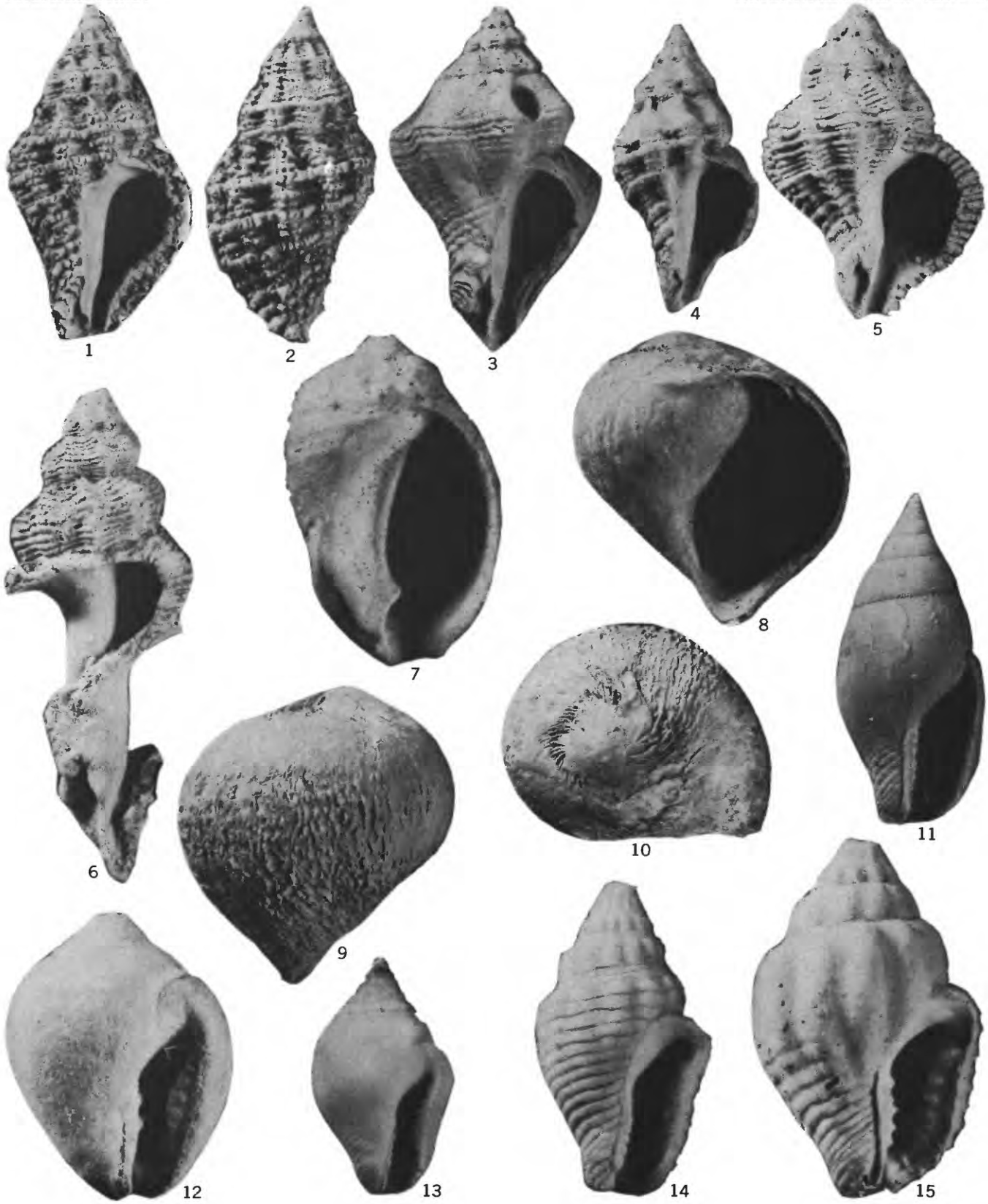
8–10. *Magilus antiquus* Montfort (p. 44).
Height 17.7 mm (× 3). Station 160, Viti Levu, Fiji; age, early Miocene (Tertiary *f*). USNM 650627.

11. *Columbella pardalina* Lamarck (p. 44).
Height 11.8 mm (× 5). Drill hole F–1, Eniwetok, depth 740–750 ft; age, late Miocene (Tertiary *g*). USNM 175012.

12, 13. *Euplica turturina* (Lamarck) (p. 44).
12. Height 10.3 mm (× 5). Drill hole 2A, Bikini, depth 242–253 ft; age, Quaternary. USNM 175007.
13. Height 8.2 mm (× 5). Drill hole Mu–4, Eniwetok, depth 21.5–22 ft; age, Holocene. USNM 175009.

14. *Euplica varians* (Sowerby) (p. 45).
Height 6.6 mm (× 8). Drill hole E–1, Eniwetok, depth 30–40 ft; age, Holocene, USNM 175019.

15. *Euplica* aff. *E. varians* (Sowerby) (p. 45).
Height 10.1 mm (× 6). Drill hole F–1, Eniwetok, depth 730–740 ft; age, late Miocene (Tertiary *g*). USNM 175060.



MAGILIDAE AND COLUMBELLIDAE

PLATE 16

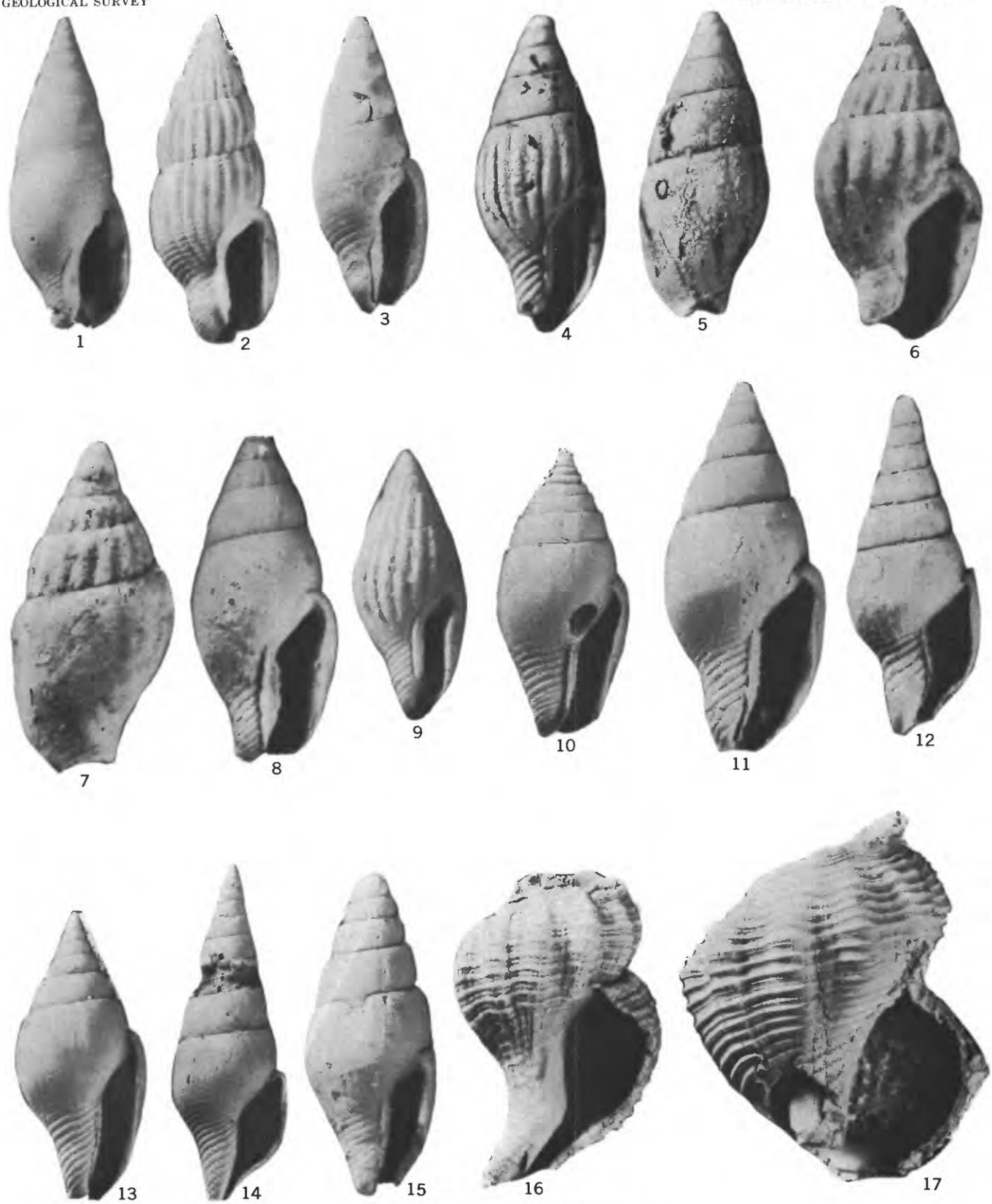
FIGURE

1. *Lavesopus eniwetokensis* Ladd, n. sp. (p. 45).
   Holotype, height 9.1 mm (× 6). Drill hole F–15–C, Eniwetok, depth 39–42 ft; age, Holocene. USNM 175013.
2. *Zafrona lifuana* (Hervier) (p. 45).
   Height 9.5 mm (× 6). Drill hole E–1, Eniwetok, depth 30–40 ft; age, Holocene. USNM 175010.
3. *Graphicomassa ligula* (Duclos) (p. 46).
   Height 17.6 mm (× 3). Station RB 32, Viti Levu, Fiji; age, probably Pliocene (Tertiary *h*). Acad. Nat. Sci. Philadelphia Geol. No. No. 31515.

4, 5. *Anachis* (*Costoanachis*) *winradi* Ladd, n. sp. (p. 46).
   Holotype, height 3.5 mm (× 15). USGS loc. 21304, Babelthuap, Palau; marls at base of Palau Limestone; age, late Miocene Tertiary *g*). USNM 17023.

6, 7. *Anachis* (*Costoanachis*) *rewaensis* Ladd, n. sp. (p. 46).
   Holotype, height 4.7 mm (× 12). Station C831, Viti Levu, Zyi; Waindina Sandstone of Suva Group; age, probably Pliocene (Tertiary *h*). USNM 175022.

8. *Anachis* (*Costoanachis*) *lauensis* Ladd, n. sp. (p. 47).
   Holotype height 7.2 mm (× 8). Station 110B, Vanua Mbalavu, Fiji, Ndalithoni Limestone; age, Pliocene (Tertiary *h*). USNM 175021.
9. *Anachis* (*Zafra*) *smithi* (Angas) (p. 47).
   Height 3.8 mm (× 15). Drill hole A–1, Eniwetok, depth 136.5–138 ft; age, Holocene. USNM 175016.
10. *Pyrene obtusa* (Sowerby) (p. 47).
    Height 12.7 mm (× 4). Drill hole E–1, Eniwetok, depth 60–70 ft; age, Holocene. USNM 175008.
11. *Mitrella sagitta* (Gaskoin) (p. 47).
    Height 8.0 mm (× 8). Drill hole F–1, Eniwetok, depth 830–840 ft; age, late Miocene (Tertiary *g*). USNM 175017.
12. *Mitrella gonzabuensis* MacNeil (p. 48).
    Height 7.3 mm (× 8). Station 817, Vanua Levu, Fiji; age, Pliocene (Tertiary *h*). USNM 175026.
13. *Mitrella oweni* Ladd, n. sp. (p. 48).
    Holotype, height 17.3 mm (× 3). USGS loc. 21301, Babelthuap, Palu; marls at the base of the Palau Limestone; age, late Miocene (Tertiary *g*). USNM 175048.
14. *Mitrella* sp. A (p. 48).
    Height 15.0 mm (× 4). Station 817, Vanua Levu, Fiji; age, Pliocene (Tertiary *h*). USNM 175020.
15. *Zemitrella bikiniensis* Ladd, n. sp. (p. 49).
    Holotype, height 3.7 mm (× 15). Drill hole 2A. Bikini, depth 852–857 ft; age, late Miocene (Tertiary *g*). USNM 175025.
16. *Siphonalia subspadicea* MacNeal (p. 49).
    Height 19.3 mm (× 3). Station 817, Vanua Levu, Fiji; age, Pliocene (Tertiary *h*). USNM 650630.
17. *Siphonalia* aff. *S. stearnsii* Pilsbry (p. 49).
    Height 33.6 mm (× 2). Station 817, Vanua Levu, Fiji; age, Pliocene (Tertiary *h*). USNM 650631.



COLUMBELLIDAE AND BUCCINIDAE

PLATE 17

FIGURE 1. *Searlesia hindlei* Ladd, n. sp. (p. 49).
Holotype, height 42.4 mm (× 1). Station VLI, Vanua Levu, Fiji; age, Pliocene (Tertiary *h*). USNM 175028.

2. *Nassa serta* (Bruguière) (p. 40).
Height 55 mm (× 1). Haloipepe quarry, Tongatopu, Tonga. (Bernice P. Bishop Mus. Cat. No. 202956); are probably Pleistocene.

3. *Euthria hoffmeisteri* Ladd, n. sp. (p. 50).
Holotype, height 20.8 mm (× 3). Station 110B, Vanua Mbalavu, Fiji, Ndalithoni Limestone; age, Pliocene (Tertiary *h*). USNM 175027.

4. *Metula* (*Metula*) *ibbotsoni* Ladd, n. sp. (p. 50).
Holotype, height 18.3 mm (× 3). Station 817, Vanua Levu, Fiji; age, Pliocene (Tertiary *h*). USNM 650650.

5. *Nawenia bartholomewi* Ladd, n. sp. (p. 51).
Holotype, height 34.5 mm (× 3). Near station VLI, Vanua Levu, Fiji; age, Pliocene (Tertiary *h*). British Mus. No. GG1842.

6-8. *Pugilina* (*Mayeria*) *swartzi* Ladd, n. sp. (p. 51).
Holotype, height 4.1 mm (× 10). Drill hole F–1, Eniwetok, depth 870–880 ft; age, early Miocene (Tertiary *f*). USNM 174979.

9. *Nassarius* (*Phrontis*) *tiarula* (Kiener) (p. 52).
Height 12.5 mm (× 4). Drill hole A–1, Eniwetok, depth. 168.2–175.3 ft; age, Holocene. USNM 175055.

10. *Nassarius* (*Zeuxis*) *vitiensis* (Hombron and Jaquinot) (p. 54).
Height 25.0 mm (× 2). Maewo, New Hebrides; age, post-Miocene. USNM 175034.

11. *Nassarius* (*Arcularius*) *leptospirus* A. Adams (p. 52).
Length 11.2 mm (× 4). USGS loc. 24794 Maewo, New Hebrides; age, Quaternary. USNM 175037.

12, 13. *Nassarius* (*Arcularius*) *graniferus* (Kiener) (p. 52).
Length 13.8 mm (× 4). Drill hole 2A, Bikini, depth 242.5–253 ft; age, Holocene, USNM 175038.

14, 15. *Nassarius* (*Arcularius*) *eniwetokensis* Ladd, n. sp. (p. 52).
Holotype, length 7.6 mm (× 6). Drill hole F–1, Eniwetok, depth 680–690 ft; age, late Miocene (Tertiary *g*). USNM 175039.

16. *Nassarius* (*Arcularius*?) sp. (p. 53).
Length 18.5 mm (× 3). USGS loc. 20653, Guam; Mariana Limestone; age, Pliocene or Pleistocene. USNM 175040.

17, 18. *Nassarius* (*Uzita*) *verbeeki* (Martin) (p. 53).
17. Height, 18.9 mm (× 2). USGS loc. 21301, Babelthuap, Palau; marls at base of Palau Limestone; age, late Miocene (Tertiary *g*). USNM 175032.
18. Height, 21.5 mm (× 2) station 817, Vanua Levu, Fiji; age, Pliocene (Tertiary *h*). USNM 175033.

19. *Nassarius* (*Uzita*) *mangkalihatensis* Beets (p. 53).
Length, 5.3 mm (× 8). USGS loc. 21301, Babelthuap, Palau; age, late Miocene (Tertiary *g*). USNM 175057.

20. *Nassarius* (*Zeuxis*) *concinnus* (Powys) (p. 53).
Length 16.8 mm (× 8). USGS loc. 20687, Guam; Mariana Limestone; age, Pliocene or Pleistocene. USNM 175059.

21. *Nassarius* (*Zeuxis*) *planicostata* (A. Adams) (p. 54).
Length, 23.8 mm (× 2). Station 817, Vanua Levu, Fiji; age, Pliocene (Tertiary *h*). USNM 175066.

BUCCINIDAE, MELONGENIDAE, NASSARIIDAE, AND THAIDIDAE

PLATE 18

FIGURES

1, 2. *Nassarius* (*Zeuxis*) *planicostata* (A. Adams) (p. 54).
Length 10.1 mm (× 5). Station 817, Vanua Levu, Fiji; age, Pliocene (Tertiary *h*). USNM 175065.

3, 4. *Nassarius* (*Niotha*) *fijiensis* Ladd, new name (p. 54).
3. Length 18.0 mm (× 2). Station 165, Viti Levu, Fiji; age, probably Pliocene (Tertiary *h*). Bernice P. Bishop Mus. Geol. No. 1165.
4. Length 16.0 mm (× 3). Station C1142, Viti Levu, Fiji; age, Pliocene (Tertiary *h*). USNM 175058.

5. *Nassarius* (*Niotha*) *ovus* (Martin) (p. 54).
Length 13.3 mm (× 3). Station C89, Viti Levu, Fiji; age, Pliocene (Tertiary *h*). USNM 175061.

6, 7. *Nassarius* (*Niotha*) *marshallensis* Ladd, n. sp. (p. 55).
6. Holotype, height 7.9 mm (× 6). Drill hole F–1, Eniwetok, depth 870–880 ft; age, early Miocene (Tertiary *f*). USNM 175063.
7. Paratype, height 5.3 mm (× 8). Drill hole F–1, Eniwetok, depth 880–890 ft; age, early Miocene (Tertiary *f*). USNM 175064.

8. *Latirus craticulatus* (Linnaeus) (p. 55).
Height 33.5 mm (× 1). USGS loc. 21028, Santo, New Hebrides; age, probably Pleistocene. USNM 175051.

9. *Latirus barclayi* (Reeve) (p. 55).
Height 43 mm (× 1). USGS loc. 20730, Guam; Alifan Limestone of late Tertiary age. USNM 175067.

10. *Peristernia nassatula* (Lamarck) (p. 56).
Height 5.6 mm (× 10). Drill hole E–1, Eniwetok, depth 970–980 ft; age, early Miocene (Tertiary *f*). USNM 175072.

11. *Peristernia incarnata* (Kiener) (p. 56).
Height 22.8 mm (× 2). Island of Matangi, Fiji; age, probably Holocene. USNM 175046.

12. *Peristernia chlorostoma* (Sowerby) (p. 56).
Height 8.9 mm (× 6). Drill hole Mu–4, Eniwetok, depth 31–31.5 ft; age, Holocene. USNM 175047.

13. *Peristernia waluensis* Ladd, n. sp. (p. 56).
Holotype, height 16.5 mm (× 3). Station 160, Viti Levu, Fiji; age, early Miocene (Tertiary *f*). USNM 175073.

14, 15. *Peristernia eniwetokensis* Ladd, n. sp. (p. 57).
14. Holotype, height 10.5 mm (× 5). Drill hole F–1, Eniwetok, depth 960–970 ft; age, early Miocene (Tertiary *f*). USNM 175052.
15. Paratype, height 9.0 mm (× 5). Drill hole E–1, Eniwetok, depth 840–850 ft; age, late Miocene (Tertiary *g*). USNM 175053.

16. *Peristernia ustulata goikulensis* Ladd, n. subsp. (p. 57).
Holotype, height 28.1 mm (× 2). USGS loc. 21304, Babelthuap, Palau; age, late Miocene (Tertiary *g*). USNM 175045.

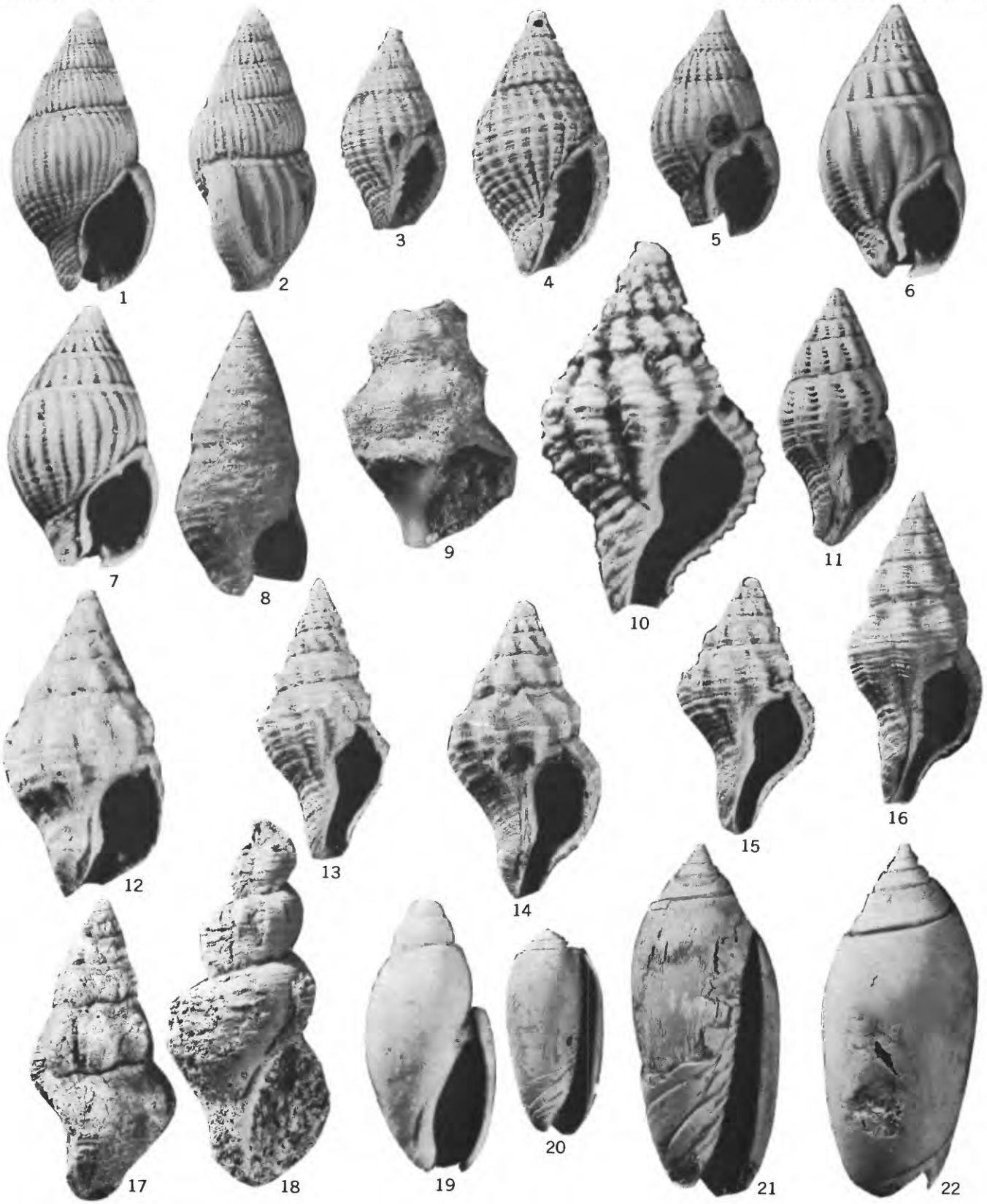
17. *Peristernia ustulata* (Reeve) (p. 57).
Height 27.1 mm (× 2). USGS loc. 20537, Guam; Mariana Limestone; age, Pliocene or Pleistocene. USNM 175042.

18. *Fusinus* sp. (p. 57).
Height 65.5 mm (× 1). Station L493, Lakemba, Fiji; Futuna Limestone; age, early Miocene (Tertiary *f*). USNM 174989.

19. *Belloliva* (*Olivellopsis*) *simplex* (Pease) (p. 58).
Length 3.8 mm (× 12). Drill hole K1–B, Eniwetok, depth 736–748 ft; age, late Miocene (Tertiary *g*). USNM 175074.

20. *Oliva carneola* (Gmelin) (p. 58).
Length 18.1 mm (× 2). Station 817, Vanua Levu, Fiji; age, Pliocene (Tertiary *h*). USNM 650640.

21, 22. *Oliva annulata* Gmelin (p. 58).
Length 31.1 mm (× 2). Station 160, Viti Levu, Fiji; age, early Miocene (Tertiary *f*). USNM 650639.



NASSARIIDAE, FASCIOLARIIDAE, AND OLIVIDAE

PLATE 19

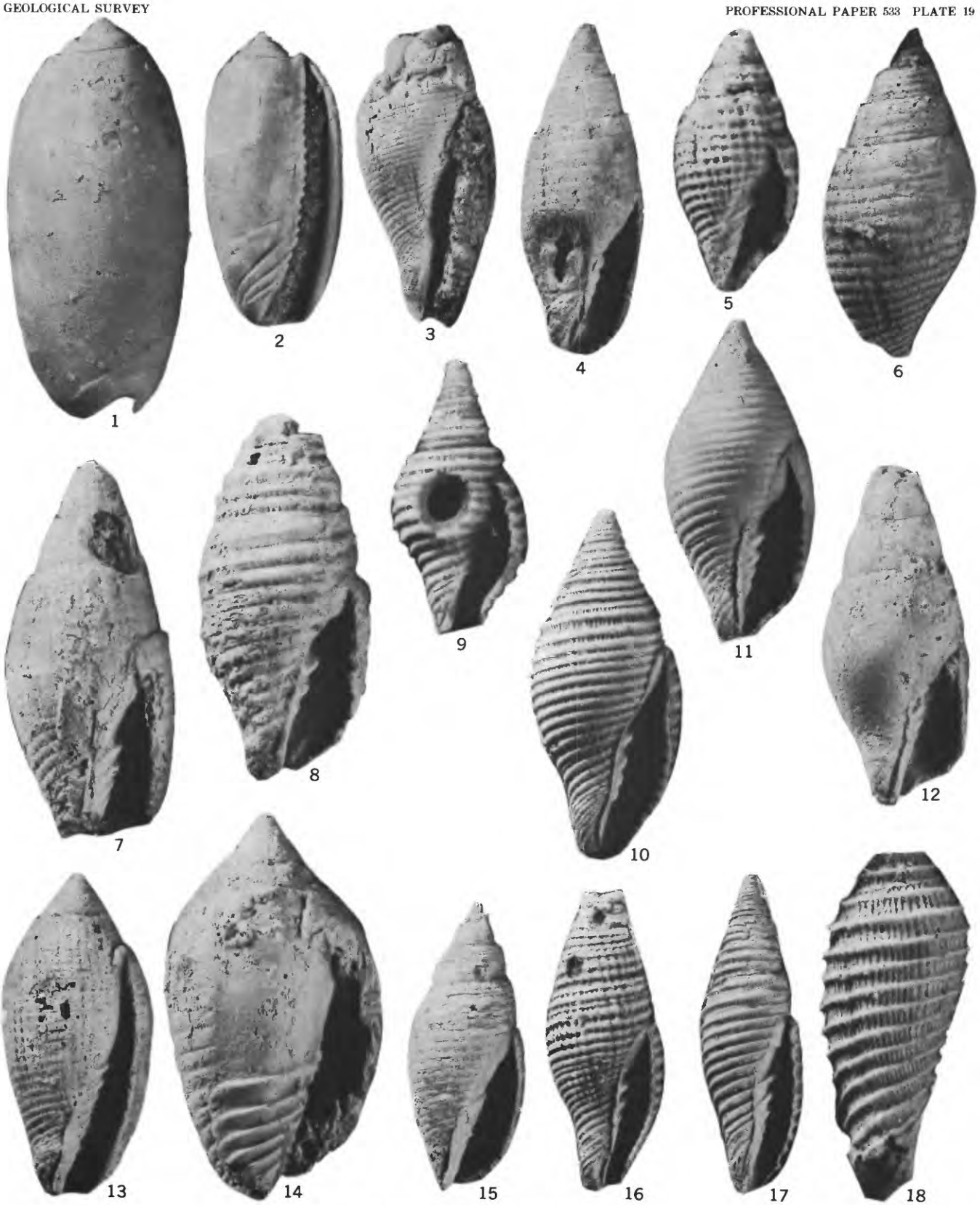
FIGURE

1. *Oliva miniacea* (Röding) (p. 59).
   Length 71.2 mm (× 1). USGS loc. 21028, Santo, New Hebrides; post-Tertiary. USNM 650641.
2. *Oliva mustelina* Lamarck (p. 59).
   Length 31.1 mm (× 2). Station RB44, Viti Levu, Fiji; Pliocene. British Mus. No. GG13322.
3. *Mitra* (*Mitra*) *eremitarum* Röding (p. 59).
   Height 35.9 mm (× 1.5). Station RB44, Viti Levu, Fiji; probably Pliocene (Tertiary *h*). British Mus. No. GG13321.
4. *Mitra* (*Mitra*) *imperialis* Röding (p. 59).
   Height 19.6 mm (× 3). Station C1640, Nanuyanuya, near Viwa, Fiji; Quaternary. USNM 175043.
5. *Mitra* (*Mitra*) cf. *M. puncticulata* Lamarck (p. 60).
   Height 7.7 mm (× 6). Drill hole 2A, Bikini, depth 1,009–1,020 ft; early Miocene (Tertiary *f*). USNM 650663.
6. *Mitra* (*Nebularia*) *aurantia* (Gmelin) (p. 60).
   Height of latex cast 20 mm (× 3). USGS loc. 20488, Guam, Barrigada Limestone, late Tertiary age. USNM 174948.
7. *Mitra* (*Nebularia*) *coronata* Lamarck (p. 60).
   Height 22.2 mm (× 3). USGS loc. 21028. Santo, New Hebrides; post-Tertiary. USNM 650642.
8. *Mitra* (*Nebularia*) *crassicostata* Sowerby? (p. 60).
   Height 22.0 mm (× 3). USGS loc. 20732, Guam; Mariana Limestone; Pliocene or Pleistocene. USNM 650645.
9. *Mitra* (*Nebularia*) *fraga* Quoy and Gaimard (p. 60).
   Height 4.6 mm (× 10). Drill hole F–1, Eniwetok, depth 60–70 ft; Holocene. USNM 174950.

10, 11. *Mitra* (*Nebularia*) *turgida* Reeve (p. 60).

10. Palau specimen, height 15.3 mm (× 4). USGS loc. 21304; Goikul Peninsula, Babelthuap, Palau; marl at base of Palau Limestone; late Miocene (Tertiary *g*). USNM 650647.
11. Eniwetok specimen, height 14.4 mm (× 4). Drill hole F–1, Eniwetok, depth 660–670 ft; late Miocene (Tertiary *g*). USNM 650648.

12. *Mitra* (*Strigatella*) *fastigium* Reeve (p. 61).
   Height 15.3 mm (× 4). Station 110B, Vanua Mbalavu, Fiji; Pliocene (Tertiary *h*). USNM 650646.
13. *Pterygia crenulata* (Gmelin) (p. 61).
   Height 29.4 mm (× 2). Station 7897, Saipan; Tanapag Limestone; Pleistocene or Holocene. USNM 650638.
14. *Pterygia fenestrata* (Lamarck) (p. 61).
   Height 23.1 mm (× 3). USGS loc. 20626, Guam; Mariana Limestone; Pliocene or Pleistocene. USNM 175006.
15. *Scabricola* (*Scabricola*) *desetangsii* (Kiener) (p. 61).
   Height 21.2 mm (× 2). USGS loc. 20726, Guam; Alifan Limestone; age, late Tertiary (Tertiary *g* or *h*). USNM 650649.
16. *Subcancilla abyssicola* (Schepman) (p. 62).
   Height 13.2 mm (× 4). Station 817, Vanua Levu, Fiji; Pliocene (Tertiary *h*). USNM 174949.
17. *Subcancilla interlirata* (Reeve) (p. 62).
   Height 19.3 mm (× 3). Station 165, Viti Levu, Fiji; late Tertiary. Bernice P. Bishop Mus., Geol. No. 1214.
18. *Subcancilla malleti* (Petit de la Saussaye) (p. 62).
   Diameter of cast 4.7 mm (× 6). USGS loc. 17446, Guam; Mariana Limestone; Pliocene or Pleistocene. USNM 174946.



OLIVIDAE AND MITRIDAE

PLATE 20

FIGURE

1. *Subcancilla nasongoensis* (Ladd) (p. 62).
   Holotype, height 18.4 mm (× 3). Station 165, Viti Levu, Fiji; late Miocene (Tertiary *g*). Bernice P. Bishop Museum, Geol. No. 1215.

2, 3. *Cancilla* (*Demiporta*) *carnicolor* (Reeve) (p. 63).
   Height (incomplete) 22.2 mm (× 3). USGS loc. 21378, Guam; Mariana Limestone; Pliocene or Pleistocene. USNM 650643.

4, 5. *Vexillum* (*Costellaria*) *amanda* (Reeve) (p. 63).
   4. Large specimen, height 18.9 mm (× 3).
   5. Average specimen, height 9.2 mm (× 6). Both specimens from marls at base of Palau Limestone (USGS loc. 21301), Goikul Peninsula, Babelthuap, Palau; late Miocene (Tertiary *g*). USNM 174944 and 174945.

6, 7. *Vexillum* (*Costellaria*) *cernohorskyi* Ladd (p. 63).
   Holotype, height 8.2 mm (× 6). Drill hole K–1B, Eniwetok, 747? 758 ft; late Miocene (Tertiary *g*). USNM 650662.

8. *Vexillum* (*Costellaria*) *deshayes* (Reeve) (p. 63).
   Height 15.1 mm (× 4). Drill hole F–1, Eniwetok, depth 850–860 ft; late Miocene (Tertiary *g*). USNM 650652.

9. *Vexillum* (*Costellaria*) aff. *V. discoloria* (Reeve) (p. 64).
   Height 7.3 mm (× 6). Drill hole 2A, Bikini, depth 1,056–1,063 ft; early Miocene (Tertiary *f*). USNM 650657.

10. *Vexillum* (*Costellaria*) *festum* (Reeve) (p. 64).
    Height 8.5 mm (× 6). Drill hole F–1, Eniwetok, depth 820–830 ft; late Miocene (Tertiary *g*). USNM 174943.

11. *Vexillum* (*Costellaria*) *leucozonias* Deshayes (p. 64).
    Height 10.8 mm (× 5). Drill hole Mu–4, Eniwetok, depth 21.5 ft; Holocene. USNM 650651.

12. *Vexillum* (*Costellaria*) *obeliscus* (Reeve) (p. 64).
    Height 22.3 mm (× 3). Station 817, Vanua Levu, Fiji; Pliocene (Tertiary *h*). USNM 650636.

13. *Vexillum* (*Costellaria*) *radius* (Reeve) (p. 65).
    Height 14.6 mm (× 4). Station 59, Viti Levu, Fiji; late Miocene (Tertiary *g*). Bernice P. Bishop Mus., Geol. No. 1193.

14. *Vexillum* (*Costellaria*) aff. *V. gembacana* (Martin) (p. 65).
    Height 7.9 mm (× 8). Drill hole F–1, Eniwetok, depth 830–840 ft; late Miocene (Tertiary *g*). USNM 175036.

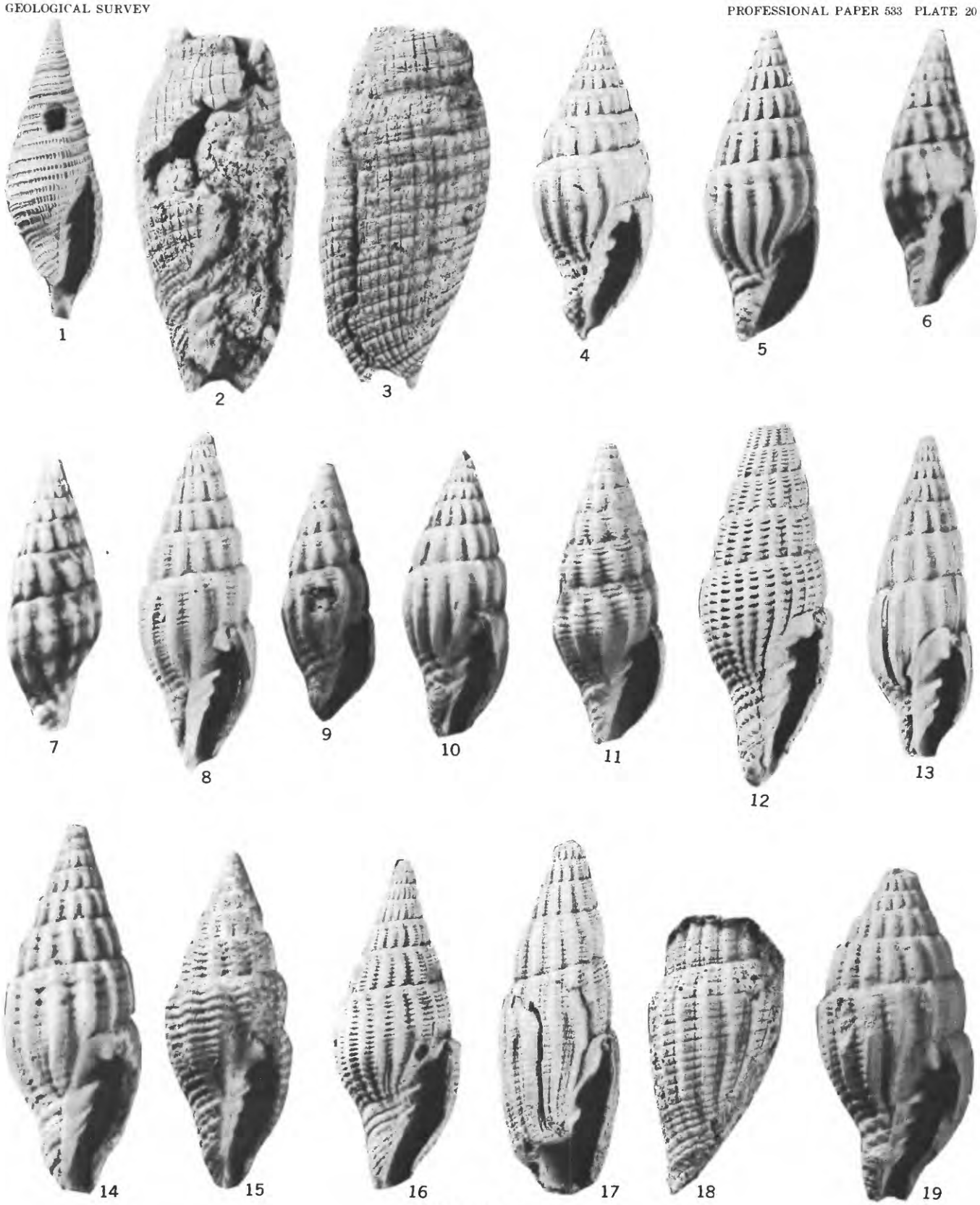
15. *Vexillum* (*Costellaria*) *roseum* (Broderip) (p. 65).
    Height 12.0 mm (× 5). Drill hole E–1, Eniwetok, depth 230–240 ft; probably Pleistocene. USNM 650658.

16. *Vexillum* (*Costellaria*) *strasfogeli* Ladd, n. sp. (p. 65).
    Holotype, height 14.8 mm (× 4). Station 817, Vanua Levu, Fiji; Pliocene (Tertiary *h*). USNM 174947.

17. *Vexillum* (*Costellaria*) *stainforthi* (Reeve) (p. 66).
    Height (incomplete) 32.5 mm (× 2). USGS loc. 25257, Santo, New Hebrides; Quaternary. USNM 175054.

18. *Vexillum* (*Costellaria*) aff. *V. zebuense* (Reeve) (p. 66).
    Height of incomplete cast 11 mm (× 3). USGS loc. 20674; Guam; Mariana Limestone, Pliocene or Pleistocene. USNM 650653.

19. *Vexillum* (*Pusia*) *approximatum* (Pease) (p. 66).
    Height 12.0 mm (× 5). Drill hole K1–B, Eniwetok, depth 925–937 ft; early Miocene (Tertiary *f*). USNM 650656.



MITRIDAE

PLATE 21

FIGURE

1. *Vexillum* (*Pusia*) *exquisitum* (Garrett) (p. 66).
   Height 5.5 mm (× 10). Drill hole E–1, Eniwetok, depth 100–110 ft; probably Holocene. USNM 650655.
2. *Vexillum* (*Pusia*) *microzonias* (Lamarck) (p. 66).
   Height 9.3 mm (× 6). Station 110B, Vanua Mbalavu, Fiji; Pliocene (Tertiary *h*). Univ. Rochester Mus. Nat. History No. 13068.
3. *Eocithara*? sp. A (p. 67).
   Length (incomplete) 30 mm (× 2). Station L389, Lakemba, Fiji; early Miocene (Tertiary *f*). USNM 174977.
4. *Harpa amouretta* Röding (p. 67).
   Diameter of cast (incomplete) 16 mm (× 3). USGS loc. 20640, Guam; Talisay Member of Alifan Limestone (Tertiary *g-h*). USNM 174978.

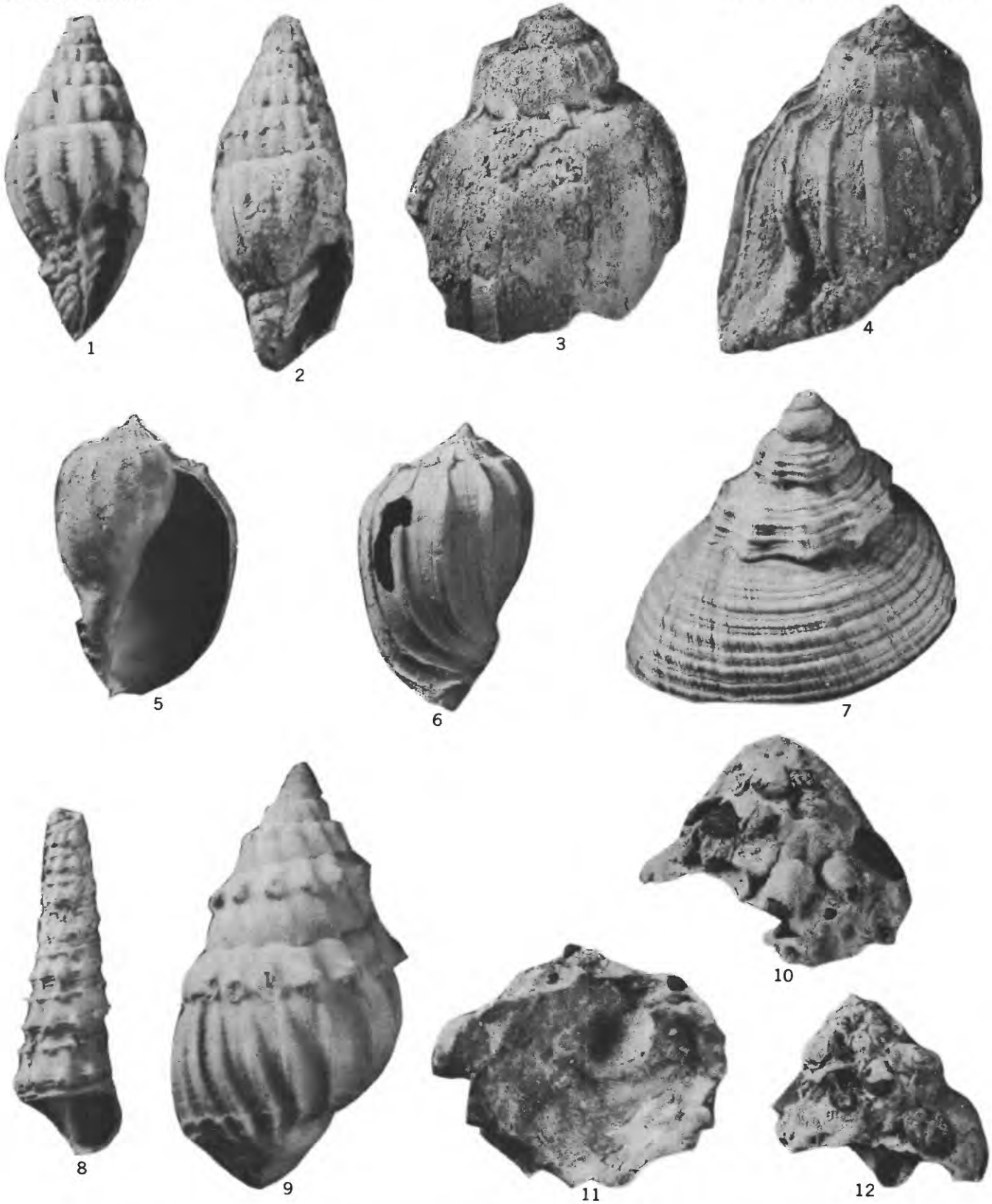
5, 6. *Harpa major* Röding (p. 67).
   Height 49.5 mm (× 1). Station SM242, Santo, New Hebrides; Pleistocene. Collection of D. I. J. Mallick.

7. *Nawenia bartholomewi* Ladd, n. gen. and n. sp. (p. 51).
   Apical view (× 6). Near station V11, Vanua Levu, Fiji; Pliocene (Tertiary *h*). British Mus. No. GG1842.
8. *Argyropeza*? *suvaensis* Ladd, n. sp. (p. 15).
   Paratype (incomplete) height 10.1 mm (× 6). Station FB–13, Suva, Fiji; early Miocene (Tertiary *f*). USNM 175062.
9. *Nassarius* (*Phrontis*) *tiarula* (Kiener) (p. 52).
   Height 12.5 mm (× 6). Drill hole A–1, Eniwetok, depth 168.2–175.3 ft; Holocene. USNM 175055.

10–12. *Xenophora corrugata* (Reeve) (p. 16).

10, 11. Height 35 mm (× 1). Station C1264, Viti Levu, Fiji; Pliocene (Tertiary *h*). USNM 175049.

12. Height 35 mm (× 1). Station C1264, Viti Levu, Fiji; Pliocene (Tertiary *h*). USNM 175076.



MITRIDAE, HARPIDAE, BUCCINIDAE, CERITHIIDAE, NASSARIIDAE, AND XENOPHORIDAE

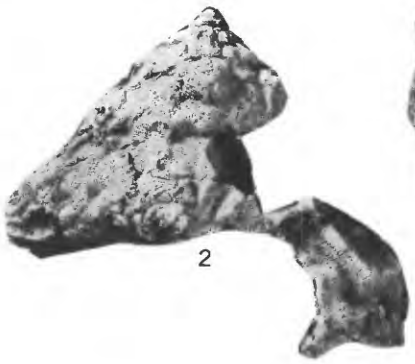
PLATE 22

FIGURES 1–3. *Xenophora konai* Habe (p. 16).
Height 15.7 mm (× 1). Station SM242, Santo, New Hebrides; Pleistocene. USNM 175090.

4–6. *Xenophora calculifera* (Reeve) (p. 16).
Height (incomplete) about 45 mm (× 1). Station SM242, Santo, New Hebrides; Pleistocene. Collection of D. I. J. Mallick.

7, 8. *Diancta* aff. *D. macrostoma* Möllendorff (p. 15).
Height 2.8 mm (× 20). Station C1142, Viti Levu, Fiji; Pliocene (Tertiary *h*). USNM 175056.

1



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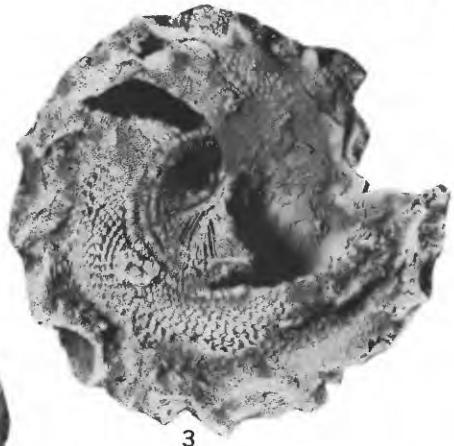

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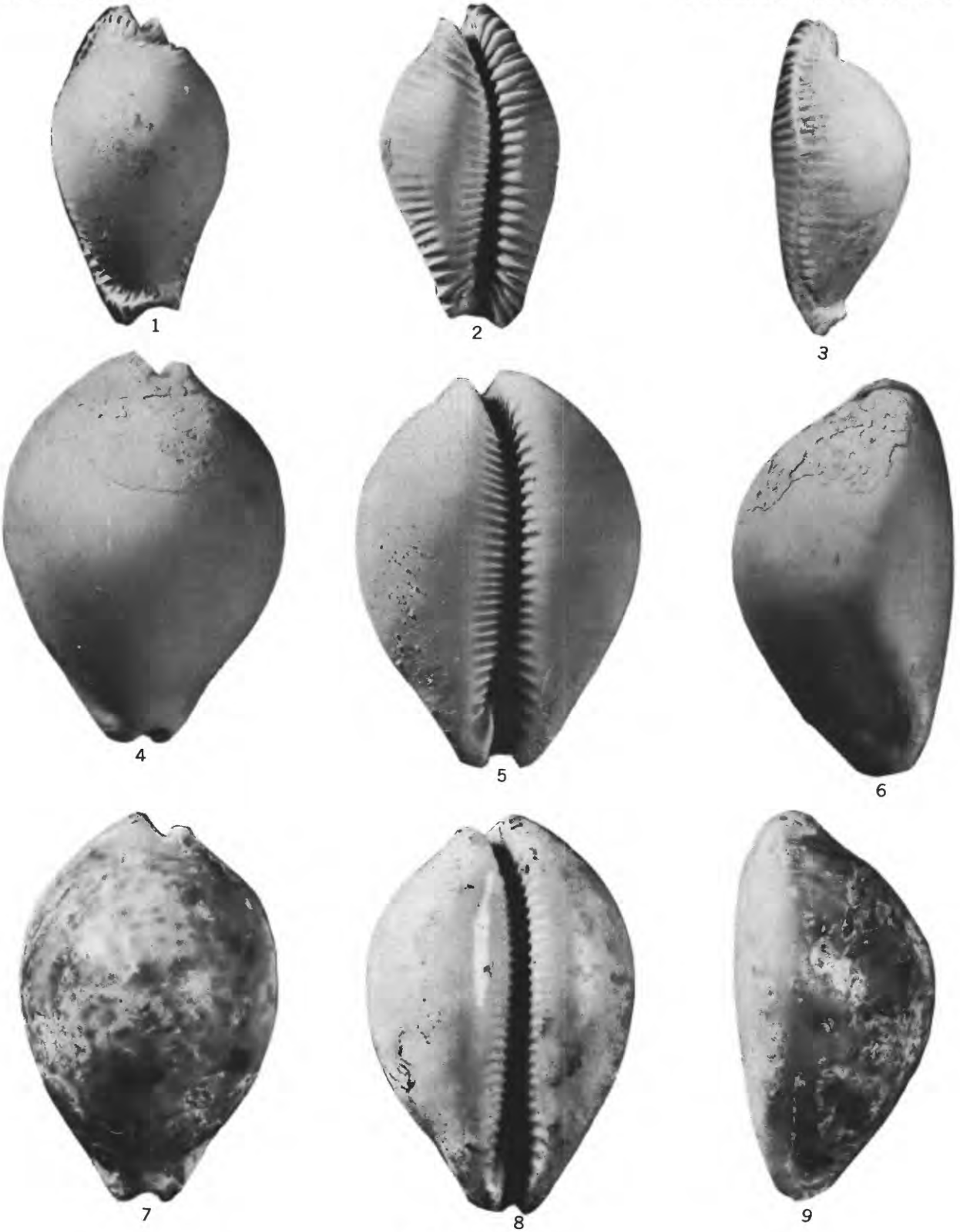
XENOPHORIDAE AND CYCLOPHORIDAE

PLATE 23

FIGURES 1–3. *Cypraea* (*Erosaria*) *guttata* Gmelin (p. 24).
Length 53.7 mm (× 1). USGS loc. 25718, Santo, New Hebrides; Pleistocene. USNM 214283.

4–9. *Cypraea* (*Lyncina*) *porteri* Cate (p. 20).
4–6. Length 43.8 mm (× 1½). Station SM242, Santo, New Hebrides; Pleistocene. Collection of D. I. J. Mallick.
7–9. Length 44.0 mm (× 1½). USGS loc. 25715, Santo, New Hebrides; Pleistocene. USNM 175077. (Figures not coated.)



CYPRAEIDAE