Tertiary and Quaternary Gastropoda of Okinawa

GEOLOGICAL SURVEY PROFESSIONAL PAPER 339

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By F. STEARNS MacNEIL

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A comparison of the late Miocene, Pliocene, and Pleistocene Gastropoda of Okinawa with related faunas of East Asia together with a résumé of the geologic setting of the fossiliferous deposits

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ILLUSTRATIONS

TERTIARY AND QUATERNARY GASTROPODA OF OKINAWA

By F. Stearns MacNeil

ABSTRACT

The general geology of the Ryukyu Islands is summarized as a background to the discussion of the stratigraphy of the fossiliferous Tertiary and Quaternary rocks. The following stratigraphic units are recognized; the Shimajiri formation, consisting of the Yonabaru clay member (late Miocene) in the lower part of the exposed section, and the Shinzato tuff member (Miocene or Pliocene) in the upper part; and the Ryukyu group, consisting of, in ascending order, the possibly contemporaneous Nakoshi sand (Pliocene) and Chinen sand (Pliocene), the Naha limestone (Pliocene), the Yontan limestone (Pleistocene), and the Machinato limestone (Pleistocene). Raised beach deposits (Post-Pleistocene) are not discussed in this report. One well on Okinawa penetrated about 2,500 feet of the Shimajiri formation not exposed at the surface. The unexposed part of the formation is not named.

A total of 333 species, subspecies, and varieties are treated systematically. The number of species obtained from each rock unit is: Yonabaru clay member of the Shimajiri formation 118, Shinzato tuff member of the Shimajiri formation 91, Chinen sand 71, Nakoshi sand 28, Naha limestone 55, Yontan limestone 46. Ninety-seven species, 6 subspecies, and one variety are described as new (see pl. 20). Six new genera and one new subgenus are described: *Tostatrochus*, *Loochooia*, *Nihonophos*, *Unedogemmula*, *Pinguigemmula*, *Nihonia*, and *Alticlavatula* (subgen. of *Clavatula*). The present treatment of *Makiyamaia* may be its first valid usage. It is a manuscript name of Kuroda's which was used in a plate legend by Kira in combination with a specific name but no other explanation. According to present rules this does not validate the name.

An analysis is made of the geographical relationships of the fauna of each formation to determine possible climatic changes in the area. In general, progressive cooling took place from Miocene to early Pliocene time, followed by warming in middle or late Pliocene time. The Pleistocene deposits represent warm stages.

Bathymetric interpretations based on dredging and collecting records for surviving representatives or close relatives of the fossil species indicate that the Yonabaru clay and Shinzato tuff members of the Shimajiri formation were deposited in moderately deep water—at least 150 to 300 fathoms, and 200 to 400 fathoms, respectively. The Shimajiri formation probably represents deposition on the side of a trench corresponding to the present Ryukyu trench. The Chinen sand appears to have been deposited in water between 50 and 100 fathoms deep; the Nakoshi sand in less than 50 fathoms. The Naha limestone has an indicated depth of about 20 to 30 fathoms, suggesting that it is either a lagoon deposit or an insular shelf deposit. The Yontan limestone is mostly a shallow reef detritus, probably deposited in water 10 fathoms deep or less.

INTRODUCTION

The fossil gastropods dealt with in this report were collected during the course of geologic mapping of Okinawa from 1946 to 1948. The project was part of the Pacific Geologic Mapping Program carried out by the U.S. Geological Survey in cooperation with the Office of Chief of Engineers, U.S. Army.

Regional geologic features are discussed in relation to the origin, structure and history of the Tertiary and Quaternary deposits from which the fossils were obtained. Stratigraphic units are recognized which differ somewhat from those used in earlier reports, mainly Japanese. Some of the stratigraphic units used earlier have been subdivided and parts of them have been recorrelated or reassigned to other formations or groups. One name has been abandoned. The stratigraphic concept outlined here results from the work of all members of the U.S. Geological Survey party but the writer is solely responsible for the statements made herein. Raymond A. Saplis helped prepare the lithologic descriptions.

Geologists who participated in the mapping and fossil collecting were H. William Burke, Gilbert C. Corwin, McClelland G. Dings, Maxim M. Elias, Delos E. Flint, Warren P. Fuller, F. Stearns MacNeil, and Raymond A. Saplis. Invertebrate fossils have been placed in the hands of various specialists and reports on the following groups are in preparation or have been published: Echinoidea (C. Wythe Cooke, published in 1954), Gastropoda (F. Stearns MacNeil), Pelecypoda (F. Stearns MacNeil), Scaphopoda (William K. Emerson), smaller Formaninifera (Leslie W. LeRoy), larger Foraminifera (W. Storrs Cole), Brachiopoda (G. Arthur Cooper, published in 1957), Corals (John W. Wells).

GENERAL GEOLOGY OF OKINAWA AND THE RYUKYU ISLANDS

LOCATION

The Ryukyu Islands (fig. 1) form one of the island arcs of the western Pacific, extending from southern Japan to the northern end of Formosa. The convex side of the islands faces the Philippine Sea and the shallow East China Sea lies behind them. The island of Okinawa lies about midway in the Ryukyu Islands between latitudes 26°04′ and 26°52′ north and longitudes 127°38′ and 128°20′ east.

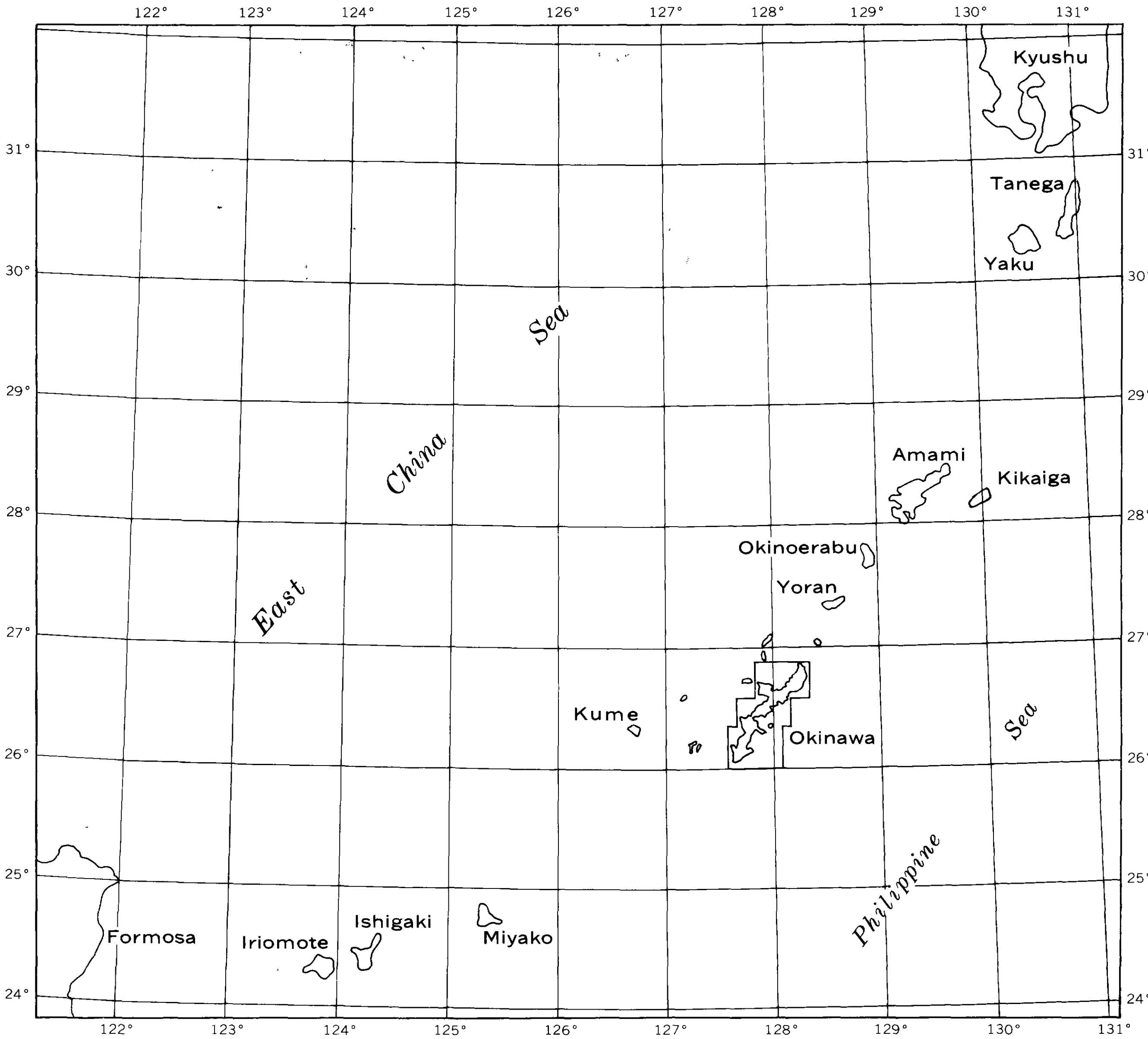

FIGURE 1.—Map of Ryukyu Islands showing location of Okinawa and area covered by index map of fossil localities (pl. 21).

PREVIOUS WORK ON OKINAWA

A summary of the contributions to the geology of the Ryukyu Islands prior to 1935 is given by Hanzawa (1935) and his account should be consulted as a supplement to the present summary. No attempt is made to repeat his commentary or to include all of his bibliographic references, a number of them being to papers in the Japanese language.

Apparently the first information on the geology of Okinawa to be published is a description of its terrain and rocks in the narrative of Commodore M. C. Perry's mission (Jones, 1856). According to Hanzawa, Döderlein (1880–84) was the first to point out the existence of parallel arcs of volcanic and sedimentary rocks in the Ryukyus.

The first geologic map and a brief account of the geology of Okinawa was published by Kada (1885), and he appears to have been the first to use the names Shimajiri and Naha in at least an informal stratigraphic sense. According to Hanzawa, Kada's map was the basis for Koto's interpretation of the structure of the Ryukyu Islands, the first really important contribution. Koto (1897) pointed out the three-fold division of the Ryukyu Islands into an inner volcanic zone, a complex middle zone of Paleozoic metamorphic and igneous intrusive rocks, and an outer zone of young Tertiary rocks. He also detected great rifts radial to the Ryukyu arc.

Certainly the first papers not in Japanese which deal with the geology of Okinawa in more than brief statements are two by Yoshiwara (Tokunaga) both of which appeared in 1901. The second of these summarizes earlier work and among the citations is a list of fossils from Okinawa reported by Furet (1860), which according to the identifications were believed erroneously to be Cretaceous species. Tokunaga's work included a simple geologic map that shows roughly the distribution of several types of Paleozoic rocks, Tertiary sands and shales, and raised reef limestone. A tabulation is given for the types of rock and their dip and strike observed on numerous traverses, and the rocks of Okinawa are compared with those of other islands in the arc. There are some good descriptions of the lithology, bedding, and attitude of the Tertiary sands and shales, and of the raised reef limestone. Fossils are listed, mostly as genera.

In 1925 Yabe and Hanzawa (1925) reported on the Foraminifera in four samples sent them from Okinawa, two from the Naha limestone as used here, one from the Yonabaru clay member of the Shimajiri formation as used here, and one from the Nakoshi sand as used here. They regarded the Naha limestone as pre-Pleistocene. They regarded the Yonabaru clay member and Nakoshi sand as not very different in age despite the faunal dissimilarities. They thought that some elements from the Yonabaru indicated a fauna which might range from deep tropical to shallow boreal water. They regarded the fauna of the Nakoshi sand as similar to recent shallow water faunas of the Philippines.

After their joint paper was prepared Hanzawa visited Okinawa to collect additional material and published a note that appeared the same year (Hanzawa, 1925). The formation to which all of his samples should be assigned in terms of the present report is not certain, but, except for Nakoshi, it seems likely that all of his samples came from the Yonabaru clay member of the Shimajiri formation as used here. The name Shimajiri group was proposed for all of the beds exposed below the limestone.

Hanzawa spent additional time in Formosa and the Ryuku Islands from 1929 to 1933, which work resulted in a comprehensive treatment of the geology of the Ryukyu Islands (Hanzawa, 1935a, b). New geologic maps were included for the islands. Aside from his previous usage of Shimajiri group, formal stratigraphic nomenclature was used in this report for the first time. Shimajiri group was changed to Shimajiri beds and, as before, the name was used for all beds below the base of the limestone. The type area was Shimajiri-gun in southern Okinawa but no type section was specified. The name was used for the entire section of sands, silts, tuffs, and clays below the limestone on all of the islands where this sequence occurs from Miyako-jima to Kikaiga-shima. A pumice bed several meters thick was mentioned as occurring in the upper part of the Shimajiri beds on Kikaiga-shima but no mention was made of pumice or tuff on Okinawa. The Shimajiri beds were stated to be rich in Foraminifera but apparently no Mollusca were found in any part of them in their type area in southern Okinawa. However, Mollusca were found at several localities near Nakoshi in northern Okinawa and collections from the area were later to become the subject of a paper by Nomura and Zinbo (1936). While the fossiliferous beds at Nakoshi were a part of the Shimajiri beds of Hanzawa, it is the Nakoshi sand of this report and is regarded as a formation of the Ryukyu group rather than part of the Shimajiri formation. The unfortunate circumstance of having the only described fossils from the Shimajiri prove to be from another unit results entirely from the discovery that the 30 feet or less of beds at the top of Hanzawa's Shimajiri beds are separated from the lower beds by an unconformity, and that the sandy beds above the unconformity are conformable with and grade into the overlying limestone.

The raised reef limestones were called in Hanzawa's report the Riukiu limestone, a term used throughout the Ryukyu Islands. The Riukiu limestone of Hanzawa consists of three unconformable and faunally distinct units, which, together with the Nakoshi sand and Chinen sand constitute the Ryukyu group as here used.

A third stratigraphic term used by Hanzawa was the Kunigami gravel. The Kunigami, as he mapped it, consists of lateritic soils and gravels; there is a wide range in clastic components of the gravel from place to place depending on the type of rock from which it was derived. Hanzawa stated that in an earlier paper in Japanese he had regarded the Kunigami gravel as contemporaneous with the basal gravel of the "Riukiu limestone" but more recently had determined that the Kunigami rests unconformably on the "Riukiu limestone." Work done by the writer and his associates indicates that both of Hanzawa's views are partly correct. The interpretation reached by the Survey party is that part of his Kunigami is the residuum of the limestone units and that part is gravel that once intertongued with now dissolved reef limestones along the shoreward margin of the former reefs. Similar gravel deposits are still found intertonguing with limestone in areas where the limestone beds are not leached.

Several short notes by other Japanese paleontologists followed Hanzawa's papers. Nomura and Hatai (1936) listed several fossils collected from limestone near Naha (the Naha limestone of this paper) and assigned an early Pliocene age to the fauna. An interesting observation in this paper is the statement that the fossils from the limestone near Naha show it to be of about the same age as the Simaziri beds near Nakoshi, and that possibly the limestone near Naha might be a limestone facies of the Simaziri beds and not a part of the Riukiu limestone. This suggestion agrees as far as correlation is concerned with the findings of Survey geologists that the Nakoshi sand belongs to the same depositional sequence as the Naha limestone. The Nakoshi sand (and the equivalent Chinen sand) is conformable with the Naha limestone above it. The Chinen sand unconformably overlies the Shimajiri formation.

Nomura (1938) published another short note on mollusks from Okinawa, Ie-shima, and Kume-shima. The fossils from Okinawa were from Hanezi-mura (=Hanechi?=Nakoshi?). None was regarded as new and their known ranges were given. Some had been known previously in deposits as old as Miocene; some, only as Recent species.

Another addition to the fossil mollusks known from Nakoshi was made by Yabe and Hatai (1941b). They confirmed the Pliocene age of the Nakoshi fauna and stated that all the fossils except for a new species of *Haliotis* occur in the Byoritzu beds of Formosa.

Yabe and Hatai (1941a) published a second note in 1941 which dealt mainly with two species of *Pecten*, *P.* (*Amussiopecten*) *praesignis* Yokoyama and *P. naganumanus* Yokoyama, from limestone near Naha. The ranges of the species were discussed and it was pointed out that while *P. praesignis* ranges from the Miocene to the lower Pliocene and *P. naganumanus* from the lower Pliocene to the Pleistocene, the limestone near Naha is the first place where they have been found occurring together.

C. Wythe Cooke's (1954) paper on the fossil echinoids from Okinawa is the first of the present series on fossils collected by the Geological Survey party. Cooke did not use the stratigraphic nomenclature finally adopted for Okinawa but stated the echinoids are from "the lower, partly sandy division of the Ryukyu limestone of recent authors." Some are from the Nakoshi sand; others, from the Naha limestone of this report.

The second paper of the series is the one on the fossil brachiopods by G. Arthur Cooper (1957) who made use of the U.S. Geological Survey collections as well as fossils obtained independently by the U.S. National Museum. Cooper used the stratigraphic names of the present report with the exception of Shimajiri formation, treating the Yonabaru clay and Shinzato tuff as independent formations.

GEOLOGIC PROVINCES

There are three distinct geologic provinces in the Ryukyu Islands represented by three roughly concentric arcs of islands, although Okinawa contains parts of two provinces. The innermost arc, or "fire ring," is composed of volcanic islands, some of them being active volcanoes. Most of the volcanic islands are concentrated between Okinawa and Japan in the northern half of the Ryukyu Islands, but volcanic islets are present in Senkaku-gunto north of Iriomote and probably Daiton Volcano at the extreme northern tip of Formosa belongs to the same line of activity. The middle arc consists of metamorphosed Paleozoic rocks in which there is some close folding and large scale thrusting. Subordinate igneous dikes cut the Paleozoic rocks. The outer ring, of which there are only three geographic elements, Kikaiga-shima, southern Okinawa and some small islands lying east of southern Okinawa, and Miyako-jima, is composed of unconsolidated late Miocene and Pliocene sedimentary rocks. Part of the sediments of the outer ring are deep water deposits and they appear to have been raised to their present position from a position on the west slope of the Ryukyu Trench. Some lower Tertiary and lower middle Tertiary sediments rest on the Paleozoic rocks on some islands of the middle arc. Pliocene and Pleistocene raised reef limestones may occur on islands of all three arcs.

STRATIGRAPHY

PRE-TERTIARY ROCKS OF OKINAWA

The pre-Tertiary rocks of Okinawa consist of partly metamorphosed sedimentary rocks with subordinate dikes and sills. The metamorphic rocks (probably all of late Paleozoic age) include greenstone, phyllite, clay-slate, sandstone, chert, and crystalline limestone. They form the mountains of the main arc of the island from Yontan-zan northward, the mountains of Motobu Peninsula, and they underlie the reef limestones of Ie-shima and the Kerama-retto; whether they underlie the Teritary rocks of southern Okinawa is not known. Igneous intrusions of rhyolite porphyry, andesite porphyry, and hypersthene andesite cut the metamorphic rocks. The age of the igneous intrusions could be as old as very late Paleozoic or as young as early Tertiary. No Mesozoic rocks have been identified in the Ryukyu Islands and unless some of the intrusives are of that age none are present. Hanzawa (1935) suggested that during Mesozoic time a great "Riukiu Cordillera" occupied the present site of the Ryukyu Islands and that most of the regional metamorphism took place during its upheaval.

No fossils have been found in the sandstone, phyllite, and greenstone. The limestone has yielded some nondiagnostic crinoid stems on Ie-shima, and in Motobu Peninsula Hanzawa collected some highly crystallized fusulinids of the genera *Neoschwagerina*, *Parafusulina*, and *Verbeekina* which indicate a Permian age, at least for the limestone.

LOWER AND MIDDLE TERTIARY ROCKS OF THE RYUKYU ISLANDS

Rocks of early Tertiary age are found in Ishigaki in the southern Ryukyu Islands and rocks of middle Tertiary age are found on several islands of the Yaeyama group. Both lower and middle Tertiary rocks are found on Tanega-shima in the Osumi group. If rocks of early or middle Tertiary age are present in the Okinawa group they underlie the exposed upper Tertiary rocks at depths below sea level.

Although the evidence is still incomplete, Otuka (1938) dated the latest crustal deformation in the Ryukyu area as late Oligocene. This was based on the fact that in Tanega-shima the Kukinaga beds, which are dated as early Miocene, rest unconformably on intensely folded Kumage beds which are dated as Eocene or early Oligocene. The Miyara beds, which occur only on the two islands in the Yaeyama group, Ishigaki and Kobama, are dated as late Eocene on the basis of *Pellatispira madrezi* Hantken, a foraminifer. According to Hanzawa they are tilted in various directions at steep angles. The Miyara beds are overlain by the Yaeyama coal-bearing beds of Miocene age, the lowest part being dated as Burdigalian by Hanzawa. The Yaeyama coal-bearing beds are cut by numerous faults but are only slightly tilted.

The oldest post-Paleozoic rocks on Okinawa are those of the Shimajiri formation, the oldest exposed part of which is believed to be of late Miocene age. Over 4,000 feet of the Shimajiri formation was penetrated in a well near Yonabaru in southern Okinawa. All of the exposed part of the Shimajiri formation is believed from a study of the smaller Foraminifera by L. W. LeRoy (written communication, 1946) to be equivalent to the upper 1,500 feet in the well. The beds at 4,000 feet, still assigned to the Shimajiri formation, are believed by LeRoy to be no older than middle Miocene.

It seems likely that the Kukinaga beds of Tanega-shima, the Yaeyama coal-bearing beds of Ishigaki and Kobama, and the Shimajiri formation of Okinawa all belong to the same regional regimen and that the lowest, still unknown part of the Shimajiri formation may prove to be of the same age as the Kukinaga beds to the north and the Yaeyama coal-bearing beds to the south. According to Hanzawa the Shimajiri beds are not present on Tanega-shima, but he may have been thinking in terms of the Pliocene Nakoshi sand of this report. Information available at present does not rule out the near equivalence of at least the lower part of the Shimajiri formation in the Yonabaru well with the Kukinaga beds and the Yaeyama coal-bearing beds.

TERTIARY AND QUATERNARY ROCKS OF OKINAWA

The oldest Tertiary rocks (late Miocene and early? Pliocene) of Okinawa are restricted to the southern part of the island and to some islands lying east of southern Okinawa. Here clays and sands of the Shimajiri formation form the basement for the overlying Ryukyu group. Younger Tertiary and Quaternary sands, gravels and limestones of the Ryukyu group (Pliocene and Pleistocene) are widespread at medium and low altitudes. In general, gravel, gravelly limestone, and sand predominate nearest to the Paleozoic rocks; limestone with subordinate sand farthest from the Paleozoic rocks. The present occurrence of limestone is fortuitous owing to solution. Limestone is most prevalent in southern Okinawa, on the lower terrace slopes of central Okinawa, in Motobu Peninsula, and on most of the outlying islands. Only one small patch of limestone is known in northern Okinawa—near sea level on the west side. If limestone was ever extensive in northern Okinawa it has been removed by solution.

The only formal stratigraphic names that have been applied to the Tertiary and Quaternary formations of Okinawa are those of Hanzawa, although some of his names were used informally by earlier authors. The present classification as well as the stratigraphic nomenclature used differs from Hanzawa's in several respects and they are contrasted in the following table. (Fig. 2.)

MIOCENE OR PLIOCENE—SHIMAJIRI FORMATION

UNEXPOSED LOWER BEDS IN THE YONABARU WELL (MIOCENE)

The lower, unexposed part of the Shimajiri formation, which is known at present only from the cuttings of two wells, is not assigned to a named member. The

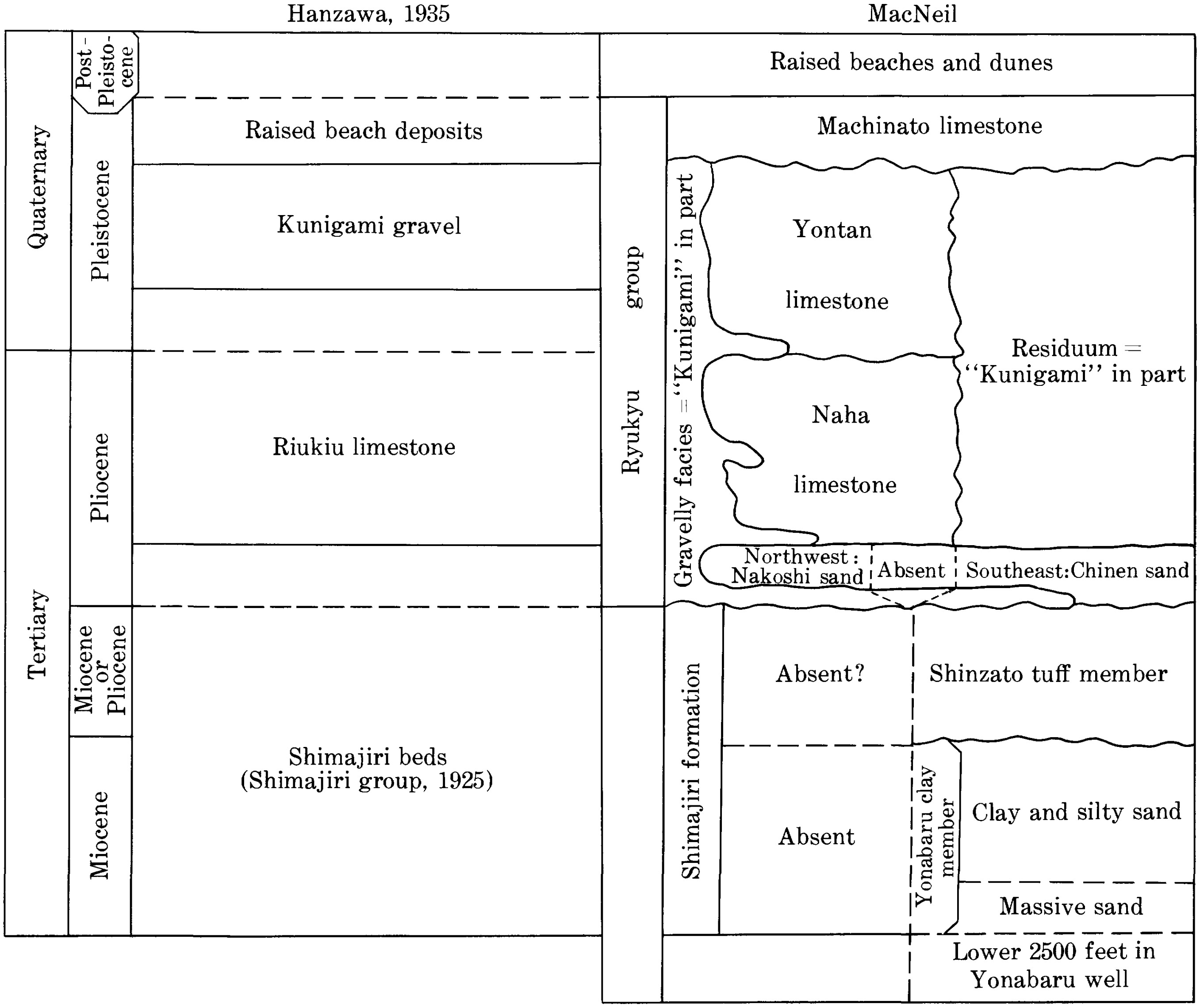

FIGURE 2.—Stratigraphic nomenclature of Tertiary and Quaternary formations; Hanzawa (1935) and MacNeil.

deeper well, drilled near Yonabaru, penetrated to a depth of 4,036 feet. The well started an estimated 300 to 500 feet below the top of the Shimajiri formation. Allowing for an approximate thickness of 200 feet for the Shinzato tuff member, the well is believed to have been spudded in approximately 100 to 300 feet below the top of the Yonabaru clay member. According to L. W. LeRoy (written communication, 1947) the Foraminifera indicate that the exposed part of the Yonabaru clay member is represented by the upper 1,500 feet in the Yonabaru well. The well thus penetrated some 2,500 feet of beds not exposed at the surface.

The lithology of the unexposed lower beds will be described by LeRoy. It contains some gray sands and shales similar to the exposed part of the formation, but in addition it contains red shales and graywacke sandstones unlike any of the exposed beds.

Neither the base nor the contact of the Shimajiri formation with the Paleozoic rocks is known. The Yonabaru well did not pass out of the formation and there are no well data near the Paleozoic outcrops.

The lowest beds penetrated in the well contain Foraminifera that are believed to be no older than middle Miocene.

YONABARU CLAY MEMBER (MIOCENE)

The name "Yonabaru clay member" is used for all of the exposed part of the Shimajiri formation below the upper tuffaceous and pumiceous zone. The Yonabaru consists of bluish to gray silty to sandy clay, commonly with hackly to conchoidal fracture (figs. 3, 4) and fine

FIGURE 3.—Yonabaru clay member of the Shimajiri formation exposed in road cut on Highway 44 about 1½ miles west of Yonabaru.

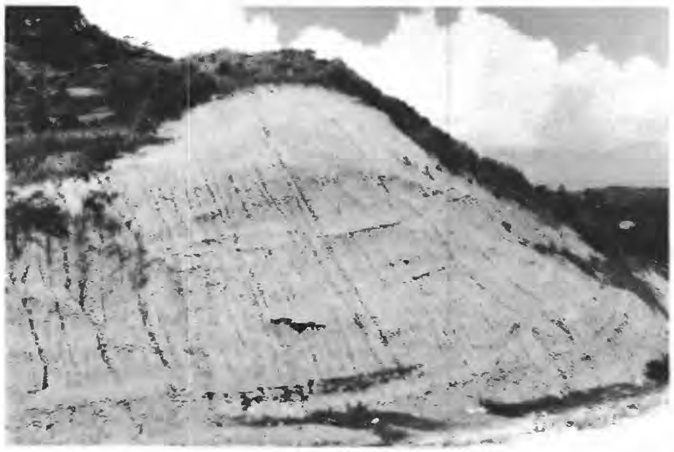

FIGURE 4.—Yonabaru clay member of the Shimajiri formation exposed in road cut on Highway 13 about 2½ miles north of Yonabaru (locality 17679).

dark-colored laminated to massive sand, weathering brown to gray, and which in places contains large lime-indurated concretions of sand. Some silty sand beds are intercalated in the more clayey parts of the section. The purer clay is barren of macrofossils but generally contains microfossils. Most of the macrofossils found were in sandy beds intercalated in the clays. Massive beds of fine sand are more common in the lower part of the exposed section, some of the beds being more than 200 feet thick, their actual thickness not determined because of inadequate exposure. No macrofossils were found in the massive sands. No pumice was found in the Yonabaru, but a few pellets of phosphate were found in beds containing fossil mollusks.

The Yonabaru clay member passes beneath the cover of the basal gravels of the Naha limestone along a line extending roughly from Kue to south of Teigan (a-a′, fig. 5) and the nearest outcrops of Paleozoic rocks rise from beneath the gravels about a mile northwest of this line. In the absence of information that would actually show the Yonabaru lapping out against Paleozoic rocks, it is assumed that it is faulted upwards against them.

Details of the stratigraphy of the Yonabaru clay member could not be determined at surface exposures because individual exposures are small and discontinuous. Detailed comparison of Foraminifera from surface exposures with those from the Yonabaru well might have yielded results if the Yonabaru well could have been studied before field work was completed. Unfortunately no information on the well was available at that time. Many surface samples were collected but apparently not enough to provide a complete structural pattern.

It was realized that the gross lithology of the Yonabaru clay member between some of the major faults crossing the island is different, some blocks containing thick beds of massive sand. The direction of displacement of these faults was determined where they cut limestone and it is inferred that higher beds of the Yonabaru are exposed in some of these blocks, and that lower beds are exposed in others, but exact correlations from block to block are not known. However, these faults were active before the deposition of the reef limestones and the displacement within the Yonabaru is probably greater than the displacement of the reef limestone, which along some faults is as much as 300 feet. Displacement of the Yonabaru clay member also took place along faults parallel with the long axis of the island but the location of these faults is less well known. Those that cut smaller areas of reef limestone are obvious only where massive sands have been moved into juxtaposition with clays. It is believed that more faults of this orientation exist than were observed.

A highly generalized and partly inferred plan of the outcrop of the Shimajiri formation is shown in the accompanying map (fig. 5). This shows the approximate area covered by the Shinzato tuff member and areas between observed or inferred faults that are believed to be high (H) or low (L) in the Yonabaru clay member. Mollusks were obtained from only two areas, (f), in beds believed to be high in the Yonabaru.

Most mollusks from the Yonabaru clay member indicate moderately shallow to moderately deep water. Probably a depth of less than 100 fathoms is indicated for the parts deposited in shallower water and probably not much more than 300 fathoms for the deeper facies. Mollusks indicating shallow water were found at one locality east of Naha (17449) along with pea-sized quartz gravel. Of all exposures of the Yonabaru examined this one suggests the shallowest water and deposition closest to shore. However, farther west near Naha, exposures of fine sand and silty clay are believed to represent a much lower part of the formation and

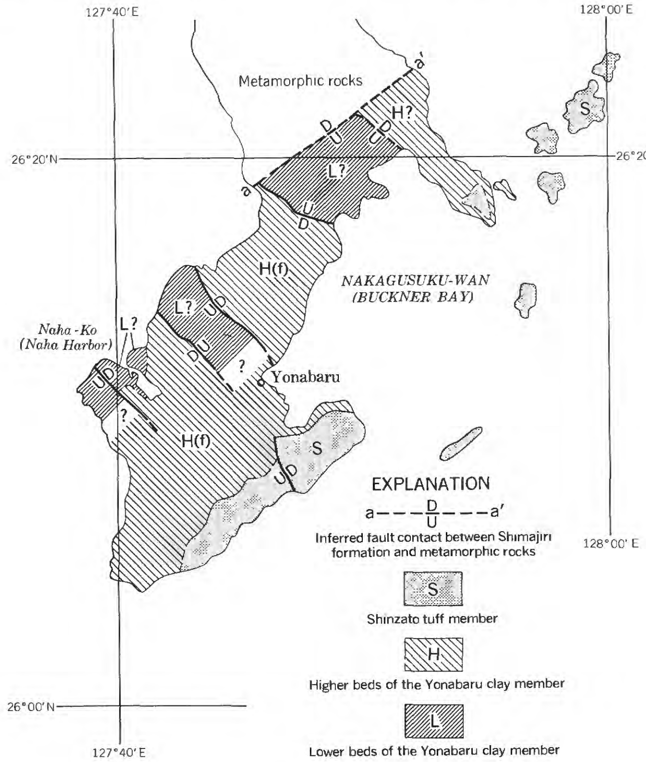

Figure 5.—Highly generalized map showing approximate distribution of parts of the Shimajiri formation as determined by known or inferred major faults and contact boundaries. Limestone and gravel cover are disregarded.

they may lie on the other side of a fault. No gravel deposits analogous to those found intertonguing with sands and limestones of the Ryukyu group have been found in the Yonabaru nearest the Paleozoic rocks. It is assumed that the Yonabaru clay member either was not receiving significant amounts of gravel at the time the parts now nearest the Paleozoic rocks were being deposited, or the gravelly facies is now concealed by faulting. Gravel may have been present in the nearshore facies of the youngest part of the Shimajiri formation, now eroded.

Two species of the pelecypod genus *Limopsis* are the most reliable fossils for distinguishing the Yonabaru clay and Shinzato tuff members in the field. The Yonabaru contains a smooth species closely related to *L. tajimae* Sowerby. The Shinzato contains a species having fine raised radial ribs that is closely related to *L. woodwardi* Adams. The two species have not been found together, but almost every fossiliferous exposure yielded one or the other species, at some places in abundance.

SHINZATO TUFF MEMBER (MIOCENE OR PLIOCENE)

The name "Shinzato tuff member" is proposed for the uppermost part of the Shimajiri formation. The Shinzato is fairly homogeneous, consisting for the most part of sandy or silty clay with minor partings of ash. Its color ranges from dark gray to light gray. Its maximum known thickness is about 200 feet. The base of the Shinzato in southernmost Okinawa is characterized by conglomeratic pumice. A channel nearly 80 feet deep filled with ash and boulders of pumice, some of them about 8 inches in diameter, cuts into the underlying Yonabaru clay member at one locality (figs. 6,

Figure 6.—Pumice-filled channel at base of Shinzato tuff member of the Shimajiri formation cutting the underlying Yonabaru clay member, about 0.2 mile east of Shinzato.

Figure 7.—Higher beds in the pumice-filled channel shown in figure 6.

7), but elsewhere the boundary is indicated by ash or by a few scattered pebbles of pumice. The Shinzato tuff member occurs down the dip as an erosional wedge and presumably it was once more extensive.

There was probably no significant time break between the deposition of the Yonabaru clay and Shinzato tuff members, the deep channels and pumice probably reflecting tectonic movements and volcanism taking place in the Ryukyu Islands in late Shimajiri time. So far as is known there is no tuff or pumice in the Yonabaru clay member.

Unlike the Yonabaru clay member which is believed to occur only to the east of the Paleozoic rocks, there are some tuffaceous pumice-bearing beds and bluish clay beds below basal gravel of the Ryukyu group in the narrow neck of Motobu Peninsula which might be a shallow-water facies of the Shinzato. No fossils were found in these beds.

The Shinzato tuff member of southern Okinawa contains mollusks that indicate water at least as deep as do the mollusks in the Yonabaru clay member, perhaps deeper. Recent dredging records indicate that 600 fathoms is about the maximum depth for living representatives of genera found in the Yonabaru clay member. The same is true for all but three of the genera in the Shinzato. However, the Shinzato contains one genus which has been found living at a depth of 984 fathoms (a single record), and another that is known from about 230 to over 970 fathoms. Some of the mollusks in the Shinzato tuff member are closely related to Recent species living in shallow water in more northern latitudes and in increasingly deeper water towards the tropics. At the latitude of Okinawa they probably should be regarded as deep-water species.

FIGURE 8.—Contact between the Shinzato tuff member of the Shimajiri formation and the overlying Chinen sand near Chinen-misaki (locality 17482).

PLIOCENE AND PLEISTOCENE—RYUKYU GROUP

The term "Ryukyu limestone" was first used by Yabe and Hanzawa (1930) for foraminiferal limestone in southern Formosa, the name being taken from tiny Ryukyu Island off the southeast coast of Formosa. Subsequent workers, including Hanzawa, have used Ryukyu limestone, or Riukiu limestone, for the raised reef limestones throughout the Ryukyu Islands. A fauna described from supposed Ryukyu limestone on Kikaigashima does not even appear to be from limestone. It has been shown by more recent workers that the Ryukyu limestone of Formosa and Ryukyu Island is of Pleistocene age. The Ryukyu limestone of the Ryukyu Islands consists of disconformable Pliocene and Pleistocene limestones. In the writer's opinion the term Ryukyu has use in the Ryukyu Islands as a group name to include Pliocene and Pleistocene formations.

NAKOSHI SAND AND CHINEN SAND (PLIOCENE)

Hanzawa's Riukiu limestone is changed to Ryukyu group because the limestone is divisible into disconformable Pliocene and Pleistocene units, and it is expanded to include sand and silt beds at its base that are conformable with the lower limestone unit. These lower sand and silt deposits were formerly included in the "Shimajiri beds" but they are disconformable with the Shimajiri formation as here restricted (fig. 8).

The lower sandy and silty part of the Ryukyu group is divided into two geographic elements, the Nakoshi sand and the Chinen sand. The Nakoshi sand is found only in Motobu Peninsula and along a thin strip of the main part of the island where Motobu peninsula joins it (fig. 9), an area on the west side of the main range of Paleozoic rocks. The Chinen sand (fig. 10) is found only

FIGURE 9.—Nakoshi sand at Nakoshi (locality 17440).

FIGURE 10.—Chinen sand, Katchin-hanto about 0.2 mile east of the junction of Highways 8 and 16; one of its most fossiliferous outcrops (locality 17442).

in southern Okinawa to the east of the Paleozoic rocks. Some fine-grained sand and silt occur along Highway 1 west of the prominence of Paleozoic rocks known as Yontan-zan at altitudes lower than nearby limestone but the outcrop is isolated and no fossils were found there. Presumably the Nakoshi sand and the Chinen sand are at least partly equivalent.

The Nakoshi sand is green to gray and locally it contains some soft, fine, light green silt, probably derived from nearby greenstones. The fossiliferous sand at Nakoshi is underlain by an undetermined thickness of unsorted gravel. The largest boulders are about 6 inches in diameter, and at least 20 feet of the gravel is exposed. Presumably it is a basal conglomerate of the formation. The Chinen sand is light-gray to dark gray and more uniformly fine than the Nakoshi sand. At one locality in Katchin-hanto the Chinen sand has partings of dark silty clay. The Chinen sand probably consists largely of Shimajiri materials reworked as a marine transgressive deposit. Its deposition was followed immediately by a period during which reefs flourished and large areas were strewn with reef detritus.

Both formations vary in thickness. The greatest thicknesses observed are only about thirty feet, and throughout the greater part of southern Okinawa the Chinen sand is absent, the Naha limestone resting directly on the Shimajiri formation (fig. 11). However,

FIGURE 11.—Yonabaru clay member of the Shimajiri formation overlain by Naha limestone in roadcut about 0.3 mile north of the intersection of Highways 5, 20, and 24.

it is possible that in some areas beds equivalent to the Chinen sand are indurated with lime and have been included in the Naha limestone. At several localities within a mile of the intersection of Highways 5 and 20 the basal part of the limestone is a very hard gray sandy limestone, containing a fauna like that found in the Chinen sand at locality 17442, and unlike that of the higher parts of the limestone. The general appearance of the sandy limestone suggests that it is indurated Chinen sand.

The Nakoshi sand and the Chinen sand have only a few species in common, and the Nakoshi fauna seems definitely to be of shallower origin than the fauna of the Chinen. Pelecypods and gastropods occur in about equal numbers in the Nakoshi fauna whereas gastropods predominate in the Chinen fauna. The "Simaziri" fauna described by Nomura and Zinbo is from the Nakoshi sand.

NAHA LIMESTONE (PLIOCENE)

The lower part of Hanzawa's Riukiu limestone is here called the Naha limestone (fig. 12). The term

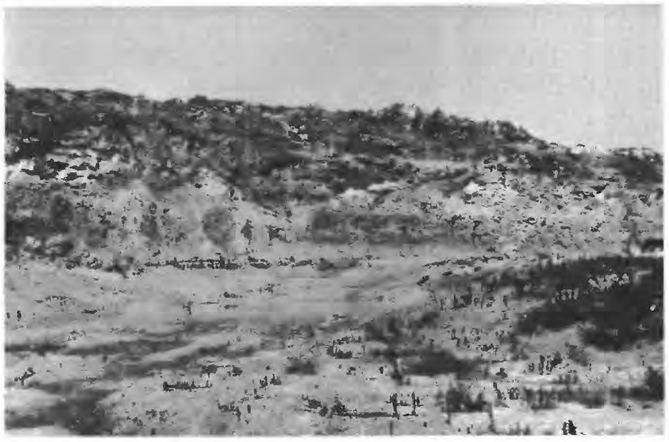

FIGURE 12.—Naha limestone in large quarry south of Naha-ko (locality 17498).

Naha rock was first used by Kada (1885) for the limestone exposed around the city of Naha, Okinawa. The same limestone is now known to be widely distributed in Okinawa. It is of Pliocene age and is separated from the overlying Yontan limestone (Pleistocene) by an erosional unconformity.

The Naha limestone is not a homogeneous lithologic unit. Most of it is a poorly indurated medium to coarse grained lime sand, but other parts of it range from a powdery limestone to a dense nonporous limestone. It ranges in color from nearly white to brownish yellow. In some areas the rock contains scattered grains of quartz sand and locally beds of coarse almost pure quartz sand fine gravel. Nearest the Paleozoic rocks unsorted sand and gravel intertongues with limestone. Steep bare faces of the limestone are usually recrystallized or "casehardened," a common phenomenon in the tropics.

The Naha limestone has been called and probably is a reef limestone, but at only a few places were corals found in it. It is presumed that the Naha limestone, at least the part of it remaining, is either a detrital lagoon deposit or a reef detritus deposited on an insular shelf. The lower part of the Naha limestone is more widespread than the upper part, probably due to subaerial erosion before the deposition of the Yontan limestone. The highest beds of the Naha limestone, where present, are less conglomeratic and generally contain abundant algal nodules.

The original thickness of the Naha limestone is not known. Single sections nearly 100 feet thick were observed but there is reason to believe that they may originally have been thicker. In some sections the gravel beds alone exceed 100 feet. Such gravel beds are believed to be residues of gravelly limestone and interbedded limestone and gravel. At present Naha limestone is found at altitudes from sea level to about 600 feet above sea level, but most occurrences above 200 feet appear to have been raised by faulting.

A faulted and highly dissected but still clearly visible plain rises in the greater part of northern Okinawa to a well-defined nip in the Paleozoic rocks. The nip lies at an altitude of about 480 feet around Yontan-zan and rises gradually to about 840 feet near the northern end of the island. The nip probably represents a marine shoreline, possibly of Naha age, but obviously the island has been tilted since the nip was cut so that the original altitude of the shoreline is not determinable anywhere. The plain below the nip is overlain at lower altitudes by erosional remnants of Naha limestone, and sporadic lateritic deposits on it at higher altitudes may be limestone residues.

Reddish soil, residual from limestone, is common in limestone terrain and these, together with gravel intertonguing with limestone near the Paleozoic rocks were included by Hanzawa in his Kunigami formation.

Nomura and Zinbo (1934) reported on a collection of fossil mollusks from supposed Ryukyu limestone on Kikaiga-shima. This fauna has little if anything in common with the fauna of the Naha limestone of Okinawa, and judging from the illustrations only a few of the fossils could have come from limestone. The fauna resembles that of the Shinzato tuff member but a few of the species have been found on Okinawa only in the Yonabaru clay member of the Shimajiri formation or the Chinen sand. The species described as *Pseudogrammatodon pacificus*, which probably should be referred to the genus *Bentharca*, is a moderately deep to deep water form not to be expected in a reef limestone. In Okinawa *Bentharca* occurs abundantly in the Yonabaru clay and the Shinzato tuff members of the Shimajiri. One worn specimen, possibly reworked, was found in the Chinen sand.

Probably the most abundant fossils in the Naha limestone are three pectens and an oyster: *Pecten* cf. *P. byoritzuensis* Nomura, *Chlamys satoi* Yokoyama, *Pecten* (*Amussiopecten*) *praesignis* Yokoyama, and *Ostrea musashiana* Yokoyama.

YONTAN LIMESTONE (PLEISTOCENE)

The Yontan limestone is the upper part of Hanzawa's Riukiu limestone. It is not clear from his statements whether he actually observed the overlying detrital veneer, here called the Machinato limestone, and, if so, whether he included it in the Riukiu limestone or in his raised beach deposit.

Some parts of the Yontan limestone have a texture similar to that of parts of the Naha limestone, but in general the Yontan is coarser. Locally it consists of unsorted detritus with fragments up to 1 foot in greatest dimension (fig. 13). None of the fragments could be identified as pieces of Naha limestone. The rock is highly porous to dense. The greatest observed thickness of Yontan limestone was about 200 feet (at Nagahama quarry, about 2 miles southeast of Bolo Point); elsewhere the greatest thickness is about 40 feet.

FIGURE 13.—Yontan limestone in small quarry on the north slope of Yuza-dake (locality 17686).

Gravel intertongues with or grades into the Yontan limestone just as it does with the Naha limestone. It may be that Hanzawa's observation of gravel and residuum of the Yontan limestone (which he would have included in his Kunigami formation) resting on Naha limestone made him revise his earlier opinion that the Kunigami was in part equivalent to the basal gravel of his Riukiu limestone in favor of the opinion that the Kunigami formation rests unconformably on the Riukiu limestone.

The Yontan limestone rests on Paleozoic rocks, on beds of the Shimajiri formation, and on the Naha limestone. Its contact with the Naha limestone is a wavy erosional disconformity and some erosional remnants of the Yontan limestone are found at much lower altitudes than nearby high points on the Naha limestone. The Yontan limestone occurs at a maximum altitude of about 450 feet, but it is believed that its presence above 250 feet is due to faulting. Two large flat-topped areas capped by Yontan limestone, one the site of Yontan airfield (225 feet), bounded by Highways 1, 6, and 12, and the other the top level of Ie-shima (240 feet), are believed to be close to the original level of fringing reefs during Yontan time. Large heads of coral in position of growth are found in the upper part of the Yontan limestone in these areas.

The fauna described by Nomura and Zinbo (1935) from limestone on Kita-Daito-jima seems to be closely allied to that of the Yontan limestone—but has little or nothing in common with the fauna of the Naha limestone. Nomura and Zinbo stated that the Kita-Daito fossils indicated an age "nearly contemporaneous with or even somewhat younger than the Ryukyu limestone." If they were comparing them with the supposed Ryukyu limestone fauna from Kikaiga-shima, which in the writer's opinion is older than the Naha limestone, they are certainly younger.

The mollusks in the Yontan limestone are mostly species still living in the area. *Tridacna* and *Corbis* (=*Fimbria*) are common genera in the Yontan limestone, but neither was found in the Naha limestone. The most abundant pecten in the Yontan limestone is *Chlamys pallium* Linné a species not found in the Naha limestone. Whole and fragmental specimens of a large *Trochus*, probably *T. niloticus* Linné, are common in the Yontan limestone. *Trochus* is rare in the Naha limestone and the specimens found either belong to a small species or are juveniles.

MACHINATO LIMESTONE (PLEISTOCENE)

Some widely separated but supposedly synchronous detrital limestone deposits that thinly veneer older formations and fill in some former coastal indentations to considerable depth are grouped together under the name Machinato limestone. The Machinato limestone rests unconformably on beds of the Shimajiri formation and on both of the older limestone formations of the Ryukyu group. For the most part the veneers consist of indurated foraminiferal sand that either covers sloping areas along the coast and back from the coast, or plasters the sides of limestone sea cliffs. At several places nips cut in the older limestones 25 to 40 feet above present sea level were coated on the inside with such foraminiferal limestone.

According to R. A. Saplis a large former coastal indentation near Minatoga on the south coast was filled in with Machinato limestone to a depth of about 100 feet (fig. 14). The Machinato limestone in this area has a basal conglomerate of boulders of both soft and

FIGURE 14.—Machinato limestone in building-stone quarries at Minatoga.

indurated clay and sand derived from the Shimajiri formation. The conglomeratic zone is about 6 feet thick. Above the conglomerate is a zone about 40 feet thick containing abundant massive colonial corals, many as much as 3 feet in diameter, most of them in positions of growth. The matrix is foraminiferal sand containing fragmental mollusk shells and sparse large unbroken *Trochus* shells. The coral zone is overlain by about 50 feet of stratified but uniform-textured foraminiferal sand.

The highest altitude at which Machinato limestone was found is about 120 feet above sea level. It is a small erosional remnant on a natural face of Naha limestone along Highway 64 near Chinen.

The type exposure of the Machinato limestone is a quarry along the edge of the coastal flat just north of Machinato (C–6). The rock here is a foraminiferal limestone containing sparse worn oyster shells.

FAULTING

At least one large thrust fault is known on Okinawa and nearby Ie-shima; crystalline limestone of Permian age is thrust over older Paleozoic rocks. The thrust plane is well exposed for several hundred feet along the north side of Ie-shima, varying scarcely from eye-level above the reef flat the entire distance. The limestone forming the mountains of Motobu Peninsula appears to belong to the same thrust sheet, but the thrust plane is below sea level, and a klippe of the same limestone occurs in the main arc of the island north of Shana-wan at an altitude of about 300 feet above sea level.

The distribution of the upper part of the Miocene sequence and its relation to the structure-controlling Paleozoic rocks of the Ryukyu arc suggest that some movement of the Paleozoic rocks took place in late Tertiary or Quaternary time. The stratigraphy and facies of the sediments referred to the Shimajiri beds by Hanzawa on Kikaiga and Miyako are not known well enough for generalizations, but on Okinawa the Shimajiri formation contains some deep-water faunas (forms living in water at least as deep as 400 fathoms), and the beds containing them were probably deposited on the west slope of the Ryukyu trench. These beds have been squeezed upwards with some distortion to their present position above sea level by outward thrusting of the Paleozoic rocks of the Ryukyu arc. Okinawa is the only island on which both the Paleozoic rocks and the Shimajiri formation occur together and on which the contact relationships could possibly be seen. Unfortunately, however, no exposures of the contact west slope of the Ryukyu trench. These beds have of the Shimajiri and the Paleozoic phyllite are known in one area about a mile apart but the intervening area is covered by gravel and limestone residues of the Ryukyu group. The contact may be a fault but its existence could not be verified (fig. 5, a—a′). Several faults paralleling the outcrop of the Paleozoic rocks and forming blocks concentric with the Ryukyu arc were observed within the Shimajiri formation. None could be traced for any distance owing to poor exposure. The movement of all concentric blocks from their original position probably was upward, although the total movement of individual blocks may have differed. Upward movement of successive concentric blocks is suggested by the width of outcrop and by dips observed within the Shimajiri formation, which indicate an exposed section of over 5,000 feet—whereas the Foraminifera show that all of the exposed section correlates with the upper 1,500 to 1,800 feet in the well near Yonabaru.

In general the Ryukyu arc appears to be cut by faults radial to it, and wedges formed by these faults are differentially depressed or raised. Some major wedges raise the Palezoic rocks to form high mountains, some maintain the Paleozoic rocks close to or just below sea level, whereas other wedges are foundered and form deep rifts such as Tokar Strait north of Amami-o-shima and the strait between Okinawa and Miyako. A difference in age for some of the rifts might be assumed because of the fact that Tokar Strait is an important zoogeographic boundary across which land animals did not migrate during low water stages of the Pleistocene, whereas the strait between Okinawa and Miyako does not seem to have been a barrier at that time. Radial faults of lesser magnitude cross the island of Okinawa, elevating and depressing alternate wedges or segments. This condition is conspicuous along the east side of northern Okinawa where faults transect a marine terrace. Adjacent segments of the terrace are raised or depressed like piano keys, some sloping evenly to the sea, others extending nearly horizontally to the coast where they terminate as sea cliffs 200 to 300 feet high.

PALEONTOLOGY

NUMBER OF SPECIES

Prior to the present publication only 6 fossil gastropods and 7 fossil pelecypods were described from Okinawa. Five of the gastropods were described by Nomura and Zinbo (1936), and one by Yabe and Hatai (1941b). All are from the Nakoshi sand of this report. The gastropods described by Nomura and Zinbo are:

Clavus (Brachytoma) simazirianus
Pseudoraphitoma nakosiensis
Raphitoma gabusogana
Vexillum (Pusia) gabusoganum
Turbo yabei

Only one of these, *Turbo yabei*, is believed to be present in the Geological Survey collections and it is regarded as a synonym of *Marmorostoma* (*Batillus*) *gemmata* (Reeve).

The one species described by Yabe and Hatai is *Haliotis gigantoides*. This species is not represented in the Geological Survey collections.

However, a large number of fossils identified as previously described species has been recorded from Okinawa. No attempt is made to repeat the lists of other authors. Most of the species are unfigured and comparison with them could not be made. Reference is made to some of the figured species in the systematic discussions.

The lists of Furet (1880–84) and Yoshiwara (Tokunaga) (1901) have little but historic interest at the present time yet they alone seem to have listed some fossils from the Shimajiri formation as here restricted. Nomura, in Yabe and Hanzawa (1925), listed 17 pelecypods and 25 gastropods from the Nakoshi sand. Nomura and Zinbo (1936) listed 56 pelecypods and 56 gastropods, of which 13 were new and a total of 29 were figured. All of their species are from the Nakoshi sand. Nomura and Hatai (1936) listed 11 pelecypods and 7 gastropods, apparently all of them from the Naha limestone. Nomura (1938) listed 12 pelecypods and 3 gastropods from the Nakoshi sand of Okinawa. In addition they listed 3 pelecypods and 1 gastropod from beds equivalent to the Nakoshi sand on Kume-shima and 1 gastropod from limestone on Ie-shima. Yabe and Hatai (1941b) list 6 pelecypods and 8 gastropods, of which one is new and 5 are figured. All of them are from the Nakoshi sand. Yabe and Hatai (1941a) discuss and figure two species of *Pecten* from the Naha limestone.

In the present paper a total of 333 species of gastropods are treated systematically. Of these, 73 are identified as previously described forms, 64 are compared to species previously described (cf.), 54 are identified only to the extent of indicating relationship to species previously described (aff.), 97 species, 6 subspecies, and one variety are described as new, and 38 are indeterminate. About 150 pelecypods are to be considered in a later report. The number of gastropod species reported here by formation is as follows: Yonabaru clay member 118, and Shinzato tuff member of the Shimajiri formation 91, Chinen sand 71, Nakoshi sand 28 (as opposed to 56 reported by Nomura and Zinbo), Naha limestone 55, Yontan limestone 46.

GEOGRAPHIC AND GEOLOGIC RANGE

The geographic and geologic ranges of the fossil gastropod species are shown in separate columns adjoining the list of species on the distribution chart (pl. 20). One column shows the areas along the coast of Asia where each species occurred at any time from the Miocene to the Recent. The other column shows the known geologic range of the species. These graphs are intended for reference only and no general conclusions are drawn from them.

In these columns unqualified identifications, supposedly correct identifications (cf.), and new species are plotted as solid lines. A few forms identified only to genus are also plotted as solid lines. These are mostly poorly preserved single specimens and the plotting indicates merely the age of beds in which they were found; not that they are new or otherwise unique. Possible new species which for one reason or another are identified only to their closest known relative (aff.) are plotted as solid lines for the Okinawan occurrences and for the outside occurrence of forms believed to be identical; the occurrence of the supposedly related named species is indicated by a question mark (?).

NORTH–SOUTH GEOGRAPHIC AFFINITIES

A second series of distribution graphs (fig. 15) is intended to show whether the fauna of each formation had greater northern or southern affinities, and the graph for each formation is contrasted with a graph for the same species or species groups occurring in modern seas. This analysis was made for the purpose of showing any general climatic trends through time. The writer does not feel, however, that it constitutes an accurate comparison of the climate of any particular period with the climate of today.

To avoid what might be purely nomenclatural restrictions an arbitrary system of plotting is used on this chart. The units are termed "bio-units" and they are defined as either unique species, a species plus all

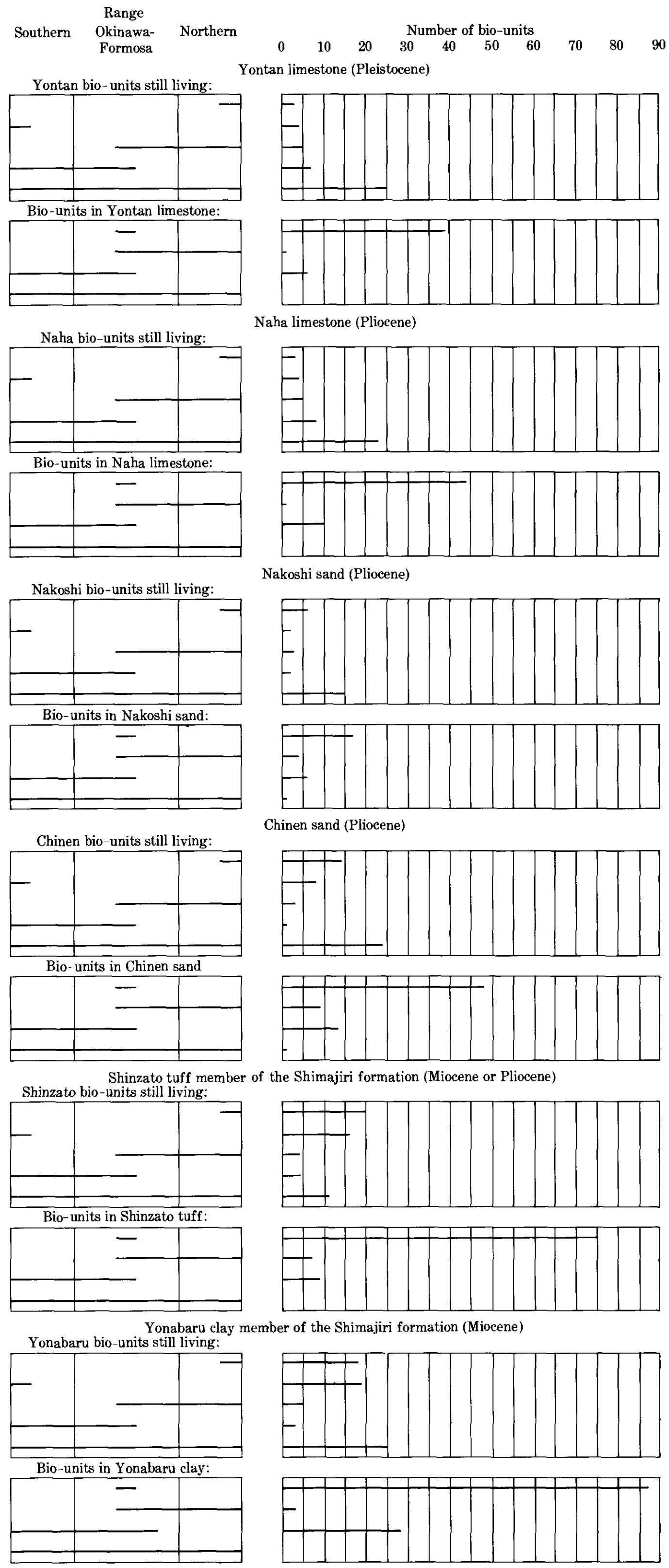

FIGURE 15.—Graphs contrasting the north-south range of the gastropods of each formation with the range of the same bio-units still living. The bio-units used are either a species, a species plus all its varieties, or a species plus its closest related species.

of its subspecies and varieties, or a species and its most closely related species that may be separated from it either geographically or stratigraphically. The units used are not, therefore, biologic taxa although some may be. The use of such bio-units makes it possible to show relationships which would be obscured if only named taxa were employed and they were plotted only for the area where they occur.

Thus, a species plotted in the distribution chart (pl. 20) as occurring only in Okinawa might be plotted in these graphs as a bio-unit occurring from Okinawa southward because there is a very closely related species in the Indonesian region but no known relative in Japan. Likewise, a fossil species and a differently named Recent species may be plotted against each other; they are regarded as being the same kind of animal and representing the same bio-unit, and presumably indicative of the same climatic environment. Twenty-eight bio-units are plotted for the Nakoshi sand and they all occur in recent seas. This does not mean that all of the Nakoshi species are still living, but rather that their linear descendants, even though they may have changed enough to warrant another name, still live in the area.

The imperfection of the fossil record may be the greatest limitation to the correctness of the relationships so determined. Each formation contains more bio-units known only in Okinawa and Formosa than are known elsewhere in beds of the same age. However, not one of the bio-units surviving in Recent seas is restricted to this area; they now live only in Japanese waters, only in Indonesian-Philippine waters, they range from the Ryukyu Islands northward or the Ryukyu Islands southward, or they are Indo-Pacific in distribution. In spite of the obvious imperfection of the fossil record, the large number of species described from both Indonesia and Japan seems to justify some attempt at comparison. The distribution of the species in the Recent fauna is probably more accurately known, but, considered alone, does not give any indication of how these mollusks might have shifted their range through time.

The chart shows two trends which, inasmuch as they appear to be reciprocal, probably result from the same cause. The first is the ratio of the northward ranging bio-units to the southward ranging bio-units. Disregarding the number of restricted bio-units, each formation has a greater number of southward ranging forms. The ratio of southward ranging bio-units over northward ranging bio-units decreases, however, from the Miocene to the early Pliocene and increases again in the late Pliocene and Pleistocene. The Yonabaru clay member of the Shimajiri formation has 28 bio-units ranging southward and only 3 ranging northward. The Shinzato tuff member of the Shimajiri has 9 bio-units ranging from Okinawa to the south and 7 ranging to the north. The Chinen sand has 13 ranging southward and 9 ranging northward. The Nakoshi sand has 6 ranging southward and 4 ranging northward. A reversal occurs in the Naha limestone where there are 10 southward ranging bio-units and only 1 northward ranging bio-unit. The Yontan limestone has 6 bio-units ranging to the south and 1 to the north.

The apparently reciprocate trend is shown by the distribution of the elements still living. Bio-units of the Yonabaru clay member still living show a subequal north-south distribution, 18 being known only to the north and 19 only to the south. Five range from Okinawa northward and 3 from Okinawa southward. The Shinzato bio-units still living have slightly greater northern affinities. Four bio-units range to the north and 4 to the south, but 20 are now restricted to northern waters as opposed to 16 restricted to southern waters. Recent survivors of the Chinen sand are definitely more northern, 14 being restricted to the north and only 8 to the south. Of the elements ranging northward and southward, 3 range to the north and 1 to the south. The Nakoshi survivors also are more northern in both categories, 6 being northern and 2 southern while 3 range northward and 2 southward. The trend reverses itself in living representatives of the Naha fauna, 3 being restricted to the north and 4 to the south, and 5 ranging northward as opposed to eight ranging southward. Almost the same ratio exists for surviving bio-units of the Yontan limestone, 3 restricted to the north, 4 to the south, and 5 ranging northward, 7 southward.

Thus it would seem that with a decrease in the excess of southward ranging forms over those that range northward in successively younger formations there is a corresponding increase in the number of bio-units restricted to northern waters or ranging into northern waters among the living representatives of the respective faunas.

These trends are taken to indicate a period of gradual cooling from the Miocene to the early or middle Pliocene, followed by warming during the reef-forming stages of the late Pliocene and Pleistocene.

DEPTH INTERPRETATIONS

Interpretations of the depth of water in which the different formations were deposited is based entirely on dredging and collecting records for Recent species identical with or closely related to the fossil species. Most of these data are from labels of specimens in the Albatross collection deposited at the U.S. National Museum. Other data are from reports of the Chal-

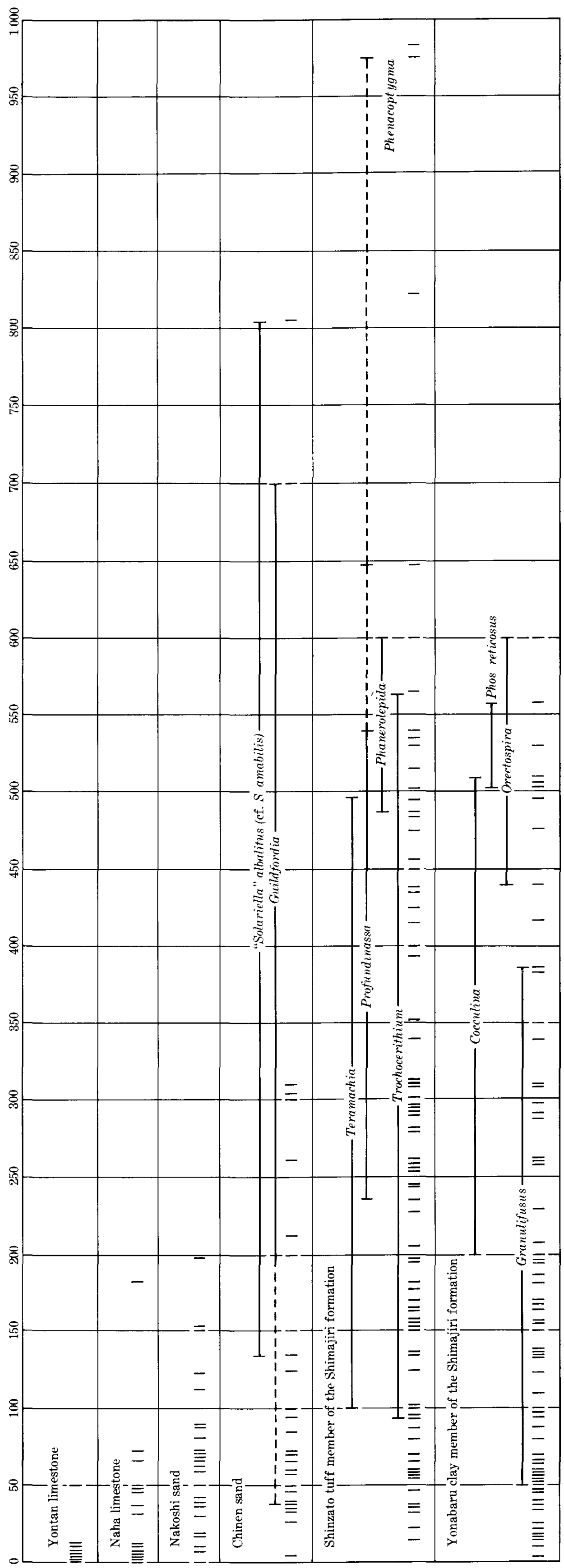

FIGURE 16.—Graph showing the bathymetric distribution, in fathoms, of the closest known Recent relatives of the Okinawan fossil gastropods.

lenger Expedition, the Siboga Expedition, the Deutschen Tiefsee-Expedition, scattered Japanese records, and a few other sources. Reliable depth data are available for less than 20 percent of the species under consideration.

The records are plotted as linear scatter diagrams (fig. 16). A somewhat arbitrary system was used in the plotting. Single records are indicated by one line. Simple statements of depth range are plotted by two lines, one for the minimum and one for the maximum depth, as are Albatross records of a few hauls (5 or 6). Records of many hauls (50 or 60) are plotted by a line for the minimum and maximum hauls, except where the greatest number of hauls are concentrated in one part of the range. Then three lines were used, two delimiting the greatest concentration, and one the erratic (in most cases it was the shallowest) depth. The single exception is *Profundinassa* which has many records between 235 and 540 fathoms, and two deeper ones, 645 and 925 fathoms. A few genera and species whose depth range is regarded as particularly significant are added by name with arrows indicating their minimum and maximum known depths.

For all forms the minimum depth data are more concentrated; the maximum depth data more scattered. On the strength of the graphs it might be assumed that the probable average depth for the Yonabaru clay member of the Shimajiri formation is 150 to 300 fathoms, and that for the Shinzato tuff member is 200 to 400 fathoms. However, both of these members contain genera whose only Recent records are in much deeper water. For instance, the only depth records for living specimens of the genus *Orectospira*, which occurs in the Yonabaru, are between 440 and 600 fathoms. *Phanerolepida*, which occurs in the Shinzato, has been dredged from 487 to 600 fathoms. *Phenacoptygma*, another genus in the Shinzato, has been obtained living only once, at a depth of 984 fathoms. Possibly the maximum depth assumed for these members is more nearly correct than the minimum depth, and both depths may be much greater.

An average figure for the depth of the Chinen sand seems to be between 50 and 100 fathoms, although here again there are some elements indicating deeper water. The Nakoshi sand is probably of shallower origin than the Chinen, its average depth being 50 fathoms or less. The Naha limestone is definitely a shallow water deposit. A possible average depth of between 20 and 30 fathoms suggests that it is a lagoonal or shelf deposit. The Yontan limestone is a shallow reef facies, probably most of it deposited in less than 10 fathoms of water. Probably parts of it were at sea level.

AGE

The age of the Tertiary and Quaternary formations of Okinawa is based on the relationships of their faunas with other faunas described from eastern Asia. Authority for the dating of the comparative faunas is taken almost entirely from the works of Van der Vlerk (1931), Altena (1938–1950), and Wissema (1947) for the Indonesian faunas, and from Hatai and Nisiyama (1952) for the Japanese faunas.

Four graphs are plotted in figure 17 to show the age range of the species in four stratigraphic zones: the Yonabaru clay member of the Shimajiri formation, the Shinzato tuff member of the Shimajiri formation, the combined Chinen and Nakoshi sands and the Naha limestone, and the Yontan limestone. The number of species having the age range of the bars in the graph are indicated in the vertical column on the right. The number of species occurring in beds of each age is

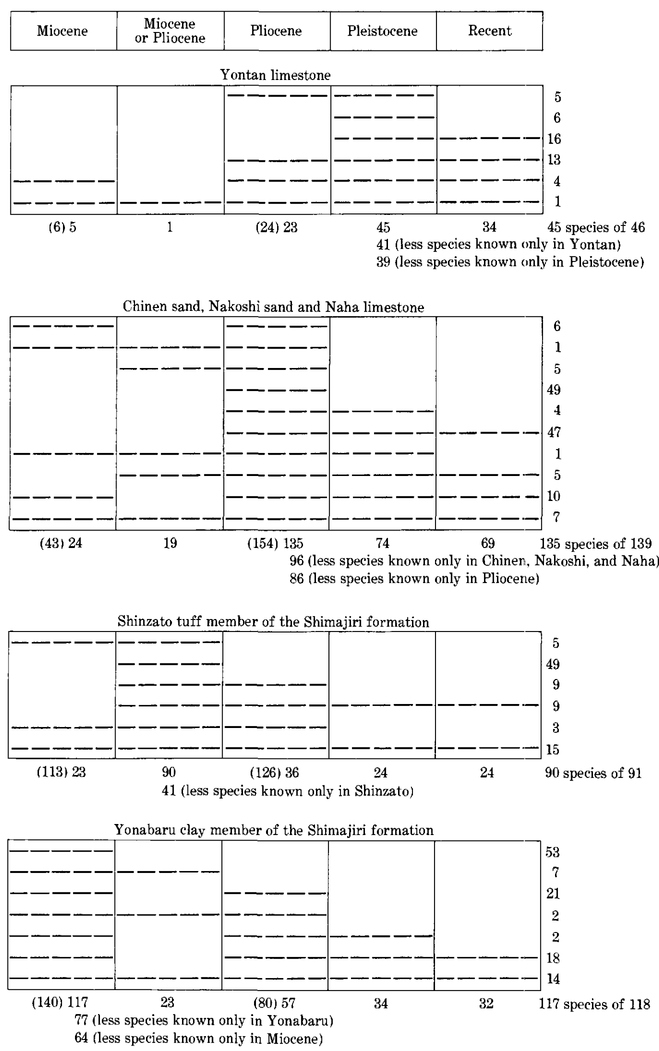

Figure 17.—Graph showing the age range of fossil gastropods of each age.

shown in the horizontal column at the base of the graphs. The fauna of the Shinzato tuff member, which is of either very late Miocene or early Pliocene age, is treated as a separate (Miocene or Pliocene) column, but alternate figures are given in parentheses beside the Miocene and Pliocene totals showing what the figure would be if the species in the Shinzato were added to either. Since each of the graphs is heavily overbal anced by the species known only in the beds in question, alternate figures are given below the totals for (a) what the figure would be if the indigenous species were eliminated, and (b) if the species found in Okinawa and in beds of the same age elsewhere were eliminated. The resulting figures still support the age assignments indicated, although less strongly.

The Byoritzu beds of Formosa are considered by the writer to be of Pliocene age and their fauna is so treated in the charts showing the geographical relationships and age of the Okinawa faunas. However, the greater part of the Byoritzu fossils are from the "Upper Byoritzu beds" which are regarded as younger than both the Nakoshi sand and the more fossiliferous lower part of the Naha limestone. Possibly the "Upper Byoritzu beds" should be correlated with the upper, sparsely fossiliferous part of the Naha limestone, but owing to the dissimilar facies in the two areas the correlation cannot be demonstrated on the basis of fossil mollusks. The less fossiliferous "Lower Byoritzu beds" are more nearly the correlative of the Nakoshi sand and the lower part of the Naha limestone.

Authors have not been consistent in locating the lower boundary of the Byoritzu beds and it is possible that the lowest part of the Byoritzu beds of at least some authors includes the equivalent of the Shinzato tuff member of the Shimajiri formation. Likewise, authors have not been consistent in either the part of the section assigned to the Byoritzu beds or Byoritzu group, in the subdivision of the Byoritzu beds into upper and lower parts (or into lower, middle, upper, and uppermost parts), or in the subdivision of the Byoritzu group into other named formations.

The stratigraphic nomenclature is so confused at present that an outsider cannot resolve it. Dr. Hayasaka (written communication, April 11, 1950) kindly gave the writer his opinion on the provenance of the Byoritzu fossils. He says:

> The material studied by Yokoyama [1928a] consisted of collections made by some petroleum geologists who provisionally divided the Byoritzu beds into lower and upper groups, based on their field observations. Thus, Yokoyama divided the Byoritzu fossil shells into two groups in his systematic study. Nomura's [1935] material included the specimens collected by Ando, Hanzawa, and others, who did not subdivide the formation. As a matter of fact, the majority of the fossil localities of the Byoritzu beds belong to the area of the uppermost part of the beds, which is represented around the village of Tsūsyō, southwest of Byoritzu. This richly fossiliferous part is named the Tsūsyō formation.
>
> Among the localities * * * there may be some that might well be regarded as belonging to the lower Byoritzu, but at the present stage of our knowledge, it is in reality difficult to draw a line between the upper and the lower Byoritzu beds. It can be said that the lower parts of the Byoritzu beds are much less fossiliferous than the upper.

Hayasaka, Lin, and Yen (1948) give a diagram in which they make the Tsūsyō sandstone the lower formation, and the Syokkōzan conglomerate the upper formation, of a Tōkazan group. The Byoritzu group underlies the Tōkazan group. Their Byoritzu group includes two formations; the upper Takuran sandstone and shale and the lower Kinsui shale. The age of the Tsūsyō sandstone is given as uppermost Neogene.

In an earlier paper by Rin (1935), what is presumed to be the Tsūsyō sandstone is called the "Lower Tōkazan beds." The equivalent of the Syokkōzan conglomerate he calls the "Upper Tōkazan beds," and the two are separated by an interval called "Transition beds." All three comprise the Tōkazan Series. The Lower Tōkazan beds are correlated with an upper part of the "Upper Byoritzu beds" of Iizuka and an upper part of the undifferentiated "Byoritzu beds" of Oinoue. Rin does not use the name Byoritzu in his own stratigraphic column, the Tōkazan Series being underlain by the Toyahara Series which in turn is divided into an upper Takuran group and a lower Hitōsan group. The Takuran group is correlated with the greater part of the Byoritzu beds of both Iizuka and Oinoue. The Lower Tōkazan beds are assigned a Calabrian age.

In a more recent paper dealing mainly with Foraminifera, Change (1956) employs the term Tōkazan formation which he divides into a Kozan facies and a Kayenzan facies. The meaning of these facies terms is not discussed and it is not apparent whether one of them refers to the Syokkōzan conglomerate. Inasmuch as Rin stated that the abundantly fossiliferous part of the "Byoritzu beds" is the Lower Tōkazan beds of the Kaenzan region, it is assumed that the Kayenzan facies is the "Upper Byoritzu beds" of authors. Chang's Tōkazan formation is underlain by the Miaoli group which consists of an upper Takuran formation and a lower Kinsui shale, units corresponding roughly to the lower Byoritzu of some authors and to the Byoritzu group as restricted by Hayasaka, Lin, and Yen. Chang shows the Kayenzan facies and the Kozan facies as being separated by a local unconformity which transgresses time, the greater part of the Kayenzan facies being of Pleistocene age. If the writer is correct in the assumption that the Kayenzan facies is the same unit as the "Upper Byoritzu beds," the "Tsūsyō sandstone," and the "Lower Tōkazan beds," he is not in agreement with its age assignment by Chang.

LOCALITIES

[Coordinates refer to map, plate 21]

Is–10. Yontan limestone. Large quarry on north side of upper level road along south side of Ie-shima, about 1.3 mi west of western limits of Ie-mura. G–19.

17440 (ME 21). Nakoshi sand. Near mouth of small stream emptying into Katena-ko, directly across road from Nakoshi Primary School. J–14.

17441 (MD 149) (22–291–9). Chinen sand. Lower part of large road cut at top of hill on Highway 31 about 0.3 mi northeast of the junction of Highways 8 and 31. G–7.

17442 (MD 25). Chinen sand. Fine gray sand exposed on east side of narrow ridge north of Highway 8 about 0.2 mi east of the junction of Highways 8 and 16. G–7.

17443 (FSM 19). Chinen sand. Hill cut back from Highway 10 just west of the junction of Highways 10 and 16. G–7.

17444 (FSM 21). Nakoshi sand. Road cut at top of ridge on Highway 116 south of Yamanuwabara, about 1.5 mi north of the west end of Nago. I–14.

17445 (RS 75). Yonabaru clay member. Fossiliferous bed at base of low hill on south side of Highway 40 about 1.0 mi west of the junction of Highways 13 and 137 in Yonabaru. C–4.

17447 (RS 196). Yonabaru clay member. Low cut on side of small promontory on top of a narrow erosional spur, about 0.5 mi north-northwest of the north junction of Highways 13 and 46 at Iwa. C–3.

17448 (RS 250). Yonabaru clay member. Low cut at edge of potato patch in higher dissected area about 0.2 mi southwest of Majikin. D–4.

17449 (RS 270). Yonabaru clay member. Cut along side of trail to Kakazu from Highway 11, near top of hill at south edge of village. B–4.

17450 (RS 368). Yonabaru clay member. Road cut along steep hill leading to small group of houses on hilltop, about 0.5 mi northwest of the north junction of Highways 13 and 46 at Iwa. C–3.

17451 (RS 369) (22–323–9). Yonabaru clay member. Road cut on east side of Highway 46 about 0.2 mi north of the northern junction of Highways 46 and 13 in Iwa. C–3.

17452 (RS 319). Shinzato tuff member. Fossiliferous beds above pumice quarry above Okinawa Central Prison, about 0.4 mi east-southeast of Shinzato. D–3.

17453 (RS 346, RS 364). Shinzato tuff member. Low road cut at end of small spur of hill west of road, about 0.6 mi north of junction of road with Highway 64 at Asato. C–2.

17454 (RS 365). Shinzato tuff member. Shallow dug hole on west side of road and at north foot of spur around which the road makes a shallow bend, about 0.6 mi north of junction of road with Highway 64 at Asato. C–2.

17454 A. Shinzato tuff member. A single specimen picked up in a potato patch in a shallow reentrant along the southwest side of an irregular hill about 0.4 mi north-northwest of Gushichan. C–2.

17455 (RS 366). Shinzato tuff member. Outcrop of tuffaceous marl up the hill slope from 17454. C–2.

17456 (RS 372). Shinzato tuff member. Thin tuffaceous bed in low road cut on east side of Highway 64 about 0.6 mi (airline) west of the junction of Highways 137 and 64 at Hiyakuna. D–3.

17458 (RS 351). Shinzato tuff member. Blue gray silty sand exposed at base of seacliff that forms a headland about 0.8 mi south of Gushichan. C–2.

17460 (RS 348). Naha limestone. Cliff at top of south bank of small reentrant into which a small stream falls, about 0.1 mi southeast of bend in Highway 64 near east edge of Gushichan. D–2.

17464 (RS 388). Naha limestone. Large quarry facing East China Sea just south of Sakibaru-saki. A–5.

17473 (RS 383). Naha limestone. Quarry on west side of Highway 7 about 0.2 mi south of the intersection of Highways 7, 13 and 52, about 1.0 mi east of Itoman. B–3.

17474 (RS 384). Naha limestone. Large quarry south of road about 0.2 mi east of the Okinawan Civil Administration Headquarters (Inafuku). D–3.

17476 (TKRS 6). Yonabaru clay member. Blue gray silty clay underlying tuffaceous beds in road cut near top of steep slope about 0.6 mi south of Miyagusuku, Takabanare-shima. I–8.

17477 (TKRS 1). Shinzato tuff member. ~~High~~ High roadcut near intersection of two main roads along northeast edge of Miyagusuku, Takabanare-shima. I–8.

17479 (TKRS 7). Chinen sand. Low cliff along beach about 0.3 mi northeast of the northwest tip of Heanza-shima. H–8.

17480 (FSM 27). Chinen sand. High road cut along Highway 64 about 0.1 mi west of sharp bend in road about 0.3 mi east of Yashitomi. E–3. This may be the Shinzato tuff.

17481 (RSWB) (22–226–30). Chinen sand. Roadside exposure near top of hill on Highway 8 leading down to "White Beach", U. S. Naval Piers. G–7. This locality could be Shinzato tuff.

17482 (FSM 28). Chinen sand. (a: base, b: middle part, c: upper beds just below limestone.) Section in both abandoned road cut and new road cut at Chinen-misaki. E–4.

17483 (ME 36). Nakoshi sand. Very fossiliferous sand exposed in road cut and ditch on road to landing on Unten-ko, about 0.2 mi from the landing. I–16.

17484 (FSM 14). Naha limestone. Road cut on south side of Highway 60 about 0.6 mi west of the junction with Highway 3. A–4.

17495 (WF 253). Chinen sand. Blue gray silty clay underlying oyster-bearing gravels in road cut on west side of Highway 5, 200 yards south of a creek and about 0.5 mi south of Yamashiro. E–9.

17497 (FSM 29). Naha limestome. a: lower bed, b: upper bed. Edge of Chinen plateau overlooking Baten-ko above the village of Sashiki. D–3.

17498 L (FSM 36) (22–251–2). Naha limestone (type locality). Lower part of large quarry south of docks at Naha Harbor, about 0.2 mi south of the junction of Highways 3 and 7. B–4.

17499 (WF 135). Naha limestone. Quarry about 0.1 mi east of the southeast corner of Kiyuna. D–6.

17502 (WF 35). Yonabaru clay member. Road cut at sharp bend in Highway 35 around west end of hill about 0.4 mi west of Arakaki. D–6.

17503 (WF 39). Yonabaru clay member. Hillside outcrop at upper edge of garden plots on steep slope overlooking Naga-gusuku-wan about west of the southern edge of Atsuta. E–7.

17509 (RS 400). Naha limestone. Large quarry south of Shuri and about 0.8 mi north-northeast of the intersection of Highways 44 and 46. C–4.

17510 (RS 404). Yontan limestone. Quarry on north side secondary road about 0.3 mi northwest of Onna. F–11.

17511 (RS 418). Yontan limestone. High cut at west end of ridge on secondary road north of Kin and about 0.3 mi west of Highway 13. H–10.

17512 (RS 419). Yontan limestone. Quarry along the abandoned part of Highway 104 about 0.1 mi southeast of the junction of the rerouted part of Highway 104 with the old road, about 0.8 mi northwest of the center of Kin. H–10.

17513 (RS 421). Yontan limestone. Quarry at east end of limestone ridge north of Kin, about 200 yards west of Highway 13. H–10. (=17647.)

17514 (RS 422). Yontan limestone. Small quarry at foot of hill and north of Highway 13, about 0.2 mi west of Ishiza. G–10.

17515 (RS 423). Yontan limestone. Quarry on east side of Highway 13 at top of hill south of river about 0.7 mi northeast of the center of Kin. H–10.

17518 (WF 32, WF 146, WF 154). Naha limestone. Quarry about 0.3 mi west of Highway 5 and about 1.0 mi east of the junction of Highways 1 and 30. D–5.

17526 (WF 169). Naha limestone. Low cliff on south wall of ravine near the mouth of Ohira-gawa. B–5.

17529 (WF 189). Naha limestone. Road cut on west side of ravine about 0.7 mi south-southeast of the junction of Highways 5 and 16. E–8.

17534 (WF 237). Naha limestone. Seacliff at north end of small beach about 0.8 mi due west of road fork at west edge of Hanza. C–9.

17537 (WF 267). Naha limestone. Large quarry at junction of Highways 13 and 24, about 0.3 mi south of Higashionna. E–9.

17538 (WF 290). Naha limestone. Lower part of quarry on north side of Highway 6 about 0.2 mi west of the intersection of Highways 1 and 6. D–10. (See 17553.)

17539 (WF 292). Naha limestone. Small quarry on north side of Highway 6 near Maeta about 0.5 mi west of the junction of Highways 1 and 6. D–10.

17540 (WF 259). Naha limestone. (=17550 L) E–9.

17541 (WF 293). Naha limestone. Road cut on south side of Highway 6 just east of creek between Masuya and Maeta. D–10.

17542 (WF 233). Yontan limestone. Quarry about 0.2 mi north-northeast of sharp road bend north of Oki. D–9.

17543 (WF 234). Yontan limestone. Large quarry 200 yards of Highway 6 about 0.7 mi southwest of the junction of Highways 6 and 12 north of Hanza. C–9.

17544 (WF 235). Yontan limestone. Large quarry on hillside east of Highway 6 about 0.6 mi north of Sobe. C–9. (=17644 b).

17545 (WF 236). Yontan limestone. Large quarry on hillside east of Highway 6 about 0.5 mi north of Sobe. C–9. (on south side of secondary road from 17644.)

17546 (WF 239). Yontan limestone. Quarry about 0.8 mi northwest of the junction of Highways 6 and 12 between Hanza and Takashiho. C–9.

17547 (WF 240). Yontan limestone. Quarry about 0.3 mi from western shore and about 0.9 mi west-southwest of the northern junction of Highways 6 and 12. C–9.

17548 (WF 257). Yontan limestone. Quarry about 200 yards northeast of the junction of Highways 5 and 6, near the south edge of Iwa. E–9.

17549 (WF 260). Yontan limestone. Upper level in large quarry on hillside west of Highway 13 about 0.4 mi south of the junction of Highways 13 and 164 at Ischicha (Ishikawa). E–9. (=17550 u and 17646.)

17550 (WF 261). U: upper bed, Yontan limestone, L: lower bed, Naha limestone. Large quarry on hillside west of Highway 13 about 0.4 mi south of the junction of Highways 13 and 164 at Ischicha (Ishikawa). E–9. (U=17549 and 17646) (L=17540.)

17551 (WF 287). Yontan limestone. Small quarry at north edge of a limestone plateau about 0.2 mi east of Highway 1 and about 0.6 mi south of the junction of Highways 1 and 6. D–10.

17552 (WF 289). Yontan limestone. Large quarry at south end of a limestone plateau about 0.2 mi east of Highway 1 and about 1.0 mi south of the junction of Highways 1 and 6. D–10.

17553 (WF 290). Yontan limestone. Upper part of quarry on north side of Highway 6 about 0.2 mi west of the intersection of Highways 1 and 6. D–10. (see 17538.)

17554 (WF 294). Naha limestone. (=17673.)

17558 (WF 246). Yontan limestone. Quarry on south side of Highway 12 about 0.75 mi east of Kina. D–9.

17561 (GC 32). Naha limestone. Sea cliff at west end of beach on south side of Akamaruno-misaki. M–17.

17564 (DF 114). Naha limestone. (Possibly an indurated phase of the Nakoshi sand.) Exposed in two cuts at junction of secondary roads about 0.5 mi southeast of Kunjabaru. J–16.

17567 (DF 126). Naha limestone. Small quarry on south side of road almost west of Nakijin Industrial High School between Janai and Fuishichi. I–16.

17571 (DF 137). Naha limestone. Quarry south of Highway 124 about 0.5 mi south of Nakaoshi. H–16.

17573 (DF 153). Yontan limestone. Road cut on secondary road along eastern edge of Imadomari, about 100 feet north of Highway 124. H–16.

17574 (DF 154). Naha limestone. Road cut on secondary road along eastern edge of Imadomari, about 200 yards north of Highway 124. H–16. This may be Yontan limestone.

17576 (DF 156). Naha limestone. Small projecting cliff near the west end of the beach at Imadomari. H–16.

17578 (DF 159). Naha limestone. Road cut on west side of Highway 124 about 0.3 mi south of road fork west of Kushichin. G–16.

17579 (DF 160). Naha limestone. Lowest part of limestone in quarry on west side of Highway 124 about 0.4 mi northeast of Jahana. G–16.

17580 (DF 161). Naha limestone. Coarse conglomerate bed 1 foot thick located about 15 feet below top of quarry. Same quarry at 17579. G–16.

17582 (DF 163). Naha limestone. Large quarry on east side of Highway 124, about 0.2 mi south of road junction west of Kushichin. G–16.

17583 (DF 164). Naha limestone. Road cut and quarry west of Highway 124 about 150 yards south of road fork west of Kushichin. G–16.

17584 (DF 165). Naha limestone. Quarry west of Highway 124 about 150 yards south of road fork west of Kushichin. From top of quarry to top of hill. G–16.

17585 (DF 166). Naha limestone. Sandy limestone in road cut on south side of Highway 124 at road fork 0.5 mi west of Kushichin. G–16.

17586 (DF 167). Yontan limestone. Large quarry on edge of plateau north of road along north shore of Urasaki-wan, about 0.8 mi west of Urasaki. G–16.

17590 (DF 176). Naha(?) limestone. Quarry at Kami-Motobu-Mura office on highway between Jahana and Urasaki. G–16.

17591 (DF 177). Yontan limestone. Small cut 100 yards west of Highway 124 at southern edge of Kitazato (?Jahana). G–16.

17593 (DF 180). Yontan limestone. Quarry on hill about 0.3 mi southeast of Urasaki. G–16.

17595 (DF 183). Yontan limestone. Limestone in large road cut on Highway 112 about 0.5 mi west of Toguchi. G–15.

17598 (DF 187). Naha limestone. Quarry east of road at the south end of Bise. G–16.

17600 (DF 116). Nakoshi sand. Half way up the seacliff above trail about 0.3 mi west of Kunjabaru. I–16.

17602 (DF 121). Naha limestone. Exposure in cut for tomb on north side of secondary road from Nakasoni to Goechi, about 0.3 mi northwest of Nakasoni. I–16.

17608 (DF 144). Naha limestone. Quarry on secondary road about 0.2 mi north of Shushi. H–16.

17610 (ME 35). Naha limestone. Road cut on north side of road at landing on Unten-ko. I–16.

17612 (FSM 61). Naha limestone. Quarry on west side of Highway 13 west of Kin. G–10.

17613 (FSM 62). Yontan limestone. Quarry on east side of secondary road just north of Kin. H–10.

17615 (FSM 58). Naha limestone. Small quarry on road to beach, west of Highway 12, about 0.8 mi west of road fork at west edge of Hanza. C–9.

17632 (FSM 13). Yonabaru clay member. Road cut about 0.1 mi below road fork at top of hill on road from Okuma to Arakaki. D–6.

17633 (FSM 11, 22–333–14). Shinzato tuff member. Low cliff at canyon head just east of trail pass through ridge about 0.4 mi southwest of China. E–4.

17637 (FSM 35). Yontan limestone. Low road cut along Highway 5 about 200–300 feet northeast of a road fork and about 0.8 mi south of Yamashiro. E–9.

17640 (RSM 50). Yontan limestone. Quarry north of secondary road about 0.6 mi east of Nagushiku. B–2.

17641 (FSM 52). Naha limestone. Deep quarry west of Highway 6. About 1.1 mi south of road fork at west edge of Hanza. a: lowest, b: middle, c: highest. C–9.

17644 (FSM 55). a: lower bed, Naha limestone, b: upper bed, Yontan limestone. Large quarry on hillside east of Highway 6 about 0.6 mi north of Sobe. C–9.

17645 (FSM 59). Yontan limestone. Small bulldozer pit just east of Highway 12 about 1 mi west of the junction of Highways 6 and 12 north of Hanza. C–9.

17646 (FSM 60). Yontan limestone. Large quarry on hillside west of Highway 13 about 0.4 mi south of the junction of Highways 13 and 164 at Ishicha (Ishikawa). E–9. (=17550 u and 17549.)

17647 (FSM 63). Yontan limestone. (=17513.) H–10.

17648 (FSM 12). Shinzato tuff member. Large road cut just below top of long hill on Highway 137 about 0.3 mi south of Shinzato. D–3.

17652 (FSM 64). Yontan limestone. Quarry at foot of hill near Navy dock, about 0.6 mi northeast of village of Tengan. F–9.

17656 (FSM 88). U: upper bed, Yontan limestone, L: lower bed, Naha limestone. Large quarry west of Highway 1, just south of Kakazu Ridge and about 0.6 mi west of the junction of Highways 1 and 153. C–6.

17658 (FSM 68). Yontan limestone. Quarry on west side of Highway 1 about 0.25 mi north of the intersection of Highways 1 and 20. D–7.

17660 (FSM 70). Yontan limestone. Quarry between shore road and large limestone pinnacle, about 0.4 mi north-northwest of the intersection of Highways 1 and 20. D–7.

17661 (FSM 71). Naha limestone. Cut on small loop road west of shore road and south of small creek about 1.4 mi south of the mouth of the Hiza-gawa (Bisha-gawa). C–8.

17663 (FSM 73). Yontan limestone. Quarry in erosional remnant of limestone lying between two secondary roads about 1.8 mi south of Yontan-zan and about 1.3 mi east of Kina. D–9.

17665 (FSM 75). U: Yontan limestone, L: Naha limestone Large quarry on west side of Highway 1 about 0.6 mi south of Kina. D–9.

17666 (FSM 76). Yontan limestone. Large quarry on west side of Highway 1 about 0.4 mi south of Kina. D–9.

17667 (FSM 77). Naha limestone. Lower level in large 2-level quarry just north of Oki. C–9.

17669 (FSM 79). Naha limestone. Bulldozer trench on south side of secondary road about 0.8 mi southwest of the road circle at Kadena. C–8.

17670 (FSM 80). Naha limestone. Road cut through north levee of Hiza-gawa (Bisha-gawa) at mouth of river. C–8.

17671 (FSM 81). Naha limestone. West end of quarry north of road at top of steep hill about 0.8 mi due east of Kina. D–9.

17672 (FSM 82). U: upper bed, Yontan limestone, L: lower bed, Naha limestone. East end of same quarry as 17671. D–9.

17673 (FSM 83). Naha limestone. Road cut and ditch on south side of Highway 6 just east of the junction of Highways 1 and 6. D–10.

17677 (22–226–29). Shinzato tuff member. Roadside exposure near base of hill on Highway 8 near "White Beach", U.S. Naval Piers. G–7.

17678 (WF 258). Yontan limestone. Small tree-covered knob of limestone between cultivated fields south of Highway 6 and about 0.6 mi west of the junction of Highways 5 and 6. E–9.

17679 (WF 278). Yonabaru clay member. High road cut on Highway 13 east of broad bend in road, about 0.9 mi north of the junction of Highways 13 and 38. D–5.

17680 Yontan(?) limestone "Small quarry on top of ridge, 150 yards east of route 418." Location unknown but believed to be near Kin. H–10? Not located on map.

17681 (TKRS 2). Shinzato tuff member. Outcrop at base of limestone cliff near top of steep slope facing Kimmu-wan, about 0.4 mi west of Ikemi, Takabanare-shima. I–8.

17686 (RS 354). Yontan limestone. Quarry on north slope of Yuza-dake about 1.2 mi west of Tomari and about 2.5 mi east of Itoman. C–2.

528175 O - 61 - 2

SYSTEMATIC PALEONTOLOGY

Class GASTROPODA

Subclass PROSOBRANCHIA

Order ARCHAEOGASTROPODA

Superfamily PLEUROTOMARIACEA

Family HALIOTIDAE

Genus HALIOTIS Linné 1758

Type: *H. asinina* Linné.

Haliotis cf. H. diversicolor Reeve

Plate 16, figure 1; plate 18, figure 1

?*Haliotis diversicolor* Reeve, 1846, Conchologia iconica, v. 3, pl. 12, fig. 39.

?(Hirase) Taki, 1951, Handbook of illustrated shells, pl. 60, fig. 1.

Internal molds and fragments showing the external sculpture were obtained from both the Naha and Yontan limestones. The sculpture, shape, and location and size of the perforations compare with *H. diversicolor.* According to some authors this is a synonym of *H. japonica* Reeve, but Reeve's figures show strong plications on *H. japonica* that are not present on *H. diversicolor.*

Yabe and Hatai (1941b, p. 76, pl. 7, fig. 1) described a new *Haliotis* from the Nakoshi sand as *H. gigantoides.* Their species, which comes from a fine gray sand, is more circular in outline and has faint spiral ribs in comparison with the specimens in the writers collection, all of which came from limestone. This suggests that different species were living in different ecological environments.

Distribution: Pliocene, (Naha limestone) Okinawa; Pleistocene, (Yontan limestone) Okinawa and Ie-Shima; Recent, Indo-Pacific region, northward to central Honshu.

Localities: Naha limestone, 17474, 17484 (figured), 17537, 17582, 17644–a; Yontan limestone, Is–10 (figured), 17514, 17644–b, 17680.

Superfamily TROCHACEA

Family TROCHIDAE

Subfamily MARGARITINAE

Genus BATHYBEMBIX Crosse 1893

Type: *Bembix aeola* Watson.

The species here referred to *Bathybembix* were included by Yokoyama (1920) under *Bembix* Watson 1879, a name preoccupied by *Bembix* Koninck 1844. The substitute name *Bathybembix* Crosse 1893 was for years considered to be predated by *Turcicula* Dall. However, Rehder (1955) has shown that the type of *Turcicula* is unique and that *Bathybembix* is the correct name for the Japanese species commonly referred to *Turcicula.* Thus, the monograph of Japanese *Turcicula* by Taki and Otuka (1942) is a monograph of Japanese *Bathybembix.* Taki (1951) and Kuroda and Habe (1952) referred these and related species to the genus *Lischkeia* Fischer 1879. Theile (1931) regarded both *Turcicula* and *Lischkeia* as "sections" of *Calliotropis* Seguenza (1903), a younger name. They were placed under *Turcicula* by Taki and Oyama (1954). Wenz (1938) treated *Turcicula, Calliotropis,* and *Lischkeia* s. s. as subgenera of *Lischkeia.*

Bathybembix sp. ind.

Plate 1, figure 1; plate 7, figures 1–2

Badly decorticated and fragmental specimens of what may be two species of *Bathybembix* were collected from the Shimajiri formation. They belong to the group of *B. aeola* (Watson) and *B. japonicum* (Dall); probably being more closely related to the former species than to the latter. The Shimajiri forms differ from each other, and from the Recent species mentioned, in the details of the sculpture above the periphery. On the fragment from the Yonabaru clay member there are 3 rows of low, unpointed nodes arranged along low spiral ridges, and connected axially by less distinct ridges. The species from the Shinzato tuff member has a lower row of nodes arranged along a low spiral ridge, and 2 less distinct rows of oblique nodes above it. The Recent *B. japonicum* has 3 rows of sharp nodes, whereas *B. aeola* has elongate oblique axial ribs above the periphery which are sometimes disconnected to form 3 or more distinct rows of short oblique axial ribs.

Distribution: Miocene, (Yonabaru clay member) Okinawa; Miocene or Pliocene, (Shinzato tuff member) Okinawa.

Localities: Yonabaru clay member, 17445 (figured); Shinzato tuff member, 17456 (figured).

Comparative bathymetric data: Both of the Recent species with which the specimens from the Shimajiri formation are compared are from deep water and are represented in the Albatross collections from southern Japan at depths between 292 and 475 fathoms.

Bathybembix cf. B. convexiusculum (Yokoyama)

Plate 10, figure 13

?*Bembix convexiusculum* Yokoyama, 1920, Tokyo Imp. Univ. Coll. Sci. Jour., v. 39, art. 6, p. 90, pl. 5, fig. 32.

It would appear from an examination of specimens in the U.S. National Museum that two distinct species have been referred to the Recent *B. argenteo-nitens* (Lischke). The typical form has a *Basilissa*-like spire and is very close to *B. convexiusculum* (Yokoyama) from the Pliocene of Japan. The other species has a central row of large nodes on all whorls. The form figured by Hirase (1936) is the second type. It was renamed *Turcicula hirasei* Kuroda (in Taki and Otuka, 1942).

Bathybembix convexiusculum differs from the Recent *B. argenteo-nitens* in that the nodes, both the subsutural and suprasutural rows, are slightly coarser and less numerous (see Lischke, 1874, pl. 4, fig. 1).

Distribution: Pliocene, (Chinen sand) Okinawa, (Kamakura and Nojima formations) Japan.

Localities: Chinen sand, 17481 (figured).

Comparative bathymetric data: Specimens of the closely related *B. argenteo-nitens* collected from the vicinity of Japan by the Albatross range in depth from 70 to 304 fathoms.

Genus Lischkeia Fischer 1879

Type: *Trochus monilifera* Lamarck.

Lischkeia aff. L. monilifera (Lamarck)

Plate 7, figures 10, 33

?*Trochus monilifera* Lamarck, 1804, Ann. Mus. Hist. Nat. Paris, v. 4, (19), p. 48.

?*Lischkeia* (*Lischkeia*) *monilifera*. Wenz, 1938, Handbuch der Paläozoologie, v. 6, pt. 2, p. 272, fig. 569.

Fragments of the shell so identified were obtained from two localities. The body whorl is angulate with a crudely bicarinate keel bearing two rows of moderately sharp beads, the upper row stronger. A single row of larger, more widely spaced blunt nodes is located about midway between the periphery and the suture. A row of sharp beads of about the same size and spacing as those along the periphery lies immediately below the suture. The base has low spirals, weakly beaded at the crest, which slope gently on the side toward the umbilicus but which are cut off more abruptly on the side toward the periphery. The umbilicus is closed by callus, and the undercut smooth siphonal fasciole is partly exposed at the edge of the umbilical callus.

This may be a new species but it is not named because the material is fragmentary. A specimen figured by Kira (1955, pl. 6, fig. 2) as *Lischkeia alwinae* (Lischke) is very close to the Okinawan species and the two may be identical. Kira gives a depth range of 50 to 100 fathoms for the species.

Localities: Shinzato tuff member, 17458 (figured), 17681.

Genus STOMATELLA Lamarck 1819

Type: *Stomatella imbricata* Lamarck. Recent, Indo-Pacific.

Stomatella cf. S. lyrata Pilsbry

Plate 10, figures 24–25

?*Stomatella lyrata* Pilsbry, 1890, Manual of conchology, v. 12, p. 12, pl. 2, figs. 3–5.

?Yokoyama, 1922, Tokyo Imp. Univ. Coll. Sci. Jour., v. 44, art. 1, p. 115, pl. 6, fig. 2.

?Taki and Oyama, 1954, Paleont. Soc. Japan Spec. Paper 2, pl. 26, fig. 2.

No differences can be discerned between the Okinawan fossil and the form figured by Yokoyama from the Pleistocene of Japan.

Distribution: Pliocene, (Nakoshi sand) Okinawa; Pleistocene, Shimosa ("Upper Musashino") Japan; Recent, northern, central and western Japan.

Localities: Nakoshi sand, 17440 (figured).

Genus "SOLARIELLA" S. Wood 1842

The species here described fall well within the complex generally referred to as *Solariella*. Kuroda and Habe (1952) refer *S. nyssona* Dall, a species discussed here, to *Machaeroplax* Friele and *S. subangulata* (Oyama), another species discussed here, to *Minolia* A. Adams. Both Thiele (1931) and Abbott (1954) regard *Machaeroplax* as a synonym of *Solariella*. Taki and Oyama (1954), however, refer both *S. nyssona* and *S. subangulata* to *Minolia*. Thiele (1931) treats *Minolia* as a "section" of *Isanda* A. Adams. The present species may fall within the genus *Isanda* as used by Wenz, possibly within one of the subgenera such as *Antisolarium* Finlay, *Zeminolia* Finlay, or *Zetela* Finlay. *Isanda* is placed by Thiele in the Unboniinae rather than in the Margaritinae.

Although Wood himself suppressed this genus in 1848 (p. 134), it has been accepted by nearly all subsequent writers as a valid genus. Unless Harmer's (1923, pl. 60, fig. 1) figure of *Solariella maculata* Wood is the species Wood had in mind in 1842 and not the one he figure in 1848, it is an error. Harmer's rather than Wood's (1848, pl. 15, fig. 3) figure was reproduced by Wenz. However, the genus as typified by Wood's 1848 figure certainly includes the species under consideration and in the sense the genus has been used by American paleontologists.

"Solariella" albalitus, n. sp.

Plate 10, figures 19–20

Shell of medium size, spire subconical, whorls on the spire with a slightly angulate periphery and flattened above the angulation, body whorl rounded. Protoconch consisting of about one half of a whorl, smooth and polished, followed by about 2¼ whorls which are sculptured by slightly crescentic axial riblets, closely set, and without spiral angulation of any kind. Aperture round; outer and inner lips thin, detached and not reflected. Umbilicus open and deep. Sutures channelled. Sculpture consisting of two principal spirals along the periphery and a row of beads below the suture channel, the slope between the beaded row and the periphery bearing weak (1 to 2) spiral threads, the base with stronger beaded spiral threads, the thread at the edge of the umbilical opening being stronger than the rest.

Holotype (USNM 562885) measures: height 8 mm, diameter 6.9 mm.

Type locality: Chinen sand, 17481.

This form appears to be unlike any other described species from the western Pacific. It is closely related to the Recent West Indian species, *S. amabilis* Jeffreys, differing from it mainly in having stronger spiral threads, especially on the base.

Solariella nyssona Dall, Recent from off Hondo, Japan, is more distantly related to this species, differing from it in having more rounded whorls, a broader subsutural platform, and spirals of nearly equal strength over the upper part of the whorls. The nodes on the spirals are sharp in *nyssona* whereas on *albalitus* they are beaded.

Distribution: Pliocene, (Chinen sand) Okinawa.

Localities: Chinen sand, 17481 (figured type).

Comparative bathymetric data: *Solariella amabilis* was obtained by dredgings from the Blake from 135 to 805 fathoms.

"Solariella" shimajiriensis, n. sp.

Plate 1, figures 2–4

Shell rather large for the genus, spire of medium height, whorls rounded with a broad subsutural slope or shoulder that is flattened and nearly horizontal. Protoconch small, consisting of not more than ¾ of a whorl, smooth, not distinctly set off from the first sculptured whorl of the spire. Aperture nearly round with a narrow area of attachment, no callus. Outer and inner lips thin and not reflected. Umbilicus open and deep. Sutures marked by a nearly right angled juncture of the subsutural shelf of the whorl below and the whorl above. Sculpture consisting of crescentic axials only on the 2½ whorls immediately following the protoconch, the next 1½ whorls cancellate with spiral lines and axials of about equal strength, and the remainder of the shell with well defined finely beaded spiral lines, the axial scupture becoming obsolete on the penultimate whorl, the threads on the lower body whorl and the basal threads becoming unbeaded and continuous except for those immediately adjoining the umbilicus.

Holotype (USNM 562646) measures: height 9.5 mm, diameter 9.4 mm.

Type locality: Yonabaru clay member, 17451.

This is a lower, more inflated species than *S. albalitus* and can be distinguished at once by its flat subsutural bench. It is probably more closely related to *S. nyssona* Dall, but is more inflated and shorter than that species and has more numerous and more evenly distributed spiral lines and weaker axial threads. *Solariella shimajiriensis* is most closely related to the Pleistocene species figured by Yokoyama (1922, p. 111, pl. 5, fig. 20) as *S. angulata* Tokunaga, since renamed *S. subangulata* (Oyama) Kuroda and Habe (1952, p. 66). A Recent specimen of *S. subangulata* collected by the Albatross Expedition from Station 4832, off Hondo, Japan, closely resembles *S. shimajiriensis* in shape but has fewer spiral threads.

Distribution: Miocene, (Yonabaru clay member) Okinawa.

Localities: Yonabaru clay member, 17449 (figured), 17451 (figured type).

Comparative bathymetric data: The Recent species from Japan (?*S. subangulata* Oyama), mentioned above, was obtained from a depth of 70 fathoms.

Genus ORECTOSPIRA Dall 1925

Type: *Basilissa babelica* Dall, Recent, Japan.

Dall proposed this as a subgenus of *Basilissa* Watson, and some of the species Watson referred to *Basilissa* certainly belong in it. By selecting *B. lampra* Watson as the type of *Basilissa*, however, Dall fixed the name *Basilissa* on the most atypical of the forms included by Watson in *Basilissa*, and in my opinion *Basilissa* and *Orectospira* should stand as distinct genera. Kuroda and Habe (1952) list *babelica* Dall under the genus *Basilissa*.

Orectospira cf. O. babelica (Dall)

Plate 1, figure 12

?*Basilissa babelica* Dall, 1907, Smithsonian Misc. Colln., v. 50, pt. 2, no. 1727, p. 168.

?*Basilissa* (*Orectospira*) *babelica*. Dall, 1925, U.S. Natl. Mus. Proc., v. 66, art. 17, no. 2554, p. 5, pl. 32, figs. 8, 12.

A fragment consisting of a little over 1 full whorl appears to be very closely related to the Recent Japanese species. The fossil form has finer spiral lines than on any Recent specimens examined. There is no indication of thin, arcuate axials on the fossil species, but not all Recent specimens have them.

Distribution: Miocene, (Yonabaru clay member) Okinawa; Recent, southern Japan.

Localities: Yonabaru clay member, 17679 (figured).

Comparative bathymetric data: The Recent species was collected by the Albatross Expedition from depths of 440 and 600 fathoms.

Subfamily CALLIOSTOMATINAE

Genus CALLIOSTOMA Swainson 1840

Subgenus TRISTICOTROCHUS Ikebe 1942

Type: *Calliostoma aculeatum* Sowerby, Recent, Japan.

Ampullotrochus Monterosato, the type of which is *Trochus granulatus* Born from the Mediterranean, is very closely related. Until the relationship of these forms is established it seems advisable to use the name *Tristicotrochus* for the Japanese forms. It might logically be made a subgenus of *Ampullotrochus*.

Calliostoma (Tristicotrochus) nahaensis, n. sp.

Plate 16, figures 2, 7

Shell of medium size, spire subconical, whorls angulate with a blunt periphery. Nuclear whorls unknown. Aperture angulate oval; outer lip thin, inner lip thickened and appressed, inner lip callus lacking a tubercle. No umbilical chink. Sculpture consisting of 6 primary spirals, the 1 immediately below the suture and the 2 on the periphery being stronger and more beaded than the 3 intervening ones, secondary spirals and weak tertiary spirals present; base bearing about 13 spiral threads with a weak secondary thread developed between some of them.

Holotype (USNM 562998) measures: height (less tip) 12 mm, diameter 11 mm.
Type locality: Naha limestone, 17484.

This species appears to be closely related to *C. aculeatum uezii* Ikebe (1942, p. 260, pl. 27, figs. 5a–c) from the Pleistocene of Japan, differing from it in having a higher spire. Other relatives of this species are some as yet undescribed species obtained by the Albatross from the Hawaiian Islands, and the relationship to one of these is very close. *Calliostoma annulatum* Solander, Recent from Alaska to San Diego, California, differs mainly in having broader spirals and coarser, more pointed beads. *Calliostoma dyscritum* Cossmann, described from the Pliocene of Karikal, India (Cossmann, 1910, p. 80), and reported from the Pliocene of Nias (Wissema, 1947, p. 13) may be related.

Distribution: Pliocene, (Naha limestone) Okinawa.
Localities: Naha limestone, 17484 (figured type).
Comparative bathymetric data: The Hawaiian species referred to above were obtained in hauls from depths ranging from 49 to 182 fathoms.

Calliostoma (Tristicotrochus) sp. ind.

A small nearly completely decorticated specimen of a sharply conical trochid was obtained. A small portion of the outer sculpture remaining does not agree with that of the preceeding species.

Occurrence: Naha limestone, 17580.

Subgenus PULCHRASTELE Iredale 1929

Type: *Calliostoma septenaria* Melville and Standen.

Calliostoma (Pulchrastele) ikebei n. sp.

Plate 16, figures 3, 8

Shell of medium size, abnormally high spired for the genus, whorls flattened, sometimes with a weak biangulate keel just above the suture. Protoconch blunt but no sculpture discernable on type. Outer lip broken on type. Inner lip tightly appressed on parietal wall, thickened where free. Suture closed to slightly open. Umbilicus small, semicircular. Sculpture consisting of two coarser beaded spirals just below the suture, finer spirals with finer and slightly elongate beads on the central part of the whorl, the beads forming rows inclined to the left along growth lines, and a pair of moderately coarse beaded spirals forming a weak keel just above the suture.

Holotype (USNM 562999) measures: height 12.8 mm, diameter 7.7 mm.
Type locality: Naha limestone, 17497a.

This species is not closely related to any fossil or Recent *Calliostoma* described from Japan. These were recently brought together in a paper by Ikebe (1942) for whom the present species is named.

Distribution: Pliocene, (Naha limestone) Okinawa.
Localities: Naha limestone, 17497a (figured type).

Calliostoma (Pulchrastele) aff. C. (P.) ikebei MacNeil

Plate 10, figures 14–15

A fragment from the Chinen sand is related to *C. ikebei* and may be identical.

Occurrence: Chinen sand, 17441 (figured).

Subfamily MONODONTINAE

Genus CHRYSOSTOMA Swainson 1840

Type: *C. nicobaricus* (Gmelin) Swainson (= *C. paradoxum* (Born)).

Chrysostoma paradoxum (Born)

Plate 10, figure 21

Helix paradoxa Born, 1780, Testacea musei Caesarei vindobonensis, p. 394, pl. 13, figs. 16–17.
Chrysostoma nicobaricus. Swainson, 1840, Treatise on malacology, p. 353.
Chrysostoma paradoxum. Hatai, 1941, Tropical Industry Inst. Palau, Bull. 7A, p. 86, pl. 3, figs. 7–8.
(Hirase) Taki, 1951, Handbook of illustrated shells, pl. 67, fig. 1.

I find no record of this species having been found previously as a fossil.

Distribution: Pliocene, (Nakoshi sand) Okinawa; Recent, northern Ryukyu Islands to the Philippines, Palau and New Caledonia.
Localities: Nakoshi sand, 17483 (figured).

Subfamily TROCHINAE

Genus TROCHUS Linné 1758

Type: *T. maculatus* Linné.

Trochus niloticus Linné

Plate 18, figures 3, 5

Trochus niloticus Linné, 1767, Systema naturae, ed. 12, p. 1227.
Trochus (Pyramidea) niloticus. Nomura, 1935, Tōhoko Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 2, p. 211, pl. 10, fig. 46.

Hatai, 1941, Tropical Industry Inst. Palau Bull. 7A, p. 83, pl. 30, figs. 1, 2 (Not figs. 3, 4 which are *maximus*.)

Trochus niloticus maximus. (Hirase) Taki, 1951, Handbook of illustrated shells, pl. 65, fig. 6.

A large trochid from the Yontan limestone appears to belong to the Recent species. Two other specimens were found in a raised beach ridge of very late age on the southern coast of Ie-shima. Nomura reported the occurrence of this species from "Raised Coral Reef" on Formosa, a deposit that carries a fauna similar to that of the Yontan limestone of Okinawa, and may be contemporaneous.

The form figured by Hirase appears to be typical *T. niloticus* rather than *T. maximus* (Koch) Philippi. Kuroda and Habe (1952, p. 92) list *T. niloticus* Linné as an invalid name and give as valid *Tectus maximus* (*Philippi*) (=*niloticus* Linné (pars)). It is not clear whether this means they do not recognize typical *T. niloticus* in Japan, or whether they believe that all members of a Linnaean species can be named, leaving no typical form. Some of the young individuals collected on Okinawa have the coarse sculpture and convex base that characterize *T. maximus*, and it may be that both forms are represented. The large specimens are all typical *T. niloticus*, however.

Distribution: Pliocene (?), Sumatra; Pliocene, (Naha limestone) Okinawa; Pleistocene, (Yontan limestone and raised beach dunes) Okinawa and Ie-shima, ("raised coral reef") Formosa; Recent, Indian Ocean, northern Australia, Philippines to Kyushu, New Caledonia, Solomon Islands and Fiji. The species now occurs in the Carolines, Marshalls, Marianas, Palau and Yap, but it is believed to have been introduced there by the Japanese.

Localities: Yontan limestone, 17543, 17544 (figured), 17644–b (figured).

Doubtful occurrences: Poorly preserved or very young individuals, some of which may be *T. maximus*, were obtained from the following:

Naha limestone: 17499, 17541, 17582, 17585, 17673.

Yontan limestone: 17510, 17551, 17573, 17591, 17613, 17640, 17645, 17656U, 17678.

Comparative bathymetric data: Specimens of this species have been obtained from tide pools on reefs, but its main habitat seems to be the off side of the outer reef.

Trochus calcaratus Souverbie

Plate 18, figures 7, 9

Trochus (*Polydonta*) *calcaratus* Souverbie, 1875, Journal de conchyliologie, v. 23, p. 41, pl. 4, figs. 7, 7a.

Trochus (*Trochus*) *calcaratus*. Nomura, 1935, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 2, p. 211, pl. 10, fig. 16.

Trochus histrio Reeve may be an older name for this species, but according to Pilsbry (1888–1896, v. 11, p. 30,) *T. histrio* cannot be positively identified, and it is more satisfactory to use Souverbie's name. Nomura reported this species from "Raised Coral Reef" of Formosa, a horizon probably the same as the Yontan limestone of Okinawa.

Distribution: Pleistocene, (Yontan limestone) Okinawa, ("raised coral reef") Formosa; Recent, southwest Pacific from New Caledonia through the Philippines to the northern Ryukyu Islands.

Localities: Yontan limestone, 17511, 17515, 17543, 17544, 17545 (figured), 17551, 17552, 17613, 17637, 17640, 17644–b, 17646, 17652, 17666 (figured).

Trochus sp. ind.

Plate 18, figure 8

A juvenile and an imperfect adult *Trochus* allied to *T. rota* Dunker were obtained from the Yontan limestone. *Trochus rota* was reported from Gabusoga, a locality in the Nakoshi sand, by Nomura and Zinbo (1936).

Localities: 17544 (figured), 17644–b. Specimens from 17512 and 17637 may represent the same species.

Tosatrochus MacNeil, new genus

Type: *Thalotia aspera* Kuroda. (Hirase) Taki, 1951, Handbook of illustrated shells, pl. 68, fig. 3 (=*attenuatus* Jonas, fide Fischer and Pilsbry); Recent, Japan.

Thalotia aspera is a new name for *Trochus elongatus* Wood, a homonym of *Trochus elongatus* Sowerby. (See Kuroda and Habe, 1952, p. 90.) According to Fischer (1879, p. 281), and Pilsbry (1888–1896, vol. 11, p. 143), *T. attenuatus* Jonas is an earlier name for *T. elongatus* Wood. *Trochus attenuatus* was unfigured, and both it and *T. elongatus* Wood are from unknown localities. Fischer reported the species from New Caledonia, and several records exist for its occurrence off Shikoku, Japan.

Trochus elongatus Wood has been assigned variously to *Thalotia*, both as a genus and as a subgenus of *Cantharidus*. In this writer's opinion it has little relationship with either. Perhaps its open umbilicus and sculpture ally it more closely with *Praecia* Gray, but *T. elegantula* Wood, the type of that species, has a lower spire.

Tosatrochus attenuatus (Jonas)

Plate 10, figures 16, 22–23

Trochus elongatus Wood (not Sowerby), 1828, Index testaceologicus, suppl., p. 17, pl. 5, fig. 19.

Trochus attenuatus Jonas, 1844, Zeitschrist für Malakozoologie, p. 170.

Trochus elongatus. Fischer, 1879, Coquilles vivantes, 2d. ed., p. 281, pl. 92, fig. 1.

Cantharidus (*Thalotia*) *elongatus*. Pilsbry, 1889, Manual of conchology, v. 11, p. 143, pl. 45, fig. 56.

Hirase, 1936, A collection of Japanese shells, pl. 68, fig. 3.

Thalotia aspera Kuroda (MS). (Hirase) Taki, 1951, Handbook of illustrated shells, pl. 68, fig. 3.
Kuroda and Habe, 1952, Recent Mollusca of Japan, p. 90.

Two specimens of this species from Nakoshi appear to be identical with the Recent species.

Distribution: Pliocene, (Nakoshi sand) Okinawa; Recent, western Pacific region from New Caledonia to Tosa (Shikoku), Japan.
Localities: Nakoshi sand, 17440 (figured).
Doubtful identifications: Two poorly preserved speciments of *Tosatrochus* from the Naha limestone may be this species, 17608 and 17644–a.

Genus CLANCULUS Montfort 1810

Type: *Trochus pharaonius* Linné.

Clanculus microdon ater Pilsbry

Plate 16, figures 4, 9

Clanculus microdon var. *ater* Pilsbry, 1901, Acad. Nat. Sci. Philadelphia Proc., v. 53, p. 200.
Clanculus microdon ater. (Hirase) Taki, 1951, Handbook of illustrated shells, pl. 66, fig. 5.

Pilsbry distinguished this form from typical *C. microdon* on the basis of color and a greater number of spiral cords. The subspecies *ater* is characterized by scattered white beads on its otherwise dark gray or black shell, and by alternating large and small threads in its spiral sculpture.

Yokoyama (1924, pl. 2, fig. 5) figured a specimen from the coral bed at Awa as *Trochus* (*Clanculus*) *atropurpureus* (Gould). Taki and Oyama (1954, pl. 39, fig. 5) reidentified it as *Clanculus* (*Euclanculus*) *microdon ater* Pilsbry.

Distribution: Pliocene, (Naha limestone) Okinawa; Pleistocene or post-Pleistocene, (coral bed at Awa) Japan; Recent, central Japan.
Localities: Naha limestone, 17484 (figured).

Clanculus margaritarius (Philippi)

Plate 18, figures 14–15

Monodonta margaritaria Philippi, 1846, Zeitschrift für Malakozoologie, p. 100.
Clanculus margaritarius. (Hirase) Taki, 1951, Handbook of illustrated shells, pl. 66, fig. 3.

A specimen with several of the apex whorls missing, but agreeing with this species in sculpture and in the apertural and umbilical characters was found in the Yontan limestone.

Distribution: Pleistocene, (Yontan limestone) Okinawa; Recent, southern Ryukyu Islands to central Japan.
Localities: Yontan limestone, 17551 (figured).

Subfamily UMBONIINAE

Genus MONILEA Swainson 1840

Type: *Trochus callifera* Lamarck.

Monilea haebaruensis, n. sp.

Plate 11, figures 1–2

Shell of medium size, whorls rounded, sutures depressed. Protoconch simple but its sculpture cannot be discerned on the specimens at hand. Aperture subquadrate. Outer lip moderately thick, not corrugated within. Inner lip thickened at the outer of two umbilical carinae and reflected at the inner carina. Parietal wall weakly callussed, the callus weakest and less emergent at the midpoint of the appression. Umbilicus deep and open. Sculpture consisting of sharpened spirals with occasional weak secondary spirals above the periphery, and rounded, more closely set spirals on the base, a strong roughened spiral thread, referred to above as the outer umbilical carina, rimming the umbilical opening.

Holotype (USNM 562889) measures: height 9.6 mm., diameter 11.8 mm.
Type locality: Chinen sand, 17442.

It cannot be decided from his figure whether this is the same species as the one reported from both the Byoritzu beds and Pleistocene raised coral reef of Formosa by Nomura (1935, p. 215, pl. 10, figs. 23a–b) as *M. lentiginosa* A. Adams, but from the general aspect it is not. The Okinawan fossil differs from Recent specimens of *M. lentiginosa* in having a narrower umbilicus with the outer umbilical carina less recessed, stronger, and lacking a deep groove between it and the finer spiral sculpture. The spirals on the spire of *M. lentiginosa* are rounded and beaded, whereas on the Okinawan form they are sharpened and simple.

Distribution: Pliocene, (Chinen sand) Okinawa.
Localities: Chinen sand, 17442 (figured type).

Subgenus ROSSITERIA Brazier 1895

(*Solanderia* P. Fischer 1879, not Duchassaing and Michelotti 1846)

Type: *Trochus nucleus* Philippi.

Monilea (Rossiteria) cf. M. (R.) nuclea (Philippi)

Plate 1, figures 8–9

?*Trochus nucleus* Philippi, 1849, Zeitschrift für Malakozoologie, p. 171.
?*Monilea nuclea*. Pilsbry, 1889, Manual of conchology, v. 11, p. 257, pl. 61, figs. 31, 32.

Monilea nuclea is difficult to identify from any of its published figures. It is fairly well fixed by Pilsbry's comparison of it with his new species, *M. nucleolus* (Pilsbry, 1903, p. 71). The species here reported from Okinawa does not appear to be separable from specimens in the Hirase Collection in the U.S. National Museum labelled "*Monilea* (*Rossiteria*) *nuclea* Phil". However, specimens labelled "*Monilea* (*Rossiteria*) *nucleolus* Pils" appear to be the same species. According to Pilsbry *M. nucleolus* is nearly smooth whereas *M. nuclea* has sharply incised spiral lines.

Distribution: Miocene, (Yonabaru clay member) Okinawa; Recent, southwest Pacific, New Caledonia to central Japan.

Localities: Yonabaru clay member, 17449 (figured).

Comparative bathymetric data: Specimens in the Thaanum Collection in the U.S. National Museum were obtained from 10 to 25 fathoms.

Genus ETHALIA A. Adams 1853

Type: *Rotella guamensis* Quoy and Gaimard.

Ethalia subpulchella, n. sp.

Plate 11, figures 16–17

Ethalia pulchella. Nomura, 1935, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 2, p. 215, pl. 10, figs. 24a, b.

Shell medium to large for the genus, sublenticular, angulate. Protoconch not well preserved on type. Aperture subquadrate, outer lip plain, parietal wall with a tongue-shaped callus, thicker towards the umbilicus, extending a little beyond the umbilicus and nearly closing it. Umbilicus not open to direct view, but with a small opening visable from an angle. Surface of shell smooth except for growth lines above, and with weak radiating corrugations on the base that die out before reaching the midline of the base.

Holotype (USNM 562898) measures: height 5 mm, diameter 9.2 mm. A slightly larger topotype is 10.2 millimeters in diameter.

Type locality: Chinen sand, 17442.

The form from the Byoritzu beds of Formosa identified as *E. pulchella* (A. Adams) by Nomura appears to belong to the species here described. *Ethalia subpulchella* differs from *E. pulchella* in having its umbilicus more completely covered by the callus.

Distribution: Pliocene, (Byoritzu beds) Formosa, (Chinen sand) Okinawa.

Localities: Chinen sand, 17442 (figured type).

Genus UMBONIUM Link 1807

Type: *Trochus vestiarium* Linné.

Umbonium aff. U. costatum (Kiener)

Plate 18, figures 2, 6

?*Rotella costata* (Valenciennes) Kiener, 1839, Coquilles vivantes, *Rotella*, p. 10, pl. 2, fig. 5.

?*Umbonium* (*Suchium*) *moniliferum.* Nomura, 1959, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 2, p. 214 (in part).

?*Umbonium costatum.* (Hirase) Taki, 1951, Handbook of illustrated shells, pl. 71, fig. 1.

Nomura followed Kuroda in regarding *U. costatum* as a synonym of *U. moniliferum* (Lamarck). Both the Okinawan fossils and specimens of *costatum* in the U.S. National Museum appear to differ from *moniliferum* in lacking the row of prominent tubercles below the suture. Most of the specimens in a collection from the upper Byoritsu beds, presented to the U.S. Geological Survey by I. Hayasaka, have very prominent subsutural tubercles and are labelled "*Umbonium* (*Suchium*) *noduliferum* (Lamarck)". However, Hayasaka, Lin and Yen (1948, p. 12) list only *U. moniliferum.* The species figured by Yokoyama (1920, pl. 6, fig. 6) as *U. costatum* has prominent subsutural tubercles and probably is typical *U. moniliferum.*

The single poorly preserved specimen from the Yontan limestone of Okinawa has a lower spire than is common for the Recent *U. costatum*, but is otherwise very similar.

Distribution: Pliocene, (Nakoshi sand) Okinawa Pleistocene, (Yontan limestone) Okinawa; Recent (*U. costatum*), southern Japan.

Localities: Nakoshi sand, 17440; Yontan limestone, 17672–u (figured).

Doubtful occurrences: Poorly preserved specimens which may be this species were found at the following: Yontan limestone, 17511, 17514, 17550.

Family STOMATIIDAE

Subfamily STOMATIINAE

Genus STOMATIA Helbling 1779

Type: *S. phymotis* Helbling.

Stomatia cf. S. rubra (Lamarck)

Plate 16, figure 5

?*Stomatella rubra* Lamarck, 1816, Encyclopédie méthodique, pl. 450, figs. 3a, b; 1822, Animaux sans vertèbres, v. 6, pt. 2, p. 210.

?*Stomatia rubra.* H. and A. Adams, 1854, Genera of Recent Mollusca, p. 436.

?*Stomatia rubra.* (Hirase) Taki, 1951, Handbook of illustrated shells, pl. 63, fig. 7.

Only a single internal mold of this form was obtained. It is a small, circular *Stomatia* with the impression of sculpture resembling that of *S. rubra.*

Distribution: Pliocene, (Naha limestone) Okinawa; Recent, Philippines to Japan sea.

Localities: Naha limestone, 17661 (figured).

Comparative bathymetric data: Specimens of the Recent species are in the Albatross collection from the Philippines from depths of 10 and 37 fathoms.

Family ANGARIIDAE

Genus ANGARIA (Bolten) Roeding 1798

Type: *Turbo delphinus* Linné.

Angaria delphinus (Linné)

Plate 16, figures 6, 11–12

Turbo delphinus Linné, 1758, Systema naturae, ed. 10, v. 1, p. 764.
Angaria delphinus. (Bolten) Roeding, 1798, Museum Boltenianum, no. 911, p. 71.
Delphinula laciniata Lamarck, 1816, Encyclopédie méthodique, pl. 451, figs. 1a, b; 1822, Animaux sans vertèbres, v. 6, p. 230.
Angaria delphinus laciniata. Hirase, 1936, A collection of Japanese shells, pl. 71, fig. 8.
Angaria delphinus. (Hirase) Taki, 1951, Handbook of illustrated shells, pl. 71, fig. 8.
Angaria delphinus laciniata. Kuroda and Habe, 1952, Recent marine Mollusca of Japan, p. 38.

Incomplete specimens whose visible characters fall well within the limits of the very variable Recent species were recovered from the Naha and Yontan(?) limestones. The form named *laciniata* by Lamarck is typical *A. delphinus* and, therefore, needs no subspecific name.

Distribution: Pliocene, (Naha limestone) Okinawa; Pleistocene, (Yontan? limestone) Okinawa: Recent, Indonesia to Japan.

Localities: Naha limestone, 17484, 17574 (figured); Yontan (?) limestone, 17637 (figured).

Comparative bathymetric data: The species is recorded from depths of less than 10 fathoms, and is frequently collected from tide pools.

Family SKENEIDAE

Genus LEUCORHYNCHIA Crosse 1867

Type: *L. caledonica* Crosse.

?Leucorhynchia sp. ind.

Plate 16, figures 13–14

A single imperfect specimen of a small, smooth form that appears to have had a *Leucorhynchia*-like umbilical callus was found. It is otherwise indeterminable.

Occurrence: Naha limestone, 17518 (figured).

Family TURBINIDAE

Subfamily LIOTIINAE

Genus LIOTIA Gray 1847

Type: *Delphinula cancellata* Gray.

Liotia sp. ind.

Plate 7, figures 3–4

A single poorly preserved specimen of a large *Liotia* probably related to *L. hermanni* Dunker was obtained from the Shimajiri formation. Its sculpture is mostly eroded but a row of rather large holes along the outer edge of the siphonal fasciole resembles that of *L. hermanni* and *L. peronii* Kiener. *Liotia fenestrata* Carpenter (See Abbott, 1954, pl. 18, fig. U) from the Pacific coast of Mexico is closely related.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa.

Localities: Shinzato tuff member, 17456 (figured).

Genus HOMALOPOMA Carpenter 1864

Type: *Turbo sanguineum* Linné.

Homalopoma is not regarded as a homonym of *Homalopomus* Girard 1857. If it is, *Leptothyra* Dall 1871 is the next available name.

Homalopoma cf. H. sangarensis (Schrenck)

Plate 11, figures 7–8

?*Turbo sangarensis* Schrenck, 1861, Bull. Acad. Imp. des Sci. de Saint Petersbourg, v. 4, no. 7, p. 409.
?*Leptothyra sangarensis.* Pilsbry, 1888, Manual of conchology, v. 10, p. 250, pl. 47, figs. 27, 28, pl. 64, fig. 59.
?Kuroda and Habe, 1952, Recent marine Mollusca of Japan, p. 62.

The specimen compared with this species is incomplete and slightly crushed, but the apertural and sculptural details appear to be identical in all respects with those of specimens so labelled in the Hirase collection in the U.S. National Museum from Fusan, Korea. *H. amussitata* (Gould) is closely related but I had no specimens for comparison.

Distribution: Pliocene, (Chinen sand) Okinawa; Recent, northern Japan and Korea.

Localities: Chinen sand, 17480 (figured).

Genus LIOTINA Munier-Chalmas 1883

Type: *Delphinula gervillei* DeFrance.

Subgenus DENTARENE Iredale 1929

Type: *D. sarcina* Iredale (=*Delphinula crenata* Kiener).

Liotina (Dentarene) chinenensis, n. sp.

Plate 11, figures 29–31

Shell medium sized for the genus, ovate in shape. Protoconoch smooth, planispiral, slightly submerged and tilted, consisting of about 1½ turns. First 1½ postnuclear whorls likewise planispiral, remaining whorls spiral and turbiniform. Aperture round. Outer lip somewhat flaring, but inner lip simple and unreflected. Suture deeply impressed. Sculpture consisting of four spiral lirations, 2 above and 2 on the periphery, the upper of the peripheral lirations stronger, peripheral lirations bearing spiny projections which begin earlier on the upper liration and which are open toward the direction of growth, axial lirations of about equal strength (about 6 visible from an angle) intersecting the spirals lirations to form a cancellate pattern; miscosculpture consisting of very fine raised lamellae all over the shell. Base bearing a row of rounded beads rimming the unbilical opening, and a much weaker row outside, fine corrugations extending from the nodes of the rim row into the umbilical opening.

Holotype (USNM 562909) measures: height 4.8 mm diameter 6.5 mm.

Type locality: Chinen sand, 17482–b.

A much larger, apparently undescribed, species is present in the Albatross collections from the Philippines, but it has a single prominent row of peripheral spines rather than two spiny peripheral carinae. *Liotina* (*Dentarene*) *cycloma* (Tomlin) (see Kira, 1955, pl. 11, fig. 2) appears to be closely related to *L.* (*D.*) *chinenensis* but the available figures of the former are not good enough for detailed comparison.

Distribution: Pliocene, (Chinen sand) Okinawa.
Localities: Chinen sand, 17482–b (figured type).

Genus PHANEROLEPIDA Dall 1907

Type: *Leptothyra transenna* Watson.

Phanerolepida was treated as a "section" of *Leptothyra* by Thiele (1931), and the type species was referred to *Leptothyra* without any subgeneric assignment by Kuroda and Habe (1952, p. 62). Wenz (1938, p. 341) regarded it as a subgenus of *Homalopoma* Carpenter of which he regarded *Leptothyra* a synonym. Otuka (1949, p. 302) also made it a subgenus of *Homalopoma.*

Phanerolepida rehderi, n. sp.

Plate 7, figures 6–8, 11–13

Shell of medium size, naticoidal, spire low, but the first 3½ to 4 turns rise more steeply than the rest, making the tip of the spire slightly papillate. Protoconch low, consisting of about 1 full turn, smooth. Aperture subcircular. Callus extending over the body whorl to cover an area nearly as large as the aperture. Sculpture on first 3 adult whorls consisting of fairly strong spiral lirations or carinae; sculpture on later whorls consisting of faint spiral lines or of alternating patches of shell with faint spiral lines and patches having a finely reticulate or shagreen-like sculpture, the boundary between the two types being sharp and irregular.

Holotype (USNM 562794) measures: height 17.5 mm, diameter 17 mm.

Type locality: Shinzato tuff member, 17454.

Before 1931 this genus was known only from a single Recent species, *P. transenna* (Watson) (1886, p. 125, pl. 6, fig. 12), which inhabits deep water on both the eastern and western sides of southern Japan. Otuka (1949, p. 302, pl. 13, fig. 4) reported the species from the Tomiya tuffaceous sandstone (Pliocene) of Japan. The Okinawan fossil species is smaller than the Recent species, and the reticulated sculpture is coarser. None of three specimens from locality 17677 have patches of shagreen-like sculpture but otherwise they are identical. Specimens lacking patches of reticulate sculpture might easily be mistaken for *Chrysostoma paradoxum. Chrysostoma paradoxum* does not have raised spiral ridges on the early adult whorls and its spire is lower.

Kuroda (1931a, p. 70) described a fossil species as *P. expansilabrum.* Otuka (1949, p. 302) mentioned it and stated that it came from the Pliocene but did not compare it with *P. transenna.* Hatai and Nisiyama (1952, p. 230) give its provenance as the upper Uchimura formation (Miocene). Kuroda's paper has not been seen by the writer.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa.

Localities: Shinzato tuff member, 17454 (figured type), 17677 (figured).

Comparative bathymetric data: The type of *P. transenna* (Watson) was obtained from a depth of 565 fathoms. Two specimens in the U.S. National Museum, collected by the Albatross, are from depths of 487 and 600 fathoms. Kuroda (1931a, p. 70; fide Otuka, 1949, p. 302) reports it from Sagami Bay at a depth of 500 fathoms.

Genus CIRSOCHILUS Cossmann 1888

Type: *Delphinula striatum* Lamarck.

Cirsochilus ryukyuensis, n. sp.

Plate 11, figures 13–15

Shell medium small, spire low, whorls slightly tricarinate. Protoconch consisting of about 1 regularly coiled smooth whorl. Aperture nearly circular. Outer lip thin at the edge but thickening behind, apparently forming an operculum receptacle; a slight tuberosity on the inner lip opposite the rim of the umbilicus. Parietal callus tongue-shaped and extending well in advance of the aperture; callus overhanging the umbilicus slightly. Suture narrowly and shallowly channeled. Sculpture consisting of fine spiral lines all over and 4 stronger spirals, 1 just below the suture and 3 others, well separated, at the periphery, the spiral below the suture beaded, but becoming smooth on the last quarter turn, the uppermost of the peripheral spirals beaded on the first half of the last turn (on both of two specimens at hand) but smooth elsewhere, base with small corrugations extending outwards from the rim of the umbilicus.

Holotype (USNM 562897) measures: height 3 mm, diameter 4.3 mm.

Type locality: Chinen sand, 17482–b.

I have not been able to associate this species with any reported from the western Pacific. Species referred to *Neocollonia* and *Collonista* ((Hirase) Taki, 1951, pl. 75) may be related but the figures are unrecognizable. There is doubt in my mind that the two Recent species from Australia referred to *Cirsochilus* by Cossmann, *Turbo filifer* Deshayes and *Collonia roseopunctata* Angas, are even congeneric with it.

There is probably some relationship between this species and *Turbo* (*Marmorostoma*) *rutteni* Beets (1942, p. 231, pl. 25, figs. 8–10) from the upper Miocene of eastern Borneo. The Borneo form is higher and more *Turbo*-like, but it may well represent the ancestral stock of the species here described.

The type species, *C. striata* (Lamarck), from the Eocene of France is slightly higher, lacks the beaded spirals, and its callus does not partly cover the umbilicus.

Distribution: Pliocene, (Chinen sand) Okinawa.

Localities: Chinen sand, 17482b (figured type).

Subfamily TURBININAE

Genus TURBO Linné 1758

Type: *T. petholatus* Linné.

Turbo petholatus Linné

Plate 18, figure 12

Turbo petholatus Linné, 1758, Systema naturae, ed. 10, p. 762.

Turbo (*Turbo*) *petholatus*. Nomura, 1935, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 2, p. 206, pl. 10, fig. 31.

Turbo petholatum. Hatai, 1941, Tropical Industry Inst. Palau, Bull. 7A, p. 90, pl. 18, figs. 10, 11.

Turbo petholatus. (Hirase) Taki, 1951, Handbook of illustrated shells, pl. 73, fig. 1.

Numerous specimens of this species were obtained from both the Naha and Yontan limestones. Nomura records it from the Byoritzu beds of Formosa.

Distribution: Miocene to Recent, Indo-Pacific region (See Wissema, 1947, p. 26); Pliocene, (Byoritzu beds) Formosa, (Naha limestone) Okinawa; Pleistocene, (Yontan limestone) Okinawa; Recent, Red Sea to Japan and islands of the Pacific.

Localities (doubtful identifications indicated by ?; opercula only by 0): Naha limestone, ?17473, 17484(0), ?17499, ?17534, 17540, 17541, 17554(0), ?17561, ?17578, 17582, ?17584, 17608, ?17612, 17615, ?17641C; Yontan limestone, 17510, 17511(0), 17512(0), ?17512, 17513, ?17543, 17544 (figured), ?17547, 17548, 17549, 17551, 17552, 17558, ?17573, 17613, 17637, 17640(0), 17644–b, 17652, 17656U, 17665U, 17665U (0), 17672U, 17680, ?17686.

Genus MARMOROSTOMA Swainson 1829

Type: *Turbo chrysostomus* Linné

Marmorostoma argyrostoma (Linné)

Plate 18, figure 4

Turbo argyrostomus Linné, 1758, Systema naturae, ed. 10, p. 176.

Turbo (*Turbo*) *argyrostomus*. Nomura, 1935, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 2, p. 207.

Turbo argyrostomus. (Hirase) Taki, 1951, Handbook of illustrated shells, pl. 73, fig. 4.

The specimens from the Yontan limestone do not show any characteristics by which they can be distinguished from the variable Recent species. Nomura reported the species from "Raised Coral Reef" of Formosa, probably equivalent to the Yontan limestone in age.

Distribution: Pliocene, (Naha? limestone) Okinawa: Pleistocene, Zanzibar, Mombasa, Nias, Tonga, ("Raised Coral Reef") Formosa, (Yontan limestone) Okinawa; Recent, Indian Ocean to the northern Ryukyus Islands and central Pacific Ocean islands.

Localities: Naha(?) limestone, 17484, 17541; Yontan limestone, 17511 (figured), 17512–a, 17543, 17544, 17672U.

Comparative bathymetric data: Specimens bearing data in the U.S. National Museum all were obtained from reefs and shallow water.

Subgenus BATILLUS Schumacher 1817

Type: *Turbo cornutus* Gmelin.

Marmorostoma (Batillus) gemmata (Reeve)

Plate 11, figure 4

Turbo gemmatus Reeve, 1848, Conchologia iconica, v. 4, *Turbo*, pl. 12, fig. 62.

Turbo? sp. Dickerson, 1922, Philippine Jour. Sci., v. 20, no. 2, pl. 5, fig. 17.

Turbo yabei Nomura and Zinbo, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 3, p. 263, pl. 11, figs. 34a, b.

Turbo (*Marmorostoma*) *gemmatus*. Altena, 1938, Leidse Geologische Mededelingen, v. 10, p. 288, fig. 12.

Cox, 1948, Schweizerische Paläontologische Abhandlungen, v. 66, p. 17, pl. 1, figs. 2a, b.

See Cox for a full discussion of this species. *Turbo yabei* was described from Gabusoga, Okinawa, a locality close to and equivalent to the exposure at Nakoshi where the specimen figured here was obtained.

This species is characterized by its strongly beaded spiral sculpture.

Distribution: Miocene or Pliocene, Philippines and northern Borneo; Pliocene, eastern Java, (Nakoshi sand) Okinawa; Pliocene or Pleistocene, Nias; Pleistocene, eastern Java; Recent, Indo-Pacific region.

Localities: Nakoshi sand, Gabusoga (Nomura and Zinbo). 17440 (figured), 17444.

Marmorostoma (Batillus) cf. M. (B.) cornuta (Humphrey)

Plate 11, figures 11–12

?*Turbo cornutus* Humphrey, 1786, Portland catalogue, p. 147, no. 3235.

?*Turbo* (*Batillus*) *cornutus*. (Hirase) Taki, 1951, Handbook of illustrated shells, pl. 73, fig. 3.

Specimens resembling the young of *M. cornuta*, the stage before the formation of spines, were recovered from the Nakoshi sand, the Naha limestone and the Yontan limestone. A new species may be represented here, but no attempt is made to describe it on the basis of the material at hand. It occurs with *M. gemmata* (*yabei*) at one locality but there is no intergradation. Young specimens of *Marmorostoma argyrostoma* resemble this species superficially. This form does not have an open umbilicus like *M. argyrostoma* and the spiral ribs and channels are much weaker, particularly on the base.

Distribution: Pliocene, (Nakoshi sand and Naha limestone) Okinawa; Pleistocene, (Yontan limestone) Okinawa; Recent, Ryukyu Islands to central Japan.

Localities: Nakoshi sand, 17440 (figured); Naha limestone, 17484, 17499, 17571, 17574, 17576, 17608, 17644-a; Yontan limestone, 17510, 17545, 17548, 17551, 17552, 17558, 17637, 17646, 17652, 17666.

Genus LUNATICA (Bolten) Roeding 1798

Type: *Turbo marmoratus* Linné.

Lunatica marmorata (Linné)

Plate 11, figure 3

Turbo marmoratus Linné, 1758, Systema, naturae, ed. 10, p. 763. (Hirase) Taki, 1951, Handbook of illustrated shells, pl. 72, fig. 3.

Nomura (1935, pl. 10, figs. 30a–b) figured a large *Lunatica* from "raised coral reef" of Formosa as *Turbo* (*Turbo*) *regenfussi* Deshayes. Nomura's specimen is a young individual, and the Okinawan specimen is only a fragment so that accurate comparison is impossible, but it may be the two represent the same species. *L. regenfussi* is an Indian Ocean form, whereas *L. marmorata* is reported to range from the Indian Ocean nearly to Japan. Pilsbry believed the two to be synonyms. Probably the shell figured by Nomura is the same species as a larger but less complete specimen figured from the Byoritzu beds by Yokoyama (1928, pl. 4, fig. 12) as *Turbo marmoratus* var. *laevis*.

Distribution: Pliocene, (Nakoshi sand) Okinawa, (?Byoritzu beds) Formosa; Pleistocene, ("raised coral reef") Formosa: Recent, Indian Ocean to the northern Ryukyu Islands.

Localities: Nakoshi sand, 17440 (figured).

Genus GUILDFORDIA Gray 1850

Type: *Astralium triumphans* Philippi.

Guildfordia yoca Jousseaume

Plate 11, figures 5–6

Guildfordia yoca Jousseaume, 1899, Le naturaliste, p. 48.

Guildfordia yoca differs from *G. triumphans* (Philippi) in being a little lower, and in lacking granules on the base. The top of *G. yoca* generally has fewer rows of granules than *G. triumphans*, although occasional specimens of *G. yoca* have granules completely covering the top of the whorls. Recent specimens of *G. triumphans* are a darker rose color than *G. yoca*.

Distribution: Pliocene, (Chinen sand) Okinawa; Recent, Indonesia to central Japan.

Localities: Chinen sand, 17482–b, 17482–c (figured).

Comparative bathymetric data: Specimens taken by the Albatross expedition ranged in depth from 38 to 700 fathoms with all records but the one at 38 fathoms being over 200 fathoms.

Genus CALCAR Montfort 1810

Type: *Trochus stellaris* Gmelin.

Calcar has been variously treated as a synonym or as a subgenus of *Astraea* (Bolten) Roeding 1798. However, in the sense that it has been used by some recent authors, the writer regards it as generically distinct from *Astraea*. The nomenclature of this whole group is in an unsatisfactory condition and needs revision.

Calcar cf. C. haematraga (Menke)

Plate 18, figures 23–25

?*Trochus haematragus* Menke, 1829, Conchylien-Sammlung der Freiherrn v. Malsburg, p. 18.

?*Astralium* (*Cyclocantha*) *haematragus*. Yokoyama, 1924, Tokyo Imp. Univ. Coll. Sci. Jour., v. 45, pl. 2, fig. 7.

?*Astraea* (*Calcar*) *haematraga*. Otuka, 1935, Earthquake Research Inst. Bull., v. 13, pt. 4, p. 850, pl. 53, figs. 40a,b.

?*Astraea haematraga*. (Hirase) Taki, 1951, Handbook of illustrated shells, pl. 74, fig. 4.

?*Astraea* (*Calcar*) *haematraga*. Taki and Oyama, 1954, Paleont. Soc. Japan Spec. Paper 2, pl. 39, fig. 7.

Two specimens from the Yontan limestone agree with the less spiny individuals of this Recent species, but most Recent specimens have the spines more developed.

Distribution: Pleistocene, (Yontan limestone) Okinawa; post-Pleistocene, (Noto and the coral bed at Awa) Japan; Recent, Formosa to central Japan.

Localities: Yontan limestone, 17644–b (figured).

Calcar sp. ind.

Plate 16, figures 15, 21

Two fragments of *Calcar* from the Naha limestone are unidentifiable, although possibly both are closely related to if not identical with *C. haematraga*. Both specimens have strong peripheral spines.

Occurrence: Naha limestone, 17440 (figured), 17497–a (figured).

Calcar loochooensis, n. sp.

Plate 16, figures 16–18

Shell moderately small and subconical, whorls slightly rounded to nearly straight, flaring abruptly at the base to nearly the diameter of the next whorl. Aperture round. Umbilicus closed. Base slightly concave. Sculpture consisting of fine oblique irregular lirations and coarser irregular, granular axial ridges, the base of the whorl with granular fine spiral lines; the periphery (just above the suture) adorned with small thin projections which extend slightly downward, and which on the spire whorls are appressed on the top of the whorls below.

Holotype (USNM 563009) measures: height 14.7 mm, diameter 12.9 mm.
Type locality: Naha limestone, 17669.

This species is closely related to *C. haematraga*, but differs from it in having a narrower spire and much finer sculpture, particularly on the base. The peripheral projections in this species are more delicate and tightly appressed whereas in *C. haematraga* they often are hollow and projecting.

Distribution: Pliocene, (Naha limestone) Okinawa.
Localities: Naha limestone, 17539 (figured), 17669 (figured type).

Genus PSEUDASTRALIUM Schepman 1908

Type: *Astralium abyssorum* Schepman.

Pseudastralium cf. P. henicus (Watson)

Plate 11, figures 9–10

?*Turbo* (*Calcar*) *henicus* Watson, 1878, Jour. Linn. Soc. London, v. 14, p. 713; 1886, Voyage H.M.S. *Challenger*, Zoology, v. 15, p. 130, pl. 6, fig. 11.

?*Astraea* (*Calcar*) *henica*. Nomura and Zinbo, 1934, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 16, no. 2, p. 146.

?*Astraea* (*Pseudastralium*) *abyssorum*. Hirase, 1936, A collection of Japanese shells, pl. 74, fig. 10.

?*Guildfordia abyssorum var.* (Hirase) Taki, 1951, Handbook of illustrated shells, pl. 74, fig. 10.

?*Guildfordia henicus* var. Kuroda and Habe, 1952, Recent marine Mollusca of Japan, p. 59.

Specimens of this genus from the Molucca Pass in the Albatross collection have a broad channelled suture and thus compare more with *P. henicus* than with *P. abyssorum* Schepman which has an appressed or nearly appressed suture. Hirase's figure appears to represent a form more closely related to *P. henicus* than to *P. abyssorum*. The Okinawan fossil also has a channelled suture, and compares closely with *P. henicus* in other respects.

Distribution: Pliocene, (Chinen sand) Okinawa, ("Ryukyus limestone") Kikaiga-shima; Recent, Indonesia, Fiji, southern Japan.
Localities: Chinen sand, 17480 (figured).
Comparative bathymetric data: Albatross specimens, probably *P. henicus*, were obtained from depths of 272, 305 and 310 fathoms.

Genus BOLMA Risso 1826

Type: *Turbo rugosa* Linné.

The forms from the Yonabaru clay and Shinzato tuff members assigned to this genus are related to *Turbo coronatus* Gmelin which was assigned to *Lunella* (Bolten) Roeding 1798 by Kuroda and Habe (1952, p. 64). Possibly *Lunella* should be used for more turbiniform species which seem to fall between the typical turbinids and *Astraea* and its allies.

Bolma cf. B. pseudomodesta (Nomura)

Plate 16, figures 10, 23

?*Astraea pseudomodesta* Nomura, 1935, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 2, p. 208, pl. 10, figs. 1a–c.

Bolma pseudomodesta was described from the Byoritzu beds of Formosa. It differs from *B. modesta* (Reeve) (See (Hirase) Taki, 1951, pl. 74, fig. 6) in being smaller and with finer sculpture, but unquestionably the two species are closely related. The Recent species is known only from Japanese waters. The specimens at hand do not differ noticeably from the Recent species in the coarseness of the granular sculpture, but the hollow spines on the two prominent revolving carinae are weaker.

Distribution: Pliocene, (Byoritzu beds) Formosa, (Naha limestone) Okinawa.
Localities: Naha limestone, 17497–b, (figured), 17529 (figured).
Comparative bathymetric data: *Bolma modesta* (Reeve) is present in the Albatross collections from near Japan and is recorded from depths of 31 to 48 fathoms.

Bolma sp. ind.

Plate 7, figure 15

A fragment of a large *Bolma* allied to *B. modesta* was collected from the Shinzato tuff member. It may be a fragment of a large individual of the preceding species, but if so the sculpture changes greatly in the adult stages.

Occurrence: Shinzato tuff member, 17681 (figured).

Bolma hataii, n. sp.

Plate 7, figures 5, 9, 14

Shell of medium size, low turbiniform, whorls weakly tricarinate with the slopes between the subsutural depressions and the upper peripheral angulations forming disconnected parts of the plane of the spire. Protoconch low and broad, consisting of about 2½ whorls, smooth except for the last ¾ whorl which has a low raised spiral both immediately above and below the suture. Aperture nearly round. Umbilicus closed or with only a pinhole chink. Outer lip broken on type. Inner lip thick and well rounded, appressed. Parietal callus thin and not completely concealing the details of the basal sculpture. Sculpture consisting of two well spaced peripheral ridges as in *Bolma* and a third less projecting ridge below which is fully visible in the basal view, the upper of the two peripheral ridges bearing low vaulted spines. A row of coarse beads lies below the suture, and between it and the suture is a flat or slightly excavated bench or shallow channel. The remainder of the surface is ornamented with spiral rows of smaller beads between which are more continuous spiral threads. The beads on the basal spirals are finer than those above the peripheral ridges.

Holotype (USNM 562793) measures: height 10.6 mm, diameter 11.8 mm.

Type locality: Shinzato tuff member, 17456.

This species is closely related to a form from the Pliocene of Java regarded by Altena (1939, p. 46, pl. 3, figs. 1a–c) as a half-grown specimen of *Astralium girgyllus* (Reeve), but there is doubt that either is conspecific with the form figured by Hirase ((Hirase) Taki, 1951, pl. 74, fig. 8) as *Astraea girgyllus* (Reeve). *Lunella coronata* (Gmelin) ((Hirase) Taki, 1951, pl. 74, fig. 2) is more turbiniform with a more rapidly expanding spire in the early whorls and it has a much less developed subsutural bench. Hirase's figure of *L. coronata* also seems to show an open umbilicus.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa.

Localities: Shinzato tuff member, 17456 (figured type).

Bolma, n. sp.?

Plate 1, figure 7

A partial specimen obtained from the Yonabaru clay member appears to be an unrecorded species but it is too incomplete to describe. It has a higher spire than both *B. hataii* and the specimen figured by Altena as *Astralium girgyllus* (Reeve), and it has only a single finely beaded spiral between the two peripheral ridges—comparing more in this respect with *Bolma pseudomodesta* (pl. 16, fig. 23).

Occurrence: Yonabaru clay member, 17451 (figured).

Superfamily NERITACEA

Family NERITIDAE

Subfamily NERITINAE

Genus NERITA Linné 1758

Type: *N. peloronta* Linné.

Nerita chamaeleon Linné

Plate 1, figures 5, 10

Nerita chamaeleon Linné, 1758, Systema naturae, ed. 10, p. 779. Nomura, 1935, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 2, p. 218, pl. 10, fig. 18.

Nerita chamaeleon laevilirata. (Hirase) Taki, 1951, Handbook of illustrated shells, pl. 75, fig. 10.

The specimen here figured compares closely with specimens so labelled in the Hirase collection in the U.S. National Museum from the Ryukyu Islands. The shell suffered an injury about a third of a turn back from the present aperture and the sculpture is abnormal.

Distribution: Miocene, (Yonabaru clay member) Okinawa; Pliocene, Java (both typical and var. *squamatulata*), Timor, Ceram, (Byoritzu beds) Formosa; Recent, Indian Ocean and Polynesia, northward to southern Japan.

Localities: Yonabaru clay member, 17679 (figured).

Nerita aff. N. reticulata Karsten

Plate 16, figures 19–20

?*Nerita reticulata* Karsten, 1789, Museum Leskeanum, p. 296. ?Tryon, 1888, Manual of conchology, v. 10, p. 21, pl. 3, figs. 49, 50.

According to Tryon, *N. signata* Mac Leay is a synonym. A single rather poorly preserved specimen from the Naha limestone is tentatively referred to this species. It compares with some individuals of the Recent species on which the spiral ribs are made discontinuous by prominent growth wrinkles.

Distribution: Pliocene, (Naha limestone) Okinawa; Recent (*N. reticulata*), Indonesia and Polynesia, northward to the Ryukyu Islands.

Localities: Naha limestone, 17610 (figured).

Comparative bathymetric data: A shallow-water species collected from beaches, bays and reefs.

Nerita cf. N. polita Linné

Plate 16, figures 27–28

?*Nerita polita* Linné, 1758, Systema naturae, ed. 10, p. 778.

?*Nerita (Amphinerita) polita*. Hirase, 1936, A collection of Japanese shells, pl. 75, fig. 13.

?*Nerita polita*. (Hirase) Taki, 1951, Handbook of illustrated shells, pl. 75, fig. 13.

?Morris, 1952, Field guide to shells of the Pacific coast and Hawaii, p. 165, pl. 36, fig. 16.

The specimen so identified is incomplete and rather poorly preserved, but the characters of the inner lip appear to be identical with those of the living *N. polita.* The general shape and smooth exterior also suggest relationship to *N. polita.*

Distribution: Pliocene, (Naha limestone) Okinawa; Recent, Red Sea, Indian Ocean, Philippines and Polynesia, northward to southern Japan.
Localities: Naha limestone, 17610 (figured).

Nerita aff. N. undata Linné

Plate 18, figure 11

A single incomplete specimen with only the younger whorls showing any trace of sculpture was obtained from the Yontan limestone. Its sculpture resembles that of specimens labelled *N. undata* Linné in the U.S. National Museum. This is probably the form figured as *Nerita* (*Ritena*) *undata striata* Burrow by Hirase (1936, pl. 75, fig. 11), corrected in the Taki edition (1951) to *N. striata* Burrow. The Yontan limestone specimen has a higher spire than normal (See Hatai, 1941, pl. 27, figs. 3–4).

Distribution: Miocene? of Java; Pleistocene, (Yontan limestone) Okinawa; Recent (*N. undata* s. l.), Indian Ocean, Pacific Islands, northward to the Ryukyu Islands.
Localities: Yontan limestone, 17514 (figured).

Superfamily COCCULINACEA

Family COCCULINIDAE

Genus COCCULINA Dall 1881

Type: *C. rathbuni* Dall.

Cocculina loochooensis, n. sp.

Plate 1, figures 6, 11, 16

Shell oval, moderately high, apex a little anterior of the center. Apex somewhat decorticated on type, but showing a small papilla on a flattened area about 2 mm in length. Sculpture consisting of moderately weak raised lines radiating from the apex, and making a cancellate pattern with the growth lines. Edge nonchalky, but the interior is lined by white chalky shell. Mantle and muscle attachments as for the genus and consisting of a horseshoe shaped attachment around the posterior two thirds of the shell, an indentation extending towards the apex about 2 to 3 times the width of the posterior band at about the anterior third of the shell, and a thin band connecting these around the anterior end.

Holotype (USNM 562649) measures: height 5.9 mm, length 14.4 mm, diameter 9.9 mm.
Type locality: Yonabaru clay member 17451.

This species is clearly related to an apparently undescribed species in the Albatross collections from the Philippines, Borneo and Celebes. The Recent species gets much larger than the fossil specimen, the largest being 37 mm in length.

Two species have been described from Japan by Dall, *C. japonica* and *C. rhyssa.* Both are smaller than the fossil species. *C. japonica* has its apex more strongly inclined to the anterior, and *C. rhyssa* differs from both the other Recent and fossil forms in being more arcuate in shape, the profile of its base being strongly curved like the lip of an eye cup.

Distribution: Miocene, (Yonabaru clay member) Okinawa.
Localities: Yonabaru clay member 17451 (figured type).
Comparative bathymetric data: All *Cocculina* are deep water forms, the Japanese species having been obtained from 200 to 503 fathoms, and the large Philippine and Indonesian species from 260 to 510 fathoms.

Order MESOGASTROPODA

Superfamily RISSOACEA

Family ADEORBIDAE (TORNIDAE)

Genus PSEUDOLIOTIA Tate 1898

Type: *Pseudoliotia micans* (A. Adams)
For a discussion of this group see Abbott (1950).

Pseudoliotia motobuensis, n. sp.

Plate 10, figures 26–28

"*Cyclostrema*" *micans.* Nomura and Zinbo, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 3, p. 264, pl. 11, fig. 35.

Shell medium small, whorls round, spire low. Protoconch, not projecting, consisting of about one full smooth whorl. Aperture round with the faint suggestion of an indentation at the position of the anal sinus; edge of entire aperture rounded. Umbilicus open. Sculpture consisting of prominent spiral ridges, about 7 in number of which the 2 along the periphery and the 1 above are the most prominent, crossed by small raised ridges along the growth lines, the 2 series of ridges giving the shell a strongly cancellate appearance.

Holotype (USNM 562888) measures: height 5 mm, diameter 8.2 mm.
Type locality: Nakoshi sand, 17483.

The specimens reported by Nomura and Zinbo from Gabusoga, Okinawa, are from the same fossil zone. The Recent *Cyclostrema pulchella* Dunker, Recent from Japan, is closely related to this species, but it is smaller and does not have the spiral ridges as strongly developed. According to Kuroda and Habe (1952, p. 50) *C. pulchella* Dunker is a synonym of *P. micans* (A. Adams) (See (Hirase) Taki, 1951, pl. 131, figs. 1–2).

"*Delphinula reeviana*" Dickerson (1922, pl. 2, fig. 17) from the Miocene or Pliocene of the Phillippines may be closely related, but it appears to have a more deflected parietal callus.

Unidentified specimens of a species, probably *P. micans*, closely related to the one here described were taken by the Albatross expedition from Tawi Tawi, and by Byrant and Palmer from off Java.

Distribution: Pliocene, Nakoshi sand, Okinawa.

Localities: Nakoshi sand, 17483 (figured type), Gabusoga (figured by Nomura and Zinbo).

Comparative bathymetric data: Specimens from Tawi Tawi (*P. micans*) are recorded from depths of 10, 18, 43, and 68 fathoms.

Superfamily CERITHIACEA

Family TURRITELLIDAE

Genus TURRITELLA Lamarck 1799

Subgenus HAUSTATOR Montfort 1810

Type: *T. imbricataria* Lamarck.

Turritella filiola Yokoyama

Plate 1, figure 20; plate 11, figures 22–26

Turritella filiola Yokoyama, 1928, Imp. Geol, Sur. Japan Rept. 101, p. 57, pl. 4, fig. 7.

Nomura, 1935, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 2, p. 189.

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

Both Yokoyama and Nomura suggested close relationship of this species to *T. fascialis* Menke. It appears to be just as closely related to specimens labelled *T. cingulifera* Sowerby in the Hirase collection in the U.S. National Museum. *Turritella filiola*, particularly the form so identified from Okinawa, more closely resembles *T. fascialis* in the possession of three strong spirals, but more closely resembles *T. cingulifera* in the degree of beading of the spiral lines. Like *T. cingulifera*, it frequently displays a tendency for the whorls to become more rounded in adults whereas *T. fascialis* maintains the same degree of flatness throughout. Some specimens of *T. filiola* have stronger spiral lirations than either *T. fascialis* or *T. cingulifera.* The more rounded variant (fig. 26) has much the form of *T. terebra* Linné (Yokoyama 1928a, pl. 4, fig. 3) but the young stage of *T. terebra* does not have 3 prominent beaded spirals.

Beets (1950a, p. 330) states that in his opinion *T. filiola* is identical with *T. cingulifera* Sowerby and that as such it occurs in the Rembang beds of Java. The Rembang beds are considerably older (Burdigalian or Aquitanian?) than the beds in Formosa and Okinawa containing *T. filiola.*

Occurrence: Miocene, (Yonabaru clay member) Okinawa; Pliocene, (Byoritzu beds) Formosa, (Nakoshi sand, Chinen? sand, and Naha limestone) Okinawa.

Localities: Yonabaru clay member, 17449 (figured), (?) 17451; Nakoshi sand, 17440, 17483 (figured), Gabusoga (Nomura and Zinbo); Chinen sand, (?) 17442; Naha limestone, 17673.

Turritella aff. T. fascialis Menke

Plate 11, figure 28

?*Turritella fascialis* Menke, 1828, Synopsis methodica molluscorum, p. 83.

?Otuka, 1938, Venus, v. 8, no. 1, p. 38, unnumbered plate, fig. 5.

?*Turritella fascialis naganumensis* Otuka, 1938, Venus, v. 8, no. 1, p. 39, unnumbered plate, fig. 8.

The Hirase collection in the U.S. National Museum contains specimens that compare with Otuka's *T. naganumensis* as well as typical *T. fascialis* and it is doubtful whether the subspecific name is justified or has any stratigraphic significance.

It is possible that the Okinawan specimen is merely a variant of *T. filiola*, but of many specimens of the latter species from other localities, none closely resembles the one figured.

Distribution: Pliocene, (Chinen sand) Okinawa. Typical *T. fascialis:* Pliocene or Pleistocene, Japan; Recent (*T. fascialis*), western Pacific northward to central Japan.

Localities: Chinen sand, 17441 (figured).

Turritella aff. T. millepunctata Nomura

Plate 1, figure 24

?*Turritella millepunctata* Nomura, 1935, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 2, p. 191, pl. 9, fig. 44.

?Otuka, 1938, Venus, v. 8, no. 1, p. 41, unnumbered plate, fig. 15.

Diagrams of the whorls are given by Otuka but the specimen from Okinawa is too eroded for accurate comparison. It shows three prominent spirals, however, with the lowest stronger than the others and forming a prominent angulation near the base of the whorl. Remnants of longitudinal striae make a row of punctations between the spirals.

Distribution: Miocene, (Yonabaru clay member) Okinawa; Pliocene (*T. millepunctata*), (Byoritzu beds) Formosa.

Localities: Yonabaru clay member, 17503 (figured).

Turritella zinboi, n. sp.

Plate 11, figure 27

Shell small, spire narrow, whorls very gently rounded. Protoconch not present on specimens at hand. Aperture subquadrate. Suture only faintly incised on normal specimens, but on the holotype it is abnormally deep owing to an injury to an early whorl. Very young whorls strongly carinate near the base (seen on paratype only), this stage being followed by several whorls bearing three rather prominent spiral lirations, the lower liration corresponding to the single carination on the very young whorls. Adult sculpture consisting of numerous weak spiral lirations, the middle of the three primary lirations being slightly stronger than the rest, and the remainder being subequal in strength, the spirals arising as secondary and tertiary lirations between the original three lirations; the last whorl of the holotype (the 12th or 13th) larger than the rest and not conforming with the spire angle.

Holotype (USNM 562907) measures: height 16.4 mm, diameter 4.0 mm.
Paratype: (USNM 563089) not figured.
Type locality: Chinen sand, 17481.

This species may be related to *T. andenensis tsushimaensis* Kotaka (1951, pl. 11, figs. 7–9), Recent from Tsushima Strait west of Japan. The resemblance is mainly in the fine texture of the spirals, and the degree of convexity of the whorls. The aperture of *T. andenensis* is rounder than that of *T. zinboi* whose aperture has a strong basal angulation. Actually the relationship between these forms may be more apparent than real.

Distribution: Pliocene, (Chinen sand) Okinawa.
Localities: Chinen sand, 17481 (figured type).

Family MATHILDIDAE

Genus MATHILDA Semper 1865

Type: *Turbo quadricarinata* Brocchi.

Mathilda loochooensis, n. sp.

Plate 7, figure 18

Shell probably large for the genus, turritelliform, whorls rounded. Protoconch not known. Aperture rounded with a weak attenuation in the siphonal region. Outer lip thin. Inner lip thickened and reflected. Parietal wall very weakly callused. Umbilicus closed except for a pinhole chink. Sculpture made cancellate by spiral and axial lirations, both series sharp and well defined, the spirals about 5 in number on the young whorls with the middle 1 stronger and forming an angulation, becoming about 9 to 10 in number on the adult whorls by the development of interstitial lines of subequal strength, sometimes on adults 2 on the periphery are stronger than the others but they do not form a distinct angulation.

Holotype (USNM 562802) measures: height 14.4 mm, diameter 6 mm.
Type locality: Shinzato tuff member 17454.

This species is probably most closely related to *M. bonneti* Cossmann (1910, p. 45, pl. 2, figs. 22–23) from the Pliocene of Karakal, India, and also reported by Wissema (1947, p. 35, pl. 1, fig. 29) from the Pliocene of Nias. It differs from *M. bonneti* in having only one spiral larger than the others in the young stages and thus being unicarinate in the young stages, whereas *M. bonneti* has two spirals enlarged and is bicarinate.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa.
Localities: Shinzato tuff member, 17454 (figured type).

Family ARCHITECTONICIDAE

Genus CLIMACOPOMA P. Fischer 1885

Type: *Solarium patula* Lamarck.

Climacopoma serratomarginata, n. sp.

Plate 7, figures 17, 23, 27

Shell thickly discoidal, periphery sharply keeled and irregularly serrate. Protoconch not well preserved, but obviously depressed. Aperture subquadrate. Outer lip projected to form a sharp flange. Inner lip appressed. Umbilicus broad and parabolic. Sculpture consisting of raised fine spiral lines, somewhat irregular in coarseness and spacing, and made irregularly beaded by growth lines that cross the spirals as depressions; peripheral keel irregularly serrated or indented.

Holotype (USNM 562801) measures: height 4.8 mm, diameter 12 mm.
Type locality: Shinzato tuff member, 17454.

This species is very closely related to one described by Schepman (1909, p. 222, pl. 14, fig. 6) from the Banda Sea as *Torinia mirabilis*. An excellent specimen of *C. mirabilis* was obtained by the Albatross expedition from Linapacan Strait, south of Culion Island in the Philippines. No similar species has been reported from post-Eocene beds, but closely related forms are known from the Upper Cretaceous and from the Eocene of Europe, Africa, India, and North America.

Climacopoma serratomarginata differs from *C. mirabilis* in being less flattened, especially on the under side where the whorls are more inflated, and in having the sutures less tightly impressed. In the living species the serrations along the periphery of the whorls are pressed tightly against the next whorl, whereas in the Okinawan form they are looser and have been broken off without leaving any impression on the subsutural area. The growth line markings of the fossil are considerably stronger than on the living species.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa.
Localities: Shinzato tuff member, 17454 (figured type).
Comparative bathymetric data: The specimen in the Albatross collection from the Philippines was dredged from a depth of 46 fathoms. The type of *C. mirabilis* was obtained from a depth of 462 meters.

Genus ARCHITECTONICA (Bolten) Roeding 1799

Type: *Trochus perspectiva* Linné.

Architectonica perspectiva (Linné)

Plate 1, figures 18, 22, 26; plate 12, figures 1, 7, 11

Trochus perspectivus Linné, 1758, Systema naturae, ed. 10, p. 757.

Architectonica perspectiva. Nomura, 1935, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 2, p. 194, pl. 9, fig. 41.

Architectonica (Architectonica) perspectivum. Wissema, 1947, Young Tertiary and Quaternary Gastropoda from the Island of Nias, Doctor's thesis, Rijksuniversiteit Leiden, p. 35.

Architectonica perspectiva. (Hirase) Taki, 1951, Handbook of illustrated shells, pl. 128, fig. 7.

Both this species and *A. modesta* Philippi, which can be differentiated from it only by color, are characterized by having a single spiral sulcus below the suture, setting off only a single row of beads below the suture. It differs from *A. maxima* Philippi which is bisulcate below the suture, making a double row of subsutural beads.

There is some variation in the height of shells referred to this species, some being flatter with a more rounded base, whereas others are more domed with a flatter or even slightly concave base. The peripheral spirals are apt to be subequal in extension on the more domed individuals, whereas the lower of the two peripheral spirals is more extended on the flattened individuals. On both types a third spiral is located close to the periphery on the base. These two types and all intermediates appear to exist in Recent populations.

Fossils from the Nakoshi sand, Chinen sand and Naha limestone are low spired with the lower peripheral spiral extended. The specimen from the Yonabaru clay member of the Shimajiri formation is high spired with subequal peripheral spirals, and a slightly concave base.

Distribution: Miocene, Java, Fiji, Assam, northwest India, Sumatra, (Yonabaru clay member) Okinawa; Pliocene, Java, Sumatra, Timor, New Guinea, (Konomine formation) Japan, (Byoritzu beds) Formosa, (Nakoshi sand and Chinen sand) Okinawa; Pliocene or Pleistocene, Nias; Pleistocene, Tanganyika, French Somaliland, Red Sea, Java, Timor, Kikaiga-shima; Recent, Indo-Pacific region.

Localities: Yonabaru clay member 17449 (figured), 17679; Nakoshi sand, 17440 (figured); Chinen sand, 17441, 17442; Naha limestone, 17610.

Architectonica maxima (Philippi)

Plate 1, figures 17, 21, 25

Solarium maximum Philippi, 1849, Zeitschrift für Malakozoologie, 1848, no. 11, p. 170.

Solarium perspectivum. Yokoyama, 1928, Imp. Geol. Sur. Japan Rept. 101, p. 62, pl. 5, fig. 7.

Architectonica maxima. Nomura, 1935, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 2, p. 194, pl. 9, fig. 40.

Architectonica (Architectonica) maxima. Wissema, 1947, Young Tertiary and Quaternary Gastropoda from the Island of Nias, Doctor's thesis, Rijksuniversiteit Leiden, p. 37.

Apparently the same range of variation exists for this species as for *A. perspectiva*. The specimen figured by Yokoyama is a high, bicarinate form, whereas the specimen here figured is a low form with the lower of the peripheral spirals more extended than the upper. The occurrence of identical varietal series in both named species might be reason for questioning the validity of the single or double sulcus below the suture as a specific character. Specimens collected by the Albatross from the Philippines, however, seem to contain all of either the unisulcate or the bisulcate type in different hauls.

Distribution: Oligocene(?), Burma; Miocene, Burma, northwest India, Java, (Yonabaru clay member) Okinawa; Miocene or Pliocene, (Vigo group) Philippines: Pliocene, Java, Sumatra, Ceram, Papua, Timor, (Karikal) India, (Byoritzu beds) Formosa, (Chinen sand) Okinawa; Pleistocene, Java, ("Ryukyu limestone") Formosa; Recent, Indo-Pacific region.

Localities: Yonabaru clay member, 17445, 17503 (figured), 17679; Chinen sand, 17441, 17442.

Subgenus SOLARIAXIS Dall 1892

Type: *Solarium elaborata* Conrad.

Architectonica (Solariaxis) nomurai, n. sp.

Plate 1, figures 19, 23, 27

Shell medium small, lenticular, top regularly domed, periphery bluntly keeled, base slightly concave adjacent to periphery, slightly convex adjacent to umbilicus. Protoconch consisting of about 1½ rapidly expanding smooth whorls, slightly involute. Aperture subquadrate. Outer lip thickest at the peripheral keel. Parietal wall thinly callussed. Umbilicus rather steep sided with a slightly overhanging beaded rim, and a single sharp thin thread along the umbilical wall. Sculpture on top consisting of small, subequal weakly beaded spirals, about seven in number, the periphery similarly beaded, the base bearing smaller more weakly beaded spirals increasing in strength towards the umbilicus, and at the umbilical rim a broad currugated band, which is not set off by a revolving sulcus.

Holotype (USNM 562656) measures: height 6.8 mm, diameter 14.5 mm.

Type locality: Yonabaru clay member, 17451.

This species is related to *S. dilecta* (Deshayes), a Recent species that was reported by Nomura and Zinbo (1934, p. 144) from the "Ryukyu limestone" of Kikaiga-shima. It differs from *S. dilecta*, however, in having a more flattened base, weaker basal spirals, and less indented sutures.

This species is closely related to the form described by Yokoyama (1920) as *Solarium lenticulatum* (See *Architectonica* (*Solariaxis*) *lenticulatum*, Taki and Oyama, 1954, pl. 5, fig. 21a–b), differing from it in having a flatter base and a sharper peripheral keel.

Distribution: Miocene, (Yonabaru clay member) Okinawa.
Localities: Yonabaru clay member, 17451 (figured type).

Architectonica (Solariaxis) aff. A. nomurai MacNeil

Plate 7, figures 16, 22, 26

A specimen from the Shinzato tuff member of the Shimajiri formation differs in several respects from the specimen described above from the Yonabaru clay member. It appears to have a more inflated base with a sharper peripheral keel which lacks the peripheral beads found in *A. nomurai*. The umbilicus is narrower and does not expand so rapidly with growth.

Although the above differences seem to be fairly well defined, the specimen is, nevertheless, pathologic, having suffered a severe injury at about the first quarter of the last whorl and the normal sculpture was not resumed. The characters listed are those of the whorls preceding the injury. Since these are young whorls, however, the individual is not mature enough for adequate description.

This form is more like *A.* (*S.*) *lenticulatum* (Yokoyama) (1920, pl. 4, fig. 21) from the Koshiba formation (lower Pliocene) of Japan than is typical *A. nomurai* from the Yonabaru clay member and it may be identical.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa.
Localities: Shinzato tuff member, 17454 (figured).

Architectonica (Solariaxis) dilecta (Deshayes)

Plate 1, figures 13–15

Solarium dilectum Deshayes, 1863, Catalogue mollusques l'île de la Réunion, p. 68, pl. 9, fig. 3–6.
Heliacus dilectus. Nomura and Zinbo, 1934, Tōhoku Imp. Univ. Sci. Repts., v. 16, no. 2, p. 144, pl. 5, figs. 35a, b.

The species here figured from the Yonabaru clay member of the Shimajiri formation of Okinawa appears to be identical with the form from the "Ryukyu limestone" of Kikaiga-shima figured by Nomura and Zinbo. It is certainly very closely related to typical *A. dilecta* from Reunion Island, but only a drawing of the Recent species is available.

Distribution: Miocene, (Yonabaru clay member) Okinawa; Pliocene(?) ("Ryukyu limestone") Kikaiga-shima; Recent, Reunion (Bourbon) Island.
Localities: Yonabaru clay member, 17679 (figured).

Family POTAMIDIAE

Subfamily POTAMIDINAE

Genus CERITHIDEA Swainson 1840

Type: *Melania lineolata* Griffith and Pidgeon (=*Murex decollata* Linné).

Cerithidea rhizoporarum A. Adams

Plate 18, figure 26

Cerithidea rhizoporarum A. Adams, 1854, Proc. Zool. Soc. London, Pt. 22, p. 85.
(Hirase) Taki, 1951, Handbook of illustrated shells, pl. 84, fig. 7.

Found in the Yontan limestone. No good specimens obtained, but not distinct from the Recent species in any respects observed.

Distribution: Pleistocene, (Yontan limestone) Okinawa; Recent, Borneo, Philippines and Japan.
Localities: Yontan limestone, 17550u (figured).
Comparative bathymetric data: This species is an estuarine form, taking its name from the mangrove, *Rhizophora*, on whose roots it lives.

Subfamily BATILLARIINAE

Genus BATILLARIA Benson 1842

Type: *Cerithium zonalis* Bruguière.

Batillaria aff. B. zonalis (Bruguière)

Plate 16, figure 25; plate 18, figure 13

?*Cerithium zonale* Bruguière, 1792, Encyclopédie méthodique, v. 1, p. 497.
?*Batillaria zonalis*. Nomura, 1935, Tohoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 2, p. 186, pl. 9, fig. 17.

Batillaria zonalis (See (Hirase) Taki, 1951, pl. 84, fig. 14) is a very variable species. In addition to the diversity shown by the series commonly referred to this species, Pilsbry suggested that *B. cumingi* (Crosse), *B. multiformis* (Lischke), and *B. aterrima* (Dunker) should all be considered varieties of it. In addition, Nomura suggested that *B. australis* (Quoy and Gaimard) is the same.

The specimens obtained from Okinawa are poorly preserved. Two strong spirals are present on the lower part of the whorls at about the latitude of the anal canal. The same is true of some specimens from the Byoritzu beds, but it is not common in the Recent species. Nomura stated that the Byoritzu form was identical with a certain living varietal form. A large number of specimens from the Byoritzu beds are in the Hayasaka collection, but I find no Recent specimens that are identical with them. The axials are consistently stronger on the Byoritzu specimens, and they tend to be more raised just below the suture than on

Recent specimens. Possibly two or more species are involved here.

Distribution: Pliocene, (?Byoritzu beds) Formosa, (Naha limestone) Okinawa; Pleistocene, (Yontan limestone) Okinawa; Recent (*B. zonalis*) Australia to Japan.

Localities: Naha limestone, 17673 (figured); Yontan limestone, 17550 U (figured).

Comparative bathymetric data: The Recent species has been collected from harbors and reefs.

Genus ZEACUMANTUS Finlay 1926

Type: *Cerithidea subcarinata* Sowerby.

Zeacumantus sp. ind.

Plate 12, figure 4; plate 16, figure 29; plate 18, figures 20, 21, 30

Poorly preserved fragments of a large cerithid that appears to be a *Zeacumantus* were obtained from both the Naha and Yontan limestones. They are related to *Z. lutulentus* (Kiener) but are larger and have less prominent axial ribs. The Okinawan form has a slight to moderately pronounced median spiral depression. Weak axial ribs extend both above and below the sulcus, but they die out at the sulcus as if they were smoothed out by a string drawn tight along this line. The upper extension of the axials is shorter and stronger than the lower extension.

The U.S. National Museum Collection contains another living species that may be even closer to the Okinawan form than *Z. lutulentus*, but its locality is not known.

Distribution: Pliocene, (Chinen sand and Naha limestone) Okinawa; Pleistocene, (Yontan limestone) Okinawa.

Localities: Chinen sand, 17441 (figured), Naha limestone, 17474 (figured); Yontan limestone, 17593, 17658 (figured).

Family CERITHIIDAE

Subfamily CERITHIINAE

Genus ARGYROPEZA Melvill and Standen 1901

Type: *A. divina* Melvill and Standen.

Argyropeza cf. A. divina Melvill and Standen

Plate 11, figure 19

?*Argyropeza divina* Melvill and Standen, 1901. Proc. Zool. Soc. London, June, p. 372, pl. 21, fig. 3.

?Melvill, 1912, Proc. Malacological Soc., v. 10, pt. 3, p. 246. pl. 12, fig. 10.

?Schepman, 1909, Resultats Siboga Expeditie, Mon. 49–1, p. 169.

This species was described from the Persian Gulf and reported by Schepman from Molucca Passage and Sumbawa. It is very abundant in the Albatross collections from the Philippines. The Okinawan fossils do not appear to be separable from the living species.

Argyropeza izekiana Kuroda (1949, p. 76), the only species living in Japanese waters, is distinguished from *A. divina* by having stronger tubercles with the top or anterior row much closer to the suture. It also appears to be more inflated. It was collected from a depth of 100 fathoms.

Distribution: Pliocene, (Chinen sand) Okinawa; Recent, Persian Gulf to the Philippines.

Localities: Chinen sand, 17481 (figured).

Comparative bathymetric data: Gulf of Oman, 156 fathoms; Molucca Passage, 397 meters; Sumbawa, 274 meters; Philippines, many localities, mostly between 150 and 300 fathoms.

Argyropeza cf. A. schepmaniana Melvill

Plate 2, figure 1

?*Argyropeza schepmaniana* Melvill, 1912, Proc. Malacological Soc., v. 10, pt. 3, p. 246, pl. 12, fig. 11.

The difference between this species and *A. divina* lies in the possession of three rows of acute nodules by this species and two rows of nodules by *A. divina*. According to Melvill *A. divina* is gregarious whereas *A. schepmaniana* is solitary and rare. It is certainly true that where *A. divina* occurs it is present in great numbers. *Argyropeza* cf. *A. schepmaniana* is known from Okinawa by a single specimen, and it did not occur in association with *A. divina* as far as is known.

Distribution: Miocene, (Yonabaru clay member) Okinawa; Recent, Gulf of Oman.

Localities: Yonabaru clay member, 17447 (figured).

Comparative bathymetric data: The type of this species was obtained from a depth of 40 fathoms.

Genus CERITHIUM Bruguière 1789

Type: *Cerithium virgatum* Montfort (=*Murex vertagus* Linné).

The status of the genus *Cerithium* has been a subject of discussion for years. Not only has there been a lack of agreement on the type designation, but there were unfortunate and unsatisfactory circumstances attending each of the alternatives. Until the names of Martyn were disregarded, *Cerithium*, by virtue of Montfort's designation, was in danger of becoming a synonym of *Clava* Martyn. Rather than have this happen, and apparently purely as a matter of expedience, various authors, following the lead of Vignal (1910), attempted to fix the type designation on *C. adansonii* Bruguière, "Le Cerite" of Adanson, construing it to be the type by indirect virtual tautonymy. Until the recent discovery of Adanson's collection this was an unsatisfactory alternative because of the uncertainty as to the identity of Adanson's species, but now that it has been determined definitely as *C. erythraeonense* Lamarck that difficulty is removed. In all probability, if the name *Cerithium* had not been threatened, this strained concept of tautonymy would never have been introduced. With the elimination of Martyn's names, "*Cerithium*" is no longer in jeopardy, and if the first available direct type designation is used, the effect is merely to transfer the name from one large cerithid to another, the group generally known as *Clava*, becoming typical *Cerithium.*

It could be argued that if *C. adansonii* is acceptable as the type in one circumstance it is correct for all. Several recent authors, including Cox (1939), and Grant and Gale (1931), have declined to accept it as a tautonymic type, however. Cox chose to ignore it, whereas Grant and Gale believed that it was untenable unless special action was taken in favor of it by the International Commission on Zoological Nomenclature. In anticipation of such a move they accepted *C. adansonii* as the type, but so far the move has not been instigated.

I feel that inasmuch as the name *Cerithium* is no longer in danger, and that as an alternate to type by indirect virtual tautonymy there is an early direct type designation, that the need for special action by the Commission no longer exists.

Cerithium cf. C. vertagus (Linné)

Plate 16, figure 22

?*Murex vertagus* Linné, 1767, Systema naturae, ed. 12, p. 1225.
?*Clava vertagus.* Hatai 1941, Tropical Industry Inst. Palau Bull. 7A, p. 95, pl. 2, figs. 11, 12.
?*Cerithium vertagus.* (Hirase) Taki, 1951, Handbook of illustrated shells, pl. 83, fig. 2.

A single partial specimen was obtained that appears to be this species. It is a little larger than any Recent specimens in the U.S. National Museum, however.

Distribution: Pliocene, (Naha limestone) Okinawa; Recent, Indo-Pacific region, northward to the Ryukyu Islands.

Localities: Naha limestone, 17473 (figured), 17608.

Comparative bathymetric data: Shallow water, bays and reefs.

Cerithium asperum (Linné)

Plate 18, figure 27

Murex asper Linné, 1758, Systema naturae, ed. 10, p. 756.
Cerithium asperum. (Hirase) Taki, 1951, Handbook of illustrated shells, pl. 83, fig. 1.

A specimen obtained from the Yontan limestone is apparently identical with the Recent species.

Distribution: Pleistocene, (Yontan limestone) Okinawa; Recent, Indian Ocean, Philippines, northward to the Ryukyu Islands.

Localities: Yontan limestone, 17652 (figured).

Comparative bathymetric data: Shallow water and reefs.

Subgenus PROCLAVA Thiele 1929

Type: *Cerithium pfefferi* Dunker (=*C. turritum* Sowerby)

Cerithium (Proclava) turritum Sowerby

Plate 12, figure 3

Cerithium turritum Sowerby, 1855, Thesaurus conchyliorum, *Cerithium*, p. 860, sp. 47, pl. 158, fig. 101.
Vertagus pfefferi Dunker, 1882, Molluscorum Maris Japonici, p. 108, pl. 4, figs. 12–14.
Cerithium turritum. Tryon, 1887, Manual of conchology, v. 9, p. 147, pl. 28, figs. 55, 56.
Cerithium pfefferi. Nomura and Zinbo, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 3, p. 260, pl. 11, fig. 28.
Altena, 1941, Leidse Geologische Mededelingen, v. 12, pt. 1, p. 18.
Clava (Proclava) pfefferi. Wissema, 1947, Young Tertiary and Quaternary Gastropoda from the Island of Nias, Doctor's thesis, Rijksuniversiteit Leiden, p. 50.
Cerithium pfefferi. (Hirase) Taki, 1951, Handbook of illustrated shells, pl. 83, fig. 6.

Presumably some recent authors do not accept the synonymy of *C. pfefferi* and *C. turritum* Sowerby, but there is no discussion of their views in the papers cited. If the two species should prove to be distinct, *C. pfefferi* Dunker is the proper assignment for the Okinawan species. At least Kuroda and Habe (1952, p. 45) regard *C. turritum* Tryon as conspecific with *C. pfefferi.*

Distribution: Pliocene, (Nakoshi sand) Okinawa; Pleistocene, Java; "raised beaches", (Bōsō Peninsula) Japan; Recent, Philippines to Japan.

Localities: Nakoshi sand, 17483 (figured), Gabusoga (Nomura and Zinbo). Nakoshi (=17440) (Nomura and Zimbo).

Cerithium (Proclava) kobelti Dunker

Plate 11, figure 21

Cerithium kobelti Dunker, 1877, Malakozoologische Blätter, v. 24, p. 67; 1882, Molluscorum Maris Japonici, p. 106, pl. 4, figs. 8, 9.
Yokoyama, 1920, Tokyo Imp. Univ. College Sci. Jour., v. 39, art. 6, p. 66, pl. 4, fig. 10.
Contumax kobelti. (Hirase) Taki, 1951, Handbook of illustrated shells, pl. 83, fig. 11.
Kuroda and Habe, 1952, Recent marine Mollusca of Japan, p. 48.
Thericium kobelti. Taki and Oyama, 1954, Paleont. Soc. Japan Spec. Paper 2, pl. 5, fig. 10.

Yokoyama reported this species from the Yokosuka zone of his "lower Musashino". The name "Yokosuka" does not appear to have been used by other writers. Hatai and Nisiyama (1952) do not mention it under the Tertiary stratigraphic terms nor do they list any of Yokoyama's "Yokosuka" species. Inasmuch as Hatai and Nisiyama did not include the Pleistocene in their compilation, it is presumed they regarded the "Yokosuka" as being of Pleistocene age.

Distribution: Pliocene, (Chinen sand and Nakoshi sand) Okinawa; (?) Pleistocene, (Otsu, Miura Peninsula) Japan; Recent, northern Ryukyu Islands and southern Japan.

Localities: Chinen sand, 17495 (figured); Nakoshi sand, 17483.

Subgenus THERICIUM Monterosato 1890

Type: *Cerithium vulgatum* Bruguière.

Cerithium (Thericium) echinatum Lamarck

Plate 18, figure 28

Cerithium echinatum Lamarck, 1822, Animaux sans vertèbres, v. 7, p. 68.

Cerithium echinatum. Tesch, 1920, Paläontologie von Timor, pt. 2, no. 14, p. 52, pl. 130, figs. 173a, b.

Contumax echinatus. Kuroda and Habe, 1952, Recent marine Mollusca of Japan, p. 48.

A single specimen referable to this species resembles the less tuberculate variety of the Recent form. It is very similar to the form figured by Tesch from Timor.

Distribution: Pliocene or Pleistocene, Timor; Pleistocene, (Yontan limestone) Okinawa; Recent, Indonesia, southwest Pacific northward to Shikoku, Japan.

Localities: Yontan limestone, 17545, 17644b (figured).

Subfamily CAMPANILINAE

Genus TROCHOCERITHIUM Cossmann and Sacco 1896

Type: *Trochus turritum* Bonelli.

Trochocerithium is by far the most likely genus to include the following species so far proposed, but they may require a new name. Beets (1950b, pp. 342–348) reviewed the genus *Trochocerithium* and included *Cerithiopsis? shikoensis* Yokoyama in it. He did not mention the Recent *Echinella* (?) *tectiformis* Watson which Kuroda and Habe (1952, p. 92) assign to *Trochocerithium* tentatively, and he excluded *Cerithium excelsum* Yokoyama from it, suggesting that the latter may belong to *Hemicerithium* Cossman. I feel that if *C. excelsum* is not a typical *Trochocerithium* it can hardly be more than subgenerically removed from it. There seem to be all gradations between specimens with a nearly median peripheral keel and specimens with the keel close to the anterior suture.

Trochocerithium aff. T. shikoensis (Yokoyama)

Plate 7, figure 20

?*Cerithiopsis shikoensis* Yokoyama, 1928, Imp. Geol. Survey Japan Rept. 101, p. 55, pl. 4, fig. 10.

?*Trochocerithium shikoense*. Nomura, 1935, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 2, p. 183.

The Okinawan form appears to have a wider apical angle and the peripheral keel may be stronger and farther removed from the anterior suture than in the form from the Byoritzu beds of Formosa. However, both appear to have equally deeply channeled sutures. *Echinella* (?) *tectiformis* Watson, a living Japanese species is certainly congeneric as well as very close specifically. *E. tectiformis* is represented by several excellent specimens in the Albatross collections from around Japan. The living species grows larger, has its periphery closer to the lower suture, and has fine spiral lines all over but the apertural and columellar characters are nearly identical.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa; Pliocene (*T. shikoensis*), (Byoritzu beds) Formosa.

Localities: Shinzato tuff member, 17454 (figured).

Comparative bathymetric data: *Trochocerithium tectiformis* Watson was reported to have been obtained by the Challenger at a depth of 565 fathoms. The species was obtained by the Albatross from depths of 94, 153, 197, 244, 258, 282, 302, and 400 fathoms.

Trochocerithium sp.

Plate 6, figure 28

A spire fragment of 8 whorls that agrees with the preceding in all respects except that it has about 8 or 9 fine spiral lines distributed over its surface, 4 above and 4 to 5 below the periphery, may be merely a variety of the smoother type. The greatest diameter of the fragment is 4 mm.

Occurrence: Shinzato tuff member, 17453.

Trochocerithium cf. T. excelsum (Yokoyama)

Plate 2, figure 2

?*Cerithium excelsum* Yokoyama, 1928, Tokyo Imp. Univ. Fac. Sci. Jour., sec. 2, v. 2, pt. 7, p. 346, pl. 67, fig. 8.

This species differs from the preceding in having a flatter base, a stronger angulation at the base of the whorl marking the edge of the base, and in having stronger and fewer peripheral nodes. *Trochocerithium excelsum* was described as having 5 equally distributed spiral lirae on each whorl. The Okinawan form does not agree with this description, having about 25 fine spiral lines evenly distributed over the surface, but aside from this agrees closely with the figures of the type specimen given by Yokoyama.

Distribution: Miocene, (Yonabaru clay member) Okinawa; Pliocene, (Kōunji formation) Japan.

Localities: Yonabaru clay member, 17445 (figured).

Family CERITHIOPSIDAE

Genus CERITHIOPSIS Forbes and Hanley 1849

Type: *Murex tubercularis* Montagu.

Subgenus ALIPTA Finlay 1927

Type: *Cerithiopsis crenistria* Suter.

The species described herewith is tentatively assigned to this subgenus. The Okinawan species does not have its inner lip detached and undulate as suggested by Wenz's figure. Suter's figure does not suggest the same type of canal as Wenz's figure. However, Wenz's figure, which he says is after Suter, is retouched and may be incorrect. The Okinawan specimen is not an adult, however, and a different type of aperture might characterize the adult stage. Schepmann's figure of "*Argyropeza*" *melvilli*, if an *Alipta*, as I believe, may be the best available figure of the aperture of *Alipta*.

Cerithiopsis (Alipta) premelvilli, n. sp.

Plate 7, figure 31

Shell small, moderately slender, whorls flattened with two rows of weak nodes. Protoconch unknown. Aperture subquadrate. Outer lip thin and rounded, subangulate at the base of the whorl, concave along the basal portion and extending to a small siphonal notch that is deflected away from the aperture. Columella above the notch slightly twisted with no indication of detachment of the inner lip. Sculpture consisting of two rows of low rounded nodes, arranged in axial rows along the spire, and with the nodes at the same stage of each whorl connected by a weaker axial ridge that often is nearly obsolete midway between the two rows. Base of whorls marked by a well defined but narrow spiral thread.

Holotype (USNM 562809) measures: height 6 mm, diameter 2 mm.

Type locality: Shinzato tuff member, 17452.

This species is closely related to *Argyropeza melvilli* Schepman from the Sulu Sea. Schepman acknowledged that his species has a different aperture and nucleus from those described for *Argyropeza*, and that its assignment to that genus is dubious. It certainly appears to be congeneric with the Okinawan species, which, as stated under the subgenus, is only tentatively assigned to *Alipta*.

Cerithiopsis premelvilli differs from *C. melvilli* in being more slender and in having the nodes arranged in axial rows, whereas in *C. melvilli* the nodes are staggered.

Cerithiopsis nodosocostatus Yokoyama (1922, p. 73, pl. 3, fig. 14) from the "Upper Musashino" (Pleistocene) of Japan is very closely related and appears to differ mainly in having more closely spaced axials. Taki and Oyama (1954, pl. 23, fig. 14) regarded this species as a synonym of *Myurella* (*Pervicacia*) *latisulcata* Yokoyama, a terebrid.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa.

Localities: Shinzato tuff member, 17452 (figured).

Comparative bathymetric data: *C. melvilli* was obtained from a depth of 535 meters.

Family TRIPHORIDAE

Genus TRIPHORA Blainville 1826

Type: *Triphora geminata* Blainville.

The Okinawan species probably are not typical *Triphora*. The new species here described may properly belong to the subgenus *Notosinister* Finlay (Type: *T. fascelina* Suter). Means for distinguishing the named subgenera of *Triphora* from each other has not been properly clarified to date, however. Probably some of the names proposed are synonyms, while other valid groups have not been delimited.

Triphora aff. T. dolicha (Watson)

Plate 7, figure 30

?*Triforis dolicha* Watson, 1886, Voyage H.M.S. *Challenger*, Zoology, v. 15, p. 565, pl. 42, fig. 1.

A small imperfect *Triphora* is certainly closely related to *T. dolicha*. Watson's figure shows his species to have three rows of beaded spirals with the beads of the center row narrow and spirally elongate. The Albatross Collection from the Philippines contains many specimens that range from the typical *dolicha* type to forms in which the middle row of beads is only slightly smaller than the upper and lower row and the beads are papillate or rounded. If this series is all one species, the Okinawan form is only a variety of *T. dolicha*.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa; Recent (*T. dolicha*), north Australia and Indo-Pacific region.

Localities: Shinzato tuff member, 17453 (figured).

Triphora aff. T. micans (Hinds)

Plate 12, figure 2

?*Triforis micans* Hinds, 1843, Annals and Mag. Nat. Hist., v. 11, p. 18.

The last three whorls of a single specimen is all that was obtained of this species. It is closely related to if not identical with the Recent species.

Distribution: Pliocene, (Shinzato tuff member) Okinawa; Recent (*T. micans*), New Guinea, Philippines and (?) Japan.

Localities: Shinzato tuff member, 17458 (figured).

Superfamily EPITONIACEA

Family EPITONIDAE

Genus TURRISCALA DeBoury 1890

Type: *Turbo torulosa* Brocchi.

Subgenus CLAVISCALA DeBoury 1909

Type: *Scala richardi* Dautzenberg and DeBoury.

Turriscala (Claviscala) shimajiriensis, n. sp.

Plate 2, figure 3

Shell slender and of medium size, whorls rounded with an intervening weak subsutural band. Protoconch unknown. Aperture of type broken but apparently round. Outer lip thin. Inner lip firmly attached to parietal wall and forming a very weak umbilical chink where it becomes detached below. Sculpture consisting of axial riblets, vertical or slightly retractive, about 8 visible from an angle, extending from the suture below to the subsutural depression above but not crossing it; about 6 to 8 spiral raised lirations present on each whorl and in the interspaces between them minute lamella-like raised growth lines are usually present. Basal disk weakly developed and partly crossed by axial ribs, spiral lirations all over the disk.

Holotype (USNM 562661) measures: height 15 mm, diameter 4 mm.

Type locality: Yonabaru clay member, 17451.

There seems to be no closely related species described from the western Pacific region. A species collected by the Albatross from the Philippines is more like the fragment listed next.

Distribution: Miocene, (Yonabaru clay member) Okinawa.
Localities: Yonabaru clay member, 17451 (figured type).

Turriscala (Claviscala) sp. ind.

Plate 7, figure 21

A specimen represented by only two whorls is sufficiently distinct from the preceding to substantiate the presence of another species. It compares with a species collected by the Albatross from off Luzon. It differs from *T. shimajiriensis* in having fewer and coarser spiral lines, which moreover are impressed lines rather than raised lines. The surface is polished and lacks the microlamellae of *T. shimajiriensis.*

Occurrence: Shinzato tuff member, 17454 (figured).

Comparative bathymetric data: The Recent and apparently undescribed species from the Phillippines was obtained from a depth of 280 fathoms.

Genus AMAEA H. and A. Adams 1853

Type: *Scalaria magnifica* Sowerby.

Subgenus DISCOSCALA Sacco 1890

Type: *Scalaria scaberrima* Michelotti.

Amaea (Discoscala) aff. A. (D.) niasensis Wissema

Plate 2, figures 4, 9

?*Amaea* (*Discoscala*) *niasensis* Wissema, 1947, Young Tertiary and Quaternary Gastropoda from the Island of Nias, Doctor's thesis, Rijksuniversiteit Leiden, p. 76, pl. 3, figs. 88, 89.

The Okinawan form is very closely related to the Nias species, and may be identical. Wissema compared his species with *A. verbeeki* (Tesch) from Timor and found it to have fewer and coarser varices than the Timor form. *Amaea ojiensis* (Yokoyama) (see Taki and Oyama, 1954, pl. 44, fig. 3) is related but not very closely. It has more numerous varices, and they are considerably more inclined than on the Okinawan form.

Distribution: Miocene, (Yonabaru clay member) Okinawa.
Localities: Yonabaru clay member, 17451 (figured).

Genus EPITONIUM Bolten (Roeding) 1798

Type: *Turbo scalaris* Linné.

Epitonium scalare (Linné)

Plate 12, figure 6

Turbo scalaris Linné, 1758, Systema naturae, ed. 10, p. 764.

Scalaria pretiosa Lamarck, 1819, Animaux sans vertèbres, v. 6, pt. 2, p. 225.

Reeve, 1874, Conchologia iconica, v. 19, *Scalaria*, pl. 1, fig. 4.

?*Epitonium tokyoense* Kuroda, 1930, Venus, v. 2, no. 1, pl. 3, text fig. 2.

Epitonium scalare. (Hirase) Taki, 1951, Handbook of illustrated shells, pl. 99, fig. 5.

Specimens of this species were found in the Nakoshi sand and the Naha limestone. The largest, a fragment, is below middle size for the species (about 20 mm diameter) and the other two are small. The species appears not to have been reported fossil.

Distribution: Pliocene, (Nakoshi sand and Naha limestone) Okinawa; Recent, Australia to Japan.
Localities: Nakoshi sand, 17483 (figured); Naha limestone, 17460, 17498L.

Comparative bathymetric data: Said to come ashore at unusual tides, but not characteristically a near-shore species.

Subgenus CRISPOSCALA De Boury 1886

Type: *Scalaria crispa* Lamarck.

The single species here referred to this subgenus appears to be another of the relicts found in the Far East. It seems to be most closely related to some of the Paris Basin Eocene species of this subgenus, particularly *Crisposcala johannae* De Boury from the Calcaire grossier.

Epitonium (Crisposcala) okinavensis, n. sp.

Plate 2, figure 5; plate 11, figures 18, 20

Shell of medium size, inflated, whorls rounded but with a strong flare of the varices below the suture making a sharp shoulder along the varices. Protoconch unknown. Aperture rounded. Lip thickened and flaring, forming a short flattened plate at the siphonal fasciolar region and another bluntly pointed area at the point of the varical flare. Umbilical chink prominent. Siphonal fasciole well formed and crossed by tightly packed extensions of the growth varices. Whorls sculptured by spiral lirae which in turn are sculptured by numerous much finer spiral lines, varices of irregular thickness and spacing, and consisting of several closely packed frilled lamellae which on some whorls, especially on the early ones, converge to form a single sharp edge at the subsutural flare; a stronger spiral line near the point of contact of the whorls with the top of the aperture marks the edge of a weak basal plate, but there is no noticeable attenuation of the varices at this point.

Holotype (USNM 562899) measures: height 26.5 mm, diameter 16 mm.

Type locality: Chinen sand, 17480.

I find no close relative of this species from the area, either fossil or living, unless *E. yamakawai* (Yokoyama) (1922, pl. 4, fig. 17) can be so regarded. Takai and Oyama (1954, pl. 24, fig. 14) referred this species to the subgenus *Cinctiscala*. It appears to differ from *E. yamakawai* in having more numerous varices, and in having a broad plate-like expansion of the lip at the position of the siphonal fasciole, successive positions of which are responsible for the fasciole. The Recent *E. denticulata* (Sowerby) may be related but specimens and accurate figures of the latter are not available. The latter species is the type of *Decussiscala* De Boury. *Crisposcala flexilamella* De Boury, Recent from an unknown locality, also appears related.

Distribution: Miocene, (Yonabaru clay member) Okinawa; Pliocene, (Chinen sand) Okinawa.

Localities: Yonabaru clay member, 17451 (figured); Chinen sand, 17480 (figured type).

Comparative bathymetric data: The type locality of this species yielded only three other species, among them a spiny rhynconellid brachiopod of the type known only in water over 150 fathoms depth.

Subgenus GLABRISCALA De Boury 1909

Type: *Scalaria glabrata* Hinds.

Epitonium (Glabriscala) submaculosum, n. sp.

Plate 16, figure 31

Shell of medium size, medium inflated, whorls rounded. Protoconch unkown. Aperture subrounded, lip rounded and reflected all around, somewhat more so in the siphonal area. Surface smooth and polished with moderately strong recurved varices, about 7 to 8 visible from an angle, thinner and somewhat more flaring below the suture.

Holotype (USNM 563019) measures: diameter 9.3 millimeters.

Type locality: Nakoshi sand, 17600.

This species is closely related to *E. maculosa* (Adams and Reeve) (1850, p. 51), differing from it mainly in having somewhat stronger varices and a greater flare on the varices below the suture. The larger varices make the suture of this species more open than in *E. maculosa*, and the apertural lip is farther removed from the parietal wall. This species could well be the direct ancestor of *E. maculosa*.

Yokoyama (1922, p. 86, pl. 4, fig. 14) identified a very closely related form from the lower Pleistocene of Otake, Japan, as *Scalaria maculosa*. Taki and Oyama (1954), pl. 24, fig. 14) reidentified it as *Epitonium* (*Glabriscala*) *stigmaticum* (Pilsbry).

Distribution: Pliocene, (Nakoshi sand) Okinawa.

Localities: Nakoshi sand, 17600 (figured type).

Superfamily PYRAMIDELLACEA

Family MELANELLIDAE

Genus NISO Risso 1826

Type: *Niso eburnea* Risso.

Niso aff. N. yokoyamai Kuroda and Habe

Plate 7, figure 19; plate 12, figure 8

?*Niso interrupta*. Yokoyama, 1926, Tokyo Imp. Univ. Fac. Sci. Jour., sec. 2, v. 1, pt. 9, p. 367, pl. 42, fig. 8.

?*Niso yokoyamai* Kuroda and Habe, 1952, Recent marine Mollusca of Japan, p. 72.

Two incomplete *Niso* are related to if not conspecific with the form reported by Yokoyama from the Konomine formation (Pliocene) of Tonohama, Shikoku, Japan. *Niso interrupta* Sowerby is a Central American species. Kuroda and Habe, who renamed Yokoyama's species, believe it still lives in waters off Shikoku and southern Honshu, Japan.

Distribution: Upper Miocene or Pliocene, (Shinzato tuff member) Okinawa; Pliocene, (Chinen sand) Okinawa; (*N. yokoyamai*) Recent, southern Japan)

Localities: Shinzato tuff member, 17677 (figured); Chinen sand, 17482–b (figured).

?Niso sp. ind.

Plate 16, figure 30

A poorly preserved melanellid was obtained from the Naha limestone. Its umbilical characters are not preserved and it could be a *Balcis* or *Eulima*.

Occurrence: Naha limestone 17518 (figured).

Family PYRAMIDELLIDAE

Genus ODOSTOMIA Fleming 1813

Type: *Turbo plicatus* Montagu.

Odostomia of this type have been referred to the subgenus *Amaura* Möller 1842 (Type: *Amaura candida* Möller). *Amaura* is preoccupied in the Lepidoptera, however, by *Amaura* (Geyer) Huebner 1837.

Odostomia cf. O. sasagensis Nomura

Plate 12, figure 9

?*Odostomia* (*Amaura*) *sasagensis* Nomura, 1939, Jubilee Publications Commemorating Prof. H. Habe's 60th Birthday, v. 1, p. 150, pl. 9, fig. 29.

The single specimen obtained appears to be very much like *O. sasagensis* in apertural characters. Nomura's figure suggests a slightly higher spire but this may be accounted for by the fact that it has at least one more whorl. *Odostomia kizakiensis* Yokoyama (1922, p. 97, pl. 4, fig. 29) from the "Upper Musashino" (Pleistocene) of Japan also appears to be related.

Distribution: Pliocene, (Chinen sand) Okinawa, (? Umegase formation) Japan.
Localities: Chinen sand, 17482–b (figured).

Genus TURBONILLA Risso 1826

Type: *Turbo lactea* Linné.

Subgenus LANCEA Pease 1868

Type: *T.* (*L.*) *elongata* Pease (=*peasi* Dall and Bartsch).

The subgenus *Lancella* Dall and Bartsch 1904 is a synonym. The name was proposed as a substitute for *Lancea* which was presumed to be a homonym of *Lancia.*

Turbonilla (Lancea) cf. T. (L.) varicosa (A. Adams)

Plate 12, figure 5

?*Chemnitzia varicosa* A. Adams, 1853, Proc. Zool. Soc. London, pt. 21, p. 181, pl. 20, fig. 15. (Not *T. varicosa* Dunker, 1860, Malakozoologissche Blätter, p. 239; 1861, Mollusca Japonica, p. 15, pl. 2, fig. 5.)
?*Turbonilla "varicosa* (A. Adams)". Kuroda and Habe, 1952, Recent marine Mollusca of Japan, p. 95.

A single incomplete specimen of this species was obtained. It appears to be identical with the Recent species in sculpture and apertural characters, but the apical angle may be narrower than on most other specimens examined. Two similar slender specimens are in the Thaanum collection from Hilo, Hawaii.

Distribution: Pliocene, (Chinen sand) Okinawa; Recent (*T. varicosa*) "Eastern Seas (A. Adams)", Philippines, Hawaiian Islands.
Localities: Chinen sand, 17482–b (figured).
Comparative bathymetric data: Philippines, off Jolo Island, 22 fathoms (Albatross collection); Hawaiian Islands, Maui, 4–12 fathoms, Oahu, 6–8, 12–25, 33–50 fathoms.

Genus SYRNOLA A. Adams 1860

Type: *Syrnola gracillima* A. Adams.

Syrnola aff. S. titizimana Nomura

Plate 2, figure 7

?*Syrnola* (s.s.) *titizimana* Nomura, 1939, Jubilee publications commemorating Prof. H. Yabe's 60th Birthday, v. 1, p. 133, pl. 9, fig. 19.

An imperfectly preserved specimen from the Yonabaru clay member of the Shimajiri formation is probably related to the Recent western Pacific species. The fossil may have a slightly stronger subsutural band or collar.

Distribution: Miocene, (Yonabaru clay member) Okinawa; Recent (*S. titizimana*), Bonin Islands.
Localities: Yonabaru clay member, 17449 (figured).

Superfamily HIPPONICACEA

Family HIPPONICIDAE

Genus CHEILEA Modeer 1793

Type: *Patella equestris* Linné.

Cheilea equestris (Linné)

Plate 16, figure 32

Patella equestris Linné, 1758, Systema naturae, ed. 10, p. 780.
Mitrularia equestris. Tryon, 1886, Manual of conchology, v. 8, p. 137, pl. 41, figs. 25–32.
Cheilea equestris. (Hirase) Taki, 1951, Handbook of illustrated shells, pl. 89, fig. 11.

Only an internal mold of this species was obtained. If it differs from the Recent species in any respect the difference cannot be ascertained. The species is highly variable and is reported to occur in the seas of both hemispheres although Woodring (1928, p. 375) questioned that such a far flung assemblage represented only one species.

Distribution: Pliocene, (Naha limestone) Okinawa, Java; Pleistocene, Timor; Recent, Indo-Pacific region, northward to the Ryukyu Islands (Woodring questions the identity of Miocene to Recent West Indian forms).
Localities: Naha limestone, 17571 (figured).
Comparative bathymetric data: Typically a reef dweller.

Cheilea layardii (Reeve)

Plate 7, figures 25, 29, 32

Calyptraea layardii Reeve, 1858, Conchologia, iconica, v. 11, *Calyptraea*, fig. 28.
Mitrularia equestris. Tryon, 1886, Manual of conchology, v. 8, p. 137, pl. 42, fig. 33.

Tryon placed this form in the synonymy of *C. equestris*, but collections in the U.S. National Museum indicate that they are distinct. This species has much coarser radials, which appear later than in *C. equestris.* The most distinctive feature is the much greater angle of the very young stage, which, after the shell has expanded to about 5 millimeters, is abruptly brought into relief by the shell expanding at a much smaller angle. This species is closely related to *C. tortilis* (Reeve) which Altena (1941, p. 35, fig. 11) records from the Upper Kalibèng beds (Pliocene) of Java.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa; Recent, Indo-Pacific region.
Localities: Shinzato tuff member, 17633 (figured).
Comparative bathymetric data: Specimens obtained by the Albatross are from depths as follows; off Leyte, 48 and 57 fathoms, Palawan Pass, 43 fathoms, off Bantayan, 32 fathoms.

Genus HIPPONIX DeFrance 1819

Type: *Patella cornucopia* Lamarck.

Subgenus ANTISABIA Iredale 1937

Type: *Hipponyx foliaceus* Quoy and Gaimard.

Hipponix (Antisabia) foliaceus Quoy and Gaimard

Plate 18, figures 10, 16–17

Hipponyx foliaceus Quoy and Gaimard, 1835, Voyage de l'*Astrolabe*, v. 3, p. 439, pl. 72, figs. 41–45.

Amalthea foliacea. Hirase, 1936, A collection of Japanese shells, pl. 89, fig. 8.

Antisabia foliacea. (Hirase) Taki, 1951, Handbook of illustrated shells, pl. 89, fig. 8.

Two specimens were obtained from the Yontan limestone. The exterior of one and the interior of the other are figured. It is assumed that the closely related American species is distinct and that the correct name for it is *Hipponix* (*Antisabia*) *antiquata* (Linné). "*Hipponix*" *tortilis* Guppy (see Woodring, 1928, pl. 29, figs. 14–15) from the Miocene of Jamaica is related, differing mainly in having a more terminal apex.

Distribution: Pliocene or Pleistocene, ("Ryukyu limestone") Kikaiga-shima; Pleistocene, (Yontan limestone) Okinawa; Recent, Indo-Pacific region, northward to Central Japan.

Localities: Yontan limestone, 17544 (figured), 17637, 17644–b (figured).

Subgenus MALLUVIUM Melvill 1906

Type: *Capulus lissus* E. A. Smith.

Melvill pointed out that the group typified by *C. lissus* secretes a calcareous plate to which the foot is attached, and that therefore its affinities were with the Hipponicidae rather than with the Capulidae. Smith questioned the validity of the group on these grounds and pointed out that there is at least a difference of opinion on whether or not *Capulus hungaricus*, the type of *Capulus*, ever secretes a calcareous base. He added in a footnote, however, that since penning his objection the radulae had been studied by Gwatkin and that *C. lissus* appeared to be a hipponicid rather than a capulid.

Amalthea Schumacher 1817 used sometimes for this group is preoccupied by *Amalthea* Rafinesque 1815.

We should probably wonder seriously when we see such forms as *Orthonychia pajerensis* Chronic (Geol. Soc. America, Mem. 58, p. 29, fig. 6a) from the Permian of Peru how much the Paleozoic paleontologists and the Recent malacologists know of each others work.

Hipponix (Malluvium) cf. H. (M.) lissus (E. A. Smith)

Plate 2, figures 6, 11, 16; plate 7, figure 28

?*Capulus lissus* E. A. Smith, 1894, Annals and Mag. Nat. Mist., v. 14, p. 166, pl. 4, figs. 4–6.

?*Amalthea lissa.* Altena, 1941, Leidse Geologische Mededelingen, v. 12, pt. 1, p. 36, figs. 12a, b.

Smith described this species as being smooth, a feature that distinguishes it from *Capulus*, as well as from the species he referred to *Capulus* which are now referred to *Malluvium.* Collections in the U.S. National Museum, including the Albatross Collection, contain a great number of specimens that range from smooth to prominently ribbed. It is suggested that *M. badius* (Dunker), which was described as obscurely radially striate, forms an unending series with *M. lissus* (Smith), and that possibly *M. lissus* should be regarded as a subspecies or variety of the older *M. badius.* Some specimens in the series show well defined radial color markings but no radial ridges on the shell. This apparently was not the impression of Kuroda and Habe (1952, p. 44) who placed *badius* under the genus *Capulus.*

Distribution: Miocene, (Yonabaru clay member) Okinawa; Miocene or Pliocene, (Shinzato tuff member) Okinawa; Pliocene, (Upper Kalibĕng beds) Java; Pleistocene, (Poetjangan beds) Java; Recent, Indo-Pacific region, north to (?) Japan.

Localities: Yonabaru clay member, 17447 (figured), 17451; Shinzato tuff member, 17633 (figured).

Comparative bathymetric data: This form shows a wide range in habitat. It was obtained by the Albatross from depths of 22 fathoms to 298 fathoms.

Superfamily STROMBACEA

Family XENOPHORIDAE

Genus TUGURIUM P. Fischer 1880

Type: *Phorus exutus* Reeve.

Tugurium exutum (Reeve)

Plate 12, figure 10

Phorus exutus Reeve, 1843, Conchologia iconica, v. 1, pl. 2, fig. 7.

Xenophora (*Tugurium*) *exuta.* Tryon, 1886, Manual of conchology, v. 8, p. 161, pl. 46, figs. 90, 91.

?*Xenophora exuta.* Yokoyama, 1927, Tokyo Imp. Univ. Fac. Sci. Jour., sec. 2, v. 2, pt. 4, p. 176, pl. 47, fig. 10.

Nomura, 1935, Tōhoku Imp. Univ. Sci. Rept., 2d ser., v. 18, no. 2, p. 198, pl. 10, figs. 25a, b.

(Hirase) Taki, 1951, Handbook of illustrated shells, pl. 89, fig. 4.

Tugurium exutum. Kuroda and Habe, 1952, Recent marine Mollusca of Japan, p. 93.

With the exception of Yokoyama's record of the species from the Pliocene of Kaga, Japan, based on a rather poor specimen, there seems to be no doubt of the identity of the fossil and Recent species.

Distribution: Miocene (?), (Moniwa formation) Japan; Pliocene, (Byoritzu beds) Formosa, (Nakoshi sand) Okinawa, (?Onma formation) Japan; Recent, Japan, the Ryukyu Islands, China and northern Philippines.

Localities: Nakoshi sand, 17440 (figured).

Comparative bathymetric data: Specimens of *T. exutum* were obtained by the Albatross from the South China Sea and northern Philippine waters at the following depths; 50, 62, 88, 106, 122, and 198 fathoms.

Genus XENOPHORA Fischer de Waldheim 1807

Type: *Trochus conchyliophorus* Born (=*Xenophora laevigata* Fischer de Waldheim).

Xenophora sp. ind.

Plate 2, figures 8, 12

Fragmental and crushed specimens of a *Xenophora*, which agglutinates shells to its upper surface in its adult stage, were obtained from the Yonabaru clay and Shinzato tuff members of the Shimajiri formation. A poorly preserved internal mold was also obtained from the Naha limestone. *Tugurium exutum* agglutinates foreign shells only in its very young stages. The unidentified form also differs from *T. exutum* in lacking well defined spiral sculpture on its base.

Occurrence: Yonabaru clay member, 17632 (figured); Shinzato tuff member, 17458; Naha limestone, 17661.

Family STROMBIDAE

Genus TIBIA (Bolten) Roeding 1798

Type: *Tibia insulae-choräb* (Bolten) Roeding (=*T. curvirostra* Lamarck).

Tibia sp. ind.

Plate 16, figure 26

Only a poorly preserved fragment was recovered.

Occurrence: Naha limestone, 17484 (figured).

Genus STROMBUS Linné 1758

Type: *Strombus pugilis* Linné.

The following species is referred by some to *Oostrombus* Sacco 1893.

Strombus aff. S. gibberulus Linné

Plate 18, figure 18

?*Strombus gibberulus* Linné, 1758, Systema naturae, ed. 10, p. 774.

?Tesch, 1920, Paläontologie von Timor, pt. 8, no. 2, p. 49, pl. 130, figs. 166a, b.

?*Strombus* (*Oostrombus*) *gibberulus*. Altena, 1941, Leidse Geologische Mededelingen, v. 12, no. 1, p. 47. (See for extended synonymy.)

?*Canarium* (*Oostrombus*) *gibberulus*. Wissema, 1947, Young Tertiary and Quaternary Gastropoda from the Island of Nias, Doctor's thesis, Rijksuniversiteit Leiden, p. 93.

?*Strombus gibberulus*. Kuroda and Habe, 1952, Recent Mollusca of Japan, p. 87.

Only fragmental and poorly preserved specimens were obtained. This species appears to be closely related to *S. luhuanus* Linné, differing from it in having a higher spire which is less involute in adults, and in having less pronounced axial nodes on the spire whorls. *Strombus luhuanus* is definitely cone-shaped whereas *S. gibberulus* is spindle-shaped.

Distribution: Pliocene, Java, Timor, Obi, (Naha limestone) Okinawa; Pleistocene, Hawaii, French Somaliland, Tanganyika, Celebes, Timor, Red Sea, Kenya, (Yontan limestone) Okinawa; Recent (*S. gibberulus*), Indian Ocean and south Pacific to the Tuamotu Archipelago and Hawaii, in western Pacific to the northern Ryukyu Islands.

Localities: Naha limestone, 17537; 17673; Yontan limestone, 17652 (figured).

Subgenus Labiostrombus Oostingh 1925

Type: *Strombus succinctus* Linné.

Strombus (Labiostrombus) cf. S. (L.) japonicus Reeve

Plate 12, figures 14–15, 22–23

?*Strombus japonicus* Reeve, 1851, Conchologia iconica, v. 6, pl. 17, fig. 42.

?Yokoyama, 1922, Tokyo Imp. Univ. Coll. Sci. Jour., v. 44, art. 1, p. 70, pl. 3, fig. 12.

?*Strombus* (*Labiostrombus*) *japonicus*. Hirase, 1936, A collection of Japanese shells, pl. 86, fig. 10.

?Nomura and Zinbo, 1936, Tōhoku Imp. Univ. Sci. Rept., 2d ser., v. 18, no. 3, p. 259, pl. 11, fig. 27.

?*Strombus taiwanicus*. Yabe and Hatai, 1941, Japanese Jour. Geology and Geography, v. 18, nos. 1, 2, p. 76.

?*Canarium* (*Labiostrombus*) *japonicus*. Taki and Oyama, 1954, Paleont. Soc. Japan, pl. 23, fig. 12.

The Okinawan form, as was recognized by Nomura and Zinbo, is more like the Recent species than the species described from the Byoritzu beds of Formosa by Nomura (1935, p. 177, pl. 8, figs. 15–16) as *S. taiwanicus*. The other new Formosan species, *S. bivaricosus*, is merely a young specimen of *S. taiwanicus*, as can be seen from numerous specimens in the Hayasaka Collection in the U.S. Geological Survey. The tendency to divarication is seen in about two thirds of the specimens of *S. taiwanicus*, whereas it is not shown at all on the Okinawan form, nor on the Recent species. *Strombus taiwanicus* is more slender, higher spired, and has stronger axial and spiral sculpture on the body whorl than *S. japonicus*.

Distribution: Pliocene, (Nakoshi sand and Naha limestone) Okinawa; Recent, Japan and the Ryukyu Islands.

Localities: Nakoshi sand, 17440 (figured) (Also reported from this locality by Yabe and Hatai), Gabusoga (Nomura and Zinbo); Naha limestone, 17561, ?17602, 17610. All localities are on the western side of Okinawa.

?Strombus sp.

Plate 12, figures 12–13

The specimen figured is obviously a juvenile. Nothing that could be the adult of it was collected. Its systematic position is not certain. It could be a buccinid but it is tentatively regarded as a *Strombus*, possibly the young of *S. isabella* Lamarck.

Locality: Chinen sand, 17495 (figured).

Superfamily CYPRAEACEA

Family ERATOIDAE

Subfamily TRIVIINAE

Genus DOLICHUPIS Iredale 1930

Type: *Cypraea producta* Gaskoin.

Subgenus TRIVELLONA Iredale 1931

Type: *T. excelsa* Iredale.

Both Schilder and Wenz placed *Trivellona* under the synonomy of *Dolichupis*. Although Wenz regarded *Dolichupis* as a subgenus of *Pusula* Jousseaume (Type: *Cypraea radians* Lamarck), Schilder regarded them both as genera under the tribe Pusulini. It seems to me that the name *Trivellona* might be useful to distinguish the species with short posterior termini from those with elongate termini. The well developed pustule at the posterior end of the inner lip also appears to set this subgenus apart.

Dolichupis (Trivellona) shimajiriensis, n. sp.

Plate 2, figures 10, 13–15

Shell medium large for the genus, inflated, spire hump well defined. Aperture narrow, gently curved centrally and anteriorly but more abruptly curved posteriorly. Anterior canal only slightly wider than the aperture above, posterior canal not appreciably sunken and slightly narrower than aperture below. Outer lip thickened and flattened both at the anterior and posterior ends. Columellar lip bearing a sharp terminal ridge at the anterior end and a sharp raised elongate pustule at the posterior end, rounded centrally. A well-defined lateral depression at the edge of the outer lip. Sculptured by sharp raised spiral ridges numbering about 22 at the inner lip edge where they become columellar teeth, 24 on the outer lip, the central ones (about 12) continuous across the dorsum with only a slight crowding, and those above and below discontinuous or recurving sharply from points about one third the distance from either end; spirals higher and sharper on the terminal ridge, at the anterior end of the outer lip, and on the posterior pustule.

Holotype (USNM 562667) measures: length 17.7 mm, width 13 mm. Paratype (a juvenile) (USNM 562668) measures: length 8.8 mm, width 7.5 mm.

Type locality: Yonabaru clay member, 17448.

This species appears to be closely related to *T. excelsa* Iredale, a Recent species from New South Wales. No similar trivid has been described from the western Pacific region, either fossil or living, but a closely related, if not identical, species is represented by a single specimen in the Philippine collections of the Albatross.

The Australian species is less inflated than the Okinawan species, and, if Iredale's figure has not been too closely trimmed, does not have the spiral lirations raised to form sharp denticles at the anterior end of the outer lip. Apparently the posterior pustule is sharper and longer in this species than on the Australian species.

Distribution: Miocene, (Yonabaru clay member) Okinawa; Recent(?), Philippines.

Localities: Yonabaru clay member, 17448 (figured type), 17449, 17451 (figured paratype).

Comparative bathymetric data: The closely related species from the Philippines was dredged from a depth of 170 fathoms. *Dolichupis producta* was obtained by the Albatross at several localities, ranging in depth from 18 to 135 fathoms.

Family CYPRAEIDAE

Subfamily CYPRAEINAE

Genus TALPARIA Troschel 1863

Type: *Cypraea talpa* Linné.

Subgenus ARESTORIDES Iredale 1930

Type: *Cypraea argus* Linné.

Talparia (Arestorides) nahaensis, n. sp.

Plate 17, figures 3, 7

Shell of medium size, moderately inflated, less inflated and more cylindrical centrally. Spire not callussed but depressed with the tip in sharp relief. Aperture to the right of the median line, narrow and more curved towards the posterior end. Fossula deep and moderately wide, sloping downwards away from the aperture rather than towards it. Columellar teeth short, sharp and denticulate, raised along a low sharp ridge anteriorly and not continuing into the body cavity. Outer lip with weakly developed teeth. Hind top of inner lip raised and sharp. Terminal ridge oblique and flaring.

Holotype (USNM 563023) measures: length 40 mm, diameter 24 mm.

Type locality: Naha limestone, 17541.

This species is very closely related to *T. argus* (Linné) from which it differs mainly in the nature of the columellar teeth, those of *T. nahaensis* being short denticles, whereas those of *T. argus* extend into and out of sight within the aperture.

Distribution: Pliocene, (Naha limestone) Okinawa.

Localities: Naha limestone, 17541 (figured type).

Genus CYPRAEA Linné 1758

Type: *C. tigris* Linné.

Cypraea sp. ind.

Plate 17, figure 1

A fragment of a large *Cypraea* that may be related to *C. tigris* Linné was obtained from the Naha limestone. There is a depressed area at the outer edge of the outer lip, however, that has not been seen on Recent specimens of *tigris*, or on any other large *Cypraea*. Only a fragment of the shell remains at this point so that it cannot be described in detail.

Occurrence: Naha limestone, 17484 (figured).

Subgenus LYNCINA Troschel 1863

Type: *Cypraea lynx* Linné.

Cypraea (Lyncina) aff. C. (L.) arenosa Gray

Plate 17, figures 4, 8

?*Cypraea arenosa* Gray, 1824, Zool. Jour., art. 19, p. 147, pl. 7, fig. 6, pl. 12, fig. 6.
?Roberts, *in* Tryon, 1885, Manual of conchology, v. 7, p. 172, pl. 6, figs. 1, 2.

A single imperfect specimen that compares with *C. arenosa* was obtained from the Naha limestone. It is probably more closely related to an undescribed variety or subspecies of *C. areonsa* that inhabits the Ryukyu region rather than to the typical form of the mid-Pacific. The Ryukyu form is about midway between *C. arenosa* and *C. sulcidentata* in the length and size of its teeth.

Distribution: Pliocene, (Naha limestone) Okinawa; Recent(?), (*C.* (*L.*) *arenosa*), Ryukyu Islands.
Localities: Naha limestone, 17484 (figured).

Cypraea (Lyncina) aff. C. (L.) carneola Linné

Plate 17, figure 5

?*Cypraea carneola* Linné, 1758, Systema naturae, ed. 10, p. 719.
?Yokoyama, 1924, Tokyo Imp. Univ. Coll. Sci. Jour., v. 45, art. 1, p. 18, pl. 1, fig. 11.
?Yokoyama, 1928, Imp. Geol. Survey Japan Rept. 101, p. 48, pl. 4, fig. 4.
?*Cypraea* (*Lyncina*) *carneola yokoyamai* Schilder, 1942, Leidse Geologische Mededelingen, v. 12, p. 177.
?*Cypraea* (*Lyncina*) *carneola carneola*. Wissema, 1947, Young Tertiary and Quaternary Gastropoda from the Island of Nias, Doctor's thesis, Rijksuniversiteit Leiden, p. 109. (With further synonymy.)

Schilder proposed a new subspecific name *yokoyamai* for the Formosan and Japanese fossil species figured by Yokoyama, and earlier (1939, p. 499) had proposed the subspecific name *carneola wanneri* for the Pliocene form of Java and Timor, including the form Tesch had figured as *Cypraea* (*Luponia*) *lynx*. Wissema recognized *wanneri*, but synonomized *yokoyamai* with typical *C. carneola*. The distinctions made by Schilder between the three subspecies are not clear to me, and the synonomy of Wissema, who has examined the Timorese and Javanese specimens, is tentatively followed.

Distribution: Pliocene, (Byoritzu beds) Formosa, (Naha limestone) Okinawa; Pleistocene, (coral bed at Awa) Japan; Recent (*C.* (*L.*) *carneola*), Indonesia, Philippines to Japan. Forms reported from the Pliocene and Pleistocene of East Africa and the western Indian Ocean, and from Hawaii, as well as Recent forms from the same areas have been assigned to other races or subspecies.
Localities: Naha limestone, 17484 (figured).

Subfamily NARIINAE

Genus PUSTULARIA Swainson 1840

Type: *Cypraea circercula* Linné (designated by both Herrmannsen and Gray, but Herrmannsen from *Peripatus* on is antedated by Gray).

Pustularia cf. P. circercula (Linné) s. l.

Plate 19, figure 1–2

?*Cypraea circercula* Linné, 1758, Systema naturae, ed. 10, p. 725.
?Roberts, *in* Tryon, 1885, Manual of conchology, v. 7, p. 197, pl. 20, figs. 55, 56.
?*Pustularia circercula*. Nomura, 1935, Tôhoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 2, p. 176, pl. 9, figs. 11a, b.
?*Pustularia* (*Pustularia*) *circercula*. Hirase, 1936, A collection of Japanese shells, pl. 94, fig. 1.
?Wissema, 1947, Young Tertiary and Quaternary Gastropoda from the Island of Nias, Doctor's thesis, Rijksuniversiteit Leiden, p. 111.
?*Pustularia bistrinotata*. (Hirase) Taki, 1951, Handbook of illustrated shells, pl. 94, fig. 1.
?Kuroda and Habe, 1952, Recent marine Mollusca of Japan, p. 80.

It is uncertain to which of the subspecies or races of *P. circercula* the Okinawan fossil should be referred. It lacks dorsal granules, has no indication of a sulcus, and the teeth tend to become weak or absent towards the central part of the aperture. It most closely resembles specimens from the mid-Pacific Islands in the above listed features and this together with the range as defined by Schilder suggests the subspecies *margarita* (Solander) Dillwyn. Neither the figures cited by Schilder or Roberts in Tryon appear to be very close to the mid-Pacific race of *P. circerula*, however, so that the Okinawan form is referred to *P. circercula* s.l. Taki reidentified Hirase's figure as *P. bistrinotata* Schilder and Schilder. Kuroda and Habe list *bistrinata*, *circercula*, and *margarita* as valid species in the Ryukyu Islands. I am not prepared to determine the validity or synonomy of this group.

Distribution (*P. circercula* and subspecies): Pleistocene, French Somaliland to the Hawaiian Islands, (Yontan limestone) Okinawa, ("Raised coral reef") Formosa; Recent, Indo-Pacific region.

Localities: Yontan limestone, 17511 (figured), 17637.

Genus EROSARIA Troschel 1863

Type: *Cypraea erosa* Linné.

Subgenus RAVITRONA Iredale 1930

Type: *Cypraea caputserpentis* Linné.

Erosaria (Ravitrona) helvola (Linné)

Plate 17, figures 2, 6

Cypraea helvola Linné, 1758, Systema naturae, ed. 10, p. 724.
Sowerby, 1870, Thesaurus conchyliorum, *Cypraea*, pl. 25, figs. 214–216.
Nomura and Zinbo, 1934, Tōhoku Imp. Univ. sa, p. 117 Sci. Repts., 2d ser., v. 16, no. 2, p. 140.
Erosaria (*Ravitrona*) *helvola*. Schilder, 1937, De Ingenieur in Nederlands Indië, ser. 4 (Mijnbouw en Geologie), v. 4, p. 201.
Schilder, 1941, Leidse Geologische Mededelingen, v. 12, p. 179.
Erosaria helvola. (Hirase) Taki, 1951, Handbook of illustrated shells, pl. 94, fig. 8.

In reporting this species from the Pliocene of Java, Schilder stated that there was no other fossil record. He apparently overlooked Nomura and Zinbo's report of the species in the "Ryukyu limestone" of Kikaiga-shima.

The Okinawan specimen is incomplete but there can be little doubt of its identity.

Distribution: Pliocene, Java, (?)Kikaiga-shima, (Naha limestone) Okinawa; Recent, Indo-Pacific region to Hawaii and Japan.

Localities: Naha limestone, 17484 (figured).

Erosaria (Ravitrona) caputserpentis (Linné)

Plate 19, figures 3, 10

Cypraea caputserpentis Linné, 1758, Systema naturae, ed. 10, p. 720.
Sowerby, 1870, Thesaurus conchyliorum, *Cypraea*, pl. 12, figs. 72, 73.
Nomura and Zinbo, 1934, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 16, no. 2, p. 140.
Nomura, 1935, Tohoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 2, p. 172.
Pustularia (*Erosaria*) *caputserpentis*. Hirase, 1936, A collection of Japanese shells, pl. 94, fig. 9.
Erosaria (*Ravitrona*) *caputserpentis*. Schilder, 1938, Proc. Malacological Soc. London, v. 23, pt. 3, p. 135.
Erosaria (*Ravitrona*) *caputserpentis reticulum*. Wissema, 1947, Young Tertiary and Quaternary Gastropoda from the Island of Nias, Doctor's thesis, Rijksuniversiteit Leiden, p. 114. (With further synonymy.)
Erosaria caputserpentis forma *reticulum*. (Hirase) Taki, 1951, Handbook of illustrated shells, pl. 94, fig. 9.
Ravitrona caputserpentis. Kuroda and Habe, 1952, Recent Mollusca of Japan, p. 82.

The specimen collected does not appear to differ from those still living in the region.

Distribution: Pliocene, (Naha limestone) Okinawa; Pleistocene, French Somaliland, Tonga, Hawaii, (raised coral reef) Formosa, Kikaiga-shima, Recent, Indo-Pacific region, Africa to Hawaii and Easter Island, north to Japan.

Localities: Naha limestone, 17554 (figured).

Comparative bathymetric data: A shallow reef dweller.

Subgenus EROSARIA Troschel 1863

Type: *Cypraea erosa* Linné.

Erosaria (Erosaria) erosa (Linné) cf. var. phragedaina (Melvill)

Plate 19, figures 9, 12

?*Cypraea erosa phragedaina* Melvill, 1888, Mem. Proc. Manchester Lit. Philos. Soc., 4th ser., v. 1, p. 223, pl. 1, fig. 11.
?*Erosaria* (*Erosaria*) *erosa duyfjesi* Schilder, 1937, De Ingenieur in Nederlands-Indië, ser. 4 (Mijnbouw en Geologie), v. 4, p. 205, figs. 23, 24.
?Schilder, 1942, Leidse Geologische Mededelingen, v. 12, p. 180. (With further synonymy.)
?*Erosaria* (*Erosaria*) *erosa phagedaina*. Wissema, 1947, Young Tertiary and Quaternary Gastropoda from the Island of Nias, Doctor's thesis, Rijksuniversiteit Leiden, p. 114. (With further synonymy.)
?*Erosaria erosa* forma *phagedarina*. (Hirase) Taki, 1951, Handbook of illustrated shells, pl. 94, fig. 11.
?*Erosaria erosa*. Kuroda and Habe, 1952, Recent marine Mollusca of Japan, p. 56.

The differences that distinguish this variety from typical *E. erosa* are slight, *E. phragedaina* being said to be more pitted and with the left side more angularly margined, and with color differences not observable in fossils. The identification here made is based more on the geographical delimitation of Schilder rather than on any morphological differences observed.

Distribution: Miocene, Java, Nias; Pliocene, Philippines, Timor, Sumatra, (Naha limestone) Okinawa; Pleistocene, (?)Timor, Celebes, (Yontan limestone) Okinawa; Recent, Cocos-Keeling, Indonesia, Malaya, Philippines and (?)Japan.

Localities: Naha limestone, 17541; Yontan limestone, 17542 (figured), 17663.

Genus STAPHYLAEA Jousseaume 1884

Type: *Cypraea staphylaea* Linné.

Subgenus NUCLEARIA Jousseaume 1884

Type: *Cypraea nucleus* Linné.

Staphylaea (Nuclearia) nucleus (Linné)

Plate 19, figures 5–6

Cypraea nucleus Linné, 1758, Systema naturae, ed. 10, p. 724.
Sowerby, 1870, Thesaurus conchyliorum, *Cypraea*, pl. 33, figs. 399, 400.
Pustularia (*Nuclearia*) *nucleus*. Hirase, 1936, A collection of Japanese shells, pl. 94, fig. 3.

Staphylaea (*Nuclearia*) *nucleus*. Schilder, 1938, Proc. Malacological Soc. London, v. 23, pt. 3, p. 130.
Staphylaea nucleus. (Hirase) Taki, 1951, Handbook of illustrated shells, pl. 94, fig. 3.
Kuroda and Habe, 1952, Recent marine Mollusca of Japan, p. 87.

According to Van Der Vlerk (1931, p. 244), Woodward reported this species from the middle Miocene of Nias in 1880, a record that needs to be verified, but aside from this there is no previous report of the species as a fossil.

Distribution: Pleistocene, (Yontan limestone) Okinawa; Recent, Indo-Pacific region, Africa to Hawaii and Japan.
Localities: Yontan limestone, 17544 (figured), 17552.

Subfamily CYPRAEOVULINAE

Genus CRIBRARIA Jousseaume 1884

Type: *Cypraea cribraria* Linné.

Subgenus TALOSTOLIDA Iredale 1931

Type: *Cypraea teres* Gmelin.

Cribraria (Talostolida) teres (Gmelin)

Plate 19, figures 4, 11

Cypraea teres Gmelin, 1791, Systema naturae, ed. 13, p. 3405.
Cribraria (*Talostolida*) *teres*. Schilder, 1938, Proc. Malacological Soc. London, v. 23, pt. 3, p. 168.
Erronea (*Tatostolida*) *teres*. Hirase, 1936, A collection of Japanese shells, pl. 93, fig. 8.
Erronea teres. (Hirase) Taki, 1951, Handbook of illustrated shells, pl. 93, fig. 8.
Talostolida teres. Kuroda and Habe, 1952, Recent marine Mollusca of Japan, p. 88.

There is no apparent difference between the fossil here figured and the Recent species from Japan and the Ryukyu Islands.

Distribution: Pleistocene, (Yontan limestone) Okinawa; Recent, (including all races) Indo-Pacific region, East Africa to Australia, Japan, Midway, New Britain and Tonga.
Localities: Yontan limestone, 17543 (figured).

Cribraria (Thalostolida) aff. C. (T.) cincta (Martin)

Plate 2, figures 17–18, 25

?*Cypraea* (*Luponia*) *cincta* Martin, 1899, Samml. Geol. Reichsmus. Leiden, v. 1, p. 172, pl. 28, fig. 399–402.
?*Cypraea cincta*. Nomura, 1935, Tôhoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 2, p. 173, pl. 9, figs. 6a, b.

How closely *Cypraea cinctoides* Yokoyama, from the Lower Byoritzu beds of Formosa, is related to the form here figured is not clear from Yokoyama's figure. Martin reported *C. cincta* from the Lower Miocene and Pliocene of Java so that the form is fairly long ranging if the specimens referred to it are conspecific. *Cribaria* aff. *C. cincta* is very closely related to *C. teres*, and the one or several species included under *C. cincta* may be ancestral to *C. teres*.

Distribution: Lower(?) Miocene, Java (type); Miocene, (Yonabaru clay member) Okinawa; Pliocene, Java, (Byoritzu beds) Formosa.
Localities: Yonobaru clay member, 17449 (figured).

"Cypraea" sp. aff. "C". asellus Linné

Plate 18, figures 19, 22

An imperfect specimen of a medium sized *Cypraea* resembles somewhat the Recent *Palmadusta asellus* (Linné), but the identification is far from certain.

Occurrence: Yontan limestone, 17544 (figured).

Unidentified Cypraeidae

Fragments, internal molds and otherwise poorly preserved specimens of cypraeids were obtained from many other localities. Some suggest the species named in the following list. Others are listed solely for the ecologic significance the family may have.

Yonabaru clay member:		Shinzato tuff member:	
17451	*erosa*?	17456	*arenosa*?
17679		17632	
		17633	
		17677	*teres*?
Naha limestone:			
17474	?	17593	?
17474	*arenosa*?	17608	*nahaensis*?
17484	*erosa*?	17608	*erosa*?
17499–l	?	17641–b	?
17499–u	*erosa*?	17641–c	*helvola*?
17526	?	17641–c	*isabella*?
17534	?	17665–u	?
17540	?	17667	?
17541	?	17667	*helvola*?
17554	*isabella*?	17669	*erosa*?
17554	?	17670	?
17567	?	17673	?
17578	?	17680	?
17579	?		
Yontan limestone:			
17495	?	17586	?
17511	*helvola*?	17637	*helvola*?
17513	?	17637	?
17543	?	17640	?
17544	*isabella*?	17644–b	?
17544	*caputserpentis*?	17646	?
17544	*carneola*?	17652	?
17546	*talpa*?	17652	*talpa*?
17547	?	17656–u	?
17550–a	*carneola*?	17658	?
17551	?	17660	?
17552	*erosa*?	17672–u	?
17552	*isabella*?	17686–u	?

Family AMPHIPERATIDAE

Subfamily AMPHIPERATINAE

Genus VOLVA (Bolten) Roeding 1798

Type: *Volva textoria* (Bolten) Roeding (=*Bulla volva* Linné)

Subgenus PELLASIMNIA Iredale 1931

Type: *Ovulum angasi* Reeve.

Volva (?Pellasimnia) sp. ind.

Plate 13, figure 8

Only one poorly preserved specimen was obtained.

Occurrence: Chinen sand, 17442 (figured).

Superfamily NATICACEA

Family NATICIDAE

Subfamily POLINICINAE

Genus POLINICES Montfort 1810

Type: *Polinices albus* Montfort (=*Nerita mammilla* Linné).

Polinices cf. P. cumingianus madioensis Altena

Plate 2, figure 19; plate 13, figure 1

?*Natica powisiana*. Martin, 1905, Samml. Geol. Reichsmus. Leiden, v. 1, p. 263, pl. 39, fig. 634.
?*Natica powisiana*. Fischer, 1927, Paläontologie von Timor, v. 15, no. 25, pl. 212, figs. 8–10.
?*Polinices (Polinices) cumingianus* var. *madioensis* Altena, 1941, Leidse Geologische Mededelingen, v. 12, p. 58, fig. 18.

Altena combined *P. cumingianus* (Recluz) and *P. powisiana* (Recluz) and cited a lengthy synonymy. The acceptance of *cumingianus* in preference to the more widely used *powisiana* is apparently based on page priority. I am not in a position to judge the synonomy of the fossils, but I would hesitate to combine Recent forms referred to the two species.

Martin had already called attention to a variety of *powisiana* having a broad funiculus which nearly fills the umbilical opening. The specimen in Martin's figure 637 and Altena's type of *madioensis* are very close to the specimens figured here. According to Altena this form is extinct.

Distribution: Miocene(?) Java (type), (Yonabaru clay member) Okinawa; Pliocene, Ceram, (Nakoshi sand) Okinawa.
Localities: Yonabaru clay member, 17449 (figured), 17679; Nakoshi sand, ?17440, 17483 (figured).

Polinices cf. P. albumen (Linné)

Plate 2, figure 23; plate 12, figure 26

?*Nerita albumen* Linné, 1758, Systema naturae, ed. 10, p. 776.
?*Natica albumen*. Tryon, 1886, Manual of conchology, v. 8, p. 47, pl. 20, fig. 5.
?*Natica (Polinices) tegalensis* Martin, 1899, Samml. Geol. Reichsmus. Leiden, v. 1, p. 266, pl. 39, fig. 641.
?*Polynices albumen*. (Hirase) Taki, 1951, Handbook of illustrated shells, pl. 91, fig. 7.

The Okinawan form is very close to the living species and it is doubtful if they could be separated. *Polinices tegalensis* from the Pliocene of Java is probably a synonym.

Polinices albumen has a very broad umbilical area and a heavy funicle. The umbilicus itself is deep, and open nearly to the apex of the spire. In full umbilical view the funicle descends in a sort of spiral stairway. It differs from two close relatives, *P. columnaris* (Recluz) and *P. sagamiensis* Pilsbry, if these two are really distinct, in that the latter have a shallow, plugged umbilicus and the funicle is more perpendicular to the plane of the umbilical area so that the last position of the funicle, which flares slightly, hides most of its track.

Although *P. albumen* is reported living to southern Japan (Kuroda and Habe, 1952, p. 78) it has not been found fossil in the area.

However, *P. sagamiensis* was reported from the Byoritzu beds of Formosa by Yokoyama (1928a, p. 63, pl. 6, fig. 2) and Taki and Oyama (1954, pl. 24, fig. 12) reidentified a specimen from the lower Pleistocene of Japan as this species. According to Nomura (1935, p. 201) the species in the Byoritzu beds is *P. "columnalis"* (Recluz) (*?columnaris*), a dubious refinement.

Dickerson (1922, pl. 4, fig. 1) reported *P. albumen* from the Vigo group in the Philippines but it is a juvenile and the identification may be incorrect.

Distribution: Miocene, (Yonabaru clay member) Okinawa; Miocene or Pliocene, ?Philippines; Pliocene, Java, (Chinen sand) Okinawa; Recent, Moluccas, Malaya, New Caledonia, Philippines to southern Japan.
Localities: Yonabaru clay member, 17451 (figured); Chinen sand, 17442 (figured).

Polinices cf. P. flemingianus (Recluz)

Plate 8, figure 3

?*Natica flemingiana* Recluz, 1844, Zool. Soc. London Proc., v. 11, no. 130, p. 209.
?Tryon, 1886, Manual of conchology, v. 8, p. 50, pl. 16, fig. 53.
?*Polynices flemingianus*. (Hirase) Taki, 1951, Handbook of illustrated shells, pl. 91, fig. 5.
?*Polinices flemingianus*. Kuroda and Habe, 1952, Recent marine Mollusca of Japan, p. 78.

Nomura and Zinbo (1936, p. 34) report this species from Nakoshi, Okinawa, but it is not present in the writers collections from there. Specimens recorded here from the Yonabaru clay and Shinzato tuff members of the Shimajiri formation are indistinguishable.

Distribution: Miocene, (Yonabaru clay member) Okinawa; Miocene or Pliocene, (Shinzato tuff member) Okinawa; Pliocene, (?Nakoshi sand) Okinawa (Nomura and Zinbo); Recent, Australia to Japan (Tryon).

Localities: Yonabaru clay member, 17448; Shinzato tuff member, 17633 (figured).

Polinices cf. P. mammilla (Linné)

Plate 12, figures 17, 21

?*Nerita mammilla* Linné, 1758, Systema naturae, ed. 10, p. 776.

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

?Altena, 1941, Leidse Geologische Mededelingen, v. 12, p. 61. (With extended synonymy.)

?Wissema, 1947, Young Tertiary and Quaternary Gastropoda from the Island of Nias, Doctor's thesis, Rijksuniversiteit Leiden, p. 12. (With extended distribution data.)

?*Polynices pyriformis*. (Hirase) Taki, 1951, Handbook of illustrated shells, pl. 91, fig. 4.

?*Polinices pyriformis*. Kuroda and Habe, 1952, Recent marine Mollusca of Japan, p. 78.

Some recent Japanese authors list the species living in the Ryukyu Islands and southern Japan as *P. pyriformis* (Récluz) (=*mammilla* Reeve non Linné). In the opinion of most systematists, however, the form figured by Reeve is Linné's species and *mammilla* is, therefore, its name. If the Japanese form is distinct it could hardly be more than a subspecies. I find no record of *pyriformis* as a fossil but *mammilla* has been reported fossil from many places.

Polinices mammilla has been reported as a fossil north of the Philippines only once previously (Nomura, 1935, p. 202); in a "raised coral reef" (Pleistocene) on Formosa.

Distribution: Miocene, Java, Borneo, Philippines, Fiji; Pliocene, Philippines, Indonesia, Kenya, (Nakoshi sand) Okinawa; Pleistocene, Formosa, Java, Red Sea, Tanganyika; Recent, Indonesia, New Caledonia, Central Polynesia, Philippines to southern Japan.

Localities: Nakoshi sand, 17483 (figured).

Genus MAMMILLA Schumacher 1817

Type: *Mammilla fasciata* Schumacher (=*Nerita melanostoma* Gmelin).

Mammilla melanostoma (Gmelin)

Plate 8, figure 1; plate 12, figure 19

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

Polinices (*Polinices*) *melanostoma*. Ladd, 1934, Bernice P. Bishop Mus. Bull. 119, p. 211.

Nomura, 1935, Tōhoku Imp. Univ. Sci. Rept., 2d ser., v. 18, no. 2, p. 203, pl. 9, fig. 32.

Polinices (*Mammilla*) *melanostoma*. Altena, 1941, Leidse Geologische Mededelingen, v. 12, p. 67.

Mammilla melanostoma. Wissema, 1947, Young Tertiary and Quaternary Gastropoda from the Island of Nias, Doctor's thesis, Rijksuniversiteit Leiden, p. 128.

Polynices opacus. (Hirase) Taki, 1951, Handbook of illustrated shells, pl. 91, fig. 1.

Polinices opacus. Kuroda and Taki, 1952, Recent marine Mollusca of Japan, p. 78.

Some recent Japanese systematists apparently believe either that *melanostoma* Reeve 1855 is the Japanese form and is not *melanostoma* Gmelin 1790, or that they are the same and the name should date from Reeve, not Gmelin, and in either case must yield priority to *opacus* (Récluz) 1850. According to most other systematists Reeve figured Gmelin's species and Gmelin's name has priority.

The specimens from the Chinen sand (pl. 12, fig. 19) retain some of the original pigment on the inner lip but there is no pigment on the parietal callus; the same color pattern is characteristic of living specimens.

The Hayasaka collection of fossils from the Byoritzu beds of Formosa, now in the U.S. Geological Survey, includes one specimen labelled "*Polinices* (*Mammilla*) *opacus* (Récluz), Kako," and it appears to be identical with the specimen from Wanga figured by Nomura, and with the Okinawan fossils. Another specimen labelled "*Polinices* (*Polinices*) *melanostoma* (Gmelin), Boshiko" is another species, possibly *P. aurantius*.

Distribution: Miocene, Java; Miocene or Pliocene, (Shinzato tuff member) Okinawa; Pliocene, Java, Sumatra, Papua, (Byoritzu beds) Formosa, (Chinen sand) Okinawa, (Konomine formation) Shikoku; Pleistocene, Java, Fiji, ?Kikaiga-shima, Red Sea; Recent, Madagascar, Mauritius, Indonesia, western Polynesia, Philippines, Ryukyu Islands and southern Japan.

Localities: Shinzato tuff member, 17633 (figured); Chinen sand, 17442 (figured).

Subfamily NATICINAE

Genus NATICA Scopoli 1777

Type: *Nerita vitellus* Linné.

As pointed out by Hanley, *Nerita vitellus* of Linné is not the *N. vitellus* of Gmelin and other authors, but rather the *Nerita rufa* of Born and Gmelin. *Nerita spadicea* of Gmelin is another synonym. Hedley stated that *N. vitellus* of Lamarck, and of authors generally, is *Nerita stellatus* Martyn, and in so doing validated the name, those of Martyn not now being accepted.

Natica cf. N. vitellus (Linné)

Plate 2, figure 22; plate 8, figure 8; plate 12, figures 20, 24

?*Nerita vitellus* Linné, 1758, Systema naturae, ed. 10. (Non auctores=*stellata* "Martyn" Hedley.)

?*Nerita rufa* Born, 1780, Testacea musei Cæsarei vindobonensis, p. 398, pl. 17, figs. 3, 4.

?*Nerita spadicea* Gmelin, 1791, Systema naturae, ed. 13, p. 3672.

?*Natica rufa*. Reeve, 1855, Conchologia iconica, *Natica*, pl. 16, sp. 70.

?Tryon, 1886, Manual of conchology, v. 8, p. 29, pl. 9, figs. 62, 63.

?*Natica* (*s. s.*) *rufa*. Fischer, 1927, Paläontologie von Timor, v. 15, no. 25, p. 46, pl. 212, fig. 6.

?*Natica* (*Natica*) *rufa*. Nomura, 1935, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 2, p. 200, pl. 9, figs. 29a–c. (With further synonymy.)

?*Natica vitellus spadicea*. Hirase, 1936, A collection of Japanese shells, pl. 90, fig. 11.

?*Natica rufa*. Altena, 1942, Leidse Geologische Mededelingen, v. 12, p. 73. (With further synonymy.)

?*Natica rufa*. Wissema, 1947, Young Tertiary and Quaternary Gastropoda from the Island of Nias, Doctor's thesis. Rijksuniversiteit Leiden, p. 134. (With further synonymy.)

Nomura also figured a specimen from the Byoritzu beds of Formosa as *Natica* (*Natica*) *vitellus* which according to his remarks is probably *N. stellatus* Hedley. The Hayasaka collection from the Byoritzu beds contains several specimens labelled *N. vitellus* and one labelled *N. rufa*. These all appear to be conspecific and are *N. vitellus* as here used.

Natica sondeiana Martin (1906, pl. 38, fig. 612) is very close to *N. vitellus* and may be the young of it. The species figured by Martin as *N. vitellus* is the *N. vitellus* of Born and Gmelin (=*stellatus*); not Linné.

Distribution: Miocene, Java, Borneo, (Yonabaru clay member) Okinawa; Miocene or Pliocene, (Vigo group) Philippines, (Shinzato tuff member) Okinawa; Pliocene, Java, Sumatra, Timor, Ceram, Philippines, New Guinea, (Byoritzu beds) Formosa, (Chinen sand) Okinawa; Recent, East Africa to Japan.

Localities: Yonabaru clay member, 17445 (figured); Shinzato tuff member, 17633 (figured); Chinen sand, 17442 (figured).

Natica sp. aff. N. stellatus Hedley

Plate 8, figures 6–7

The specimens so identified may belong to a new species but the specimens at hand are not complete enough for an adequate description. Dr. Altena was kind enough to compare photographs of this form with specimens of *N. stellatus* from Indonesia and stated that the Okinawan species has a higher spire, deeper sutures, a narrower umbilicus and a less developed callus; *N. stellatus* has a tongue-shaped outgrowth to the left just above the umbilicus (see Tryon, 1886, pl. 8, fig. 60). The callus outgrowth on the best preserved specimen from Okinawa (pl. 8, fig. 7) is comparatively blunt and rounded.

This species may be related also to *N. helvacea* Lamarck (=*globosa* Chemnitz) but the latter also has a lower spire, less impressed sutures, and the callus at the anal end of the aperture is heavier and more upward directed.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa.

Localities: Shinzato tuff member, 17454 (figured), 17677 (figured).

Genus NATICARIUS Dumeril 1806

Type: *Nerita canrenus* Linné.

Naticarius marochiensis (Gmelin) s. l.

Plate 15, figures 21–22

?*Nerita marochiensis* Gmelin, 1791, Systema naturae, ed. 13, p. 3673.

?*Natica marochiensis*. Tryon, 1886, Manual of conchology, v. 8, p. 22, pl. 5, fig. 74.

Natica colliei. Yokoyama, 1928, Imp. Geol. Sur. Japan Rept. 101, p. 63, pl. 6, fig. 1.

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

Natica (*Natica*) *ala-papilionis*. Nomura, 1935, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 2, p. 198.

Natica marochiensis. Altena, 1941, Leidse Geologische Mededelingen, v. 12, no. 1, p. 79. (? in part, but with extended synonymy.)

Naticarius (*Naticarius*) *marochiensis*. Wissema, 1947, Young Tertiary and Quaternary Gastropoda from the Island of Nias, Doctor's thesis, Rijksuniversiteit Leiden, p. 136. (With further synonymy).

The specimen figured by Dickerson (1922, pl. 4, fig. 4) from the Vigo group of Luzon as *N. lacernula* d'Oribigny probably also belongs here.

Altena states that some of his specimens from the Kendeng beds of Java have the umbilicus entirely closed by the funiculus. Possibly he included specimens referable to *P. andoi* Nomura.

Kuroda and Habe (1952, p. 71) list "*marochiensis* auct." as a synonym of *N. sagittata* Menke, an Indonesian species, presumably because Gmelin's species is supposed to have come from Morocco. They accept *N. rufilabris* Reeve 1855 as the valid name for the east Asian form generally known as *marochiensis* var. *livida* Pfeiffer 1840, although they state that it is the var. *lurida* Philippi. According to Tryon (1886, p. 23), *livida* is plicate at the suture. Strong, regular plications are shown on Hirase's figures of *rufilabris* ((Hirase) Taki, pl. 90, fig. 13). *Naticarius marochiensis* (= ?*sagittata*) is nonplicate or weakly and irregularly plicate. Tryon does not mention plications under the variety *lurida*. The writer is not in a position to determine the identity of *sagittata* Menke so that *marochiensis* is used as it has been used by most authors.

The Hayasaka collection from the Byoritzu beds contains specimens labelled both *P. rufilabris* and *P. alapapilionis*. Further preparation of them reveals that they are identical with each other and both probably are *livida;* this name having priority over *rufilabris*. This form was not found on Okinawa.

Naticarius (*Naticarius*) *bayeri* Wissema (1947, p. 138, pl. 6, figs. 130–132) is stated to differ from *N. marochiensis lurida* (= ?*livida*) in the form of the parietal callus. The value of this name is questionable. Specimens figured by Wissema appear to fall within the varietal range of *N. livida* Pfeiffer.

Distribution: Miocene, Java, Borneo, Fiji; Miocene or Pliocene, (Vigo group) Philippines; Pliocene, Java, Sumatra, Timor, Ceram, Obi, (Karikal) India, (Byoritzu beds) Formosa, (Nakoshi sand) Okinawa; Pleistocene, Java, ?Hawaii, Red Sea, East Africa.

Localities: Nakoshi sand, 17483 (figured).

Naticarius aff. N. concinnus (Dunker)

Plate 2, figure 21

?*Natica concinna* Dunker, 1860, Malakozoologische Blätter, v. 6, p. 232; 1861, Mollusca Japonica, p. 14, pl. 2, fig. 21.
?Otuka, 1935, Earthquake Research Inst. Bull., v. 13, pt. 4, p. 867, pl. 53, fig. 32.
?(Hirase) Taki, 1951, Handbook of illustrated shells, pl. 90, fig. 6.
?Kuroda and Habe, 1952, Recent marine Mollusca of Japan, p. 70.

This is a a small, delicate form with a small but prominent funiculus located at about the center of the umbilicus.

The living Japanese species which most resemble the Okinawan fossils are *N. concinnus* (Dunker) and *N. hilaris* (Sowerby) (see (Hirase) Taki, 1951, pl. 90).

Tryon (1886, p. 26) regarded *N. concinnus* as a synonym of *N. colliei* Recluz but the latter is not listed in the Japanese fauna by Kuroda and Habe (1952). It is not the *N. colliei* of Yokoyama (1928a, pl. 6, fig. 1) which is here referred to *N. marochiensis*.

Natica prosthenoglossa Cossmann (1910, p. 58, pl. 4, figs. 8–10) is very close to the Okinawan form and may be identical. Cossmann's species, from Karikal, India, differs from *N. marochiensis* in having a smaller, more central funicle, no trace of axial wrinkles, and a better defined suture.

Oostingh (1935, p. 46, pl. 5, fig. 54) figured a shell from the Pliocene of Java as *N. lineata* Lamarck. No dimensions are given for his shell but it appears to be a small species. I am not convinced that it is the same species as the one figured by Reeve (1885, pl. 7, fig. 24; refigured by Tryon, 1886, pl. 8, fig. 57).

Both the Okinawan specimens and *N. lineata* Oostingh have relatively large apertures, but the anal extremity of the aperture in the latter flares upwards whereas in the Okinawan specimens the outer lip is attached to the parietal wall more horizontally.

Natica zebra Oostingh (1935, pl. 5, fig. 55) has a similar parietal attachment but the funiculus appears to be larger and lower. A large suite of specimens in the Hayasaka collection from the Byoritzu beds of Formosa labelled *N. zebra* is all typical *N. alapapilionis*. In all of these specimens the suture is deep, the shell moderately thick, and the funiculus long and narrow, extending into the umbilicus only a short distance. The Byoritzu collections contain nothing like the Okinawan form figured here.

Distribution: Miocene, (Yonabaru clay member) Okinawa; Pliocene, possibly Karikal, India, as *N. prosthenoglossa* Cossmann, (Chinen sand) Okinawa.

Localities: Yonabaru clay member, 17451 (figured); Chinen sand, 17458.

Naticarius cf. N. andoi (Nomura)

Plate 10, figures 17, 29; plate 12, figure 25

?*Natica (Tectonatica?) andoi* Nomura, 1935, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 2, p. 201, pl. 9, figs. 35, 36.

Nomura's figures do not show the exact shape and position of the funiculus of his species. The funiculus of the Okinawan form completely hides the umbilicus in full basal view and it is similar in this view to Nomura's species. However, in apertural view (pl. 12, fig. 25) there is a deep, narrow chink around the central and upper side of the funiculus.

This form is certainly very closely related to *N. marochiensis* and might be regarded by some as identical, or at most a subspecies of it. However, in typical *N. marochiensis* the umbilicus continues as a groove around the lower side of the funiculus to the inner lip and in *N.* cf. *andoi* it does not.

Altena (1941, p. 80) mentions specimens of *N. marochiensis* from Java in which "the umbilicus is entirely or almost entirely closed by the funiculus".

Occurrence: Pliocene, ?(Byoritzu beds) Formosa, (Chinen sand) Okinawa, (Naha limestone) Okinawa; Pleistocene, (Yontan limestone) Okinawa.

Localities: Chinen sand, 17442 (figured); Naha limestone, 17537; Yontan limestone, 17553 (figured), 17646.

Naticarius cf. N. niasensis Wissema

Plate 8, figures 2, 4–5; plate 12, figures 16, 18

?*Naticarius (Naticarius) niasensis* Wissema, 1947, Young Tertiary and Quaternary Gastropoda from the Island of Nias, Doctor's thesis, Rijksuniversiteit Leiden, p. 139, pl. 6, figs. 133–135.

If the assumption that specimens from Okinawa are this species is correct, Wissema's type is a juvenile. Three specimens were obtained, the smallest about the size of the type, the largest about four times as large. The strong regular axial wrinkles are continuous from the suture to the base only on the smallest specimen. On the intermediate specimen they die out centrally leaving a broad central band which is sculptured only by faint spiral lirae. On the largest specimen the axial wrinkles become irregular on about the last quarter turn; actually becoming rather crude growth lines and as such again extend from the suture to the umbilicus.

Wissema compared his species with *N. broderipiana* (Recluz) from western Colombia and Mazatlan, a species which Tryon regarded as a variety of *N. alapapilionis*. The umbilicus of the larger Okinawan specimens is similar to the umbilicus of *alapapilionis*, but they have a lower spire and the suture is less impressed. Besides, *N. alapapilionis* has no trace of axial wrinkles. The axial wrinkles of *N. livida* are more widely spaced than in *N. niasensis* and the umbilicus is more like that of *N. marochiensis*.

Possibly this species should be referred to the genus *Stigmaulax* Mörch (see Woodring, 1928, p. 382). *Stigmaulax* has an operculum with a heavy central rib. The operculum of *N. niasensis* is not known.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa; Pliocene, Nias.

Localities: Shinzato tuff member, 17453 (figured), 17458 (figured), 17633 (figured).

Locality 17458 is included in the Shinzato tuff member but it may be Chinen sand.

Genus EUSPIRA L. Agassiz (in J. Sowerby) 1838

Type: *Euspira glaucinoides* Sowerby (=*Natica labellata* Lamarck).

Euspira cf. E. pallida (Broderip and Sowerby)

Plate 2, figures 20, 26

?*Natica pallida* Broderip and Sowerby, 1829, Zool. Jour., v. 4, p. 372.

?Tryon, 1886, Manual of conchology, v. 8, p. 37, pl. 14, figs. 26–28.

?*Euspira pallida*. Dall, 1921, U.S. Natl. Mus. Bull. 112, p. 164, pl. 14, fig. 5.

?Kuroda and Habe, 1952, Recent marine Mollusca of Japan, p. 57.

?*Lunatia pallida*. Abbott, 1954, American seashells, D. Van Nostrand Co., New York, p. 190, fig. 43c.

According to some authors *E. pallida*, *E. borealis* (Gray), and *E. groenlandica* (Möller) are all the same species. It is mainly an Arctic and boreal group but *E. pallida* has been collected off Redondo Beach, California at a depth of 100 fathoms so that its presence in deep-water deposits on Okinawa is not too suprising.

Dr. Altena kindly examined photographs of the Okinawan specimens and reported that he knew of nothing similar in the fossil or Recent collections from Indonesia.

Euspira sandwichensis (Dall), obtained from a depth of 298 fathoms in the Hawaiian Islands, may also be related to this species, but it has a lower spire and less incised sutures.

Yokoyama (1920, p. 77, pl. 4, fig. 1) figured a specimen from the "Lower Musashino" (Pliocene) of Koshiba, Japan, as *Polinices pallidus*. Hatai and Nisiyama (1952, p. 235) later placed it in the genus *Gennæsosinum*, a dubious assignment. More recently Taki and Oyama (1954, pl. 5, fig. 1) reidentified Yokoyama's specimen as *Uberella yokoyamai* (Kuroda and Habe). *Uberella* Finlay had not been recognized previously outside of New Zealand waters. Having seen nothing but poor figures of *Uberella* I am noncommittal and prefer for the time being to refer the Okinawan specimens as well as the "Lower Musashino" form to *Euspira*.

Distribution: Miocene, (Yonabaru clay member) Okinawa; Pliocene(?), Japan (as *Uberella yokoyamai*); Pliocene to Recent in Arctic and boreal waters and probably in temperate waters at depth.

Localities: Yonabaru clay member 17449 (figured), 17451 (figured).

Superfamily TONNACEA

Family CASSIDIDAE

Genus ONISCIDIA Swainson 1840

Type: *Oniscia cancellata* Sowerby.

The type species has been referred variously to *Morum* and *Morum* (*Oniscidia*). In my opinion *Oniscidia* is a distinct genus.

Oniscidia cf. O. cancellata (Sowerby)

Plate 17, figure 9

?*Oniscia cancellata* Sowerby, 1824, Genera of Recent and fossil shells, no. 24, pl. 233.

?*Oniscidia cancellata*. Swainson, 1840, Treatise on malacology, p. 300.

?*Oniscia* (*Oniscidia*) *cancellata*. Tryon, 1855, Manual of conchology, v. p. 282, pl. 10, fig. 21.

?*Morum cancellatum*. Kuroda and Habe, 1952, Recent marine Mollusca of Japan, p. 68.

I know of no record that this species has been found previously as a fossil. The identification is tentative since only a fragment was obtained. Nomura (1935, p. 170, pl. 8, fig. 23) described a related species, *Morum subcancellatum*, from the Byoritzu beds of Formosa. His species is more closely related to another Recent species, *O. macandrewi* Sowerby, and may actually be a synonym of it.

Distribution: Pleistocene, (Yontan limestone) Okinawa; Recent, China and southern Japan.

Localities: Yontan limestone, 17652 (figured).

Oniscidia cf. O. subcancellata (Nomura)

Plate 2, figure 28

?*Morum subcancellata* Nomura, 1935, Tōhoku Imp. Univ. Sci. Rept., 2d ser., v. 18, no. 2, p. 170, pl. 8, figs. 23a, b.

The fragment obtained shows the outer lip and a small part of the body whorl. Nomura's figure shows blunter spirals than on *O. cancellata* and the axials are more irregularly spaced and less pronounced.

Distribution: Miocene, (Yonabaru clay member) Okinawa; Pliocene, (Byoritzu beds) Formosa.

Localities: Yonabaru clay member, 17447 (figured).

Genus SEMICASSIS Reeve 1852

Type: *Cassis japonica* Reeve.

Semicassis pila (Reeve)

Plate 13, figures 2–3

Cassis pila Reeve, 1848, Conchologia iconica, v. 5, *Cassis*, pl. 9, fig. 21.

Cassis saburon var. pila. Tryon, 1885, Manual of conchology, v. 7, p. 275, pl. 5, fig. 75.

Phalium (*Semicassis*) *pila.* Hirase, 1936, a collection of Japanese shells, pl. 97*B*, fig. 4.

Altena, 1943, Leidse Geologische Mededelingen, v. 13, p. 93. (With further synonymy.)

Semicassis (*Semicassis*) *pila.* Wissema, 1947, Young Tertiary and Quaternary Gastropoda from the Island of Nias, Doctor's thesis, Rijksuniversiteit Leiden, p. 141.

Phalium (*Semicassis*) *pila.* Cox, 1948, Schweizerische Paläontologische Abhandlungen, v. 66, p. 36, pl. 1, figs. 9a, b.

Semicassis pila var. (Hirase) Taki, 1951, Handbook of illustrated shells, pl. 97*B*, fig. 4.

Kuroda and Habe, 1952, Recent marine Mollusca of Japan, p. 85.

While most authors have distinguished this form from *S. japonica* (Reeve), some have admitted that they are not always easily distinguishable. After a study of many specimens in the collection of the U.S. National Museum, including named specimens of each obtained from Hirase, I am of the opinion that the two are connected in an unbroken series of variants. Typical *pila* has less incised spiral lines and broader smooth interspaces. The subspecies or variety *japonica* has more deeply incised spiral lines, which both below the suture and near the base are spiral grooves nearly as broad as the interspaces. Moreover, growth lines on *japonica* form granulations or beads where they cross the spiral threads, particularly on the younger whorls.

The form from Formosa figured by Yokoyama (1928a, p. 46, pl. 3, fig. 3; see also Nomura, 1935, p. 169) is typical *japonica*. The Hayasaka collection of Byoritzu fossils in the U.S. Geological Survey includes nearly identical specimens.

Distribution: Miocene, Java, New Guinea, Borneo; Miocene or Pliocene, (Shinzato tuff member) Okinawa; Pliocene, Java, Sumatra, Ceram, New Guinea, ?Mindanao, (Byoritzu beds) Formosa; Pleistocene, Java; Recent, East Africa to Australia and Japan.

Localities: Shinzato tuff member, 17458 (figured). This locality may be high in the Shinzato or a transitional zone between the Shinzato and the Chinen sand.

Comparative bathymetric data: Specimens of typical *pila* and the variety *japonica* were obtained by the Albatross Expedition in the Philippines at depths of 37 to 182 fathoms. Probably in shallower water as well.

Doubtful identifications: Decorticated specimens and fragments were obtained from the Nakoshi sand at 17440 and 17483 and from the Chinen sand at 17481.

Semicassis sp.

A worn fragment consisting of part of the spire and the parietal attachment of a varix was obtained from the Yonabaru clay member of the Shimajiri formation. It has well defined raised growth lines crossing the spirals and probably is referable to *S. pila japonica* (Reeve).

Locality: Yonabaru clay member, 17451.

Family CYMATIIDAE

Genus CYMATIUM (Bolten) Roeding 1798

Type: *Murex femorale* Linné.

Subgenus LINATELLA Gray 1857

Type: *Cassidaria cingulata* Lamarck.

Cymatium (Linatella) cingulatum (Lamarck)

Plate 13, figures 6–7

Cassidaria cingulata Lamarck, 1822, Animaux sans vertèbres, v. 7, p. 216.

Triton undosum Kiener, 1841, Coquilles vivantes, *Triton*, p. 44, pl. 6, fig. 2.

Triton cingulatus. Reeve, 1844, Conchologia iconica, v. 2, *Triton*, fig. 35; Tryon, 1881, Manual of conchology, v. 3, p. 15, pl. 8, fig. 55.

Eutritonium cingulatum. Martin, 1926, Wetenschappelijke Mededelingen Dienst v.d. Mijnbouw in Nederlandsche—Oost-Indië, no. 4, p. 10, fig. 16.

Cymatium (*Linatella*) *cingulatum.* Oostingh, 1935, Wetenschappelijke Mededelingen Dienst v.d. Mijnbouw in Nederlandsche—Oost-Indië, no. 26, p. 61.

Cymatium cingulatum. Kuroda and Habe, 1952, Recent marine Mollusca of Japan, p. 51.

There is no discernable difference between the specimen here figured and a specimen of the Recent species in the U.S. National Museum.

A very closely related form was described by Martin (1899, p. 135, pl. 21, figs. 310, 310a) from the Pliocene of Java as *Purpurea bantamensis.* The spirals on the subsutural slope and shoulder appear to be more strongly beaded on the Java form and the spire slightly higher. It is entirely possible that these characters are variable and the Javanese and Okinawan forms are identical.

Cymatium andoi Nomura (1935, p. 167, pl. 8, fig. 21) from the Byoritzu beds of Formosa has oblique corrugations on its columella and no prominent shoulder spiral. Furthermore the early whorls appear to bear oblique axials.

Distribution: Pliocene, Java, (Chinen sand) Okinawa; Recent, Philippines, Singapore, Amboina, Flores, Madoera. Tryon's record at St. Thomas, West Indies, is probably erroneous.

Localities: Chinen sand, 17442 (figured).

Subgenus LAMPUSIA Schumacher 1817

Type: *Murex pileare* Linné.

Cymatium (Lampusia) cf. C. (L.) pileare (Linné)

Plate 17, figure 10

?*Murex pileare* Linné, 1767, Systema naturae, ed. 12, p. 1217.
?*Triton* (*Simpulum*) *pilearis*. Tryon, 1881, Manual of conchology, v. 3, p. 12, pl. 6, fig. 31. (After Reeve.)
?*Triton* (*Simpulum*) *pilearis* var. Martin, 1899, Samml. Geol. Reichsmus. Leiden, v. 1, p. 141, pl. 22, figs. 323, 324.
?*Cymatium* (*Lampusia*) *pileare*. Altena, 1942, Leidse Geologische Mededelingen, v. 13, p. 101. (With extended synonymy.)
?Wissema, 1947, Young Tertiary and Quaternary Gastropoda from the Island of Nias, Doctor's thesis, Rijksuniverseteit Leiden, p. 146.
?*Cymatium pileare*. (Hirase) Taki, 1951, Handbook of illustrated shells, pl. 95, fig. 5.
?Kuroda and Habe, 1952, Recent marine Mollusca of Japan, p. 51.

Cox (1948, p. 39, pl. 4, figs. 1a–b) described a variety from the Miocene or Pliocene of Borneo as *C.* (*L.*) *pileare* var. *borneana*. It is characterized mainly by a longer canal and by delicately reticulate ornamentation. He thought that a specimen from the upper Miocene of Java figured by Martin (1899, pl. 22, fig. 324) might be the same variety. Another specimen figured by Martin (1899, pl. 22, fig. 323) as *Triton pilearis* var. was believed by Cox to be typical *T. pileare*. The latter (fig. 323) has two prominent peripheral spirals, a character which influenced Martin to regard it as a varietal form.

The Okinawan specimen here figured has its canal broken off so that the length of its canal is not known. However, its sculpture is delicately reticulate as in *borneana*. It also has two prominent spirals along its shoulder. It thus combines two characters, one of which Cox recognized in the variety *borneana* and one which he regarded as more properly belonging to the typical form.

Distribution: Miocene, Java, Borneo; Pliocene, Java, Sumatra, Timor, (Naha limestone) Okinawa; Pleistocene, French Somaliland, Kenya, Red Sea, Java, Celebes, Japan, Hawaii; Recent, East Africa to India, Australia, Malaya, Phillippines, Japan, Micronesia, Melanesia, Hawaii, Loyalty Islands, and the Tuamotu Archipelago.

Localities: Naha limestone, 17484 (figured).

Comparative bathymetric data: The shell of this species is the most common abode of hermit crabs along some beaches, suggesting that it lives in shallow water nearby.

Genus BIPLEX Perry 1811

Type: *Biplex perca* Perry.

Biplex seems to be distinctive enough to justify recognition as a distinct genus. This not only seems to be the soundest practice biologically, in view of modern restriction of most genera, but it circumvents the bewildering number of generic and subgeneric combinations to which the type species has been referred in the past.

Biplex perca Perry

Plate 2, figure 30; plate 8, figure 9; plate 13, figure 4

Biplex perca Perry, 1811, Conchology, pl. 4, no. 5.
Ranella pulchella Sowerby, 1825, Tankerville catalog, app., p. 18.
Ranella pulchra (Gray) Sowerby, 1835, Conchological illustrations, *Ranella*, pl. 93, fig. 19, (original plate explanations; not revised explanations dated 1841); Jay, 1839, Catalog of shells, pl. 2, fig. 6.
Bursa (*Eupleura*) *pulchra*. H. and A. Adams, 1853, Genera of Recent Mollusca, p. 107.
Ranella pulchra. Lischke, 1871, Japanische Meeres-Conchylien, p. 37.
Ranella (*Argobuccinum*) *pulchra*. Tryon, 1881, Manual of conchology, v. 3, p. 43, pl. 23, fig. 51.
Ranella perca. Dunker, 1882, Index molluscorum Maris Japonici, p. 32.
Ranella (*Eupleura*) *perca*. Watson, 1886, Voy. H.M.S. *Challenger*, Zoology, v. 15, p. 402.
Ranella (*Biplex*) *pulchra*. Tesch, 1920, Paläontologie von Timor, v. 8, no. 14, p. 43, pl. 129, fig. 156a, b.
Gyrineum (*Biplex*) *perca prisca* Makiyama, 1927, Kyoto Imp. Univ. Coll. Sci. Mem., ser. B., v. 3, p. 71, pl. 3, fig. 16.
Gyrineum (*Biplex*) *perca*. Yokoyama, 1931, Imp. Geol. Survey Japan, Catalog of shells of Japan, p. 35.
Argibuccinum (*Gyrineum*) *perca*. Hirase, 1936, A catalog of Japanese shells, pl. 128, fig. 2.
Apollon (*Biplex*) *perca*. Wenz, 1941, Handbuch der Paläozoologie, v. 6, pt. 5, p. 1060.
Gyrineum (*Biplex*) *perca*. Altena, 1942, Leidse Geologische Mededelingen, v. 13, no. 1, p. 100.
Apollon (*Biplex*) *perca*. Wissema, 1947, Young Tertiary and Quaternary Gastropoda from the Island of Nias, Doctor's thesis, Rijksuniversiteit Leiden, p. 145.
Gyrineum (*Biplex*) *perca*. Cox, 1948, Schweizerische Paläontologische Abhandlungen, v. 66, no. 2, p. 41, pl. 4, figs. 3a, b.
Apollon perca. (Hirase) Taki, 1951, Handbook of illustrated shells, pl. 128B, fig. 2.
Kuroda and Habe, 1952, Recent marine Mollusca of Japan, p. 39.

Makiyama distinguished his subspecies *prisca* by saying that the varices are less stellate and the axial sculpture less developed than on the typical form. In my opinion, however, his specimen falls well within the range of variation of the Recent species.

Two forms were described by Martin from the Miocene of Java under the generic name *Ranella*. One of these, *B. pamotanensis* (Martin) (1899, p. 151, pl. 23, fig. 352), has more numerous axials and better developed beading at the intersection of the axials and spirals than the writer has observed on *B. perca*. Furthermore, its varices are rounded or with only very weak points. The other Miocene form, *B. magnifica* (Martin) (1879, p. 53, pl. 10, fig. 1) appears to be identical with specimens figured here from the Yonabaru clay (pl. 2, fig. 30) and Shinzato tuff (pl. 8, fig. 9) members of the Shimajiri formation. These forms all have more uniformly spaced axials and stronger beading than most Recent specimens. However, several lots from the Philippines in the Albatross collection contain specimens with axials and beading like *B. magnifica* and the Okinawan Miocene specimens. I hesitate to pass judgment on the validity of *B. magnifica* without having seen specimens but am inclined to regard it as a variety of *B. perca;* at most not more distant than a subspecies.

Distribution: Miocene, ?India, ?Java (as *B. magnifica*), (Yonabaru clay member) Okinawa; Miocene or Pliocene, (Shinzato tuff member) Okinawa; Pliocene, Java Sumatra, Timor, Nias; Pleistocene, Java; Recent, Indo-Pacific region, north to Japan.

Localities: Yonabaru clay member, 17448 (figured); Shinzato tuff member, 17458 (figured), 17633 (figured). Locality 17458 may actually belong in the Chinen sand.

Comparative bathymetric data: Japan, 57, 139 and 163 fathoms; in the Albatross collection from the Philippines at over 50 localities ranging in depth from 80 to 350 fathoms, the largest lots being from between 100 and 200 fathoms. Nearly 300 specimens were taken in one haul at 135 fathoms.

Family BURSIDAE

Genus BURSA (Bolten) Roeding 1798

Type: *Bursa monitata* (Bolten) Roeding (=*Murex bufonia* Gmelin).

Subgenus BUFONARIA Schumacher 1817

Type: *Bufonaria spinosa* Schumacher (=*Gyrineum echinatum* Link).

Bursa (Bufonaria) rana (Linné)

Plate 13, figure 5

Murex rana Linné, 1758, Systema naturae, ed. 10, p. 748.

Ranella albivaricosa Reeve, 1844, Conchologia iconica, v. 2, *Ranella*, pl. 1, fig. sp. 2; Tryon, 1881, Manual of conchology, v. 3, pl. 18, fig. 6.

Ranella (Bursa) subgranosa. Tesch, 1915, Paläontologie von Timor, v. 5, no. 9, p. 70, pl. 82, fig. 1952.

Ranella (Bursa) nobilis. Tesch, 1920, Paläontologie von Timor, v. 8, no. 14, p. 41, pl. 129, fig. 153.

Ranella subgranosa. Dickerson, 1922, Philippine Jour. Sci., v. 20, no. 2, pl. 4, fig. 13b.

Ranella (Bursa) subgranosa. Fischer, 1927, Paläontologie von Timor, v. 15, no. 25, p. 65.

Gyrineum scelestum. Yokoyama, 1928, Imp. Geol. Survey Japan Rept. 101, p. 44, pl. 3, figs. 5, 6.

?*Bursa nobilis.* Nomura and Zinbo, 1934, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 16, no. 2, p. 137.

Bursa (Gyrineum) subgranosa. Nomura, 1935, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 2, p. 165.

Bursa rana. Hirase, 1936, A collection of Japanses shells, pl. 96, fig. 7; same in (Hirase) Taki, 1951.

Bursa (Bursa) subgranosa. Altena, 1942, Leidse Geologische Mededelingen, v. 13, p. 112. (In part.)

Gyrineum (Gyrineum) subgranosum. Wissema, 1947, Young Tertiary and Quaternary Gastropoda from the Island of Nias, Doctor's thesis, Rijksuniversiteit Leiden, p. 160.

Bursa rana. Kuroda and Habe, 1952, Recent marine Mollusca of Japan, p. 42.

Altena concluded that *Ranella albivaricosa* Reeve (=*B. rana* Linné) is only a variety of *R. subgranosa* Beck of Sowerby. If the figures given by both Reeve and Tryon (see Tryon, 1881, v. 3, pl. 18, fig. 6 and pl. 19, fig. 8) for these forms are correct, I am inclined to regard them as distinct species. *Bursa rana* has a broad sharp spine at the anal position whereas *B. subgranosa* has a well rounded flare.

Nomura identified a form occurring abundantly in the Byoritzu beds of Formosa as *B. subgranosa*, but stated that it might be a variety of *B. rana.* He cited Reeve's figure (Reeve, v. 2, pl. 1, fig. 1=Tryon, vol. 3, pl. 19, fig. 8). The Hayasaka collection of Byoritzu fossils in the U.S. Geological Survey includes 25 specimens whose end members compare respectively with Tryon's pl. 18, fig. 6 ("*R. albivaricosa*") and pl. 8, fig. 7 ("*R. elegans* Beck=*subgranosa*"), both of which probably should be referred to *B. rana.* No specimens close to Tryon's pl. 19, fig. 8 ("*B. subgranosa*") are included.

A closely related species occurs in the Miocene of Java (Martin, 1899, pl. 23, figs. 340–342). Both Martin and Altena identify it as *B. nobilis* (Reeve), a Recent species (see Tryon, pl. 21, fig. 68). *Bursa nobilis* has a short, strongly recurving columella from which the lower part of the inner lip is detached, making a weak crescent-shaped umbilical opening. The columella of *B. rana* is nearly straight or even slightly outward-curving and the inner lip is appressed.

According to available records *B. rana* has not been positively identified in beds older than Pliocene whereas *B. nobilis*, or at least a very closely related form, ranges as far back as the lower Miocene.

Distribution: Miocene or Pliocene, (Vigo group) Philippines; Pliocene, Java, Nias, Timor, Ceram, Papua, (Byoritzu beds) Formosa, (Nakoshi sand) Okinawa; Pleistocene, Java, Celebes, New Guinea, Philippines; Recent, East Africa, Madagascar, Indonesia, Philippines, Japan, Melanesia and the Tuamotu Archipelago.

Localities: Nakoshi sand, 17440 (figured).

Comparative bathymetric data: Mud banks exposed at spring-tides to 204 meters (Altena). The species was collected in the Philippines by the Albatross Expedition at depths from 7 to 153 fathoms, all records but one being less than 80 fathoms.

Subgenus TUTUFA Jousseaume 1881

Type: *Murex lampas* Linné.

Bursa (Tutufa) aff. B. (T.) corrugata (Perry)

Plate 8, figures 10–11

?*Biplex corrugata* Perry, 1811, Conchology, pl. 5, fig. 1.

No further synonymy is attempted owing to the uncertain identification. This may be a new species but because it might also be one of several described species which I am not in a position to identify the matter is left open.

Bursa corrugata is the form sometimes known as *B. affinis* (Broderip). Two other species which are undoubtedly close are *B. granularis* (Roeding) and *B. ranelloides* (Reeve). Martin (1899, pl. 23, fig. 346) figured another related species from the Pliocene of Java as *Ranella lampas* (Linné) but according to Altena (1942, p. 108) it is *Bursa rubeta* (Roeding).

Aside from the gross sculpture features which are well shown in the figures (pl. 8, figs. 10–11), this form has an equisite microsculpture consisting of a regular reticulation of fine raised lines which covers all other features, including the rows of large and small spiral beds and the growth varices, with approximately equal strength.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa. This form may be identical with one of several living species.

Localities: Shinzato tuff member, 17633 (figured), 17458.

Family TONNIDAE

Genus TONNA Brünnich 1772

Type: *Buccinum galea* Linné.

Tonna luteostoma (Küster)

?Plate 2, figure 29; plate 13, figure 9

Dolium luteostomum Küster, 1857, Conchylien Cabinet, v. 3, pt. 1, p. 66, pl. 58.

Dolium japonicum Dunker, 1858–1870, Novitates conchologicæ, p. 104, pls. 35, 36.

Dolium luteostomum. Tokunaga, 1906, Tokyo Imp. Univ. Coll. Sci. Jour., v. 21, art. 2, p. 17, pl. 1, fig. 30.

Yokoyama, 1920, Tokyo Imp. Univ. Coll. Sci. Jour., v. 39, art. 6, p. 66, pl. 4, fig. 2.

Yokoyama, 1922, Tokyo Univ. Coll. Sci. Jour., v. 44, art. 1, p. 69, pl. 3, fig. 10.

Tonna luteostoma. Nomura and Zinbo, 1934, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 16, no. 2, p. 139.

Nomura, 1935, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 2, p. 171.

Hirase, 1936, A collection of Japanese shells, pl. 98, fig. 5; (Hirase) Taki, 1951, Handbook of illustrated shells, pl. 98, fig. 5.

Osima, 1943, Conchologia Asiatica, v. 1, pt. 4, p. 116, pl. 1, fig. 1.

Kuroda and Habe, 1952, Recent Mollusca of Japan, p. 90.

Taki and Oyama, 1954, Paleont. Soc. Japan Spec. Paper 2, pl. 5, fig. 2; pl. 23, fig. 10.

The majority of the specimens referred to this species come from the Naha limestone and the Chinen sand. Most specimens from the Chinen sand are badly crushed, but their deep spiral interspaces make the identification certain. All specimens from the Naha limestone are internal molds. Specimens from the Yonabaru clay and Shinzato tuff members of the Shimajiri formation and the Yontan limestone are young shells and their identification is tentative.

Küster's statement that this species occurs in the Indian Ocean appears to be erroneous and he probably is the source from whom numerous other authors give this occurrence in addition to Japan and the Ryukyu Islands. Specimens in the U.S. National Museum are all from the Japanese region. Bayer (1937) in a catalogue of the Doliidae in the Rijksmuseum lists the species only from Japan.

Nomura (1935, p. 171) lists *T. luteostoma* from the Byoritzu beds of Formosa but the Hayasaka collection contains only *T. zonata* (Green).

The specimen figured from the Chinen sand (pl. 13, fig. 9) is one of the most complete specimens found but it is a young individual. Other fragments from the same locality indicate the adults reach a diameter of 130 mm or more.

Distribution: Miocene, (Yonabaru clay member) Okinawa; Miocene or Pliocene, (Shinzato tuff member) Okinawa; Pliocene, (Byoritzu beds) Formosa, (Chinen sand) Okinawa, (Naha limestone) Okinawa; Pleistocene, Japan, Kikaiga-shima, (Yontan limestone) Okinawa; Recent, Japan and the Ryukyu Islands.

Localities: Yonabaru clay member, 17449 (figured); Shinzato tuff member, 17633; Chinen sand, 17442 (figured), 17479 (Heanza-shima), 17482b; Naha limestone, 17473, 17484, 17509, 17564, 17610; Yontan limestone, 17514.

Family FICIDAE

Genus Ficus (Bolten) Roeding 1798

Type: *Bulla ficus* Gmelin.

Ficus subintermedia (D'Orbigny)

Plate 2, figure 24; plate 8, figure 13

Pyrula ficoides Lamarck, 1822, Animaux sans vertèbres, v. 7, p. 142, no. 11. (Non Brocchi, 1814.)

Pyrula subintermedia d'Orbigny, 1852, Prodrome paléontologie, v. 3, p. 173.

Pirula reticulata. Cossman, 1903, Journal de conchyliologie, v. 51, no. 2, p. 163, pl. 6, figs. 10, 11.

Ficus ficoides. Nomura, 1935, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 2, p. 172.

Hirase, 1936, A collection of Japanese shells, pl. 98, fig. 9.

Pyrula subintermedia. Bayer, 1939, Zoologische Mededelingen, v. 21, p. 379. (With further synonymy.)

Ficus subintermedia. Altena, 1942, Leidse Geologische Mededelingen, v. 13, p. 120. (With further synonymy.)

Ficus (Ficus) subintermedia. Wissema, 1947, Young Tertiary and Quaternary Gastropoda from the Island of Nias, Doctor's Thesis, Rijksuniversiteit, Leiden, p. 165. (With further synonymy.)

Ficus subintermedius. Kuroda and Habe, 1952, Recent marine Mollusca of Japan, p. 57.

The fossils appear to be identical with Recent specimens in all respects.

Distribution: Miocene, Java, (Yonabaru clay member) Okinawa, Miocene or Pliocene, (Vigo group) Philippines, (Shinzato tuff member) Okinawa; Pliocene, Java, Sumatra, Ceram, Papua and Karikal (India), (Byoritzu beds) Formosa; Pleistocene, Java, Philippines, Japan; Recent, Indo-Pacific region, Zanzibar to Japan.

Localities: Yonabaru clay member, 17451 (figured), 17503, 17632, Shinzato tuff member, 17633 (figured).

Comparative bathymetric data: Altena states that this species has been obtained at depths of 54 to 90 meters, or approximately 15 to 60 fathoms.

Order NEOGASTROPODA

Superfamily MURICACEA

Family MURICIDAE

Subfamily RAPANINAE

Genus RAPANA Schumacher 1817

Type: *Buccinum bezoar* Linné.

?Rapana sp.

Plate 18, figure 29

A specimen from limestone with only a small part of the basal part of the body whorl retaining the external sculpture is identified tentatively as a *Rapana.* The sculpture is closest to that of *R. thomasiana* Crosse (see (Hirase) Taki, 1951, pl. 110, fig. 21).

Locality: Yontan limestone, 17515 (figured).

Subfamily MURICINAE

Genus Chicoreus Montfort 1810

Type: *Murex ramosus* Linné.

Chicoreus sp. ind.

A badly decorticated specimen of a medium sized *Chicoreus* was obtained that has rather narrow spire with sharp, narrow varices, each with a broken single spine. Only the early whorls are not decorticated. Two well-defined axial nodes are developed between each varix. The species probably is related to one of the higher spired Japanese *Chicoreus*, such as *C. asianus* Kuroda or *C. pliciferoides* Kuroda (1942, p. 80) but no closer identification is possible. The columella of a larger specimen which may belong to the same species was obtained at the same locality. There are two prominent spines near the base of each varix.

Nomura (1935, pl. 8, fig. 11) figured a specimen from the Byoritzu beds of Formosa as *Murex (Chicoreus) sinensis* Reeve, the form which Kuroda renamed *C. asianus.* The Hayasaka collection in the U.S. Geological Survey includes a specimen of the same species. It has sharp fine equisized spiral threads all over the whorl and on this character alone is clearly not the *Chicoreus* reported here which has a microsculpture of smooth, irregular axial wrinkles. The Byoritzu form resembles closely a Pliocene form from Timor figured by Tesch (1915, pl. 82, fig. 142) as *Murex microphyllus* Lamarck.

Locality: Yonabaru clay member, 17445.

Subgenus SIRATUS Jousseaume 1880

Type: *Murex senegalensis* Gmelin.

Chicoreus (Siratus) aff. C. (S.) anguliferous (Lamarck)

Plate 3, figure 1

?*Murex anguliferous* Lamarck, 1822, Animaux sans vertèbres, v. 7, p. 171.

?Reeve, 1845, Conchologia iconica, v. 3, pl. 11, fig. 43a.

A juvenile specimen with a broken canal was obtained from the Yonabaru clay member of the Shimajiri formation that appears to be more like *C. anguliferous* than any of the species now found in the western Pacific. The specimen is hardly distinguishable from the young of a lot so labelled from the Gulf of Aden. The moderately low spire, the single spine at about the upper third of the varix, and the early stabilization of a single intervarical node (although the intervarical area shown on the figured specimen has two) appear to set this species off from its nearest relatives in the Indo-Pacific region.

Nomura (1935, pl. 7, fig. 37) described a species as *Nassaria monospina* which may be identical with the species here figured.

Distribution: Miocene, (Yonabaru clay member) Okinawa; Recent (*C. anguliferus*), East Africa, Red Sea, India, Bourbon, Seychelles.

Localities: Yonabaru clay member, 17679 (figured).

Genus Murex Linné 1758

Type: *M. pecten* Montfort=*tribulus* Linné.

Although the species referred to this genus from Okinawa (as well as the Recent species mentioned in connection with them) resemble the genus *Haustellum* in shape, length of the canal, and in the absence or near absence of spines, they differ from *Haustellum haustellum* in not having an anal notch. Probably most of the species that have been referred to *Haustellum* have been so referred on the more superficial characters. The sharp, often constricted, anal notch of *Haustellum* is so characteristic, however, it is doubtful that any species without it should be admitted to the genus.

Murex saplisi, n. sp.

Plate 8, figures 14–15; ? plate 13, figure 13

Shell of medium size or below medium for the genus, trivaricate, moderately inflated, spire short, canal long. Protoconch not preserved on any specimens at hand. Aperture subrounded, siphonal slit narrow, open and elongate. Outer lip projecting beyond the varix as a thin edge, slightly denticulate and crenulate within; inner lip thin and detached below the parietal wall, but lightly appressed on the parietal wall. Varices not strong, bearing a blunt point at about the upper third but not hollowed; 2, 3 and rarely 4 intervarical nodes. Spiral lines moderately developed but not strong, slightly granular. Microsculpture consisting of faint, very irregular growth lines.

Holotype (USNM 562821) measures: height (spire incomplete) 25 mm, diameter 17.2 mm. Figured paratype (USNM 562822) measures: height (spire incomplete) 25.5 mm, diameter, 18 mm.

Type locality: Shinzato tuff member, 17633.

Murex saplisi is related to *M. rectirostris* Sowerby and to *M. sobrinus* A. Adams. Both of these species have coarser spiral sculpture and heavier, more undercut varices with moderately strong hollow spines. *Murex sobrinus* has a tendency to be more spiny all over than the Okinawan Miocene form.

Murex saplisi resembles, but is clearly distinct from, two species in the Byoritzu beds of Formosa, *M. tribulus* Linné (=*M. ternispina*, Yokoyama, 1928a, pl. 3, fig. 2) and *M. rarispina* Lamarck (Nomura, 1935, pl. 8, fig. 7). *Murex tribulus* is much more spiny. Several specimens of *M. rarispina* are in the Hayasaka collection. They have stronger and more regular spiral sculpture and are more slender and have a higher spire than *M. saplisi.*

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa.

Localities: Shinzato tuff member, 17633 (figured type).

Doubtful identifications: Chinen sand, 17481 (figured).

Murex cf. M. bonneti Cossmann

Plate 3, figure 5

?*Murex bonneti* Cossman, 1903, Journal de conchyliologie, v. 51, p. 150, pl. 5, figs. 26, 27.

A poorly preserved young specimen and three fragments were obtained that compare closely with *M. bonneti* from the Pliocene of Karikal, India. Neither the figured specimen nor any of the fragments obtained show any tendency to develop more than two axial nodes between the varices. The varices are stronger and more undercut than those of *M. saplisi* and the latter has three and sometimes four intervarical nodes.

The specimen figured as *M. bonneti* by Wissema (1947, pl. 6, fig. 149) has three intervarical nodes and in this respect compares more with *M. saplisi* than *M. bonneti.* The varices of Wissema's specimen also appear to be larger and more expanded than those of *M. saplisi* and *M. bonneti.* All of these forms are very closely related and it is possible that when more is known of them all may prove to belong to the same species.

None of these related forms has been found in the Byoritzu beds of Formosa.

Murex bantamensis Martin (1895, p. 126, pl. 19, figs. 288–289) is also very closely related. Some figures of that species show two small spines high on the columella. There is no trace of columellar spines on either *M. saplisi* or *M. bonneti.*

Distribution: Miocene, (Yonabaru clay member) Okinawa; Pliocene, (Karikal) India, ?Nias.

Localities: Yonabaru clay member, 17451, 17503 (figured).

Genus TYPHIS Montfort 1810

Type: *Murex tubifer* Bruguière.

Typhis cf. T. arcuatus Hinds

Plate 13, figure 14

?*Typhis arcuatus* Hinds, 1843, Zool. Soc. London Proc., v. 11, no. 121, p. 19.

?Tryon, 1880, Manual of conchology, v. 2, p. 136, pl. 30, figs. 293, 297.

?*Typhis duplicatus.* Nomura, 1935, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 2, p. 161, pl. 8, fig. 17.

?*Typhis arcuatus.* Kuroda and Habe, 1952, Recent marine Mollusca of Japan, p. 96.

?*Siphonochelus* (s.s.) *japonicus.* Taki and Oyama, 1954, Paleont. Soc. Japan Spec. Paper 2, pl. 23, fig. 3.

Typhis arcuatus Hinds, *T. duplicatus* Sowerby, and *T. japonicus* A. Adams are so closely related that most systematists have regarded them as the same species, an opinion in which I concur.

Only one immature specimen is present in the Okinawan collections, but undoubtedly it belongs to the same species as a specimen in the Hayasaka collection from the Byoritzu beds of Formosa.

Distribution: Pliocene, (Byoritzu beds) Formosa, (Chinen sand) Okinawa; Pleistocene, Japan; Recent (*T. arcuatus*) Cape of Good Hope, China, Japan.

Localities: Chinen sand, 17442 (figured).

Subfamily DRUPINAE

Genus NASSA (Bolten) Roeding 1798

Type: *Nassa picta* (Bolten) Roeding (=*Buccinum sertum* Bruguière).

Nassa serta (Bruguière)

Plate 19, figure 8

Buccinum sertum Bruguière, 1789, Encyclopédie Méthodique, p. 262.
Buccinum coronatum Gmelin, 1791, Systema naturae, ed. 13, p. 3486.
Nassa picta (Bolten) Roeding, 1798, Museum Boltenianum, p. 132, no. 1655.
Jopas (Jopas) sertum. Hirase, 1936, A collection of Japanese shells, pl. 110, fig. 7.
Jopas (Jopas) francolinum. Hatai, 1941, Tropical Industry Inst. Palau, Bull. 7A, p. 23.
Nassa francolinus. (Hirase) Taki, 1951, Handbook of illustrated shells, pl. 110, fig. 7.
Kuroda and Habe, 1952, Recent marine Mollusca of Japan, p. 69.

According to some recent Japanese authors *Buccinum sertum* Bruguière is a synonym of *Buccinum francolinus* Bruguière (1789, p. 261).

Only two specimens were obtained. They appear to be identical with the living species.

Distribution: Pliocene, (Naha limestone) Okinawa; Pleistocene, (Yontan limestone) Okinawa; Recent, Red Sea to Japan and Hawai.

Localities: Naha limestone, 17554; Yontan limestone, 17544 (figured).

Comparative bathymetric data: A reef and lagoon dweller.

Incerta sedis

Plate 17, figure 16

A fragment of a gastropod with remnants of sculpture resembling that of *Nucella* was obtained from the Naha limestone. No more definite identification can be made.

Locality: Naha limestone, 17608 (figured).

Genus Ceratostoma Herrmannsen 1846

Type: *Murex* (*Cerostoma*) *nuttalli* Conrad.

Herrmannsen's name is an emendation pro Latin of *Cerostoma* Conrad 1837.

Ceratostoma brachypteron (A. Adams)

Plate 3, figures 3–4; plate 15, figure 15

Pteronotus brachypteron A. Adams, 1862, Zool. Soc. London Proc., pt. 3, p. 371.
Murex (*Cerostoma*) *brachypteron*. Tryon, 1880, Manual of conchology, v. 2, p. 114.
Murex (*Pteronotus*) *brachypteron*. Pilsbry, 1895, Catalog of marine Mollusks of Japan, p. 42.
Ocenebra brachypteron. Kuroda and Habe, 1952, Recent marine Mollusca of Japan, p. 72.

I can find no record of this species having been figured previously. It is unmistakably marked, however, by its rather narow varices, closed canal, and maculate or zig-zag chestnut color pattern. Among the half dozen specimens at hand there is a range from nearly white to rather dark chestnut coloration. The species is present in the Hirase collection in the U.S. National Museum, having been previously labelled *P. plorator* Adams and Reeve, a related but much more darkly colored form with a central white band.

Both the living species and the fossils here referred to it have delicately fimbriated varices with little or no evidence of a slot or groove for the sinus. The surface of the shell bears a fine and somewhat irregular spiral microsculpture.

Kuroda and Habe place this species under the genus *Ocenebra*. They place "*Murex*" *plorator* Adams and Reeve and the closely related *M. burnetti* Adams and Reeve in the genus *Ceratostoma*. It is probable that Kuroda and Habe interpret *P. brachypteron* as being a species other than the one figured here. In my opinion *plorator* and *brachypteron* are so closely related that they may be only color varieties of one species.

Distribution: Miocene, (Yonabaru clay member) Okinawa; Recent, southern Japan.

Localities: Yonabaru clay member, 17451 (figured).

The Recent figured specimen is from Kii, Japan (USNM 344163).

Comparative bathymetric data: A specimen dredged by the Albatross Expedition from off Ose Zaki, Honshū, Japan, was obtained at a depth of 63 fathoms. Tryon gives a record of 12 fathoms at Uraga, Japan.

Family MAGILIDAE

Genus CORALLIOPHILA H. and A. Adams, 1853

Type: *Murex neritoidea* Chemitz (=*Purpura violacea* Kiener).

Subgenus HIRTOMUREX Coen, 1922

Type: *Fusus lamellosa* Philippi.

Coralliophila (Hirtomurex) iwaensis, n. sp.

Plate 3, figure 8

Shell of medium size moderately inflated, spire about ¾ the length of the aperture, apical angle large, whorls bearing prominent spiral lirations which are further offset by raised lamellae. Protoconch not preserved on the type. Aperture moderately large and subovate, wider posteriorly than anteriorly. Outer lip thick, weakly indented to slightly flaring at each external spiral. Inner lip weakly appressed centrally and slightly raised both on the upper part of the parietal wall and adjoining the columella. Siphonal fasciole not prominent. Umbilicus not open but forming a well developed cleft. No internal folds on the columella. Sculpture consisting of weak axial ribs of which 7 are visible from an angle, and coarse spiral lines which are brought into greater relief by closely set upturned flutings; 2 of the spirals, 1 along the shoulder and 1 just below, stronger than the rest, the upper of these having its flutings distinctly upturned and giving the shell a coronate effect.

Holotype (USNM 562689) measures: height 28.7 mm, diameter 18 mm.

Type locality: Yonabaru clay member, 17451.

This species is closely related to *Latiaxis* (*Tolema*) *winckworthi* Fulton (see Kira, 1955, pl. 25, fig. 15), a living Japanese species. The Recent species is more inflated and the shoulder is more prominent with the shoulder spiral more frilled and flaring. According to Kira the living species lives at a depth of about 70 to 80 fathoms.

Pollia luliana Martin (1884, pl. 6, fig. 106) and *Tritonidea* (*Pollia*) *luliana*, Tesch (1915, pl. 81, fig. 120), from the upper Miocene of Java and the Pliocene of Timor, respectively, are probably closely related. However the Okinawan form has a lower spire and stronger axials. *Lataxiena luliana*, Nomura (1935, pl. 8, fig. 27) from the Byoritzu beds of Formosa is in my opinion quite a different species from that of Martin and Tesch. Specimens of the Byoritzu species are in the Hayasaka collection in the U.S. Geological Survey. They are closely related to *C. shimajiriensis* but the Byoritzu species has a concave subsutural slope whereas *C. shimajiriensis* has a convex one. Probably the Formosan species is closer to one figured by Altena (1950, p. 217, fig. 8) from the Miocene of Java as *Ocinebrina cereus* (E. A. Smith).

Coralliophila miocenica (Guppy) (see Woodring, 1928, pl. 18, fig. 5) has a lower spire, less lamellose spirals, and a larger umbilicus.

Distribution: Upper Miocene, (Yonabaru clay member) Okinawa; Pliocene(?), (Naha limestone) Okinawa.

Localities: Yonabaru clay member, 17451 (figured type).

Doubtful identifications: A fragment of a shell in limestone may be this species, Naha limestone, 17474.

Subgenus FUSOMUREX Coen, 1922

Type: *Purpura alucoides* Blainville.

Coralliophila (Fusomurex) shimajiriensis, n. sp.

Plate 3, figures 6, 12

Shell medium small, spire moderately high, canal moderately long, sutures well indented, whorls subrounded. Protoconch consisting of about 1½ smooth whorls, subnaticoidal and slightly inclined. Aperture subrounded, produced anteriorly to form a narrow, elongated canal. Outer lip of type broken back about 2 to 3 mm with no sulcations showing along the broken edge. Inner lip thin and sharp, detached anteriorly and forming an angulation at the posterior end of the siphonal canal, appressed on the parietal wall. Canal curving back weakly from the plane of the aperture and giving a twist to the columella, a well-formed denticle or short fold present at the posterior end of the canal. Umbilicus not open, but a narrow crease extends between the raised inner lip of the canal and the fasciole. Fasciole bearing well spaced imbrications. Sculpture both axial and spiral; axials not sharp and gently retractive, about 5 visible from an angle; spirals moderately coarse with a single interstitial spiral between the primary spirals below the shoulder, but fine and subequal in size on the subsutural slope, slightly imbricated, especially where they cross the axials, two prominent spiral lines above the suture on the younger whorls with the shoulder spiral tending to develop nearly closed hollow spines where they cross the axials.

Holotype (USNM 562687) measures: height 12 mm, diameter 6.1 mm.

Type locality: Shinzato tuff member, 17458.

This species may be closely related to a species figured by Yokoyama (1931, p. 200, pl. 12, fig. 3) from the Tanagura beds of Kiritani, Japan, (Miocene) as *Murex polygonulus* Lamarck. Hatai and Nisiyama (1952, p. 217) assign it to *Tritonalia inornata* (Recluz). However, I cannot be certain of the relationship from Yokoyama's figures. Kuroda and Habe (1952, p. 72) place *inornata* (Recluz) in the genus *Ocenebra*. The Okinawan species is close to the type of *Fusomurex*, *F. alucoides* (Blainville) from the Gulf of Naples, Italy.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa.

Localities: Shinzato tuff member, 17458 (figured type).

Coralliophila (?Fusomurex) sp.

Plate 3, figures 2, 9–10

Two specimens were obtained from the Yonabaru clay member of the Shimajiri formation which seem to agree in all characters except the degree of development of the siphonal fasciole and the twist of the columella. I believe them to be the same species, nevertheless. This species may also be related to "*Murex*" *polygonulus*, Yokoyama (see remarks under *C. shimajiriensis*), but I cannot be certain from Yokoyama's figures.

The Yonabaru specimens appear to have coarser primary spirals than *C. shimajiriensis* and there are no weak spirals on the subsutural slope as on the latter. The specimen with the well developed siphonal fasciole (pl. 3, fig. 2) compares with *C. shimajiriensis* (pl. 3, fig. 6) in this respect, at least.

The Yonabaru species has a definitely shorter spire than *C. shimajiriensis* from the Shinzato tuff member.

Distribution: Miocene, (Yonabaru clay member) Okinawa.
Localities: Yonabaru clay member, 17451 (figured), 17503 (figured).

Incerta sedis

Plate 3, figure 7

Only a fragment of this shell, probably a purpurid or coralliophilid, was obtained.

Locality: Yonabaru clay member, 17449 (figured).

Genus MAGILUS Montfort 1810

Type: *M. antiquus* Montfort.

Magilus antiquus Montfort

Plate 19, figures 13, 15–16

Magilus antiquus Montfort, 1810, Conchyliologie systèmatique, v. 2, p. 43.
Sowerby, 1823, Genera of Recent and fossil Shells, no. 21.
Martin, 1879, Tertiärschichten auf Java, p. 77, pl. 13, figs. 7, 8.
Tryon, 1880, Manual of conchology, v. 2, p. 216, pl. 68, figs. 400–411.

So variable are both the coiled and uncoiled stages of Recent *Magilus* that it is doubtful that more than one species exists—in spite of the numerous names that have been proposed. The specimen figured by Martin from the Miocene of Java does not appear to be distinguishable in any way from the Recent form.

The young specimen in figure 16 has weak spiral sculpture on the last whorl but cancellate sculpture on the penultimate whorl.

Distribution: Miocene, Java; Pleistocene, (Yontan limestone) Okinawa; Recent, western Indian Ocean, Indonesia to Japan.
Localities: Yontan limestone, 17513, 17542 (figured), 17637, 17644b (figured), 17652.
Comparative bathymetric data: A borer in reef-forming corals.

?Magilus sp.

Plate 16, figure 24

A poorly preserved fragment which may be a young *Magilus* was obtained from the Naha limestone. It could be a *Nerita.*

Locality: Naha limestone, 17585 (figured).

Superfamily BUCCINACEA

Family COLUMBELLIDAE

Genus PYRENE (Bolten) Roeding 1798

Type: *P. rhombifera* (Bolten) Roeding (=*Buccinum punctatum* Bruguière).

It is generally believed that the Chemnitz figures on which the above species are based represent the same species as the figures on which *Voluta discors* Gmelin is based. Bruguière's name narrowly antedates the other two.

Pyrene punctata (Bruguière)

Plate 19, figure 20

Buccinum punctatum Bruguière, 1789, Encyclopédie méthodique, p. 281.
Pyrene rhombiferum (Bolten) Roeding, 1789, Museum Boltenianum, pt. 2, p. 134.
Voluta discors Gmelin, 1791, Systema naturae, ed. 13, v. 1, pt. 6, p. 3455.
Conidea discors. Tryon, 1883, Manual of conchology, v. 5, p. 182, pl. 59, figs. 73–77.
Pyrene punctata. (Hirase) Taki, 1951, Handbook of illustrated shells, pl. 107, fig. 3.

A well preserved specimen of this species was obtained from the Yontan limestone. Another fragment from the Yontan limestone is doubtfully referred to it.

Distribution: Pleistocene, (Yontan limestone) Okinawa; Recent, ?East Africa, New Guinea, Borneo, Philippines to Japan.
Localities: Yontan limestone, ?17543, 17552 (figured).

Pyrene aff. P. flava (Bruguière)

Plate 13, figures 10, 17

?*Pyrene flava.* (Hirase) Taki, 1951, Handbook of illustrated shells, pl. 107, fig. 4.

Two specimens, one a large adult lacking a spire and the other a medium-sized individual without a callus, were obtained from the Chinen sand. They appear to be closely related to *P. flava*, a Recent Japanese species, and may actually be that species.

Distribution: Pliocene, (Chinen sand) Okinawa. According to Tryon the Recent species ranges from the Indian Ocean to Japan and Polynesia.
Localities: Chinen sand, 17442 (figured).

Pyrene aff. P. ligula (Duclos)

Plate 17, figure 18

?*Columbella* (*Mitrella*) *ligula.* Tryon, 1883, Manual of conchology, v. 5, p. 119, pl. 47, fig. 55.

The only specimen so identified comes from limestone. It is incomplete but the aperture and columella are well preserved. This specimen may be the same species as the preceding one referred to *P. flava* but it is less inflated.

Distribution: Pliocene, (Naha limestone) Okinawa. Tryon gives the Recent distribution as Philippines, Solomon Islands and Uiti (Fiji) Islands. Kuroda and Habe report it in the southern Ryukyu Islands.
Localities: Naha limestone, 17474 (figured).

Genus **MITRELLA** Risso 1826

Type: *Mitrella flaminea* Risso (=*Murex scriptus* Linné).

Mitrella gonzabuensis, n. sp.

Plate 3, figure 13

Shell of medium size for the genus, elongate and moderately slender, spire accounting for a little more than half the length of the shell, whorls very gently rounded, smooth. Protoconch unknown. Aperture moderately narrow, slightly constricted anteriorly to form a weak canal, widest at the basal constriction of the body whorl; anal notch moderately well developed. Outer lip thin at the edge but thickening rapidly toward a blunt varix just behind the edge, about 7 weak, elongate denticles inside opposite the external varix. Inner lip thin and appressed. Upper surface of whorls smooth except for crowded, slightly undulating growth lines locally, not present everywhere; columella sculptured with incised spiral grooves that are coarser along the basal constriction. Traces of color markings indicate that a sharp, narrow light-colored band was present along the position of the posterior end of the aperture.

Holotype (USNM 562691) measures: height 11.8 mm, diameter 4.2 mm.
Type locality: Yonabaru clay member, 17449.

The type and two other specimens were obtained.

This species may be closely related to *M. sagitta* (Gaskoin). Tryon's figure of this species (1883, pl. 52, fig. 83) does not show a light colored band, but the description states that it has "a band on the periphery and sometimes another at the suture". The color band does not show on the figure of the holotype owing to the ammonium chloride coating used in photographing and, moreover, it is best preserved on the side opposite the aperture.

In form this species somewhat resembles *Columbella* (*Atilia*) *smithi* Yokoyama (1922, p. 61, pl. 2, fig. 24) but the latter has more definitely formed axials, although still weak, and a sharper angulation on the lower part of the body whorl.

There are several closely related species in the Miocene of Florida. (See Gardner, 1947, pl. 52.)

Distribution: Miocene, (Yonabaru clay member) Okinawa.
Localities: Yonabaru clay member, 17449 (figured type).

Mitrella aff. M. burchardi (Dunker)

Plate 13, figures 12, 18

?*Columbella* (*Mitrella*) *burchardi*. Tryon, 1883, Manual of conchology, v. 5, p. 129, pl. 49, fig. 17.

?*Columbella* (*Atilia*) *burchardi*. Yokoyama, 1920, Tokyo Imp. Univ. Coll. Sci. Jour., v. 39, art. 6, p. 59, pl. 3, fig. 7.

?*Pyrene burchardi*. Kuroda and Habe, 1952, Recent marine Mollusca of Japan, p. 81.

?*Mitrella* (s. s.) *burchardi* var. Taki and Oyama, 1954, Paleont. Soc. Japan Spec. Paper 2, pl. 4, fig. 7.

Whether or not the Pliocene, Pleistocene, and Recent forms assigned to this species are really conspecific is difficult to determine from the published figures but their close relationship seems beyond question.

The fine incised spiral lines are strongest on the lower part of the whorl and columella, and one or two strong ones are present just below the suture. On one of the figured specimens (fig. 18) they are weakly developed on the central part of the whorls; on the other (fig. 12) they are absent centrally. Both specimens have 10 denticles on the inside of the outer lip. The columella is smooth.

There is a striking resemblance between this shell and *Mitrella* (*Columbellopsis*) *mississippiensis* (Meyer and Aldrich) (see Palmer, 1937, pl. 38, figs. 17, 21–22) from the middle Eocene of Mississippi.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa; Pliocene, (Chinen sand) Okinawa; Pleistocene, Japan; Recent, Japan.
Localities: Shinzato tuff member, 17458 (figured); Chinen sand 17482b (figured).

Genus **ANACHIS** H. and A. Adams 1853

Type: *Columbella scalerina* Sowerby.

Subgenus **COSTOANACHIS** Sacco 1890

Type: *Columbella* (*Anachis*) *turrita* Sacco.

Anachis (Costoanachis) leroyi, n. sp.

Plate 13, figure 11

Shell medium small, moderately inflated, sagittate, spire over one-half the length of the shell, spire whorls very gently rounded. Protoconch smooth and slightly inclined, only the last whorl preserved on the holotype. Aperture moderately narrow, sharply constricted anteriorly to form a short narrow canal; anal notch shallow but well defined. Outer lip thin with a blunt varix immediately behind it, 6 slightly elongate denticles on the inside opposite the varix. Inner lip appressed on the parietal wall to form a thin callus, appressed along the columella except for the leading edge which is detached and erect; 5 slightly elongate denticles on the inner lip where it is appressed to the columella. Body whorl sharply constricted at the base, making the transition to the columella abrupt. Columella slightly tapering anteriorly, moderately short. Sculpture consisting of moderately strong, nearly vertical axials on the first four whorls which become obsolete after the fifth whorl; body whorl smooth. Columella bearing strong, rounded spiral threads, ending abruptly at the basal constriction.

Holotype (USNM 562936) measures: height 8.5 mm, diameter 3.7 mm.

Type locality: Chinen sand, 17481.

The importance of the denticles on the columella of this species is not clear. They do not appear to be merely the reflection of the coarse spirals through a thin callus because they are slightly offset from them, short, and built up of callus material. In most respects *A. leroyi* appears to be related to *Pyrene* (*Mitrella*) *yabei* Nomura (1935, p. 157, pl. 7, fig. 28). However, the latter has axials that persist longer, being weakly developed near the suture on the sixth or seventh whorl, and according to the description the columella is not denticulate.

Distribution: Pliocene, (Chinen sand) Okinawa.
Localities: Chinen sand, 17481 (figured type).

Anachis (Costoanachis) chinenensis, n. sp.

Plate 14, figure 4

Shell small, moderately inflated, spire about half the length of the shell, spire whorls moderately rounded. Protoconch naticoidal, smooth, consisting of about one and a half whorls, slightly inclined. Aperture of moderate width, produced anteriorly to form a narrow canal; anal canal not well defined. Outer lip thin at the edge but thickening rapidly, 4 prominent denticles inside, the upper 3 slightly elongate, the lower one blunt and rounded. Inner lip thin, tightly appressed on the parietal wall, weakly appressed or very slightly detached on the columella, bearing 3 well-defined denticles. Body whorl moderately constricted at the base. Columella moderately stout and tapering. Sculpture consisting of moderately strong, slightly protractive, rounded axials which die out on the lower part of the body whorl, 7 to 8 visible from an angle, and low rounded spiral ridges which are weaker near the suture, stronger towards and on the columella; a narrow but well-defined collar just below the suture, which is made weakly nodose by the top of the axial ribs.

Holotype (USNM 562957) measures: height 5.4 mm diameter 2.5 mm.

Type locality: Chinen sand, 17482b.

I cannot be certain from the published illustrations how closely this species is related to any living species in the Indo-Pacific region. It may be distantly related to the species listed by Kuroda and Habe (1952, p. 81) as *Pyrene conspersa* (Gaskoin) (see Tryon, 1883, p. 145, pl. 52, fig. 78), but *P. conspersa* has a moderately broad shoulder, more denticles in the aperture, and more axial ribs.

Anachis (*Costoanachis*) *aulata* Woodring (1928, p. 277, pl. 16, fig. 17) from the Bowden formation (Miocene) of Jamaica resembles *A.* (*C.*) *chinenensis* very much in general form but it too has more denticles in its aperture and the base of the body whorl is less constricted.

Distribution: Pliocene, (Chinen sand) Okinawa.
Localities: Chinen sand, 17482–b (figured type).

Family BUCCINIDAE

Loochooia, new genus

Type: *Loochooia hanzawai*, n. sp.

Shell inflated, spire inflated, columella short and slightly twisted. Protoconch slightly bulbous, involute, smooth. Sculpture spiral and raised, no axials except for growth lines. Aperture simple, no folds, or denticles, broadly canaliculate anteriorly and slightly twisted. Siphonal canal broad and short. Callus impressed.

This genus is closest to some buccinid genera known only from cold water, particularly *Latisipho* Dall and *Clinopegma* Grant and Gale; the latter proposed as a section of *Neptunea* (*Sulcosipho*) Dall. It will include some species formerly placed in *Neptunea* by other authors such as *N. onchodes* (Dall) (see Dall, 1921, pl. 9, fig. 8).

Loochooia hanzawai, n. sp.

Plate 8, figure 12

Shell medium small, medium inflated, spire about the same length as the aperture. Protoconch involute and slightly bulbous, the first half-turn in a different plane from the succeeding whorl and somewhat irregular in shape and surface, the next half-turn smooth and evenly coiled. Aperture broadly lenticular. Outer lip thin and simple, smooth within. Siphonal canal short and broad, slightly twisted. Parietal callus thin and tightly appressed, preceded by a narrow etched zone; the spiral sculpture being removed before deposition of the callus. Columella simple and slightly twisted, moderately short. Sculpture consisting of fine spiral threads, three on the periphery being stronger than the rest, the lower of these covered by succeeding whorls on the spire, spirals low, rounded and slightly irregular in size elsewhere, crossed by growth lines which just below the suture are sometimes slightly raised.

Holotype (USNM 562819) measures: height 15.8 mm, diameter 8 mm.

Type locality: Shinzato tuff member, 17454.

The writer finds no recent or fossil warm water species from the western Pacific with which this species can be compared. However, it appears to be very closely related to a cold water species described by Dall as *Chrysodomus oncodes*, a species recorded from the Sea of Okhotsk along the Kuril Islands, and Bering Sea on Petrel Bank north of Semisopochnoi Island in the Aleutians. Kuroda and Habe report it also from the Japan Sea side of Sakhalin. *Ancistrolepsis trochoideus* Dall (1921, pl. 9, fig. 5) may be the young of the same species. *Loochooia oncodes* is a larger species (height 103 millimeters) than *L. hanzawai* and it has four or five primary spirals on the central part of the body whorl whereas *L. hanzawai* has two.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa.

Localities: Shinzato tuff member, 17454 (figured type).

Comparative bathymetric data: *Loochooia oncodes* (Dall) was obtained from depths of 54 fathoms (Petrel Bank, Bering Sea) and 229 fathoms (Sea of Okhotsk).

Genus SIPHONALIA A. Adams 1863

Type: *Buccinum cassidariaeformis* Reeve.

Siphonalia yonabaruensis, n. sp.

Plate 3, figures 14–15

Shell inflated and moderately low, whorls well rounded with a weak but well defined shoulder, spire a little more than a third the height of the shell, canal of moderate length and nearly straight. Protoconch not known. Aperture moderately broad, produced anteriorly to form a broad canal. Outer lip thin. Inner lip thin and tightly appressed on both the parietal wall and columella. Columella weakly twisted. Anal fasciole well developed but not prominent, bounded above by a low, sharp keel. Axial ribs nearly vertical and rounded, about 8 to 10 visible from an angle, best developed on the central part of the whorl but continuing weakly to the suture. Spiral sculpture on subsutural slope and columella consisting of alternating finer and coarser raised spiral threads, but on the central part of the body whorl the spiral threads tend to flatten, broaden, and break up irregularly.

Holotype (USNM 562692) measures: height 18 mm, diameter 11 mm.

Type locality: Yonabaru clay member, 17449.

The species is represented by the holotype and two fragments from another locality. It may be related to *S. cassidariaeformis* (Reeve) which it resembles in shape but it has more numerous, thinner, and more elongate axial ribs than the living species. The specimen figured by Yokoyama (1923, pl. 1, fig. 13) from the Pliocene of Dainichi, Japan, as *S. cassidariaeformis* also appears to have fewer and shorter axial ribs. It has been generally assumed by some recent Japanese paleontologists that the specimen from Dainichi cited above is referable to *S. declivis* Yokoyama (1926, p. 337, pl. 38, figs. 19–21), also from Dainiti, but this is open to question. Although I have only the figures to go by, I suggest that two species are involved and that the specimen figured by Yokoyama in 1923 belongs to the *S. cassidariaeformis*—*S. yonabaruensis* group.

Siphonalia yonabaruensis is more like *S. modificata* (Reeve) (see Makiyama, 1941, pl. 4, fig. 11) in the shape of its columella and the details of its siphonal fasciole. However, living *S. modificata* is a higher spired species.

Distribution: Miocene, (Yonabaru clay member) Okinawa.

Localities: Yonabaru clay member, 17449 (figured type), 17679.

Siphonalia aff. S. dainitiensis Makiyama

Plate 13, figures 24–25

?*Siphonalia dainitiensis* Makiyama, 1927, Kyoto Imp. Univ. Coll. Sci. Mem., ser. B, v. 3, p. 117, pl. 5, fig. 11.
?Makiyama, 1941, Kyoto Imp. Univ. Coll. Sci. Mem., ser. B, v. 16, no. 2, p. 90.

The species so identified very closely resembles Makiyama's species in general shape and sculpture. It can be distinguished easily from *S. subspadicea* (compare it particularly with the low spired form, pl. 13, fig. 15) by the inclination of the axials; those of *S. subspadicea* being nearly straight and vertical whereas those of *S.* aff. *S. dainitiensis* curve to the left ventrally. It is not obvious from Makiyama's figure whether or not the same is true of the specimens from Dainiti, nor do any of the siphonalids figured by Makiyama in his paper on the genus *Siphonalia* (1941) have recurving axials. However, a lesser degree of recurvature is shown by the axials of the Miocene *S. yonabaruensis* (see pl. 3, figs. 14–15).

A specimen of the same or a very closely related species is in the Hayasaka collection from the Byoritzu beds of Formosa in the U.S. Geological Survey. It is labelled "*Siphonalia cassidariaeformis* (Reeve), Loc. Wanga." It may be the same species as that figured by Nomura (1935, pl. 7, fig. 34) as *S. cassidariaeformis*, but it does not have its outer lip preserved.

The columellar and fasciolar characters as well as the curving axials all suggest that the Byoritzu specimen above, *S.* aff *S. dainitiensis* from Okinawa, and *S. yonabaruensis* are more closely interrelated than any of these forms is to Recent *S. cassidariaeformis*.

Distribution: Pliocene, (Nakoshi sand) Okinawa, (Dainiti formation) Japan.

Localities: Nakoshi sand, 17440 (figured).

Siphonalia subspadicea, n. sp.

Plate 13, figures 15, 16

Shell of medium size for the genus, medium to moderately inflated, spire ranging from slightly shorter to slightly longer than the aperture, whorls convexly rounded below the shoulder but slightly concave above the shoulder, columella moderately short and twisted. Protoconch consisting of about two smooth whorls, the first one and a half whorls slightly inclined and subnaticoidal, the last half-turn becoming more in the axis of the later whorls. Aperture subovate, terminating posteriorly in a well defined U-shaped anal notch, produced anteriorly to form a short curved siphonal canal. Outer lip thick but with a sharp edge, the inner side with numerous elongate raised lirations. Inner lip a moderately heavy callus, appressed tightly on the parietal wall and columella, but becoming slightly detached anteriorly where it forms the wall of the siphonal canal, a very small umbilical chink formed at the place of detachment. Suture appressed and with a narrow but well-defined collar. Siphonal fasciole moderately prominent, the posterior margin on some specimens a sharp, raised keel, on others merely sharply recurving growth lines. Sculpture consisting of axial ribs and spiral lirations; axials nearly vertical and on some indivduals strong and narrow and extending nearly to the base of the whorls, on others low and short with a tendency to become obsolete on the body whorl, about 6 to 7 axials visible from an angle; spiral lirations sharply raised on the young whorls but becoming lower and less regular on the later whorls, perhaps becoming obsolete on the center of the body whorl, generally developing a secondary liration between the primary lirations on the columella.

Holotype (USNM 562942) measures: height 28 mm, diameter 13 mm. Paratype (USNM 562941), height 25 mm, diameter 13 mm.

Type locality: Chinen sand, 17481.

Siphonalia subspadicea is closely related to the Recent *S. spadicea* but is apparently a smaller species. Several specimens that appear to be full-grown adults average between 25 and 27 mm in height, whereas Recent *S. spadicea* averages about 45 mm. The axial ribs of the Okinawan form are broader and extend nearly to the base of the whorl, whereas on *S. spadicea* they are weaker and extend to little beyond the middle of the whorl.

Distribution: Pliocene, (Chinen sand) Okinawa.

Localities: Chinen sand, 17481 (figured type).

Siphonalia mikado makiyamai, n. subsp.

Plate 8, figure 17

Shell of medium size, medium inflated, spire of about the same length as the aperture, whorls bluntly carinate and nodose. Protoconch smooth, bulbous and slightly tilted, only the last whorl preserved on the type. Aperture broadly elliptical, terminating in a narrow groove posteriorly and produced to form a twisted canal anteriorly. Outer lip thick but thinning rapidly at the edge, with numerous elongate denticulations on the inside. Parietal wall with a well-developed callus. Inner lip appressed posteriorly and bearing a small blunt tubercle opposite the anal notch, detached slightly along the columella above the siphonal fasciole, appressed on the fasciole, and detached and sharp along the siphonal canal; shell not umbilicate but with a well-defined chink where the inner lip is detached. Siphonal fasciole with rounded, irregular growth lines and a low sharp keel along the posterior edge. Sculpture consisting of blunt, rounded, somewhat shortened axial ribs (5 to 6 visible from an angle) which are highest at the periphery but which become obsolete on the lower part of the body whorl, and blunt raised spiral lirations which are weakest on the subsutural slope, strongest at and just below the periphery, and on the lower part of the whorl are interspaced with secondary and tertiary lines; on the young whorls two prominent spirals are developed along the periphery with a third appearing between them at a later stage.

Holotype (USNM 562824) measures: height 41 mm, diameter 20 mm.

Type locality: Shinzato tuff member, Takabanare-shima, 17477.

This species is very closely related to *S. mikado* and is made a subspecies of it. It differs from typical *S. mikado* in having fewer and wider axials (5 to 6 visible as opposed to 8 or 9 in *S. mikado*), in having only a chink whereas *S. mikado* has a shallow, open umbilicus, and in having a pair of prominent spirals on the young whorls whereas *S. mikado* has several spirals of nearly uniform strength on the young whorls. Regardless of these differences, *S. mikado makiyamai* appears to be more closely related to the typical form than to any of the subspecies described from the Ketienzian series of Japan by Makiyama (1941).

Distribution: Miocene, (Yonabaru clay member) Okinawa; Miocene or Pliocene, (Shinzato tuff member) Takabanare-shima, Okinawa-gunto.

Localities: Yonabaru clay member, 17451; Shinzato tuff member, 17477 (figured type).

Comparative bathymetric data: Two lots of the Recent *S. mikado* were obtained by the Albatross Expedition from off Japan at depths of 57 and 65–125 fathoms.

Siphonalia aff. S. mikado Melvill

Plate 3, figure 16

A single incomplete specimen of a *Siphonalia* related to *S. mikado* Melvill (1909, p. 348) was obtained from the Yonabaru clay member. No apertural parts are preserved on the specimen, but its sculpture compares closely with a specimen in the Hirase collection in the U.S. National Museum from Tosa, Japan, labelled *S. funera* Pilsbry. The Recent specimen is very pale yellowish brown rather than the deep chocolate brown of *S. funera*, and moreover seems to be indistinguishable from *S. mikado* in apertural characters; presumably it is an undescribed form. The primary spirals are stronger and the secondary spirals better developed on both the Okinawan fossil and the Recent specimen in question than on typical *S. mikado*. Typical *S. mikado* rarely has secondary spirals, whereas the present species has a well developed secondary spiral and between some of the lines faint tertiary lines are present.

Localities: Yonabaru clay member, 17502 (figured).

Siphonalia laddi, n. sp.

Plate 8, figure 16

Shell moderately large, slender, spire about 1¼ times the length of the aperture, whorls rounded with a nearly straight subsutural slope. Protoconch unknown. Aperture subovate, produced anteriorly to form a sligthly twisted canal of moderate length. Siphonal fasciole moderately developed. Outer lip with a thin weakly serrated edge, but thickening rapidly. Parietal wall dissolved by the advancing aperture resulting in a low step at the edge of the parietal callus, the callus thickening on the columella and tightly appressed with no umbilical opening. Sculpture consisting of regular axial ribs, about 7 visible on the young whorls and 9 on the later whorls, which completely cross the visible part of the spire whorls but die out at about the level of the suture on the body whorl, and strong spiral lines all over the shell, those of the peripheral region being stronger than those of the subsutural slope and basal part of the whorl, the spirals and interspaces being subequal in width all over the whorl.

Holotype (USNM 562823) measures: height 50 mm, diameter 20 mm.

Type locality: Shinzato tuff member, 17454.

Unless I am entirely wrong in the generic assignment of this shell it has a combination of characters that make it unique. It is possible that it really belongs to some other genus such as *Searlsia* or *Kelletia*. It may be closely related to a species figured as *Searlsia coreanica* (Smith) by Kanehara (1942, pl. 49, fig. 6) from the Pliocene of the Katanishi Oilfield, Japan.

Occasional specimens of *S. spadicea* have a recessed parietal callus similar to that of *S. laddi*, but more commonly the inner lip is free and raised. A specimen in the U.S. National Museum labelled *S. stearnsi* Pilsbry and coming from Mogi, Japan, has similar sculpture but differs in having a larger, more twisted columella, a more tightly appressed suture, and a free, slightly raised inner lip.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa.

Localities: Shinzato tuff member, 17454 (figured type).

Genus HINDSIA (Gray) Mörch 1852

Type: *Hindsia alba* (Martini) (*Nassa alba* Martina =*pusilla* (Bolten) Roeding).

Although *Hindsia* has been treated as a synonym of *Nassaria* Link 1807 by many authors, *Nassaria* has been flatly rejected by others. Iredale would not accept *Nassaria* because of the previous *Nassarius* Dumeril, but this objection seems to be taken care of adequately by opinion 115 of the International Commission on Zoological Nomenclature. Otherwise the argument seems to hinge on whether the type designation for *Nassaria* that would make it a synonym of *Hindsia* is a valid one. Mörch (1862, p. 227) pointed out that the designation of *Buccinum niveum* Gmelin as type of *Nassaria* is not acceptable because Link's figure reference is an error. Link's citation reads "*N. lyrata*. L. G. p. 3494. M. C. 4, t. 122, f. 1122, 1123." *Buccinum lyratum* Gmelin appears on page 3494 of Gmelin's 13th edition of Linné but the Martini-Chemnitz reference to *B. lyratum* is "t. 127, 1221, 1222." Martini's figures 1122 and 1123 refer to *Buccinum niveum* Gmelin. *Buccinum niveum* would not be available as type, therefore, unless it were construed that Link's erroneous citation made both *lyratum* and *niveum* available. A validly proposed species listed as a synonym by name, even if not now regarded as a synonym, would be available as type, but it is extremely doubtful that an erroneous reference without the citation of a name would make the species represented by the reference available.

Hindsia nivea (Gmelin) would be the valid name for the type species of *Hindsia* except for the fact that *Buccinum niveum* Gmelin (p. 3494) is preoccupied by *Buccinum niveum* Gmelin (p. 3471), a species of another genus. Roeding's name is the next available.

Hindsia is generally credited to H. and A. Adams, 1853. If the type designation given above, made by Kobelt, 1878, for "*Hindsia* Adams" is not valid for *Hindsia* (Gray) Mörch, the present treatment is probably the first subsequent designation.

Nihonophos MacNeil, new subgenus

Type: *Nassaria magnifica* Lischke.

The type species has been referred to either *Nassaria* or *Hindsia* by practically all writers. Species included under both generic names range from high spired to low spired and from species having a channelled suture to species with an appressed suture and a flattened or slightly concave subsutural slope. The channelled suture results from prominence of the posterior extremity of the outer lip. The subgenus *Nihonophos* is here proposed for the type having an appressed suture and a concave subsutural slope. This type is usually high spired and has a columella of moderate length although there are exceptions. Typical *Hindsia* has a convex subsutural area and the suture is not broadly appressed; it may be lower than the highest point on the subsutural area.

Hindsia (Nihonophos) magnifica (Lischke)

Plate 3, figures 17–18

Nassaria magnifica Lischke, 1871, Malakozoologische Blätter, v. 18, p. 148.

Lischke, 1871, Japanische Meeres-Conchylien, v. 2, p. 38, pl. 4, figs. 11, 12.

Dunker, 1882, Index Molluscorum Maris Japonici, p. 38, (In part.)

Nassaria (=*Hindsia*) *magnifica*. Pilsbry, 1895, Catalog of the marine mollusks of Japan, p. 34. (In part.)

Nassaria magnifica. Yokoyama, 1926, Tokyo Imp. Univ. Faculty Sci. Jour., v. 1, pt. 9, p. 338, pl. 41, fig. 6.

Specimens obtained from the Yonabaru clay member of the Shimajiri formation are referred tentatively to this species. They agree with Recent specimens in all details except that the secondary spiral lirations tend to be finer and more regular. There is considerable variation in this character on Recent specimens, however, some being much coarser and some approaching the Okinawan fossils so that the writer hesitates to regard the latter as even subspecifically distinct without examining additional Recent shells.

The smaller figured specimen (pl. 3, fig. 18) has more axial ribs than the larger specimen figured (fig. 17), a character that seems also to be inconsistent on Recent specimens. A specimen figured by Hirase (1908, vol. 2, no. 4, pl. 27, fig. 50,), as well as the form figured as *Nassaria magnifica* var. by Lischke (1874, v. 3, pl. 1, figs. 5, 6), has more numerous axials than the typical form but it has secondary spirals that are generally stronger than those of the typical form, whereas the secondary spirals on the Okinawan fossils are weaker than on most individuals of the typical form.

Distribution: Miocene, (Yonabaru clay member) Okinawa; Miocene or Pliocene, (Shinzato tuff member) Okinawa; Pliocene, (Hijikata formation) Japan; Recent, northern South China Sea to central Japan.

Localities: Yonabaru clay member, 17448 (figured), 17451 (figured); Shinzato tuff member, 17677.

Comparative bathymetric data: Specimens obtained by the Albatross from off southern Honshū and Kyūshū are from depths of 70, 88, 94, 150, 153, and 197 fathoms. A specimen from off Pratas Island (northern South China Sea) was taken at 150 fathoms.

Hindsia (Nihonophos) magnifica shimajiriensis, n. subsp.

Plate 3, figures 22–23

Shell of medium size, moderately inflated, spire about one and a third times as long as the aperture, whorls subangulate with a bicarinate periphery in the young stages which becomes more evenly rounded in adults. Protoconch moderately small, subnaticoidal and slightly tilted, consisting of about 1¼ to 1½ turns, unsculptured. Aperture broadly elliptical, the anterior end extended to form a canal of moderate length that is twisted directly back from the plane of the aperture. Outer lip thin, but thickening towards a varix just a short distance back from the edge and with a row of denticles inside opposite the varix. Parietal wall and columella weakly callused. Columella bearing two weak folds just above the point of twist. Sculpture on the young whorls consisting of regular but weak axials, about 7 visible from an angle, not present beyond the fifth whorl; axials crossed by 3 prominent spirals on the first 2 whorls, two on the third, fourth and fifth whorls, and subequal spirals on subsequent whorls beyond the point where the axials die out; secondary spiral lirations appearing on about the third whorl which become subequal in size with the primary spirals on about the fifth whorl, the spirals increasing greatly on the body whorl, numbering over 45 on the body whorl and columella.

Holotype (USNM 562699) measures: height 30 mm, diameter 13.3 mm.

Type locality: Yonabaru clay member, 17451.

The type of this species has an immature aperture indicating that the specimen is not full grown. Although the adult sculpture differs greatly from that of specimens referred to *H. magnifica* occurring with it, the sculpture of the early whorls is almost identical with that of *H. magnifica*. The apertural and columellar characters likewise indicate that the two are very closely related. No other species of *Hindsia* appears to have been described with sculpture exactly like that of *H. magnifica shimajiriensis*. Possibly the form nearest to it is the "nontuberculate" variety of *N. magnifica* figured by Kobelt (see Tryon, v. 3, pl. 84, fig. 552). Whether or not this form is part of an evenly grading series with the typical form I have been unable to determine.

Distribution: Miocene, (Yonabaru clay member) Okinawa.

Localities; Yonabaru clay member, 17451 (figured type).

Hindsia (Nihonophos) magnifica okinavia, n. subsp.

Plate 13, figure 26

Shell of medium size, moderately inflated, spire a little longer than the aperture, spire whorls made bicarinate by two rows of beaded spirals, additional spirals visible on the body whorl. Protoconch small, consisting of about 1¼ whorls, smooth, subnaticoidal and slightly tilted. Aperture subovate, produced anteriorly to form a narrow canal of moderate length, twisted back and slightly to the left of the plane of the aperture. Outer lip with a thin, weakly serrated edge which has a moderately strong varix located just behind it, and a row of denticles within it opposite the varix. Parietal callus thin and appressed. Columella bearing a single weak fold just above the columellar twist; another moderately well defined fold on the parietal wall close to the posterior end. Sculpture consisting of well developed axial ribs (7 to 8 visible from an angle) which cross the subsutural slope nearly to the suture above and die out before reaching the columella below, and prominent primary and secondary spiral lines, the primaries set with a strong elongate bead where they cross the axials, 1 weak primary on the subsutural slope, 2 prominent primaries along the periphery of the spire whorls, and 4 additional primaries becoming weaker towards the base on the body whorl, secondary spirals subequal in strength all over, about 6 above the weak primary on the subsutural slope and from 2 to 3 between the other primaries. A prominent varix is formed just behind the aperture of adults.

Holotype (USNM 562948) measures: height 21.3 mm, diameter 10.1 mm.

Type locality: Chinen sand, 17481.

This species is very closely related to *H. whitmorei* in sculptural details but differs from it in being much more slender. Enough specimens of each are on hand to show that there is no intergradation in this respect. In shape it more closely resembles the form figured as *Nassaria magnifica* by Yokoyama from the Hijikata formation (Pliocene) of Japan, but the latter has fewer axials, only 5 or 6 being visible on Yokoyama's figure whereas on *H. okinavia* usually 7 or 8 are visible from any angle. The axials are stronger on the subsutural slope than on the specimens referred to *H. magnifica* from the Yonabaru clay member of the Shimajiri formation. However they are similar to Recent specimens in this respect. *Hindsia takabanarensis* has no secondary spirals and is slenderer than this species.

Hindsia okinavia is undoubtedly related to *H. magnifica* Lischke, but is considerably smaller. Several specimens of *H. okinavia*, including the type, have adult apertures and presumably are full grown, whereas specimens of *H. magnifica* of the same size have immature apertures.

Distribution: ?Miocene or Pliocene, (Shinzato tuff member) Okinawa; Pliocene, (Chinen sand) Okinawa.

Localities: Chinen sand, 17481 (figured type).

Doubtful occurrences: Shinzato tuff member, 17677.

Hindsia (Nihonophos) whitmorei, n. sp.

Plate 3, figure 19

Shell of medium size, inflated, spire and aperture subequal in length, whorls slightly concave on the subsutural slope and rounded below the periphery with two prominent spirals along the periphery. Protoconch small, naticoidal and slightly tilted, smooth and consisting of about 1¼ whorls. Aperture subovate, extended anteriorly to form a siphonal canal of moderate length which curves back and slightly to the left from the plane of the aperture. Outer lip with a thin rounded edge and bearing a row of denticles within opposite an external varix, the denticles stronger anteriorly. Parietal wall and columella slightly callused; columella bearing a weak but well-defined fold at the base which marks the beginning of the canal; parietal wall bearing a weak fold close to the anterior end of the aperture. Sculpture consisting of axial nodes and both primary and secondary spiral lirations; axials more numerous and more closely set on the young whorls, about 8 or 9 visible from an angle on the young whorls, 7 on the penultimate whorl, and 6 on the body whorl; primary spirals two in number on the spire whorls, with occasionally a third visible just above the suture, and 7 or 8 on body whorl, gradually diminishing in size towards the base and becoming subequal in size with the secondary lirations, the secondary spirals numbering about 12 on the subsutural slope, and from 2 to 5 between the primary spirals on the body whorl.

Holotype (USNM 562696) measures: height 21.3 mm, diameter 13 mm.

Type locality: Yonabaru clay member, 17445.

The nearest relative of this species that I can find is the species figured by Yokoyama (1926, p. 338, pl. 41, fig. 6) as *Nassaria magnifica* from the Hijikata formation (Pliocene) of Japan. I do not believe that Yokoyama's fossil should be combined with the Recent species. The sculpture of *H. whitmorei* compares very closely with that of the Hijikata form but the latter is a considerably slenderer shell. Both forms have the closely appressed suture, the slightly concave subsutural slope, and the non-alate outer lip that characterize the subgenus *Nihonophos* even though *H. whitmorei* compares more with the majority of the species of typical *Hindsia* in the height of its spire.

In sculptural details it agrees closely with *H.* (*N.*) *magnifica* and its subspecies *okinavia*. There are sufficient specimens at hand to show that it is a distinct form and that there is no integration between the low, inflated *H.* (*N.*) *whitmorei* and *H.* (*N.*) *magnifica*.

Distribution: Miocene, (Yonabaru clay member) Okinawa; ?Miocene or Pliocene, (Shinzato tuff member) Okinawa.

Localities: Yonabaru clay member, 174475 (Figured type), 17502.

Doubtful occurrences: Shinzato tuff member, 17458 (a fragment).

Hindsia (Nihonophos) takabanarensis, n. sp.

Plate 13, figure 19

Shell of medium size to small, moderately slender, spire about one and a half times the length of the aperture, whorls weakly bicarinate with a concave subsutural slope. Protoconch medium small, subnaticoidal and tilted, smooth, consisting of about one and a quarter turns. Aperture moderately narrow, produced anteriorly to form a canal of medium length that is twisted almost directly backward. Outer lip with a thin edge but with a row of well defined denticles a short distance back from the edge. Columella with two short folds at the base which lie opposite the lower denticles of the outer lip and mark the point of separation of the aperture and the siphonal canal. Parietal wall and columella with a well-defined callus, bearing 2 well defined folds just above the columellar twist, and 1 well defined fold just below the posterior end of the aperture; parietal callus appressed. Sculpture consisting of low straight axials, about 7 visible from an angle, which are crossed by 2 strong spirals on the spire whorls, the spirals being much stronger where they cross the axials than in the intervening area, and on the body whorl below the suture 4 more similar spirals of gradually decreasing strength are present; 1 very weak secondary spiral is present on the type between the 2 peripheral spirals, but elsewhere the sculpture consists of faint growth lines only.

Holotype (USNM 562943) measures; height 16 mm, diameter 7 mm.

Type locality: Chinen sand, 17476.

I can find no close relative of this species. It is obviously related to *H. magnifica* but the latter has neither the columellar nor the parietal folds as well developed and the denticulations inside the outer lip are much weaker. The holotype of *H. takabanarensis* has a strong varix behind the aperture and is apparently a full grown adult, whereas living *H. magnificia* do not develop mature aperatures until the shells reach a size of from 40 to 50 millimeters.

Distribution: Miocene, (Yonabara clay member) Takabanare Shima, Okinawa Gunto.

Localities: Yonabara clay, member 17476 (figured type).

Genus PHOS Montfort 1810

Type: *Murex senticosus* Linné

Subgenus CORAEOPHOS Makiyama 1936

Type: *Phos* (*Coraeophos*) *meisensis* Makiyama.

This subgenus may prove to be a synonym of *Antillophos* Woodring 1928 which Woodring made a subgenus of *Tritiaria* Conrad. The specimen here figured appears to be very closely related to *Tritiaria* (*Antillophos*) *moorei* (Guppy) (see Woodring, 1928, pl. 15, fig. 11). *Coraeophos* is used here tentatively because its type is an asiatic species.

Phos (Coraeophos) aff. P. reticosus Hinds

Plate 3, figure 20

?*Phos reticosus* Hinds, 1844. Zoology of the voyage of the *Sulphur*, v. 2, Mollusca, p. 37, pl. 10, fig. 3, 4.

A specimen from the Shimajiri formation compares favorably with Hinds species. It has slightly less developed teeth on the columella and parietal wall but may be no more than subspecifically removed from typical *P. reticosus.*

The single specimen obtained from the Yonabaru clay member has 2 or 3 fine spiral lirations between each of the coarser spirals; they do not show well in the figure.

The type of *Coraeophos*, *C. meisensis* Makiyama (1936, p. 225, pl. 5, figs. 18–19) from the Miocene near Meisen, Korea, has more coarsely cancellate sculpture but it is probably closely related.

Distribution: Miocene, (Yonabaru clay member) Okinawa.

Localities: Yonabaru clay member, 17451 (figured).

Comparative bathymetric data: *Phos reticosus* Hinds was obtained by the Albatross Expedition from 2 stations, 1 at 502 and the other at 554 fathoms, both off Leyte in the Philippines.

Subgenus TRITIARIA Conrad 1865

Type: *Buccinum mississippiensis* Conrad.

Phos (Tritiaria) dingsi, n. sp.

Plate 3, figure 21

Shell of medium size and inflation, whorls well rounded, spire about one and a half times as long as the aperture. Protoconch multispiral, consisting of 4 evenly expanding whorls, each with a larger blunt peripheral carination, and a smaller, sharper carination just above the suture which locally may be concealed beneath the suture. Aperture subovate, produced anteriorly to form a moderately constricted and slightly twisted canal. Outer lip thin at the edge but thickening back from the edge and bearing elongate raised denticles inside that die out in about half the visible distance. Columella slightly twisted, not truncated, and bearing a single small plait. Inner lip thin centrally, thickening both where it forms the parietal callus and on the lower part of the columella where it is slightly detached, forming a small umbilical chink; a small denticle on the parietal wall. Sculpture consisting of low narrow raised axial ribs, about 13 visible from an angle and every 8th or 9th forming a varix;

weak spirals present all over the whorls, rounded on the upper part of the whorl, but inequilateral on the base of the whorl with the posterior edge raised.

Holotype (USNM 562698) measures: height 16.8 mm, diameter 7.6 mm.

Type locality: Yonabaru clay member, 17447.

This species may be related to *P. hirasei* Sowerby (see (Hirase) Taki, 1951, pl. 105, fig. 14), a Recent Japanese species, but the latter is 2 to 3 times as large, has stronger spiral lirations, a more twisted columella, and lirations on the inside of the lip that continue beyond the limit of visibility.

Distribution: Miocene, (Yonabaru clay member) Okinawa.
Localities: Yonabaru clay member, 17447 (figured type).

Genus COMINELLA Gray 1850

Type: *Buccinum testudinea* Lamarck.

Subgenus COMINULA Finlay 1926

Type: *Cominella quoyana* A. Adams.

The assignment of the following species to this subgenus is tentative.

Cominella (Cominula) okinavensis, n. sp.

Plate 8, figures 18, 24

Shell moderately small, moderately inflated, spire slightly shorter than the aperture and evenly tapering. Protoconch naticoidal, smooth and slightly tilted. Aperture elongate oval, broadly canaliculate at the forward end. Outer lip thin and smooth within. Columella smooth. Inner lip moderately thin and tightly appressed, the sculpture on the parietal wall and columella being dissolved along a narrow etched area preceding it. Sculpture consisting of low axial riblets which curve forwards on the subsutural slope on the middle and upper part of the whorls, about 10 visible from an angle; axials with a small blunt nob just below the suture and an elongate nob at the shoulder; area below the shoulder with depressed spiral lines which grow stronger towards the columella, but which decrease in strength again at the base of the columella, the spiral originating just below the posterior end of the aperture much deeper than the rest.

Holotype (USNM 562826) measures: height 10.2 mm, diameter 5.8 mm. A larger figured paratype (562825) measures: height (incomplete) 12.5 mm, diameter 7.1 mm.

Type locality: Shinzato tuff member, 17454.

The species of *Cominella*, except for the subgenus *Ptychosalpinx*, if, as according to Wenz, it is properly a subgenus of *Cominella*, are all Australian and New Zealandian. The present species is the first described from the western Pacific. *C. okinavensis* resembles *C. suturalis* A. Adams from south Australia but can readily be distinguished from it by the absence of denticles on the inside of the lip in the Okinawan species, and by the strong spiral groove or sulcus on the lower part of the body whorl. The Okinawan species seems to be the only one to possess this strong, *Cantharus*-like, spiral groove. *Cominella nassoides* (Reeve) from an unknown locality (Tryon, 1881, pl. 81, fig. 442) and *C. nodicincta* (Martens) from the Auckland Islands (Tryon, 1881, pl. 81, fig. 443) also seem to be closely related.

The body whorl of a gastropod from Habaro Coal Field of northern Hokkaido, figured by Yokoyama (1927, pl. 52, fig. 8) as *Cancallaria* cf. *C. lischkei*, bears a striking resemblance to *C. okinavensis*, but the similarity may be superficial. However, inasmuch as the locality from which *C. okinavensis* was obtained contains other shells which resemble northern cold water species, the possibility that *C. okinavensis* is not an Austro-New Zealand derivative, but rather a migrant from the boreal north Pacific cannot be overlooked.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa.

Localities: Shinzato tuff member, 17453, 17454 (figured type), 17456.

Genus AFER Conrad 1858

Type: *Fusus afer* Lamarck (=*Murex afer* Gmelin).

The most cited figure for *Murex afer*, that of Kiener, appears to be one of a juvenile shell. *Murex afer* is here presumed to be a species belonging to the same genus as *Tudicla porphyrostoma* Adams and Reeve, the type species of *Streptosiphon* Gill 1867. If this assumption is incorrect, and *Afer* really represents another group, *Streptosiphon* is the valid name for the genus as here used. Chavan (1944, p. 530) treated *Afer* as a subgenus of *Tudicla* (Bolten) Roeding, a genus placed in the Vasidae by many authors.

Tryon (1881, p. 143) used *Streptosiphon* for *porphyrostoma* Adams and Reeve (and *recurva* A. Adams which he regarded as a synonym), but another species, *cumingii* Jonas, he placed in *Tudicla* along with *spirillus* Linné, a true *Tudicla*. He placed both genera in the Buccinidae. *Afer* Conrad he placed in the Fusidae.

Both Beets (1941, p. 220) and Altena (1950, p. 230) used *Buccinulum* Deshayes 1830 rather than *Afer* or *Streptosiphon* for the group under consideration, but in my opinion the type of *Buccinulum*, *Buccinum lineatum* Chemnitz (=*B. lineatum* Quoy and Gaimard), can hardly be considered congeneric with any of the species they refer to *Buccinulum;* certainly not to the ones they figure. Beets regarded "*B.*" *orangense* and "*B.*" *wanneri*, two species closely related to the Okinawan species figured here, as probably referable to the subgenus *Janiopsis* Roveretto (=*Jania* Bellardi non Lamarck, type: *Murex angulosus* Brocchi). *Janiopsis* appears, however, to represent another group, possibly related to *Hindsia*, and a species from Okinawa is referred to it (pl. 13, figs. 20–21).

Afer chinenensis, n. sp.

Plate 8, figure 19; ?plate 15, figures 23–24

Shell above medium size, medium slender, spire about the same length as the aperture exclusive of the canal, whorls angulate. Protoconch not known. Aperture subovate, terminating posteriorly in a shallow notch, produced anteriorly to form a moderately narrow canal (most of which is missing on the type). Outer lip heavy but with a thin edge, crenulate within. Parietal wall bearing a moderately heavy callus which is lightly appressed along the parietal region and weakly detached on the columella, a small tubercle developed adjacent to the anal notch, and an elongate tubercle developed on the columella, forming the terminal end of the siphonal constriction. Canal broken on type, but apparently elongate and without a well-developed fasciole; not umbilicate but the detachment of the inner lip callus on the columella makes a slight chink. Sculpture consisting of low axial swellings (about 6 to 7 visible from an angle), highest along the peripheral angulation and diminishing rapidly below; raised, slightly irregular spiral lines all over the whorls, those above the carina subequal in size with those on the middle part of the whorl, while those at the base of the whorl and columella are slightly coarser with secondary and tertiary threads.

Holotype (USNM 562827) measures: height (incomplete) 49 mm, diameter 26 mm.

Type locality: Shinzato tuff member, 17633.

A Recent specimen (pl. 15, figs. 23–24) which may represent this species was collected by the Albatross from Korea Strait. It has a strongly recurving canal. The aperture, spire, and sculpture are identical with the fossil here described.

This species is related to the Recent Chinese form, *Afer couderti* (Petit), a species described under *Fusus*, referred to *Tudicla* by Kuster and Tryon, and by Cossmann (Pliocene of Karakal, India) to *Streptosiphon*. Tryon (1881, p. 144) regarded "*T.*" *couderti* as a synonym of "*T.*" *cumingii* Jonas. Nomura (1935, p. 137) regarded *Fasciolaria iizukai* Yokoyama from the "Upper Byoritzu" of Formosa as representing the same species. While these forms are obviously related to *B. chinenensis*, they have shorter spires and longer straighter canals, approaching *Tudicla* in general shape rather than *Afer*. However, they do not have the broad, flaring inner lip of *Tudicla*.

Afer chinenensis has a more elongate spire and a distinctly more carinated periphery than either "*Buccinulum*" *orangense* Beets or "*Siphonalia*" *longicanalis* Nomura and Zinbo. In peripheral angulation, the Okinawan fossil species more closely resembles *B. spinosa* (Bellardi), an Italian Miocene species. Bellardi described this species under *Euthria* (J. E. Gray in M. E. Gray, 1850, type: *Murex corneum* Linné).

Siphonalia longicanalis Normua and Zinbo (1934, pl. 5, fig. 26) was described from the "Ryukyu limestone" of Kikaiga-shima. Makiyama (1941, p. 77) regarded *S. longicanalis* as a synonym of *S. lubrica* Dall, a Recent Japanese species. He did not regard the latter as a *Siphonalia*, but made no statement as to what he thought it was. More recently Kuroda and Habe (1952, p. 86) proposed a new generic name, *Siphonofusus*, for *S. lubrica*. Eight to nine axial nodes are visible from an angle on *S. lubrica*, whereas only 5 are visible on *S. longicanalis* and it is doubtful if they are the same species. In my opinion, however, both "*S.*" *lubrica* and "*S.*" *longicanalis* belong to the genus *Afer*.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa; Recent(?), Korea Strait (Albatross sta. 4877).

Localities: Shinzato tuff member, 17633 (figured type).

Comparative bathymetric data: The specimen collected by the Albatross Expedition in Korea Strait came from a depth of 59 fathoms.

Afer aff. A. oostinghi (Altena)

Plate 3, figures 24–25, 27–28, 33

?*Buccinulum oostinghi* Altena, 1950, Leidse Geologische Mededelingen, v. 15, p. 230, fig. 19.

Specimens so identified closely resemble the above species from the lower Pleistocene of Java. The periphery of the Okinawan specimen is slightly more angulate than is indicated on Altena's figure of *A. oostinghi*, but less angulate and the spire is lower than on *A. chinenensis*.

Afer orangense (Beets) from the upper Miocene of eastern Borneo is also related. There is some indication from the figures that the posterior end of the siphonal canal of typical *A. oostinghi* and of *A. orangense* is less constricted than in the specimens from Okinawa, but this could be an illusion.

As pointed out by Altena, *Siphonalia* (*Kelletia*) *kelletiiformis* Vredenburg, from supposed lower Tertiary beds of Burma, bears a remarkable resemblance to these forms. Altena speculated that it might be an immature *Buccinulum* (=*Afer*). The peripheral angulation of the Burmese form is more like that of the Okinawan species of *Afer*.

Distribution: Miocene, (Yonabaru clay member) Okinawa.

Localities: Yonabaru clay member, 17449 (figured), 17451 (figured—2 specimens).

Genus PISANIA Bivona-Bernardi 1832

Type: *Murex pusia* Linné.

?Pisania sp.

Plate 3, figure 11

The specimen is worn and incomplete. The body whorl behind the aperture, however, has color markings preserved. They are discontinuous brown bands along narrow raised spiral threads. The inside of the outer lip bears about 9 moderately strong spiral ridges which extend nearly as far as can be seen in the shell. If this shell is a *Pisania* it is probably *P. cingulata* (Reeve) or a species very closely related to it. The color pattern of *P. cingulata* is identical.

Localities: Yonabaru clay member, 17679 (figured).

Genus CANTHARUS (Bolten) Roeding 1798

Type: *C. globularis* (Bolten) Roeding = *Buccinum tranquebaricus* Gmelin.

Cantharus okinawa, n. sp.

Plate 8, figures 20–21

Shell of medium size, moderately inflated, whorls rounded and with a weak shoulder, spire about the same length as the aperture or slightly shorter. Protoconch unknown. Aperture subovate, produced anteriorly to form a short canal. Outer lip of moderate thickness, heavy at the varices, denticulate within, a larger denticle near the posterior end marking the edge of a very shallow anal notch. Parietal callus thin; inner lip forming a moderately thick, appressed callus on the columella but detached anteriorly to form a small umbilical chink; the sculpture on the body whorl dissolved in advance of the callus, the callus lower than the sculptural relief. Columella short and thick, apparently not twisted. Suture subangulate, the lower whorl pressed neatly against the whorl above, filling in between the axials of the whorl above but developing no collar. Sculpture consisting of well developed axial ribs, most of which extend from the suture to the siphonal fasciole below as true varices (6 visible from an angle); and sharp, raised spiral threads which on the subsutural slope have an interstitial thread, on the middle part of the whorl have two interstitial threads, and on the columella may have three interstitial threads. Three spirals, 1 along the periphery, 1 just above the suture, and 1 at about the base of the whorl are stronger than the others and become more elevated where they cross the axial ribs. A well-developed narrow furrow originates at about the lower third of the outer lip and disappears beneath the callus just below the parietal attachment of the lip.

Holotype (USNM 562828) measures; height 29 mm, diameter 16.7 mm; paratype (USNM 562829) measures; 23.5 mm, diameter 15 mm.

Type locality: Shinzato tuff member, 17633.

This species probably is related to *C. cecillii* (Philippi), apparently an older name for *C. balteatus* (Reeve), reported by Tryon from China, Japan, and Torres Strait. The axials on *C. okinawa* are narrower and sharper than on *C. cecillii* and the three prominent spirals are not present on the Recent species. This makes the periphery of the Recent form blunt whereas on *C. okinawa* it is sharp and subangular. There is no indication of the well-defined furrow on the only specimen of *C. cecillii* in the U.S. National Museum, but a strong furrow is shown on an early figure by Hirase (1908, pl. 25, fig. 33).

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa.
Localities: Shinzato tuff member, 17633 (figured types).

Subgenus POLLIA Sowerby 1843

Type: *Buccinum undosum* Linné.

Cantharus (Pollia) sp. ind.

Plate 17, figure 22

A fragment of a shell that appears to be a rather slender species of *Pollia* was found at one locality in the Naha limestone. The sculptural details preserved closely resemble those of *C. undosus*, but the apical angle is narrower and the spire is longer than on the living species.

Distribution: Pliocene, (Naha limestone) Okinawa.
Locality: Naha limestone, 17484 (figured).

Genus JANIOPSIS Rovereto 1899

Type: *Murex angulosa* Brocchi.

Although the genus *Janiopsis* has been reported from the Eocene through the Pliocene, it seems to have been restricted during most of that time to Europe and Africa. A living deep-water species probably referable to the genus was obtained by the Albatross Expedition in the Philippines, and if this assignment is correct, this is the sole surviving species of the genus. A similar species was reported from the Pliocene of Timor. Probably the genus is close to *Hindsia H.* and A. Adams.

Janiopsis hirasei, n. sp.

Plate 13, figures 20–21

Shell of medium size, medium inflated, spire moderately elongate, a little over one-half the length of the shell, whorls rounded, varicate. Protoconch subnaticoidal and slightly tilted, consisting of about one full whorl, spiral lines that extend into the adult sculpture appearing on about the last quarter turn or less. Aperture subovate, produced anteriorly to form a slightly twisted canal of moderate length. Outer lip broken on the type. Inner lip appressed at the posterior end but detached elsewhere, moderately heavy, bearing elongate denticulations within which correspond to the spiral lirae and which are covered by the callus, a single heavy truncation marking the beginning of the siphonal canal. Sculpture consisting of rather narrow slightly retractive axial ribs and larger varices spaced variously at from one third to one half a turn, both ribs and varices extending from the suture to the columella; and rather sharp spiral threads all over the whorls, a secondary series appearing at about the 4th whorl, and a tertiary series appearing on the body whorl.

Holotype (USNM 562944) measures: height 33 mm, diameter 14 mm.

Type locality: Chinen sand, 17482b.

This species may be related to an undescribed(?) species collected by the Albatross Expedition from deep water in the Philippines. A species very closely related to the living Philippine species was described from the Pliocene of Timor by Tesch (1915, p. 69, pl. 82, fig. 150) as *Hindsia wanneri* Tesch. The fossil species from Okinawa has a slightly more slender spire, and the axial ribs are not quite as strongly developed. In addition, *J. hirasei* seems to have the secondary and tertiary spiral lines more strongly developed. The apertural characters are similar. It is difficult to tell from the figure, but this species may be very close to the species figured by Tryon (1881, pl. 73, fig. 253) as "*Cantharus biliratus* Reeve (=*fumosus* var.)." However, it is not related to the shell figured by Altena (1950, p. 232, fig. 20) as *Cantharus* (*Cantharus*) *fumosus* (Dillwyn).

Distribution: Pliocene, (Chinen sand) Okinawa.

Localities: Chinen sand, 17482b (figured type).

Incerta sedis

Three unidentified juvenile shells are figured. No attempt is made to assign them to a family and they are inserted here merely because it seems to be their general systematic position.

Plate 3, figure 26. This specimen has a slender conical protoconch of about three and a half whorls, all of them bearing delicate axial lirations which curve slightly to the left anteriorly. The shoulder of the young whorls is sharp with a concave, platformlike subsutural slope between it and the suture. There are about 10 well defined axial ribs visible from an angle and strong spiral lirations below the shoulder, the interspaces sculptured by very fine secondary spirals (3–4). Yonabaru clay member, 17451.

Plate 8, figure 23. The protoconch of this specimen consists of three or more rapidly expanding whorls but the surface of them is decorticated. The surface of the succeeding whorls bears prominent flaring or frilled growth lines and crude axial ribs. Two prominent spirals are left above the suture and 3 prominent spirals are present on the last whorl with 4 weaker spirals on the base of the whorl and columella. Shinzato tuff member, 17454.

Plate 17, figure 15. No protoconch preserved. The whorls are not shouldered and the upper half of the whorls have broad, rounded axial ribs. Prominent spirals cover the entire shell wth secondary and sometimes tertiary threads between the primary spirals. A blunt fold is present on the columella at the posterior end of the siphonal canal. This may be a young *Cantharus*. Naha limestone, 17474.

Family NASSARIIDAE

Genus PROFUNDINASSA Thiele 1929

Type: *Nassa babylonica* Watson.

Profundinassa babylonica (Watson)

Plate 8, figure 26

Nassa (*Aciculina*) *babylonica* Watson, 1882, Jour. Linnean Soc. London, v. 16, p. 336, sp. 4; 1886, Voyage H.M.S *Challenger*, Zoology, v. 15, p. 185, pl. 11, fig. 8.

Profundinassa babylonica. Otuka, 1949, Japanese Jour. Geology and Geography, v. 21, p. 303, pl. 13, fig. 5.

A single imperfect specimen has the unmistakable sculpture of Watson's species, which was described from the Philippines. The Albatross collection in the U.S. National Museum also contains many specimens of this species from the Philippines, Molucca Strait and the Banda Sea, all from deep water. The specimen figured by Yokoyama (1928, pl. 1, fig. 5) from the Byoritzu beds of Formosa as *Terebra* sp. appears to be this species. Otuka, in reporting this species from the Tomiya sandstone (Pliocene) of Japan, stated that it was indistinguishable from the living species, but mentioned no other occurrences as a fossil.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa; Pliocene, (Tomiya sandstone) Japan; Recent, Molucca Strait, Banda Sea, Philippines to Japan.

Localities: Shinzato tuff member, 17454 (figured).

Comparative bathymetric data: The Albatross collection contains this species from 30 dredging stations, 28 of which fall within depths of 236 and 540 fathoms, and the other two at depths of 647 and 976 fathoms.

Genus ALECTRION Montfort 1810

Type: *Alectrion papillosus* (Linné).

Alectrion papillosus (Linné)

Plate 19, figures 17–18

Buccinum papillosum Linné, 1758, Systema naturae, ed. 10, p. 737.
Nassa (Alectrion) papillosa. Tryon, 1882, Manual of conchology, v. 4, p. 30, pl. 9, fig. 74.
Nassarius papillosus. Hatai, 1941, Tropical Industry Inst. Palau, Bull. 7A, p. 137, pl. 20, figs. 10, 11.
Kuroda and Habe, 1952. Recent marine Mollusca of Japan, p. 70.

A single incomplete specimen that is not distinguishable from the living species was found in the Yontan limestone.

Distribution: Pleistocene, (Yontan limestone) Okinawa; Recent Cocos-Keeling, Philippines to Japan, Pacific Islands to Hawaii.

Localities: Yontan Limestone, 17652 (figured).

Comparative bathymetric data: From 2–3 fathoms in the lagoon at Cocos Keeling; 12 fathoms off Honolulu.

Genus NASSARIUS Dumeril 1806

Type: *Buccinum arcularia* Linné.

As pointed out by Woodring, (1928, p. 264) the type of *Nassarius* depends on whether it is accepted as a substitute name for *Nassa*, for which there is no direct evidence, or a new name. *Buccinum arcularia* is its type if it is a new name, whereas *Buccinum mutabile* Linné would be its type if it is a substitute name.

Subgenus NIOTHA H. and A. Adams 1853

Type: *Nassa cummingi* A. Adams.

Nassarius (Niotha) gemmulatus (Lamarck) Deshayes

Plate 13, figure 29

Buccinum gemmulatum Deshayes, 1844, Animaux sans vertèbres, 2d ed., v. 10, p. 169.
Nassa (Niotha) gemmulata. Yokoyama, 1928, Imp. Geol. Survey Japan Rept. 101, p. 40, pl. 2, fig. 8.
Nassarius (Niotha) gemmulatus. Nomura, 1935, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 2, p. 153.
Nomura and Zinbo, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 3, p. 255.
Nassarius gemmulatus. Hirase, 1936, A collection of Japanese shells, pl. 106, fig. 9.
Nassarius clathratus. (Hirase) Taki, 1951, Handbook of illustrated shells, pl. 106, fig. 9.

There seems to be no way to distinguish the Okinawan specimens from either the Recent western Pacific form or the form occurring in the Byoritzu beds of Formosa. The Hayasaka collection in the U.S. Geological Survey includes many fine specimens from the "Upper Byoritzu". A closely related form was figured by Martin from the Pliocene of Java, but as implied by Martin it is not typical. The species described by Makiyama (1927, p. 121, pl. 6, fig. 3) from Dainiti, Japan, as *Nassarius (Hinia) kurodai* is closely related to *N. gemmulatus*, but at least the figured specimen is a little more slender.

Distribution: Pliocene, (Nakoshi sand) Okinawa, (Byoritzu beds) Formosa, Japan, Ceram, Sumatra; Recent, Sunda Straits, Australia to Japan.

Localities: Nakoshi sand, 17440 (figured).

Comparative bathymetric data: This species was collected by the Albatross Expedition in the Philippines along shore and at depths of 16 and 18 fathoms. Two broken specimens were obtained in hauls at 88 and 150 fathoms.

Nassarius (Niotha) caelatus (A. Adams)

Plate 13, figure 30

Nassa caelata A. Adams, 1851, Proc. Zool. Soc. London, p. 97.
Nassa (Hima) verbeeki. Yokoyama, 1928, Imp. Geol. Survey Japan Rept. 101, p. 40, pl. 2, figs. 9, 13.
Nassarius (Zeuxis) caelatus. Nomura, 1935, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 2, p. 152.
Otuka, 1935, Earthquake Research Inst. Bull., v. 13, pt. 4, p. 871, pl. 53, fig. 44.
Nassarius (Alectrion) caelatus. Nomura and Zinbo, 1936. Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 3, p. 256, pl. 11, fig. 24.
Nassarius caelatus. Hirase, 1936, A collection of Japanese shells, pl. 106, fig. 5.

I would follow Nomura and Zinbo, and Hirase in the identification of this species rather than Tryon who regarded it as synonym of *N. siquijorensis*, a more turreted species with a more deeply channelled suture. Possibly the spiral lines are thinner and more neatly incised in the Okinawan form than in the Recent species, but if so, it could not be adequately determined from the few specimens at hand. Some range in the strength of the spiral lines is shown by the specimens at hand.

Makiyama (1927, p. 122, pl. 5, figs. 17–18) named a subspecies as *N. (Hinia) caelatus dainitiensis* which he distinguished from the typical form in having a canaliculate suture. The Okinawan specimens as well as a very large suite from the Byoritzu beds of Formosa in the Hayasaka collection show variation in the suture from specimens in which the margin of the lower whorl is rounded, through specimens having a narrow flat shelf, to specimens having a definite flat-bottomed depression. There is also considerable variation in the strength of the spirals and the degree to which they form gemmules where they cross the axials.

Distribution: Pliocene, (Nakoshi sand and Chinen sand) Okinawa, (Byoritzu beds) Formosa, Japan; Pleistocene, Japan; Recent, Indo-Pacific region, including Japan and central Polynesia.

Localities: Nakoshi sand, 17440; Chinen sand, 17442, 17481 (figured), Naha limestone, 17550L.

Comparative bathymetric data: Specimens obtained by the Albatross Expedition from Japan are from depths of 37, 39, 57, 66, and 70 fathoms. The species is also obtained along beaches.

Nassarius (Niotha) fulleri, n. sp.

Plate 13, figures 27–28

Shell of medium size, moderately inflated, spire moderately low. Protoconch worn on the specimens at hand. Aperture subquadrate. Outer lip thickened and slightly flaring, bearing fine lirations within but not extending to the edge, not denticulate. Parietal callus heavy and extending across about half of the parietal area. Columella denticulate within, terminating in a moderately sharp edge at the siphonal canal. Canaliculate notch deep and sharp, strongly reflected to the left. Whorls sculptured by moderately strong, slightly inclined axial ribs which are symmetrical and rounded over the greater part of the shell, but asymmetrical with a sharpened edge on the side away from the lip on about the last quarter whorl of full grown adults; spirals narrow but strongly incised and continuing across both the axials and interspaces, the uppermost spiral stronger and more than the width between the lower spirals away from the suture, and leaving a subsutural band that is made nodose by the strong upper end of the axial ribs.

Holotype (USNM 562949) measures: height 15 mm, diameter 8.9 mm; paratype, 562950.
Type locality: Chinen sand, 17495.

This species may be related to *N. caelatus*, but it is more inflated, has a larger parietal callus, and the spirals cross the axials whereas in *N. caelatus* they do not. It is probably most closely related to *N. liviscens* Philippi. It is smaller than *N. liviscens* but of nearly the same shape and with a similar large parietal callus. It differs from *N. liviscens* in having somewhat weaker spiral lines giving its surface a more neatly incised spiral sculpture and a less beaded appearance.

Distribution: Pliocene, (Chinen? sand) Okinawa.
Localities: Chinen sand, 17495 (figured types). The inclusion of this locality in the Chinen sand is tentative. It may be a shallow water facies of the Shinzato tuff member of the Shimajiri formation.

Nassarius (?Niotha) concinnus (Powys)

Plate 13, figure 23

Nassa concinna Powys, 1835, Proc. Zool. Soc. London, p. 95.
Nassarius (*Hinia*) *concinnus*. Nomura and Zinbo, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 3, p. 256.

Only the spire was collected of this species, but its delicate and characteristic sculpture appears to be typical for the species. *Nassarius crebrilineata* Hombron and Jaquinot, which Tryon makes a synonym of *N. concinnus* (see Tryon, 1882, pl. 15, fig. 258) is nearly identical with the Okinawan fossil; it certainly comes closer to it than any other of Tryon's figures.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa: Pliocene, (Nakoshi sand) Okinawa (Nomura and Zinbo); Recent, Mauritius, Australia, Ryukyu Islands, Polynesia.
Localities: Shinzato tuff member, 17458 (figured); Nakoshi sand, Gabusoga (Nomura and Zinbo).

Nassarius (?Niotha) metuliformis, n. sp.

Plate 3, figure 29

Shell of medium size and slender, spire slightly longer than the aperture, whorls rounded, aperture subovate, columella truncated at base by a siphonal notch. Protoconch not complete on type; last whorl large and smooth. Aperture subovate, produced anteriorly to form a short broad siphonal canal which terminates in a well defined notch behind the base of the columella, and forming an indentation at the beginning of the siphonal fasciole. Outer lip thin, inside lip bearing weak spiral ridges that extend as far as can be seen. Inner lip appressed and thin; parietal callus thin; no parietal tooth; a well-defined fold or raised edge along the columellar margin of the siphonal canal. Sculpture consisting of subequal rounded axial and spiral lirations, the axials nearly vertical and forming a cancellate pattern with the spirals, a rounded bead at the points of intersection; a weak secondary and sometimes faint tertiary spirals between the primary spirals.

Holotype (USNM 562704) measures: height 15 mm., diameter 6.3 mm.
Type locality: Yonabaru clay member, 17632.

This species resembles the genus *Metula* in sculpture but the greater basal construction, the columellar truncation, and the location of the siphonal notch on the left side of the columella in full apertural view suggest that it is a *Nassarius*.

I have found no species of either *Metula* or *Nassarius* from the Indo-Pacific region with which this species could be confused. Dall (1896, p. 310, pl. 28, fig. 15; see also Maury, 1917, p. 88, pl. 14, fig. 17) described a species under *Phos*, *P. metuloides*, which may be related to *N. metuliformis*. Dall's species, which was described from the Miocene of Santo Domingo and has also been reported from Panama, is more inflated and has a shorter spire.

Distribution: Miocene, (Yonabaru clay member) Okinawa.
Localities: Yonabaru clay member, 17632 (figured type).

Nassarius (?Niotha) acteon, n. sp.

Plate 3, figure 30

Shell medium small but uncallussed, so probably not mature, medium inflated, whorls rounded, aperture about the same length as the spire. Protoconch naticoidal and smooth, consisting of about 1½ turns. Aperture subovate. Outer lip of medium thickness, denticulate within, the denticles dying out gradually towards the inside, but not abruptly. Parietal callus and columellar callus of about equal width and tightly appressed. Columella smooth inside but with a narrow raised edge at the base. Sculpture consisting of about 14 to 15 incised spiral lines crossed by inclined growth wrinkles which on the young whorls are well-defined axial ribs, but which on the body whorl are weak and die out on the lower half of the whorl; in some areas the spiral lines are disconnected and punctate between the growth wrinkles; two spirals just below the suture are stronger than the rest.

Holotype (USNM 562705) measures: height 9.5 mm., diameter 5.5 mm.
Type locality: Yonabaru clay member, 17449.

The only species known from the western Pacific region that could be closely related to *N. acteon* is *Nassa congrua* Yokoyama (1926, p. 339, pl. 41, fig. 18) from the Satsuka formation (Pliocene) of Japan. *Nassarius congrua* has much broader spiral furrows and does not appear to have the two prominent subsutural spirals. It resembles *N. albescens* Dunker in shape, but *N. albescens* is larger and more inflated and has both stronger axials and spirals; the spirals having a tendency to be divided or paired.

Distribution: Miocene, (Yonabaru clay member) Okinawa.
Localities: Yonabaru clay member, 17449 (figured type).

Subgenus HINIA Leach 1847

Type: *Buccinum reticulatum* Linné.

Nassarius (Hinia) prefestivus, n. sp.

Plate 13, figure 31

Shell moderately small, medium inflated, spire of medium height. Protoconch small, subnaticoidal, consisting of about one full, unsculptured turn. Aperture subovate. Outer lip moderately thick with 4 or 5 short denticles on the inside. Parietal callus moderately broad but not thick. Columella bearing 3 or 4 irregular elongate denticles. Sculpture consisting of well developed slightly inclined axials, about 7 visible from an angle, crossed by flattened raised spirals of which there are 7 on the body whorl, the intersection of the axials and spirals forming an elongate rectangular bead; the subsutural slope bearing a few finer spiral lines.

Holotype (USNM 562953) measures: height 11.4 mm, diameter 6.6 mm.
Type locality: ?Chinen sand, 17495.

This species is closely related to *N. festivus* Powys and is probably its forerunner. However, it is only about one-half to one-third the size of *N. festivus*. Although there is some variation in the strength of the spiral lines in the Recent species, most Recent specimens have stronger spirals than the Okinawan fossils.

Distribution: Pliocene, (Chinen? sand) Okinawa.
Localities: Chinen sand, 17495 (figured type). This locality may be in the Shinzato tuff member of the Shimajiri formation.

Subgenus ZEUXIS H. and A. Adams 1853

Type: *Buccinum taenia* Gmelin.

Nassarius (Zeuxis) cf. N. (Z.) picta (Dunker)

Plate 17, figures 12–13

?*Buccinum pictum* Dunker, 1846, Zeitschrift für Malakozooligie, p. 172.
?*Nassarius* (*Alectrion*) *pictus*. Nomura, 1935, Tōkohu Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 2, p. 151, pl. 8, fig. 32.

The single specimen found falls well within the limits of this species as delimited by Tryon. Of the several species he regarded as synonyms, some certainly seem to be at least varieties or subspecies, but a great deal of work remains to be done to ascertain which names are valid. Kuroda and Habe (1952) do not list *N. pictus* as a valid Japanese species. The Okinawan specimen is somewhat more slender than most forms referred to the species and it does not have crenulations on the shoulder except on the first 2 to 3 whorls. The siphonal fasciole bears 5 raised spiral lines in addition to the strong one that marks the former position of its upper edge.

The shell that seems most closely related to the Okinawan fossil specimen is a Recent shell in the Hirase collection labelled "*Nassarius dorsatus* Bolten" and stated to have come from Kikaiga-shima in the Ryukyu Islands. Kuroda and Habe (1952, p. 70) regard *N. dorsatus* as the valid name for *N. canaliculatus* Lamarck. However, both the Recent specimen in the Hirase collection and the fossil from Okinawa have an appressed, noncanaliculate suture and a broad, heavy parietal callus. They are closer to the form from the Byoritzu beds which Nomura identified as *N. pictus*. The Hayasaka collection of Byoritzu fossils in the U.S. Geological Survey contains one specimen in a lot identified as *N. canaliculatus* which seems to be the *N. pictus* of Nomura. It is slightly more inflated than the Okinawan form but in other respects it is indistinguishable.

Distribution: Pliocene, (Byoritzu beds) Formosa, (Naha limestone) Okinawa; Recent, Mauritius to central Polynesia according to Tryon but the synonymy he gives may not be correct.

Localities: Naha limestone, 17673 (figured).

Nassarius (Zeuxis) subbalteatus, n. sp.

Plate 8, figure 22

Shell of medium size somewhat inflated, whorls rounded, spire about the same length as the aperture. Protoconch not preserved on the specimen at hand. Aperture broadly ovate. Outer lip slightly thickened back from the edge, but moderately thin at the very edge; a narrow row of crenulations inside but not extending to the edge. Parietal callus broad but moderately thin, tightly appressed. Columella with about two short irregular denticles at the base. Parietal wall bearing a low tooth at the border of the anal notch. Sculpture consisting of inclined axial riblets and incised spiral lines on the first 2 postnuclear whorls, 2 weak incised spiral lines on the shoulder of the next whorl, and smooth thereafter except for slight irregular wrinkles along the shoulder; body whorl with 1 or 2 very weakly incised spiral lines just above the siphonal fasciole, and about 2 obscure raised spiral lines on the fasciole.

Holotype (USNM 562830) measures: height 16.2 mm, diameter 9.6 mm.

Type locality: Shinzato tuff member, 17456.

The specimen on which this species is based has a well-developed apertural callus at a much smaller stage than does the Recent *N. balteatus* (Lischke), and is therefore probably a smaller species. Furthermore, the living species has from 4 to 5 incised spirals at the base of the body whorl whereas *N. subbalteatus* has only 1 to 2 very weak ones. There is some variation in the edge of the lip in the Recent species, some specimens being sharply denticulate and others nearly smooth. The Okinawan fossil does not have a denticulate margin.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa.

Localities: Shinzato tuff member, 17456 (figured type).

Genus CYLLENE Gray 1833

Type: *Buccinum lyrata* Lamarck.

This genus bears a superficial resemblance to *Sconsia.*

Cyllene gracilenta (Yokoyama)

Plate 2, figure 27

Cassis gracilenta Yokoyama, 1928, Imp. Geol. Survey Japan Rept. 101, p. 46, pl. 3, fig. 4.

Cyllene lugubris. Nomura, 1935, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 2, p. 156, pl. 8, fig. 3.

Nomura (1935, p. 54) listed *Cassis gracilenta* as one of the species reported by Yokoyama from the Byoritzu but not present in his collections. However, his collection contains "many specimens" of the form identified as *C. lugubris.*

Yokoyama's type is badly decorticated but there is no doubt in my mind that it is *C. lugubris* of Nomura and the form figured here.

Nomura states that the spiral lines are quite distinct on some specimens; obsolete on others. The Okinawan specimen has spirals on the subsutural slope and base only, the central part of the body whorl bearing crude weak axials only.

Cyllene angasanana Martin (1921, pl. 59, fig. 37) from the Njalingungschicten of Java is very similar to this species in shape and in its apertural and columellar characters. However, the spirals of *C. angasanana* persist over the entire whorl and the axials are more numerous and recurve strongly on the subsutural collar. On *C. gracilenta* the axials are straight.

This species appears to be most closely related to the living *C. pulchella* Adams and Reeve (see Tryon, 1881, v. 3, pl. 84, fig. 567).

Distribution: Miocene, (Yonabaru clay member) Okinawa; Pliocene, (Byoritzu beds) Formosa.

Localities: Yonabaru clay member, 17632 (figured).

Comparative bathymetric data: According to Tryon *Cyllene* inhabits shallow water and shore lines.

Family FASCIOLARIIDAE

Subfamily FASCIOLARIINAE

Genus LATIRUS Montfort 1810

Type: *Latirus aurantiacus* Montfort (=*Murex gibbulus* Gmelin).

Latirus cf. L. polygonus (Gmelin)

Plate 19, figure 7

?*Murex polygonus* Gmelin, 1791, Systema naturae, ed. 13, p. 3555.

?*Latirus polygonus.* Tryon, 1881, Manual of conchology, v. 3, p. 88, pl. 66, figs. 106–108.

?(Hirase) Taki, 1951, Handbook of illustrated shells, pl. 100, fig. 1.

?Kuroda and Habe, 1952, Recent marine Mollusca of Japan, p. 62.

A single specimen from limestone, only about half-grown and of only fair preservation, appears to belong to this species.

Distribution: Pleistocene, (Yontan limestone) Okinawa; Recent, Red Sea to the Philippines and Japan, and the central Pacific.

Localities: Yontan limestone, 17553 (figured).

Comparative bathymetric data: A reef dweller.

Genus LATIRULUS Cossmann 1889

Type: *Fusus subaffinis* d'Orbigny.

Lathyrulus Cossmann 1901 was an emendation of his earlier *Latirulus*.

Latirulus cf. L. cracticulatus (Linné)

Plate 17, figures 11, 17; plate 19, figure 22

?*Murex cracticulatus* Linné, 1768, Systema naturae, ed. 12, p. 1224.

?*Lathyrus cracticulatus*. Hirase, 1936, A collection of Japanese shells, pl. 100, fig. 2.

?*Latirus cracticulatus*. (Hirase) Taki, 1951, Handbook of illustrated shells, pl. 100, fig. 2.

?Kuroda and Habe, 1952, Recent marine Mollusca of Japan, p. 62.

Two poorly preserved specimens from limestone compare with this species. One has stronger axial ribs than the other but both fall within the range of Recent specimens in this respect. A related species, *L. turritus* (Gmelin) was reported by Tesch (1915, p. 54, pl. 81, fig. 117) from the Pliocene of Timor.

Distribution: Pliocene, (Naha limestone) Okinawa; Pleistocene, (Yontan limestone) Okinawa, Celebes; Recent, Red Sea to Japan and central Polynesia.

Localities: Naha limestone, 17484 (figured); Yontan limestone, 17545 (figured).

Genus DOLICHOLATIRUS Bellardi, 1884

Type: *Turbinella bronni* Michelotti.

Dolicholatirus cf. D. acus (Adams and Reeve)

Plate 3, figure 31

?*Fusus acus* Adams and Reeve, 1850, Zoology of the voyage of H.M.S. *Samarang*, Mollusca, p. 41, pl. 7, figs. 3a, b.

?Tryon, 1881, Manual of conchology, v. 3, p. 63, pl. 38, fig. 160.

No specimens of this species are available for study and the available figures are poor. The specimen from Okinawa resembles Adams and Reeve's figure as to shape and apertural characters, and the spirals answer the description of being "peculiarly flatly excavated". The spirals and interspaces are subequal in width, the spirals flat-topped, and the grooves nearly flat-bottomed, at least on the early whorls. I have found no reference to other related species with this type of sculpture.

Distribution: Miocene, (Yonabaru clay member) Okinawa; Recent, South China Sea off Borneo to Japan.

Localities: Yonabaru clay member, 17632 (figured).

Genus PSEUDOLATIRUS Bellardi 1884

Type: *Fusus bilineatus* Partsch.

Pseudolatirus yonabaruensis, n. sp.

Plate 4, figures 1–4

Shell elongate and slender, spire about two-thirds as as long as the aperture, whorls rounded with prominent spirals. Protoconch moderately small and conical, consisting of about three whorls, smooth and polished. Aperture narrow and elongate, produced anteriorly to form an elongate canal. Outer lip blunt with shallow depressions on the inside opposite the external spirals, 3 or 4 on the peripheral region stronger than the others. Parietal and columellar callus thin and appressed. No prominent siphonal fasciole or umbilical chink. Columella bearing a single weak fold. Suture undulating and appressed. Sculpture consisting of regular, moderately strong, slightly oblique axials of which from 6 or 7 are visible from an angle on the body whorl, the axials barely reaching the suture above and dying out on the body whorl before reaching the columella, and well-defined primary spirals, 4 or 5 of which make swellings where they cross the axials, the remainder of which are of equal strength on and between the axials, the interspaces bearing weaker and sometimes tertiary spirals which do not thicken on the axials.

Holotype (USNM 562708) measures: height 34.3 mm, diameter 10.5 mm; paratype 562709.

Type locality: Yonabaru clay member, 17451.

This species is related to *P. fusiformis* (Tesch) (1915, p. 55, pl. 81, fig. 119) from the Pliocene of Timor, from which it differs in having a longer, slenderer canal and narrower and more numerous axials. Two other species from the Pliocene of Timor, *P. burcki* Koperberg (1931, pl. 3, fig. 33) and *P. esi* Koperberg (1931, pl. 3., fig. 34), are also related. Although these two species are slenderer than *P. fusiformis*, they more closely resemble it in the length of the canal and the strength of the axials than they resemble *P. yonabaruensis*. The basal constriction of *P. yonabaruensis* is more gradual than in any of the Timor species, and the axials are less well developed on the subsutural slope than on those species. Species that very closely resemble both *P. burcki* and *P. esi* were obtained by the Albatross from Philippine waters, and it may prove impossible to distinguish the living forms from those described as fossils. None of the Recent Philippine specimens seems to be identical with any specimens of *P. yonabaruensis*. The inadequately described and figured *Fusus pfeifferi* Philippi may be a *Pseudolatirus* rather than a *Fusinus* and if so might be one of the Recent Philippine species.

Distribution: Miocene. (Yonabaru clay member) Okinawa.

Localities: Yonabaru clay member, 17450 (figured), 17451 (figured types).

Comparative bathymetric data: The Recent Philippine species that compare closely with *P. burcki* and *P. esi* were obtained from numerous stations ranging between 96 and 288 fathoms.

Subfamily FUSININAE

Genus FUSINUS Rafinesque 1815

New name for *Fusus* Bruguière 1789, not Helbling 1779.

Type: *Murex colus* Linné.

The type of *Fusus* is generally considered to have been fixed by Lamarck in 1799 when he assigned *Fusus colus* to it, the first specific name to be assigned to the genus. Should it be decided that the species figured by Bruguière constitute the original list, and that a type must be selected from them, the designation of the same species, *Murex colus*, by Montfort in 1810 would be the first valid designation.

Fusinus cf. F. nodosoplicatus (Dunker)

Plate 14, figures 1–2

?*Fusus nodosa plicatus* Dunker 1858–70, Novitates conchologicae, p. 99, pl. 33, figs. 3–4.
?Lischke, ?1874, Japanische Meeres-Conchylien, suppl., pl. 3, fig. 6.
?Tryon, 1881, Manual of conchology, v. 3, p. 54, pl. 34, figs. 110–111.
?*Fusinus nodosoplicatus*. Nomura, 1935, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 2, p. 142, pl. 8, fig. 9.

The specimens so identified are incomplete and poorly preserved but they appear to fall within the range of available illustrations of this species.

Fusinus nodosoplicatus shows some range in the strength and number of its axial ribs and in the number visible from an angle (5 or 6). The spirals are subequal in strength and differ in this respect from those of *F. perplexus* which are stronger and elongately beaded on the periphery.

Fusinus nodosoplicatus was reported by Nomura from the Byoritzu beds of Formosa, and specimens so identified in the Hayasaka collection of Byoritzu fossils in the U.S. Geological Survey appear to be identical with specimens from Okinawa here figured. Yokoyama (1927, p. 412, pl. 46, fig. 14) figured a specimen from the Pleistocene of Japan as *F. nodosoplicatus* but Taki and Oyama (1954, pl. 43, fig. 14) reidentified it as *F. perplexus*. In the writer's opinion Yokoyama's specimen is more properly referable to *F. nodosoplicatus*.

Distribution: Pliocene, (Chinen sand) Okinawa, (Nakoshi sand) Okinawa, (Byoritzu beds) Formosa; Pleistocene, Japan; Recent, Japan.

Localities: Chinen sand, 17442 (figured), 17443; Nakoshi sand, 17440 (figured).

Fusinus perplexus (A. Adams)

Plate 13, figure 22

Fusus perplexus A. Adams, 1864, Linnaean Soc. London Jour., v. 7, p. 106.
Fusus inconstans Lischke, 1869, Japanische Meeres-Conchylien, v. 1, p. 34, pl. 2, figs. 1–6; 1871, v. 2, p. 26, pl. 3, figs. 1–5.
Fusus perplexus. E. A. Smith, 1879, Zool. Soc. London Proc., pt. 2, p. 202.
?Cossman, 1903, Journal de conchyliologie, v. 51, p. 125, pl. 4, figs. 17–18. (Karikal)
?*Fusinus perplexus*. Nomura and Hatai, 1936, Geol. Soc. Japan Jour., v. 43, no. 512, p. 39.
(Hirase) Taki, 1951, Handbook of illustrated shells, pl. 100, fig. 8.

As pointed out by E. A. Smith who examined A. Adams specimens, there is little doubt that the unfigured *F. perplexus* is the same as *F. inconstans* of Lischke. Furthermore, there seems to be no way of distinguishing the Okinawan fossil from Recent specimens.

Distribution: Pliocene, (Chinen sand) Okinawa, ?(Karikal) India; Recent, Japan.

Localities: Chinen sand, 17481 (figured); ?Limestone near Naha (Nomura and Hatai).

Comparative bathymetric data: Only two specimens in the U.S. National Museum have depth data. Both were collected by the Albatross and come from depths of 66 and 71 fathoms.

Fusinus sp.

The worn columella of a large *Fusinus* was obtained from the Yonabaru clay member of the Shimajiri formation.

Locality: Yonabaru clay member, 17632.

?Fusinus sp.

Plate 8, figure 27

A specimen lacking both its columella and the tip of its spire is presumably a *Fusinus* but its sculpture is different from that of other species in the Okinawan collection. It may be a new species but no attempt is made to describe it on the basis of the single incomplete specimen.

Locality: Shinzato tuff member, 17454 (figured).

Genus APTYXIS Troschel 1868

Type: *Murex syracusanus* Linné.

Aptyxis okinawa, n. sp.

Plate 4, figures 5, 9

Shell moderately small, slender, aperture less than half the height of the shell, spire moderately slender with well rounded whorls, columella moderately short and curved. Protoconch subnaticoidal and slightly tilted, consisting of about one and a quarter smooth whorls. Aperture subovate and extended anteriorly to form a canal of moderate length. Outer lip moderately thick and made sinuous by shallow internal furrows which are strongest at the very edge of the lip but which extend inside for only 2 to 3 mm. Parietal callus very thin. Columellar callus smooth, moderately thick, narrow and appressed, slightly detached anteriorly where it borders the canal. Suture appressed tightly just below one of the spiral lirae. Sculpture consisting of slightly inclined, moderately strong, rounded axials (6 or 7 visible from an angle) which extend from the suture nearly to the base of the body whorl, and strong, regular, rounded spiral lirae which are elongately beaded where they cross the axials, some of the spiral interspaces on the middle and lower part of the body whorl with a fine secondary spiral thread.

Holotype (USNM 562711) measures: height 11 mm. (the tip of the columella is broken), diameter 6.7 mm.

Type locality: Yonabaru clay member, 17447.

This may be an immature shell but even if so its sculpture cannot be matched on any other specimens in the Okinawan collection. It may be closely related to a species from the Pliocene of Timor figured by Tesch (1915, p. 53, pl. 80, fig. 114) as *Siphonalia* aff. *varicosa* Chemnitz. Chemnitz figure, however, is of a much more inflated shell.

Two other species have been described from Japan which resemble *A. okinawa* and could be related to it although their past generic assignment gives no indication of it. One is *Microfusus acutispiratus* Sowerby which Kuroda and Habe (1952, p. 70) list as *Nassaria acutispirata*. The other is *Fusus coreanicus* Smith. A specimen from the Pleistocene of Japan which Yokoyama (1922, pl. 2, fig. 10) identified as this species was reidentified by Taki and Oyama (1954, pl. 22, fig. 10) as *Searlsia fuscolabiata* (Smith).

Distribution: Miocene, (Yonabaru clay member) Okinawa.
Localities: Yonabaru clay member, 17447 (figured type).

Genus GRANULIFUSUS Kuroda and Habe 1952

Type: *Fusus niponicus* Smith.

Granulifusus niponicus (Smith)

Plate 3, figure 32; plate 4, figures 6–7

Fusus niponicus Smith 1879, Zool. Soc. London Proc., p. 203, pl. 20, fig. 34.
Fusus suboblitus Pilsbry, 1904, Acad. Nat. Sci. Philadelphia Proc., p. 18, pl. 1, fig. 5.
?*Fusus rufinoides*. Schepman, 1911, Resultats Siboga Expeditie, Mon. 49–1d, pt. 14, p. 291.
Fusus niponicus. Yokoyama, 1922, Tokyo Imp. Univ. Coll. Sci. Jour., v. 44, art. 1, p. 52, pl. 2, fig. 11.
Fusinus niponicus musashiensis Makiyama, 1922, Geol. Soc. Tokyo Jour., v. 29, p. 168. (Comments in Japanese.)

According to Pilsbry, the type of *F. suboblitus* had been in the collection of the Academy for years prior to its description in 1904 without any other specimens becoming known. Yokoyama apparently was first to realize that *A. suboblitus* Pilsbry is the same as *A. niponicus* which had been poorly figured. Only one dead specimen was obtained by the Albatross Expedition from Japan. In the Philippines, however, the Albatross Expedition obtained over 65 specimens from 33 stations, indicating, possibly, that the center of distribution for the species is in the Philippines. Schepman reported *Fuscus rufinoides* from the Arafura Sea in his account of the mollusca collected by the Siboga Expedition, but his specimen has a straighter canal than typical *F. rufinoides* and compares more with *A. niponicus* in this respect. Likewise, the specimen figured by Koperberg (1931, pl. 2, fig. 32) from Pliocene and Pleistocene beds of Timor as *F. rufinoides* may also be more closely related to *A. niponicus*. Koperberg's specimen shows rather strong crenulations on the inside of the inner lip. No such crenulations can be seen on the Okinawan fossils, but on the Recent specimens from the Philippines they occur on about 1 in 10. Occasionally they are well back in the interior and do not reach the edge of the lip.

As pointed out by Koperberg, the species in question are closely related to two European fossils, *F. tournoueri* Mayer from the Oligocene of Italy, and *F. pustulatus* Bellardi and Michelotti from the Miocene of Italy. Both of these species were included under the subgenus *Aptyxis* by Cossmann, but they do not appear to be related to *F. syracusanus* Linné, the type of *Aptyxis*.

Yokoyama (1920, p. 49, pl. 2, fig. 7) figured another specimen from the Pleistocene of Japan as *Fusus niponicus*, but it belongs to another species. Taki and Oyama (1954, pl. 3, fig. 7) reidentified it as *Granulifusus makiyamai* (Otuka).

Distribution: Miocene, (Yonabaru clay member) Okinawa and Takabanare-shima, Okinawa gunto; Pleistocene, Japan; Recent, Japan, Philippines, Indonesia.

Localities: Yonabaru clay member, 17445, 17448 (figured), 17476 (figured). Station 17476 could be in the Shinzato tuff member.

Comparative bathymetric data: The type comes from a depth of 52 fathoms (Smith). The Japanese specimen in the Albatross collection comes from a depth of 58 fathoms and one specimen from the Philippines is from 50 fathoms. The remaining 32 stations in the Philippines are fairly evenly distributed between 105 and 385 fathoms.

Genus STREPTOCHETUS Cossmann 1889

Type: *Fusus intortus* Lamarck.

Cossmann made this genus the basis for a new subfamily of the Fusidae. To it were referred the *Latirus*-like fusids having tilted subnaticoidal protoconchs and moderately elongate to elongate twisted canals. The type comes from the Eocene of the Paris Basin, and species referable to it are present in the Eocene and Oligocene of North America. *Fasciolaria* (*Fasciolaria*) *suryai* Beets (1941, p. 104, pl. 6, figs. 217–218) from the upper Miocene of Borneo may be a *Streptochetus* but the details of the columella are not clearly shown.

Streptochetus paeteliana riukiuana, n. subsp.

Plate 4, figure 10

This form is very closely related to a Recent species figured by Küster and Kobelt (1874, p. 71, pl. 18, fig. 2–3) as *Turbinella paeteliana* Kobelt, believed to be from China. Küster's figure seem to be of a form with a slightly higher spire, and possibly a greater number of axials (5 to 6 being visible from an angle) as opposed to 4 on the holotype of *riukiuana*. Hedley (1912, p. 149, pl. 43, fig. 34) described a variety of the species from the Gulf of Carpentaria, Australia, as *Latirus paeteliana* var. *carpentariensis*. Hedley distinguished his variety only by stating that compared with the typical form it had the same number of whorls at three-quarters the shell size. In this respect, as well as in the number of axials on each whorl, the Okinawan fossil appears to be more like the Australian variety.

Another closely related species from the Pliocene of Timor was illustrated by Tesch (1915, pl. 81, fig. 118) as *Latirus madiunensis* Martin. However, it is doubtful if the Timor form is the same as Martin's species which comes from the Pliocene of Java. The Timor form appears to have a shorter, less twisted columella than *riukiuana*.

Holotype (USNM 562715) measures: height 34.5 mm, diameter 14.2 mm.
Type locality: Yonabaru clay member, 17451.
Distribution: Miocene, (Yonabaru clay member) Okinawa.
Localities: Yonabaru clay member, 17451 (figured type).

Genus PERISTERNIA Mörch, 1852

Type: *Turbinella nassatula* Lamarck.

Peristernia generally has been classified as a fasciolarid related to *Latirus*, but it has a tilted subnaticoidal protoconch like that of the fusinids, and species referred to it appear to merge with forms having longer canals referable to *Streptochetus*. Probably it is better to regard *Peristernia* as a separate genus but its relationship with *Streptochetus* is very close.

Peristernia preluchuana, n. sp.

Plate 8, figure 25

Shell less than medium size for the genus, moderately inflated, aperture slightly shorter than the spire, whorls rounded with a subsutural sulcus. Protoconch unknown. Aperture subovate with a relatively short slightly twisted siphonal canal and a sharp anal notch at the posterior end. Outer lip with several narrow elongate lirations within. Parietal wall and columella with a thin but well defined callus which is closely appressed on the parietal wall but becomes progressively detached along the columella and is slightly raised below the columellar twist. Columella with a narrow fold along the edge of the truncation, opposite a narrow diagonal fold on the inside of the outer lip, the two forming a very narrow constriction at the entrance to the siphonal canal. Axial sculpture strong, the axial ribs (6 visible from an angle) not extending across the subsutural collar and dying out rather abruptly at the base of the whorl; spiral sculpture consisting of moderately strong rounded spirals with an occasional interstitial thread, the spirals slightly stronger on the columella than on the peripheral region.

Holotype (USNM 562832) measures: height 17.8 mm diameter 9.4 mm.
Type: Shinzato tuff member 17456.

This species appears to be very closely related to *Peristernia ustulata* var. *luchuana* Pilsbry. The relationship is probably closer than that of the variety *luchuana* to typical *P. ustulata*, and in the writer's opinion *luchuana* should stand as an independent species. *Peristernia preluchuana* has a slightly more abrupt basal constriction and a slightly longer and slenderer canal than *P. luchuana*, and in addition the inner lip is partly detached whereas in *P. luchuana* it is not. Even the finest details of sculpture appear to be identical in the two species, however. *Peristernia preluchuana* is also related to *Streptochetus paetelliana* but has a much shorter canal. Moreover, the peculiar folds on the base of the columella and outer lip that partly constrict the entrance to the canal are well developed on both *S. paetelliana* and *P. preluchuana* but *P. luchuana* seems to lack this structure. It is possible that *P. preluchuana* despite its great similarity to *P. luchuana*, and its short canal, should really be placed in *Streptochetus*.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa.
Localities: Shinzato tuff member, 17456 (figured type).

Superfamily VOLUTACEA

Family OLIVIDAE

Subfamily OLIVINAE

Genus ANCILLA Lamarck 1799

Type: *Voluta ampla* Gmelin.

Subgenus BARYSPIRA P. Fischer 1883

Type: *Ancilla australis* Sowerby.

Ancilla (Baryspira) cf. A. (B.) albocallosa (Lischke)

Plate 4, figure 11; plate 8, figure 32; plate 14, figure 3

?*Ancillaria albo-callosa* Lischke, 1873, Malakozoologische Blätter, v. 21, p. 21; 1874, Japanische Meeres-Conchylien, v. 3, p. 44, pl. 2, figs. 24, 25.

?*Ancillaria rubiginosa.* Tryon, 1883, Manual of conchology, v. 5, p. 94, pl. 38, fig. 27; not pl. 37, fig. 25.

?*Ancilla rubiginosa.* Yokoyama, 1926, Tokyo Imp. Univ. Fac. Sci. Jour., v. 1, pt. 9, p. 334, pl. 38, fig. 11.

?Nomura and Zinbo, 1934, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 16, no. 2, p. 133, no. 110.

?Nomura, 1935, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 2, p. 134.

?*Ancilla albocallosa.* (Hirase) Taki, 1936, Handbook of illustrated shells, pl. 113, fig. 8.

?Yabe and Hatai, 1941, Japanese Jour. Geology and Geography, v. 18, nos. 1, 2, p. 75.

Nomura suggested that *A. albocallosa*, *A. hinomotoensis* Yokoyama (1922, p. 48, pl. 2, fig. 5), and *A. okawai* Yokoyama (1923, p. 7, pl. 1, figs. 4–7) were all varieties of *A. rubiginosa* Swainson. In my opinion Yokoyama's fossil species are distinct. Furthermore, specimens in the U.S. National Museum do not bear out the identity of *A. albocallosa* and *A. rubiginosa*, but indicate that the white callus in advance of the aperture, while always present on *A. albocallosa* is never present on *A. rubiginosa*, and that the spire callus of *A. albocallosa* is much darker than the color of the rest of the whorl, whereas the spire callus of *A. rubiginosa* is lighter than the rest of the whorl. In addition, *A. albocallosa* is more inflated and has a shorter, thicker spire. Except for the difference in inflation and thickness of the spire, and a possible difference in the thickness of a callus along the siphonal fasciole, it might be difficult to distinguish uncolored fossil shells of the two species from each other.

Although there is some range in the shape of the shell among the numerous specimens obtained from Okinawa, no lot of specimens appears to possess characters that would enable distinguishing it from another lot.

Specimens from the Byoritzu beds of Formosa in the Hayasaka collection in the U.S. Geological Survey are labelled *A. rubiginosa* (Swainson) and they are presumably the unfigured species reported by Nomura (1935, p. 134). They are not distinguishable from specimens figured here from Okinawa.

Two similar *Ancilla* were described from the Pliocene of Ceram by Beets under the names *A. capeduncula* and *A. commendabile*. It would be impossible to say how Beets' species differ from the Okinawan form on the basis of the figures alone. *Ancilla asphaltoides* Beets from supposed upper Oligocene beds of Buton (off southeast Celebes) is also related.

Distribution: Miocene, (Yonabaru clay member) Okinawa; Miocene or Pliocene, (Shinzato tuff member) Okinawa; Pliocene, (Byoritzu beds) Formosa, (Chinen sand) Okinawa; Pleistocene, Kikaiga-shima, ?Japan; Recent, China and Japan.

Localities: Yonabaru clay member, 17445, 17447, 17448, 17450 (figured), 17451, 17502, 17503, 17632, 17679; Shinzato tuff member, 17453, 17454, 17456, 17477, 17633 (figured); Chinen sand, 17481 (figured).

Comparative bathymetric data: Specimens from Japan in the U.S. National Museum bearing bathymetric data were obtained from the following depths: 39, 59, 60, 94, 124, and 65–125 fathoms.

Subgenus TURRANCILLA von Martens 1903

Type: *Ancilla* (*Turrancilla*) *lanceolata* von Martens.

Ancilla (Turrancilla) cf. A. (T.) lanceolata (von Martens)

Plate 8, figure 31

?*Ancillaria lanceolata* von Martens, 1903, Sitzungs-Bericht der Gesellschaft naturforschender Freunde, no. 1, p. 23; 1903, Gastropoden der Deutschen Tiefsee Expedition, p. 110, pl. 3, fig. 10.

?*Ancilla suavis* Yokoyama, 1926, Tokyo Imp. Univ. Fac. Sci. Jour., sec. 2, v. 1, pt. 9, p. 334, pl. 38, fig. 17.

This species and its related forms can be distinguished from the group of *A. albocallosa* by differences that are probably subgeneric. The shell is decidely more slender, and the basal or anterior callus is broader. If there are any incised spiral grooves on the base of the whorl, as in the *A. albocallosa* group, they are covered completely by callus. I cannot determine whether *A. sauvis* Yokoyama is identical with the species figured here but certainly both are very closely related to *A. lanceolata.*

Ancilla miserula Yokoyama (1928b, p. 343, pl. 66, fig. 16) from the Takajo formation (Pliocene) of Japan has a similar basal callus but the figured specimens at least are shorter and more inflated. Beets described another related form from supposed Oligocene beds of Butan (off southeast Celebes) as *A. stupaeformis.*

Distribution: Miocene, (Yonabaru clay member) Okinawa; Miocene or Pliocene, (Shinzato tuff member) Okinawa; Pliocene, ?(Chinen sand) Okinawa, ?(Hijikata formation) Japan (as *A. suavis* Yokoyama); Recent, East Africa, Indian Ocean and the Philippines.

Localities: Yonabaru clay member, 17447; Shinzato tuff member, 17453 (figured), 17454, 17456; ?Chinen sand 17482b.

Comparative bathymetric data: Numerous specimens were obtained by the Albatross in the Philippines from depths ranging from 182 to 530 fathoms, the largest specimens being from 310 and 415 fathoms.

Ancilla (Turrancilla) chinenensis, n. sp.

Plate 8, figure 30

Shell of less than medium size, moderately slender, spire moderately elongate, aperture less than half the length of the shell. Protoconch not well preserved, but apparently small and blunt. Outer lip of moderate thickness but with a slight recess near the edge, apparently the position of the operculum when withdrawn. Inner lip appressed, callus moderately thin, with a narrow elongate nearly vertical raised ridge opposite the parietal attachment of the aperture and forming a crude anal canaliculate notch. Columella moderately thick, with several fine folds which converge to form three stronger folds at the base of the columella; columella set off by a moderately deep basal sulcus. Exterior of shell sculptured only by growth lines, spire callused and smooth, base of whorl callused with no spiral lines visible above it.

Holotype (USNM 562837) measures: height 23.4 mm, diameter 8 mm.

Type locality: Shinzato tuff member, 17633.

This species is more slender and has a higher spire than specimens of *A.* cf. *lanceolata* of comparable size. Furthermore, the basal spiral callus of *A. chinenensis* descends at a slightly greater angle from the horizontal. Tesch (1915, p. 43, pl. 79, fig. 91) figured a specimen from the Pliocene of Timor as *Ancillaria* aff. *nuda* Martin which was later renamed *Ancillaria* (*Ancilla*) *teschi* by Koperberg (1931, p. 71). It is related to both *A. chinenensis* and *A. lanceolata* and appears to be intermediate between the two.

Occurrence: Miocene or Pliocene, (Shinzato tuff member) Okinawa.

Localities: Shinzato tuff member, 17633 (figured type).

Comparative bathymetric data: The Albatross Collection contains some nearly identical Recent specimens from the Philippines obtained at depths of 262 and 502 fathoms.

Genus ANCILLINA Bellardi 1882

Type: *Ancillaria pusilla* Fuchs.

According to Wenz, *Ancillina* occurs in the Oligocene and Miocene of Europe and questionably of North America. However, I regard a living Hawaiian species and a fossil described here from Okinawa as belonging to this genus.

Ancillina iwaensis, n. sp.

Plate 4, figure 12

Shell small, moderately inflated, spire longer than the aperture, early whorls expanding more rapidly than the later whorls. Protoconch conical, smooth and polished and consisting of about two whorls; passing into the early adult whorls without any change in shape or sculpture, a mottled coloration beginning at about the third whorl being taken as the termination of the protoconch. Aperture subovate with a narrow groove formed partly by callus at the posterior end, and expanded at the anterior end to form a very short but moderately wide canaliculate notch. Outer lip thin. Columella short, with a slightly basal truncation. Exterior smooth and glabrous where not callused, with two closely set but rather strong incised spiral lines at the base. Callus of moderate width on the columella. Parietal callus slightly thicker than the columellar callus and extending to about midway between the posterior end of the aperture and the suture above so that its trace forms a callus on the lower half of the exposed part of the spire whorls, leaving the upper half uncallussed. The callus starts at about the beginning of the fifth whorl including the protoconch so that about the first three adult whorls have no callus. Another spiral callus covers the fasciolar region at the base.

Holotype (USMA 562717) measures: height 8 mm, diameter 3.1 mm.

Type locality: Yonabaru clay member, 17451.

This species may be related to the several forms from the west coast of South America which Tryon (1883, p. 67, pl. 15, figs. 70–73) collected under the name of *Olivella columellaris* Sowerby. A form which is undoubtedly closely related is living around the Hawaiian Islands but it remains unpublished in a Dall manuscript.

Distribution: Miocene, (Yonabaru clay member) Okinawa.

Localities: Yonabaru clay member, 17451 (figured type).

Comparative bathymetric data: The Hawaiian form was obtained from depths of 259 to 382 fathoms, 10 stations being represented.

Genus OLIVA Bruguière 1789

Type: *Voluta porphyria* Linné.

Oliva mustellina paucicallosa, n. subsp.

Plate 4, figures 8, 13

The form so named is very closely related to the Recent *O. mustellina* Lamarck. Its spire is very low and barely projects above the rim of the penultimate whorl. It resembles in this respect the lowest spired variants of *O. mustellina* but individuals of the Recent form with nearly plane spires are rare. Its main difference is in the strength and shape of the spiral callosity. Typical *O. mustellina* has a rather heavy callus which rises well above the rim of the penultimate whorl and just obscures the rim of the penultimate whorl so that the callus has the appearance of a rounded, raised open spiral. A narrow groove between the callus and the outer rim forms the open track of the spiral.

The subspecies *paucicallosa* has a relatively thin callus which rises to a sharp rim parallelling the rim of the penultimate whorl. The rim of the whorl and the rim of the callus thus form a neat double spiral, the two tracks of which are separated by a space about half the width of the space between the callus rim and the rim of the outer whorl (fig. 8).

Holotype (USNM 562714) measures: height 25 mm, diameter 12 mm.

Type locality: Yonabaru clay member, 17449.

Distribution: Miocene, (Yonabaru clay member) Okinawa.

Localities: Yonabaru clay member, 17449 (figured type).

Oliva ispidula (Linné)

Plate 4, figure 14

Voluta ispidula Linné, 1758, Systema naturae, ed. 10, v. 1, p. 730.
Oliva ispidula. Tesch, 1915, Paläontologie von Timor, v. 5, p. 41, pl. 79, fig. 86.
Oliva ispidula. Nomura, 1935, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 2, p. 133, pl. 7, fig. 16.

No attempt is made to distinguish between the numerous varieties of this species or to deal with its voluminous synonymy. The specimen here figured compares favorably with those figured by the above mentioned authors.

Distribution: Miocene, (Yonabaru clay member) Okinawa, Java, Sumatra; Pliocene; Java, Sumatra, Timor; Pleistocene, Formosa; Recent, Indo-Pacific region, north to Japan.
Localities: Yonabaru clay member, 17502 (figured).

Oliva aff. O. australis Duclos

Plate 4, figures 15–16

The form so identified is probably the young of *O. australis* or a closely related species. A specimen having similar proportions was figured by Martin (1906, pl. 9, fig. 144) as *O. acuminata* Lamarck. This does not appear to be the same species as the one figured by Cossmann (1903) from Karikal, India, as *Olivancillaria* (*Aragonia*) *acuminata* (Lamarck).

Distribution: Miocene, (Yonabaru clay member) Okinawa.
Localities: Yonabaru clay member, 17451 (figured).

Genus OLIVELLA Swainson 1831

Type: *Oliva dama* Mawe.

Olivella sp. aff. O. fulgurata (Adams and Reeve)

Plate 4, figures 21, 23–25

?*Oliva fulgurata* Adams and Reeve, 1850, Zoology of the voyage of H.M.S. *Samarang*, Mollusca, p. 31, pl. 10, fig. 12.

The species of *Olivella* have not been satisfactorily discriminated partly because the habitat of many of the described species is not known. *Olivella fulgurata* came from the China Sea, however, so that it probably is the valid name of one of the western Pacific species. In shape the Okinawan fossils agree closely with the form figured by Marrat (1870, pl. 24, fig. 425) as *O. fulgurata.* The species was described as having a reddish tinge on its columella, but no specimens in the U.S. National Museum collection have a reddish columella. Most of the unsorted specimens from Japan and the China coast have a white or brownish columella, and a lot from the Bonin Islands has a purplish columella. The latter species may be close to *O. nota* Marratt from Vancouver Island. Kuroda and Habe (1952, p. 74) list *O. nota* as a species occurring in the Ryukyu Islands.

Distribution: Miocene, (Yonabaru clay member) Okinawa.
Localities: Yonabaru clay member, 17449 (figured), 17503 (figured), 17632 (figured).
Comparative bathymetric data: Specimens very similar to the Okinawan fossils were obtained by the Albatross Expedition in the Philippines at depths ranging from 49 to 340 fathoms.

Family MITRIDAE

Subfamily VEXILLINAE

Genus PUSIA Swainson 1840

Type: *Mitra microzonias* Lamarck.

The species here described are referable to *Pusia* as currently used, but it is possible that the much inflated species with large axial ribs such as *P. patriarchalis* and *P. tuberosa* and the new species are at least subgenerically distinct from *P. microzonias.*

Pusia meganodosa, n. sp.

Plate 19, figure 19

Shell over medium size for the genus, moderately inflated, whorls subrounded to subangulate, spire low and broad. Protoconch unknown. Aperture moderately narrow and elongate, about three-fifths the length of the shell. Outer lip of moderate thickness. Parietal callus not well preserved on the type. Columella with three prominent folds and a weak fourth fold, the posterior one the strongest and most projecting with each successive anterior fold becoming weaker. Sculpture consisting of broad, low axial ribs (five visible from an angle) which are developed mostly above the suture and become obsolete at or just below the level of the suture, the axials crossed by roughly punctate incised spiral lines which become obsolete at or just below the lower limit of the axials; the lower part of the whorl sculptured by a few weak spirals but these lower spirals are separated from the upper ones by an area that is smooth except for growth lines.

Holotype (USNM 563078) measures: height 18 mm, diameter 9.2 mm.
Type locality: Yontan limestone, 17652.

This species appears to be more closely related to *P. tuberosa* (Reeve) than to any other. It has broader and blunter axials than *P. tuberosa,* however. The spiral sculpture of *P. tuberosa* is present all over the whorl with about equal development, whereas in the new species it is absent centrally. *Pusia tuberosa* also has a well developed siphonal fasciole and its columella has a definite twist. *Pusia meganodosa* has a nearly straight columella and no noticeable siphonal fasciole.

Distribution: Pleistocene, (Yontan limestone) Okinawa.
Localities: Yontan limestone, 17652 (figured type).

Pusia cf. P. emmae (Yokoyama)

Plate 14, figure 6

?*Mitra emmae* Yokoyama, 1920, Tokyo Imp. Univ. Coll. Sci. Jour., v. 39, art. 6, p. 49, pl. 6, fig. 4.

?*Pusia emmae*. Taki and Oyama, 1954, Paleont. Soc. Japan Spec. Paper 2, pl. 7, fig. 4.

There seems to be no way to distinguish the Okinawan form from the specimen figured by Yokoyama except that it may be a trifle more inflated—probably an allowable variation. The species was described from the Pliocene of Japan. Possibly the most closely related Recent species is *P. vanattai* (Pilsbry), a species which Kuroda and Habe (1952, p. 67) regard as a synonym of *Pusia aemula* (Smith). The axial ribs of *P. vanattai* are broadly rounded, becoming obsolete on the lower part of the body whorl and not quite reaching the suture above. On the Okinawan specimen the axials are sharp, or with a sharply rounded crest, and they extend from the suture above to the siphonal fasciole below. There are no spiral markings other than four strong spiral ridges on the fasciolar region.

Occurrence: Pliocene, (Nakoshi sand) Okinawa.
Localities: Nakoshi sand, 17440 (figured).

Genus UROMITRA Bellardi 1887

Type: *Uromitra antegressa* Bellardi.

Uromitra cophina gonzabuensis, n. subsp.

Plate 4, figures 18–19

This form, although described as a subspecies of *U. cophina* Gould, can be distinguished from it by its shorter columella and better developed subsutural collar. *Uromitra cophina* and the new subspecies seem to be unique, at least as far as the collections in the U.S. National Museum are concerned, in having one or two axial creases between each of the axial riblets. This ranges from a single creaselike line in some individuals to a double crease with a tiny raised foldlike liration between them in other individuals. Some specimens have a crease and a ridge alongside it, the other crease not being developed. Typical *M. cophina* more generally has a double crease enclosing a raised line, whereas the subspecies *gonzabuensis* more generally has a single incised crease.

Holotype (USNM 562722) measures: height 12.3 mm, diameter 4.5 mm; paratype, 562723.
Type locality: Yonabaru clay member, 17449.
Distribution: Miocene, (Yonabaru clay member) Okinawa.
Localities: Yonabaru clay member, 17449 (figured type).

Uromitra aff. U. obeliscus (Reeve)

Plate 4, figure 17; plate 14, figures 5, 7–8

?*Mitra obeliscus* Reeve, 1844, Conchologia iconica, v. 2, *Mitra*, no. 107.

?*Turricula obeliscus*. Tryon, 1882, Manual of conchology, v. 4, p. 179, pl. 53, fig. 535.

?*Vexillum obeliscus*. Kuroda and Habe, 1952, Recent marine Mollusca of Japan, p. 96.

There is little or no difference in sculpture between the Okinawan fossils and Recent specimens of *U. obeliscus* the writer has seen, but there is considerable range in the thickness of the columella, the amount of columellar twist, and in the strength of the siphonal fasciole in both. The fold of callus on the parietal wall adjacent to the anal notch tends to be more horizontal in *U. obeliscus* and more vertical in the Okinawan fossils. However, a specimen from the Miocene of Java figured by Martin (1891, p. 82, pl. 12, fig. 182) has a parietal fold like that on the specimens shown on plate 14, figures 7–8, and in all probability this character is also variable.

Some of the specimens which Martin included in his *Mitra javana* (1879, pl. 6, fig. 2) may belong to this species. The form identified by Tesch (1915, p. 48, pl. 80, fig. 104) as *Turricula* (*Vulpecula*) *javana* (Martin) is another species.

The Hayasaka collection from the Upper Byoritzu beds of Formosa, now in the U.S. Geological Survey, includes a specimen that is identical with the specimen from the Yonabaru clay member of the Shimajiri formation shown on plate 4, figure 17. This species was not reported from the Byoritzu beds by either Yokoyama or Nomura.

Distribution: Miocene, (Yonabaru clay member) Takabanareshima, Okinawa gunto, ?Java; Pliocene, (Chinen sand) Okinawa, (Byoritzu beds) Formosa, Java; Recent, Andaman Islands, Philippines, Fiji Islands, Japan.
Localities: Yonabaru clay member, 17476 (figured); Chinen sand, 17442 (figured), 17481 (figured).

Uromitra teschi, n. sp.

Plate 8, figure 28

?*Turricula obeliscus*. Tesch, 1915, Paläontologie von Timor, v. 5, no. 9, p. 49, pl. 80, fig. 106.

Shell of medium size, slender, whorls flattened with well developed shoulders. Protoconch unknown. Aperture less than half the length of the shell, moderately narrow, but not narrowing towards the posterior end. Outer lip not entire on the type, moderately thick on the broken edge, not crenulate within. Inner lip not detached, callus light except at the posterior end where a moderately heavy callosity forms the inner side of a weak anal notch. Columella with three well developed folds, the uppermost the strongest. Canal moderately elongate and gently curved. Sculpture consisting of well-developed nearly straight axial riblets, about 12 visible from an angle, and raised spiral lirations that cross but show only weakly on the axials, and are separated by depressed interspaces of about the same width or slightly wider than the spiral lirations.

Holotype (USNM 562835) measures: height 20 mm, diameter 6.5 mm.

Type locality: Shinzato tuff member, 17633.

This species is closely related to *U. obeliscus* (Reeve), differing from it mainly in having swollen shoulders with more deeply recessed sutures and nearly straight-sided whorls. The specimen from the Pliocene of Timor figured by Tesch may be referable to this species but the Okinawan form is designated the type in case it should be found that they are not identical.

Another very closely related species was described by Oostingh (1935, p. 93, pl. 9, fig. 92) under the name *Vexillum* (*Vexillum*) *limiticum.* It occurs in the Pliocene of Java. The axials of *U. limiticum* appear to be more inclined but there is little difference in other respects.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa; Pliocene(?), Timor.

Localities: Shinzato tuff member, 17633 (figured type).

Uromitra fulleri, n. sp.

Plate 8, figure 29

Shell medium small, moderately inflated, spire longer than the aperture, whorls rounded. Protoconch not known. Aperture slightly wider at the posterior end. Outer lip broken on type but with a sharp edge where preserved. Interior of outer lip with a row of short crenulations well back from the edge. Inner lip with a thin detached edge except on the parietal wall where it is appressed and forms a thin callus. Columella moderately short and straight, bearing three strong plications and a weak fourth one; upper part of parietal region with another foldlike callosity that marks the inner side of the anal notch. Siphonal fasciole weakly developed and narrow. Whorls weakly shouldered with a well defined *Terebra*-like subsutural collar. Sculpture consisting of gently curved blunt to sharp crested axial riblets (12 visible on the body whorl) which do not diminish in strength at their upper end along the collar, but actually produce a slight coronation along the sutural side of the collar, and weak spiral threads that are present only between the axials on the upper part of the whorls, but broad and predominating over the axial sculpture on the lower part of the columella. Interspaces roughly V-shaped with the base of the V located close to the right of the axials; the left slope from the axials being longer and gentler than the right slope.

Holotype (USNM 562836) measures: height 13.9 mm., diameter 5.1 mm.

Type locality: Shinzato tuff member, 17677.

The sculpture of this species recalls that of *U. cophina gonzabuensis* in general pattern. Both have the narrow groove in the axial interspaces and a well defined subsutural collar. However, the aperture of *U. fulleri* is longer with relation to the spire and the spiral lirations on the periphery are weaker. The greatest difference is in the strength of the spirals on the base of the whorl and columella, those on *U. fulleri* being over twice as large as on *U. cophina gonzabuensis.*

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa.

Localities: Shinzato tuff member, 17677 (figured type).

Uromitra aff. U. lirocostata (Cossmann)

Plate 14, figure 14

?*Turricula lirocostata* Cossmann, 1903, Journal de conchyliologie, v. 51, no. 2, p. 124, pl. 4, fig. 15, 16.

There is some range in shape in the Okinawan specimens referred to this species. Some have a sharp even taper, whereas others are more inflated, comparing more with Cossmann's figured specimen. All have identical sculpture, however. The sculpture at the base of the whorl, consisting of a single strong spiral and a weaker spiral above and below it, the weak spirals separated from the strong spiral by a broad, shallow interspace, is especially characteristic.

The Hayasaka collection from the upper Byoritzu beds of Formosa contains several specimens of what may be the same species, although they are worn. They were labelled *Vexillum* (*Pusia*) *gembacanum* Martin, a species described from the lower Miocene of Java. How closely related the Javanese species is to *U. lirocostata* from the Pliocene of Karikal, India, as well as to the Formosan and Okinawan forms tentatively assigned to it is difficult to determine from the published figures, but the sculpture at the base of Martin's species appears to be different.

Distribution: Pliocene, (Nakoshi sand) Okinawa, ?(Karikal) India, ?(Byoritzu beds) Formosa.

Localities: Nakoshi sand, 17440 (figured).

Subfamily MITRINAE

Genus MITRA Lamarck 1798

Type: *Mitra episcopalis* Linné (=*Mitra mitra* (Linné)).

Montfort is generally regarded to have designated the type of *Mitra.* However, it appears that a clear case for regarding *M. episcopalis* as its type by tautonymy rather than by original designation can be made since *M. episcopalis* is typical *Mitra mitra. Voluta Mitra* was one of the few cases where Linné used subspecies. The name *Mitra* is printed in both the 10th and 12th editions in the same font as other Linnean species but with no diagnosis or indications. Under it are two names printed in italics, *episcopalis* and *papalis*, obviously intended to be of subspecific rank. That *Mitra* was used in a specific sense is borne out by Linné's use of *Voluta Mitra* in the Museum Ludovicae Ulricae where indications of both *episcopalis* and *papalis* are included but neither subspecific name is used. Linné appears to have believed, therefore, that where subspecies are used all must be named and that no one of them is to be regarded as being the typical form. Müller, in his free German version of the 12th edition of the Systema naturae (Natursystem, p. 431, Nürnberg, 1775), lists *Voluta Mitra*, under which he gives some of Linné's indications of *episcopalis*, and *Voluta Mitra papalis* under which he gives some of Linné's indications for that form. Müller thus anticipated the modern practice of regarding one of a number of subspecies as the typical form of the species. It seems, therefore, that the name *Mitra episcopalis* commonly used should give way to *Mitra mitra*, and as such should automatically become the type of the genus. *Mitra papalis* (Linné) is now regarded by most authors as a distinct species.

Authorship of *Mitra* was long credited to Lamarck, 1799, with *Voluta episcopalis* the type by monotypy. Dall concluded in 1905 (U.S. Natl. Museum Proc., v. 29, p. 428) that the name should be credited to Martyn, 1786, and designated *Mitra tessellata* Martyn the type. In 1923 (Nautilus, v. 37, no. 2, p. 45) however, he remarked that both Meuschen (Index Museum Gronovianum, p. 299, 1781) and Linné (Systema naturae, ed. 10, p. 732, 1758) used *Voluta* with the "name *Mitra* intercalated, presumably in a subgeneric sense". As already stated, *Mitra* is printed in roman in the Systema, as are all Linnean species, whereas *episcopalis* and *papalis* are in italics indicating that they are subspecies and not species. It does not seem possible, therefore, to construe *Mitra* as a subgenus of Linné. Recently it has been shown that Martyn's system of nomenclature is non-Linnean and consequently invalid.

Authorship of *Mitra* does not revert to Lamarck, 1799, however, since it has been ruled that the generic names that first appeared on plates in the Encyclopédie Méthodique, 1798, are valid. The name goes, therefore, either to the author of the Encyclopédie Méthodique or to Roeding, both 1798. The writer is indebted to Dr. Harold Rehder for pointing out that the Encyclopédie Méthodique antedates Roeding. According to Sherborn and Woodward, plate 369 of the Encyclopédie Méthodique was issued in 1798 (An. vi). An vi (the year 6 of the Revolutionary Calender) ended September 22, 1798, whereas the Bolten Catalogue of Roeding is thought to have been issued in November or December of 1798, the introduction being dated September 1798, and notices that it could be obtained by mail first appearing in January 1799.

Lamarck rather than Bruguière is here regarded as the author of plates 369–377 of the Encyclopédie Méthodique. Livraison 64 containing plates 287 to 390, and livraison 84 containing plates 391 to 588 are both supposed to have been issued under the supervision of Lamarck and others, even though the plates of livraison 64 and some of the plates of livraison 84 were prepared by Bruguière. It is likely that some of the plates of livraison 64, including those of *Mitra*, were also prepared by Lamarck. This is suggested by the fact that Lamarck makes no mention of *Mitra* among the genera said to be restricted by Bruguière in the Encyclopédie in his discussion of it in the 1799 Prodrome, and furthermore, *Mitra* does not appear in Bruguière's generic list (Tableau systematique des Vers) in the introduction to the Encyclopédie Méthodique. In spite of the possibility that some of the names in both livraisons 64 and 84 are Bruguière's, there is no clear statement that this is the case, as required in the new rules of zoological nomenclature. Consequently, they should be credited to Lamarck.

Regardless of whether Bruguière, Lamarck 1799 or 1798, or Roeding is considered the author of the genus, or of how the type was designated, there has really never been any misunderstanding of its type species outside of the temporary acceptance of the names of Martyn.

Subgenus NEBULARIA Swainson 1840

Type: *M.* (*N.*) *contracta* Swainson. (=*Voluta abbatis* (Chemnitz) Dillwyn, not. *Mitra abbatis* Perry).

Mitra (Nebularia) aff. M. (N.) chrysostoma Broderip

Plate 17, figure 21

?*Mitra chrysostoma* Broderip, 1836, Zool. Soc. London Proc., p. 194.

?*Mitra* (*Strigitella*) *chrysostoma*. Tryon, 1882, Manual of conchology, v. 4, p. 155, pl. 46, figs. 330, 331.

?*Strigatella chrysostoma*. Dautzenberg, 1935, Mus. royal d'Historie nat. de Belgique Mém., hors ser., v. 2, pt. 17, p. 101. (With extended synonymy.)

The specimens so identified appear to belong to the group which Tryon included under the names *chrysostoma* Swainson and *scutulata* Lamarck. The synonymy of this group is involved and I am not in a position to determine which of the names included in it might be valid species so that no closer identification is attempted.

Distribution: Pliocene, (Naha limestone) Okinawa; Pleistocene(?), (Yontan limestone) Okinawa.

Localities: Naha limestone, 17673 (figured); Yontan limestone, ?17550.

Comparative bathymetric data: *Mitra chrysostoma* is a reef dweller.

Mitra (Nebularia) cf. M. (N.) hanleyana Dunker

Plate 17, figure 14

?*Mitra hanleyana* Dunker, 1877, Malakozoologische Blätter,, v. 24, p. 70.
?Dunker, 1882, Index Molluscorum Maris Japonici, p. 51, pl. 2, figs. 6, 7.
?Hirase, 1936, A collection of Japanese shells, pl. 100, fig. 10.

Although Tryon listed this among his undetermined species, it is actually one of the more striking and easily recognizable species of *Mitra*. The Hirase collection in the U.S. National Museum contains two specimens, one about the same size and identical with the one figured by Dunker. Another specimen is present from Fokien Province, China.

Mitra hanleyana is one of the few *Mitra* that has recurving growth lines below the suture, due to a backward curve of the outer lip close to the suture. The Okinawan fossil fragment shows growth lines that recurve rather strongly, and the details of the sculpture compare with those of *M. hanleyana*, although perhaps the incised lines which in both forms are punctate, are not quite as deep.

Mitra hanleyana is probably the *Mitra wrighti* of Crosse (see Tryon, 1882, pl. 34, fig. 44), described a year later, but whether or not it is the same as *M. inquinata* Reeve, with which *M. wrighti* was synonymized by Tryon is debatable.

Distribution: Pliocene, (Naha limestone) Okinawa; Recent, China coast, Ryukyu Islands, Japan.
Localities: Naha limestone, 17484 (figured).

Subgenus CANCILLA Swainson 1840

Type: *Mitra isabella* Swainson.

Mitra (Cancilla) yokoyamai Nomura

Plate 14, figure 9

Mitra isabella. Yokoyama, 1928, Imp. Geol. Survey Japan Rept. 101, p. 35, pl. 2, fig. 1.
Mitra (*Scabricola*) *yokoyamai* Nomura, 1935, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 2, p. 138, pl. 7, figs. 25a, b.

The specimen figured here from Okinawa appears to be identical with the specimens figured by both Yokoyama and Nomura. Several specimens identified as this species are in the Hayasaka collection from Formosa and came from both the Tsūsyō sandstone and Shiko beds, both of which are referable to the "upper Byoritzu" of Yokoyama. All of the specimens in the Hayasaka collection have somewhat sharper spiral lines than the Okinawan form and, as far as can be observed from the photographs, they are sharper than those on the specimens figured by Yokoyama and Nomura. Furthermore, the aperture on the specimens in the Hayasaka collection is over three-fifths the height of the shell whereas on the Okinawan species it is less than half the height and on Yokoyama's specimen it is only slightly more than half. However, the base of the columella on the Okinawan specimen was broken and repaired and it might once have been comparable in height to that of *M. yokoyamai.* At any rate neither *M. yokoyamai* nor the specimen from Okinawa referred to it is regarded as being conspecific with the species present in the Hayasaka collection. The latter are more like an Australian species *Mitra pia* Dohrn (see Tryon, 1882, pl. 41, fig. 189) although Tryon says that *M. multilirata* A. Adams, supposedly from China, may be the same species.

Distribution: Pliocene, (Byoritzu beds) Formosa, (Chinen sand) Okinawa.
Localities: Chinen sand, 17481 (figured).

Mitra (Cancilla) filaris (Linné)

Plate 14, figure 11

Voluta filaris Linné, 1771, Mantissa, p. 548.
Mitra filosa gracilis Philippi, 1850, Zeitschrift für Malakozoologie, no. 2, p. 26. (Not *Mitra gracilis* Wood, 1828.)
Mitra (*Cancilla*) *filaris*. Dautzenberg and Bouge. 1923, Journal de conchyliologie, v. 67, no. 2, p. 107.
Mitra (*Cancilla*) *filaris* var. *gracilis*. Dautzenberg, 1935, Mus. royal d'Histoire nat. de Belgique Mém., hors ser., v. 2, pt. 17, p. 17. (With further synonymy.)
Mitra (*Cancilla*) *filaris*. Nomura, 1935, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 2, p. 138, pl. 7, fig. 24.
Hirase, 1936, A collection of Japanese shells, pl. 101, fig. 1.

Two closely related forms, one slender with a high spire, and the other more inflated and with a low spire are living. Considerable difference of opinion has existed among authors as to which is the typical form and which the variety or subspecies. At least the name *gracilis* of Philippi is a homonym.

Both the Okinawan fossil and the form figured by Nomura from Formosa appear to be identical with the slender living form. This species is not present in the Hayasaka collection from the Byoritzu beds.

The specimen figured by Hirase was reidentified by Taki ((Hirase) Taki, 1951, pl. 101, fig. 1) as *Mitra praestantissima* Roeding (*M. filaris* auct., non Linné) and Kuroda and Habe (1952, p. 66–67) use the same synonomy. In addition, the latter authors use "*gracilis* Reeve", the quotations theirs, as the name of a living Japanese species. I follow the interpretation of Dautzenberg and Bouge of 1923 and Nomura in regarding the slender form as typical *filaris. Mitra circula* Kiener of Martin (1891–1922, pl. 11, fig. 172) from the Pliocene of Java appears to be this species. Presumably this is the *M. circulata* which Tryon (1882, p. 208) regarded as a synonym of *M. filaris.*

Distribution: Pliocene, (Byoritzu beds) Formosa, (Chinen sand) Okinawa; Recent, Indonesia, Philippines, Japan, South Pacific and Hawaii.

Localities: Chinen sand, 17442 (figured).

Mitra (Cancilla) cf. M. (C.) flammea Quoy and Gaimard

Plate 14, figure 10

?*Mitra* (*Cancilla*) *flammea*. Nomura, 1935, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 2, p. 139.

Mitra flammea. Yabe and Hatai, 1941, Japanese Jour. Geology and Geography, v. 18, nos. 1, 2, p. 75.

Only a fragment of the spire was obtained, but it appears to be similar in shape to the specimen figured by Nomura. A specimen from the Byoritzu beds of Formosa in the Hayasaka collection is identical.

Distribution: Miocene, Java, Sumatra, Borneo, Nias; Pliocene, Java, Timor, Ceram, (Byoritzu beds) Formosa, (Chinen sand and Nakoshi sand) Okinawa; Recent, Australia to Japan, Polynesia north to Hawaii.

Localities: Chinen sand, 17442 (figured), Nakoshi sand, Nakoshi Primary School (Yabe and Hatai).

Mitra (Cancilla) yonabaruensis, n. sp.

Plate 4, figure 29

Shell of medium size, medium slender, whorls evenly rounded, spire of medium height. Protoconch not preserved on the specimens at hand. Aperture narrow, about half the length of the shell. Outer lip moderately heavy, but with a sharp edge, not crenulate within. Inner lip not distinguishable except near the base of the columella where a slight umbilical chink is developed. Parietal callus very thin and a part of the sculpture on the parietal wall appears to be dissolved in advance of the aperture. Columella bearing two strong folds and a weak third fold, and on some specimens a very weak fourth fold. Sculpture consisting of well developed raised, flattened spirals which on the young whorls are narrower than the depressed interspaces, but which become broader than the interspaces on the later whorls, especially on the lower part of the whorl, wider and narrower spirals alternating on the central and lower part of the body whorl on some specimens; growth lines forming small axially elongate or punctate pits between the spirals.

Holotype (USNM 562735) measures: height 21.5 mm, diameter 7.5 mm.

Type locality: Yonabaru clay member, 17451.

This species is probably related to *Mitra* (*Chrysame*) *semari* Beets (1941) from the upper Miocene of Mangkalihat, eastern Borneo, but seems to be more slender and the spiral ribs are more irregular.

How closely related this species is to other forms with broad spiral ribs in the adult stage, such as *M. granatinaeformis* and the related *M. junghuhni* Martin is not certain. *Cancilla* with this type of sculpture are more common in the Miocene in the Indo-Pacific region.

Mitra strigillata Sowerby, a species of unknown habitat, has broad spiral ridges on the adult whorls, but has a low spire and the shoulders are rather strong. It is probably related to *M. philippinarum* A. Adams.

Distribution: Miocene, (Yonabaru Clay member) Okinawa.

Localities: Yonabaru clay member, 17451 (figured type), 17503.

Mitrá (Cancilla) aff. M. (C.) menkrawitensis Beets

Plate 4, figure 30

?*Mitra* (*Cancilla*) *menkrawitensis* Beets, 1941, Verhandelingen van het Geologisch-Mijnbouwkundig Genootschap voor Nederland en Kolonien, Geologische Serie, v. 13, Eerste Stuk, p. 116, pl. 6, figs. 239, 240.

The form figured here from Okinawa is very closely related to the eastern Borneo form, so much so that it is impossible to say how they might differ from the figures alone. Since both are believed to be of upper Miocene age, it is possible that they are identical.

Distribution: Miocene, (Yonabaru clay member) Okinawa, ?Eastern Borneo.

Localities: Yonabaru clay member, 17451 (figured), ?17502.

Mitra (Cancilla) cf. M. (C.) granatinaeformis Martin

Plate 4, figures 20, 22, 31

?*Mitra granatinaeformis* Martin, 1884, Samml. Geol. Reichsmus. Leiden, 1 ser., v. 3, p. 86, pl. 5, fig. 87.

Mukerjee, 1939, Geol. Survey India Mem., new ser., v. 28, mem. 1, p. 65, pl. 3, fig. 25.

Martin's figure is not good enough for definite identification with this species, but the specimen from the Garo Hills of Assam figured by Mukerjee appears to be identical with the Okinawan species. Inasmuch as Mukerjee states that his identification was made from the figures and description, the more positive identification is with his form rather than Martin's.

The very young whorls have raised spiral threads, which although flattened on top, are about as wide as the depressed interspaces (see fig. 31, a juvenile). The spirals widen on successive whorls, becoming so wide as to make the interspaces appear as little more than narrow incised lines (figs. 20, 22).

The species figured here is very closely related to *M. junghuhni* Martin (1879, p. 23, pl. 6, fig. 1). How close these forms are it is difficult to say from the figures. However, it is possible that *M. junghuhni* as figured by both Martin and Tesch is the adult form of *M. granatinaeformis*. In that case *M. junghuhni* would be the valid name for this species.

Distribution: Miocene, ?Java, (Yonabaru clay member) Okinawa.

Localities: Yonabaru clay member, 17449 (figured), 17502 (figured), ?17632.

Mitra (?Cancilla) sp. ind.

Plate 4, figure 28

The body whorl only of another *Mitra* was obtained from the Yonabaru clay member of the Shimajiri formation. It has weak axials on the upper part of the whorl and weak spirals over the face of the whorl, becoming stronger on the columella.

This species may be related to *Mitra pauciplicata* Yokoyama (1928b) from the Pliocene of Hyuga, but on the basis of its smaller and more numerous axials is probably not identical.

Locality: Yonabaru clay member, 17451 (figured).

Subgenus FUSIMITRA Conrad 1855

Type: *Fusimitra millingtoni* Conrad.

Mitra (Fusimitra) loochooensis, n. sp.

Plate 4, figures 26–27, 32–33

Shell medium small, slender, spire less than the length of the aperture, whorls rounded. Protoconch sharp pointed and consisting of about 3¼ smooth whorls. Aperture narrow, outer lip thin and plain; no inner lip. Parietal wall very weakly callussed with the parietal sculpture dissolved away in advance of the aperture and callus. Columella bearing three folds, the lower very weak; base of columella simple or very slightly reflected, some but not all specimens showing a very weak umbilical chink; siphonal fasciolar region not swollen. Sculpture consisting of low flat spiral lirations separated by moderately strong incised pitted lines on the young whorls, but on the adult whorls the incised lines become very weak and punctate and are located mainly on the base of the whorl with sometimes one or two below the suture; the central portion of the whorl on adults showing a spiral banding of different densities (color markings?) within the shell but with no surface relief.

Holotype (USNM 562730) measures: height 19.3 mm., diameter 6 mm. Paratype (USNM 562732) measures: height 14.4 mm., diameter 5 mm.

Type locality: Yonabaru clay member, 17451.

This species may be related to the Recent *Mitra chinensis* Gray from China, but it is definitely smaller and slenderer than that species. Furthermore, the incised spiral lines on *chinensis* are not pitted as in *M. loochooensis*. The only other species described from the Indo-Pacific area that appears to be closely related to this species is *Turricula hirmanica* Vredenberg from the lower Tertiary of India. Vredenberg compared his species with *T. zonalis* Quay and Gaimard, a Recent species, but the two are not closely related. *Mitra loochooensis* is apparently another of the relict elements of the lower Tertiary that persisted into the upper Tertiary in the Indo-Pacific region.

Distribution: Miocene, (Yonabaru clay member) Okinawa.

Localities: Yonabaru clay member, 17451 (holotype, paratype and two topotypes figured).

Subfamily CYLINDROMITRINAE

Genus CYLINDROMITRA P. Fischer 1884

Type: *Voluta crenulata* Chemnitz.

Cylindromitra undulosa (Reeve)

Plate 17, figure 19

Mitra undulosa Reeve, 1844, Zool. Soc. London Proc., p. 185; 1844, Conchologia iconica, v. 2, pl. 24, fig. 192.

Cylindromitra undulosa. Dautzenberg, 1935, Mus. royal d'Histoire nat. de Belgique Mém., hors ser., v. 2, fasc. 17, p. 176. (With further synonymy.)

A single specimen was obtained that resembles in shape and sculpture the Recent species. The basal spirals of *C. undulosa* are not papillose as they are on the closely related *C. crenulata*.

Distribution: Pliocene, (Naha limestone) Okinawa; Recent, Indo-Pacific, north to Japan.

Localities: Naha limestone, 17610 (figured).

Family VASIDAE

Genus VASUM (Bolten) Roeding 1798

Type: *Vasum turbinellus* (Bolten) Roeding (=*Vasum turbinellus* (Linné)).

?Vasum sp. ind.

Plate 4, figure 34

Only an anterior fragment was obtained of this shell. Its generic assignment is tentative but its heavy siphonal fasciole and broad shallow umbilicus can be matched in several species of *Vasum*.

Localities: Yonabaru Clay member, 17449 (figured). Another fragment from the Shinzato tuff member, 17456, may also be a *Vasum*.

Family VOLUTIDAE

Subfamily VOLUTINAE

Genus Teramachia Kuroda 1931

Teramachia Kuroda, 1931, Venus, v. 3, no. 1, p. 45.

Prodallia. Bartsch, 1942, Nautilus, v. 56, no. 1, p. 10.

Type: *T. tibiaeformis* Kuroda.

The name *Prodallia* first appeared in a banquet brochure honoring William Healey Dall in 1915. In this a figure and a name "*Prodallia dalli* Bartsch" appeared along with illustrations of other animals named in honour of Dr. Dall. This was not followed by a formal description until 26 years later, whereas in the meantime the genus had been described by Kuroda. In view of the fact that the brochure was nothing more than a souvenir memo and not a regularly distributed scientific publication, periodical, or catalog it is extremely doubtful that it could receive favorable action by the International Commission on Zoological Nomenclature.

Teramachia shinzatoensis, n. sp.

Plate 9, figure 1

Shell of medium size and inflation for the genus, fusiform, whorls rounded. Protoconch not present on type. Aperture subelliptical. Outer lip slightly flaring and widest at about the lower third; a narrow notch at the posterior end of the aperture for the anal sinus. Parietal wall and columella with a broad thin callus. Columella slender and straight, bearing two weak folds well within the aperture. Sculpture consisting of narrow curved axials (about 18–19 visible from an angle) which become obsolete on the penultimate whorl, and very weak raised spirals on the columella.

Holotype (USNM 562840) measures: height 69.8 mm., diameter 23.7 mm.

Type locality: Shinzato tuff member, 17648.

Five living species of *Teramachia* have been described; *T. tibiaeformis* Kuroda (1931, p. 45, figs. 2–3; also Kuroda and Habe, 1950, p. 36, pl. 5, fig. 1), the type species from Japan, and four species collected by the Albatross Expedition from the Philippines and described by Bartsch (1942) under the generic name *Prodallia*. They are, *T. dalli*, the type of *Prodallia*, *T. smithi*, *T. johnsoni*, and *T. barthelowi*.

Teramachia shinzatoensis is most closely related to *T. johnsoni* as far as sculpture is concerned, but it differs from that species in being less slender and its axial sculpture becomes obsolete at an earlier stage.

Teramachia dalli differs from the Okinawan form in having its anal sinus notch set apart from the suture so that a deep groove lies between the suture and the collar. *T. smithi* has fewer and more widely spaced axials and a slightly more flaring aperture. *T. barthelowi* is by far the smallest species of those described, and its sculpture becomes obsolete on about the 5th whorl.

This appears to be the first record of a fossil *Teramachia*.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa.

Localities: Shinzato tuff member, 17648 (figured type).

Comparative bathymetric data: The Philippine species were dredged from the following depths: *T. dalli*, 393 and 422 fathoms; *T. smithi*, 281 and 439 fathoms; *T. johnsoni*, 340 fathoms; *T. barthelowi*, 495 fathoms. The specimen of *T. tibiaeformis* figured by Kuroda and Habe has written on it, "Tosa 100 fms."

Genus BENTHOVOLUTA Kuroda and Habe 1950

Type: *Phenacoptygma? kiiensis* Kuroda (=*Voluta hilgendorfi* v. Martens).

Assignment of the following species to this genus is tentative. *Benthovoluta hilgendorfi* is described as having three plaits on its columella, whereas the present species has only two. *Phenacoptygma* Dall has two columellar plaits.

Benthovoluta okinavensis, n. sp.

Plate 9, figures 2–3

Shell small, slender, fusiform, whorls gently rounded. Protoconch small, the first whorl highly tilted and involute, the next quarter-turn in the same plane as the spire whorls. Aperture broken on type, but apparently narrow, produced anteriorly into a slightly curved canal. Parietal wall with a very weak callus. Columella moderately long, curved, and bearing two weak folds. Sculpture consisting of straight or very slightly curved axial ribs (about 6 visible from an angle) which become obsolete on about the 5th whorl; those on the first 3 whorls reaching the suture but those on the 4th whorl dying out below the suture.

Holotype (USNM 562841) measures: height 27 mm, diameter 7.4 mm.

Type locality: Shinzato tuff member, 17454.

This species is most closely related to a species from the Pliocene of Japan which Yokoyama (1920, p. 48, pl. 2, fig. 16) described under the name *Mitra plicifera*, and which Taki and Oyama (1954, pl. 3, fig. 16) reidentified as *Benthovoluta hilgendorfi* (v. Martens). Yokoyama's figure shows more axial ribs than Kuroda and Habe's figure (1950, pl. 5, fig. 2) of *B. hilgendorfi* and I am inclined to doubt Taki and Oyama's specific assignment, although it probably is a *Benthovoluta*. *Benthovoluta okinavensis* has about the same number of axial ribs as typical *B. hilgendorfi* but it is slenderer, has a more pronounced constriction at the base of the body whorl, and a slightly twisted columella of more nearly the same thickness from top to bottom. In addition, its spiral sculpture appears from the figures to be weaker than on *B. hilgendorfi*.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa.

Localities: Shinzato tuff member, 17454 (figured type), 17456.

Genus PHENACOPTYGMA Dall 1918

Type: *Surculina cortezi* Dall (described as *Daphnella (Surculina) cortezi*).

Although the genus *Phenacoptygma* was once used in the Japanese province for the species which later became the type of *Benthovoluta* and thereafter believed not to be present in the western Pacific region, another species found fossil in Okinawa, and here figured, is believed to be a typical *Phenacoptygma*. The spire is long and slender, a character not well shown in Dall's figure (see Oldroyd, 1927, vol. 2, pt. 2, pl. 13, fig. 7) of the type of *P. cortezi* which has a worn spire.

Phenacoptygma n. sp.

Plate 9, figures 4–5

Two fragments figured here I believe to represent the same species but to be parts of different specimens. The form appears to be new but it will not be described on this fragmentary material. The columella has two weak but well-defined folds similar to those of *Benthovoluta okinavensis*. The protoconch is small and not well preserved but appears to be subnaticoidal and slightly tilted. The axial ribs are nearly vertical, short and rather weak and are developed mainly on the upper part of the peripheral region. The subsutural slope is moderately broad and slightly depressed. The spiral threads on the subsutural slope are considerably weaker than those on the periphery and base.

The figured specimens taken together indicate a shell about 35 millimeters in length and about 8 millimeters in diameter.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa.

Localities: Shinzato tuff member, 17454 (figured).

Comparative bathymetric data: The type of *Phenacoptygma*, *P. cortezi* (Dall) came from off San Diego, California at a depth of 984 fathoms.

Genus FULGORARIA Schumacher 1817

Type: *Fulgoraria chinesis* Schumacher (=*Voluta rupestris* Gmelin).

Fulgoraria is one of the few genera in the Okinawan faunas that ranges northward but not southward. It was not found fossil in Formosa, nor is it present in the Albatross Expedition collections from the Philippines.

Fulgoraria aff. F. hirasei (Sowerby)

Plate 14, figure 13

?*Voluta hirasei* Sowerby, 1912, Annals and Mag. Nat. Hist., ser. 8, v. 9, p. 472, fig. 1.

?*Fulgoraria hirasei.* Kuroda and Habe, 1950, Illustrated catalog of Japanese shells, no. 5, p. 34, pl. 6, fig. 5.

Only the spire of a young individual was obtained. It has prominent spiral lirations and in this respect compares with at least three of the species illustrated by Kuroda and Habe; *F. kaneko* Kuroda and Habe, *F. cancellata* Kuroda and Habe, and *F. hirasei* (Sowerby). Its parietal callus is broad and the posterior border takes a nearly horizontal strike away from the aperture for a short distance; in this respect it compares most nearly with *F. hirasei.*

Another fragment with strong spiral lirations was obtained from the Yonabaru clay member of the Shimajiri formation at station 17502 (pl. 5, fig. 2) but it is so poorly preserved that its relationship to the other fragment cannot be determined.

Distribution: Pliocene, (Chinen sand) Okinawa; Recent. Japan.

Localities: Chinen sand, 17481 (figured).

Subgenus SAOTOMEA Habe 1943

Type: *Fulgoraria delicata* (Fulton) (=*Voluta delicata* Fulton).

Fulgoraria (Saotomea) delicata (Fulton)

Plate 5, figure 1; plate 9, figure 6

Voluta (Fulgoraria) delicata Fulton, 1940, Malacological Soc. London, v. 24, p. 31, pl. 2, fig. 2.

Fulgoraria (Saotomea) delicata. Kuroda and Habe, 1950, Illustrated catalog of Japanese shells, no. 5, p. 35, pl. 5, fig. 4.

The subsutural collar of this species has a tendency to become decorticated, and in some specimens where this has happened the suture appears large and open. There is some variation in the strength of the spiral lines among the numerous specimens at hand, some being nearly smooth whereas others have spirals of equal strength all over the whorls.

Fulgoraria delicata has not been reported previously as a fossil although other species have been found fossil in Japan. Among them are a species in the Pliocene of the Miura Peninsula which Yokoyama identified as *Voluta megaspira* Sowerby and which Otuka (1949, p. 304) renamed *Fulgoraria* (*Psephaea*) *kamakurensis*.

Fulgoraria delicata can be distinguished from the *F. kamakurensis* group by its high angulate shoulder and concave subsutural slope.

Distribution: Miocene, (Yonabaru clay member) Okinawa; Miocene or Pliocene, (Shinzato tuff member) Okinawa; Recent, Japan.

Localities: Yonabaru clay member, 17445 (figured); Shinzato tuff member 17454, (figured), 17677.

Genus LYRIA Gray 1847

Type: *Voluta nucleus* Lamarck.

Lyria rex Hirase

Plate 17, figures 20, 23–24

Lyria rex Hirase, 1908, The Conchological Mag., v. 2, no. 7, p. 36; v. 2, no. 6, pl. 33, fig. 129, Kyoto.

Hirase described this fossil species from "a Pliocene(?) deposit" on Kikaiga-shima. Nomura and

Zinbo (1934, p. 110) mention it but apparently had no specimens of it in their collection of "Ryukyu limestone" fossils from Kikaiga-shima. A specimen, presumably from the type lot, is in the Hirase collection in the U.S. National Museum. It is well cleaned but a few grains of sand and some iron stained Foraminifera were obtained from its interior. It does not appear to have come from limestone.

If the type of this species was in the part of the Hirase collection housed in the Research Institute for Natural Resources, a building completely destroyed by bombs during the war, it is lost. The specimen in the U.S. National Museum, the one shown on plate 17, figure 20, may be the only existing specimen from the type lot and possibly it should be designated the neotype. The propriety of this in view of the fact that a satisfactory figure of the type is published is debatable.

Hirase's figure of the type shows broad but weak spirals over most of the whorl. The specimen in the Hirase collection in the U.S. National Museum has no spiral sculpture on the main part of the whorl but it has fine well-defined spiral lines on the base of the whorl. A poorly preserved specimen from the Naha limestone (pl. 17, figs. 23–24) has similar spirals on the base of the whorl and finer spirals on the rest of the whorl, those on the subsutural slope being stronger than those on the periphery.

Distribution: Pliocene, Kikaiga-shima, (Naha limestone) Okinawa.

Localities: Naha limestone, 17484 (figured).

Lyria hanzawai, n. sp.

Plate 9, figure 7

Shell of medium size for the genus, rather slender, spire high. Protoconch not entirely preserved but the last whorl is large, smooth, and slightly tilted. Aperture over half the length of the shell. Columella straight to weakly twisted. No siphonal fasciolar swelling on the shells with a straight columella but on shells with a twisted columella a swelling usually develops; the greater the twist the more prominent the swelling. Sculpture consisting of heavy, vertical, axial ribs, about six visible from an angle; no spiral sculpture.

Holotype (USNM 562845) measures; height 42.3 mm, diameter 17 mm.

Type locality: Shinzato tuff member, 17633.

Lyria hanzawai is closely related to *L. rex*, differing from it in being more slender, less constricted at the base of the body whorl, and in lacking spiral sculpture. All of the five specimens at hand are about the same size, suggesting they are adults. If so, the species attains only about half the size of *L. rex*, the type of which was 84 mm in height.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa.

Localities: Shinzato tuff member, 17455, 17633 (figured type).

Lyria aff. L. hirugaensis (Yokoyama)

Plate 5, figure 3

?*Voluta hirugaensis* Yokoyama, 1926, Tokyo Imp. Univ. Fac. Sci. Jour., sec. 2. v. 1, pt. 9, p. 335, pl. 38, fig. 16.

?*Voluta koyuana* Yokoyama, 1928, Tokyo Imp. Univ. Fac. Sci. Jour., sec. 2, v. 2, pt. 7, p. 343, pl. 66, fig. 13.

The species figured here from Okinawa appears to be very close to the above two named forms from Japan. Yokoyama did not compare them and the writer may be in error in assuming them to be congeneric, but from the figures they could well be conspecific. Hatai and Nisiyama (1952, p. 283) place the former in *Fulgoraria*, the latter in *Volutocorbis* (*Ternivoluta*).

Lyria hirugaensis comes from the Sagara formation (Miocene) of Hirugaya; *L. koyuana* from the Kounji formation (Pliocene) of Kounji.

Both the Japanese forms and the Okinawan form have six large axial ribs visible from an angle. However, *L. hirugaensis* compares more closely with the Okinawan form in outline. *Lyria koyuana* appears to have a stronger basal constriction.

Distribution: Miocene, (Yonabaru clay member) Okinawa, ?(Sagara formation) Japan; Pliocene(?), (Kounji formation) Japan.

Localities: Yonabaru clay member, 17450, 17679 (figured).

Family CANCELLARIIDAE

Genus CANCELLARIA Lamarck 1799

Type: *Voluta reticulata* Linné.

Cancellaria yonabaruensis, n. sp.

Plate 5, figure 4

Shell small (although type may be a juvenile) and inflated, whorls subangulate, spire moderately short. Protoconch consisting of about 2½ smooth whorls lying within the same cone as the adult whorls, the first whorl simple and small, not involute. Aperture broadly elliptical, over half the length of the shell. Outer lip thin, weakly crenulated inside. Inner lip weakly callussed with three folds on the columella and one short node on the parietal wall. Umbilicus open but partly hidden. Siphonal fasciole present but weakly elevated. Sculpture consisting of strong axial ribs, seven to eight visible from an angle, which extend to the suture above and die out just before gaining the siphonal fasciole below, and strong spirals, about 15 on the body whorl with an equal number of smaller interstitial spirals between the coarser spirals, the interstitial spirals filling the interspaces completely.

Holotype (USNM 562741) measures: height 7.8 mm, diameter 5.6 mm.

Type locality: Yonabaru clay member, 17445.

This species is closely related to the Recent *C. paucicostata* Sowerby. The protoconch and characters of the early whorls are nearly identical for the two species, but *C. paucicostata* has a more concealed umbilicus and stronger crenulations on the outer lip.

Among the living western Pacific species *Cancellaria laticosta* Löbbecke (see Tryon, 1885, pl. 4, fig. 52) may be most closely related to *C. yonabaruensis*. It is not clear from the figure, however, whether *C. laticosta* has secondary spirals, and its columellar folds appear to be less steeply inclined than those of *C. yonabaruensis*.

Distribution: Miocene, (Yonabaru clay member) Okinawa.
Localities: Yonabaru clay member, 17445 (figured type).

Cancellaria chinenensis, n. sp.

Plate 14, figure 12

Shell of medium size and moderately inflated, whorls rounded, spire of medium length. Protoconch slightly tilted and consisting of less than one full smooth turn. Aperture of moderate width, about half the length of the shell. Outer lip broken on type. Parietal callus well developed. Inner lip slightly detached below leaving a narrow umbilical chink. Siphonal fasciole well developed and narrow. Sculpture consisting of strong but relatively narrow axial ribs, about eight visible from an angle, which continue nearly to the suture above and across the siphonal fasciole below, and strong spiral sculpture of primary, secondary, and some tertiary threads. The axials flare slightly near the suture but are truncated above the flare, leaving a narrow revolving recess along the suture.

Holotype (USNM 562965) measures: height 15.5 mm, diameter 9.3 mm.

Type locality: Chinen sand, 17482b.

This species does not appear to be very closely related to any reported previously from the western Pacific region. *Cancellaria kurodai* Makiyama (see Hatai and Nisiyama, 1940) lacks the strong spirals, has a broader shoulder, and a tooth immediately behind the anal sinus. *Cancellaria pristina* Yokoyama has similar sculpture but is much more slender.

Cancellaria chinenensis has spiral sculpture resembling that of *C. yonabaruensis* on its early whorls, the tertiary spirals appearing later. However, the axials of *C. yonabaruensis* do not flare near the suture and there is, therefore, no narrow passage above the axials along the suture.

Distribution: Pliocene, (Chinen sand) Okinawa.
Localities: Chinen sand, 17482b (figured type).

Cancellaria aff. C. pristina (Yokoyama)

Plate 5, figures 5–6

?*Mitra pristina* Yokoyama, 1923, Tokyo Imp. Univ. Coll. Sci. Jour., v. 45, art. 2, p. 8, pl. 1, figs. 8–12.

?*Cancellaria pristina*. Makiyama, 1927, Kyoto Imp. Univ. Coll. Sci. Mem., ser. B, v. 1, art. 1, p. 85, pl. 4, figs. 3–4.

?*Cancellaria pristina*. Haitai and Nisiyama, 1940, Saito Ho-on Kai Mus. Research Bull., no. 19, p. 125, pl. 5, figs. 1, 4.

A single incomplete specimen is compared tentatively with this Japanese Pliocene form. It is not as slender as most of the specimens figured as this species. Like *C. pristina* it has three fine spirals of more or less equal strength between each coarse spiral and the axials are weak, irregular, and rather strongly inclined.

Distribution: Miocene, (Yonabaru clay member) Okinawa.
Localities: Yonabaru clay member, 17503 (figured).

?Cancellaria sp.

Plate 17, figure 28

A poorly preserved and recrystallized specimen from the Naha limestone may be a *Cancellaria*. If so it may be *C. reeveana* Crosse or one of its varieties, particularly a form named by Kobelt as *C. subsinensis* (see Tryon, 1885, pl. 4, fig. 51).

Locality: Naha limestone, 17464 (figured).

Family MARGINELLIDAE

Genus MARGINELLA Lamarck 1799

Type: *Voluta glabella* Linné.

Marginella tomuiensis, n. sp.

Plate 9, figures 8–9

Shell about medium sized for the genus, inflated, the greatest diameter being above the mid-line of the shell and forming a shoulder-like angulation; spire of moderate height. Protoconch smooth, low and rapidly expanding, sutures not marked by a depression. Aperture of moderate width, slightly rounded. Outer lip weakly callussed. Columella bearing four folds, the top fold nearly horizontal, the lowest forming the canal margin and nearly vertical. Sculpture smooth except for weak growth lines. Sutures weakly indented.

Holotype (USNM 562846) measures; height 6.8 mm diameter 4.2 mm; paratype (USNM 562847) measures; height 8 mm, diameter 4.2 mm.

Type locality: Shinzato tuff member, 17454.

I can find nothing described from the western Pacific region with which this species could be confused. *Marginella flaccida* (Yokoyama) (1928b, pl. 67, fig. 1) from the Kounji formation (Pliocene) of Japan has a higher spire and its area of greatest inflation is lower on the body whorl.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa.

Localities: Shinzato tuff member, 17454 (holotype and paratype figured).

Superfamily CONACEA

(TOXOGLOSSA)

Family TURRIDAE

Subfamily TURRINAE

Genus LOPHIOTOMA Casey 1904

Type: *Pleurotoma tigrina* Lamarck.

Some recent authors including Cox (1948), and Kuroda and Habe (1952) apparently have been unable to delimit the genera *Turris* (Bolten) Roeding and *Lophiotoma* with any degree of certainty and assigned shells of this type to *Turris*. Confidence in assigning species to these genera, as well as to *Polystira* Woodring, seems almost to end with the assignment of the type species themselves. I tentatively follow Powell (1942) in regarding the location of the anal sinus as the first order criterion in the classification of this group. The sinus of *Lophiotoma* is located on the peripheral keel, or at least on the most prominent spiral, whereas in *Turris* it is located on a weaker spiral above the peripheral spiral.

Some authors have maintained that the protoconch should be the first order taxonomic criterion in this group, but certainly no consistency can be detected in its relationship to the position of the anal sinus, the type of spiral ribbing, or to the length and shape of the columella.

The present concept of *Lophiotoma* may not be what Casey intended, possibly because he included in it species whose protoconch he did not know. He described (1904, p. 130) *Lophiotoma* as "having the small smooth embryo of a single whorl, polished surface and obsolete lines of growth". This describes rather closely the protoconch of *Pleurotoma leucotropis* Adams and Reeve, one of the species tentatively identified here. However, Woodring (1928, p. 146) selected *Pleurotoma tigrina* Lamarck as type, and Powell (1944, p. 8) included a description of its protoconch in a revised description of the genus: "the protoconch is small, conical, of about 2½ whorls, followed by a half whorl of brephic axials". One of the species here included in *Lophiotoma* has a protoconch of the type described by Casey; the other a protoconch similar to the one described by Powell.

When the phylogeny of this group is known better the protoconch may prove to be the most important classificatory character. If so, Woodring's type designation may have left the group for which Casey intended *Lophiotoma* without a name.

An almost exact parallel exists in the genus *Pleuroliria* De Gregorio as used by Casey (1904, pp. 131–132). He divided it into "Group 1.—Embryo multispiral and acute", and "Group 2.—Embryo small, obtuse and paucispiral". Woodring (1928, p. 145) proposed the name *Polystira* for the latter group. Gardner (1937, pl. 38, figs. 24, 26) figured protoconchs of both types and used *Pleuroliria* as a subgenus of the younger name *Polystira*.

I am inclined to believe that no handling of this section of the Turrinae thus far is completely satisfactory when all of the known species are considered.

Lophiotoma cf. L. leucotropis (Adams and Reeve)

Plate 5, figures 8–9; plate 14, figures 15, 21

?*Pleurotoma leucotropis* Adams and Reeve, 1849, Zoology of the voyage of the *Samarang*, p. 40, pl. 10, fig. 7.

?*Lophiotoma leucotropis*. Casey, 1904, St. Louis Acad. Sci. Trans., v. 14, no. 5, p. 130.

Pleurotoma oxytropis. Yokoyama, 1928, Imp. Geol. Survey Japan Rept. 101, p. 31, pl. 1, fig. 11.

Turris (*Turris*) *oxytropis*. Nomura, 1935, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 2, p. 112.

Turris oxytropis. Yabe and Hatai, 1941, Japanese Jour. Geology and Geography, v. 18, nos. 1, 2, p. 75.

?*Turris leucotropis*. Kuroda and Habe, 1952, Recent marine Mollusca of Japan, p. 95.

Yokoyama (1928, p. 31, pl. 1, fig. 11) and Nomura (1935, p. 112) both identified a species from the Byoritzu beds of Formosa as *oxytropis* Sowerby. The Hayasaka collection of Byoritzu fossils in the U.S. Geological Survey includes two distinct species so labelled; one of them *leucotropis*, the other apparently the form figured by Nomura (1935, pl. 6, fig. 31) as *Turris polytropa* (Helbling), a species of *Unedogemmula* here described.

Tryon doubted the west American occurrences of *L. oxytropis*. However, the type seems to have come from Panama. The proper name for the western Pacific species often so identified is *L. leucotropis* (Adams and Reeve).

The specimen shown on plate 14, figure 21 has a protoconch consisting of a slightly tilted, subnaticoidal part of about 1¼ whorls, followed by about ½ a whorl bearing fine, curved axials. Specimens from the Byoritzu beds are identical.

Distribution; probably more widespread than the following verified local occurrences: Miocene, (Yonabaru clay member) Okinawa; Miocene or Pliocene, (Shinzato tuff member) Okinawa; Pliocene, (Byoritzu beds) Formosa, (Chinen sand) Okinawa: Recent, western Pacific region.

Localities: Yonabaru clay member, 17449 (figured), 17502, 17679; Shinzato tuff member, 17453; Chinen sand, 17442 (figured).

Lophiotoma marmorata (Lamarck)

Plate 14, figures 17–18

Pleurotoma marmorata Lamarck, 1816, Encyclopédie méthodique, pl. 439, fig. 6, Liste, p. 8.
Lophiotoma marmorata. Casey, 1904, St. Louis Acad. Sci. Trans., v. 14, no. 5, p. 130.
Turris marmorata. Hedley, 1922, Australian Mus. Rec., v. 13, no. 6, p. 215. (In part.)
Kuroda and Habe, 1952, Recent marine Mollusca of Japan, p. 95.

The specimen figured here is identical with specimens labelled *marmorata* in the Casey collection, the Albatross collection, and the general Pacific collection in the U.S. National Museum.

Only one specimen was found on Okinawa. Its protoconch is conical and slender, consisting of about 1¾ smooth whorls, followed by about 1¼ turns bearing axial riblets, faint and curved when first appearing but becoming stronger, straighter and more widely spaced at the end.

Distribution: Pliocene, (Chinen sand) Okinawa; Recent, Indian Ocean, Philippines to Japan, Polynesia.

Localities: Chinen sand, 17442 (figured).

Comparative bathymetric data: This species was obtained by the Albatross Expedition in the Philippines at depths of 28 to 50 fathoms.

Turrinid ind.

Plate 19, figure 30

A poorly preserved fragment was obtained from the Yontan limestone. Its sculpture resembles that of *Turris* (*Turris*) *tigrinaeformis* Nomura (1935, pl. 7, fig. 32) from the Byoritzu beds of Formosa, but the relationship is by no means certain.

Locality: Yontan limestone, 17551 (figured).

Unedogemmula MacNeil, new genus

Type: *Turris unedo* (Keiner) (as figured by Hirase, A Collection of Japanese Shells, 5th ed., pl. 115, fig. 2, 1936); Recent, Japan.

Pleurotoma unedo (Valenciennes MSS) Keiner was stated to be from "mers de l'Inde". Keiner's figure shows three lirations along the peripheral carina, whereas specimens in the Hirase collection in the U.S. National Museum show two. Should any question arise as to the correct name for the Japanese species, the species figured by Hirase is the type.

This genus is *Lophiotoma*-like in the adult stages, but the protoconch is conical and multispiral like that of *Gemmula* and the young whorls have *Gemmula*-like nodes on the peripheral carina. The types of *Lophiotoma*, *Turris*, and *Polystira* are not gemmuliform in the young stages. *Unedogemmula* is intermediate between *Lophiotoma* and *Gemmula* and possibly should be treated as a subgenus of *Gemmula*, the more primitive type. *Gemmula* in turn approaches *Bathytoma* and *Micantapex* which presumably are closer to the supposed pleurotomarid ancestors which have short or no columellas and an open umbilicus.

Although *Pleurotoma unedo* was included in *Lophiotoma* by Casey (1904, p. 130), he mentioned *P. albina* Lamarck and *P. deshayesii* Doumet as having denticulations on the peripheral carina in the young stages but losing them in the adult, and he placed these species under *Gemmula* on that account.

The species in the Byoritzu beds identified by Nomura (1935, pl. 6, fig. 31) as *Turris* (*Turris*) *polytropa* (Helbling) is a *Unedogemmula*. Another Recent species of *Unedogemmula* is in the Albatross collection from the Philippines in the U.S. National Museum. It has strong revolving lirations and a much more concave subsutural slope than any of the above species. It was recovered from two stations near Luzon at depths of 106 and 114 fathoms. It may be *Turris indica* (Bolton) Roeding, but I have not seen a verified specimen of that species nor an accurate description of its early whorls. The form figured by Cox (1948, pl. 5, fig. 8) as *Turis indica* is close to the Philippine species and if it is identical, *T. indica* is probably also a *Unedogemmula*.

Unedogemmula cf. U. indica ((Bolten) Roeding)

Plate 14, figures 19–20

?*Turris indica* (Bolten) Roeding, 1798, Museum Boltenianum, p. 124.
?Hedley, 1922, Australian Mus. Rec., v. 13, no. 6, p. 215.
?Cox, 1948, Schweizerische Paläontologische Abhandlungen, v. 66, p. 54, pl. 5, fig. 8.
?Kuroda and Habe, 1952, Recent marine Mollusca of Japan, p. 95.

This identification is based on Cox's figure, the form and sculpture being identical, and unless his specimen lacks granulations on the keel of the early whorls (which cannot be determined from his figure) there is little doubt that they are the same species. There might be some doubt, however, that *Pleurotoma gendinganensis* Martin which Cox placed in the synonymy of *T. indica* is related to it. Martin's figure of the tip (1895, pl. 5, fig. 84) definitely does not show a granulated early keel. The subsutural slope of *Pl. gendinganensis* is narrower and less concave.

This is the first record of this species as a fossil in the Formosa–Ryukyu–Japan area.

Distribution: Miocene or Pliocene, Borneo; Pliocene, (Chinen sand) Okinawa; Recent, ?Indian Ocean, Australia, ?Philippines, Japan.

Localities: Chinen sand, 17481 (figured).

Unedogemmula ina, n. sp.

Plate 5, figure 7

Shell of medium size, fusiform. Protoconch not preserved on type. Aperture about half as long as shell, produced anteriorly to form a straight canal. Anal sinus as determined by growth lines openly V-shaped, slightly broader at the inner end than the peripheral keel. Parietal callus thin. Whorls angulate with a prominent peripheral keel. Sculpture consisting of moderately strong revolving lines on the lower part of the body whorl with secondary and tertiary threads and less prominent revolving lines on the subsutural slope and columella. Subsutural collar persistent in adult stage, very strong in young gemmulate stage.

Holotype (USNM 562743) measures: height 40.2 mm, diameter 13 mm.

Type locality: Yonabaru clay member, 17451.

This species differs from *U. indica* in having coarser sculpture, and in having a more prominent peripheral keel. The lower part of the whorls are less convex and the subsutural slope is nearly plane rather than strongly concave as in *U. indica.* It is definitely more slender than *U. indica.*

This species strongly resembles some of the shells figured as *Pleurotoma gendinganensis* Martin (see Martin, 1895, pl. 5, fig. 81), but it is by no means certain that all of the shells so figured, even by Martin, are conspecific or even congeneric. It is not obvious from the figures whether any of Martin's specimens had gemmulate keels. The protoconch figured by Martin (pl. 5, fig. 84) may belong to the shell shown in his figure 83 which may be a *Lophiotoma,* whereas figure 81 may be a *Unedogemmula.*

Distribution: Miocene, (Yonabaru clay member) Okinawa.

Localities: Yonabaru clay member, 17447? 17451 (figured type).

Genus GEMMULA Weinkauff 1875

Type: *Pleurotoma gemmata* Reeve.

Several *Gemmula* closely allied to *G. gemmata* (Reeve) and *G. granosa* (Helbling) are present in the Okinawan collections. It is virtually impossible to identify them with confidence on the basis of existing figures, nor is it possible to say how much variation should be taken into account in separating them. Typical *G. gemmata* as figured by Harris (1937, pl. 1, figs. 33, 33a) is very slender with two prominent lirations on the peripheral nodes. Strong raised spiral lines on the lower part of the body whorl accentuate the basal constriction. Because most of the specimens at hand are incomplete or juvenile, the following treatment is highly tentative. However, one new subspecific name is proposed.

Gemmula cf. G. granosa (Helbling)

Plate 5, figures 10–11; plate 14, figure 23

?*Murex* (*Fusus*) *granosus* (Helbling, 1779, Abhandlung einer Privat Gesellsch in Boehmen, v. 4, p. 116, pl. 2, fig. 16.

?*Turris* (*Gemmula*) cf. *granosa.* Makiyama, 1927, Kyoto Imp. Univ. Coll. Science Mem., ser. B, v. 3, no. 1, art. 1, p. 95.

?*Turris* (*Gemmula*) *granosa.* Nomura, 1935, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 2, p. 114.

Makiyama and Nomura regarded all the related forms including *G. carinata* (Reeve), *G. carinata* var. *woodwardi* (Martin), and *G. asukana* (Yokoyama 1928; not 1926), described from the Miocene, Pliocene and Pleistocene of Indonesia, the Philippines, and Japan as conspecific with this Recent species. I am not prepared to offer an opinion on this except to say that if only one species is represented, some forms appear to be distinct enough for subspecific or varietal names.

Makiyama (1927, p. 95) quotes Tesch as saying that this species in Neogene rocks in Timor is very variable in both sculpture and outline. Specimens here assigned to this species show some range in the degree of inflation and the ratio of height to width, in the strength of the peripheral keel and the size, shape and spacing of the nodes on it, in the strength of the subsutural collar, and in the width and concavity of the subsutural slope.. However, the Albatross collection from the Philippines in the U.S. National Museum contains several forms falling within the range of the species as here used but specimens from each station are very much alike, a condition which might argue either that more than one species is involved, or that the varieties or subspecies are ecologic entities.

The specimen from the Chinen sand (pl. 14, fig. 23) is close to the specimen figured by Yokoyama (1928b, pl. 66, fig. 10) as *Pleurotoma asukana.* This probably is not the species described as *Drillia asukana* by Yokoyama (1926, p. 331, pl. 38, fig. 18).

Distribution: Miocene, Java, Borneo, the Philippines, (Yonabaru clay member) Okinawa; Pliocene, Java, Sumatra, Timor, Ceram, (Byoritzu beds) Formosa, ("Ryukyu limestone") Kikaiga-shima, (Chinen sand) Okinawa and Takabanare-shima, Japan; Recent, Japan to the Indian Ocean.

Localities: Yonabaru clay member, 17451 (figured), 17503 (figured); Chinen sand, 17479, 17481 (figured).

Comparative bathymetric data: A specimen in the U.S. National Museum from Suruga Gulf, Japan, came from 47 fathoms. The Albatross collection contains several forms falling within the range of the species as here used. However, specimens from each station are all the same variety. Depths from which the various forms were recovered range from 35 fathoms to 310 fathoms. Specimens agreeing most closely with the specimen from the Yonabaru clay member figured on plate 5, figure 11 are recorded from 262 fathoms.

Gemmula granosa ryukyuensis, n. subsp.

Plate 14, figure 24

Shell of medium size, moderately slender. Protoconch consisting of 1½ whorls smooth and unsculptured, and 2½ whorls bearing curved axial riblets, more inclined when first appearing. Aperture a little less than half the length of the shell. Canal long and straight. Anal sinus symmetrical and V-shaped, located along the peripheral carina. Outer lip bearing spiral lirations on the inside, and near the edge depressed grooves corresponding with the coarse sculptural lirations of the exterior, a second faint sinus present on the only specimen with a perfect aperture just below the body whorl constriction. Parietal callus thin. Sculpture consisting of fine revolving lines on the concave subsutural depression, axial nodes along the peripheral carina which are crossed by three parallel revolving lirations, and two to three coarse lirations on the lower part of the body whorl with secondary and tertiary lirations between; columella bearing medium and evenly spaced lirations with some secondary lines; subsutural collar narrow but detached leaving a narrow shallow groove behind it.

Holotype (USNM 562975) measures: height 47 mm., diameter 15 mm.

Type locality: Shinzato tuff member, 17458.

This subspecies has a broader subsutural slope than is common for the species and the subsutural collar is weaker. It has fewer and larger nodes on the peripheral carina. All of the specimens at hand have two or three coarse spirals below the periphery, those below on the base of the body whorl and columella being much weaker. The latter condition is approached by occasional specimens of the more typical form of the species but on *ryukyuensis* it is consistent.

Distribution: Miocene, (Yonabaru clay member) Okinawa and Takabanare-shima; Miocene or Pliocene, (Shinzato tuff member) Okinawa.

Localities: Yonabaru clay member, 17451, 17476; Shinzato tuff member, 17458 (figured type), 17633.

Gemmula aff. G. asukana (Yokoyama) 1926

Plate 5, figure 12

?*Drillia asukana* Yokoyama, 1926, Tokyo Imp. Univ. Fac. Sci. Jour., sec. 2, v. 1, pt. 9, p. 331, pl. 38, fig. 18. (Not *Pleurotoma asukana* 1928).

There seems to be little doubt that the specimen Yokoyama referred to this species in 1928 is a true *Gemmula*. However, doubt has been raised over the identity of the species described under this name in 1926. Hatai and Nisiyama (1952, p. 198) place it in *Clavatula*. Yokoyama's figure is poor but nevertheless he says in the description that "the angle is the place where the old sinus band is present, on which the periodic ends of the sinus remain as tubercles". If this description is accurate it would almost certainly place the shell in the Turrinae and probably in the genus *Gemmula*.

Both the specimen figured here and the type of *Drillia asukana* appear to be juveniles so that the assumed relationship is tentative at best. The nodes on the carina of the Okinawan species may be shorter and pointed compared with the nodes on *asukana*.

The specimen here figured may be close to *G. longwoodensis* Powell (1952, p. 49, pl. 13, fig. 13) from the upper Oligocene of Australia.

Distribution: Miocene, (Yonabaru clay member) Okinawa; Pliocene, ?Japan.

Localities: Yonabaru clay member, 17445, 17502 (figured), 17632, 17679.

Gemmula sp. ind.

Plate 9, figure 11; plate 14, figure 25

Two incomplete specimens of *Gemmula* which do not appear to belong to any of the above species were collected from the Shinzato tuff member of the Shimajiri formation. One specimen has a broader subsutural slope than the other but both have a double banded subsutural collar, a peripheral carina bearing four secondary spiral lines, and rather coarse spiral lines below the periphery. It is not certain whether they represent the same or different species.

Localities: Shinzato tuff member, 17458 (figured), 17633 (figured).

Pinguigemmula, new genus

Type: *Pinguigemmula okinavensis*, n. sp.; Shinzato tuff member, Shimajiri formation, Okinawa.

Shell of medium size and stout, apical angle being approximately 45 degrees. Protoconch unknown. The canal is long and straight with the aperture over half as long as the shell. The anal sinus is variable in shape, but normally of medium depth and inequilateral, the side towards the apex forming an angle of about 45 degrees with the peripheral keel, the side towards the base curving sharply at first and becoming tangential with the base of the keel near the apex of the sinus which is situated on the peripheral carina. Sculpture generally consisting of coarse, beaded, highly elevated spirals above the periphery and moderately coarse unbeaded spirals on the lower part of the whorl and columella. On some specimens the outer lip is indented to form a secondary sinus below the peripheral carina, possible an accessory incurrent siphonal canal.

This genus is closely related to *Gemmula* but it differs mainly in having a much greater apical angle, and in having the spirals on the subsutural slope very much stronger than the spirals below the periphery. The common deep fluting of the lower part of the outer lip into a siphonal projection is also found in some of the large deep water *Gemmula* in the Philippines, some specimens having as many as four flutings. This may be a response to an oxygen-poor environment in which one or more accessory incurrent siphons are developed.

Pinguigemmula okinavensis, n. sp.

Plate 9, figures 12–14

Shell of medium size and very stout. Protoconch not present on any specimens at hand. Aperture over half as long as the shell, produced anteriorly to form a straight canal. Anal sinus terminating on the peripheral carina, asymmetrically V-shaped with the lower limb nearly horizontal and the upper limb inclined nearly 45 degrees. Outer lip sharply lobate below the anal sinus, recurving sharply to a point opposite the posterior end of the siphonal canal to form a second sinuslike notch, and descending nearly vertically thereafter to the anterior end of the canal; outer lip above the anal sinus with moderately deep grooves on the inside corresponding to the strong raised lirations outside; no internal grooves opposite the lirations below the sinus. Parietal and columellar callus of moderate thickness and appressed, apparently dissolving the spiral lirations in advance of its deposition. Subsutural slope bearing four, strong, fencelike, beaded spirals, the lowest one bearing two rows of beads and forming the peripheral carina; the peripheral spiral often separated from the spiral above it by a very shallow grove whereas the two spiral ridges nearest the suture are isolated by deep grooves. Sculpture below the periphery consisting of rounded, unbeaded spirals which are coarsest below the periphery and become less coarse on the base of the whorl and columella, those on the columella commonly interspaced with secondary spirals. Suture closed and hidden in a deep groove, the sutural groove being slightly wider than the others.

Holotype (U.S.N.M. 562851) measures; height 41.5 millimeters, diameter 20.2 millimeters.

Type locality: Shinzato tuff member, 17454a.

No species referable to this genus has been described previously. However, a possibly allied but slenderer species is present in the Albatross collection from the Philippines. The apparent similarity lies mainly in the degree of inflation, however, and the Recent species does not have its strongest spirals above the periphery; it probably is a true *Gemmula*. The Philippine species may be the form described as *Pleurotoma fusiformis* Thiele in the report of the Deutschen Tiefsee-Expedition (1925, p. 176, pl. 34, fig. 24).

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa.

Localities: Shinzato tuff member, 17453 (figured), 17454, 17454a (figured type), 17455 (figured), 17456.

Comparative bathymetric data: The species in the Albatross collections was taken from depths of 178, 280, and 297 fathoms.

Genus MICANTAPEX Iredale 1936

Type: *Bathytoma agnata* Hedley and Pettard.

Micantapex striato-tuberculata (Yokoyama)

Plate 5, figures 14, 17

Pleurotoma subdeclivis var. *striato-tuberculata* Yokoyama, 1928,Tokyo Imp. Univ. Fac. Sci. Jour., sec. 2, v. 2, pt. 7, p. 340, pl. 66, fig. 6.

This species was not adequately described. The name was proposed for a supposed variety of a species of another genus; the form here called *Makiyamaia coreanica subdeclivis* (Yokoyama). It was distinguished by a descriptive phrase and illustrated by an excellent figure and is here recognized with the following description:

Shell of medium size, moderately inflated. Protoconch subnaticoidal, consisting of about 1½ turns, the extreme tip round and bulbous. Aperture over half as long as the shell, canal nearly as wide as aperture and not distinctly set off. Anal sinus asymmetrically V-shaped, the upper limb diagonal at about 45 degrees, but the lower limb horizontal for a short distance, terminating on the beaded carina. Outer lip gently curving from the sinus to the siphonal canal and without folds on the inside. Columella lacking the single fold found in *Bathytoma*. Parietal callus thin but the callussed area extends well outside the aperture. Sculpture consisting of fine revolving lines on the subsutural slope and coarser lirations below the peripheral carina with secondary and sometimes tertiary lirations present near the body whorl constriction; peripheral carina with short axial *Gemmula*-like nodes on the young whorls, but they become less pronounced and slightly crescentic on the adult, the carina becoming less in relief and even slightly submerged on the body whorl. Suture appressed, but with the lower edge in slight relief, no distinct collar.

The only turrids resembling *Bathytoma* or *Micantapex* living in the area today are *M. luhdorfi* (Lischke) and an apparently undescribed species from the Philippines. *Micantapex luhdorfi* (Lischke, 1874, pl. 1, figs. 2–4) has broad bandlike revolving lirations of very low relief on the body whorl and considerably larger nodes on the peripheral carina. *Micantapex luhdorfi* has no folds on the inside of the inner lip, thus comparing with *M. striato-tuberculata.* The Philippine species has strong folds or crenulations on the outer lip like typical *Bathytoma.* Neither of these forms could be confused with *M. striato-tuberculata.*

Distribution: Miocene, (Yonabaru clay member) Okinawa: Pliocene, (Kounji formation) Japan.

Localities: Yonabaru clay member, 17445 (figured), 17448, 17449 (figured), 17450.

Micantapex? tomuiensis, n. sp.

Plate 9, figure 16

Shell small (the type is probably a juvenile), moderately inflated. Protoconch subnaticoidal, consisting of about $1\frac{1}{4}$ turns, smooth, slightly inclined. Aperture about half the length of the shell or slightly less. Canal short and slightly twisted. Anal sinus broadly **V**-shaped, terminating on the peripheral carina. Sculpture consisting of a nodose peripheral carina, two strong revolving lines on the body whorl below the carina, and finer lines below on the columella; subsutural slope without revolving sculpture but with diagonal wrinkled sculpture outlining former positions of the anal sinus. Suture appressed but with the lower edge prominent, forming a narrow raised collar which is slightly wrinkled.

Holotype (USNM 562855) measures: height 7 mm, diameter 3.8 mm.

Type locality: Shinzato tuff member, 17454.

This species is readily distinguished from *M. striato-tuberculata* by it shorter siphonal canal and complete absence of spiral sculpture on the upper part of the whorls. The peripheral carina has somewhat sharper nodes and the subsutural collar is much stronger than in *M. striato-tuberculata.*

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa.

Localities: Shinzato tuff member, 17454 (figured type).

Subfamily TURRICULINAE

Genus NIHONIA, new genus

Type: *Nihonia shimajiriensis* n. sp.

Shell of medium size. Protoconch subnaticoidal and unsculptured, consisting of about $1\frac{1}{2}$ whorls, homeostrophous. Columella long and straight. Aperture of moderate width. Anal sinus deeply **U**-shaped, situated on the subsutural slope. Sculpture consisting of moderately coarse spiral lirations on the lower part of the whorls and periphery.

The track of the anal sinus of this genus is low on the subsutural slope and the growth lines indicate that it was symmetrically **U**-shaped and about $1\frac{1}{2}$ times as deep as wide.

This genus is reminiscent of *Lophiotoma* and *Polystira* in shape and ornamentation, but the position of its anal sinus definitely places it in the Turriculinae rather than in the Turrinae. It possesses many of the characteristics of *Protosurcula* Casey, but the latter has a multispiral protoconch in which the last two whorls bear inclined axial riblets.

A Recent specimen in the Hirase collection in the U.S. National Museum labelled *Orthosurcula mirabilis* (Sowerby) is referable to this genus, but it does not appear to be the species figured as *Fusosurcula mirabilis* (Sowerby) by Taki (see (Hirase) Taki, 1951, pl. 115, fig. 12). I can find no other reference to the name *Fusosurcula.*

Maoritomella Powell 1942 (type *Pleurotoma albula* Hutton) resembles this genus in the height of its spire and in ornamentation, but *Maoritomella* has a shorter columella and is placed in the Clavinae on that account.

Nihonia shimajiriensis, n. sp.

Plate 5, figure 15

Shell of medium size and inflation. Protoconch consisting of $1\frac{1}{2}$ smooth whorls, subnaticoidal and homeostrophous. Aperture long and of moderate width, about half as long as shell. Columella straight. Anal sinus situated about midway between the suture and the periphery, marked by broad **U**-shaped markings. Sculpture consisting of revolving lirations, one at the periphery being strongest with a slightly weaker one above, and a series of lirations below the periphery diminishing in strength towards the columella, interspaces with secondary, tertiary and sometimes quaternary lirations; subsutural slope bearing fine lirations above the anal fasciole and very faint lirations on the fasciole. Suture appressed. Whorls somewhat carinate in young, but becoming more rounded on the later whorls.

Holotype (USNM 562751) (an incomplete specimen) measures: height 26 mm, diameter 10 mm.

Type locality: Yonabaru clay member, 17445.

This species is closely related to *Pleurotoma pervirgo* Yokoyama (1928b, pl. 66, figs. 7–8), the only other known fossil species referable to this genus. *Pleurotoma pervirgo*, named from its supposed relationship to *Polystira virgo* (Wood), appears to have a microsculpture consisting of more irregular fine revolving lines, as well as somewhat broader primary lirations. Yokoyama's species was described from the Kounji formation (Pliocene) of Japan.

Hatai and Nisiyama (1952, p. 232) considered *pervirgo* a subspecies (or variety?) of *mirabilis* Sowerby, listing it as *Orthosurcula mirabilis pervirgo* (Yokoyama). Kuroda and Habe (1952, p. 95) list *mirabilis* (Sowerby) under the genus *Turricula*, while Taki

((Hirase) Taki, 1951, pl. 115, fig. 12) refers it to *Fusosurcula* [n. gen.?].

Distribution: Miocene, (Yonabaru clay member) Okinawa.
Localities: Yonabaru clay member, 17445 (figured type), 17502, 17503.

Genus PARACOMITAS Powell 1942

Type: *Surcula castlecliffensis* Marshall and Murdoch. The genus *Paracomitas* has a carinate protoconch which lies in the same cone as the spire, thus differing from typical *Comitas* in which the protoconch is noncarinate, bulbous and tilted. Although the type of *Comitas*, *C. oamarutica* (Suter), is *Drillia*-like in the ornamentation of its spire, some species referred to *Comitas* by Powell on the basis of the protoconch, such as *C. allani* Powell, are similar in adult sculpture to *Paracomitas*. The protoconch of the species here referred to *Paracomitas* is small and appears to be slightly tilted, and the last quarter-turn or less is slightly angulate, but not definitely carinate.

Paracomitas rodgersi, n. sp.

Plate 9, figure 17

Shell of medium size and inflation, whorls nearly straight sided, interrupted mainly by the nodose peripheral carina. Protoconch small, subnaticoidal and tilted. Aperture moderately narrow, about half the length of the shell. Outer lip thin, broken on the specimens at hand, but shown by growth lines to recurve sharply into the anal sinus. Anal sinus moderately broad and deep, adjacent to the suture, the growth lines recurving only slightly from the apex of the sinus to the suture. Sculpture consisting of short axial nodes on the periphery, about ten of the peripheral nodes visible from an angle; lower part of body whorl and columella bearing weak raised spirals which are wider near the periphery, narrower and nearly obsolete on the columella; peripheral nodes crossed by both the spiral sculpture and diagonal lines of growth; subsutural slope smooth and flat except for lines of growth marking former positions of the anal sinus, and the small tubercles or wrinkles just below the suture on the juvenile whorls.

Holotype (USNM 562856) measures: height 27 mm, diameter 11.4 mm.

Type locality: Shinzato tuff member, 17454.

Paracomitas rodgersi superficially resembles both *P. castlecliffensis* Marshall and Mudoch from the upper Pliocene of New Zealand and *Comitas allani* Powell from the lower and middle Pliocene of New Zealand. Without better figures of either of these species than those now available it would be difficult to make close comparison.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa; Pliocene (?), (Chinen sand(?)) Okinawa. The latter locality may also be Shinzato.

Localities: Shinzato tuff member, 17454 (figured type); Chinen sand(?), 17480.

Comparative bathymetric data: A species closely related to the Okinawan fossil was obtained from the Gulf of Boni, Celebes, at a depth of 484 fathoms.

Genus Makiyamaia (Kuroda MSS), n. gen.

(*ex.* Oyama 1952, *nom. nud.*, *ex.* Kira 1955, *nom. nud.*)

Type: *Pleurotoma coreanica* Adams and Reeve.

Shell somewhat pagodiform, whorls angulate, with or without peripheral nodes. Spire moderately elongate. Columella of medium length and slightly twisted. Protoconch subnaticoidal and tilted, about 1½ whorls, greater in diameter than first adult whorl. Sculpture consisting of short axial nodes and fine spiral lines, either of which may be absent. Anal sinus located on the subsutural slope, closer to the periphery than to the suture.

Dr. Kuroda kindly supplied me with the following additional information regarding this genus. "The operculum fans out from a mediolateral nucleus on the columellar side: it is a Clavatulinae-type, not a *Turricula* nor a *Leucosyrinx*."

The genus resembles *Surcula* superficially, differing from it mainly in the nearly complete absence of spiral sculpture. The columella is shorter than that of *Surcula*. The genus is known in the Kakegawa group of Japan, the Shimajiri formation of Okinawa, and living off Japan where it is represented by species and varieties similar to those found fossil.

Suavodrillia Dall (type: *Drillia kennicottii* Dall) has been used for this group, and one of the species included here, *M. subdeclivis* Yokoyama, takes its name from its supposed relationship to *S. declivis*, a species very close to *S. kennicottii*.

Some recent Japanese authors, Hatai and Nisiyama (1952, p. 232–233) and Kuroda and Habe (1952, p. 62 and 87), assign the two species included here to different genera; *coreanica* Adams and Reeve to *Leucosyrinx* Dall, and *subdeclivis* Yokoyama to *Spirotropis* Sars.

The name *Makiyamaia* appears to have been used for the first time by Oyama (1952, p. 62) in a list as "*Makiyamaia coreanica* (Adams and Reeve)." Kira (1955, pl. 35, fig. 3) used the same citation in a plate legend and gives an excellent colored figure of the type species. Neither of these authors give any description, reference, or discussion. Under the International Rules, therefore, neither of these usages validates the name. Dr. Kuroda informs me that the genus was to have been described in a still-incomplete paper entitled, "Monograph of the

Molluscan shells of the Sagami Bay," a paper based on shells collected by the Emperor of Japan, but he asked me to treat the naming of the group in any way I saw fit. Another name was proposed for this group in the original draft of this manuscript, but because *Makiyamaia* has been used in as recent a publication as Kira's with such an excellent illustration, it is here validated. The author is, of course, Kuroda.

Makiyamaia coreanica (Adams and Reeve)

Plate 5, figures 16?, 18; plate 9, figures 15, 19

Pleurotoma coreanica Adams and Reeve, 1850, Zoology of the voyage of the *Samarang*, Mollusca, p. 40, pl. 10, fig. 8.
Pleurotoma shimomatana Yokoyama, 1926, Tokyo Imp. Univ. Faculty Sci. Jour., sec. 2, v. 1, pt. 9, p. 330, pl. 38, figs. 6, 7.
Pleurotoma subdeclivis forma *glabra* Yokoyama, 1928, Tokyo Imp. Univ. Fac. Sci. Jour., sec. 2, v. 2, pt. 7, p. 339 ("var. *glabra*" on pl. 66, fig. 5).
Pleurotoma subdeclivis forma *tuberculata* Yokoyama, idem.
Pleurotoma subdeclivis forma *intermedia* Yokoyama, idem.
Turricula shimomatana. Makiyama, 1931, Kyoto Imp. Univ. Coll. Sci. Mem., ser. B, v. 7, no. 1, p. 46.
Turricula coreanica. Kuroda, 1934, Venus, v. 4, no. 6, p. 386, figs. 15, 16.
Leucosyrinx coreanica. Kuroda and Habe, 1952, Recent marine Mollusca of Japan, p. 62.
Makiyamaia coreanica. Kira, 1955, Coloured illustrations of the shells of Japan, pl. 35, fig. 3.

There seems to be no way to distinguish the Recent *M. coreanica* from *M. shimomatana* (Yokoyama). Yokoyama later came to the conclusion that *shimomatana* was merely a variety of *P. subdeclivis*, also described by him. He proposed that the smooth variety be known as "forma *glabra*" the partly tuberculate variety as "forma *intermedia*", and the strongly tuberculate or "*shimomatana*" variety as "forma *tuberculata*". Actually the form he figured as *glabra* is weakly tuberculate.

The form here regarded as typical *subdeclivis* is the relatively high spired form entirely without peripheral tubercles, comparing closest with Yokoyama's original figure. As pointed out by Makiyama, this form has fine spiral striations, which Yokoyama did not mention; they are present on specimens from Okinawa. However, occasional high spired tuberculate specimens have fine spiral striations. This type is here named the variety *okinavensis*. Makiyama (1931, p. 46) regarded *subdeclivis* and *shimomatana* as distinct species. *Subdeclivis* is here treated as a variety of *coreanica* (=*shimomatana*).

The specimen shown on plate 5, figure 16 is included here with some reservations. Only one specimen like this was found. It has weak tubercles like those of the specimen figured as "var. *glabra*" by Yokoyama (1928, pl. 66, fig. 5) but the apical angle is greater and the peripheral carina appears to be higher on the whorls. It approaches the type of *Borsonella* (see Oldroyd, 1927, pl. 6, fig. 4) in shape but there is no suggestion of a columellar fold.

Distribution: Miocene, (Yonabaru clay member) Okinawa; Miocene or Pliocene, (Shinzato tuff member) Okinawa; Pliocene, (Hijikata formation, Kechienji formation, Takanabe group) Japan; Recent, Japan.

Localities: Yonabaru clay member, ?17445 (figured), 17448 (figured), Shinzato tuff member, 17454 (figured—2 specimens), 17677.

Comparative bathymetric data: Specimens of *M. coreanica* were obtained by the Albatross from off Japan at depths of 88, 124, 153, 167, 197, and 207 fathoms.

Makiyamaia coreanica subdeclivis (Yokoyama)

Plate 5, figure 20

Pleurotoma subdeclivis Yokoyama, 1926, Tokyo Imp. Univ. Fac. Sci. Jour., sec. 2, v. 1, pt. 9, p. 329, pl. 38, fig. 8; p. 367, pl. 42, fig. 4.
Turricula subdeclivis. Makiyama, 1927, Kyoto Imp. Univ. Coll. Sci. Mem., ser. B, v. 3, no. 1, p. 99.
Spirotropis subdeclivis. Kuroda and Habe, 1952, Recent marine Mollusca of Japan, p. 87.

Yokoyama believed his species to be related to *Pleurotoma declivis* Martens, a species either closely related to or identical with *Drillia kennicottii* Dall, the type of the genus *Suavodrillia.* In the writer's opinion *Makiyamaia subdeclivis* is unrelated to *Suavodrillia declivis.* Apparently Makiyama held a similar view inasmuch as he did not mention *S. declivis* in his discussion of "*Turricula*" *subdeclivis.*

Two years after the name was proposed Yokoyama decided to combine *subdeclivis* and *shimomatana*, maintaining the former name on page priority. Under *P. subdeclivis* he recognized four varieties or "forma". He proposed that the typical or smooth form be known as "forma *glabra*," but the specimen he figured to illustrate *glabra* is not the elongate, nontuberculate type he originally figured as the type of *subdeclivis*, but a shorter, weakly tuberculate form that seems to merge with typical *shimomatana.* Makiyama redefined the species *subdeclivis* and stated that the whorls were finely striated, a character that Yokoyama did not mention. This character is present on elongate individuals from Okinawa, whether tuberculate or nontuberculate, and on similar Recent specimens, but not on the short, *shimomatana* type, regardless of the degree of tubercule development.

The variety *subdeclivis* as here used is high spired, without tubercles on its periphery, and has fine incised spiral lines.

The "forma *striato-tuberculata*" included in this varietal series by Yokoyama belongs to the genus *Micantapex.*

Distribution: Miocene, (Yonabaru clay member) Okinawa; Pilocene, (Hagima conglomerate of the Horinouchi group; erroneously reported as Sagara formation (Miocene)—fide Makiyama, Uchida formation, Kechienji formation—fide Makiyama) Japan; Recent, Japan.

Localities: Yonabaru clay member, 17445 (figured), 17450.

Comparative bathymetric data: Living specimens of *M. subdeclivis* were obtained by the Albatross off southern Japan at a depth of 57 fathoms.

Makiyamaia coreanica okinavensis, n. var.

Plate 14, figure 22

This form is more slender than typical *M. coreanica.* It has fine incised spiral lines like those of the variety *subdeclivis* and tubercles along the periphery similar to those of typical *coreanica.* The tubercles are not as sharp as those of *M. coreanica*, however. This variety is intermediate between typical *coreanica* and the variety *subdeclivis* in that it combines the peripheral tubercles and the fine spiral sculpture.

Holotype (USNM 562973) measures: height 31 mm, diameter 11.9 mm.

Type locality: Shinzato tuff member, 17458.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa.

Localities: Shinzato tuff member, 17454, 17458 (figured type).

Genus TURRICULA Schumacher 1817

Type: *T. flammea* Schumacher=*Murex tornata* Dillwyn.

Turricula aff. T. tornata (Dillwyn)

Plate 5, figures 22–23

Two incomplete specimens of a *Turricula* that is related to *T. tornata* were obtained from the Yonabaru clay member of the Shimajiri formation. The species is not describable on the basis of the rather poor specimens at hand. It is characterized, however, by being sculptured by fine, somewhat irregular raised spiral lirations of about equal strength all over the whorls. On both specimens at hand there is a weak raised spiral ridge located at about every twenty of the fine lirations, the one below the periphery being the strongest, and each successive one below diminishing in strength. There is apparently no tendency for the fine spirals to become coarser on the columella, as in *T. tornata.*

Localities: Yonabaru clay member, 17450 (figured), 17451 (figured).

Incerta sedis

Plate 5, figure 28

A completely decorticated spire of a large turrid? was obtained from the Yonabaru clay member of the Shimajiri formation. No opinion is held on its relationships. This could be a *Fusinus* related to *F. laticanaliculatus* Nomura.

Locality: Yonabaru clay member, 17451 (figured).

Genus FUSISYRINX Bartsch 1934

Type: *F. fenimorei* Bartsch.

Fusisyrinx sp. ind.

Plate 5, figures 19, 24

A single fragment of a large turrid appears to be closely related to the type species of *Fusisyrinx.* It differs from *F. fenimorei*, a deep water form from the Puerto Rican Deep in having slightly more elongate axial ribs but other details of the shell and sculpture are nearly identical.

Figured specimen (USNM 562754) measures: height 29 mm, diameter 17 mm.

Locality: Yonabaru clay member, 17451 (figured).

Turriculinid gen. ind.

Plate 10, figures 5–6

Two fragments of a large turrid were obtained that resemble both *Turricula* Schumacher and *Orthosurcula* Casey to some extent, but differs from both in not having a well developed subsutural sulcus. The Okinawan form has a very slight suggestion of a depression below the suture and the whorls have a nearly evenly curved profile. The sinus is rather deep, broad, and does not recurve very much on the sutural side.

Locality: Shinzato tuff member, 17454.

Subfamily COCHLESPIRINAE

Genus CORONASYRINX Powell 1944

Type: *Coronasyrinx venusta* Powell.

The species here described appears to be very close to one of the species, *C. semiplana*, which Powell included in the original list of this genus. However, the anal sinus on the Okinawan species does not agree with Powell's description of the genus. He says, "the sinus occupies the upper two-thirds of the shoulder; its upper arms ascends almost vertically to the suture, but the lower arm is arcuately produced forwards." The apex of the suture on the Okinawan species is located about midway between the suture and the crest of the peripheral keel so that the U-shaped terminus and the upper arm together occupy about the upper two-thirds of the interval between the keel and the suture. However, the growth lines recurve towards the suture in a curve at first less than 45 degrees above the horizontal, gradually becoming a little greater than 45 degrees as they approach the suture. Possibly Powell's description is of the type species, *C. venusta*, and the sinus of *C. semiplana* is more like the sinus of the Okinawan species which it resembles closely in all other respects.

Coronasyrinx takabanarensis, n. sp.

Plate 5, figure 21

Shell of medium size, medium inflated. Protoconch consisting of two whorls, the first turn small and tilted, the second turn more swollen and conforming in orientation with the spire whorls, developing a weak peripheral keel on the last quarter turn but no axial nodes. Aperture slightly more than half the length of the shell, produced anteriorly to form a narrow straight canal. Anal sinus U-shaped, situated on the subsutural slope just above the peripheral keel. Outer lip thin and gently rounded. No visible parietal callus. Sculpture consisting of rather sharp axial nodes or beads on the peripheral carina, about eleven visible from an angle, nodes sculptured diagonally by growth lines; subsutural slope smooth but with visible lines of growth, a second and more finely beaded keel present on the lower part of the body whorl; columella bearing very weak revolving lines. Whorls slightly concave above the peripheral carina, divided into two concave areas by the lower keel. Suture tightly closed, the subsutural slope and a narrow strip above the suture lying within the same arc of curvature.

Holotype (USNM 562756) measures: height 33 mm, diameter 11.4 mm.

Type locality: Yonabaru clay member, 17476.

Coronasyrinx semiplana Powell (1944, p. 22, pl. 1, fig. 2) is a juvenile of five whorls whereas the specimen figured here has ten whorls. The peripheral keel of *C. semiplana* appears to be slightly upturned and there are more nodes to the whorl. Powell's figure shows stronger spirals below the lower carina which may be either an exaggeration in the drawing or a juvenile character. The basal spirals on *C. takabanarensis* are similar in size and number and are clearly visible as darker, frosted lines but they do not show through the ammonium chloride coating used in photographing the specimen.

The Albatross collection from the Philippines contains two species of this genus, one closely related to *C. takabanarensis*, the other with coarser sculpture on the columella.

Distribution: Miocene, (Yonabaru clay member) Takabanare-shima, Okinawa-gunto.

Localities: Yonabaru clay member, 17476 (figured type).

Comparative bathymetric data: The closely related species in the Albatross Philippine collection was taken from the Jolo Sea off Cagayan at 495 fathoms. Another species with coarser spiral sculpture on the columella was taken off Pt. Tagolo, northern Mindinao, with no depth data.

Genus LEUCOSYRINX Dall 1889

Type: *Pleurotoma verrilli* Dall.

Leucosyrinx iwaensis, n. sp.

Plate 9, figure 24

Shell of medium size moderately slender; spire fusiform whorls subangulate. Protoconch consisting of 1½ smooth whorls, the first full turn slightly tilted, moderately small. Aperture about half as long as shell, moderately narrow. Outer lip thin and rounded, recurving sharply to the anal sinus. Columella of moderate length and straight. Anal sinus moderately broad and deep, adjacent to the suture and showing only a slight amount of recurving from the apex of the sinus to the suture. Sculpture consisting of inclined axials, about eight visible from an angle on the young whorls but becoming obsolete on the body whorl; medium textured raised spiral lines below the periphery, extending with about equal strength to the tip of the columella; subsutural slope sculptured with similar lines which are weaker immediately above the periphery, but stronger near the suture.

Holotype (USNM 562862) measures: height 25 mm, diameter 8.3 mm.

Type locality: Shinzato tuff member, 17454.

There seems to be no relative of this species described from the western Pacific region. It differs from the type of *Leucosyrinx* in being slenderer and having more regular spiral markings, those of *L. verrilli* being discontinuous near the periphery. The axial nodes of *L. verrilli* are shorter and somewhat stronger.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa.

Localities: Shinzato tuff member, 17454 (figured type).

Subfamily CLAVATULINAE

Genus CLAVATULA Lamarck 1801

Type: *Clavatula coronata* Lamarck.

Subgenus ALTICLAVATULA, n. subgen.

Type: *Pleurotoma patruelis* Smith.

This subgenus is more slender and elongate than typical *Clavatula* to which the type species is referred by most recent Japanese authors. The spire is relatively longer, the columella relatively shorter, and the umbilicus is closed rather than forming a chink. *Alticlavatula* has a small, polished, untilted protoconch of about 1½ whorls.

In addition to the type species and the species under consideration *Alticlavatula* also includes: *Drillia* *dainichiensis* Yokoyama from the Dainichi formation (Pliocene) of Japan, *Clavatula dainichiensis viva* Makiyama, living off Japan, *Clavatula taiwanensis* Nomura from the Byoritzu beds (Pliocene) of Formosa, *Pleurotoma djocdjocartae* Martin from the Miocene of Java, and *Pl. djocdjocartae serana* Fischer from the Pliocene of Ceram.

Clavatula (Alticlavatula) cf. C. (A.) kakegawensis (Makiyama)

Plate 14, figure 16

?*Clavatula kakegawensis* Makiyama, 1927, Kyoto Imp. Univ. Coll. Sci. Mem., ser. B, v. 3, no. 1, p. 100, pl. 4, fig. 5.

The Okinawan form is separable from *C.* (*A.*) *dainichiensis* (Yokoyama, 1923, p. 6, pl. 1., fig. 2) by the same difference that Makiyama recognized for typical *C.* (*A.*) *kakegawensis*, namely that it has about 26 axials per whorl as opposed to fifteen for *dainichiensis; patruelis* has fourteen. Nomura states that the axials on *C.* (*A.*) *taiwanensis* (Nomura, 1935, p. 116, pl. 6, fig. 60) number seventeen on the subsutural slope, but split to form about 25 on the periphery. Nothing like this is indicated on specimens of this species in the Hayasaka collection of Byoritzu fossils, nor is there any indication of splitting on the Okinawan specimen. However, an occasional axial appears on the central and lower part of the whorl between other axials that extend to the suture above. It is possible that *taiwanensis* and *kakegawensis* will prove to be one species.

Distribution: Pliocene, (?Tenno formation) Japan, (Chinen sand) Okinawa, (?Byoritzu beds) Formosa.

Localities: Chinen sand, 17442 (figured).

Subfamily CLAVINAE

Genus ANTIMELATOMA Powell 1942

Type: *Drillia maorum* Smith.

?Antimelatoma sp.

Plate 9, figure 10

The specimen so identified is a juvenile and it is referred to this genus with reservations. It bears some resemblance to *A. benthicola* Powell although the base of the whorl is more constricted on the Okinawan specimen. It is not *Turricula byoritzuensis* Nomura which has moderately strong spiral lirations on its subsutural slope.

Locality: Unknown, but believed to have come from the Shinzato tuff member (figured).

Genus PSEUDOINQUISITOR Powell 1942

Type: *Pseudoinquisitor problematicus* Powell.

This generic assignment is tentative and is made entirely on the similarity of the species here figured to *P. trinervis* Powell (1944, pl. 3, fig. 3). The first whorl and protoconch of the Okinawan specimen are decorticated but the protoconch appears to be small and very slightly tilted.

Pseudoinquisitor? cf. P.? pulchra (Schepman)

Plate 5, figure 13

?*Surcula pulchra* Schepman, 1913, Resultats Siboga Expeditie, Mon. 49–1, pt. 5, p. 426, pl. 28, fig. 2.

This small specimen, probably a juvenile, appears to be very close to the form from the Banda Sea, but does not have any close relatives in the region of Japan. *Pleurotoma* (*Drillia*) *ermelingi* Martin from the Miocene of Java may also be related.

Distribution: Miocene, (Yonabaru clay member) Okinawa; ?Recent, Banda Sea.

Localities: Yonabaru clay member, 17445 (figured).

Genus MAUIDRILLIA Powell 1942

Type: *Mangilia praecophinoides* Suter.

Mauidrillia? kachabaruensis, n. sp.

Plate 9, figures 27, 30

Shell of medium size, whorls angulate. Protoconch missing on specimen at hand. Aperture of moderate width, constricted appreciably anteriorly to form a narrow canal. Outer lip sharply curved as shown by growth lines, sweeping back toward the anal sinus which is broad and deep. Inner lip uncallussed and without folds. Scultpure consisting of short axial nodes which are slightly oblique and situated just above the suture and at the base of the subsutural slope, about eight visible from an angle; weak spiral lines over the rest of the shell, those above the basal constriction sometimes doubling, those below the basal constriction remaining single and somewhat stronger, generally absent at the very top of the axial nodes.

Holotype (USNM 562865) measures: height 18.2 mm, diameter 6.8 mm.

Type locality Shinzato tuff member, 17456.

Surcula undosa Schepman (1913, p. 425, pl. 27, fig. 13), Recent from the Flores Sea, may be related to this species, but at least the Recent species has a well developed parietal callus.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa.

Localities: Shinzato tuff member, 17456 (figured type).

Comparative bathymetric data: *Surcula undosa* Schepman was stated to have come from a depth of 794 meters.

Genus SPLENDRILLIA Hedley 1922

Type: *Drillia woodsi* Beddome.

Splendrillia and *Syntomodrillia* Woodring are very closely related. According to Powell (1944, p. 32) they are distinguished by the presence of a subsutural fold (collar?) in *Syntomodrillia* and in the fact that its axials extend from suture to suture whereas in *Splendrillia* they are restricted to the periphery. However, neither of these characters show any sharp demarcation and seem to connect rather than delimit the species involved. *Syntomodrillia* is being used as a subgenus of *Splendrillia* for one of the species reported here but without any great confidence in its usefulness. Another species referred to *Splendrillia* s.s. is close to one referred to *Syntomodrillia* by Powell.

Splendrillia nomurai, n. sp.

Plate 5, figure 25

Shell moderately small, whorls angulate, aperture less than half the length of the shell. Protoconch consisting of two smooth whorls, the first whorl tilted, the second in the same cone as the spire. Aperture moderately broad, siphonal canal broad and short. Anal sinus broad and shallow. Outer lip thin and moderately curved. Parietal callus moderately heavy, slightly heavier opposite the anal sinus with the edge weakly raised; a slightly elongate chink present along the edge of the columellar callus. Sculpture consisting of a row of short, faceted axial nodes, about 7 to 8 visible from an angle, each of which curves sharply to the left at the periphery, giving the whorl a moderately sharp angulation, another weaker crescent-shaped extension crossing the subsutural slope to the suture; axials irregular on lower part of the whorl, some dying out more rapidly below than others, other segments appearing that have no upward extension; columella bearing raised spiral lines, about seven in number.

Holotype (USNM 562759) measures: height 20 mm., diameter 12.6 mm.

Type locality: Yonabaru clay member, 17451.

I find no species from the region of Japan that resembles this one. It may be related to some forms from New Zealand, particularly *S. cristata* Powell (1942, pl. 12, fig. 4) from the Nukumaruan beds (Pliocene). However, Powell's figure is too generalized to permit close comparison.

Syntomodrillia circincta Powell (1944, pl. 2, fig. 12) from the lower Miocene of Australia appears to have its axials faceted on the periphery and the curved extensions of the axials cross the subsutural slope as in *S. nomurai*. These two species are undoubtedly very close.

Distribution: Miocence, (Yonabaru clay member) Okinawa.
Localities: Yonabaru clay member, 17451 (figured type).

Splendrillia incompta, n. sp.

Plate 5, figure 26

Shell moderately small, whorls angulate. Protoconch consisting of about 1½ smooth whorls, the entire protoconch slightly tilted. Aperture approximately half the length of the shell, narrow, and produced to form a narrow, moderately elongate canal. Parietal callus with a weakly detached edge at the posterior end but appressed lower on the parietal wall; columellar callus appressed. Sculpture consisting of short, blunt axial nodes that give the whorls a definite angulation; spiral sculpture very weak, restricted to a few lines near the base of the columella.

Holotype (USNM 562760) measures: height 11.8 mm., diameter 4 mm.

Type locality: Yonabaru clay member, 17450.

This species differs from *S. nomurai* in being slenderer, in lacking the crescent-shaped extensions of the axials across the subsutural slope, in having blunt rather than faceted peripheral nodes, and in lacking axials on the lower part of the whorls. The spiral sculpture at the base of the columella is also decidedly weaker than in *S. nomurai.*

Distribution: Miocene, (Yonabaru clay member) Okinawa.
Localities: Yonabaru clay member, 17450 (figured type).

Subgenus SYNTOMODRILLIA Woodring 1928

Type: *Drillia lissotropis* Dall.

Splendrillia (Syntomodrillia) atsutaensis, n. sp.

Plate 5, figure 31

Shell small, medium slender, whorls rounded with a slight constriction in the outline below the collar. Protoconch not complete on type. Aperture of moderate width, short, not forming a definite canal, but deflected at the anal end rather abruptly. Siphonal notch well developed. Outer lip thin and gently curved for the most part but swinging back abruptly at the anal sinus. Anal sinus deep, slightly constricted at the mouth. Parietal wall bearing an elongate callus at the mouth of the anal sinus. Columella slightly callussed, the callus set off by a weak chink where it forms the inner lip. Sculpture consisting of weak low axials, no spiral sculpture definitely visible although a few weak lines may be present near the base of the columella.

Holotype (USNM 562765) measures: height 9.4 mm, diameter 3.6 mm.

Type locality: Yonabaru clay member, 17503.

This species is closely related to *Clavus* (*Cymatosyrinx*) *pseudohumilis* Nomura from the Byoritzu beds of Formosa (see also Otuka, 1949, pl. 13, fig. 12). Specimens so labelled in the Hayasaka collection in the U.S. Geological Survey have a shallower anal sinus. Only one specimen has a constriction setting off a subsutural collar as on *S. atsutaensis;* it may belong to the variety shown in Nomura's figure 48 (1935, pl. 6).

Distribution: Miocene, (Yonabaru clay member) Okinawa.
Localities: Yonabaru clay member, 17503 (figured type).

Genus CRASSOPLEURA Monterosato 1884

Type: *Pleurotoma maravignae* Bivona.

Crassopleura aff. C. brevis (Yokoyama)

Plate 5, figure 27

?*Drillia glabriuscula* var. *brevis* Yokoyama, 1922, Tokyo Imp. Univ. Coll. Sci. Jour., v. 44, art. 1, p. 41, pl. 1, fig. 32.
?*Clavus* (*Elaeocyma*) *glabriuscula brevis*. Taki and Oyama, 1954, Paleont. Soc. Japan Spec. Paper 2, pl. 21, fig. 32.

The Okinawan species is similar in outline and sculpture to the form from the lower Pleistocene of Japan figured by Yokoyama, but it is impossible from the figures to compare them in detail.

Distribution: Miocene, (Yonabaru clay member) Okinawa; ?Pleistocene, Japan.

Localities: Yonabaru clay member, 17449 (figured).

Genus CRASSISPIRA Swainson 1840

Type: *Pleurotoma bottae* Valenciennes (Kiener).

The genus *Crassispira* is used here as it was used by Woodring (1928); for shells having a high spire, a strong subsutural collar, a moderately narrow but strongly concave subsutural slope, strong axial ribs that do not cross the subsutural slope, and strong spiral threads between the axial ribs. The type of *Crassispira* does not have strong spiral sculpture. Shells of the type here referred to *Crassispira* have been referred to *Inquisitor* Hedley 1918 by some recent authors, and they certainly fall within the wide range of species included in *Inquisitor* by Hedley in 1922.

A large number of turrid genera have been proposed by Australian and New Zealand authors, but in my opinion a confusing picture exists insofar as the species assigned to them is concerned. It is difficult to see why Powell considers "*Splendrillia*" *adelaidae* (1944, pl. 2, fig. 6) to be congeneric with "*Splendrillia*" *formosa* (1944, pl. 2, fig. 5) and "*Splendrillia*" *edita* (1942, pl. 2, fig. 3) while *Pseudoinquisitor problematicus* (1944, pl. 3, fig. 3) belongs to a different genus.

Crassispira pseudoprincipalis (Yokoyama)

Plate 14, figure 28

Pleurotoma (*Drillia*) *pseudo-principalis* Yokoyama, 1920. Tokyo Imp. Univ. Coll. Sci. Jour., v. 39, art. 6, p. 37, pl. 1, fig. 21.
Drillia pseudo-principalis. Yokoyama, 1926, Tokyo Imp. Univ. Fac. Sci. Jour., sec. 2, v. 1, pt. 9, p. 330.
Inquisitor pseudoprincipalis. Makiyama, 1927, Kyoto Imp. Univ. Coll. Sci. Mem., ser. B, v. 3, no. 1, art. 1, p. 104; 1931, ser. B, v. 7, no. 1, art. 1, p. 7.
Clavus (*Brachytoma*) *pseudoprincipalis*. Nomura, 1935, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 2, p. 124, pl. 6, fig. 38.
Hatai and Nisiyama, 1952, Tōhoku Univ. Sci. Repts., 2d ser., spec. v. 3, p. 232.

The Okinawan specimens appear to agree closely with the typical form from the Naganuma formation (Pliocene) of Japan.

A large suite of specimens so labelled is in the Hayasaka collection from the Byoritzu beds. There is some variation in the width of the apical angle, a fact mentioned by Nomura, and the number of interstitial threads between the primary spirals ranges from one to three, some specimens with three interstitials having all three of equal strength and others having the middle thread stronger.

According to Makiyama (1927, p. 104), Japanese specimens of this species differ from *C. bataviana* (Martin) in having a shorter canal. The same appears to be true of the Okinawan and Formosan specimens.

Distribution: Miocene, (Tamari formation) Japan; Pliocene, (Naganuma formation, Dainichi formation, Satsuka formation) Japan, (Nakoshi sand) Okinawa, (Byoritzu beds) Formosa

Localities: Nakoshi sand, 17440 (figured).

Crassispira hataii, n. sp.

Plate 5, figure 30; plate 6, figure 1

Shell of medium size and inflation, whorls sharply rounded in profile. Protoconch somewhat eroded, but apparently consisting of three whorls, conical, and smooth. Aperture of medium width, produced anteriorly to form a short canal; only a slight indication of a siphonal notch. Outer lip gently curving. Anal sinus sharp, but of only moderate depth. Sculpture consisting of coarse axial ribs, slightly inclined to the right towards the apex, six visible from an angle; delicate but distinctly raised spiral lines crossing the axial ribs and interspaces alike, some of the spiral interspaces with secondary lines; anal fasciole bearing lines of about the same width, but with less relief. Subsutural slope with a moderately strong subsutural collar and below it a sharp, concave anal fasciole.

Holotype (USNM 562764) measures: height 30 mm, diameter 9 mm.

Type locality: Yonabaru clay member, 17451.

Crassispira hataii is generically akin to *C. pseudoprincipalis* but may belong to an entirely distinct group of species. The axial ribs of *C. hataii* are fewer in number and larger, and the spiral lines are much finer and cross the axials and axial interspaces alike rather than being absent over the crest of the axials as in *C. pseudoprincipalis*. In addition, the body whorl of *C. pseudoprincipalis* is more constricted at the base, the canal is relatively shorter, and the siphonal notch is larger.

Distribution: Miocene, (Yonabaru clay member) Okinawa.

Localities: Yonabaru clay member, 17451 (holotype and one other specimen figured).

Genus CLATHRODRILLIA Dall 1918

Type: *Pleurotoma gibbosa* Reeve.

Clathrodrillia cf. C. jeffreysii (Smith)

Plate 14, figure 29

?*Drillia jeffreysii* Smith, 1875, Annals and Mag. Nat. Hist., ser. 4, v. 15, p. 5.

?*Inquisitor jeffreysii.* Makiyama, 1927, Kyoto Imp. Univ. Coll. Sci. Mem., ser. B, vol. 3, no. 1, art. 1, p. 104.

?*Drillia pseudoprincipalis.* Yokoyama, 1928, Imp. Geol. Survey Japan Rept. 101, p. 32, pl. 1, fig. 15.

Two closely related species, *C. jeffreysii* and *C. flavidula* Lamarck live in Japanese waters. Fossil species have been referred to both species, but without more and better illustrations than those available, it is difficult to determine which assignments are correct. *C. jeffreysii* is a little stouter and has a shorter and broader body whorl and a shorter canal. Probably the forms included under *Inquisitor jeffreysii* by Makiyama are in part referable to *C. flavidula*, but the form from the Upper Byoritzu which Yokoyama identified as *pseudoprincipalis* appears to be more like *C. jeffreysii.* Two specimens in the Hayasaka collection from Formosa are identical with specimens from Okinawa.

Distribution: Pliocene, (Byoritzu beds) Formosa, (Chinen sand) Okinawa; Pliocene(?) to Recent of Japan.

Localities: Chinen sand, 17442 (figured).

Genus COMPSODRILLIA Woodring 1928

Type: *C. urceola* Woodring.

Compsodrillia nakamurai Makiyama

Plate 6, figure 2

Compsodrillia nakamurai Makiyama, 1931, Kyoto Imp. Univ. Coll. Sci. Mem., ser. B, v. 7, p. 49, pl. 2, fig. 18.

As well as can be ascertained from his figure this species is identical with the species described by Makiyama from the Hosoya formation (Pliocene) of Japan.

Distribution: Miocene, (Yonabaru clay member) Okinawa; Pliocene, (Hosoya formation-Kakegawa group) Japan, (?Chinen sand) Okinawa.

Localities: Yonabaru clay member, 17451 (figured); Chinen sand?, 17442.

Compsodrillia? torvita, n. sp.

Plate 9, figure 25

Shell of medium size and inflation, whorls well rounded. Protoconch not well preserved, but apparently smooth, bulbous and tilted. Aperture of moderate width, constricted very little toward the canal; siphonal notch weak. Outer lip well rounded. Anal sinus moderately narrow and moderately shallow. Anal fasciole not deeply impressed. Sculpture consisting of heavy axial ribs, 7 to 8 visible from an angle, crossed by moderately heavy spiral lines of low relief; spirals absent on anal fasciole, but 1 may be present on the subsutural collar. Subsutural slope not well defined, but having a low indistinct subsutural collar, and a moderately indented anal fasciole, the anal fasciole not subtended by sharp truncations of the axial ribs.

Holotype (USNM 562863) measures: height 38 mm, diameter 10.9 mm.

Type locality: Shinzato tuff member, 17454.

This species has some resemblance to the species of *Crassispira* figured here but it can be distinguished from them immediately by its coarser, less well-defined spirals and by the complete lack of spiral sculpture on the subsutural slope.

It is possible that this is merely a full grown specimen of the species here identified as *C. nakamurai.* The axials of the latter have a slight slant, however, whereas the axials of *C. torvita* are vertical. Furthermore, *C. nakamurai* has sharper spiral threads.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa.

Localities: Shinzato tuff member, 17454 (figured type).

Genus AGLADRILLIA Woodring 1928

Type: *A. callothyra* Woodring.

Of the two spirally sculptured species originally referred to *Agladrillia*, one, the type, *A. callothyra*, has spiral grooves which are present between the axials only, and the other, *A. leptalea*, has spiral threads which cross the axials. The Okinawan species is of the latter type.

Agladrillia nakazaensis, n. sp.

Plate 9, figures 20, 31

Shell medium to moderately inflated, whorls rounded. Protoconch missing on type. Aperture less than half the length of the shell, produced anteriorly to form a short but well-defined canal. Parietal callus thin except for a small bulge adjacent to the anal sinus. Sculpture consisting of moderately heavy axials, about 5 to 6 visible from an angle, crossed by narrow but sharp raised threads, somewhat narrower on the subsutural slope, and frequently with secondary threads on the lower part of the columella; anal fasciole not distinct due to the fact that the axials reach nearly to the subsutural collar, and between the axials the collar dips gently.

Holotype (USNM 562858) measures: height 17 mm, diameter 6.4 mm.

Type locality: Shinzato tuff member, 17453.

This species is probably closely related to *Drillia ferenuda* Cossmann (1920) from the Pliocene of Karakal, India, but the latter species has larger and more widely spaced axials, only 4 to 5 visible from an angle.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa.

Localities: Shinzato tuff member, 17453 (figured type).

Subfamily BORSONIINAE

Genus BORSONIA Bellardi 1839

Type: *B. prima* Bellardi.

The genus *Borsonia* has been used to include forms with both one and two plaits on the columella. The species here referred to it has a single very weak plait.

Borsonia shimajiriensis, n. sp.

Plate 9, figure 32

Shell of medium size, fusiform, spire moderately elongate, whorls concave on subsutural slope, convex below. Protoconch missing from specimen at hand. Aperture of moderate width, narrowing appreciably at the canal, the extreme tip of which is missing on the type specimen. Outer lip gently curving as seen from growth lines. Columella weakly callused with a weak low fold starting about a quarter turn back from the edge of the callus. Sculpture consisting of moderately strong axial ribs, six to seven visible from an angle, strongest and terminating abruptly at the periphery, dying out anteriorly near the mid-point of the whorls; spiral sculpture absent on the subsutural slope but consisting of weak raised lirations from the periphery to the tip of the columella. Growth lines on the anal fasciole indicate that the sinus had a medium indentation and covered the entire subsutural slope.

Holotype (USNM 562868) measures: height 22 mm, diameter 8 mm.

Type locality: Shinzato tuff member, 17454.

The nearest relative I find of this species is *B. mitromorphoides* Suter (1917, p. 59, pl. 121, fig. 22) from the Upper Oligocene of Wharekuri, New Zealand. It differs from the New Zealand form in having 6 to 7 axials visible from an angle whereas the New Zealand species has 5, in having a single weak columellar plait whereas the New Zealand form has 2 fairly strong plaits, and in having a subsutural slope devoid of spiral sculpture whereas the New Zealand form has fine spirals on the anal fasciole. *Borsonia clifdenesis* Finlay from the lower Miocene of New Zealand (see Powell, 1942, pl. 4, fig. 2) is also related but it has two columellar plaits and a shorter columella.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa.

Localities: Shinzato tuff member, 17454 (figured type).

Genus BORSONELLA Dall 1908

Type: *Borsonia dalli* Arnold.

The type of this genus (see Oldroyd, 1927, pl. 6, fig. 8) has a single, rather strong, nearly horizontal fold on its columella but another species of the genus, *B. diegensis* Dall (see Oldroyd, 1927, pl. 6, fig. 4), has a faint, sharply inclined fold. The species here included in the genus has an inclined very weak fold.

Borsonella shinzato, n. sp.

Plate 9, figure 18

Shell moderately small (probably a juvenile), moderately inflated. Protoconch globular, consisting of about 1½ turns, moderately large and slightly tilted, bearing weak sharp raised revolving lines on the last ¾-turn, not definitely carinate. Whorls nearly straight sided on spire with a low beaded periphery standing out. Aperture of moderate width, a little over half the length of the shell. Canal short and straight. Outer lip thin, recurving sharply to the anal sinus. Parietal callus thin. Anal sinus broad and moderately deep, adjacent to the suture and occupying the entire subsutural slope, the growth lines recurving only slightly from the apex of the sinus to the suture. Sculpture consisting of small oblique nodes on the periphery, terminating abruptly above, and dying out more gradually below; no visible spiral sculpture; subsutural slope smooth and straight, but with a thickening below the suture making the suture appear somewhat incised.

Holotype (USNM 562857) measures: height 16.6 mm, diameter 7.8 mm.

Type locality: Shinzato tuff member, 17454.

This species appears to be most closely related to *B. diegensis* Dall, a species obtained from deep water (822 fathoms) off San Diego, California. The Okinawan species has a wider, less concave subsutural slope and the inclined axial nodes are stronger. The columellar fold is very faint.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa.

Localities: Shinzato tuff member, 17454 (figured type).

Subfamily MANGELIINAE

Genus "MANGELIA" Risso 1826

The following species seems to fall within the complex once included in *Mangelia*. Without a complete aperture it would be difficult to place it more precisely. It has specific characters that are unmistakable, however, and the species is described. This species could belong in the Clavinae rather than the Mangeliinae.

"Mangelia" china, n. sp.

Plate 9, figure 26

Shell small, fusiform, whorls bluntly carinate, spire moderately sharp, of about the same length as the aperture. Protoconch not well enough preserved on the type for description. Aperture of medium width, narrowing anteriorly where it is produced to form a canal of moderate length. Outer lip not preserved on the type but shown by growth lines to recurve above the periphery to form a moderately broad, moderately deep sinus. Parietal wall lightly callussed posteriorly and slightly resorbed anteriorly. Sculpture consisting of blunt, slightly protractive axial ribs, about seven visible from an angle, and fine somewhat irregular spiral lirations which are slightly more crowded on the subsutural slope and slightly coarser on the columella; some secondary threads present. Suture appressed with a well defined subsutural collar.

Holotype (USNM 562864) measures: height 14 mm, diameter 5 mm.
Type locality: Shinzato tuff member, 17633.

I can find nothing described from the region with which I could compare this shell with any degree of confidence.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa.
Localities: Shinzato tuff member, 17633 (figured type).

Genus NEOGURALEUS Powell, 1939

Type: *Drillia sinclairi* Gillies.

Neoguraleus kutekinensis, n. sp.

Plate 14, figure 27

Shell moderately small but large for the genus, whorls evenly rounded, spire moderately inflated. Protoconch blunt, subnaticoidal, slightly tilted, consisting of 1½ smooth whorls. Aperature of moderate width, less than half the length of the shell. Outer lip forming a gentle inverted **S** in outline, the upper broad shallow curve being the anal sinus. Parietal callus thin except opposite the anal sinus where it forms a small pad. Sculpture consisting of thin, gently curving axials extending from the suture to the base of the body whorl, 8 to 9 visible from an angle; spirals narrow weakly raised, extending over most of the whorl with a few coarser ones on the columella below the lowest extent of the axials.

Holotype (USNM 562978) measures: height 14.5 mm, diameter 5.4 mm.
Type locality: Chinen sand, 17482b.

This species bears strong resemblance to *N. oruaensis* Powell (1942, pl. 6, fig. 7), Recent from New Zealand. It has fewer axials per whorl, 9 visible on the body whorl as opposed to 13 for the New Zealand species.

Distribution: Pliocene, (Chinen sand) Okinawa.
Localities: Chinen sand, 17482b (figured type).

Neoguraleus loochooensis, n. sp.

Plate 9, figure 23

Shell moderately small, whorls subangulate. Protoconch consisting of 1½ whorls, the first smooth and tilted, the last half turn with spiral threads, becoming fenestrate by the addition of axial lines towards the end. Aperture of moderate width, broken on the type, less than half the length of the shell. Anal sinus shallow. Sculpture consisting of thin gently curving axials which make a sharper curve forwards at the position of the anal sinus, about nine to ten visible from an angle; spiral lines incised and considerably stronger and somewhat coarser below the shoulder than on the subsutural slope; columella lacking axials, and the spirals have the appearance of being raised lirations rather than incised lines.

Holotype (USNM 562861) measures: height 9.1 mm, diameter 4 mm.
Type locality: Shinzato tuff member, 17454.

This species differs from *kutekinensis* in having part of its protoconch with fenestrate sculpture, in having subangulate rather than rounded whorls, and in having stronger spiral sculpture.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa.
Localities: Shinzato tuff member, 17454 (figured type).

Genus BENTHOMANGILIA Thiele 1925

Type: *Surcula trophonoides* Schepman.

Benthomangilia cf. B. cosibensis (Yokoyama)

Plate 9, figure 28

?*Pleurotoma* (*Drillia*) *cosibensis* Yokoyama, 1920, Tokyo Imp. Univ. Coll. Sci. Jour., v. 39, art. 6, p. 38, pl. 1, fig. 26.

A single specimen from the Shinzato tuff member of the Shimajiri formation appears to be closely related to *C. cosibensis*. Yokoyama stated that his species had 19 axials on the body whorl, whereas the present species has only 15 so that unless the Japanese species is variable, the Okinawa form may be distinct. In other respects they appear to be identical.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa; Pliocene, (Koshiba formation) Japan.
Localities: Shinzato tuff member, 17454 (figured).

Genus GLYPHOSTOMA Gabb 1872

Type: *G. dentiferum* Gabb.

Glyphostoma cf. C. costicrenata (Cossmann)

Plate 9, figure 29

?*Clathurella costicrenata* Cossmann, 1900, Journal de conchyliologie, v. 48, p. 47, pl. 3, figs. 16, 17.

A specimen obtained from the Shinzato tuff member of the Shimajiri formation compares closely with the species described by Cossmann from the Pliocene of Karakal, India.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa; Pliocene, (Karikal) India.
Localities: Shinzato tuff member, 17456 (figured).

Glyphostoma subcosticrenata, n. sp.

Plate 14, figure 26

Shell about medium sized for the genus, whorls rounded. Protoconch unknown. Aperture of moderate width, siphonal canal narrow. Outer lip bearing about 8 denticles on the inside, but the edge of the lip is thin and smooth. Inner lip prominent but attached, bearing 3 to 4 small denticles, and a single stronger denticle on a pad of callus directly opposite the anal sinus. Sculpture consisting of coarse, low axials, about 7 visible from an angle, which are crossed by fine, raised spiral lines having nearly equal intensity over both the subsutural slope and the lower part of the whorl.

Holotype (USNM 562977) measures: height 10 mm, diameter 4.9 mm.
Type locality: Chinen sand, 17442.

This species differs from *G. costicrenata* in being somewhat stouter and in lacking interstitial or secondary spiral lines.

Distribution: Pliocene, (Chinen sand) Okinawa.
Localities: Chinen sand, 17442 (figured type).

Genus ETREMA Hedley 1918

Type: *Mangilia* (*Glyphostoma*) *aliciae* Melvill and Standen.

The species here described is not very closely related to the type of the genus, but is closely related to some other species referred to the genus by both Hedley and Powell. Among the related species are *E. sparula* Hedley, *E. culmea* Hedley, and *E. glabriplicata* (Sowerby).

Etrema saplisi, n. sp.

Plate 15, figure 10

Shell of medium size, moderately inflated, whorls sharply rounded, suture angulate and depressed with the subsutural slope slightly concave and the suprasutural wall slightly convex. Protoconch not complete on the type but the last whorl is sharply carinate. Aperture of moderate width, the lip and lower end of the canal missing on the type. Parietal wall bearing a weak denticle at the edge of the callus a short distance below the anal notch. Columella bearing about 8 weak folds, the upper 4 or 5 coinciding with the strong spiral lirations of the external sculpture, but the lower 3 arranged somewhat diagonal to the external lirations. Sculpture consisting of rather prominent, well rounded axial ribs (about 6 to 7 visible from an angle) which do not extend quite to the suture above, become obsolete on the lower part of the body whorl, and are practically obsolete at the suture; spiral sculpture consisting of fine raised lirae, those on the subsutural slope delicately raised and finely beaded on top and without interstitials, those on the middle and lower part of the whorl divided into primary and secondary, and frequently tertiary threads, with the primary threads smooth but the secondary and tertiary threads finely beaded like those on the subsutural slope.

Holotype (USNM 562988) measures: height 16 mm, diameter 7.5 mm.
Type locality: Chinen sand, 17481.

It is difficult to compare this species with others decribed without having specimens of the other species. The details of sculpture and the strength of the columellar plaits fairly closely resembles those of *E. glabriplicata* Sowerby (see Hedley, 1922, pl. 47, fig. 79), a species living from Australia to Japan, but *E. glabriplicata* is a slenderer species with a higher spire. *Lienardia peristernioides* Schepman (1913, p. 437, pl. 29, fig. 4) appears to be very closely related.

Distribution: Pliocene, (Chinen sand) Okinawa.
Localities: Chinen sand, 17481 (figured type).

Genus LIOGLYPHOSTOMA Woodring 1928

Type: *L. adematum* Woodring.

The species here referred to this genus is decidedly more elongate than the Jamaican species referred to it, and the protoconch lacks the median keel on the last whorl. The apertural and sculptural features are more in agreement with *Lioglyphostoma* than with any other described genus, however.

Lioglyphostoma tenuata, n. sp.

Plate 15, figure 1

Shell moderately small, slender and elongate, whorls subangulate. Protoconch consisting of over two whorls, smooth and regularly expanding. Aperture narrow, over half as long as the shell. Canal long and slender. Anal sinus slightly constricted with a slight callus around the edge. Outer lip broken on the type.

Inner lip thin and appressed except opposite the anal sinus where it is callused and weakly detached. Sculpture consisting of moderately strong rounded axials, about five visible from an angle, which do not completely cross the subsutural slope and die out near the base of the body whorl; fine rounded elevated spiral lirations with occasional secondary lirations over the entire whorl, those on the subsutural slope somewhat weaker than those below. Suture with a well developed collar.

Holotype (USNM 562981) measures: height 12.4 mm, diameter 3.7 mm.
Type locality: Shinzato tuff member, 17458.

No relatives of this species have been described from the western Pacific. It is decidedly more elongate and finely sculptured than the type species, *L. ademataum* Woodring, from the Miocene of Jamaica.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa.
Localities: Shinzato tuff member, 17458 (figured type).

Lioglyphostoma chinenensis, n. sp.

Plate 15, figure 3

Shell of medium size, moderately inflated, whorls subangulate. Protoconch consisting of a little less than two smooth, evenly expanding whorls. Aperture of medium width, less than half the length of the shell. Outer lip broken on type. Inner lip slightly callused, appressed except opposite the anal sinus where it is callused heavily and partly free. Anal sinus partly broken, but apparently round with a constriction at the opening. Sculpture consisting of gently curved axials, about seven visible from an angle, which do not entirely cross the subsutural slope, and die out below near the base of the body whorl; spiral lines fine, raised and of almost equal strength all over the whorl.

Holotype (USNM 562983) measures: height 11.4 mm., diameter 3.7 mm.
Type locality: Chinen sand, 17482b.

This species can be distinguished at once from *L. tenuata* by its less elongate shape and its more angulate whorls.

Distribution: Pliocene, (Chinen sand) Okinawa.
Localities: Chinen sand, 17482b (figured type).

Genus EUCLATHURELLA Woodring 1928

Type: *Clathurella vendryesiana* Dall.

Euclathurella fimbria, n. sp.

Plate 15, figure 2

Shell moderate to large for the genus. Protoconch missing from type. Aperture narrow and elongate, about or over half the length of the shell. Outer lip moderately heavy and crenulate at the edge. Parietal wall very weakly callused except opposite the anal sinus where a small callosity occurs. Anal sinus moderately narrow and deep, the maximum width visible only from a nearly vertical angle. No subsutural collar present. Sculpture consisting of very weak axial nodes on the adult whorls, but which are stronger on the young whorls, about six visible from an angle, and fine, raised spiral lirations, those below the shoulder having secondary lirations, and those above the shoulder finer and without secondary lines.

Holotype (USNM 562982) measures: height 20.7 mm, diameter 7.1 mm.
Type locality: Chinen sand, 17442.

This species is very closely related to a Recent specimen in the Hirase collection in the U.S. National Museum labelled "*Glyphostoma* (?) *carmen* Sowerby, Hirado, Hizen, Japan". It differs from the Recent species in having weaker axials, but is otherwise indistinguishable. Another specimen of "*G.* (?) *carmen*" is labelled "Eastern Sea, 53 fathoms".

Distribution: Pliocene, (Chinen sand) Okinawa.
Localities: Chinen sand, 17442 (figured type).
Comparative bathymetric data: A closely related living species was obtained in the East China Sea South of Nagasaki at a depth of 53 fathoms.

Incerta sedis

Plate 5, figure 29

A fragment, presumed to be a turrid, consisting of a protoconch and about two spire whorls, was obtained from the Yonabaru clay member of the Shimajiri formation.

Locality: Yonabaru clay member, 17679 (figured).

Subfamily DAPHNELLINAE

Genus TYPHLOSYRINX Thiele 1925

Type: *Pleurotoma* (*Leucosyrinx*) *vepallida* Martens.

Typhlosyrinx sp. indet.

Plate 9, figure 21

A single poorly preserved specimen is referred to this genus with some reservation. It has all the sculptural characteristics of the *Typhlosyrinx-Spergo-Pleurotomella* group of turrids, but its protoconch is missing.

Locality: Shinzato tuff member, 17453 (figured).

Genus PLEUROTOMELLA Verrill 1873

Type: *P. packardi* Verrill.

Pleurotomella? ryukyuensis, n. sp.

Plate 9, figure 22

Shell medium small, of medium inflation, spire moderately elongate with the aperture a little more than a third the height of the shell. Whorls angulate.

Protoconch consisting of over 4 complete turns, the first turn smooth, the last 3¼ turns bearing finely cancellate sculpture. Anal sinus broad and moderately deeply but not sharply indented. Outer lip thin with a moderately sharp curve. Parietal callus thin. Sculpture consisting of short axial nodes, about nine visible from an angle, those on the young whorls extending from about the middle of the subsutural slope to the suture, but reduced on the later whorls to oblique pointed protuberances on the shoulder; small puckers along growth lines rather distantly spaced along the anal fasciolar region; spiral sculpture very weak and irregular on the upper part of the whorls, but consisting of weak raised threads on the base of the body whorl and columella.

Holotype (USNM 562860) measures: height 18 mm, diameter 6.6 mm.

Type locality: Shinzato tuff member, 17456.

This species is probably closely related to *P.? dubia* Schepman (1913, p. 448, pl. 30, fig. 8) from the Ceram Sea, from which it differs mainly in having more axial ribs. *Pleurotomella? dubia* has 6 axials showing, whereas *P.? ryukyuensis* has 9.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa.

Localities: Shinzato tuff member, 17456 (figured type).

Comparative bathymetric data: *Pleurotomella? dubia* was obtained from the Ceram Sea at a depth of 835 meters (456 fathoms).

Genus DAPHNELLA Hinds 1844

Type: *Pleurotoma lymneiformis* Kiener.

Daphnella ryukyuensis, n. sp.

Plate 10, figure 1; plate 15, figure 4

Shell of medium size, medium to moderately slender, lymneiform, whorls flattened in the young state but rounded in adults. Protoconch consisting of 2¾ whorls, the first very small and smooth, the remainder microscopically diagonally cancellate, the diagonal lines being rough and irregular. Aperture of medium width. Outer lip thin and gently rounded. Anal sinus shallow, located nearly adjacent to the suture. Sculpture on the juvenile whorls consisting of a row of small rounded beads set on a low shoulder directly beneath the suture and with weak spiral lines below; adult sculpture consisting of very faint spiral lines, somewhat more evident and coarser on the lower part of the body whorl and columella.

Holotype (USNM 562984) measures: height 24 mm, diameter 8.7 mm.

Type locality: Chinen sand, 17481.

Nomura and Zinbo (1934, p. 132, pl. 5, fig. 23) identified a *Daphnella* from Kikaiga-shima as *D. lymneiformis*. Kuroda and Habe (1952, p. 53) reidentified it as *D. mitrellaformis* Nomura. Nomura and Zinbo's figure shows a shorter spire and a longer and more constricted siphonal canal than *D. ryukyuensis*. *Daphnella patula* (Reeve) (See Tryon, 1884, pl. 26, fig. 90.) also has a shorter spire. It has a low beaded keel just below the suture but it persists through the adult stage whereas in *D. ryukyuensis* it is only present on the first two postnuclear whorls. The Albatross collection from the Philippines contains specimens which probably are *D. patula*.

Two other closely related species were described from East Africa, *D. aequatorialis* (Thiele) (1925, p. 253, pl. 41, fig. 13) and *D. distincta* (Thiele) (idem, fig. 15). Both are based on immature shells so that it is difficult to compare them with the Recent Philippine and fossil Okinawan species. Thiele gives depths of 750 meters and 463 meters for his species.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa; Pliocene, (Chinen sand) Okinawa.

Localities: Shinzato tuff member, 17454 (figured); Chinen sand, 17481 (figured type).

Comparative bathymetric data: Specimens of *D. patula* were obtained in the Philippines by the Albatross at depths ranging from 170 to 244 fathoms.

Genus SPERGO Dall 1895

Type: *S. glandiniformis* Dall.

Spergo fusus, n. sp.

Plate 10, figures 4, 9

Shell spindle shaped, moderately inflated, whorls subangulate. Protoconch consisting of about three rapidly expanding whorls (approximately the first half turn missing on the type), sculptured by minute intersecting diagonal lines. Aperture about half the length of the shell, moderately wide. Anal sinus very shallow and broad. Outer lip thin. Parietal callus very thin, apparently no more than a film. Sculpture consisting of short, low axials, eight to nine visible from an angle, located at the subangulate periphery of the shell, obsolete on the upper part of the subsutural slope and on the lower part of the body whorl, and becoming less strong on the later whorls; a second system of axial sculpture that consists of wrinkles or puckers in the growth lines on the anal fasciolar region; spiral sculpture very faint above the periphery, but consisting of weak raised spirals on the lower part of the whorls, becoming stronger and more closely spaced on the columella.

Holotype (USNM 562871) measures: height 36 mm, diameter 23 mm.

Type locality: Shinzato tuff member, 17454.

Spergo fusus has coarser sculpture, both spiral and axial, than either *S. glandiniformis* or *S. daphnelloides* of Dall from the Hawaiian Islands. In shape it more nearly approximates *S. sibogae* Schepman (1913, p. 448, pl. 30, fig. 9) from the "Kei Islands" (Moluccas), but that species also has much weaker spiral sculpture.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa.

Type locality: Shinzato tuff member, 17454 (figured type).

Comparative bathymetric data: *Spergo sibogae*, 560 meters (308 fathoms); *S. daphnelloides*, 298 fathoms; *S. glandiniformis*, 298 fathoms; *S. procellana* (Watson), off Pernambuco, 350 fathoms.

Genus BUCCINARIA Kittl 1887

Type: *B. hoheneggeri* Kittl.

The shells here referred to this genus are quite dissimilar in the adult stage, but the protoconchs and young stages are nearly identical. The species referred to typical *Buccinaria* is *Bathytoma*-like in shape, has axial nodes, and is superficially like some species referred to *Austrotoma* in both shape and adult ornamentation. Its protoconch, however, is entirely different from those of either of these genera and consists of about 2 to 2½ whorls that form a small, sharp, conical tip. Except for about the first half turn, the protoconch is sculptured by fine, diagonal cancellations resembling engine turnings. This type of sculpture is sometimes referred to as "sinusigerid", but probably the term refers to the *Aphorais*-like outer lip that some protoconchs of this type, particularly that of *Cypraea*, possess. The species referred to the subgenus *Ootomella* is spindle-shaped and superficially resembles a fusinid or volutid. The young whorls of both *Buccinaria ss* and *Ootomella* have a strongly denticulate periphery, the denticles standing out strongly above the suture below. The subsutural slope is swollen, particularly just below the suture, and in a few specimens a weaker row of nodes is present along this swelling.

Beets (1944, p. 32) was the first to point out the close relationship of the Austrian Tertiary genus *Buccinaria* to *Ootomella* Bartsch (1933, p. 76; new name for *Ootoma* Koperberg) from the Tertiary of Timor, and to regard *Ootomella* as a subgenus of *Buccinaria*. *Eosipho* Theile, which he also made a subgenus of *Buccinaria* is unrelated. More recently Kuroda (1952, p. 65) described the genus *Pionotoma* and under it two new species, *P. pyrum* and *P. teramachii*, both from off Tosa, Japan. Kuroda indicated on a reprint sent to me that he now regards the name a synonym of *Ootomella*.

Buccinaria has been referred alternately to the Turritidae and to the Buccinidae with something approaching regularity. Kittl regarded *Buccinaria* as a buccinid. Hornes and Auinger (1891) included species of *Buccinaria* under the turrid genus *Pseudotoma*. Cossmann placed *Buccinaria* in the Buccinidae. Koperberg referred her genus *Ootoma* to the Turritidae. Beets treated *Ootomella* as a subgenus of *Buccinaria* and referred the genus to the Buccinidae, and in this he was followed by Altena (1950). Powell (1942) placed *Ootoma* in the subfamily Borsoniinae of the family Turritidae. Wenz (1941) regarded it as buccinid.

Powell regarded the diagonally cancellate sculpture of the protoconch as restricted to the Daphnellinae among the turrids, although it is present in genera belonging to other families such as *Thais* and *Cypraea*. Because of its protoconch and the fact that it has a well-defined though shallow indentation of its labial profile, I believe *Buccinaria* to be a turrid, and tentatively place it in the subfamily Daphnellinae.

Buccinaria okinawa, n. sp.

Plate 6, figures 3, 9; plate 10, figures 2–3

Shell of medium size, inflated, spire shorter than the aperture, whorls subcarinate to subrounded. Protoconch small, conical and pointed, consisting of two and one half whorls ornamented with fine, diagonally cancellate or "sinusigerid" sculpture. Aperture rather broad and forming a broad short canal anteriorily. Outer lip thin, gently curving, and narrowly indented to form a weak anal sinus along the subsutural slope. Parietal callus weak with the sculpture on the lower part of the whorls partly dissolved with the advance of the callus. Sculpture consisting of axial nodes along the periphery which flatten out rapidly both above and below the periphery, those of the young stages being sharp and denticulate; shell covered by raised spiral lines which are finer and more closely set above the periphery but broader and more widely spaced towards the base of the whorl, the interspaces on the lower part of the whorl bearing secondary and even tertiary threads.

Holotype (USNM 562870) measures: height 15.5 mm, diameter 8 mm.

Type locality: Shinzato tuff member, 17677.

The closest relatives of this species appear to be the Austrian Miocene species *B. hoheneggeri* (Kittl) and *B. orlaviensis* (Kittl). *Buccinaria* (*Ootomella*) *jonkeri* (Koperberg) lacks axial nodes and has a less depressed subsutural slope. The species bears at least superficial resemblance to some of the species of *Austrotoma*, *Awateria*, and *Marshallaria*, but none of these agree with *Buccinaria* in nuclear characters.

The low spired variety from the Yonabaru clay member of the Shimajiri formation (pl. 6, fig. 9) approaches in shape the form described by Altena (1950, p. 224, fig. 15) as *B.* (*Ootomella*) *javanensis*, but the latter appears to have two rows of less prominent peripheral nodes instead of one row of more prominent ones.

Distribution: Miocene, (Yonabaru clay member) Okinawa; Miocene or Pliocene, (Shinzato tuff member) Okinawa.

Localities: Yonabaru clay member, 17451 (figured—2 specimens); Shinzato tuff member, 17677 (figured type).

Subgenus OOTOMELLA Bartsch 1933

Type: *Ootoma jonkeri* Koperberg.

This subgenus includes the smoother, spindle-shaped members of *Buccinaria.* The very young stages of typical *Buccinaria* and *Ootomella* are similar, but adults of *Ootomella* lack a well defined shoulder and subsutural slope and have no trace of axial ribs or nodes. The spiral sculpture of typical *Buccinaria* ranges from moderate to strong; that of *Ootomella* from moderate to almost obsolete. Adults of *Ootomella* do not have an anal sinus.

In addition to the type, the subgenus would include *B. martini* (Koperberg), *B. koperbergi* (Martin), *B. pyrum* (Kuroda), *B. teramachii* (Kuroda), and the species described here. In my opinion, *B.* (*Ootomella*) *javanensis* Altena is a typical *Buccinaria.*

Buccinaria (Ootomella) loochooensis, n. sp.

Plate 15, figures 5–9

Shell of medium size, moderately inflated, spire slightly shorter than the aperture, whorls rounded in adults but with a denticulate peripheral carination on the young whorls. Protoconch not perfectly preserved on any specimen at hand, but at least the last $1\frac{1}{2}$ whorls sculptured with diagonal cancellations and apparently part of a small, sharply conical tip. Aperture subelliptical and moderately broad, sharply attenuated at the posterior end, but forming a rather broad, short canal anteriorly. Anal sinus not present in adults. Parietal callus of medium width and thickness; columellar callus heavier than the parietal callus on some individuals but not consistently. Sculpture consisting of low blunt spiral threads that are stronger and more closely set in the area above the periphery and on the base of the whorl, but which tend to be obsolete on the central part of the whorl; gently curving lines of growth well developed; young whorls with a blunt, denticulate peripheral carination just above the suture.

Holotype (USNM 562985) measures: height 26.5 mm, diameter 11.5 mm.

Type locality: Chinen sand, 17481.

The young stages of this species indicate close relationship with *B. okinawa*, in fact the young of the two species are almost inseparable. Adults of *B. okinawa* become bucciniform, resembling some species of *Siphonalia* with both the axial and spiral sculpture persisting, even becoming stronger. Adults of *B.* (*O.*) *loochooensis*, on the other hand, become more spindle-shaped and smoother.

I can find nothing described from the Japan region with which this species could be confused. It resembles *Daphnella lymneiformis* in a superficial way. However, the row of denticles on the juvenile whorls of this species are just above the suture whereas in *D. lymneiformis* a denticle-bearing ridge lies just below the suture.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa; Pliocene, (Chinen sand) Okinawa.

Localities: Shinzato tuff member, 17677; Chinen sand, 17481 (figured type).

Buccinaria (Ootomella) sp.

Plate 6, figure 4

A juvenile specimen closely related to *B.* (*O.*) *loochooensis* was obtained from the Yonabaru clay member of the Shimajiri formation. It is more inflated in the peripheral region and more constricted at the base than specimens of *loochooensis* from the Chinen sand and Shinzato tuff member of the Shimajiri but all of the latter specimens at hand are adults and it is not known whether juveniles of typical *loochooensis* are more inflated.

Locality: Yonabaru clay member, 17451 (figured).

Family THATCHERIIDAE

Genus THATCHERIA Angas 1877

Type: *T. mirabilis* Angas.

Powell (1942, p. 167) proposed a new family name for *Thatcheria* to include it and *Waitara* Marwick rather than place them in either the Turridae or Conidae where they have been variously placed by others. Apparently Yokoyama did not know of *Thatcheria* when he described the genus *Cochlioconus.*

Powell stated that the protoconch of *Thatcheria* is unknown. Neither of two specimens presented to the U.S. National Museum by Mrs. J. S. Schwengel has a protoconch. One specimen from Okinawa lacks a protoconch stage, but does have the sculpture preserved nearly to the protoconch stage, apparently an unusual condition owing to a slight tendency for the early whorls to become decorticated. The early sculpture is strongly turrid, the periphery being ornamented with well defined blunt denticulations, about 9 or 10 visible from an angle, and the denticulations themselves are crossed by fine spiral lines. Kuroda (1954, fig. 1) figured the protoconch and first nepionic whorl of a specimen of *T. mirabilis.* The protoconch has intersecting series of curved lines forming a reticulate sculpture like that of the Daphnellinae. Furthermore, he states that the radula is daphnellid. However, the carina is not denticulate. While one might be unduly cautious in wondering whether the young shell figured by Kuroda is really a *Thatcheria*, it is true, nevertheless, that the first nepionic whorl is quite different from that of the Okinawan species figured here. For the time being, therefore, Powell's family Thatcheriidae is being retained.

Thatcheria cf. T. gradata (Yokoyama)

Plate 15, figures 11–12

?*Cochlioconus gradatus* Yokoyama, 1928, Toyko Imp. Univ. Fac. of Sci. Jour., sec. 2, v. 2, pt. 7, p. 338, pl. 66, figs. 3, 4.
?*Thatcheria gradata.* Yokoyama, 1930, Tokoyo Imp. Univ. Fac. of Sci. Jour., sec. 2, v. 2, pt. 10, p. 406.
?*Thatcheria mirabilis.* Hatai and Nisiyama, 1952, Tōhoku Imp. Univ. Sci. Repts., 2d ser., spec. v. 3, p. 191.

The specimens from Hyuga on which Yokoyama based his species and the Okinawan specimens are incomplete, so that the identification is tentative. The Okinawan fossils are plane to only slightly concave on the broad shoulder. Yokoyama states that *T. gradata* is horizontal and flat or slightly excavated above the angle. In contrast, the Recent species, *T. mirabilis* Angas, has the shoulder definitely depressed with the periphery slightly upturned. The sculpture on the Recent species is finer than on either of the fossils, and neither the Hyuga or Okinawan specimens show evidence of crowding of the spirals immediately below the periphery, whereas the spirals of *T. mirabilis* show definite crowding below the periphery. The spirals on the Okinawan specimens are stronger where they cross the peripheral denticulations than elsewhere. The spiral lines are much weaker above the periphery than below it, and on the very young whorls the flattened area above the periphery and the suture is without spiral sculpture.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa; Pliocene, (Chinen sand) Okinawa.

Localities: Shinzato tuff member, 17633; Chinen sand, 17481 (figured).

Comparative bathymetric data: One specimen of *T. mirabilis* in the U.S. National Museum was dredged from off Tosa, Japan, at 100 fathoms.

Family CONIDAE

Genus CONUS Linné 1758

Type: *Conus marmoreus* Linné.

Conus sieboldianus Makiyama

Plate 6, figures 10, 15–16

Conus sieboldianus Makiyama, 1927, Kyoto Imp. Univ. Coll. Sci. Mem., ser. B, v. 3, no. 1, art. 1, p. 92, pl. 4, figs. 16, 17.

This species appears to be identical with the species described by Makiyama. It is characterized by the 2 to 4 spiral lines immediately below the shoulder and very weak spirals on the subsutural slope.

Conus oinouyei Yokoyama (1928, pl. 1, fig. 16) from the Lower Byoritzu beds of Formosa is very closely related, but has a slightly lower spire. Although Yokoyama did not mention the spirals below the shoulder, they are clearly visible on his figure. Whether or not the specimens Nomura referred to *C. odengensis* Martin are actually that species I am not prepared to say, but it seems quite certain that his placing of *C. oinouyei* in the synonymy of *C. odengensis* is incorrect.

Distribution: Miocene, (Yonabaru clay member) Okinawa; Pliocene, (Tenno formation) Japan.

Localities: Yonabaru clay member, 17447 (figured), 17451 (figured).

Conus aff. C. djarianensis Martin

Plate 6, figures 17, 22

?*Conus djarianensis* Martin, 1895, Samml. Geol., Reichsmus. Leiden, v. 1, no. 5, p. 20, pl. 3, figs. 45–50.
Conus djarianensis. Nomura, 1935, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 2, p. 105, pl. 7, figs. 13a, b, 14a, b.

Whether or not the species figured by Nomura is identical with the form described by Martin from the Miocene of Java the writer is not prepared to say. The Okinawan species appears to be identical with the Formosan species, however. Nomura described another species, *C. bonus*, which compares closely with the Okinawan form in shape, but *C. bonus* is stated to have fine spiral lines all over, a character that is not evident from the figures. The Okinawan species has only coarse spirals and those only on the lower part of the whorl, the condition described for *C. djarianensis*.

Distribution: Miocene, ?Java, (Yonabaru clay member) Okinawa; Pliocene, (Byoritzu beds) Formosa.

Localities: Yonabaru clay member, 17451 (figured).

Conus cf. C. aculeiformis Reeve

Plate 6, figure 29

?*Conus aculeiformis* Reeve, 1844, Conchologia iconica, v. 1, pl. 44, fig. 240.
?Tryon, 1884, Manual of conchology, v. 6, p. 75, pl. 23, figs. 90–94.
?Nomura, 1935, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 2, p. 109, pl. 7, fig. 10.

The Hayasaka collection of Byoritzu fossils in the U.S. Geological Survey contains several specimens of this species showing a wide range in the texture, number and spacing of the incised spiral lines. The spirals are always made semipunctate by thin partitions crossing them, the partitions being continuous with the growth lines on the flat bands between the incised grooves. The early whorls have small nodes along the shoulder which remain visible just above the suture.

Conus d'orbignyi (Andouin) which occurs in the Byoritzu beds also has semipunctate incised spirals but its shoulder nodes are coarser and persist on the adult whorls.

Nomura regarded three fossils from Java which Martin (1906) identified as living species, *C. insculptus* Kiener, *C. longurionis* Kiener, and *C. vimineus* Reeve as synonyms of *C. aculeiformis*. They are certainly very closely related if not identical. One of Martin's species, *C. menengtenganus*, probably also should be included in this category.

Distribution: Miocene, ?Java, (Yonabaru clay member) Okinawa; Pliocene, ?Java; ?Sumatra, ?Timor, ?Ceram, (Byoritzu beds) Formosa, Japan; Recent, Indian Ocean, Australia, Philippines.

Localities: Yonabaru clay member, 17447 (figured).

Conus cf. C. cosmetulus Cossmann

Plate 6, figure 6

?*Conus* (*Leptoconus*) *cosmetulus* Cossmann, 1900, Journal de conchyliologie, v. 48, p. 63, pl. 4, figs. 11, 12.

This species compares closely with the species described by Cossmann from the Pliocene of Karikal, India. *Conus sondeianus* Martin from the Pliocene of Java is definitely more slender and has a higher spire.

Distribution: Miocene, (Yonabaru clay member) Okinawa; Pliocene, (Karikal) India.

Localities: Yonabaru clay member, 17449 (figured), 17503.

Conus precancellatus, n. sp.

Plate 10, figure 11

Shell small to medium sized, medium inflated, spire of medium height. Protoconch incomplete on the type, but the last whorl and a half are conical and polished. Aperture of even width and moderately narrow. Anal sinus shallow. Sculpture consisting of depressed spiral grooves which are made semipunctate by fine lattice-like cross bars, the spiral grooves being narrower than the smooth, flat-topped interspaces on the upper part of the whorl, but as wide as or wider than the interspaces on the lower part, the interspaces changing from flattened to rounded at the base of the whorl; spire sculptured by weak nodes along the shoulder on the young whorls, but these disappear on the last whorls; subsutural slope marked by crescent-shaped growth lines but no spiral sculpture.

Holotype (USNM 562876) measures: height 17 mm, diameter 7.8 mm.

Type locality: Shinzato tuff member, 17633.

This species is related to *C. cancellatus* Hwass, a Recent species recorded from Japan (stated by Hwass to be from Hawaii), but is somewhat less constricted on the lower part of the body whorl, and lacks the faint spiral lines on the subsutural slope of the Recent species.

Conus eugrammatus Bartsch and Rehder (1943, p. 85), Recent from the Hawaiian Islands, is also related but lacks the fine cross walls in the spiral grooves. Like *C. cancellatus*, *C. eugrammatus* has weak spiral lines on the subsutural slope.

This species differs from *C.* cf. *C. cosmetulus* (pl. 6, fig. 6) in having a more constricted base, no spiral sculpture on the subsutural slope, and in having weak, irregular nodes on its shoulder.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa.

Localities: Shinzato tuff member, 17456, 17633 (figured type).

Conus mucronatus Reeve

Plate 6, figures 7, 14

Conus mucronatus Reeve, 1843, Conchologia inconica, v. 1, pl. 37, sp. ? 204.

Nomura and Zinbo, 1934, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 16, no. 2, p. 132.

Conus mucronatus is represented in the collection of the U.S. National Museum by only a single specimen bearing the label "Indo-Pacific". The fossil shell from Okinawa seems to be identical with this shell in every respect. According to Reeve, the type of the species is from the Philippines.

The spiral sulcations of this species lack the minute fencelike partitions found in *C. aculeiformis* and *C. precancellatus*, and the sulcations are broader and less sharp. The sulcations near the base sometimes have a weak raised thread within them.

Distribution: Miocene, (Yonabaru clay member) Okinawa; Pliocene, Kikaiga-shima; Recent, Philippines.

Localities: Yonabaru clay member, 17679 (figured).

Conus shimajiriensis, n. sp.

Plate 6, figures 5, 11

Shell moderately small, medium inflated, spire of medium height. Protoconch missing on the type except for a small fragment of the last whorl which is smooth and polished. Aperture slightly narrower at anal end than at siphonal end. Sculpture on the body whorl nearly smooth although a few very weak spiral ridges can be made out; spire sculptured by four incised spiral lines on the subsutural slope and poorly developed nodes along the periphery.

Holotype (USNM 562771) measures: height 21 mm, diameter 10 mm.

Type locality: Yonabaru clay member 17451.

This species may be related to *C. tuberculatus* Yokoyama (=*tuberculosus* Tomlin) from the Koshiba formation (Pliocene) of Japan, but both its spiral sculpture and peripheral tubercules are weaker than on the Koshiba species.

Distribution: Miocene, (Yonabaru clay member) Okinawa. Localities: Yonabaru clay member, 17451 (figured type).

Conus comatosaeformis Yokoyama

Plate 10, figures 7–8

Conus comatosaeformis Yokoyama, 1928, Imp. Geol. Survey Japan Rept. 101, p. 29, pl. 1, fig. 10.
Yokoyama, 1929, Imp. Geol. Survey Japan Rept. 104, p. 12, pl. 7, fig. 7.
Nomura, 1935, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 2, p. 110.
Conus (Asprella) comatosaeformis. Hatai and Nisiyama, 1952, Tōhoku Imp. Univ. Sci. Repts., 2d ser., spec. v. 3, p. 192.

Nomura suggested that this species might prove to be a synonym of *C. aculeiformis* but this is doutbful. The shell of this species is very thin, which alone would distinguish them, and moreover the shell is not as slender anteriorly as *C. aculeiformis*. Unfortunately the spiral sculpture on the only specimen found is nearly obliterated.

Conus smirna Bartsch and Rehder (1943, p. 87), a living Hawaiian species, compares favorably with this species in shape and in the almost paper thinness of the shell. Bartsch and Rehder stated that no similar species was known to them. It was obtained from 257-312 fathoms.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa; Pliocene, (Byoritzu beds) Formosa, (Kônomine formation) Japan.

Localities: Shinzato tuff member, 17633 (figured).

Comparative bathymetric data: The type of *C. smirma*, presumably a close relative of this species, was obtained off Hawaii from between 257 and 312 fathoms.

Conus cf. C. yabei Nomura

Plate 6, figure 8; plate 15, figures 14, 17

?*Conus yabei* Nomura, 1935, Tōhoku Imp. Univ. Sci Repts., 2d ser., v. 18, no. 2, p. 107, pl. 7, figs. 5a, b, 6a, b.

As pointed out by Nomura, the Formosan species, *C. yabei*, is closely related to *C. ngavianus* Martin from the Miocene and Pliocene of Java but has a higher spire. The larger specimen from Okinawa figured here has the spiral lines at the base of the whorl sharply delimited from the smooth area above, but on young shells (pl. 6, fig. 8) they die out gradually upwards. The young whorls show from 2 to 3 crowded spirals immediately below the shoulder. Peripheral nodes are strong on the young whorls, but they die out on the later whorls. These features appear to hold on some of the specimens figured for *C. ngavianus* but not on others and it is possible that more than one species is represented by Martin's figures. The sculpture on *C. yabei* is not well shown by the figures.

One of the specimens figured by Nomura has a lower spire than the other, and about the same range exists among specimens here taken to represent this species.

Large high spired cones are rare in western Pacific faunas and apparently inhabited moderately deep water. The Albatross collection from the Philippines contains two specimens of a species, possibly *C. sieboldii* Reeve, that is related to the Okinawan form. They were obtained at depths between 139 and 186 fathoms.

Distribution: Miocene, (Yonabaru clay member) Okinawa; Miocene or Pliocene, (Shinzato tuff member) Okinawa; Pliocene, (?Byoritzu beds) Formosa.

Localities: Yonabaru clay member, 17445 (figured), ?17447, ?17448, ?17451; Shinzato tuff member, 17458 (figured).

Conus cf. C. litteratus Linné

Plate 6, figures 12–13, 18, 23

?*Conus litteratus* Linné, 1758, Systema naturae, ed. 10, p. 712.
?Tryon, 1884, Manual of conchology, v. 6, p. 10 pl. 2, figs. 17–19.
?Cossman, 1900, Journal de conchyliologie, v. 48, p. 54, pl. 4, fig. 1.
?(Hirase) Taki, 1951, Handbook of illustrated shells, pl. 113, fig. 16.

A young adult, a juvenile and several fragments are compared with this Recent species. There are no traces of color on the fossils but there seems to be no way to distinguish them on form and sculpture.

Distribution: Miocene, (Yonabaru clay member) Okinawa; Miocene or Pliocene, (?Shinzato tuff member) Okinawa; Pliocene, (Karikal) India; Recent, Ceylon, Malaya, Indonesia, Philippines to the Ryukyu Islands, Fiji Islands, Palau, Yap.

Localities: Yonabaru clay member, 17445, 17449 (2 specimens figured); Shinzato tuff member, 17452, ?17456, ?17633.

Conus cf. C. eburneus Hwass

Plate 15, figures 13, 16

?*Conus eburneus* Hwass, 1792, Encyclopédie méthodique, v. 1, p. 640, pl. 324, figs. 1, 2.
?*Conus eburneus*. Nomura and Hatai, 1936, Geol. Soc. Japan Jour., v. 43, no. 512, p. 39.

One of the specimens from Okinawa, from a marly facies of the Naha limestone, still retains spiral rows of short orange dashes identical with the coloration of Recent specimens.

Distribution: Pliocene, (Nakoshi sand) Okinawa, (Naha limestone) Okinawa; Pleistocene, (Yontan limestone) Okinawa; Recent, Mauritius to Japan.

Localities: Nakoshi sand, 17440 (figured), Naha limestone, 17598; Yontan limestone, 17553.

Comparative bathymetric data: Specimens in the Philippine collection contain no depth data, indicating that they were not obtained by dredging. A lot collected by H. S. Ladd from Viti-

Levu, Fiji Islands, was obtained from the reef. The species is apparently a shallow water form.

Conus loochooensis, n. sp.

Plate 7, figure 24; plate 10, figure 12

Shell of medium size, inflated and somewhat rounded in outline, spire of medium height. Protoconch not preserved on type. Aperture moderately wide. Outer lip very gently curved in central part and rounded at the ends. Anal sinus not impressed, with the growth lines across the anal fasciole showing little or no curvature. Siphonal fasciole weakly developed. Sculpture consisting of 6 to 7 weak incised spirals at the base of the whorl, which is otherwise smooth; spire bearing 3 well defined and subequal spiral depressions on the subsutural slope of the early whorls, but these become less distinct with 1 predominating over the others on the later whorls.

Holotype (USNM 562877) measures: height 46 mm, diameter 26.7 mm.
Type locality: Shinzato tuff member, 17633.

This species does not compare closely with any now living in the western Pacific or Indo-Pacific region. It has somewhat the shape of *C. obesus* Hwass, but that species has a much more strongly developed siphonal fasciole.

Some specimens of *C. tesulatus* Born approximate this species in the characters of the spire, but they are not as rounded and inflated.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa.
Localities: Shinzato tuff member, 17456, 17633 (figured type).

Conus cf. C. vitulinus Hwass

Plate 19, figures 14, 21, 27

?*Conus vitulinus Hwass*, 1792, Encyclopédie méthodique, v. 1, p. 648, pl. 326, fig. 3.
?Tryon, 1884, Manual of conchology, v. 6, p. 51, pl. 14, figs. 86, 87.

Several cones obtained from the Yontan limestone compare closely with the Recent *C. vitulinus* Hwass. The spire is sculptured with from three to four spiral lines on each whorl, and the suture ranges from closed to moderately open as on Recent specimens.

Distribution: Pleistocene, (Yontan limestone) Okinawa; Recent, Indo-Pacific region.
Localities: Yontan limestone, 17544 (figured).

Conus geographus Linné

Plate 19, figure 26

Conus geographus Linné, 1758, Systema naturae, ed. 10, p. 718.
Hatai, 1941, Tropical Industry Inst. Palau Bull. 7B, p. 148, pl. 4, fig. 1; pl. 5, fig. 1.
(Hirase) Taki, 1951, Handbook of illustrated shells, pl. 114, fig. 17.

A fragment of a large cone is undoubtedly referable to this species.

Distribution: Pleistocene, (Yontan limestone) Okinawa; Recent, Indo-Pacific region.
Localities: Yontan limestone, 17552 (figured).

Conus lividus Hwass

Plate 19, figures 25, 31

Conus lividus Hwass, 1792, Encyclopédie méthodique, v. 1, p. 630, pl. 321, fig. 5.
Tesch, 1915, Paläontologie von Timor, v. 5, pt. 9, p. 20, pl. 74, figs. 19–21.
Dickerson, 1922, Philippine Jour. Sci., v. 20, no. 2, p. 216, pl. 2, fig. 12.
(Hirase) Taki, 1951, Handbook of illustrated shells, pl. 114, fig. 9.

A specimen obtained from the Yontan limestone appears to be identical with the Recent species.

Distribution: Pliocene, Timor, Ceram, Philippines; Pleistocene, Timor, Celebes, (Yontan limestone) Okinawa; Recent, Indo-Pacific region.
Localities: Yontan limestone, 17544 (figured), 17552, 17586.
Comparative bathymetric data: Specimens bearing data in the U.S. National Museum are from beaches and barrier reefs.

Conus cf. C. glans Hwass

Plate 19, figures 23, 29

?*Conus glans* Hwass, 1792, Encyclopédie méthodique, v. 1, p. 735, pl. 342, figs. 7–9.
?Tryon, 1884, Manual of conchology, v. 6, p. 79, pl. 25, figs. 26–28.

A small badly worn cone compares fairly well with small specimens of *C. glans*, but has a somewhat higher spire than is common for the species.

Distribution: Pleistocene, (Yontan limestone) Okinawa; Recent, Indo-Pacific region.
Localities: Yontan limestone, 17544 (figured).
Comparative bathymetric data: Specimens in the U.S. National Museum were obtained from beaches and reefs, indicating a shallow-water habitat.

Conus aff. C. capitaneus Linné

Plate 6, figure 31

?*Conus capitaneus* Linné, 1758, Systema naturae, ed. 10, p. 713.
?(Hirase) Taki, 1951, Handbook of illustrated shells, pl. 114, fig. 3.

Specimens from the Yontan limestone compare with *C. capitaneus* and with the closely related species, *C. rattus* Hwass. Without color markings it is difficult to determine which they more closely resemble.

Distribution: Pleistocene, (Yontan limestone) Okinawa; Recent, Indo-Pacific region, north to Japan.
Localities: Yontan limestone, 17511 (figured), 17512.
Comparative bathymetric data: A shallow-water form, collected mostly from beaches and reefs.

Other cones

Poorly preserved shells, fragments, and internal molds of several other cones are present. These are tentatively identified as follows:

1. *Conus* aff. *C. virgo* Linné (not figured). Chinen sand, 17442.
2. *Conus* aff. *C. textile* Linné (pl. 17, fig. 25). Naha limestone, 17590; Yontan limestone, 17543 (figured).
3. *Conus* aff. *C. musatella* Linné (pl 17, fig. 26). Naha limestone, 17540; Yontan limestone, 17595 (figured).
4. *Conus aff. C. raphanus* Hwass (not figured). Yonabaru clay member, 17502, 17632, 17679.
5. Twenty nine other lots of cones are so poorly preserved they cannot be identified beyond the genus.

Family TEREBRIDAE

Genus TEREBRA Bruguière 1789

Type: *Buccinum subulatum* Linné.

Terebra aff. T. formosana Yokoyama

Plate 19, figure 28

?*Terebra formosana* Yokoyama, 1928, Imp. Geol. Survey Japan Rept. 101, p. 26, pl. 1, fig. 6.

Only a fragment consisting of the last two whorls was obtained. Yokoyama states his species has "3 engraved spiral lines" whereas the present specimen has 7. However, 3 spirals, possibly 4, are more prominent than the rest and some variation might be allowed. The subsutural crinkles so prominent in Yokoyama's figure are only weakly developed on the Okinawan specimen. The columella has 1 blunt but prominent fold.

The parietal callus is heavy and broad, a feature which Yokoyama's specimen does not show, but this character might be present only on a full-grown individual. The callus is similar to that of *T. chlorata* Lamarck (see Tryon, 1885, pl. 11, fig. 21), an Indian Ocean species which has only one prominent spiral groove.

Nomura (1935, p. 54) lists this species as being unrepresented in his Byoritzu collection, and there is nothing like it in the Hayasaka collection.

Distribution: Pliocene, (?Byoritzu beds) Formosa; Pleistocene, (Yontan limestone) Okinawa.
Localities: Yontan limestone, 17550 (figured).

Terebra aff. T. amabilis Makiyama

Plate 6, figure 24

?*Terebra amabilis* Makiyama, 1927, Kyoto Imp. Univ. Coll. Sci. Mem., ser. B, v. 111, p. 88, pl. 4, figs. 11, 12.

This small *Terebra* resembles *T. amabilis* from the Dainichi formation (Pliocene) of Japan in form, differing from it mainly in having four incised spirals instead of five. *Terebra quadriarata* Yokoyama (1922, p. 34, pl. 1, fig. 22) from the Pleistocene of Japan is related but its whorls are slightly convex rather than straight sided to slightly concave.

Distribution: Miocene, (Yonabaru clay member) Okinawa; (of typical *T. amabilis*) Pliocene, (Dainichi formation) Japan.
Localities: Yonabaru clay member, 17503 (figured).

Terebra torquata Adams and Reeve

Plate 15, figures 18–19

Terebra torquata Adams and Reeve, 1850, Zoology of the voyage of H.M.S. *Samarang*, p. 30, pl. 10, fig. 13.
Terebra naumanni. Yokoyama, 1928, Imp. Geol. Survey Japan, Rept. 101, p. 25, pl. 1, fig. 3. (Not the species described from Naganuma, Japan.)
Terebra torquata Nomura. 1935, Tōrhoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 2, p. 102, pl. 6, fig. 25.

This species compares with Recent specimens in the Hirase collection in the U.S. National Museum.

Kuroda and Habe (1952, p. 90) regard *T. torquata* as a synonym of *T. serotina* Adams and Reeve.

Koperberg (1931, p. 38) based a subspecies, *T. (Myurella) torquata pliocenica*, from the Pliocene of Timor, on the form figured by Tesch (1915, pl. 79, fig. 77) as *T. pamotanensis* Martin. The lower of the two subsutural bands appears to be weaker and narrower in this subspecies than on the typical form.

The Hayasaka collection contains specimens labelled both *T. torquata* and *T. naumanni*, both of which are identical with the Okinawan specimens. One specimen in the Hayasaka collection has faint color markings which are light yellowish-brown rectangles irregularly offset from whorl to whorl.

Distribution: Pliocene, (Byoritzu beds) Formosa, (Chinen sand) Okinawa; Recent, India, Indonesia to Japan.
Localities: Chinen sand, 17481 (figured).

Terebra aff. T. torquata Adams and Reeve

Plate 6, figure 25

The fragment from the Yonabaru clay member of the Shimajiri formation differs from the specimen from the Chinen sand in having axial sculpture predominating over the spiral sculpture. In typical *T. torquata* the spiral lines predominate. The nodes on the two large subsutural bands are somewhat sharper in the Yonabaru form.

Locality: Yonabaru clay member, 17447 (figured).

Terebra pretiosa Reeve

Plate 10, figure 18

Terebra pretiosa Reeve, 1842, Proc. Zool. Soc. London, v. 10, p.200; Reeve, 1859–61, Conchologia iconica, v. 12, pl. 8, fig. 30a.
Terebra (Strioterebrum) pretiosa. Hirase, 1936, A collection of Japanese shells, pl. 117, fig. 9.

The specimen here figured is identical with specimens in the Hirase collection in the U.S. National Museum.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa; Recent, Japan.
Localities: Shinzato tuff member, 17633 (figured).

Terebra aff. T. anomala Gray

Plate 6, figure 27

?*Terebra* cf. *anomala*. Cossmann, 1900, Journal de conchyliologie, v. 48, p. 23, pl. 2, figs. 15–17.

This species is very close to the form figured by Cossmann from Karakal. It is characterized by axials that are present on the subsutural band and the apical side of the whorls, but which become obsolete or nearly so on the apertural side of the whorl.

There is no previous report of this species in the region of Japan. However, it may very well be a variety of *T. evoluta* Deshayes, a species reported from the Byoritzu beds of Formosa by Nomura (1935, p. 99, pl. 6, fig. 26). A specimen in the Hayasaka collection consisting of a body whorl and the penultimate whorl, labelled *T. dussumieri* Kiener, is apparently the species identified as *T. evoluta* by Nomura. It differs from the specimen from Okinawa figured here mainly in having a less sharply incised groove below the subsutural collar.

Distribution: Miocene, (Yonabaru clay member) Okinawa; Pliocene(?), (Karikal) India; Recent(?), Singapore (Gray). Nomura reports *T. evoluta* from the Pliocene (Byoritzu beds) of Formosa, the Pliocene of central Honshū, Japan, and living off Japan and China.
Localities: Yonabaru clay member, 17632 (figured).

Terebra shimajiriensis, n. sp.

Plate 6, figure 30

Shell small, moderately slender; sculpture consisting of thin axial ribs, ten to eleven visible from a side, that incline to the left in the direction of the apex, weak below the suture on the latter whorls, but terminating at the suture in a moderately sharp raised node on the early whorls. The nodes give the early whorls the appearance of having a subsutural collar, but it is not set off by an impressed line, either continuous or punctate.

Holotype (USNM 562789) measures: height 15.5 mm, diameter 3.8 mm.
Type locality: Yonabaru clay member, 17448.

There appear to be no Japanese terebrids with which this species can be confused.

Distribution: Miocene, (Yonabaru clay member) Okinawa.
Localities: Yonabaru clay member, 17448 (figured type).

Subclass OPISTHOBRANCHIA

Order TECTIBRANCHIA

Family ACTEONIDAE

Genus ACTEON Montfort 1810

Type: *Voluta tornatilis* Gmelin.

Acteon aff. A. teramachii Habe

Plate 10, figure 10

?*Acteon teramachii* Habe, 1950, Illustrated catalog of Japanese shells, no. 6, p. 40, pl. 8, fig. 3.

A single incomplete specimen of *Acteon* was obtained from the Shinzato tuff member of the Shimajiri formation. It appears to be related to *A. teramachii*, resembling it in having a weak columellar fold and nearly equidistant spiral rows of moderately coarse punctations, but it differs from it in being slenderer with a higher spire. In shape it more closely resembles *A. sieboldi* (Reeve) (see Habe, 1950, pl. 8, fig. 4), a species reported from the Byoritzu beds of Formosa by Nomura (1935, p. 93, pl. 6, fig. 5). However, *A. sieboldi* has finer punctate spirals which are irregularly spaced and absent in the shoulder region.

According to Habe, *A. teramachii* is a deep water species although no depth data is given. The locality from which the Okinawan specimen was obtained yields other deep-water forms, most of them species (or related to species), that inhabit shallower cold water in northern latitudes.

Distribution: Miocene or Pliocene, (Shinzato tuff member) Okinawa. The type of the species lives off Tosa, Japan.
Localities: Shinzato tuff member, 17454 (figured).

Family RINGICULIDAE

Genus RINGICULA Deshayes 1838

Type: *Auricula rigens* Lamarck.

Subgenus RINGICULELLA Sacco 1892

Type: *Marginella auriculata* Ménard.

Ringicula (Ringiculella) cf. R. musashinoensis Yokoyama

Plate 15, figure 20

?*Ringicula musashinoensis* Yokoyama, 1920, Tokyo Imp. Univ. Coll. Sci. Jour., v. 39, art. 6, p. 30, pl. 1, figs. 3, 8.
?*Ringicula doliaris*. Hatai and Nisiyama, 1952, Tōhoku Imp. Univ. Sci. Repts., 2d ser., spec. v. 3, p. 240.
?*Ringicula doliaris musashinoensis*. Taki and Oyama, 1954, Paleont. Soc. Japan Spec. Paper 2, pl. 2, figs. 3, 8.

Nomura (1935, p. 98) placed this species in the synonymy of *R. arctata* Gould, stating that it was a variety with a thinner outer lip and a heavier parietal callus. The Hayasaka collection includes several specimens identified as *R. arctata* which are definitely not the same as the Okinawan form figured here. They are smaller with a very heavy outer lip, a thick tonguelike extension of callus over the base of the columella and umbilical area, and the spirals are weakly developed or absent. Probably they should be referred to *R. yokoyamai* Takeyama (see Habe, 1950a, p. 8, pl. 2, fig. 10).

Ringicula sikokuensis Nomura (1937, p. 89, pl. 6, fig. 2) is similar to the Okinawan species in shape but its outer lip is denticulate whereas the lip of the Okinawan species is smooth.

According to Habe (1950a, p. 8) *R. doliaris* Gould is a highly variable species and should include *R. musashinoensis* Yokoyama, *R. oehlertiae* Morlet, and *R. siogamensis* Nomura. He also regards the form Lischke figured as *R. arctata* as belonging to this species but he does not mention *R. arctata* Gould. Kuroda and Habe (1952, p. 82), however, make *arctata* Gould a synonym of *doliaris* Gould. Nomura (1939, p. 13) regarded *arctata* Gould and *doliaris* Gould as distinct species.

Distribution: Pliocene, (Chinen sand) Okinawa, (?Naganuma formation) Japan.
Localities: Chinen sand, 17481 (figured).

Family ATYIDAE

Genus ATYS Montfort 1810

Type: *Atys cymbulus* Montfort (=*Bulla naucum* Linné).

Atys? okinawa, n. sp.

Plate 6, figure 21

Shell small, inflated, broadly ovate, greatest diameter about central, spire area on type repaired after injury. Protoconch not shown on type. Aperture moderately narrow at anal end, broadening below the periphery but not flaring. Outer lip thin and evenly rounded. Parietal wall with a moderately heavy but narrow callus that thins towards the base of the wall; callus thickening again on the inner lip with a broader segment of it extending over the umbilical area. Sculpture consisting of nearly equidistant weakly punctate incised spiral lines that are slightly coarser and less punctate on the base.

Holotype (USNM 562782) measures: height 5 mm., diameter 3.8 mm.
Type locality: Yonabaru clay member, 17447.

The generic assignment of this species is tentative. The apex may have been exposed and uncallused but an injury near the present aperture resulted in the deposition of a thin callus over it on the type. The tonguelike extension of callus over the umbilical area—on a *Bulla*-shaped shell with punctate spirals—makes this shell fairly unique among western Pacific opistobranchs. It may be related to *Roxania aequatorialis* Thiele (1925, p. 243, pl. 44, fig. 18), a Recent Indonesian species. The latter has a broader, more flaring columellar callus.

Distribution: Miocene, (Yonabaru clay member) Okinawa.
Localities: Yonabaru clay member, 17447 (Figured type).

Subgenus ALICULASTRUM Pilsbry 1896

Type: *Bulla cylindrica* Helbling.

Atys (Aliculastrum) cylindrica (Helbling)

Plate 19, figure 24

Bulla cylindrica Helbling, 1779, Abhandlung einer Privat Gesellsch in Boehmen, v. 4, p. 122, pl. 2, figs. 30, 31.
Atys cylindrica. Sowerby, 1866–70, Conchologia iconica, v. 17, pl. 2, figs. 7a, b.
?*Atys* species indet. Nomura, 1935, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 2, p. 96.

Nomura reported a mold of a shell resembling this species from the Byoritzu beds of Formosa. The present specimen is well preserved and is indistinguishable from shells so labelled in the collection of the U.S. National Museum.

Distribution: Pleistocene, (Yontan limestone) Okinawa; Recent, Red Sea, Indo-Pacific region to Fiji Islands.
Localities: Yontan limestone, 17652 (figured).
Comparative bathymetric data: Specimens are present in the Philippine collection from 10 and 12 fathoms.

Family SCAPHANDRIDAE

Genus CYLICHNA Lovén 1846

Type: *Bulla cylindracea* Pennant.

Cylichna musashiensis Tokunaga

Plate 6, figure 26

Cylichna musashiensis Tokunaga, 1906, Tokyo Imp. Univ. Coll. Sci. Jour., v. 21, art. 2, p. 32, pl. 2, fig. 12.
Yokoyama, 1920, Tokyo Imp. Univ. Coll. Sci. Jour., v. 39, art. 6, p. 27, pl. 1, fig. 4.
?Nomura, 1935, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 18, no. 2, p. 96.

This species resembles the specimen figured by Yokoyama in both the outline of the aperture and the apical depression which is smooth and funnel-shaped. Nomura compared the species with *C. arachis* Quoy and Gaimard, but the latter has an apical depression in which the sutures are deeply impressed. *Cylichna braunsi* Yokoyama is definitely more cylindrical.

Distribution: Miocene, (Yonabaru clay member) Okinawa: Pliocene, (?Byoritzu beds) Formosa, Japan; Pleistocene, Japan.
Localities: Yonabaru clay member, 17449 (figured), 17503.

Cylichna cf. C. arachis (Quoy and Gaimard)

Plate 17, figure 27

?*Bulla arachis* Quoy and Gaimard, 1835, Voyage de l'*Astrolabe*, v. 2, p. 361, pl. 26, figs. 28–30.

?*Cylichna arachis*. Kobelt, 1896, Systematisches conchylien-Cabinet, v. 1, pt. 9, p. 37, pl. 7, figs. 10, 11.

Nomura stated that the species from the Byoritzu beds of Formosa that he identified as *C. musashiensis* was closely related to *C. arachis* and might prove to be identical. If the species figured by Yokoyama (1920, pl. 1, fig. 4) is *C. musashiensis*, however, the two cannot be confused.

The species figured here is small compared with Recent *C. arachis*, but it resembles it in shape, and has the same apical features.

Distribution: Pliocene, (Naha limestone) Okinawa; Recent, Australia, Indonesia.

Localities: Naha limestone, 17499 (figured).

Comparative bathymetric data: The species is reported living in Australia at 2 to 5 fathoms.

Genus SCAPHANDER Montfort 1810

Type: *Bulla lignaria* Linné.

Scaphander yonabaruensis, n. sp.

Plate 6, figure 20

Shell moderately small, pear-shaped, apex open with a thin callus within, aperture narrow posteriorly, splayed anteriorly. Protoconch concealed. Parietal wall thinly callused. Inner lip narrowly callused with the callus appressed. Sculpture consisting of fine incised spiral lines which are faintly punctate, those on the middle of the whorl more widely spaced with weaker and stronger spirals alternating, those near the apex and base more crowded.

Holotype (USNM 562781) measures: height 9.4 mm, diameter 5.1 mm.

Type locality: Yonabaru clay member, 17451.

This species is probably related to *S. elegans* Martin (1879–1880, p. 85, pl. 13, fig. 22) from the upper Miocene of Java. It differs from it in having a more inflated whorl which makes its parietal wall more rounded and the posterior end of the aperture correspondingly narrower.

Distributions: Miocene, (Yonabaru clay member) Okinawa.

Localities: Yonabaru clay member, 17451 (type locality).

Comparative bathymetric data: A very similar species was collected by the Albatross Expedition from the Philippines from 16 to 230 fathoms; more commonly between 50 and 150 fathoms.

?Scaphander sp.

Plate 6, figure 19

A broken shell with a decorticated apex is tentatively referred to this genus. It may belong to a new species but it is too poorly preserved to describe. It is slender for a *Scaphander* but is similar to a species described from the Azores by Watson as *S. gracilis*. The same species (or more probably a closely related one) was reported from off Sidney, Australia (see discussion by Pilsbry (1893, p. 247–248)).

The sculpture of the Okinawan specimen consists of irregularly sized and irregularly spaced shallow incised spirals, a few of them being indistinctly punctate.

Locality: Yonabaru clay member, 17451 (figured).

Addendum

The beautifully illustrated book entitled "Coloured Illustrations of the Shells of Japan" by Tetsuaki Kira, Osaka, Japan, 1955, was received after this manuscript was completed. Therefore, references to this book are not included in the synonymies in this paper, nor is the abundant depth data given by Kira used in the depth analyses of the faunas. The only changes made after reviewing this book were the recognition of the genus *Makiyamaia*, a group for which I had proposed a new name, and comparison of several fossils with Recent species figured by Kira, all of them species which I had stated previously had no known close relatives in the western Pacific.

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INDEX

[Italic numbers indicate main reference]

PLATES 1–19

PLATE 1

Gastropoda of the Yonabaru clay member of the Shimajiri formation

FIGURE 1. *Bathybembix* sp. ind. (p. 22). Figured specimen (USNM 562645). Fragment of body whorl (×1½), greatest dimension 21 mm. Yonabaru clay (17445).

2–4. "*Solariella*" *shimajiriensis*, n. sp. (p. 24). Holotype (USNM 562646). 2. Apertural view (×3), height 9.5 mm, diameter 9.4 mm. 3. Basal view of same. Yonabaru clay (17451). Figured specimen (USNM 562647). 4. Nonapertural view (×4), height 5.8 mm, diameter 5.5 mm. Yonabaru clay (17449).

5, 10. *Nerita chamaeleon* Linné (p. 34). Figured specimen (USNM 562648). 5. Apertural view (×2), height 16.2 mm, diameter 16.5 mm. 10. Nonapertural view of same. Yonabaru clay (17679).

6, 11, 16. *Cocculina loochooensis*, n. sp. (p. 35). Holotype (USNM 562649). 6. Top view (×2), length 14.4 mm, diameter 9.9 mm, height 5.9 mm. 11. Side view of same. 16. Base of same. Yonabaru clay (17451).

7. *Bolma*, n. sp.? (p. 34). Figured specimen (USNM 562650). Nonapertural view (×2), height 15 mm, greatest diameter 12.6 mm. Yonabaru clay (17451).

8–9. *Monilea* (*Rossiteria*) cf. *M.* (*R.*) *nuclea* (Philippi) (p. 27). Figured specimen (USNM 562651). 8. Apertural view (×4), height 5.9 mm, diameter 6.2 mm. 9. Base of same. Yonabaru clay (17449).

12. *Orectospira* cf. *O. babelica* (Dall) (p. 24). Figured specimen (USNM 562652). Nonapertural view (×2), greatest dimension 14 mm. Yonabaru clay (17679).

13–15. *Architectonica* (*Solariaxis*) *dilecta* (Deshayes) (p. 39). Figured specimen (USNM 562653). 13. Top view (×4), height 4 mm, diameter 8.5 mm. 14. Base of same. 15. Apertural view of same. Yonabaru clay (17679).

17, 21, 25. *Architectonica maxima* (Philippi) (p. 38). Figured specimen (USNM 562654). 17. Top view (×3), height 8 mm, diameter 17.3 mm. 21. Base of same. 25. Near-apertural view of same. Yonabaru clay (17503).

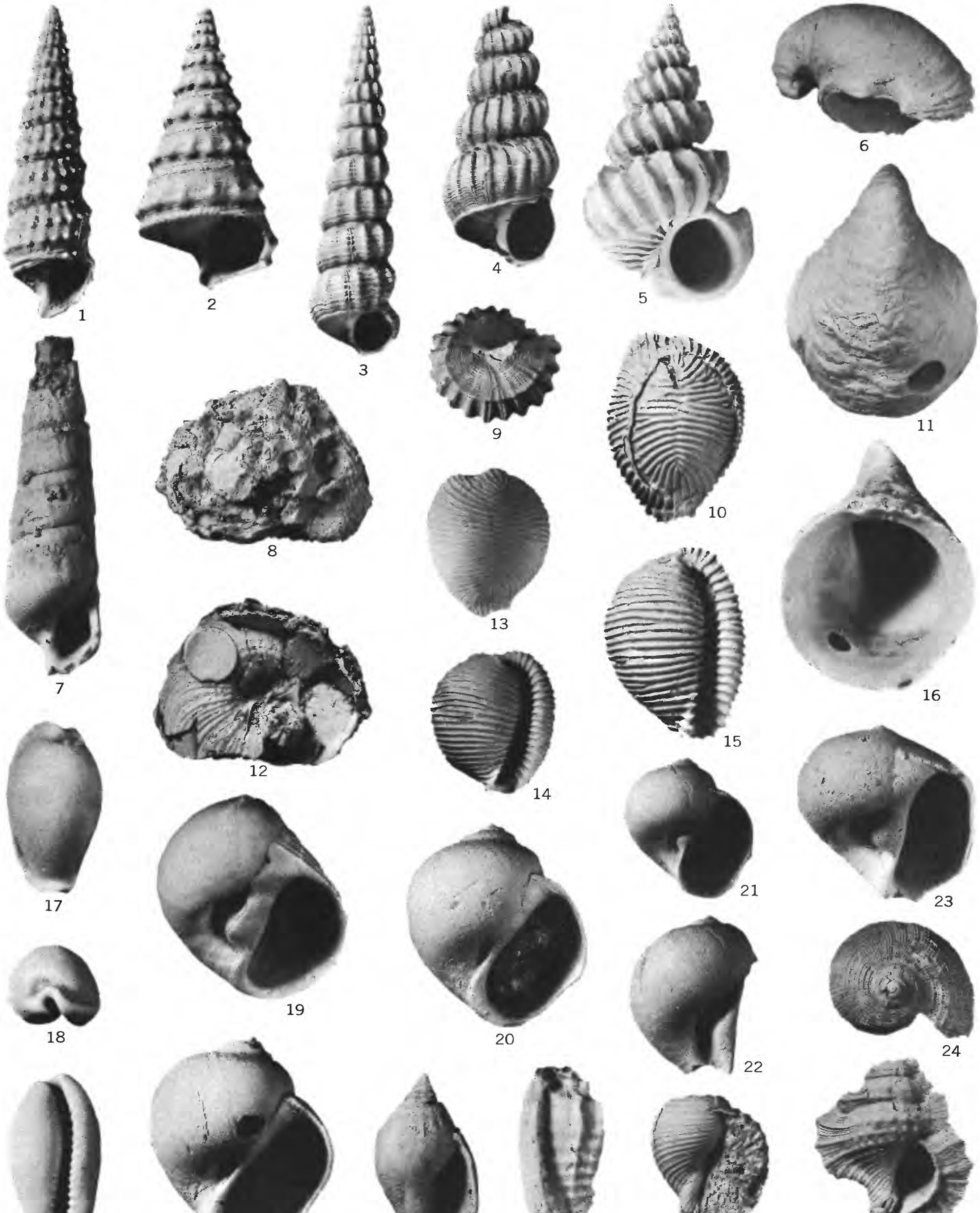
18, 22, 26. *Architectonica perspectiva* (Linné) (p. 38). Figured specimen (USNM 562655). 18. Top view (×3), height 9.1 mm, diameter 17.8 mm. 22. Basal view of same. 26. Apertural view of same. Yonabaru clay (17449).

19, 23, 27. *Architectonica* (*Solariaxis*) *nomurai*, n. sp. (p. 38). Holotype (USNM 562656). 19. Top view (×3), height 6.8 mm, diameter 14.5 mm. 23. Base of same. 27. Apertural view of same. Yonabaru clay (17451).

20. *Turritella filiola* Yokoyama (p. 36). Figured specimen (USNM 562657). Near-apertural view (×3), height 13 mm, diameter 3.9 mm. Yonabaru clay (17449).

24. *Turritella* aff. *T. millepunctata* Nomura (p. 36). Figured specimen (USNM 562658). Nonapertural view (×3), height 10.4 mm, diameter 4.9 mm. Yonabaru clay (17503).

MOLLUSKS OF THE YONABARU CLAY MEMBER OF THE SHIMAJIRI FORMATION



MOLLUSKS OF THE YONABARU CLAY MEMBER OF THE SHIMAJIRI FORMATION

PLATE 2

Gastropoda of the Yonabaru clay member of the Shimajiri formation

FIGURE 1. *Argyropeza* cf. *A. schepmaniana* Melvill (p. 40). Figured specimen (USNM 562659). Apertural view (×6), height 9.1 mm, diameter 2.7 mm. Yonabaru clay (17447).

2. *Trochocerithium* cf. *T. excelsum* (Yokoyama) (p. 42). Figured specimen (USNM 562660). Near-apertural view (×4), height 12.7 mm, diameter 6.7 mm. Yonabaru clay (17445).

3. *Turriscala* (*Claviscala*) *shimajiriensis*, n. sp. (p. 43). Holotype (USNM 562661). Near-apertural view (×4), height 15 mm, diameter 4 mm. Yonabaru clay (17451).

4, 9. *Amaea* (*Discoscala*) aff. *A.* (*D.*) *niasensis* Wissema (p. 44). Figured specimen (USNM 562662). 4. Apertural view (×1½), height 32 mm, diameter 15.8 mm. 9. Base of same. Yonabaru clay (17451).

5. *Epitonium* (*Crisposcala*) *okinavensis*, n. sp. (p. 44). Figured specimen (USNM 562663). Apertural view (×3) height 18.2 mm, diameter 10.3 mm. Yonabaru clay (17451).

6, 11, 16. *Hipponix* (*Malluvium*) cf. *H.* (*M.*) *lissus* (E. A. Smith) (p. 47). Figured specimen (USNM 562664). 6. Side view (×6), height 5 mm, length 7.3 mm, width 5.8 mm. 11. Top of same. 16. Base of same. Yonabaru clay (17447).

7. *Syrnola* aff. *S. titizimana* Nomura (p. 46). Figured specimen (USNM 562665). Near-apertural view (×8), height 7.7 mm, diameter 2.2 mm. Yonabaru clay (17449).

8, 12. *Xenophora* sp. ind. (p. 48). Figured specimen (USNM 562666). 8. Top view (×1½), greatest diameter 27 mm. 12. Base of same. Yonabaru clay (17632).

10, 13–15. *Dolichupis* (*Trivellona*) *shimajiriensis*, n. sp. (p. 49). Holotype (USNM 562667). 10. Nonapertural view (×2), length 17.7 mm, width 13 mm. 15. Apertural view of same. Yonabaru clay (17448). Paratype (USNM 562668). 13. Nonapertural view (×3), length 8.8 mm, width 7.5 mm. 14. Apertural view of same. Yonabaru clay (17451).

17–18, 25. *Cribraria* (*Talostolida*) aff. *C.* (*T.*) *cincta* (Martin) (p. 52). Figured specimen (USNM 562669). 17. Nonapertural view (×1½), length 21.8 mm, diameter 11.8 mm. 18. Posterior end of same. 25. Apertural view of same. Yonabaru clay (17449).

19. *Polinices* cf. *P. cumingianus madioensis* Altena (p. 53). Figured specimen (USNM 562670). Apertural view (×1), height 38 mm, diameter 35.8 mm. Yonabaru clay (17449).

20, 26. *Euspira* cf. *E. pallida* (Broderip and Sowerby) (p. 57). Figured specimens. 20. (USNM 562671). Apertural view (×3). Yonabaru clay (17449). 26. (USNM 562672). Apertural view (×3), height 18 mm, diameter 11.8 mm. Yonabaru clay (17451).

21. *Naticarius* aff. *N. concinnus* (Dunker) (p. 56). Figured specimen (USNM 562673). Apertural view (×3), height 8.2 mm, diameter 8.2 mm. Yonabaru clay (17451).

22. *Natica* cf. *N. vitellus* (Linné) (p. 54). Figured specimen (USNM 562674). Near-apertural view of broken specimen (×3), height 9.8 mm. Yonabaru clay (17445).

23. *Polinices* cf. *P. albumen* (Linné) (p. 53). Figured specimen (USNM 562675). Apertural view (×2½), height 12 mm, diameter 11.3 mm. Yonabaru clay (17451).

24. *Ficus subintermedia* (D'Orbigny) (p. 61). Figured specimen (USNM 562676). Apical view (×1½), diameter 19.5 mm. Yonabaru clay (17451).

27. *Cyllene gracilenta* (Yokoyama) (p. 82). Figured specimen (USNM 562677). Apertural view (×2), height 16.2 mm, diameter 9.8 mm. Yonabaru clay (17632).

28. *Oniscida* cf. *O. subcancellata* (Nomura) (p. 57). Figured specimen (USNM 562678). Fragment (×1). Yonabaru clay (17447).

29. *Tonna luteostoma*? (Kuster) (p. 61). Figured specimen (USNM 562679). Apertural view of a juvenile (×1½), height 19 mm, diameter 15 mm. Yonabaru clay (17449).

30. *Biplex perca* Perry (p. 59). Figured specimen (USNM 562680). Apertural view (×1½), height 23 mm, diameter 20 mm. Yonabaru clay (17448).

PLATE 3

Gastropoda of the Yonabaru clay and Shinzato tuff (figs. 6, 12)

FIGURE 1. *Chicoreus* (*Siratus*) aff. *C.* (*S.*) *anguliferous* (Lamarck) (p. 62). Figured specimen (USNM 562681). Apertural view (×2), diameter 13 mm. Yonabaru clay (17679).

2, 9–10. *Coralliophila* (?*Fusomurex*) sp. (p. 65). Figured specimens. 2. (USNM 562682). Apertural view (×4), diameter 6.3 mm. Yonabaru clay (17451). 9. (USNM 562683). Apertural view (×4), height 11 mm, diameter 6.7 mm. 10. Nonapertural view of same. Yonabaru clay (17503).

3–4. *Ceratostoma brachypteron* (A. Adams) (p. 64). Figured specimens. 3. (USNM 562684). Nonapertural view view (×2), height less columella 18 mm. 4. (USNM 562685). "Apertural view", the body whorl being broken away to the first varix behind the aperture (×2), height 18 mm. Yonabaru clay (17451).

5. *Murex* cf. *M. bonneti* Cossmann (p. 63). Figured specimen (USNM 562686). Apertural view (×2), height 23.2 mm, diameter 11 mm. Yonabaru clay (17503).

6, 12. *Coralliophila* (*Fusomurex*) *shimajiriensis*, n. sp. (p. 65). Holotype (USNM 562687). 6. Near-apertural view (×4), height 12 mm, diameter 6.1 mm. 12. Nonapertural view of same. Shinzato tuff (17458).

7. *Incerta sedis* (p. 66). Figured specimen (USNM 562688). Fragment (×4). Yonabaru clay (17449).

8. *Coralliophila* (*Hirtomurex*) *iwaensis*, n. sp. (p. 64). Holotype (USNM 562689). Apertural view (×1½), height 28.7 mm, diameter 18 mm. Yonabaru clay (17451).

11. ?*Pisania* sp. (p. 77). Figured specimen (USNM 562690). Apertural view (×2), diameter 10 mm. Yonabaru clay (17679).

13. *Mitrella gonzabuensis*, n. sp. (p. 67). Holotype (USNM 562691). Apertural view (×4), height 11.8 mm, diameter 4.2 mm. Yonabaru clay (17449).

14–15. *Siphonalia yonabaruensis*, n. sp. (p. 69). Holotype (USNM 562692). 14. Apertural view (×2), height 18 mm, diameter 11 mm. 15. Nonapertural view of same. Yonabaru clay (17449).

16. *Siphonalia* aff. *S. mikado* Melvill (p. 70). Figured specimen (USNM 562693). Apertural view (×1½), height (of fragment) 24 mm, diameter 14.2 mm. Yonabaru clay (17502).

17–18. *Hindsia* (*Nihonophos*) *magnifica* (Lischke) (p. 72). Figured specimens. 17. (USNM 562694). Apertural view (×1½), height 21.9 mm, diameter 11.8 mm. Yonabaru clay (17448). 18. (USNM 562695). Apertural view (×2). Yonabaru clay (17451).

19. *Hindsia* (*Nihonophos*) *whitmorei*, n. sp. (p. 73). Holotype (USNM 562696). Apertural view (×1½), height 21.3 mm, diameter 13 mm. Yonabaru clay (17445).

20. *Phos* (*Coraeophos*) aff. *P. reticosus* Hinds (p. 74). Figured specimen (USNM 562697). Apertural view (×2), height 14.4 mm, diameter 7 mm. Yonabaru clay (17451).

21. *Phos* (*Tritiaria*) *dingsi*, n. sp. (p. 74). Holotype (USNM 562698). Apertural view (×1½), height 16.8 mm, diameter 7.6 mm. Yonabaru clay (17447).

22–23. *Hindsia* (*Nihonophos*) *magnifica shimajiriensis*, n. subsp. (p. 72). Holotype (USNM 562699). 22. Apertural view (×1½), height 30 mm, diameter 13.3 mm. 23. Nonapertural view of same. Yonabaru clay (17451).

24–25, 27–28, 33. *Afer* aff. *A. oostinghi* (Altena) (p. 76). Figured specimens. 24. (USNM 562700). Apertural view of worn juvenile (×1½). 25. Nonapertural view of same. Yonabaru clay (17451). 27. (USNM 562701). Apertural view of a juvenile (×3). 28. Nonapertural view of same. Yonabaru clay (17451). 33. (USNM 562702). Apertural view (×1½), height 34 mm, diameter 16 mm. Yonabaru clay (17449).

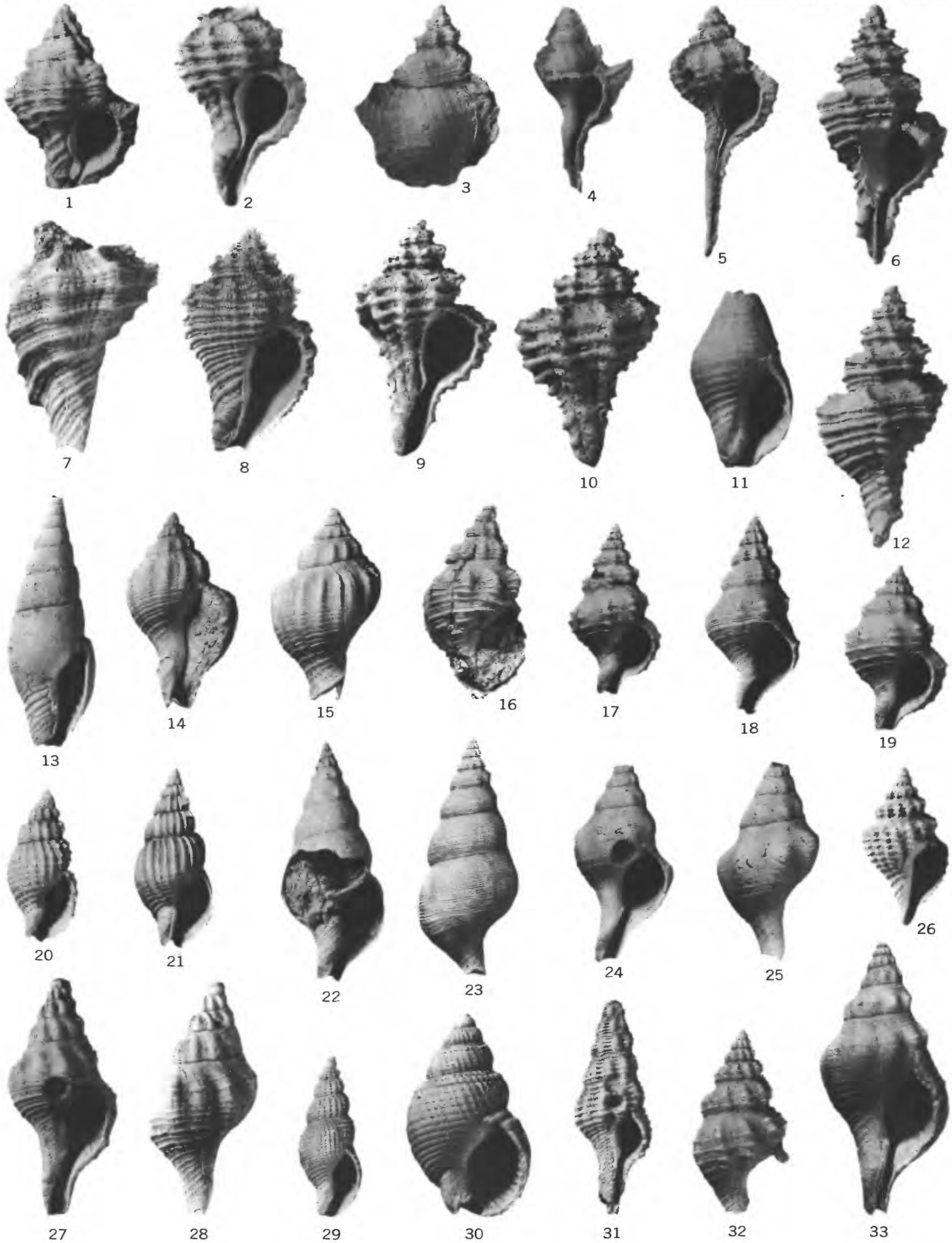
26. *Incerta sedis* (p. 78). Figured specimen (USNM 562703). Apertural view (×4), height 7.4 mm, dimaeter 4.1 mm. Yonabaru clay (17451).

29. *Nassarius* (?*Niotha*) *metuliformis*, n. sp. (p. 80). Holotype (USNM 562704). Apertural view (×2), height 15 mm, diameter 6.3 mm. Yonabaru clay (17632).

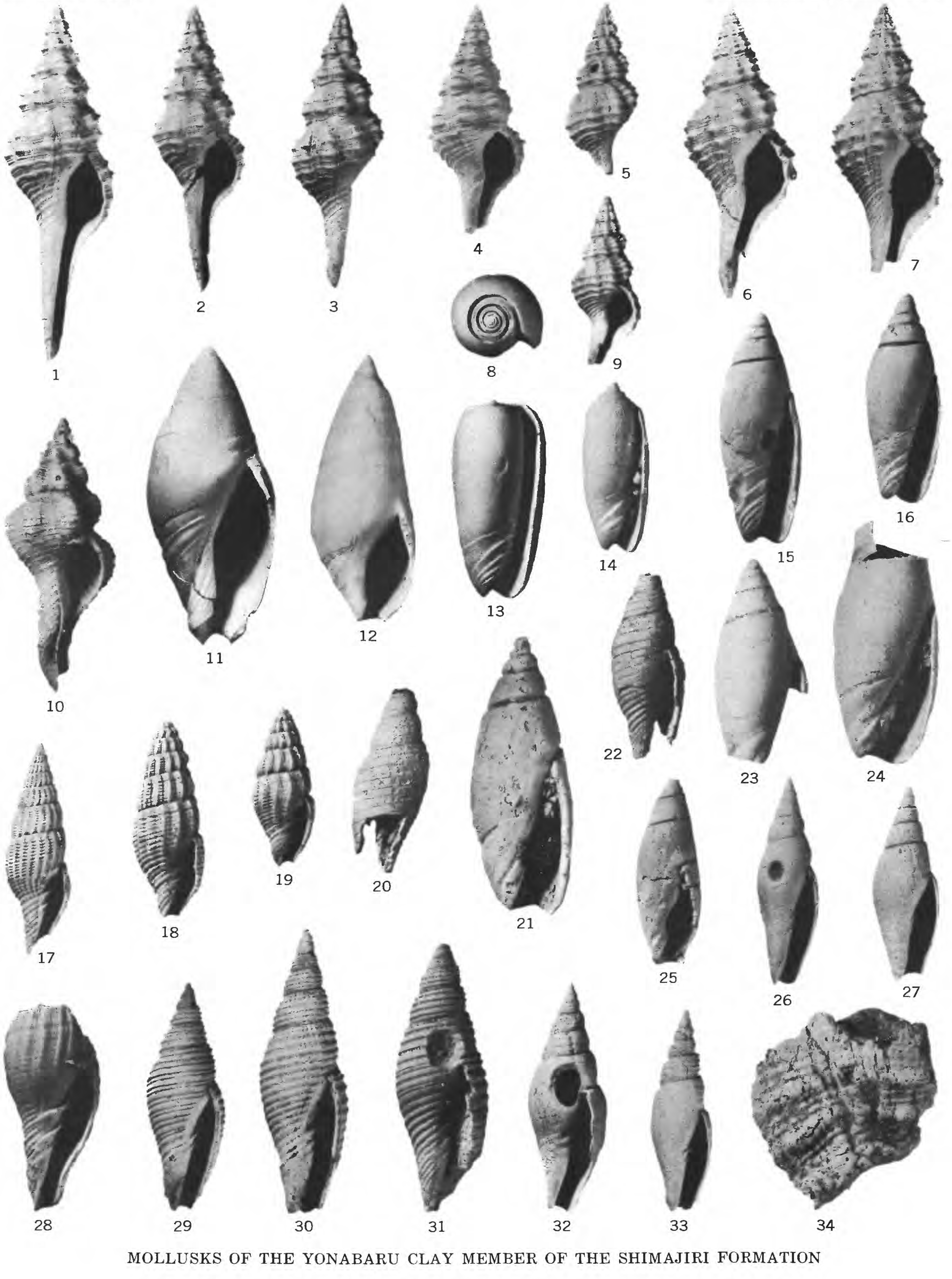
30. *Nassarius* (?*Niotha*) *acteon*, n. sp. (p. 81). Holotype (USNM 562705). Apertural view (×4), height 9.5 mm diameter 5.5 mm. Yonabaru clay (17449).

31. *Dolicholatirus* cf. *D. acus* (Adams and Reeve) (p. 83). Figured specimen (USNM 562706). Apertural view (×1½), height 27.3 mm, diameter 10 mm. Yonabaru clay (17632).

32. *Granulifusus niponicus* (Smith) (p. 85). Figured specimen (USNM 562707). Apertural view of incomplete specimen (×2), diameter 9.4 mm. Yonabaru clay (17448).



MOLLUSKS OF THE YONABARU CLAY AND SHINZATO TUFF MEMBERS OF THE SHIMAJIRI FORMATION



MOLLUSKS OF THE YONABARU CLAY MEMBER OF THE SHIMAJIRI FORMATION

PLATE 4

Gastropoda of the Yonabaru clay member of the Shimajiri formation

FIGURES 1–4. *Pseudolatirus yonabaruensis*, n. sp. (p. 83). 1. Holotype (USNM 562708). Apertural view (×2), height 34.3 mm, diameter 10.5 mm. 2. Paratype (USNM 562709). Apertural view (×2). 3. Nonapertural view of same. Yonabaru clay (17451). 4. Figured specimen (USNM 562710). Apertural view (×2). Yonabaru clay (17450).

5, 9. *Aptyxis okinawa*, n. sp. (p. 84). Holotype (USNM 562711). 5. Nonapertural view (×2), height 11 mm, diameter 6.7 mm. 9. Apertural view of same. Yonabaru clay (17447).

6–7. *Granulifusus niponicus* (Smith) (p. 85). Figured specimens. 6. (USNM 562712). Apertural view (×2), height 27.5 mm, diameter 11 mm. Yonabaru clay (17448). 7. (USNM 562713). Apertural view (×2). ?Yonabaru clay (17476).

8, 13. *Oliva mustellina paucicallosa*, n. subsp. (p. 88). Holotype (USNM 562714). 8. Top view (×1½). 13. Apertural view (×1½), height 25 mm, diameter 12 mm. Yonabaru clay (17449).

10. *Streptochetus paeteliana riukiuana*, n. subsp. (p. 86). Holotype (USNM 562715). Apertural view (×1½), height 34.5 mm, diameter 14.2 mm. Yonabaru clay (17451).

11. *Ancilla* (*Baryspira*) cf. *A.* (*B.*) *albocallosa* (Lischke) (p. 86). Figured specimen (USNM 562716). Apertural view (×1½), height 37.7 mm, diameter 17.6 mm. Yonabaru clay (17450).

12. *Ancillina iwaensis*, n. sp. (p. 88). Holotype (USNM 562717). Apertural view (×6), height 8 mm, diameter 3.1 mm. Yonabaru clay (17451).

14. *Oliva ispidula* (Linné) (p. 89). Figured specimen (USNM 562718). Apertural view (×1½), height 21.4 mm, diameter 9.2 mm. Yonabaru clay (17502).

15–16. *Oliva* aff. *O. australis* Duclos (p. 89). Figured specimens. 15. (USNM 562719). Apertural view (×3), height 14.5 mm, diameter 5.5 mm. 16. (USNM 562720). Apertural view (×3). Yonabaru clay (17451).

17. *Uromitra* aff. *U. obeliscus* (Reeve) (p. 90). Figured specimen (USNM 562721). Apertural view (×2), height 20.2 mm, diameter 6.3 mm. Yonabaru clay (17476).

18–19. *Uromitra cophina gonzabuensis*, n. subsp. (p. 90). 18. Holotype (USNM 562722). Apertural view (×3), height 12.3 mm, diameter 4.5 mm. 19. Paratype (USNM 562723). Apertural view (×3), height 9.8 mm, diameter 4.5 mm. Yonabaru clay (17449).

20, 22, 31. *Mitra* (*Cancilla*) cf. *M.* (*C.*) *granatinaeformis* Martin (p. 94). Figured specimens. 20. (USNM 562724). Nonapertural view (×1½), diameter 9.9 mm. 22. (USNM 562724). Apertural view of same. Yonabaru clay (17502). 31. (USNM 562725). Apertural view of a juvenile specimen (×4), height 12.6 mm, diameter 4.5 mm. Yonabaru clay (17449).

21, 23–25. *Olivella* sp. aff. *O. fulgurata* (Adams and Reeve) (p. 89). Figured specimens. 21. (USNM 562726). Apertural view (×6), height 8.4 mm, diameter 3.2 mm. Yonabaru clay (17632). 23. (USNM 562727). 24. (USNM 562728). Apertural view of two fragmental specimens (×6). Yonabaru clay (17449). 25. (USNM 562729). Apertural view (×3), height 11.7 mm, diameter 4.1 mm. Yonabaru clay (17503).

26–27, 32–33. *Mitra* (*Fusimitra*) *loochooensis*, n. sp. (p. 95). 26. Holotype (USNM 562730). Apertural view (×2), height 19.3 mm, diameter 6 mm. 27. Figured specimen (USNM 562731). Apertural view (×2). 32. Paratype (USNM 562732). Apertural view (×3), height 14.4 mm, diameter 5 mm. 33. Figured specimen (USNM 562733). Apertural view (×2). Yonabaru clay (17451).

28. *Mitra* (?*Cancilla*) sp. ind. (p. 95). Figured specimen (USNM 562734). Apertural view of a body whorl (×3), diameter 6 mm. Yonabaru clay (17451).

29. *Mitra* (*Cancilla*) *yonabaruensis*, n. sp. (p. 94). Holotype (USNM 562735). Apertural view (×2), height 21.5 mm, diameter 7.5 mm. Yonabaru clay (17451).

30. *Mitra* (*Cancilla*) aff. *M.* (*C.*) *menkrawitensis* Beets (p. 94). Figured specimen (USNM 562736). Apertural view (×2), height 27 mm, diameter 8.5 mm. Yonabaru clay (17451).

34. ?*Vasum* sp. ind. (p. 95). Figured specimen (USNM 562737). Nonapertural view of an anterior fragment (×2). Yonabaru clay (17449).

PLATE 5

Gastropoda of the Yonabaru clay member of the Shimajiri formation

Figure 1. *Fulgoraria (Saotomea) delicata* (Fulton) (p. 97). Figured specimen (USNM 562738). Apertural view (×2), height 30.3 mm, diameter 11.8 mm. Yonabaru clay (17445).

2. *Fulgoraria* sp. (p. 97). Figured specimen (USNM 562739). Fragment (×3). Yonabaru clay (17502).

3. *Lyria* aff. *L. hirugaensis* (Yokoyama) (p. 98). Figured specimen (USNM 562740). Apertural view (×2), height 25.7 mm, diameter 13.6 mm. Yonabaru clay (17679).

4. *Cancellaria yonabaruensis*, n. sp. (p. 98). Holotype (USNM 562741). Apertural view (×6), height 7.8 mm, diameter 5.6 mm. Yonabaru clay (17445).

5–6. *Cancellaria* aff. *C. pristina* (Yokoyama) (p. 99). Figured specimen (USNM 562742). 5. Nonapertural view (×6), height 8.1 mm, diameter 4.5 mm. 6. Apertural view of same. Yonabaru clay (17503).

7. *Unedogemmula ina*, n. sp. (p. 102). Holotype (USNM 562743). Apertural view (×1½), height 40.2 mm, diameter 13 mm. Yonabaru clay (17451).

8–9. *Lophiotoma* cf. *L. leucotropis* (Adams and Reeve) (p. 100). Figured specimen (USNM 562744). 8. Nonapertural view (×1½), height 31 mm, diameter 12.2 mm. 9. Apertural view of same. Yonabaru clay (17449).

10–11. *Gemmula* cf. *G. granosa* (Helbling) (p. 102). Figured specimens. 10. (USNM 562745). Apertural view (×2), height 21 mm, diameter 9.5 mm. Yonabaru clay (17451). 11. (USNM 562746). Apertural view (×1½), height 28.2 mm, diameter 11.2 mm. Yonabaru clay (17503).

12. *Gemmula* aff. *G. asukana* (Yokoyama) (p. 103). Figured specimen (USNM 562747). Nonapertural view (×3), height 12.5 mm, diameter 4.9 mm. Yonabaru clay (17502).

13. *Pseudoinquisitor*? cf. *P.*? *pulchra* (Schepman) (p. 110). Figured specimen (USNM 562748). Apertural view (×6), height 7.5 mm, diameter 3.4 mm. Yonabaru clay (17445).

14, 17. *Micantapex striato-tuberculata* (Yokoyama) (p. 104). Figured specimens. 14. (USNM 562749). Nonapertural view of a juvenile (×4), height 13 mm, diameter 6 mm. Yonabaru clay (17445). 17. (USNM 562750). Apertural view of an incomplete adult (×1½), height 43 mm, diameter (from labial side) 15.4 mm. Yonabaru clay (17449).

15. *Nihonia shimajiriensis*, n. sp. (p. 105). Holotype (USNM 562751). Nonapertural view (×2), height 26 mm, diameter 10 mm. Yonabaru clay (17445).

16?, 18. *Makiyamaia coreanica* (Adams and Reeve) (p. 107). Figured specimens. 16. (USNM 562752). Apertural view (×1½), height 29 mm, diameter 13.8 mm. Yonabaru clay (17445). 18. (USNM 562753). Apertural view (×2), height 20.8 mm, diameter 9.7 mm. Yonabaru clay (17448).

19, 24. *Fusisyrinx* sp. ind. (p. 108). Figured specimen (USNM 562754). 19. Near-apertural view (×1½). 24. Nonapertural view. Yonabaru clay (17451).

20. *Makiyamaia coreanica subdeclivis* (Yokoyama) (p. 107). Figured specimen (USNM 562755). Apertural view (×2), height 21 mm, diameter 7.9 mm. Yonabaru clay (17445).

21. *Coronasyrinx takabanarensis*, n. sp. (p. 109). Holotype (USNM 562756). Apertural view (×1½), height 33 mm, diameter 11.4 mm. Yonabaru clay (17476).

22–23. *Turricula* aff. *T. tornata* (Dillwyn) (p. 108). Figured specimens. 22. (USNM 562757). Near-apertural view (×2), height 21 mm, diameter 9 mm. Yonabaru clay (17451). 23. (USNM 562758). Near-labial view (×1½), height 30 mm. Yonabaru clay (17450).

25. *Splendrillia nomurai*, n. sp. (p. 111). Holotype (USNM 562759). Apertural view (×2), height 20 mm, diameter 12.6 mm. Yonabaru clay (17451).

26. *Splendrillia incompta*, n. sp. (p. 111). Holotype (USNM 562760). Apertural view (×4), height 11.8 mm, diameter 4 mm. Yonabaru clay (17450).

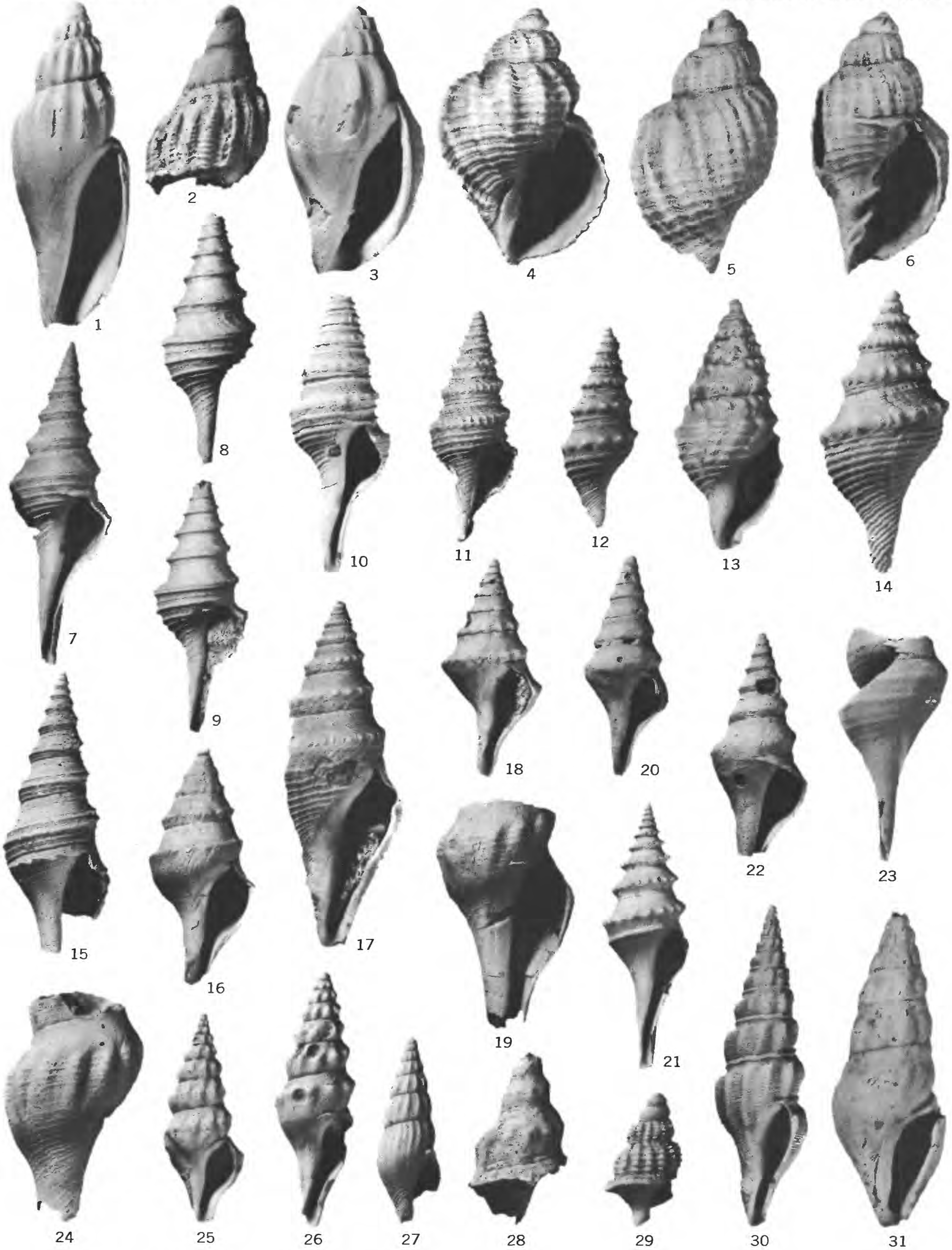
27. *Crassopleura* aff. *C. brevis* (Yokoyama) (p. 112). Figured specimen (USNM 562761). Apertural view (×3), height 11.5 mm, diameter 4 mm. Yonabaru clay (17449).

28. *Incerta sedis* (p. 108). Figured specimen (USNM 562762). Decorticated spire (×1½). Yonabaru clay (17451).

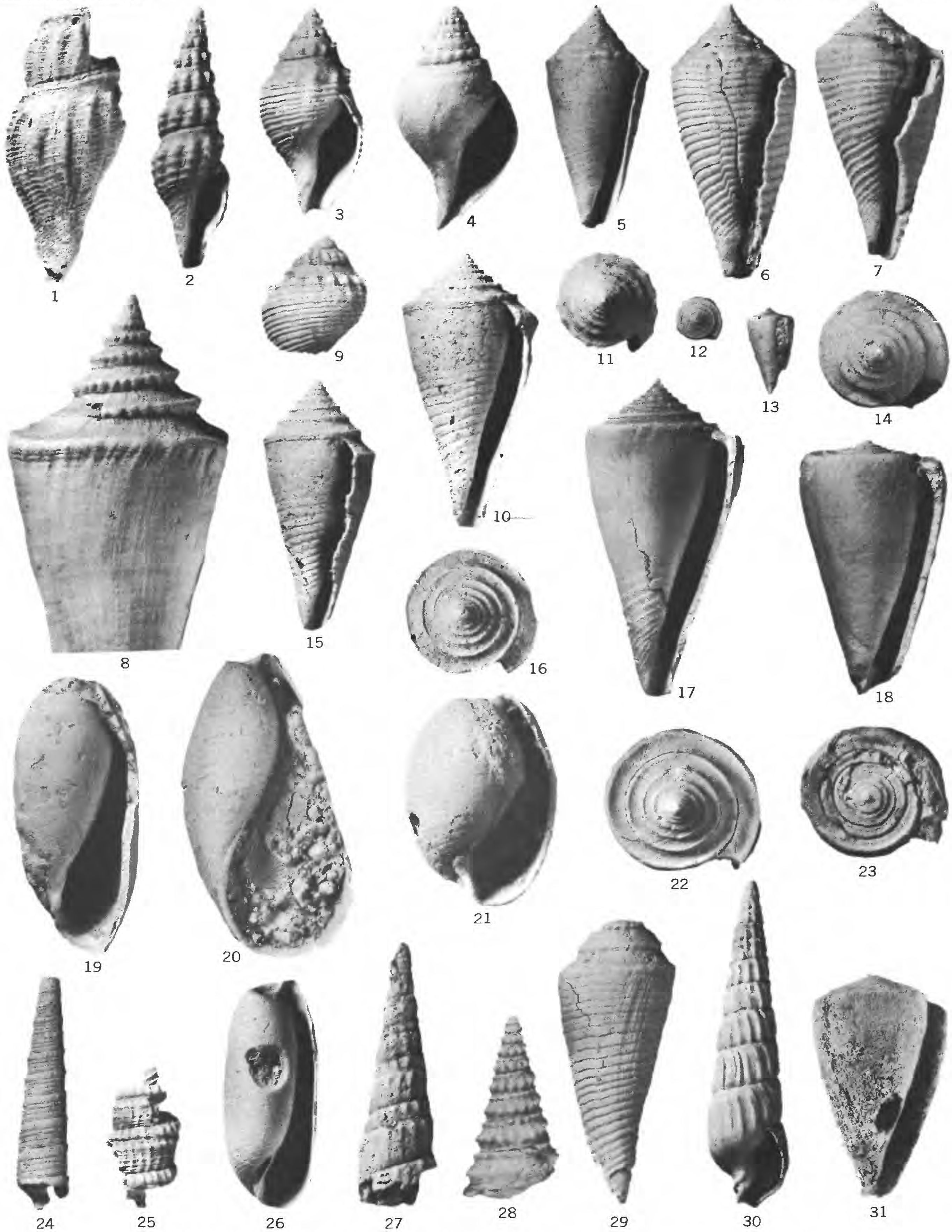
29. *Incerta sedis* (p. 117). Figured specimen (USNM 562763). Spire fragments (×4). Yonabaru clay (17679).

30. *Crassispira hataii*, n. sp. (p. 112). Holotype (USNM 562764). Apertural view (×2), height 30 mm, diameter 9 mm. Yonabaru clay (17451).

31. *Splendrillia (Syntomodrillia) atsutaensis*, n. sp. (p. 111). Holotype (USNM 562765). Apertural view (×6), height 9.4 mm, diameter 3.6 mm. Yonabaru clay (17503).



MOLLUSKS OF THE YONABARU CLAY MEMBER OF THE SHIMAJIRI FORMATION



MOLLUSKS OF THE YONABARU CLAY AND SHINZATO TUFF MEMBERS OF THE SHIMAJIRI FORMATION AND YONTAN LIMESTONE

PLATE 6

Gastropoda of the Yonabaru clay and Shinzato tuff (fig. 28) members of the Shimajiri formation

FIGURE 1. *Crassispira hataii*, n. sp. (p. 112). Figured specimen (USNM 562766). Nonapertural view of a fragment (×2). Yonabaru clay (17451).

2. *Compsodrillia nakamurai* Makiyama (p. 113). Figured specimen (USNM 562767). Apertural view (×3), height 16.4 mm, diameter 4.9 mm. Yonabaru clay (17451).

3, 9. *Buccinaria okinawa*, n. sp. (p. 119). Figured specimens. 3. (USNM 562768). Apertural view of a medium high spired individual (×2), height 19.5 mm, diameter 10 mm. 9. (USNM 562769) Nonapertural view of a low spired fragment (×2). Yonabaru clay (17451).

4. *Buccinaria* (*Ootomella*) sp. (p. 120). Figured specimen (USNM 562770). Near-apertural view (×4), height 10.6 mm, diameter 6 mm. Yonabaru clay (17451).

5, 11. *Conus shimajiriensis*, n. sp. (p. 122). Holotype (USNM 562771). 5. Apertural view (×2), height 21 mm, diameter 10 mm. 11. Top of same. Yonabaru clay (17451).

6. *Conus* cf. *C. cosmetulus* Cossmann (p. 122). Figured specimen (USNM 562772). Apertural view (×3), height 17.2 mm, diameter 8.2 mm. Yonabaru clay (17449).

7, 14. *Conus mucronatus* Reeve (p. 122). Figured specimen (USNM 562773). Apertural view (×3), height 16.2 mm, diameter 8.2 mm. 14. Top of same. Yonabaru clay (17679).

8. *Conus* cf. *C. yabei* Nomura (p. 123). Figured specimen (USNM 562774). Nonapertural view of a juvenile (×4), diameter 10.7 mm. Yonabaru clay (17445).

10, 15–16. *Conus sieboldianus* Makiyama (p. 121). Figured specimens. 10. (USNM 562775). Apertural view (×2), height 26 mm, diameter 13 mm. 16. Top view of same. Yonabaru clay (17451). 15. (USNM 562776). Apertural view (×2), height 23.5 mm, diameter 11 mm. Yonabaru clay (17447).

12–13, 18, 23. *Conus* cf. *C. litteratus* Linné (p. 123). Figured specimens. 12. (USNM 562777). Top of a juvenile (×1½). 13. Apertural view of same. 18. (USNM 562778). Apertural view (×1½), height 31.6 mm, diameter 19 mm. 23. Top of same. Yonabaru clay (17449).

17, 22. *Conus* aff. *C. djarianensis* Martin (p. 121). Figured specimen (USNM 562779). 17. Apertural view (×1½), height 40 mm, diameter 20.5 mm. 22. Top of same. Yonabaru clay (17451).

19. ?*Scaphander* sp. (p. 128). Figured specimen (USNM 562780). Apertural view (×3), height 17.6 mm, diameter 8.4 mm. Yonabaru clay (17451).

20. *Scaphander yonabaruensis*, n. sp. (p. 128). Holotype (USNM 562781). Apertural view (×6), height 9.4 mm, diameter 5.1 mm. Yonabaru clay (17451).

21. *Atys*? *okinawa*, n. sp. (p. 127). Holotype (USNM 562782). Apertural view (×8), height 5 mm, diameter 3.8 mm. Yonabaru clay (17447).

24. *Terebra* aff. *T. amabilis* Makiyama (p. 125). Figured specimen (USNM 562783). Specimen with broken body whorl (×2), height 22 mm, diameter 5 mm. Yonabaru clay (17503).

25. *Terebra* aff. *T. torquata* Adams and Reeve (p. 125). Figured specimen (USNM 562784). Fragment (×2), diameter 6.2 mm. Yonabaru clay (17447).

26. *Cylichna musashiensis* Tokunaga (p. 127). Figured specimen (USNM 562785). Apertural view (×4), height 11 mm, diameter 4.4 mm. Yonabaru clay (17449).

27. *Terebra* aff. *T. anomala* Gray (p. 126). Figured specimen (USNM 562786). Spire fragment (×4), height 12.5 mm, diameter 4 mm. Yonabaru clay (17632).

28. *Trochocerithium* sp. (p. 42). Figured specimen (USNM 562787). Spire (×4). Shinzato tuff (17453).

29. *Conus* cf. *C. aculeiformis* Reeve (p. 121). Figured specimen (USNM 562788). Nonapertural view (×2), height 26.7 mm, diameter 11.2 mm. Yonabaru clay (17447).

30. *Terebra shimajiriensis*, n. sp. (p. 126). Holotype (USNM 562789). Apertural view (×4), height 15.5 mm, diameter 3.8 mm. Yonabaru clay (17448).

31. *Conus* aff. *C. capitaneus* Linné (p. 124). Figured specimen (USNM 562790). Apertural view (×1), height 44 mm, diameter 26.7 mm. Yontan limestone (17511).

PLATE 7

Gastropoda of the Shinzato tuff member of the Shimajiri formation

FIGURES 1–2. *Bathybembix* sp. ind. (p. 22). Figured specimen (USNM 562791). 1. Apertural view (×1½), height 20 mm, diameter 18 mm. 2. Nonapertural view of same. Shinzato tuff (17456).

3–4. *Liotia* sp. ind. (p. 29). Figured specimen (USNM 562792). 3. Apertural view (×3), height 8 mm, diameter 8.7 mm. 4. Base of same. Shinzato tuff (17456).

5, 9, 14. *Bolma hataii*, n. sp. (p. 34). Holotype (USNM 562793). 5. Apertural view (×3), height 10.6 mm, diameter 11.8 mm. 9. Top of same. 14. Base of same. Shinzato tuff (17456).

6–8, 11–13. *Phanerolepida rehderi*, n. sp. (p. 30). Holotype (USNM 562794). 6. Apertural view (×1½), height 17.5 mm, diameter 17 mm. 11. Top of same. Shinzato tuff (17454). Figured topotype (USNM 562795). 7. Apertural view (×1½). 12. Top of same. Figured specimen (USNM 562796). 8. Apertural view (×1½). 13. Top of same. Shinzato tuff (17677).

10, 33. *Lischkeia* aff. *L. monilifera* (Lamarck) (p. 23). 10. Figured specimen (USNM 562797). Fragment showing sculpture of whorls (×2). 33. Figured specimen (USNM 562798). Basal fragment (×2). Shinzato tuff (17458).

15. *Bolma* sp. ind. (p. 33). Figured specimen (USNM 562799). Fragment (×1½). Shinzato tuff (17681).

16, 22, 26. *Architectonica* (*Solariaxis*) aff. *A.* (*S.*) *nomurai* MacNeil (p. 39). Figured specimen (USNM 562800). 16. Top view (×4), height 5.3 mm, diameter 8.7 mm. 22. Base of same. 26. Near-apertural view of same. Shinzato tuff (17454).

17, 23, 27. *Climacopoma serratomarginata*, n. sp. (p. 37). Holotype (USNM 562801). 17. Top view (×3), height 4.8 mm, diameter 12 mm. 23. Base of same. 27. Apertural view of same. Shinzato tuff (17454).

18. *Mathilda loochooensis*, n. sp. (p. 37). Holotype (USNM 562802). Apertural view (×3), height 14.4 mm, diameter 6 mm. Shinzato tuff (17454).

19. *Niso* aff. *N. yokoyamai* Kuroda and Habe (p. 45). Figured specimen (USNM 562803). Near-apertural view (×6), height 6.2 mm, diameter 3.1 mm. Shinzato tuff (17677).

20. *Trochocerithium* aff. *T. shikoensis* (Yokoyama) (p. 42). Figured specimen (USNM 562804). Apertural view (×4), height 11.1 mm, diameter 6 mm. Shinzato tuff (17454).

21. *Turriscala* (*Claviscala*) sp. ind. (p. 44). Figured specimen (USNM 562805). Near-apertural view (×4), diameter 5.5 mm. Shinzato tuff (17454).

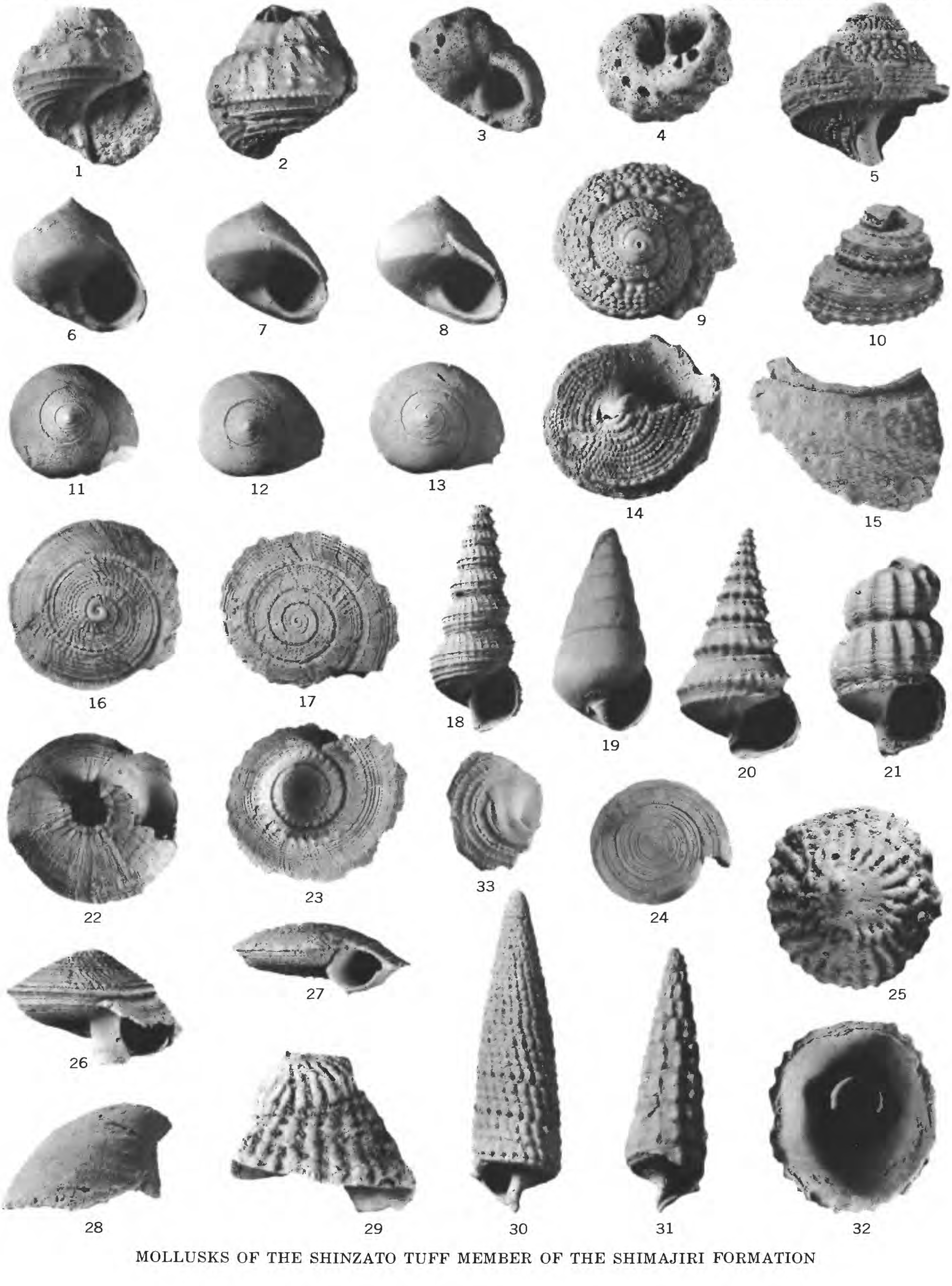
24. *Conus loochooensis*, n. sp. (p. 124). Top view of holotype (pl. 10, fig. 12).

25, 29, 32. *Cheilea layardii* (Reeve) (p. 46). Figured specimen (USNM 562806). 25. Top view (×4), height 6 mm, length 9.5 mm, width 8 mm. 29. Side view of same. 32. Basal view of same. Shinzato tuff (17633).

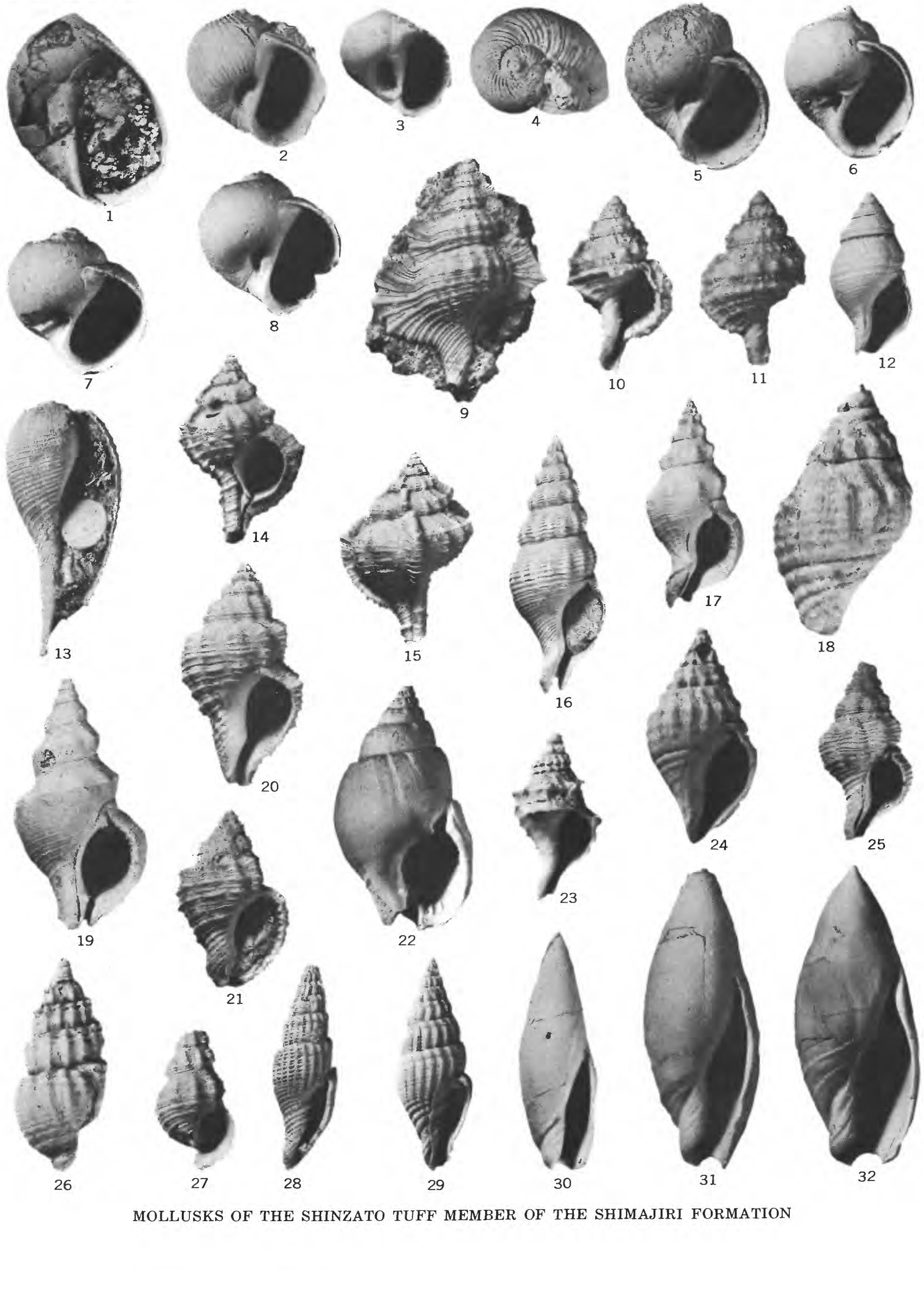
28. *Hipponix* (*Malluvium*) cf. *H.* (M) *lissus* (E. A. Smith) (p. 47). Figured specimen (USNM 562807). Side view (×4), height 4.6 mm, length 8.4 mm, width 7.3 mm. Shinzato tuff (17633).

30. *Triphora* aff. *T. dolicha* (Watson) (p. 43). Figured specimen (USNM 562808). Near-apertural view (×8), height 7.5 mm, diameter 2 mm. Shinzato tuff (17453).

31. *Cerithiopsis* (*Alipta*) *premelvilli*, n. sp. (p. 43). Holotype (USNM 562809). Near-apertural view (×8), height 6 mm, diameter 2 mm. Shinzato tuff (17452).



MOLLUSKS OF THE SHINZATO TUFF MEMBER OF THE SHIMAJIRI FORMATION



MOLLUSKS OF THE SHINZATO TUFF MEMBER OF THE SHIMAJIRI FORMATION

PLATE 8

Gastropoda of the Shinzato tuff member of the Shimajiri formation

FIGURE 1. *Mammilla melanostoma* (Gmelin) (p. 54). Figured specimen (USNM 562810). Apertural view (×2), height 19.4 mm, diameter 15 mm. Shinzato tuff (17633).

2, 4–5. *Naticarius* cf. *N. niasensis* Wissema (p. 56). Figured specimens. 2. Apertural view of a medium-sized specimen (×2), (USNM 562811). 4. Top view of same. Shinzato tuff (17633). 5. Apertural view of large specimen (×1½), (USNM 562812), height 21 mm, diameter 19.7 mm. Shinzato tuff (17453).

3. *Polinices* cf. *P. flemingianus* (Recluz) (p. 53). Figured specimen (USNM 562813). Apertural view (×2), height 11.5 mm, diameter 10.6 mm. Shinzato tuff (17633).

6–7. *Natica* sp. aff. *N. stellatus* Hedley (p. 55). Figured specimens. 6. (USNM 562814). Apertural view (×3). Shinzato tuff (17454). 7. (USNM 562815). Apertural view (×1½), height 20 mm, diameter 18 mm. Shinzato tuff (17677).

8. *Natica* cf. *N. vitellus* Linné (p. 54). Figured specimen (USNM 562816). Apertural view (×3), height 9.3 mm, diameter 9.7 mm. Shinzato tuff (17633).

9. *Biplex perca* Perry (p. 59). Figured specimen (USNM 562817). Nonapertural view (×1½), height 30.3 mm, diameter 23.5 mm. Shinzato tuff (17633).

10–11. *Bursa* (*Tutufa*) aff. *B.* (*T.*) *corrugata* (Perry) (p. 61). Figured specimen (USNM 562818). "Apertural view," the body whorl being broken away to the first varix behind the aperture (×2), height 17 mm, diameter 10.5 mm. 11. Nonapertural view of same. Shinzato tuff (17633).

12. *Loochooia hanzawai*, n. gen. et sp. (p. 68). Holotype (USNM 562819). Apertural view (×2), height 15.8 mm, diameter 8 mm. Shinzato tuff (17454).

13. *Ficus subintermedia* (D'Orbigny) (p. 61). Figured specimen (USNM 562820). Apertural view (×1½), height 33.5 mm, diameter 16.7 mm. Shinzato tuff (17633).

14–15. *Murex saplisi*, n. sp. (p. 63). 14. Holotype (USNM 562821). Apertural view (×1½), height 25 mm, diameter 17.2 mm. 15. Paratype (USNM 562822). Nonapertural view (×1½), height 25.5 mm, diameter 18 mm. Shinzato tuff (17633).

16. *Siphonalia laddi*, n. sp. (p. 71). Holotype (USNM 562823). Apertural view (×1), height 50 mm, diameter 20 mm. Shinzato tuff (17454).

17. *Siphonalia mikado makiyamai*, n. subsp. (p. 70). Holotype (USNM 562824). Apertural view (×1), height 41 mm, diameter 20 mm. Shinzato tuff (17477).

18, 24. *Cominella* (*Cominula*) *okinavensis*, n. sp. (p. 75). 18. Paratype (USNM 562825). Nonapertural view (×4), height 12.5 mm, diameter 7.1 mm. 24. Holotype (USNM 562826). Apertural view (×4), height 10.2 mm, diameter 5.8 mm. Shinzato tuff (17454).

19. *Afer chinenensis*, n. sp. (p. 76). Holotype (USNM 562827). Apertural view (columella missing) (×1), height 49 mm, diameter 26 mm. Shinzato tuff (17633).

20–21. *Cantharus okinawa*, n. sp. (p. 77). 20. Holotype (USNM 562828). Apertural view (×1½), height 29 mm, diameter 16.7 mm. 21. Paratype (USNM 562829). Apertural view (×1½). Shinzato tuff (17633).

22. *Nassarius* (*Zeuxis*) *subbalteatus*, n. sp. (p. 82). Holotype (USNM 562830). Apertural view (×3), height 16.2 mm, diameter 9.6 mm. Shinzato tuff (17456).

23. *Incerta sedis* (p. 78). Figured specimen (USNM 562831). Near-apertural view (×4), height 8.3 mm. Shinzato tuff (17454).

25. *Peristernia preluchuana*, n. sp. (p. 86). Holotype (USNM 562832). Apertural view (×2), height 17.8 mm, diameter 9.4 mm. Shinzato tuff (17456).

26. *Profundinassa babylonica* (Watson) (p. 78). Figured specimen (USNM 562833). Nonapertural view (×4), height 10.2 mm, diameter 5 mm. Shinzato tuff (17454).

27. ?*Fusinus* sp. (p. 84). Figured specimen (USNM 562834). Apertural view of an incomplete specimen (×2), diameter 7.8 mm. Shinzato tuff (17454).

28. *Uromitra teschi*, n. sp. (p. 90). Holotype (USNM 562835). Apertural view (×2), height 20 mm, diameter 6.5 mm. Shinzato tuff (17633).

29. *Uromitra fulleri*, n. sp. (p. 91). Holotype (USNM 562836). Apertural view (×3), height 13.9 mm, diameter 5.1 mm. Shinzato tuff (17677).

30. *Ancilla* (*Turrancilla*) *chinenensis*, n. sp. (p. 87). Holotype (USNM 562837). Apertural view (×2), height 23.4 mm, diameter 8 mm. Shinzato tuff (17633).

31. *Ancilla* (*Turrancilla*) cf. *A.* (*T.*) *lanceolata* (von Martens) (p. 87). Figured specimen (USNM 562838). Apertural view (×1½), height 39.4 mm, diameter 16 mm. Shinzato tuff (17453).

32. *Ancilla* (*Baryspira*) cf. *A.* (*B.*) *albocallosa* (Lischke) (p. 86). Figured specimen (USNM 562839). Apertural view (×1½), height 39.1 mm, diameter 17.8 mm. Shinzato tuff (17633).

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PLATE 9

Gastropoda of the Shinzato tuff member of the Shimajiri formation

FIGURE 1. *Teramachia shinzatoensis*, n. sp. (p. 96). Holotype (USNM 562840). Apertural view (×1), height 69.8 mm, diameter 23.7 mm. Shinzato tuff (17648).

2–3. *Benthovoluta okinavensis*, n. sp. (p. 96). Holotype (USNM 562841). 2. Near-apertural view (×2), height 27 mm, diameter 7.4 mm. 3. Nonapertural view of same. Shinzato tuff (17454).

4–5. *Phenacoptygma* n. sp. (p. 97). Figured specimens. 4. (USNM 562842). A spire (×2). 5. (USNM 562843). Near-apertural view of a body whorl fragment (×2). Shinzato tuff (17454).

6. *Fulgoraria (Saotomea) delicata* (Fulton) (p. 97). Figured specimen (USNM 562844). Apertural view (×2), height 26.4 mm, diameter 11.1 mm. Shinzato tuff (17454).

7. *Lyria hanzawai*, n. sp. (p. 98). Holotype (USNM 562845). Apertural view (×1½), height 42.3 mm, diameter 17 mm. Shinzato tuff (17633).

8–9. *Marginella tomuiensis*, n. sp. (p. 99). 8. Holotype (USNM 562846). Apertural view (×6), height 6.8 mm, diameter 4.2 mm. 9. Paratype (USNM 562847). Apertural view, outer lip uncalloused (×6), height 8 mm, diameter 4.2 mm. Shinzato tuff (17454).

10. ?*Antimelatoma* sp. (p. 110). Figured specimen (USNM 562848). Near-apertural view (×6), height 9.6 mm, diameter 3.6 mm. Shinzato(?) tuff, locality unknown.

11. *Gemmula* sp. ind. (p. 103). Figured specimen (USNM 562849). Spire (×2). Shinzato tuff (17633).

12–14. *Pinguigemmula okinavensis*, n. sp. (p. 104). 12. Figured specimen (USNM 562850). Labial view showing anal sinus, the sharp central labial lobe, and the obtuse notch below it (×1½). Shinzato tuff (17453). 13. Holotype (USNM 562851). Labial view (×1½), height 41.5 mm, diameter 20.2 mm. Shinzato tuff (17454a). 14. Figured specimen (USNM 562852). Apertural view showing grooves opposite the subsutural lirations (×1½). Shinzato tuff (17455).

15, 19. *Makiyamaia coreanica* (Adams and Reeve) (p. 107). Figured specimens. 15. (USNM 562853). Apertural view (×2), height 26.3 mm, diameter 11 mm. 19. (USNM 562854). Apertural view (×2), height 24.4 mm, diameter 11.4 mm. Shinzato tuff (17454).

16. *Micantapex*? *tomuiensis*, n. sp. (p. 105). Holotype (USNM 562855). Apertural view (×6), height 7 mm, diameter 3.8 mm. Shinzato tuff (17454).

17. *Paracomitas rodgersi*, n. sp. (p. 106). Holotype (USNM 562856). Near-apertural view (×1½), height 27 mm, diameter 11.4 mm. Shinzato tuff (17454).

18. *Borsonella shinzato*, n. sp. (p. 114). Holotype (USNM 562857). Apertural view (×3), height 16.6 mm, diameter 7.8 mm. Shinzato tuff (17454).

20, 31. *Agladrillia nakazaensis*, n. sp. (p. 113). Holotype (USNM 562858). 20. Apertural view, outer lip broken (×2), height 17 mm, diameter 6.4 mm. 31. Nonapertural view of same. Shinzato tuff (17453).

21. *Typhlosyrinx* sp. ind. (p. 117). Figured specimen (USNM 562859). Spire (×1½). Shinzato tuff (17453).

22. *Pleurotomella*? *ryukyuensis*, n. sp. (p. 117). Holotype (USNM 562860). Apertural view (×2), height 18 mm, diameter 6.6 mm. Shinzato tuff (17456).

23. *Neoguraleus loochooensis*, n. sp. (p. 115). Holotype (USNM 562861). Near-apertural view (×4), height 9.1 mm, diameter 4 mm. Shinzato tuff (17454).

24. *Leucosyrinx iwaensis*, n. sp. (p. 109). Holotype (USNM 562862). Apertural view (×2), height 25 mm, diameter 8.3 mm. Shinzato tuff (17454).

25. *Compsodrillia*? *torvita*, n. sp. (p. 113). Holotype (USNM 562863). Apertural view (×1½), height 38 mm, diameter 10.9 mm. Shinzato tuff (17454).

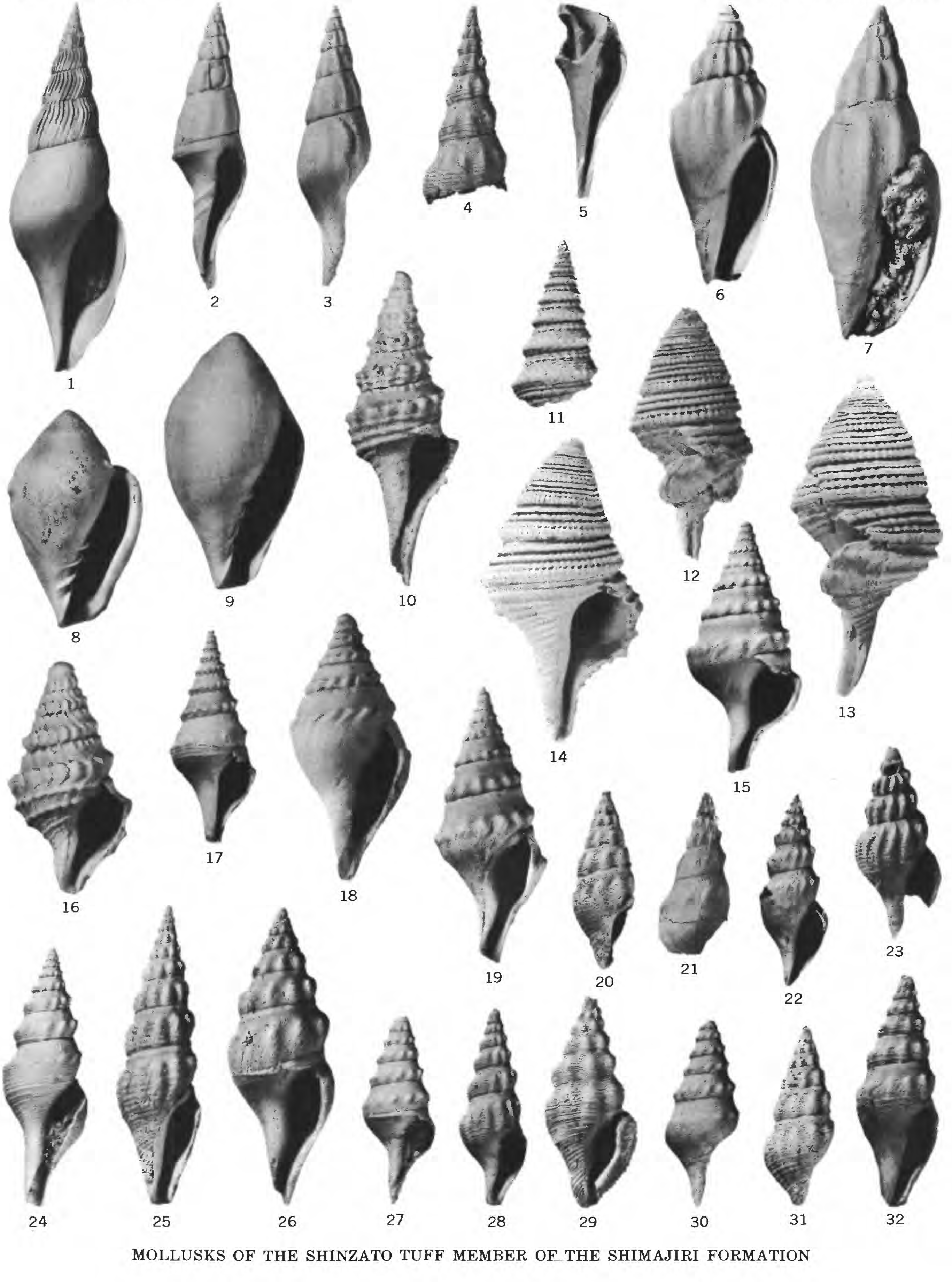
26. "*Mangelia*" *china*, n. sp. (p. 115). Holotype (USNM 562864). Near-apertural view (×4), height 14 mm, diameter 5mm. Shinzato tuff (17633).

27, 30. *Mauidrillia*? *kachabaruensis*, n. sp. (p. 110). Holotype (USNM 562865). 27. Near-apertural view (×2), height 18.2 mm, diameter 6.8 mm. 30. Nonapertural view of same. Shinzato tuff (17456).

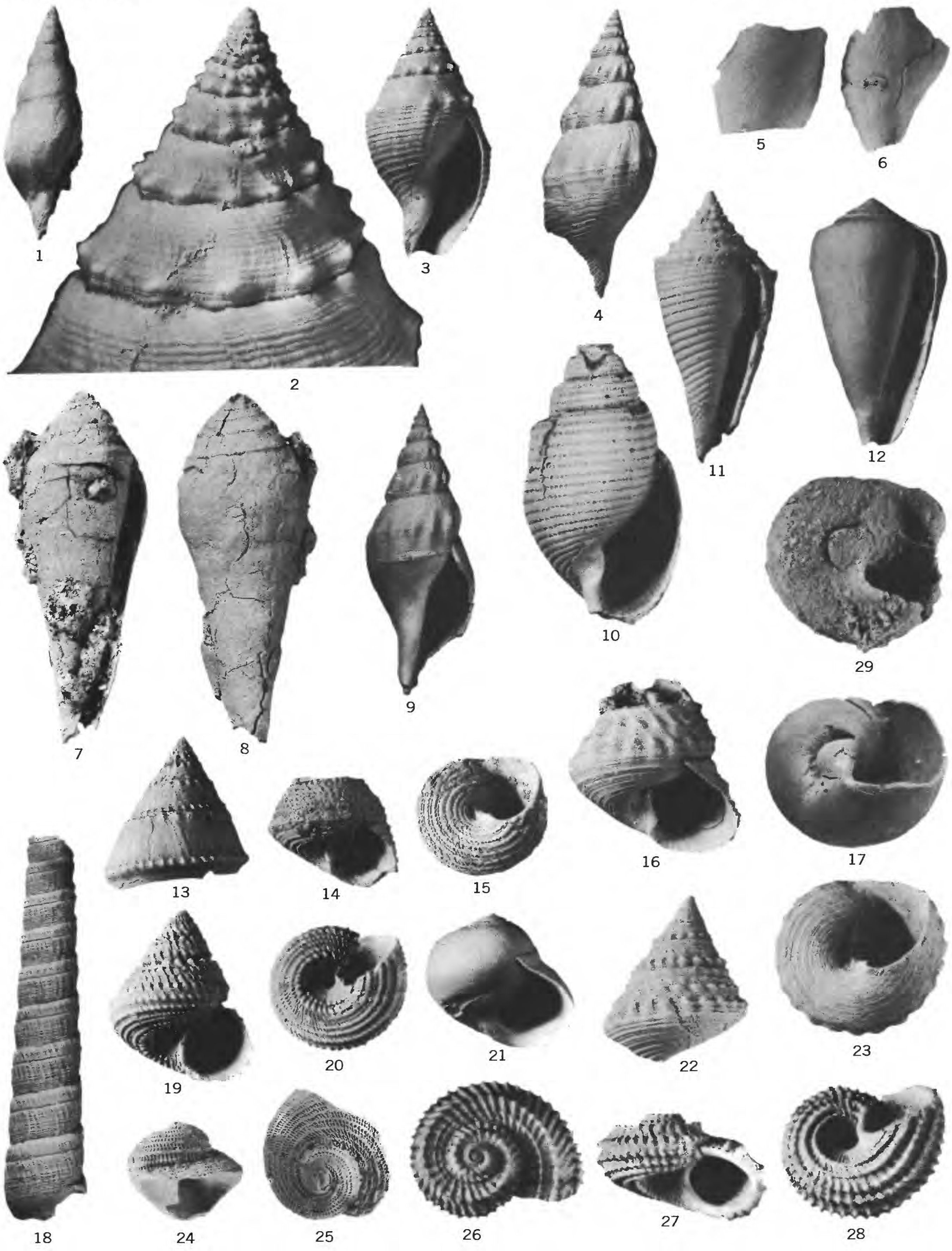
28. *Benthomangilia* cf. *B. cosibensis* (Yokoyama) (p. 115). Figured specimen (USNM 562866). Apertural view (×2), height 18.5 mm, diameter 6.7 mm. Shinzato tuff (17454).

29. *Glyphostoma* cf. *G. costicrenata* (Cossmann) (p. 116). Figured specimen (USNM 562867). Apertural view (×3), height 13.5 mm, diameter 6 mm. Shinzato tuff (17456).

32. *Borsonia shimajiriensis*, n. sp. (p. 114). Holotype (USNM 562868). Apertural view (×2), height 22 mm, diameter 8 mm. Shinzato tuff (17454).



MOLLUSKS OF THE SHINZATO TUFF MEMBER OF THE SHIMAJIRI FORMATION



MOLLUSKS OF THE SHINZATO TUFF MEMBER OF THE SHIMAJIRI FORMATION, CHINEN SAND, NAKOSHI SAND, AND YONTAN LIMESTONE

PLATE 10

Gastropoda of the Shinzato tuff member of the Shimajiri formation, Chinen sand, Nakoshi sand, and Yontan limestone (fig. 29)

FIGURE 1. *Daphnella ryukyuensis*, n. sp. (p. 118). Figured specimen (USNM 562869). Apertural view, outer lip broken (×1½), height 30 mm, diameter 10.8 mm. Shinzato tuff (17454).

2–3. *Buccinaria okinawa*, n. sp. (p. 119). Holotype (USNM 562870). 2. Spire enlarged (×10). 3. Apertural view (×3), height 15.5 mm, diameter 8 mm. Shinzato tuff (17677).

4, 9. *Spergo fusus*, n. sp. (p. 118). Holotype (USNM 562871). 4. Nonapertural view (×1½), height 36 mm, diameter 23 mm. 9. Near-apertural view of same. Shinzato tuff (17454).

5–6. Turriculinid gen. ind. (p. 108). Figured specimens; body whorl fragments showing growth lines outlining the anal sinus (×1½). 5. (USNM 562872). 6. (USNM 562873). Shinzato tuff (17454).

7–8. *Conus comatosaeformis* Yokoyama (p. 123). Figured specimen (USNM 562874). 7. Apertural view (×1), height 65 mm. diameter, crushed but approximately 26 mm. 8. Nonapertural view of same. Shinzato tuff (17633).

10. *Acteon* aff. *A. teramachii* Habe (p. 126). Figured specimen (USNM 562875). Near-apertural view (×6), height 8.5 mm, diameter 5 mm. Shinzato tuff (17454).

11. *Conus precancellatus*, n. sp. (p. 122). Holotype (USNM 562876). Apertural view (×3), height 17 mm, diameter 7.8 mm. Shinzato tuff (17633).

12. *Conus loochooensis*, n. sp. (p. 124). Holotype (USNM 562877). Apertural view (×1), height 46 mm, diameter 26.7 mm. Shinzato tuff (17633).

13. *Bathybembix* cf. *B. convexiusculum* (Yokoyama) (p. 22). Figured specimen (USNM 562878). Spire whorls (×2), greatest diameter 14.5 mm. Chinen sand (17481).

14–15. *Calliostoma* (*Pulchrastele*) aff. *C.* (*P.*) *ikebei* MacNeil (p. 25). Figured specimen (USNM 562879). 14. Apertural view of fragment (×3), height 7 mm, diameter 8.5 mm. 15. Base of same. Chinen sand (17441).

16, 22–23. *Tosatrochus attenuatus* (Jonas) (p. 26). Figured specimen (USNM 562880). 16. Apertural view of specimen with broken spire (×1½), diameter 21.6 mm. 23. Basal view of same. Figured specimen (USNM 562881). 22. Nonapertural view of small specimen showing spire (×2), height 16.5 mm, diameter 13.3 mm. Nakoshi sand (17440).

17, 29. *Naticarius* cf. *N. andoi* (Nomura) (p. 56). Figured specimens. 17. (USNM 562882). Base of specimen shown on plate 12, figure 25 (×3). Chinen sand (17442). 29. (USNM 562883). Base (×2½), height 14.4 mm, diameter 13.8 mm. Yontan limestone (17553).

18. *Terebra pretiosa* Reeve (p. 125). Figured specimen (USNM 562884). Specimen with broken aperture (×1½), height 48 mm, diameter 10.3 mm. Shinzato tuff (17633).

19–20. "*Solariella*" *albalitus*, n. sp. (p. 23). Holotype (USNM 562885). 19. Apertural view (×4), height 8 mm, diameter 6.9 mm. 20. Basal view of same. Chinen sand (17481).

21. *Chrysostoma paradoxum* (Born) (p. 25). Figured specimen (USNM 562886). Apertural view (×1½), height 17 mm, diameter 19 mm. Nakoshi sand (17483).

24–25. *Stomatella* cf. *S. lyrata* Pilsbry (p. 23). Figured specimen (USNM 562887). 24. Near-apertural view (×3), greatest diameter 8.7 mm, height 6.7 mm. 25. Top of same. Nakoshi sand (17440).

26–28. *Pseudoliotia motobuensis*, n. sp. (p. 35). Holotype (USNM 562888). 26. Top view (×4), height 5 mm, diameter 8.2 mm. 27. Apertural view of same. 28. Base of same. Nakoshi sand (17483).

PLATE 11

Gastropoda of the Chinen sand and Nakoshi sand

FIGURES

1–2. *Monilea haebaruensis*, n. sp. (p. 27). Holotype (USNM 562889). 1. Apertural view (×3), height 9.6 mm, diameter 11.8 mm. 2. Base of same. Chinen sand (17442).

3. *Lunatica marmorata* (Linné) (p. 32). Figured specimen (USNM 562890). Apertural view of basal fragment (×1). Nakoshi sand (17440).

4. *Marmorostoma* (*Batillus*) *gemmata* (Reeve) (p. 31). Figured specimen (USNM 562891). Apertural view (×1½), height 23 mm, diameter 19.2 mm. Nakoshi sand (17440).

5–6. *Guildfordia yoca* Jousseaume (p. 32). Figured specimen (USNM 562892). 5. Top view of crushed specimen (×1), greatest diameter 36 mm. 6. Base of same. Chinen sand (17482c).

7–8. *Homalopoma* cf. *H. sangarensis* (Schrenck) (p. 29). Figured specimen (USNM 562893). 7. Nonapertural view (×6), height 5.5 mm, diameter 5 mm. 8. Base of same. Chinen sand (17480).

9–10. *Pseudastralium* cf. *P. henicus* (Watson) (p. 33). Figured specimen (USNM 562894). 9. Nonapertural view (×1½), height 17.8 mm, diameter 18.8 mm. 10. Base of same. Chinen sand (17480).

11–12. *Marmorostoma* (*Batillus*) cf. *M.* (*B.*) *cornuta* (Humphrey) (p. 32). Figured specimen (USNM 562895). 11. Apertural view of small specimen (×1½). Figured specimen (USNM 562896). 12. Nonapertural view of large specimen (×1½), height 34.5 mm, diameter 24 mm. Nakoshi sand (17440).

13–15. *Cirsochilus ryukyuensis*, n. sp. (p. 30). Holotype (USNM 562897). 13. Apertural view (×6), height 3 mm, diameter 4.3 mm. 14. Top of same. 15. Base of same. Chinen sand (17482b).

16–17. *Ethalia subpulchella*, n. sp. (p. 28). Holotype (USNM 562898). 16. Apertural view (×3), height 5 mm, diameter 9.2 mm. 17. Base of same. Chinen sand (17442).

18, 20. *Epitonium* (*Crisposcala*) *okinavensis*, n. sp. (p. 44). Holotype (USNM 562899). 18. Basal view (×1½), height 26.5 mm, diameter 16 mm. 20. Apertural view of same. Chinen sand (17480).

19. *Argyropeza* cf. *A. divina* Melvill and Standen (p. 40). Figured specimen (USNM 562900). Apertural view (×6), height 11 mm, diameter 3.2 mm. Chinen sand (17481).

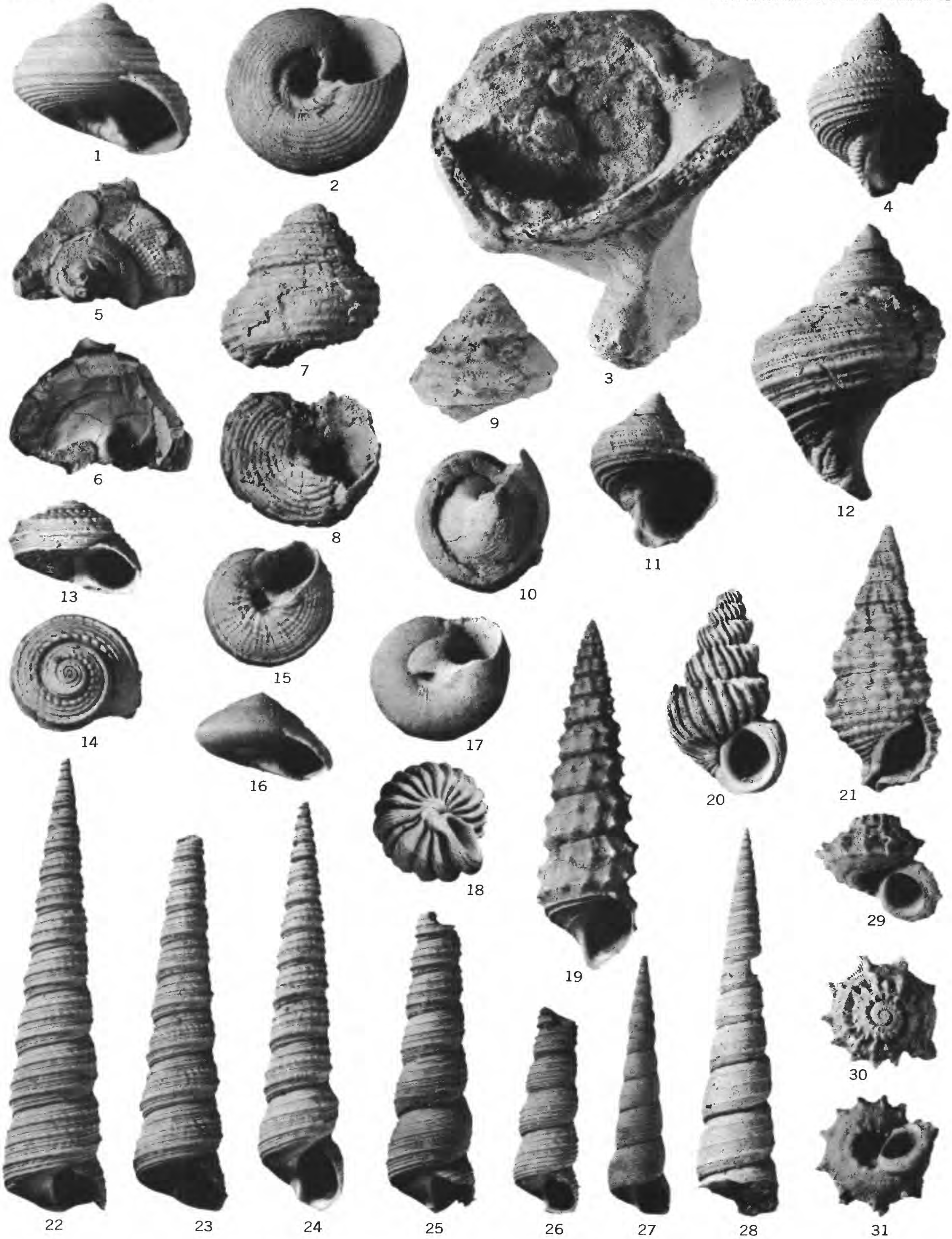
21. *Cerithium* (*Proclava*) *kobelti* Dunker (p. 41). Figured specimen (USNM 562901). Apertural view (×3), height 16.8 mm, diameter 7.3 mm. Chinen sand (17495).

22–26. *Turritella filiola* Yokoyama (p. 36). Figured specimens (USNM 562902–22, 562903–23, 562904–24, 562905–25, 562906–26). All apertural views (×3), largest specimen, height 28.5 mm, diameter 6.8 mm. Nakoshi sand (17483).

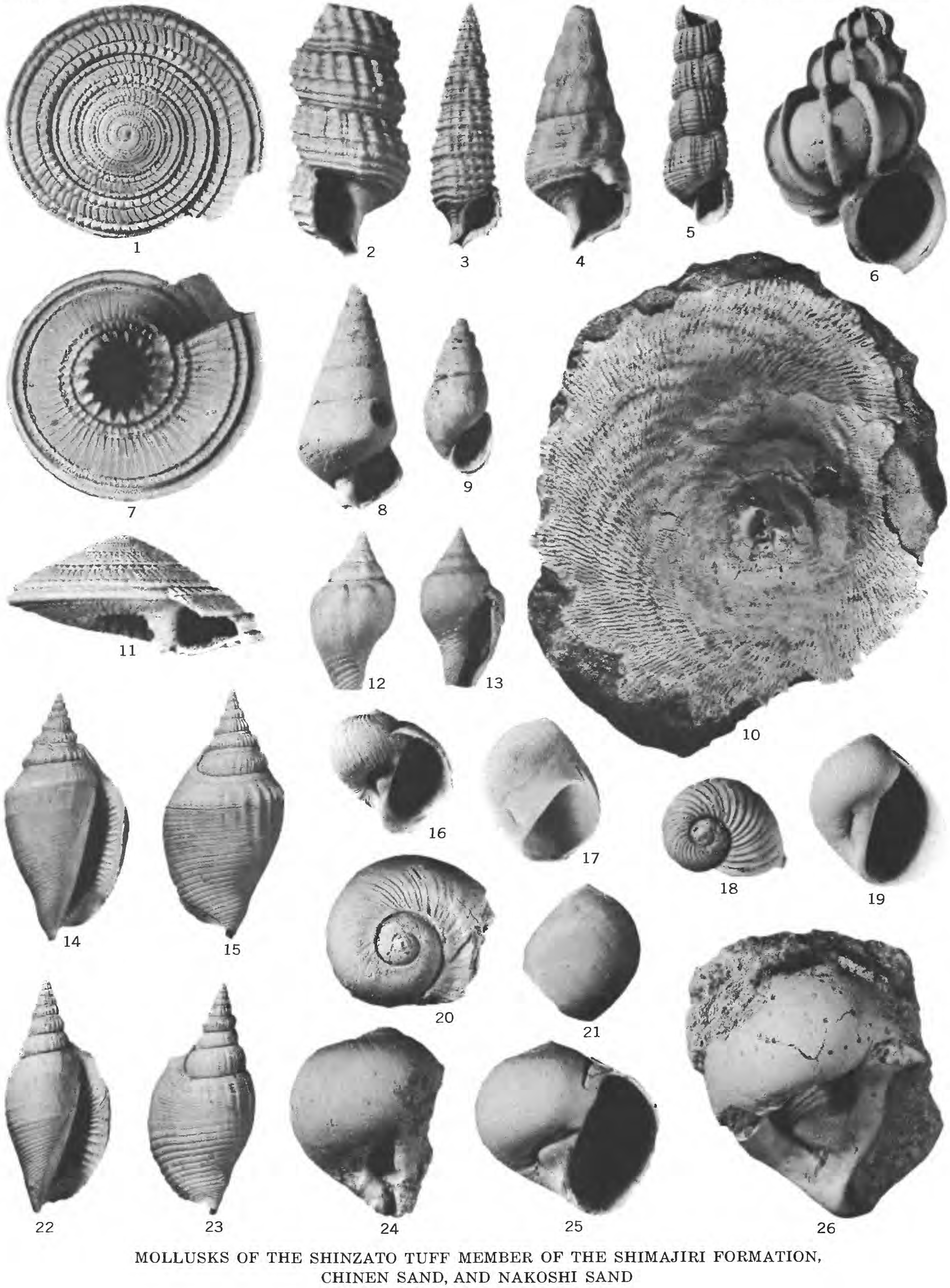
27. *Turritella zinboi*, n. sp. (p. 36). Holotype (USNM 562907). Apertural view (×3), height 16.4 mm, diameter 4 mm. Chinen sand (17481).

28. *Turritella* aff. *T. fascialis* Menke (p. 36). Figured specimen (USNM 562908). Near-apertural view (×3), height 24.4 mm, diameter 5.1 mm. Chinen sand (17441).

29–31. *Liotina* (*Dentarene*) *chinenensis*, n. sp. (p. 29). Holotype (USNM 562909). 29. Apertural view (×4), height 4.8 mm, diameter 6.5 mm. 30. Top of same. 31. Base of same. Chinen sand (17482b).



MOLLUSKS OF THE CHINEN SAND AND NAKOSHI SAND



MOLLUSKS OF THE SHINZATO TUFF MEMBER OF THE SHIMAJIRI FORMATION, CHINEN SAND, AND NAKOSHI SAND

PLATE 12

Gastropoda of the Shinzato tuff member of the Shimajiri formation (figs. 16, 18), Chinen sand and Nakoshi sand

FIGURES 1, 7, 11. *Architectonica perspectiva* (Linné) (p. 38). Figured specimen (USNM 562910). 1. Top view (×3), height 7.5 mm, diameter 16.6 mm. 7. Basal view of same. 11. Apertural view of same. Nakoshi sand (17440).

2. *Triphora* aff. *T. micans* (Hinds) (p. 43). Figured specimen (USNM 562911). Near-apertural view (×6), diameter 4 mm. Chinen sand (17458).

3. *Cerithium* (*Proclava*) *turritum* Sowerby (p. 41). Figured specimen (USNM 562912). Apertural view (×3), height 15.2 mm, diameter 4.6 mm. Nakoshi sand (17483).

4. *Zeacumantus* sp. ind. (p. 40). Figured specimen (USNM 562913). Apertural view of a young specimen (×6), height 7.5 mm, diameter 3.4 mm. Chinen sand (17441).

5. *Turbonilla* (*Lancea*) cf. *T.* (*L.*) *varicosa* (A. Adams) (p. 46). Figured specimen (USNM 562914). Apertural view of incomplete specimen (×4), diameter 3.3 mm. Chinen sand (17482b).

6. *Epitonium scalare* (Linné) (p. 44). Figured specimen (USNM 562915). Apertural view (×4), height 12.8 mm, diameter 9 mm. Nakoshi sand (17483).

8. *Niso* aff. *N. yokoyamai* Kuroda and Habe (p. 45). Figured specimen (USNM 562916). Near-apertural view (×8), height 5.1 mm, diameter 2.6 mm. Chinen sand (17482b).

9. *Odostomia* cf. *O. sasagensis* Nomura (p. 45). Figured specimen (USNM 562917). Apertural view (×6), height 4.9 mm, diameter 2.3 mm. Chinen sand (17482b).

10. *Tugurium exutum* (Reeve) (p. 47). Figured specimen (USNM 562918). Top view (×1), height 28 mm, diameter 90 mm. Nakoshi sand (17440).

12–13. ?*Strombus* sp. (p. 48). Figured specimen (USNM 562919). 12. Nonapertural view (×3), height 10 mm, diameter 5.5 mm. 13. Apertural view of same. Chinen sand (17495).

14–15, 22–23. *Strombus* (*Labiostrombus*) cf. *S.* (*L.*) *japonicus* Reeve (p. 48). Figured specimen (USNM 562920). 14. Apertural view (×1), height 47 mm, diameter 24.5 mm. 15. Nonapertural view of same. Figured specimen (USNM 562921). 22. Apertural view (×1), height 44.2 mm, diameter 21 mm. 23. Nonapertural view of same. Nakoshi sand (17440).

16, 18. *Naticarius* cf. *N. niasensis* Wissema (p. 56). Figured specimen (USNM 562922). 16. Apertural view of a young specimen (×3), height 6 mm, diameter 6 mm. 18. Top of same (×3). Shinzato tuff (17458).

17, 21. *Polinices* cf. *P. mammilla* (Linné) (p. 54). Figured specimen (USNM 562923). 17. Apertural view (×1½), height 18.5 mm, diameter 15.2 mm. 21. Nonapertural view of same. Nakoshi sand (17483).

19. *Mammilla melanostoma* (Gmelin) (p. 54). Figured specimen (USNM 562924). Apertural view (×2), height 19.5 mm, diameter 12.6 mm. Chinen sand (17442).

20, 24. *Natica* cf. *N. vitellus* (Linné) (p. 54). Figured specimen (USNM 562925). 20. Top view (×1). 24. Apertural view of broken specimen (×1), height 36.3 mm. Chinen sand (17442).

25. *Naticarius* cf. *N. andoi* (Nomura) (p. 56). Figured specimen (USNM 562882). Apertural view (×3), height 11 mm, diameter 11.5 mm. Chinen sand (17442).

26. *Polinices* cf. *P. albumen* (Linné) (p. 53). Figured specimen (USNM 562926). Apertural view (×1), height 53 mm, diameter 48 mm. Chinen sand (17442).

PLATE 13

Gastropoda of the Shinzato tuff member of the Shimajiri formation (figs. 2–3, 4, 12, 23), Chinen sand and Nakoshi sand

FIGURE 1. *Polinices* cf. *P. cumingianus madioensis* Altena (p. 53). Figured specimen (USNM 562927). Apertural view (×1½), height 23 mm, diameter 20.6 mm. Nakoshi sand (17483).

2–3. *Semicassis pila* (Reeve) (p. 58). Figured specimen (USNM 562928). 2. Apertural view (×1), diameter 32 mm. 3. Nonapertural view of same. Shinzato tuff (17458).

4. *Biplex perca* Perry (p. 59). Figured specimen (USNM 562929). Apertural view of incomplete specimen (1), diameter 34.5 mm. Shinzato tuff (17458).

5. *Bursa* (*Bufonaria*) *rana* (Linné) (p 60). Figured specimen (USNM 562930). Nonapertural view (×1), height 40 mm, diameter of view shown 27 mm. Nakoshi sand (17440).

6–7. *Cymatium* (*Linatella*) *cingulatum* (Lamarck) (p. 58). Figured specimen (USNM 562931). 6. Apertural view (×1½), diameter 17.7 mm. 7. Nonapertural view of same. Chinen sand (17442).

8. *Volva* (?*Pellasimnia*) sp. ind. (p. 53). Figured specimen (USNM 562932). Apertural view (×1½), length 19.5 mm. Chinen sand (17442).

9. *Tonna luteostoma* (Küster) (p. 61). Figured specimen (USNM 562933). Near-apertural view of specimen with outer lip missing (×1), height 59 mm. Chinen sand (17442).

10, 17. *Pyrene* aff. *P. flava* (Bruguière) (p. 66). Figured specimens. 10. (USNM 562934). Apertural view of an adult with a broken spire (×2), diameter 10 mm. 17. (USNM 562935). Apertural view of an uncalloused specimen (×3), height 14.5 mm, diameter 5.9 mm. Chinen sand (17442).

11. *Anachis* (*Costoanachis*) *leroyi*, n. sp. (p. 67). Holotype (USNM 562936). Apertural view (×4), height 8.5 mm, diameter 3.7 mm. Chinen sand (17481).

12, 18. *Mitrella* aff. *M. burchardi* (Dunker) (p. 67). Figured specimens. 12. (USNM 562937). Apertural view (×4), height 7.5 mm, diameter 3.9 mm. Shinzato tuff (17458). 18. (USNM 562938). Apertural view (×4). Chinen sand (17482b).

13. ?*Murex saplisi* MacNeil (p. 63). Figured specimen (USNM 562939), a fragment (×1½). Chinen sand (17481).

14. *Typhis* cf. *T. arcuatus* Hinds (p. 63). Figured specimen (USNM 562940). Apertural view (×6), height 7 mm, diameter 4.1 mm. Chinen sand (17442).

15–16. *Siphonalia subspadicea*, n. sp. (p. 69). 15. Paratype (USNM 562941). Apertural view (×1½), height 25 mm, diameter 13 mm. 16. Holotype (USNM 562942). Apertural view (×1½), height 28 mm, diameter 13 mm. Chinen sand (17481).

19. *Hindsia* (*Nihonophos*) *takabanarensis*, n. sp. (p. 74). Holotype (USNM 562943). Apertural view (×2), height 16 mm, diameter 7 mm. Chinen sand (17476).

20–21. *Janiopsis hirasei*, n. sp. (p. 77). Holotype (USNM 562944). 20. Apertural view (×1½), height 33 mm, diameter 14 mm. 21. Nonapertural view of same. Chinen sand (17482b).

22. *Fusinus perplexus* (A. Adams) (p. 84). Figured specimen (USNM 562945). Apertural view (×1), height 89 mm, diameter 26 mm. Chinen sand (17481).

23. *Nassarius* (?*Niotha*) *concinnus* (Powys) (p. 80). Figured specimen (USNM 562946). Fragment of spire (×4). Shinzato tuff (17458).

24–25. *Siphonalia* aff. *S. dainitiensis* Makiyama (p. 69). Figured specimen (USNM 562947). 24. Apertural view (×2), height 16.7 mm, diameter 8.5 mm. 25. Nonapertural view of same. Nakoshi sand (17440).

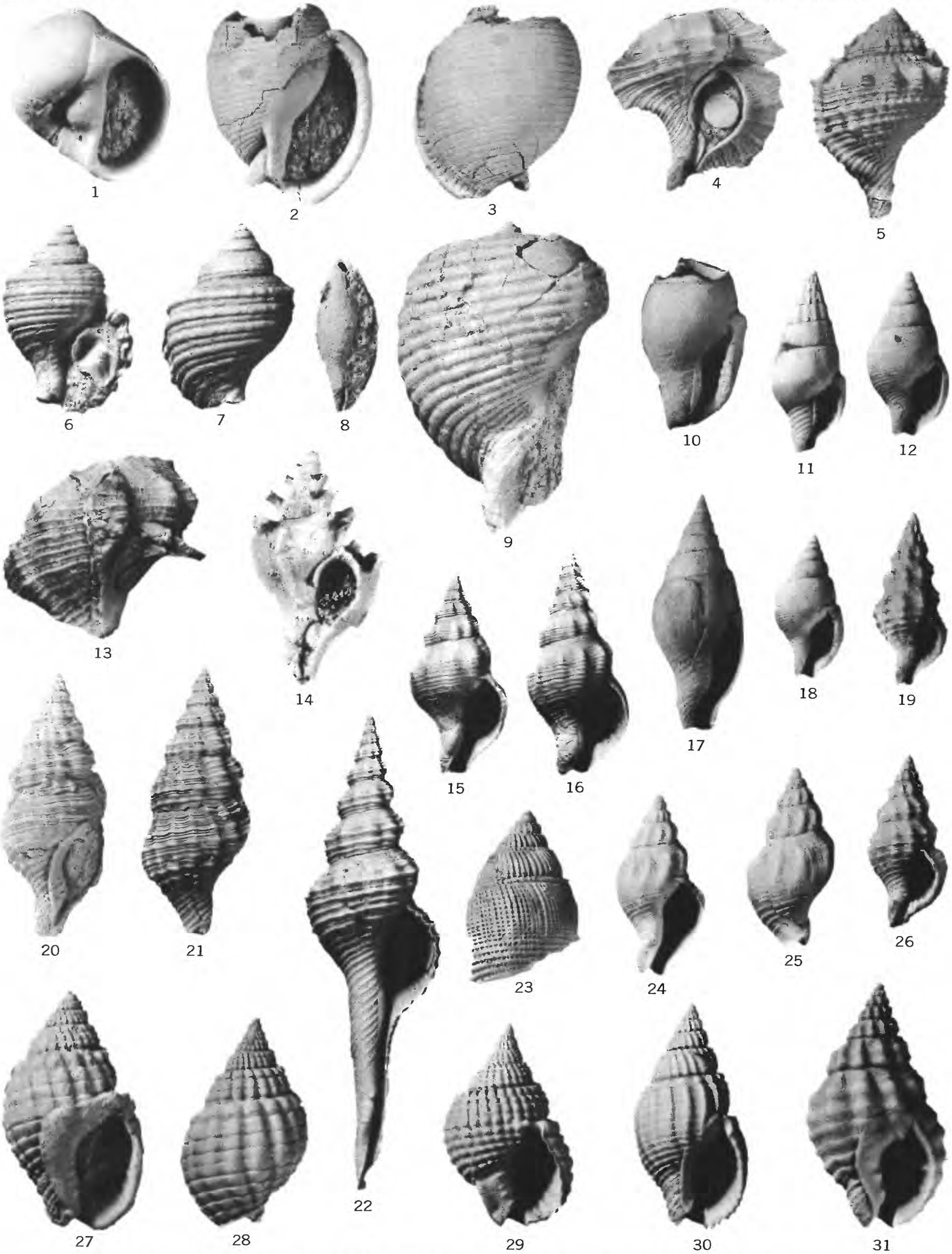
26. *Hindsia* (*Nihonophos*) *magnifica okinavia*, n. subsp. (p. 72). Holotype (USNM 562948). Apertural view (×1½), height 21.3 mm, diameter 10.1 mm. Chinen sand (17481).

27–28. *Nassarius* (*Niotha*) *fulleri*, n. sp. (p. 80). 27. Holotype (USNM 562949). Apertural view (×3), height 15 mm, diameter 8.9 mm. 28. Paratype (USNM 562950). Nonapertural view (×3). (?)Chinen sand (17495).

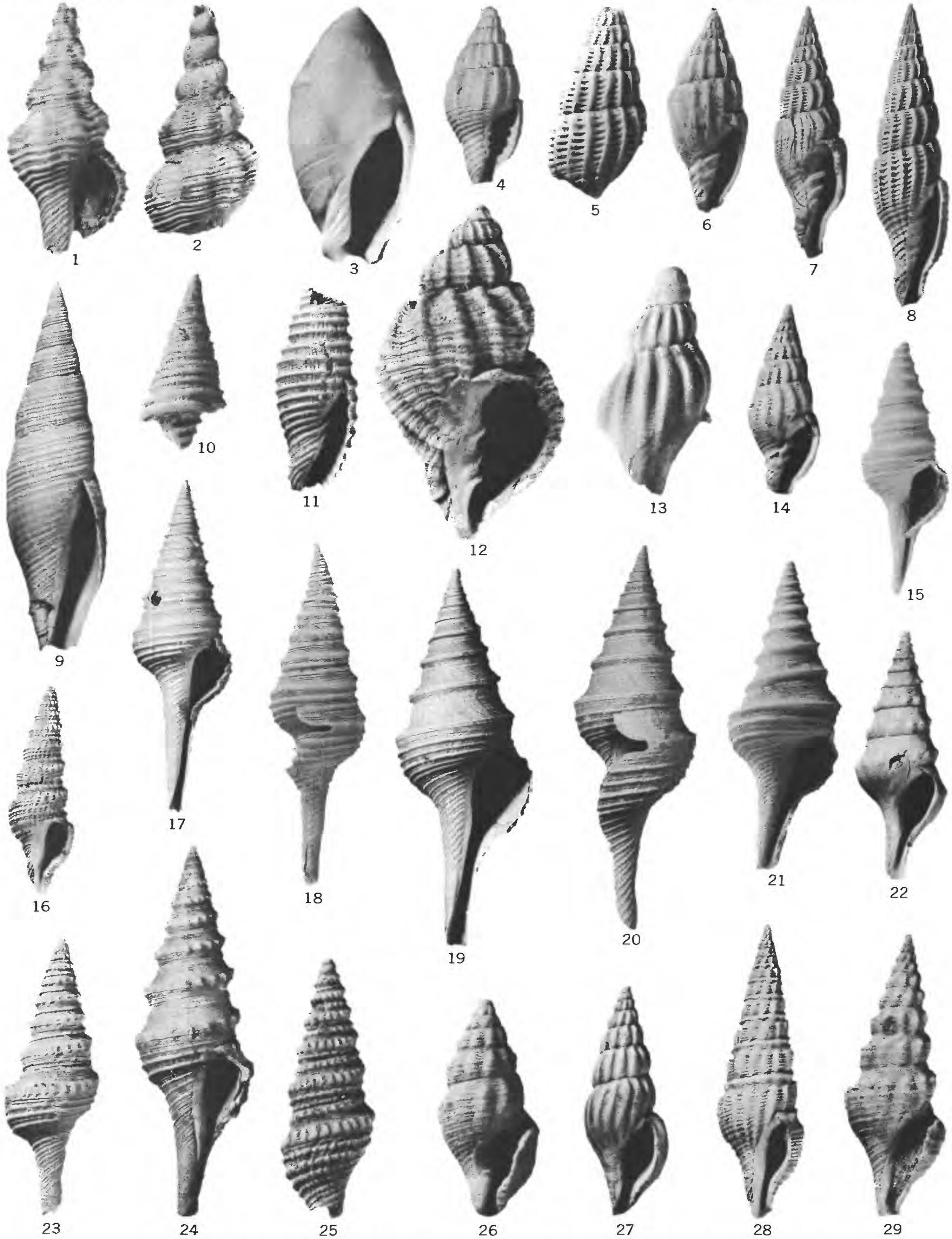
29. *Nassarius* (*Niotha*) *gemmulatus* (Lamarck) Deshayes (p. 79). Figured specimen (USNM 562951). Apertural view (×1½), height 26.2 mm, diameter 17.2 mm. Nakoshi sand (17440).

30. *Nassarius* (*Niotha*) *caelatus* (A. Adams) (p. 79). Figured specimen (USNM 562952). Apertural view (×2), height 21 mm, diameter 11 mm. Chinen sand (17481).

31. *Nassarius* (*Hinia*) *prefestivus*, n. sp. (p. 81). Holotype (USNM 562953). Apertural view (×4), height 11.4 mm, diameter 6.6 mm. (?)Chinen sand (17495).



MOLLUSKS OF THE SHINZATO TUFF MEMBER OF THE SHIMAJIRI FORMATION, CHINEN SAND, AND NAKOSHI SAND



MOLLUSKS OF THE SHINZATO TUFF MEMBER OF THE SHIMAJIRI FORMATION, CHINEN SAND, AND NAKOSHI SAND

PLATE 14

Gastropoda of the Shinzato tuff member of the Shimajiri formation (figs. 22, 24, 25), Chinen sand and Nakoshi sand

FIGURES 1–2. *Fusinus* cf. *F. nodosoplicatus* (Dunker) (p. 84). Figured specimens. 1. (USNM 562954). Apertural view of a juvenile with broken canal (×2), height 23.5 mm, diameter 11.8 mm. Nakoshi sand (17440). 2. (USNM 562955). Nonapertural view of a partly decorticated spire (×1), diameter 22.4 mm. Chinen sand (17442).

3. *Ancilla* (*Baryspira*) cf. *A.* (*B.*) *albocallosa* (Lischke) (p. 86). Figured specimen (USNM 562956). Apertural view (×2), height 24.7 mm, diameter 12.5 mm. Chinen sand (17481).

4. *Anachis* (*Costoanachis*) *chinenensis*, n. sp. (p. 68). Holotype (USNM 562957). Apertural view (×6), height 5.4 mm, diameter 2.5 mm. Chinen sand (17482b).

5, 7–8. *Uromitra* aff. *U. obeliscus* (Reeve) (p. 90). Figured specimens. 5. (USNM 562958). Fragment showing sculpture (×3). Chinen sand (17442). 7. (USNM 562959). Apertural view of a pathologic? specimen (×1½). 8. (USNM 562960). Apertural view (×1½), height 37.8 mm, diameter 10 mm. Chinen sand (17481).

6. *Pusia* cf. *P. emmae* (Yokoyama) (p. 90). Figured specimen (USNM 562961). Apertural view (×3), height 13 mm, diameter 5.1 mm. Nakoshi sand (17440).

9. *Mitra* (*Cancilla*) *yokoyamai* Nomura (p. 93). Figured specimen (USNM 562962). Apertural view (×1), height 69 mm, diameter 19.7 mm. Chinen sand (17481).

10. *Mitra* (*Cancilla*) cf. *M.* (*C.*) *flammea* Quoy and Gaimard (p. 94). Figured specimen (USNM 562963). Spire fragment (×3). Chinen sand (17442).

11. *Mitra* (*Cancilla*) *filaris* (Linné) (p. 93). Figured specimen (USNM 562964). Apertural view (×3), diameter 5.4 mm. Chinen sand (17442).

12. *Cancellaria chinenensis*, n. sp. (p. 99). Holotype (USNM 562965). Apertural view (×4), height 15.5 mm, diameter 9.3 mm. Chinen sand (17482b).

13. *Fulgoraria* aff. *F. hirasei* (Sowerby) (p. 97). Figured specimen (USNM 562966). Near-apertural view of a fragment (×2), diameter 11 mm. Chinen sand (17481).

14. *Uromitra* aff. *U. lirocostata* (Cossmann) (p. 91). Figured specimen (USNM 562967). Apertural view (×4), height 8.8 mm, diameter 3.6 mm. Nakoshi sand (17440).

15, 21. *Lophiotoma* cf. *L. leucotropis* (Adams and Reeve) (p. 100). Figured specimens. 15. (USNM 562968). Apertural view (×1½), height 32.8 mm, diameter 11 mm. 21. (USNM 562969). Apertural view (×3), height 19.4 mm, diameter 7.1 mm. Chinen sand (17442).

16. *Clavatula* (*Alticlavatula*) cf. *C.* (*A.*) *kakegawensis* (Makiyama) (p. 110). Figured specimen (USNM 562970). Apertural view (×2), height 19.8 mm, diameter 6.4 mm. Chinen sand (17442).

17–18. *Lophiotoma marmorata* (Lamarck) (p. 101). Figured specimen (USNM 562971). 17. Apertural view (×1½), height 41 mm, diameter 13 mm. 18. Labial view of same showing sinus. Chinen sand (17442).

19–20. *Unedogemmula* cf. *U. indica* ((Bolten) Roeding) (p. 101). Figured specimen (USNM 562972). 19. Apertural view (×1½), height 48 mm, diameter 17 mm. 20. Labial view of same showing sinus. Chinen sand (17481).

22. *Makiyamaia coreanica okinavensis*, n. var. (p. 108). Holotype (USNM 562973). Apertural view (×1½), height 31 mm, diameter 11.9 mm. Shinzato tuff (17458).

23. *Gemmula* cf. *G. granosa* (Helbling) (p. 102). Figured specimen (USNM 562974). Nonapertural view (×3), height 17.3 mm, diameter 6 mm. Chinen sand (17481).

24. *Gemmula granosa ryukyuensis*, n. subsp. (p. 103). Holotype (USNM 562975). Apertural view (×1½), height 47 mm, diameter 15 mm. Shinzato tuff (17458).

25. *Gemmula* sp. ind. (p. 103). Figured specimen (USNM 562976). Nonapertural view (×4), height 12 mm, diameter 4.5 mm. Shinzato tuff (17458).

26. *Glyphostoma subcosticrenata*, n. sp. (p. 116). Holotype (USNM 562977). Apertural view (×4), height 10 mm, diameter 4.9 mm. Chinen sand (17442).

27. *Neoguraleus kutekinensis*, n. sp. (p. 115). Holotype (USNM 562978). Apertural view (×3), height 14.5 mm, diameter 5.4 mm. Chinen sand (17482b).

28. *Crassispira psuedoprincipalis* (Yokoyama) (p. 112). Figured specimen (USNM 562979). Apertural view (×2), height 27.5 mm, diameter 8.3 mm. Nakoski sand (17440).

29. *Clathrodrillia* cf. *C. jeffreysii* (Smith) (p. 113). Figured specimen (USNM 562980). Apertural view (×2) height 26.8 mm, diameter 9.6 mm. Chinen sand (17442).

PLATE 15

Gastropoda of the Shinzato tuff member of the Shimajiri formation (figs. 1, 14, 17), Chinen sand, Nakoshi sand, and Recent series (figs. 15, 23–24)

FIGURE 1. *Lioglyphostoma tenuata,* n. sp. (p. 116). Holotype (USNM 562981). Apertural view (×4), height 12.4 mm, diameter 3.7 mm. Shinzato tuff (17458).

2. *Euclathurella fimbria,* n. sp. (p. 117). Holotype (USNM 562982). Apertural view (×2), height 20.7 mm, diameter 7.1 mm. Chinen sand (17442).

3. *Lioglyphostoma chinenensis,* n. sp. (p. 117). Holotype (USNM 562983). Apertural view (×4), height 11.4 mm, diameter 3.7 mm. Chinen sand (17482b).

4. *Daphnella ryukyuensis,* n. sp. (p. 118). Holotype (USNM 562984). Apertural view (×2), height 24 mm, diameter 8.7 mm. Chinen sand (17481).

5–9. *Buccinaria (Ootomella) loochooensis,* n. sp. (p. 120). 5. Holotype (USNM 562985). Apertural view (×1½), height 26.5 mm, diameter 11.5 mm. 7. Nonapertural view of same. 6. Figured specimen (USNM 562986). Apertural view (×1½), height 28.3 mm, diameter 12.1 mm. 8. Nonapertural view of same. 9. Figured specimen (USNM 562987). Enlargement of tip (×10). Chinen sand (17481).

10. *Etrema saplisi,* n. sp. (p. 116). Holotype (USNM 562988). Near-apertural view (×3), height 16 mm, diameter 7.5 mm. Chinen sand (17481).

11–12. *Thatcheria* cf. *T. gradata* (Yokoyama) (p. 121). Figured specimen (USNM 562989). 11. Magnification of early whorls (×6). 12. Near-apertural view of same specimen (×1), greatest diameter 28.7 mm. Chinen sand (17481).

13, 16. *Conus* cf. *C. eburneus* Hwass (p. 123). Figured specimen (USNM 562990). 13. Top (×1½). 16. Apertural view (×1½), height 36 mm, diameter 19.5 mm. Nakoshi sand (17440).

14, 17. *Conus* cf. *C. yabei* Nomura (p. 123). Figured specimen (USNM 562991). 14. Top (×1). 17. Apertural view (×1), height 65 mm, diameter 30.5 mm. Shinzato tuff (17458).

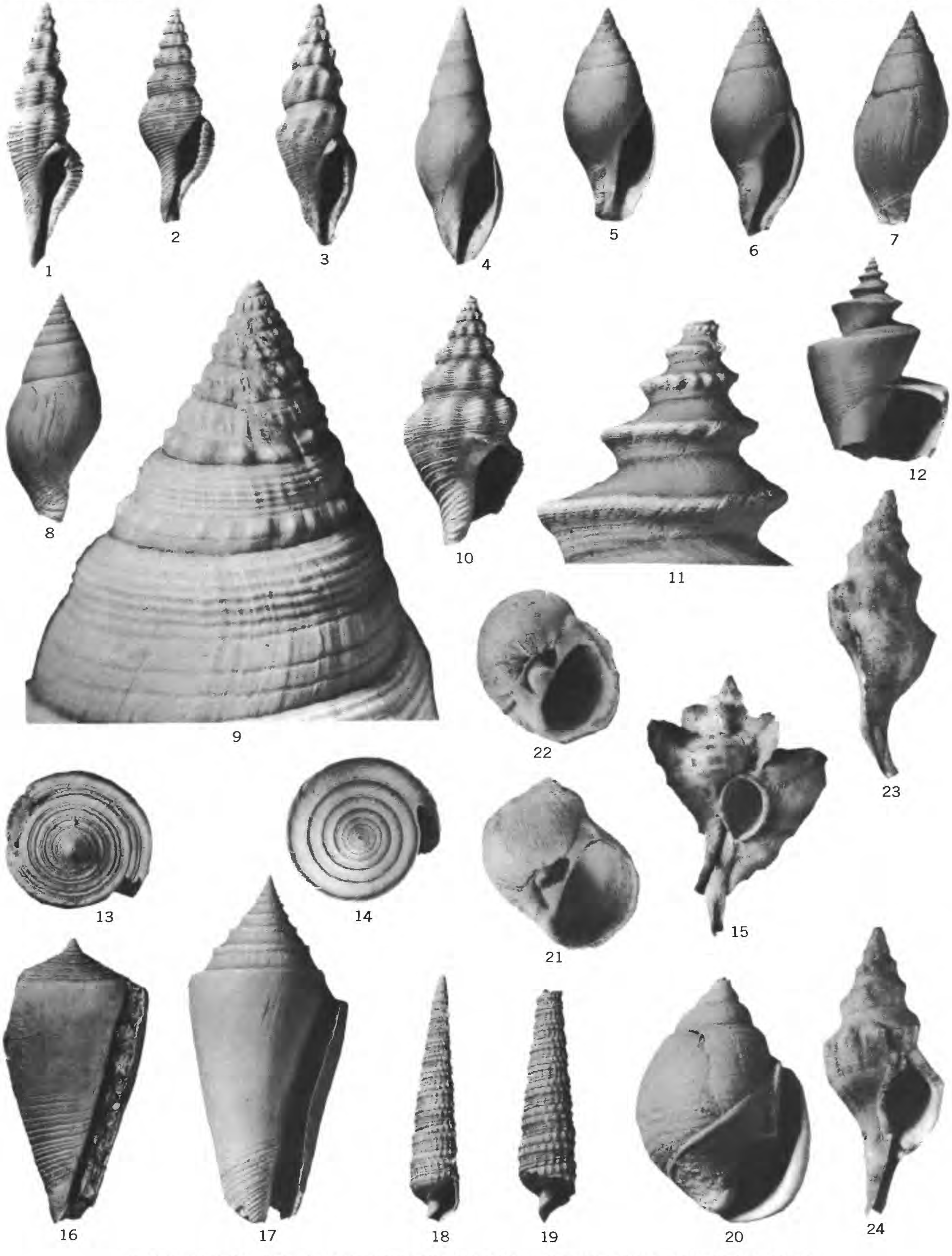
15. *Ceratostoma brachypteron* (A. Adams) (p. 64). Figured specimen (USNM 344163). Apertural view (×1). Recent, Kii, Japan.

18–19. *Terebra torquata* Adams and Reeve (p. 125). Figured specimens. 18. (USNM 562992). Apertural view (×2), height 23 mm, diameter 4.8 mm. 19. (USNM 562993). Nonapertural view of a larger specimen (×2), diameter 5.5 mm. Chinen sand (17481).

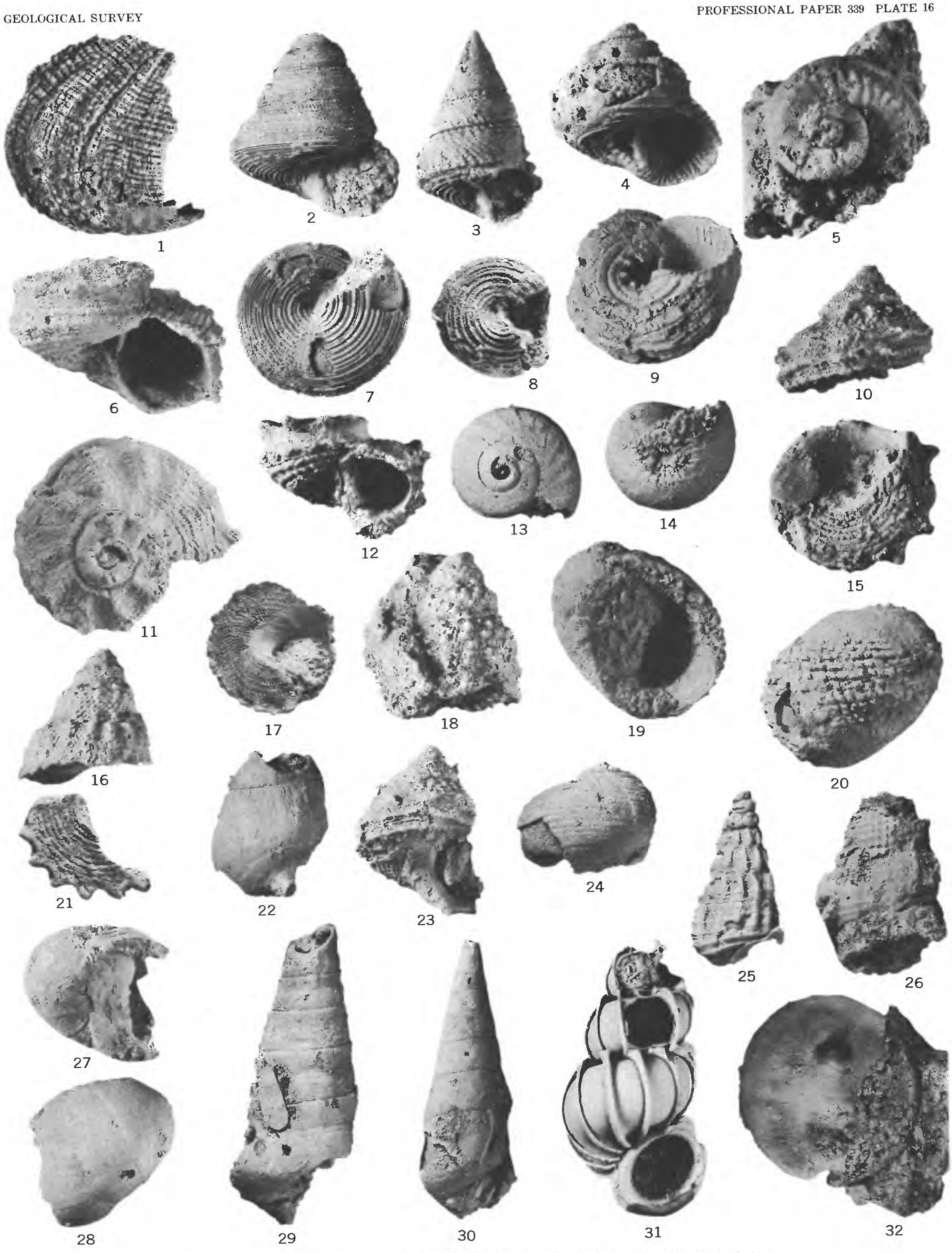
20. *Ringicula (Ringiculella)* cf. *R. musashinoensis* Yokoyama (p. 126). Figured specimen (USNM 562994). Apertural view (×8), height 5.7 mm, diameter 4 mm. Chinen sand (17481).

21–22. *Naticarius marochiensis* (Gmelin) s. l. (p. 55). Figured specimens. 21. (USNM 562995). Apertural view (×3), height 10.6 mm, diameter 9.7 mm. 22. (USNM 562996). Base (×3). Nakoshi sand (17483).

23–24. *Afer chinenensis*? MacNeil (p. 76). Figured specimen (USNM 205355). 23. Labial view (×1). 24. Apertural view (×1). Recent, Korea Strait, Japan Sea.



MOLLUSKS OF THE SHINZATO TUFF MEMBER OF THE SHIMAJIRI FORMATION, CHINEN SAND, NAKOSHI SAND, AND RECENT SERIES



MOLLUSKS OF THE NAHA LIMESTONE AND YONTAN(?) LIMESTONE

PLATE 16

Gastropoda of the Naha limestone

FIGURE 1. *Haliotis* cf. *H. diversicolor* Reeve (p. 22). Figured specimen (USNM 562997). Fragment of exterior (×1), greatest diameter 45 mm. Naha limestone (17484).

2, 7. *Calliostoma* (*Tristicotrochus*) *nahaensis*, n. sp. (p. 25). Holotype (USNM 562998). 2. Apertural view (×3), height 12 mm, diameter 11 mm. 7. Base of same. Naha limestone (17484).

3, 8. *Calliostoma* (*Pulchrastele*) *ikebei*, n. sp. (p. 25). Holotype (USNM 562999). 3. Apertural view (×3), height 12.8 mm, diameter 7.7 mm. 8. Base of same. Naha limestone (17497a).

4, 9. *Clanculus microdon ater* Pilsbry (p. 27). Figured specimen (USNM 563000). 4. Apertural view (×3), height 10.5 mm, diameter 11.5 mm. 9. Basal view of same. Naha limestone (17484).

5. *Stomatia* cf. *S. rubra* (Lamarck) (p. 28). Figured specimen (USNM 563001). Top view of an internal mold (×2), diameter 15.6 mm. Naha limestone (17661).

6, 11–12. *Angaria delphinus* (Linné) (p. 29). Figured specimen (USNM 563002). 6. Apertural view (×1½), height 20 mm, diameter 29 mm. 11. Top of same. (?) Yontan limestone (17637). Figured specimen (USNM 563003). 12. Apertural view (×1½), height 17 mm, diameter 22.7 mm. Naha limestone (17574).

10, 23. *Bolma* cf. *B. pseudomodesta* (Nomura) (p. 33). Figured specimen (USNM 563004). 10. Nonapertural view (×1½), height 18.3 mm, diameter 20.4 mm. Naha limestone (17529). Figured specimen (USNM 563005). 23. Apertural view of broken specimen (×2). Naha limestone (17497b).

13–14. ?*Leucorhynchia* sp. ind. (p. 29). Figured specimen (USNM 563006). 13. Top view (×6), diameter 3.9 mm. 14. Base of same. Naha limestone (17518).

15, 21. *Calcar* sp. ind. (p. 33). Figured specimen (USNM 563007). 15. Base (×1½). Naha limestone (17497a). Figured specimen (USNM 563008). 21. Fragment of base (×1½). Naha limestone (17440).

16–18. *Calcar loochooensis*, n. sp. (p. 33). Holotype (USNM 563009). 16. Nonapertural view (×2), height 14.7 mm, diameter 12.9 mm. 17. Base of same. Naha limestone (17669). Figured specimen (USNM 563010). 18. Nonapertural view (×2). Naha limestone (17539).

19–20. *Nerita* aff. *N. reticulata* Karsten (p. 34). Figured specimen (USNM 563011). 19. Apertural view (×2), height 15 mm, diameter 16.4 mm. 20. Nonapertural view of same. Naha limestone (17610).

22. *Cerithium* cf. *C. vertagus* (Linné) (p. 41). Figured specimen (USNM 563012). Nonapertural view of a partial specimen (×1), diameter 23 mm. Naha limestone (17473).

24. ?*Magilis* sp. (p. 66). Figured specimen (USNM 563013). Nonapertural view (×3). Naha limestone (17585).

25. *Batillaria* aff. *B. zonalis* (Bruguière) (p. 39). Figured specimen (USNM 563014). Apertural view of broken specimen (×2), diameter 9 mm. Naha limestone (17673).

26. *Tibia* sp. ind. (p. 48). Figured specimen (USNM 563015). Fragment (×2). Naha limestone (17484).

27–28. *Nerita* cf. *N. polita* Linné (p. 34). Figured specimen (USNM 563016). 27. Apertural view of broken specimen (×2), height about 16 mm. 28. Nonapertural view of same. Naha limestone (17610).

29. *Zeacumantus* sp. ind. (p. 40). Figured specimen (USNM 563017). Nonapertural view (×1½), height 39 mm. Naha limestone (17474).

30. ?*Niso* sp. ind. (p. 45). Figured specimen (USNM 563018). Near-apertural view (×4), height 13 mm, diameter 4.7 mm. Naha limestone (17518).

31. *Epitonium* (*Glabriscala*) *submaculosum*, n. sp. (p. 45). Holotype (USNM 563019). Apertural view (×3), diameter 9.3 mm. Naha limestone (17600).

32. *Cheilea equestris* (Linné) (p. 46). Figured specimen (USNM 563020). Internal mold in limestone (×1), length 36 mm, width 34 mm, height 13 mm. Naha limestone (17571).

PLATE 17

Gastropoda of the Naha limestone, Yontan limestone (fig. 25), and "Pliocene?, Kikaiga-shima" (figs. 20, 23–24)

FIGURE 1. *Cypraea* sp. ind. (p. 50). Figured specimen (USNM 563021). Apertural view (×1), length 64 mm, diameter 48 mm. Naha limestone (17484).

2, 6. *Erosaria* (*Ravitrona*) *helvola* (Linné) (p. 51). Figured specimen (USNM 563022). 2. Posterior end (×1½), length 22 mm, width 16.4 mm. 6. Apertural view of same. Naha limestone (17484).

3, 7. *Talparia* (*Arestorides*) *nahaensis*, n. sp. (p. 49). Holotype (USNM 563023). 3. Posterior end (×1), length 40 mm, diameter 24 mm. 7. Apertural view of same. Naha limestone (17541).

4, 8. *Cypraea* (*Lyncina*) aff. *C.* (*L.*) *arenosa* Gray (p. 50). Figured specimen (USNM 563024). 4. Posterior end (×1), length 29 mm. 8. Apertural view of same. Naha limestone (17484).

5. *Cypraea* (*Lyncina*) aff. *C.* (*L.*) *carneola* Linné (p. 50). Figured specimen (USNM 563025). Apertural view (×1), length 46 mm, diameter 29 mm. Naha limestone (17484).

9. *Oniscidia* cf. *O. cancellata* (Sowerby) (p. 57). Figured specimen (USNM 563026). Nonapertural view (×1), diameter 25 mm. Yontan limestone (17652).

10. *Cymatium* (*Lampusia*) cf. *C.* (*L.*) *pileare* (Linné) (p. 59). Figured specimen (USNM 563027). Partial specimen (×1½), height 22.5 mm. Naha limestone (17484).

11, 17. *Latirulus* cf. *L. cracticulatus* (Linné) (p. 83). Figured specimen (USNM 563028). 11. Nonapertural view (×2), diameter 11.6 mm. 17. Apertural view of same. Naha limestone (17484).

12–13. *Nassarius* (*Zeuxis*) cf. *N.* (*Z.*) *picta* (Dunker) (p. 81). Figured specimen (USNM 563029). 12. Apertural view (×2), height 19 mm, diameter 11.4 mm. 13. Nonapertural view of same. Naha limestone (17673).

14. *Mitra* (*Nebularia*) cf. *M.* (*N.*) *hanleyana* Dunker (p. 93). Figured specimen (USNM 563030). Fragment (×1½). Naha limestone (17484).

15. *Incerta sedis* (p. 78). Figured specimen (USNM 563031). Apertural view (×4), diameter 6.3 mm. Naha limestone (17474).

16. *Incerta sedis* (p. 64). Figured specimen (USNM 563032). Fragment showing sculpture (×2). Naha limestone (17608).

18. *Pyrene* aff. *P. ligula* (Duclos) (p. 66). Figured specimen (USNM 563033). Apertural view (×2), height 19.6 mm. Naha limestone (17474).

19. *Cylindromitra undulosa* (Reeve) (p. 95). Figured specimen (USNM 563034). Apertural view (×1½), height 28.5 mm, diameter 14.5 mm. Naha limestone (17610).

20, 23–24. *Lyria rex* Hirase (p. 97). Topotype? (USNM 344378). Apertural view (×1), height 53.4 mm, diameter 23 mm. "Pliocene (?) deposit", Kikaiga-shima. 23. Figured specimen (USNM 563035). Near-apertural view (×1½), diameter 15 mm. 24. Nonapertural view of same. Naha limestone (17484).

21. *Mitra* (*Nebularia*) aff. *M.* (*N.*) *chrysostoma* Broderip (p. 92). Figured specimen (USNM 563036). Apertural view (×1½), height 37 mm, diameter 14.6 mm. Naha limestone (17673).

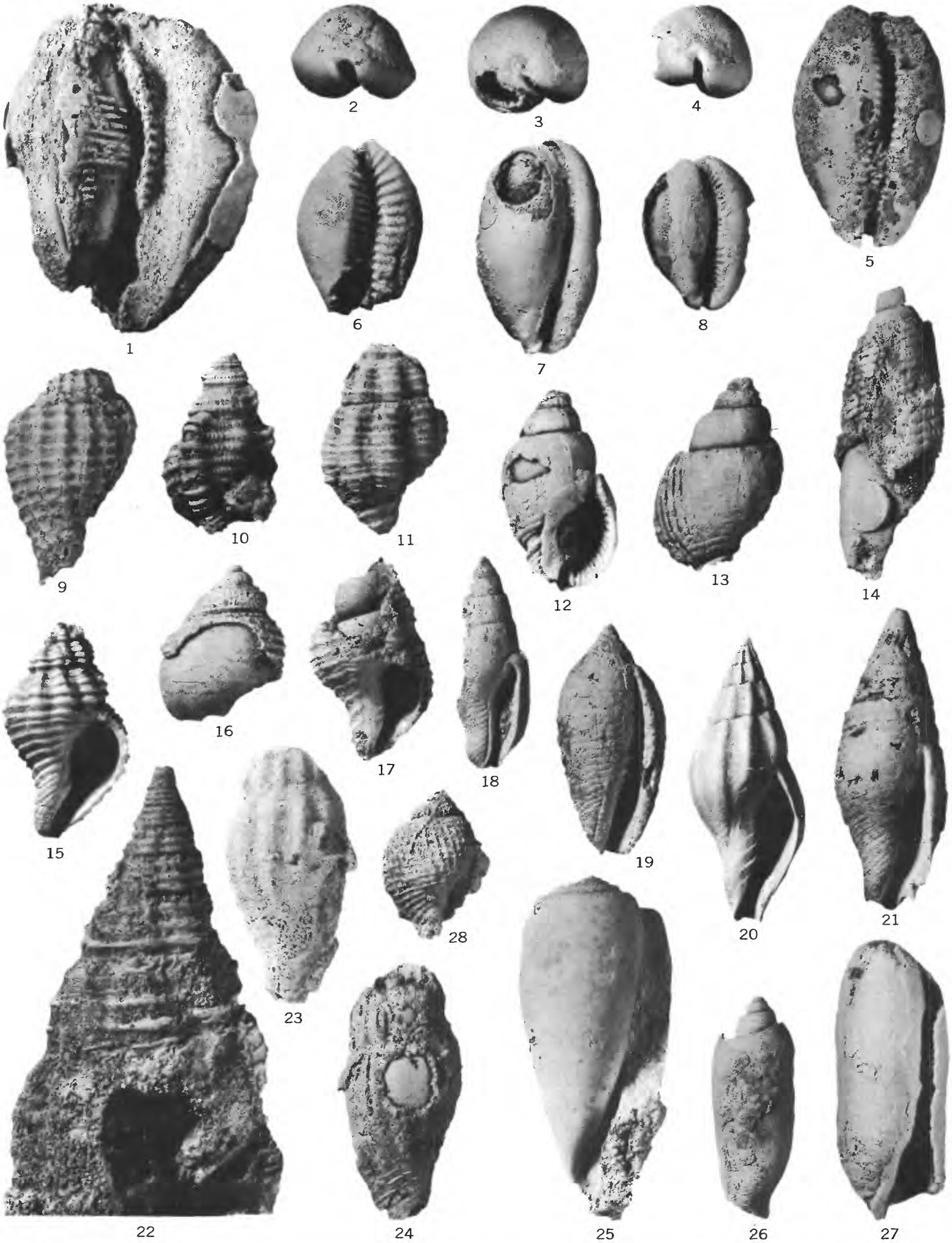
22. *Cantharus* (*Pollia*) sp. ind. (p. 77). Figured specimen (USNM 563037). Spire showing details of sculpture (×4). Naha limestone (17484).

25. *Conus* aff. *C. textile* Linné (p. 125). Figured specimen (USNM 563038). Internal mold (×1). Yontan limestone (17543).

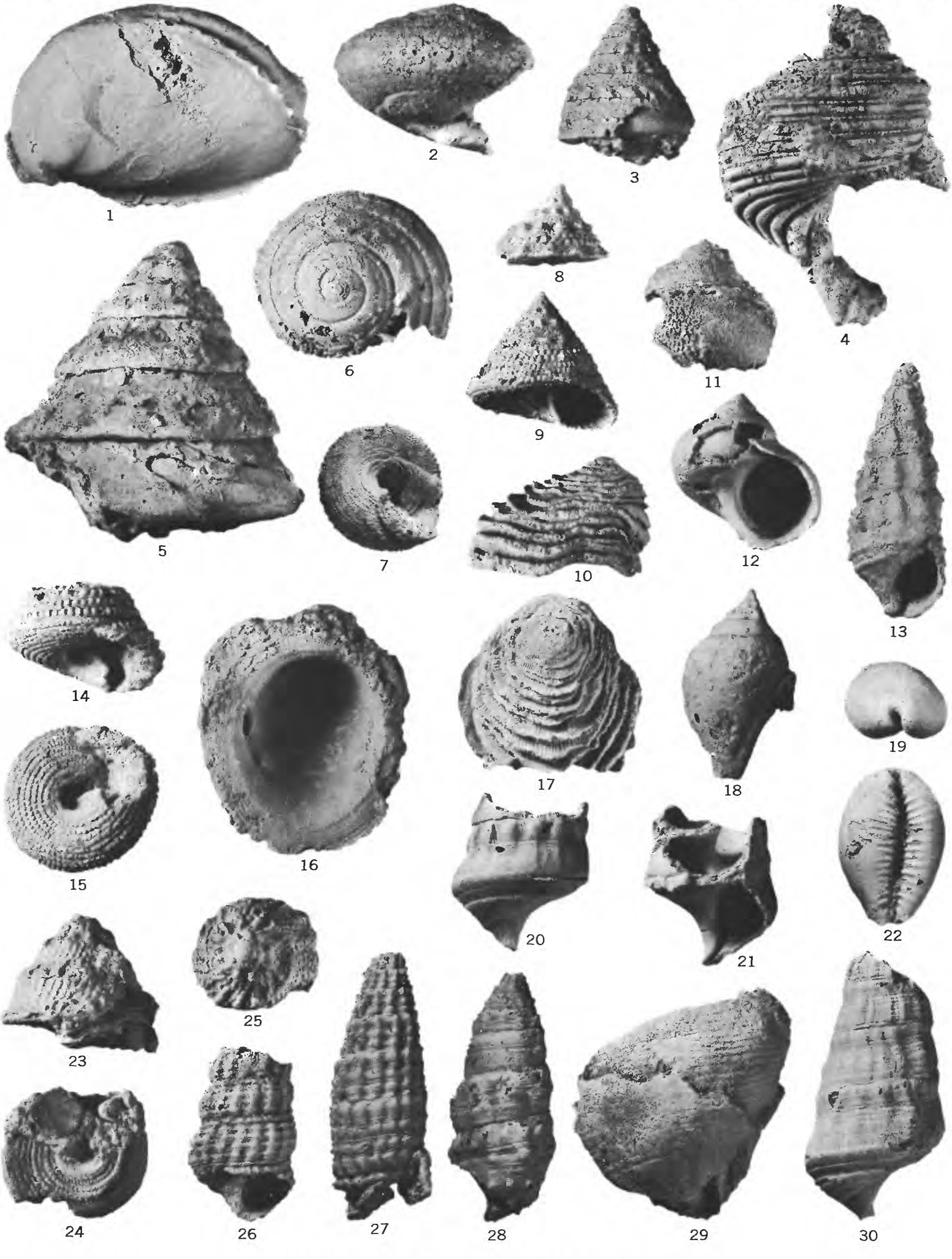
26. *Conus* aff. *C. musatella* Linné (p. 125). Figured specimen (USNM 563039). Internal mold (×1). Yontan limestone (17595).

27. *Cylichna* cf. *C. arachis* (Quoy and Gaimard) (p. 128). Figured specimen (USNM 563040). Apertural view (×6), height 9 mm, diameter 3.6 mm. Naha limestone (17499).

28. ?*Cancellaria* sp. (p. 99). Figured specimen (USNM 563041). Apertural view (×2), height 14 mm, diameter 10 mm. Naha limestone (17464).



MOLLUSKS OF THE NAHA LIMESTONE, YONTAN LIMESTONE, AND PLIOCENE(?) OF KIKAIGA-SHIMA



MOLLUSKS OF THE YONTAN LIMESTONE

PLATE 18

Gastropoda of the Yontan limestone

FIGURE 1. *Haliotis* cf. *H. diversicolor* Reeve (p. 22). Figured specimen (USNM 563042). Internal mold (×⅔), length 86 mm, diameter 59 mm. Yontan limestone (Is–10).

2, 6. *Umbonium* aff. *U. costatum* (Kiener) (p. 28). Figured specimen (USNM 563043). 2. Apertural view of incomplete specimen (×3), height 9 mm, diameter 12.9 mm. 6. Top of same. Yontan limestone (17672U).

3, 5. *Trochus niloticus* Linné (p. 25). Figured specimen (USNM 563044). 3. Nonapertural view of a young specimen (×1), height 33 mm. Yontan limestone (17644b). Figured specimen (USNM 563045). 5. Nonapertural view of a large specimen (×½), height 100 mm. Yontan limestone (17544).

4. *Marmorostoma argyrostoma* (Linné) (p. 31). Figured specimen (USNM 563046). Apertural view of broken specimen (×1), height 55 mm, greatest diameter 47 mm. Yontan limestone (17511).

7, 9. *Trochus calcaratus* Souverbie (p. 26). Figured specimen (USNM 563047). 7. Basal view (×1), diameter 28 mm. Yontan limestone (17666). Figured specimen (USNM 563048). 9. Apertural view (×1½), height 18 mm, diameter 19.6 mm. Yontan limestone (17545).

8. *Trochus* sp. ind. (p. 26). Figured specimen (USNM 563049). Nonapertural view (×2), height 9 mm, diameter 11.2 mm. Yontan limestone (17544).

10, 16–17. *Hipponix* (*Antisabia*) *foliaceus* Quoy and Gaimard (p. 47). Figured specimen (USNM 563050). 10. Side view (×4), width 8.7 mm, height 5.6 mm. 17. Top view of same. Yontan limestone (17644b). Figured specimen (USNM 563051). 16. Basal view (×4). Yontan limestone (17544).

11. *Nerita* aff. *N. undata* Linné (p. 35). Figured specimen (USNM 563052). Fragment (×2). Yontan limestone (17514).

12. *Turbo petholatus* Linné (p. 31). Figured specimen (USNM 563053). Apertural view (×1), height 31 mm, diameter 31 mm. Yontan limestone (17544).

13. *Batillaria* aff. *B. zonalis* (Bruguière) (p. 39). Figured specimen (USNM 563054). Apertural view (×3), height 16 mm, diameter 6 mm. Yontan limestone (17550u).

14-15. *Clanculus margaritarius* (Philippi) (p. 27). Figured specimen (USNM 563055). 14. Apertural view of a partial specimen (×3), diameter 10.6 mm. 15. Base of same. Yontan limestone (17551).

18. *Strombus* aff. *S. gibberulus* Linné (p. 48). Figured specimen (USNM 563056). Apertural view of incomplete specimen (×1½), height 24 mm, diameter 15 mm. Yontan limestone (17652).

19, 22. "*Cypraea*" sp. aff "*C.*" *asellus* Linné (p. 52). Figured specimen (USNM 563057). 19. Posterior end (×1½), length 20 mm, width 13.5 mm. 22. Apertural view of same. Yontan limestone (17544).

20, 21, 30. *Zeacumantus* sp. ind. (p. 40). Figured specimen (USNM 563058). 20. Nonapertural view (×2), diameter 12.8 mm. 21. Apertural view of same. Figured specimen (USNM 563059). 30. Nonapertural view (×4), diameter 6.6 mm. Yontan limestone (17658).

23–25. *Calcar* cf. *C. haematraga* (Menke) (p. 32). Figured specimen (USNM 563060). 23. Near-apertural view (×1½), height 17 mm, diameter 20 mm. 24. Base of same. Figured specimen (USNM 563061). 25. Top of a smaller specimen (×2). Yontan limestone (17644b).

26. *Cerithidea rhizoporarum* A. Adams (p. 39). Figured specimen (USNM 563062). Near-apertural view (×1½), diameter 13.5 mm. Yontan limestone (17550u).

27. *Cerithium asperum* (Linné) (p. 41). Figured specimen (USNM 563063). Apertural view (×1½), height 34 mm, diameter 13.6 mm. Yontan limestone (17652).

28. *Cerithium* (*Thericium*) *echinatum* Lamarck (p. 42). Figured specimen (USNM 563064). Nonapertural view (×1½), height 31 mm, diameter 13 mm. Yontan limestone (17644b).

29. ?*Rapana* sp. (p. 62). Figured specimen (USNM 563065). Nonapertural view (×1). Yontan limestone (17515)

PLATE 19

Gastropoda of the Yontan limestone

FIGURES 1–2. *Pustularia* cf. *P. circercula* (Linné) s.l. (p. 50). Figured specimen (USNM 563066). 1. Nonapertural view (×3), length 14 mm, width 8.6 mm. 2. Apertural view of same. Yontan limestone (17511).

3, 10. *Erosaria* (*Ravitrona*) *caputserpentis* (Linné) (p. 51). Figured specimen (USNM 563067). 3. Apertural view (×1), length 29 mm, width 23 mm. 10. Posterior end of same. Naha limestone (17554).

4, 11. *Cribraria* (*Talostolida*) *teres* (Gmelin) (p. 52). Figured specimen (USNM 563068). 4. Apertural view (×1½), length 25.8 mm, width 14.6 mm. 11. Posterior end of same. Yontan limestone (17543).

5–6. *Staphylaea* (*Nuclearia*) *nucleus* (Linné) (p. 51). Figured specimen (USNM 563069). 5. Nonapertural view (×1½), length 21 mm, width 13.8 mm. 6. Apertural view of same. Yontan limestone (17544).

7. *Latirus* cf. *L. polygonus* (Gmelin) (p. 82). Figured specimen (USNM 563070). Apertural view (×1½), height 24 mm, diameter 12 mm. Yontan limestone (17553).

8. *Nassa serta* (Bruguière) (p. 64). Figured specimen (USNM 563071). Apertural view (×1), height 42.4 mm, diameter 23 mm. Yontan limestone (17544).

9, 12. *Erosaria* (*Erosaria*) *erosa* (Linné) cf. var. *phragedaina* (Melvill) (p. 51). Figured specimen (USNM 563072). 9. Apertural view (×1½), length 25 mm, width 15.5 mm. 12. Posterior end of same. Yontan limestone (17542).

13, 15–16. *Magilus antiquus* Montfort (p. 66). Figured specimens. 13. (USNM 563073). Nonapertural view of a juvenile (×2). Yontan limestone (17644b). 15. (USNM 563074). Basal view of an uncoiled adult (×1), diameter of coiled portion 37 mm. 16. Top view of same. Yontan limestone (17542).

14, 21, 27. *Conus* cf. *C. vitulinus* Hwass (p. 124). Figured specimens. 14. (USNM 563075). Top view (×1½). 27. Nonapertural view of same specimen (×1½), height 22.5 mm, diameter 18 mm. 21. (USNM 563076). Top view of another specimen (×1½). Yontan limestone (17544).

17–18. *Alectrion papillosus* (Linné) (p. 79). Figured specimen (USNM 563077). 17. Nonapertural view (×1½), diameter 21.5 mm. 18. Apertural view of same. Yontan limestone (17652).

19. *Pusia meganodosa*, n. sp. (p. 89). Holotype (USNM 563078). Apertural view (×2), height 18 mm, diameter 9.2 mm. Yontan limestone (17652).

20. *Pyrene punctata* (Bruguière) (p. 66). Figured specimen (USNM 563079). Apertural view (×2), height 16.6 mm, diameter 11 mm. Yontan limestone (17552).

22. *Latirulus* cf. *L. cracticulatus* (Linné) (p. 83). Figured specimen (USNM 563080). Apertural view (×2), height 20 mm, diameter 9.8 mm. Yontan limestone (17545).

23, 29. *Conus* cf. *C. glans* Hwass (p. 124). Figured specimen (USNM 563081). 23. Apertural view (×2), height 20.5 mm, diameter 11.5 mm. 29. Nonapertural view of same. Yontan limestone (17544).

24. *Atys* (*Aliculastrum*) *cylindrica* (Helbling) (p. 127). Figured specimen (USNM 563082). Apertural view (×3), height 14.4 mm, diameter 8 mm. Yontan limestone (17652).

25, 31. *Conus lividus* Hwass (p. 124). Figured specimen (USNM 563083). 25. Top view (×1½). 31. Apertural view of same (×1½), height 39 mm, diameter 22 mm. Yontan limestone (17544).

26. *Conus geographus* Linné (p. 124). Figured specimen (USNM 563084). Nonapertural view of a fragment of a body whorl (×1). Yontan limestone (17552).

28. *Terebra* aff. *T. formosana* Yokoyama (p. 125). Figured specimen (USNM 563085). Apertural view of a fragment (×1½), diameter 14.5 mm. Yontan limestone (17550).

30. Turrinid ind. (p. 101). Figured specimen (USNM 563086). Apertural view (×2). Yontan limestone (17551).

MOLLUSKS OF THE NAHA LIMESTONE AND YONTAN LIMESTONE