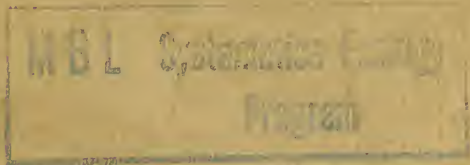


MOLLUSKS
OF THE
TROPICAL EASTERN
PACIFIC

PARTICULARLY FROM THE SOUTHERN HALF
OF THE PANAMIC-PACIFIC FAUNAL
PROVINCE (PANAMA TO PERU)

Panamic-Pacific Pelecypoda

By
AXEL A. OLSSON



PALEONTOLOGICAL RESEARCH INSTITUTION

ITHACA, N. Y.

1961

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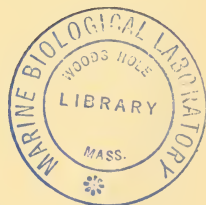
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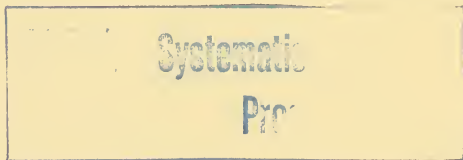
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On various surveys and trips along the coast of Central America and South America, the author has been accompanied by many geologists and engineers too numerous to mention here. In Costa Rica and Panama, the author was accompanied by R. A. Terry on many arduous trips, mainly for geological investigations but on which collections of both fossil and marine molluscan shells were generally secured. Notably amongst these expeditions in Panama were the ones to the Darien and the Pearl Islands; the Los Santos Province and to the Burica Peninsula, all in 1935. During parts of 1935 and 1936, the author accompanied by O. D. Boggs of the International Petroleum Company travelled along the greater part of the coast of western Colombia and Ecuador between Buenaventura and the Gulf of Guayaquil, and except for stretches of mangrove, the traverse was made largely on foot. This long trek of many months offered opportunities for collecting at many remote localities and to assemble data on regional distribution.

Since the beginning of this study of the Pelecypoda in 1953, two major expeditions have been made to Ecuador and Panama, both aided in part by grants from the American Philosophical Society. On the first of these in 1953, the author was accompanied by two famed collectors and students of Recent mollusks, T. G. McGinty of Boughton Beach, Florida, and J. Weber of Miami. Alfred G. Fischer, at that time geologist for the Inter-

national Petroleum Company and now at Princeton University, was also a member of this expedition. A second expedition to Ecuador was made in 1955 when the writer was accompanied by the late Ted Dranga and Mrs. A. Dranga. Amongst Panama Canal Zone personnel, the author is especially indebted to the late James Zetek, former Resident Manager of Barro Colorado Island Wildlife Reservation and his assistant, Mrs. A. Gomez, for many courtesies; and among local naturalists and collectors the following: Captain W. S. Bitler, USN, Mr. and Mrs. Lee Beil, Mr. and Mrs. H. Johnson, Mr. and Mrs. H. B. Haskell and Mr. Stewart Jadis. Lastly, the author wishes to thank Katherine V. W. Palmer, Director of the Paleontological Research Institution for much help in the past, tracing literature references and under whose editorial guidance this work was published. Myra Keen's comprehensive work on Panamic mollusks appeared after the major part of our study had been completed; hence only occasional reference to it will be found in this memoir.

DEPOSITION OF TYPES AND FIGURED SPECIMENS

The holotypes of the new species described in this work have been deposited at the Academy of Natural Sciences in Philadelphia, and where additional material is available, the paratypes of the same species will be placed in other museum collections. Unless otherwise indicated, the figured specimens, largely from my own collection, have been deposited at the Paleontological Research Institution at Ithaca, New York.

Coral Gables, Florida
July 1st, 1958.

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PART I. INTRODUCTION

1. GENERAL STATEMENT

This work on Panamic mollusks deals with the genera and species of the Pelecypoda known principally from the southern half of the great Panamic-Pacific zoogeographic province or more precisely from the region extending from Costa Rica southward to northern Peru. This large faunal region in its fullest development begins in the Gulf of California in northwestern Mexico and extends southward to northern Peru or along a coast-line of more than 4500 nautical miles. In spite of its great length, its molluscan fauna is remarkably uniform throughout and efforts to divide the province into smaller subregions, not strictly ecological in character, have so far failed. It is in the southern half of the province (which includes Panama) where the Panamic fauna attains its most typical development, and where the majority of its species were first discovered and afterwards named. It is also the region so fully explored by Hugh Cuming at the beginning of the 19th century, the great era of oceanic exploration and conchological description. Shell collecting in Panama and Ecuador may be at times rewarding in the large number of species obtainable at a few special localities where optimum conditions of environment exist, and where large tracts of sea bottom become uncovered during periods of abnormally low or minus tides.

To the geologist and especially to the invertebrate paleontologist familiar with West Indian, Caribbean, and South American Tertiary fossils, the living mollusks of the Panamic-Pacific region have a special meaning. During the greater part of Tertiary time and more especially in the Miocene and early Pliocene, the tropical West Atlantic and the tropical East Pacific constituted a single zoogeographical province or faunal region (West Tethyan), its species for the most part of Atlantic origin. Channels or seaways across parts of northwestern Colombia, Panama, and Costa Rica were then open affording free communication between the Pacific on the one hand and the Caribbean or West Atlantic on the other; hence the Miocene mollusks of the West Indian-Caribbean region are related and in many cases identical with those from rocks of the same age in Ecuador and northern Peru. Towards the end of the Pliocene and more fully in the Pleistocene, the isthmian straits were closed by an uplift forming a final land connection between North America and South America. This period of earth disturbance, world-wide in scope, appears to have culminated in the mid-Pleistocene, the time of maximum glaciation in the Northern Hemisphere and of a general lowered sea-level elsewhere (see K. K. Landes, 1952). It seems likely that large tracts of the shallower parts of the Caribbean Sea were then drained, resulting in extinction of many species and forcing others to retreat into the deeper portion of the basin. As compared to its richness in the Miocene, the present-day Caribbean mollusks appear strangely modified and greatly impoverished; on the other hand,

the Panamic-Pacific molluscan fauna has remained fundamentally unchanged. The living Panamic-Pacific mollusks are, therefore, a part of a larger relict fauna, once more widely distributed, left isolated in the Pacific zone by the isthmian land uplift of Pleistocene times. This aspect of the origin and affinities of our Panamic mollusks was forecast by early paleontological studies but its full significance and bearing on the Recent faunas were not until now so fully understood.

In this work the main attention will be focused on the neritic species of the Pelecypoda or those which live along a bottom environment of 100 meters (300 feet) or less. This belt of shallow water has sometimes been called the "littoral zone". This is the zone of strong daytime illumination or of light penetration (the Photo zone) suitable for the growth of green plants on which in the ultimate analyses all life in the sea depends. Today the term "littoral" is generally used in a more restricted sense, or for the small area laid bare by tidal changes (intertidal zone) and to the immediate strand line along which a limited number of marine species live. To the larger region of shallow waters extending from extreme low tide to the edge of the continental shelf, the term "neritic" is employed, a name proposed by Haeckel to complement the expression "oceanic" or the environment of blue waters of the open sea. For the same region of shallow water, Ekman proposed the term "shelf zone".

Modern methods of classification and the naming of animal and plant species (taxonomy) commenced with the adoption of the binomial system of nomenclature introduced by Linnaeus, that of the animal kingdom dating from the publication of the 10th edition of *Systema Naturae* in 1758. Many excellent works on mollusks had appeared before the *Systema* but lacking in a uniform method of species naming, their interest to the average student is largely historical. After Linnaeus, the second half of the 18th and the first half of the 19th century, witnessed a feverish activity in exploration and in the naming of new species of mollusks from all parts of the world. In this haste of species making, many new names were proposed without adequate description or illustration so that their subsequent identification was both difficult and uncertain. It was fortunate for the science of malacology that interest in shells was sufficiently broad that the preparation of a fine series of well-illustrated monographs or Iconographs was soon begun. Some of these works on conchology, such as that of Chenu's magnificent *Conchological Illustrations* in four large folio volumes, are the finest colored illustrations of shells ever produced. At the same time, studies on the soft parts of the animal were started, and the importance of the radula in classification discovered.

A careful survey of any large family of mollusks will generally show the need for closer generic differentiation and for a revision in classification. Many families of mollusks, as defined at present, are of composite or polyphyletic origin, the genera placed together for convenience or in sharing a few common characters. Such families on close study will be broken apart or divided into smaller categories such as subfamilies which generally means

the lower taxa must also be divided, and often new ones proposed. This condition has been the case in the Arcidae, Veneridae, and the Olividae. Other large families are more compact, such as the Tellinidae and Conidae, and efforts to divide them even into clearly defined genera have been less successful. The author is strongly opposed to name changing for mere priority reasons or to give undue recognition to works of questionable value, thereby replacing generic names well established by long usage and scientific authority.

2. HISTORICAL REVIEW

The collecting of plant specimens, mainly for the purpose of discriminating those with food or medicinal value began shortly after the Spanish Conquest, but the first serious studies projected along modern scientific lines in tropical America was that of the French Mission sent out by the Academie des Sciences in 1735-44 for the purpose of obtaining an exact measure of a degree of the meridian at the equator and from which the size and figure of the earth could be calculated in conjunction with observations of a similar character at other points of the earth's surface. Members of this mission included C. M. de la Condamine, Pierre Bouguer, and Louis Godin as geodesist and Joseph de Jussieu as botanist. No marine shells were obtained by this group. This mission was followed in the opening years of the 19th century by the famous journey of Alexander von Humboldt and Aime Bonpland who travelled through the greater part of northern South America from eastern Venezuela to Peru. No other expedition to South America accomplished so much in the whole realm of science or left as lasting impression of good will in the lands through which these distinguished visitors journeyed. During the last stages of this remarkable expedition, Humboldt and Bonpland traversed southern Ecuador and reached the upper Amazon or the Marañon at Tompenda situated above the cataracts known as the Ponga de Retema. This was a point of some geographic significance because of an earlier astronomical fix made by Condamine. From this place on the upper Amazon, Humboldt and Bonpland began the ascent of the Peruvian Andes which they crossed in the latitude of Cajamarca and Cotumaza and finally reached the coast at Trujillo from which point they continued on southward to Lima. As the two travellers descended the last slopes of the Andes and approached the coast, they entered into a strange land which became increasingly more arid, the slopes of the mountains beyond the narrow limits of the valley floor devoid of plant growth aside from a few straggling bushes and cacti. This was the travellers' introduction to the great coastal desert of Peru which begins in the north near the Ecuadorian border and extends far southward into middle Chile. Gaining the coast, they noticed that the air held a feeling of coldness, the sky overcast, and the nearby landscape at times obscured by a blanket of mist (*garua*) which drifted inland from the sea, tainted with a scent of ammonia arising from offshore rocks and islands, whitened with guano. Humboldt speculated deeply on this unusual climatic set-up

in latitudes so near the equator, quickly sensed its cause, attributed it to the cooling effects of a stream of cold waters swept northward along the Peruvian coast by an oceanic current. As far as known, Humboldt's description and accurate diagnoses of the Peruvian current (now sometimes called the Humboldt Current) is the first mention of this important oceanic stream in the literature. Humboldt secured a few shells along the Peruvian coast, others in Mexico, which were described by Valenciennes a few years later.

Humboldt's achievements in South America attracted widespread attention in Europe and several other expeditions were shortly organized. The first of these expeditions to South America was one sponsored by the Museum National d'Histoire Naturelle de Paris who selected Alcide d'Orbigny to serve as a travelling naturalist and to explore the southern half of the continent thus complementing in some respects the work accomplished by Humboldt in the north. D'Orbigny at the age of 24, was exceptionally well qualified for this task, both in the fields of zoology and in geology. He sailed from France, the 31st of July, 1826, and about a month later, landed at Rio de Janeiro at a time of war between Brazil and Argentina. Over the next six years, D'Orbigny travelled through a large part of southern Brazil to Argentina, then into Bolivia, Chile, and finally to Peru, often through wild, unexplored, and at times dangerous country. He finally reached Lima and while there met M. Fontaine, a countryman of his and a physician on the French warship, the *Griffon* then anchored in the roadstead of Calloa. The two close friends roamed the countryside and dredged for mollusks in the harbour. After a stay of about 10 days, D'Orbigny departed for France while Fontaine continued his collecting of both shells and fossils as far north as Paita.

The work of D'Orbigny on the natural history of South America is monumental in its scope, the results published in five magnificently illustrated volumes ("Voyage dans l'Amérique Méridionale") issued from 1835 to 1847. The volume on the mollusks is a work of 758 pages (quarto) and illustrated by an atlas of 85 (82 colored) plates many of the figures showing the extended animal. This is the largest single work devoted exclusively to South American Mollusca, but as far as the marines are concerned, it deals mainly with southern species from Peru, Chile, and the Argentine.

The visit of Charles Darwin to South America as naturalist and geologist aboard *HMS Beagle* commanded by Captain Fitz Roy followed that of D'Orbigny or with a small overlap. The two naturalists did not meet in the field. Although Darwin's work led to important results in the fields of geology and paleontology and in laying the foundation for his later studies in evolution, Darwin paid no particular attention to Recent mollusks, his chief interest in shells was their occurrence in high level terraces and as indicators of uplift along certain parts of the coast of Chile and Peru in relatively Recent times.

By far, the largest collection of shells ever assembled by one man was that of Mr. Hugh Cuming. The Cuming Collection, although somewhat depleted by sale and by trade, was acquired by the British Museum (Natural History) in 1865 when it was reputed to have contained about 19,000 specimens. Reeve in the preface to volume 20 of the *Conchologica Iconica* stated that the collection (Cuming) for its richness and completeness then rivaled all other collections of marine shells in the world together. In recent years, most of its type specimens have been segregated, although others may still remain to be identified and picked out of the general systematic collection amongst which they had been distributed. Mr. Hugh Cuming, an Englishman by birth, went to Chile about 1819, and resided in Valparaiso with some interruptions until 1831. He apparently prospered in his business connections so well that he was able to retire early and from then on to devote his time and fortune to the collecting of shells on a large scale. He built a yacht, named the *Discoverer*, which was fitted out especially for the collecting and dredging of marine specimens. He made his first trip to Juan Fernandez off the coast of Chile, then to Easter Island, and still further afield. On his second voyage which lasted two years, he explored the coast of Peru, then northward to Ecuador, Panama, Costa Rica, Mexico, and finally to Galapagos. Cuming returned to London in 1831 where his interest in shells took on a still larger field, leading to the organization of an expedition to the Philippines. Much adverse criticism¹ has been directed against Cuming mainly from envious zoologists who were denied access to his material or on the grounds that his locality labels were faulty and unreliable. This criticism may be partly true, but it should be remembered that Cuming was not a trained naturalist, and it is hardly fair to judge him by modern standards of field collecting. There has been little reluctance on the part of systematists from describing new species without locality records or many to base new species on scarcely recognizable material or without suitable illustration.²

The Cuming Collection contained only the choicest specimens available, and its new species were described for the most part by the ablest conchologists of the time. Probably its greatest defect is that specimens were added to it from time to time, as better ones were secured, replacing some of the older ones. Cuming was in residence in Valparaiso at the time of the great earthquake of November, 1822, when his home was destroyed. An account of this quake was read before the Geological Society of London by Captain Fitz Roy of the *Beagle* who described the great tidal wave which swept in after the earth shocks, causing widespread damage. According to a note by Dall, tradition relates that Cuming's interest in col-

1. Gray, the most severe critic of Cuming, although then connected with the British Museum and contemporary of Sowerby and others, did not name directly any of Cuming's shells.

2. Darwin held Cuming in high esteem and often appealed to him for identification or for information on habitat station with respect to shells obtained from elevated terraces along the Chilean coast.

Mr. S. P. Dance of the British Museum (Natural History) has through diligent search of museum records and correspondence unearthed much new information on Cuming, his life and accomplishments.

lecting was then aroused by the quantity of shells and other products of the sea carried ashore by the great wave.

We have unfortunately no account of the collecting activities of Cuming during his Pacific voyages or if any records were kept, they have since been destroyed. Most of the new species were described by Broderip, the two Sowerbys, Hanley, Reeve, and Deshayes, the most eminent conchologists in England at the time and published mainly in the Proceedings of the Zoological Society of London. It is largely from the supplementary remarks accompanying these descriptions that some information on the localities visited by Cuming can be obtained. These locality citations show that Cuming collected extensively and at such places as Tumbes in northwestern Peru; and in Ecuador at Isla del Muerte and Puna Island in the Gulf of Guayaquil, at Santa Elena, Xipixapa (Jipijapa [Puerto Callo]), Salango, Isla la Plata, Manta (Montecristi), Bahia (Bahia de Caraquez), Atacames. Northward, he continued on to Panama, collecting at the Pearl Islands, and then on to Costa Rica and Mexico. From my own experiences along the coast of Peru and Ecuador, the locality citation for Cuming's shells have proved correct with the possible exception of one or two species, the same forms being common at the places mentioned; a good example is *Litharca lithodomus*. This species was described from a few specimens collected by Cuming at Montecristi (present-day Manta) and stated as found in holes in stones, pierced by Pholades at low water. The specimens were apparently taken alive as borne out by the appearance of the shells in the British Museum. *Litharca* is fairly common at Manta, living in deep bores in sandstone ledges between softer shales uncovered at low tide. Elsewhere *Litharca* is extremely rare and known only from a few drift valves.

During the 18th and a considerable part of the early 19th century, the nations of Europe vied with each other in organizing expeditions of oceanic exploration to distant lands, much of it connected with the opening up of new trade routes and the determination of geographic points necessary for the tracing of trustworthy, navigational charts. Several such ships fitted out by the French and British, touched at points along the west coast of South America and then continued their journey on across the Pacific and around the world. The accomplishments of the French ships in particular were often of a high order and through their finely illustrated reports, we have the first real account of the geology and natural history of many places. The drawings of Quoy and Gaimard for instance, in color of the living, fully expanded mollusks published in the plates of the "Voyage of the *Astrolabe*", are unexcelled and have not often been equalled since. On March 9, 1823, the French ship *La Coquille* anchored in the Bay of Paita and remained there until March 23d. Messrs. Garnon, Lesson, and Gaudichaud served as naturalists aboard this vessel. During the stay at Paita, excursions were made through various parts of the surrounding country as far as the village of Amotape in the Chira Valley. Notice was taken of the fossiliferous calcareous formation (the tablazo beds capping

the cliffs behind Paita) which they compared with the Calcaire Grossier of the Paris Basin. Fossils collected by this group were later described by D'Orbigny. The next French ship to visit Paita was the *La Bonite* which arrived there on July 25th, 1836. On this vessel, Messrs. Eydoux and Souleyet served as zoologists and Chevalier as geologist. Chevalier explored the environs of Paita and gave the first correct description of the geology accompanied by a structural section. He considered the capping tablazo limestones as much younger than the Calcaire Grossier and compared it rather with the falaise of Touraine and with Pampean formation of Buenos Aires. After leaving Paita, the *La Bonite* touched in at Santa Elena in Ecuador and then sailed for the Sandwich Islands. Due to the death of Eydoux at Martinique in 1841 of yellow fever, the description of the *La Bonite* mollusks has remained unfinished.

Roughly of the same date as the *La Bonite*, is the voyage of *HMS Sulphur*, an English ship commanded at first by Commander Kellett and afterwards by Captain Sir Edward Belcher, the latter taking a particular interest in the collecting of shells in which he was assisted by Richard B. Hinds, the ship's surgeon. After a visit to Callao and Paita, the *Sulphur* began a survey of the coast from the Gulf of Guayaquil northward to Panama. Dredging was carried on in the Gulf of Guayaquil with gratifying results ("we on one occasion spent a forenoon in the Bay of Guayaquil in using the dredge, and the results gave upwards of fifty species, and at other times, I have repeatedly enumerated between twenty and thirty species from a single cast"). It is reported that the cabin of Captain Belcher soon became so filled with marine products as to take on the aspects of a museum. The many new species discovered on the voyage of the *Sulphur* were afterwards described in a special work devoted to the zoology of the voyage, the author of the names given to the mollusks was Hinds. Since the *Sulphur* dredged in waters of moderate depth and often some distance from shore, many special species were discovered which have remained rare to the present-day.

By now, Panama had become known for its many fine shells, and its location as a transshipment point between the Atlantic and Pacific made it a convenient stop-over for travellers, some of whom brought back shells. This was true in particular during the late 40ths and 50ths when traffic across the isthmus was greatly augmented by miners and adventurers enroute to the newly discovered gold fields in California. During this period, several collectors visited Panama, the most important being Colonel Ezekiel Jewett who had served under General Scott in the Mexican wars. Jewett spent ten weeks in Panama in the early part of 1849 or about two years ahead of the visit there of C.B. Adams. Afterwards he collected in California and at Acapulco and Mazatlan. It is reported that Jewett's collection of Panama shells was large but as a result of an almost continuous change of residence along with the transmission of specimens for identification, the material became mixed and its labels deranged or lost. A list of species from the Jewett Collection was published by Philip Carpenter.

Later Jewett returned east, became interested in Paleozoic fossils of New York State, of which he amassed an unsurpassed collection and in this way he became associated with James Hall and finally awarded the post of Curator of the State Museum at Albany.

The name of C. B. Adams will always remain closely associated with Panamic shells. Adams was a professor of zoology at Amherst College in Massachusetts and in his earlier years had collected extensively in Jamaica, B.W.I., describing many species of both land and marine mollusks from there. On a leave of absence from teaching, Adams went to Panama, landed at Chagres on November 22, 1850 which at that time was the usual starting point for crossing the isthmus. With two companions, he started upriver by canoe and reached Las Cruces on the 25th. There they secured horses and rode the remaining few miles into Panama City where he secured lodging at the American Hotel. Adams stayed at Panama five weeks, collected assiduously, and kept copious notes recording species abundance and habitat station. Adams' account of his stay in Panama and of the collecting conditions met with there then are of high scientific, as well as historical value, and have often been quoted in part as an illustration of the exuberance of life which is sometimes developed in tropical waters where abundant food and suitable environment attain their optimum conditions.

The material gathered by Adams was shipped to Amherst filling eight large cases and when unpacked and sorted was found to contain 30,920 specimens of 515 species of mollusks of which 157 were afterward described as new, a large part of these new species being small or minute forms overlooked or ignored by the earlier collectors. Adams' Panama paper was published in 1852 but unfortunately the new species were not figured so that their identification until recently was difficult and uncertain. The Adams Collection was on loan at the Academy of Natural Sciences of Philadelphia for some time where the author had an opportunity to examine it closely. The collection has since been acquired by the Museum of Comparative Zoology at Harvard College, and a paper illustrating its type specimens was published by Ruth Turner in 1955.

A large collection of Mexican marine shells was made by Frederick Reigen, a Belgian, while in residence at Mazatlan between 1848 and 1850. This collection was sent to Liverpool and was eventually acquired by P. P. Carpenter. The shells selected by Carpenter, augmented by a large number of small or minute forms picked from the debris washed from *Chama* and *Spondylus* became the subject of a report published as a catalogue by the British Museum in 1875. More than 600 species of marine mollusks are covered in this work, the descriptions composed in Latin and accompanied in most cases by fairly copious notes. A large number of new species were described, mostly minute forms, and being unaccompanied by figures, the Mazatlan Catalogue has been difficult to use so that in many respects it retarded rather than advanced our knowledge of Pacific Coast shells for a long time. In full justice to Carpenter, no one was better qualified to monograph the Pacific Coast mollusks. Carpenter was already fully

familiar with the Cuming's Collection in the British Museum and the lack of illustration in the Mazatlan Catalogue was partly offset by the duplicate collections which he arranged and deposited in the museums at Washington, D.C., Albany, and Montreal. There is also at Washington, a set of plates of fine, camera-lucida drawings of the majority of the species described in the Mazatlan Catalogue. The main Mazatlan Collection is in the British Museum (Natural History) where it is readily available, the larger specimens are glued on glass plates, the smaller species such as *Caecum* and the vitrinellids on glass slivers placed in vials. Since many of the minute species were obtained from the pickings of *Spondylus*, and the like, the specimens are often broken and worn and being stuck down and in some cases deeply embedded in glue, only a single surface is exposed, and a critical study of the shell is difficult.

In 1891 and again in 1904-05, the United States Fish Commission steamer *Albatross* under the direction of Alexander Agassiz, carried on extensive dredging operations along the coasts of Mexico, Panama, Ecuador, Peru, and around the Galapagos Islands. As the *Albatross* mollusks were taken mostly in deep water they do not embrace many forms proper to the Panamic-Pacific province. The report on the mollusks was prepared by Dall and published as a separate bulletin of the Museum of Comparative Zoology at Cambridge, Massachusetts. This report is the first general account we have of the deep-sea mollusks of the eastern Pacific, the *Challenger* of the British Expedition having entered this region for a brief spell only and taken but a few hauls. Being mainly deepwater species, the *Albatross* forms do not particularly concern us in this work, but several closely allied species are known as fossil in Panama and Ecuador.

At the request of the Peruvian government, R. E. Coker connected with the United States Bureau of Fisheries spent several years in Peru, and reported upon the marine resources of that country, including studies on the nesting habits of the guano birds. Coker assembled large collections of marine invertebrates which were distributed amongst several specialists to work up, Dall reporting on the mollusks. ("Report on a Collection of Shells from Peru, with a Summary of the Littoral Marine Mollusca of the Peruvian Zoological Province," Proc. U.S. Nat. Museum, vol. 37, No. 1704, 1909) In this important paper, Dall besides describing the Coker material, also compiled a checklist of Peruvian marine mollusks, largely from the literature, thus bringing the subject up-to-date. The paper also contains a discussion of the Panamic and Peruvian faunal areas and a bibliography.

Between 1929 and 1931, H. N. Lowe, a Californian, collected assiduously along the coast of Mexico, San Salvador, Costa Rica, and Panama. An account of his experiences in the field was published in the *Nautilus* and in the Proceedings of the Academy of Natural Sciences. The latter paper in collaboration with Pilsbry also contains a section devoted to the description of the many new species secured as well as copious notes on many others. The paper is illustrated with a series of 17 plates.

In more recent years, much additional collecting of Panamic mollusks has been made under both professional and private auspices. In the former class belong the extensive explorations carried out throughout the eastern Pacific by expeditions sponsored by the New York Zoological Society under the direction of William Beebe and that of the Templeton Crocker Expedition, the combined molluscan material worked up by L. G. Hertlein and A. M. Strong of the California Academy of Sciences and published in various issues of *Zoologica* and in the *Bulletin of the American Museum of Natural History*. In these papers, the authors have described a large number of new species and extended the range of many others. Their revision of Panamic Pelecypoda is especially important.

The hobby of shell collecting and study amongst the Panama Canal Zone personnel has expanded greatly since the war, and the author is extremely indebted to many of the local naturalists who have contributed specimens, extended their hospitality, or guided him on many a trip to the beach. James Zetek, former resident manager of Barro Colorado Wildlife Refuge, has been an ardent collector of both land and marine mollusks for many years, and science is indebted to him for the discovery of many fine species described by Dall, Pilsbry, and others. Walter D. Clark, a former postmaster in the Canal Zone, ranks also as a good collector and through his discoveries contributed many new species described in the main by Maxwell Smith. Captain W. S. Bitler, USN, formerly stationed in the Zone, carried on extensive dredgings in the vicinity of Panama City and around the Pearl Islands and to whom the author is indebted for many specimens of *Oliva* and *Olivella* containing the soft parts for radular extraction.

3. COASTAL FEATURES BETWEEN PANAMA AND THE NORTHWESTERN PART OF PERU

Panama is naturally the center of the faunal province bearing its name as well as by its historical associations. The extraordinary abundance of marine mollusks at certain places in the vicinity of Panama City was emphasized through the writings of C. B. Adams, and it has often been debated whether shell life is still as abundant there as formerly. There is little doubt that the construction of the canal resulted in great destruction of marine life through its disturbances of the sea bottom, pollution, and other factors, at least locally, but perhaps in some measure mitigated through the creation of other environmental sites favorable to marine growth such as the building of the Amador causeway of rock ballast, amongst which many species live and breed. The entrance to the canal requires almost constant dredging of the ship channel and much mud from this source drifted on the tide has silted in considerable parts of the bay opposite Old Panama, covering its bottom with a layer of black mud leaving only a narrow beach at the upper tide level which can be safely traversed on foot. Beach collecting at Old Panama is usually good and such fragile species as *Harvella elegans*, *Pandora panamensis*, and *Nuculana*

polita, rare at most other localities, are common here, as well as a host of smaller forms, all of which must find congenial living quarters in the slimy mud outside. For the newcomer to Panama and to most of the shellers in residence in the Canal Zone, the favorite localities for collecting are Palo Seco (near the Leper colony) and Venado Beach. Both places are on the west side of the canal; both offer expansive mud flats, sand bars, rocky areas exposed at low water. Collecting is always best at night with a strong lantern, as many shy mollusks, which in the daytime lie buried in the mud or hidden under rocks, are then active and appear on the surface. A shelling spree in Panama at midnight at the right season and under proper guidance is an unforgettable experience, well worth the tramp through mud, with sore back, and general exhaustion which is sure to follow the next day. Almost any part of the long coastline of Panama offers good collecting of some sort but places as productive as Venado Beach are few. Perhaps the best locality in Panama outside of Venado Beach is Búcaro at the southern end of the Los Santos Peninsula, but at present difficult of access.

Molluscan records from western Colombia are scanty as much of its coastline has not been well explored, its northern part from Buenaventura to the Panama border not readily accessible by ordinary means of transportation, while its southern half is almost one continuous line of mangrove swamps. Our molluscan records for this coast are confined largely to the general vicinity of Tumaco, in Narino in southwestern Colombia. Good collections of shells were obtained on Isla del Gallo, a small island in the mouth of the Río Patia, and also from the mud flats exposed at Tumaco.

To the naturalist, the highly diversified coast of Ecuador offers unlimited opportunities for faunal studies for nearly its whole length. The mangrove swamp environment of southern Colombia continues into northern Ecuador, covering the banks of the numerous esteros around Punta Mangle with heavy forest growth and reaching into the lower portions of the Santiago and Cayapas river systems. There are, however, a few open spots near Puerto Limones where some collecting is possible. At Tola, at the mouth of the Cayapas, the coast changes gradually to a sand beach as the land behind it becomes higher. This condition continues on to Río Verde and then to Esmeraldas with diminishing patches of mangrove so, except for short stretches, travel by car or truck on the beach is feasible at low water. Similar conditions continue past Esmeraldas to Atacames (a Cuming locality) and Galeras, although at times, large scale land slides off the cliffs at Punta Gorda render a continuous traverse along the shore impassable by any means. The Galeras Peninsula must be crossed in the rear by a foot trail, its shore lined with rock cliffs rising sheer from the waters' edge and are passable only with great difficulty. At San Francisco, a small settlement on the south side of the peninsula, mangrove again makes its appearance in force and extends past Mompiche to Cojimenes. Cojimenes is a small village at the mouth of the river of the same name and at present an outlet for bananas shipped by small boats to

Esmeraldas for export. At this place, car travel in a southerly direction again becomes possible, partly along the beach to Jama and from there inland to Bahia. The road from Jama to Bahia is exceedingly rough and can be travelled only during the dry season. The shore can be followed on foot with some difficulty from Jama southward to Cabo Pasado, past Punta Borracho composed of fossiliferous Pliocene beds which are subject in wet weather to much slumping, covering the narrow beach with a thick mass of impassable mud. Cabo Pasados, so named because of its position just below the equator, is a small settlement and port offering some shelter and anchorage for small boats. South of the Cabo, the shore is precipitous and impassable on foot.

Bahia de Caráques, the third most important city along the west coast of Ecuador, lies at the head of the poorly defined Bahia de Manta, at the mouth of the Río Chones and the gateway to a rich agricultural hinterland. At Bahia, and for a considerable distance to the west, there are alternating stretches of sand beach and shelving flats of soft rock flanked by high cliffs of Tertiary formations. As seen so frequently along the coast of Ecuador, the soft rocks at water level are riddled with the borings of pholads and worms so thick that a fresh sample of the rock cannot be secured, the hammer or pick sinking to the hilt in the soft mass when struck. From Bahia the coastal trend is almost due south to Charapoto near the mouth of the small Río Puertoviejo and then more westerly on to Jaramijo and Manta. This long stretch of beach is usually passable by car or truck but the trip must be well timed so as to pass the mouth of Río Puertoviejo at the lowest stage of the tide, there being no bridge. The beach route is sometimes closed by slides near the Bahia end; then the much longer inland road to Montecristi, Puertoviejo, and Rocafuerte must be taken.

Manta is the largest city on the coast of Ecuador and, until lately, its most important port. (Esmeraldas, because of the banana trade, now ranks first in Ecuadorian export). At Manta and along the coast east to Jaramijo and west to San Mateo are some of the best collecting grounds met with in Ecuador but subject to great seasonal variation. The environs of Manta are semiarid, since this section of the coast is affected by the cooling influence of winds from the Humboldt Current far out to sea, hence the ravages of the "aguaje" is felt here as strongly as at Santa Elena. At such times, the region is deluged with torrential rains, the waters of the bay become rough and stormy, the waves lashing the shore with destructive effects both to the life in the shallows and to nearby objects on land. At normal times shells are plentiful at Manta, and a large number of species have been recorded from here. Rock borers are plentiful, amongst which is the interesting *Litharca lithodomus*, first taken here by Cuming.

Travel by car from Manta south towards Guayaquil or Jijijapa is over inland roads, first to Montecristi, and then forking towards the various destinations. A collector or naturalist wishing to follow along the coast must do so either on foot or in the saddle. West of San Mateo the

coast trend becomes more southerly until Cabo San Lorenzo is reached, a commanding headland formed of chert and igneous rocks. In this direction, the land rises, and the shore is lined with high cliffs, some of which are impassable even at lowest tide. The heights behind San Lorenzo are fairly wet or humid, and there are small strips of cultivated lands, and good water in springs or small streams is more plentiful. The more flourishing aspect of the country side is shown by the fresher, greener vegetation, and especially by the large clumps of bamboo, poles of which are cut and carried to Manta and other points for general construction. The shore south of San Lorenzo is for the most part a rock platform planed off by wave action. At Punta Blanca, about five miles below San Lorenzo, the shore cliffs are formed of beds of Pliocene age full of beautiful fossils, many of which are the same as Recent species. This rocky shore ends at Punta Canoa, replaced by a narrow sand beach awash at high water.

Callo, the port of Jipijapa (center of Montecristi Panama Hat industry) sits at the head of a large coastal indentation, widely open to the northwest, protected only by some outlying rocks and a small island. This is the commencement of the next, large coastal bulge known as Salango, the ocean end of a range of rugged mountains known as the Cordillera de Chongon and Colonche. Along the projected extension of this range out to sea in a northwesterly direction is the small Isla la Plata formed for the most part of igneous rocks and chert, its top shows remnants of several, wave-cut terraces or tablazos, covered locally with a thin veneer of Pleistocene deposits. The island is the type locality for many species, first collected by Cuming. Shell collecting is difficult as the shore line is precipitous and there is only one landing spot. Strong currents sweep past the island on both sides.

Salango, already mentioned, may be reached by a dry-weather road running between Jipijapa to Puerto Lobos and Machililla, or from Manglaralto if approached from the south. This is an extremely rugged area, the coast indented by many small coves between jagged, rocky points. At the head of some of the coves there are small beaches, usually with habitations. The small villages of Lobos and Machalilla have such location. Salango is also one of Cuming's locality, referred to by the authors of his species. Because of its general remoteness, Salango has not received the study from naturalists that it deserves.

South of Salango, the trend of the coast becomes southeasterly forming the northern arm of the large, open bay of Santa Elena. In this stretch are the villages of Manglaralto and San Pedro, the region still semihumid, with a fine fringe of coconut trees along the beach and small stands of mangrove, the last such met with on the west coast of Ecuador. Passing Punta Ayanque, the climate undergoes a marked change and becomes semi-arid, increasingly more southward to Santa Elena. Shortly below Puerto Palmar, the outlet for Colonche, the coast swings outward towards the southwest and opens into the more sheltered part of the bay of Santa Elena.

Distributed along this section of the Santa Elena Peninsula are the small villages of La Libertad, San Antonio, and Salinas, which become resort towns for the Ecuadorians during the rainy season in the interior. The small town of Santa Elena, lies inland a few miles from the shore. The Santa Elena Peninsula is the type locality for many of the species taken by Cuming and by other visiting naturalists; most of these records probably refer to the small stretch of coast between La Libertad and La Puntilla. Collecting along the beach at Santa Elena is unpredictable. At times the shore is smothered under a blanket of shells, at other times quite bare. At San Antonio and other places, fishermen setting nets for langosta (crayfish) often bring in a load of *Murex* and other large gastropods; the crayfish is reserved for sale in Guayaquil, the mollusks consumed by the local population. Excellent beach drift has been obtained along the north side of the peninsula, rich in small species. The rocky coves around La Puntilla (now a military reservation) and at the nearby Punta Carnera on the south side of the peninsula are good collecting spots at all times.

The extreme western point of the Santa Elena Peninsula is known as La Puntilla, a long, narrow neck composed of hard cherty and igneous rocks and cut into by several levels of tablazo. Passing this point, the south shore of the peninsula is deflected sharply towards the southwest to form the northern shoreline of the Gulf of Guayaquil for more than 60 miles. This is an open coast pounded by strong surf and except for a short stretch of rocky cliffs at the west (Punta Ancon and P. Carnera), it is mainly a soft sandy beach flanked behind by cliffs of Tertiary and tablazo beds, the seaward margin of a large plain which extends far inland. At the eastern end of this long stretch of monotonous coast, are the small resort villages of Playas and Posorja; across the Estero de Morro is the large well-wooded island of Puna, situated in the entrance to the Guayas River and a pilot station for steamers ascending the river to Guayaquil. The banks of the Guayas River and the numerous esteros connected with it are lined with a magnificent stand of tall mangrove trees, the same growth continuing on southward along the Jambeli channel and the coast of Río de Oro almost to the Peruvian border. *Anadara grandis* and *A. tuberculosa*, found here in great abundance, are sold in the market places in Guayaquil, and the large piles of their shells seen everywhere on shore testify to the importance which these mollusks must play in the food economy of the native population. Outside in the open sea of the Gulf of Guayaquil is the small, rocky island of Santa Clara or "El Muerte" frequently mentioned in molluscan and natural history reports.

Beyond the Jameli Channel the coast trend turns sharply to the southwest and continues in this direction past the Peruvian border near Tumbes to Cabo Blanco, forming the much longer southern limb of the Gulf of Guayaquil. This is also the north end of the great coastal desert of Peru which becomes increasingly more arid towards the south. At the Peruvian-Ecuadorian border, the climate is still sufficiently wet to support a fairly good growth of small trees and bushes nourished by yearly rains

while the Tumbes River, rising far back in the Andes, is a permanent, fast flowing stream. In the lower reaches of the Tumbes River, where its waters are rendered brackish by the tide, its banks are lined with a substantial growth of mangrove. This is the most southerly occurrence of this plant along the west coast of South America at this time. In the Pleistocene, the climate or northwestern Peru was at times more humid than at present, with mangrove extending at least two degrees or about 120 nautical miles further south as shown by the occurrence of its fossil leaves in clay beds near Talara and by specimens of *Anadara grandis* and *A. tuberculosa* at Sechura, and near Lagunitas; these mollusks as shown above occur in abundance only where mangrove conditions exist. During the climatic disturbances known as the invasion of "The El Niño" or the Aguaje, mangrove seedlings from the inner reaches of the Gulf of Guayaquil drift southward on the current. They become stranded in lagoonal areas along the coast, take root, and are established for a short time. Botanists have shown that the maintenance of successful growth of mangrove is dependent upon a minimum amount of annual rainfall even though other ecological factors are favorable.

At the mouth of the Tumbes River (Puerto Pizarro), the shore is formed by a sandy beach grading into mud flats and good collecting is generally obtained there. Tumbes is the type locality for many fine species obtained by Cuming. Good collecting is also generally available at Zorritos, especially if dredging can be done. Further west and south along the coast are numerous collecting spots mentioned as locality records in Part II of this work under the names: Punta Picos; Boca Pan; Caletto Mero; Caletto Sal; Mancora; Pena Negra; and Cabo Verde. The location of these places is shown on the Tumbes and Piura sheets of the American Geographical Society 1: 1,000,000 map of South America. This section of the Peruvian coast is readily accessible, being followed by the Pan-American Highway.

Cabo Blanco at the southwest end of the Gulf of Guayaquil is the most northerly member of a series of three large, bulging headlands which so well characterize this part of the northwest coast of Peru. The Cabo itself is a low ridge of sandstone but immediately behind it the land climbs rapidly to El Alto (an oil camp) situated on a high terrace plain (Talara and Mancora tablazo), a full thousand feet above the sea. Cabo Blanco is a famous fishing camp for marlin and other sport fish in the waters offshore. Passing southward of Cabo Blanco and its near neighbor Restin, the shore has a nearly due south trend and is formed mainly by a sand beach as far as Punta Nautilus, a small patch of sandstone rocks famous for its fossil nautiloids found there in abundance. A short distance further south is the oil town of Lobitos, lying in a small bay protected from the south by Punta Capullana. Punta Capullana is also the north boundary of the La Brea-Parinas estate of the International Petroleum Company, the largest oil producing property in coastal Peru. After crossing the wide, sandy stretch of the lower Parinas Valley with its green Algarroba (Honey Mesquite) trees scattered along its dried-up stream channel, there is

a stretch of sandy and rocky coast and then comes the small covelike harbor of Talara. Much changed from pioneer days, Talara today is an important, modern city with its refinery, shops and fine homes of the oil workers in this part of Peru. About five miles south of Talara is the town of Negritos, now less important than in former times, overlooking the sea with nearby Punta Parinas and Punta Balcones, the most westerly points of all South America.

Continuing southward past Punta Parinas with its light beacon perched on its shoulder and the nearby Punta Balcones, another long stretch of open sand beach is encountered which trends to the southeast past Portochuelo and the mouth of the Chira River, and thence to Colon. The coast then curves towards the west to form the next large bay "the Bay of Paita", widely open to the north but affording safe anchorage opposite its southern shore. The old city of Paita, founded in early colonial days, sits in a small gap at the base of high cliffs at the junction point of two contrasting rock formations. To the east of the city, there are high cliffs of the Chira shales capped by heavy beds of tablazo sands and coquina limestones; to the west by much older slates and schists, both rock formations, in spite of their great differences in hardness are planed off more or less evenly by a marine sea-transgression and overlain by a variable thickness of Pleistocene deposits of the Mancora tablazo forming a plain of wide extent. At this place the tablazo plain is elevated about 200 feet above the sea. Collecting along the shore at Paita is generally poor, but Paita is the type locality of many species, for the most part, dredged in the bay outside.

The middle bulge in the coast of northwestern Peru is that of the Paita Peninsula bounded on the north by the Bay of Paita and on the south by the deep Bay of Sechura. The peninsula is a broad, irregularly shaped area, its basement formed of ancient slates, schist, seamed with quartz veins and intruded by large masses of granodiorite. Near the middle of this area rise the Paita Mountains, a group of small, barren peaks which attain an elevation of about 400 meters above sea level. Elsewhere, the general surface of the peninsula is a flat plain or tablazo, barren for the most part of any vegetation. Along the west side of the peninsula, there are segments of Tertiary rocks infaulted between the slates and where these softer beds come to the shore, they have been eroded into deep, picturesque coves and small bays between the much harder slates which jut seaward in jagged, rocky points. In this section is located the small village of Yasila, easily accessible from Paita. Yasila is a good locality for Eocene fossils, and at times may offer collecting possibilities for marine shells. The south side of the peninsula is rugged, the shore lined with high cliffs of Cretaceous rocks overlain by a massive bed of tablazo limestone. This is a good locality for Cretaceous fossils. Nearby is the small fishing settlement of Tortuga.

South of the Paita Peninsula and between it and the third major headland of the coast, that of the Illescas Peninsula, is the large open Bay of Sechura. Like its much smaller neighbor to the north (Bay of Paita), the outline of its shore is shaped like that of a large fish hook, its sharp, barbed end at Punta Aguja pointing northwest, its long shank forming the seaward margin of the great Sechura desert stretching far inland. At both its northern and southern ends, the shores of Sechura Bay are rocky lined with high, steep cliffs; in between the long stretch of the inner bay is an open sandy beach. Bayovar at the south end, is a small, abandoned settlement, at one time the port and terminus of a small railway to some sulphur deposits at Revantazon at the southeast end of the Illescas Mountains. West of Bayovar towards Punta Aguja, the shore is rugged, formed for the most part of schist and other metamorphic rocks.

The beach at Bayovar is generally strewn with shells, many species of which attain a larger size here than they do in the north. This condition is well illustrated by *Mexicardia procera* which often has a height of 100 mm. or more. The beach is also covered with the dead valves of *Anomia peruviana*, large banks of which must lie off shore. *Aequipecten purpuratus* is as large here as so commonly seen south of Lima. During the severe aguaje of 1925, the shore at Salinas was swept by strong waves and large quantities of marine life of all sorts cast upon the beach. Many seabirds, deprived of their normal source of food, died in large numbers or wandered around on shore in a starved condition.

4. FAUNAL PROVINCES

Using the mollusks as a basis, Woodward, a century ago, arranged the coastal or shallow-water faunas of the eastern Pacific into five main geographic provinces, his data for the most part being the list of species compiled by D'Orbigny. Dall in 1910, followed Woodward's classification with only a few, minor changes. In 1936, Schenck and Keen suggested some modifications of the same system for the west coast of the United States, and placed the main boundaries at somewhat different points. They further indicated that the faunal provinces were not so sharply limited as first believed but were separated by wide belts of overlap or transition in which the species were more or less mixed. It will be seen later that an overlap or transitional zone separates the tropical Panamic-Pacific fauna from that of the cooler water Peruvian fauna along the northwest coast of Peru. Detailed studies along the Pacific coast of Central America and South America may perhaps show the need for other modifications or for the recognition of sub-regions, as for instance around the Galapagos Islands.

From the north southward, the main faunal or zoogeographic provinces

generally recognized along the Pacific Coast of North America, Central America, and South America are as follows:

1. The Aleutian or Oregonian Province

Extends from the limit of floating ice in Bering Sea south to Point Concepcion in California.

2. The Californian Province

From Point Concepcion south to Cape San Lucas at the southern end of the peninsula of Lower California.

3. The Panamic Province (the Panamic-Pacific)

From the head of the Gulf of California (about lat 30° 30' N.) south to Cabo Blanco in northwestern Peru (lat 4° 15' S.). A tropical zone with average surface temperatures between 80 and 85 degrees Fahrenheit except where modified by upwellings of cooler waters.

4. The Peruvian Province

From Punta Aguja at the southwestern end of Sechura Bay in northwestern Peru (lat 5° 40' S.) south to near Chiloe Island, Chile (near lat 42° S.). Temperature of the surface waters controlled by the Humboldt Current and extensive submarine upwellings. Temperature range between 58 to 65 degrees Fahrenheit.

5. The Magellanic or Patagonian Province

From Chiloe southward to Cape Horn and thence northward along the coast of Argentina.

The geographic points selected as marking the boundaries between the main faunal provinces are certain prominent capes or headlands where the coast generally shows a marked change of trend. It is usually in the vicinity of such headlands that major shifts in oceanic circulation frequently occur, resulting in marked differences in the temperature of the surface waters on either side. Usually, the change from one faunal zone to another is gradual, producing a transitional or overlap zone with a mixed assemblage of species spread over a belt of many miles.

a. THE PANAMIC-PACIFIC PROVINCE
ITS LIMITS AND FAUNAL CHARACTERISTICS

Largest in areal extent, the middle Province or the Panamic is also the richest and most diversified in its faunal makeup. As the Republic of Panama, from which the name "Panamic" is derived, borders on both the Atlantic (Caribbean) and the Pacific, the term "Panamic-Pacific" more clearly denotes the Pacific side and will be used in this work in place of the single term "Panamic".

The northern limits of the Panamic-Pacific faunal region can be drawn closely since it lies at the head of the Gulf of California at approximately lat 30° 30' N. and about long 114° W. From this point, the province extends in a southeasterly direction, its waters bathing the coast of Mexico, Guatemala, Nicaragua, Costa Rica, Panama, western Colombia, Ecuador, and northwestern Peru, or for a distance of about 4500 statute miles. It may also be somewhat expanded so as to include the waters around such offshore islands as Tres Marias, Cocos, and the island archipelago of the Galapagos. At the south, its limits cannot be fixed so closely and opinion has varied as to its location. For geographic reasons, the south boundary seems best placed at Cabo Blanco at the lower end of the Gulf of Guayaquil and the most westerly point of the South American continent. For the same reason, the north border of the Peruvian Province is placed at Punta Aguja (Dall location) at the southwest end of the Bay of Sechura, thus leaving between the two faunal regions a transitional zone about 120 nautical miles wide, here called the "Paita Buffer Zone" after the city and Bay of Paita situated near its middle point.

The Panamic-Pacific faunal region is essentially a tropical one as would be expected from its geographic location, but at many places strong upwellings occur which materially lower the temperature of the surface waters. Such belts of relatively cooler waters are met with frequently in the Gulf of Panama and off certain sections of Costa Rica. They periodically appear along the coast of Ecuador and when severe or of long duration may bring to those sections of the coastal lands a climatic upset similar to that of the Humboldt Current much further south in Peru. In Ecuador, as in Peru, the winds blowing steadily from the sea onto a more highly heated land, become dry and desiccating, and produce belts of aridity along the coast, in some cases nearly as barren and desert as in Peru (Santa Elena, Isla la Plata, Manta). Where the coast trend offers shelter from the sea winds, the climate is more humid and wet, the hills are clothed with vegetation, and the shore itself lined with mangrove (the inner section of the Gulf of Guayaquil, Manglaralto, Salango).

Although the waters of the Panamic-Pacific Province are somewhat cooler than would normally be expected in these latitudes, its fauna is essentially a tropical one but much less so than that of the Indo-Pacific, as shown by the general absence of reef corals and in the mollusks by the fewer species of *Conus*, *Cypraea*, and others. It is probably due to this factor that so few Indo-Pacific species have been able to establish themselves along the mainland coast although many such species have been able to do so on some of the off shore islands as reported by Hertlein.

In spite of its great length, the fauna of the Panamic-Pacific Province is remarkably uniform throughout with many of its most common species ranging from the Gulf of California southward to Peru. This fact is particularly well illustrated by the Pelecy-poda as shown by the tabulation on page 26. These percentages are based upon existing data and can be expected to change as the range of some species becomes better known.

Percentage of known species ranging from Gulf of
California to Ecuador or to Peru

<i>Family</i>	<i>Percentage</i>
Arcidae	73
Glycymeridae	55
Mytilidae	58
Pinnidae	33
Pteriidae	75
Diplodontidae	37
Lucinidae	45
Chamidae	57
Cardiidae	55
Veneridae	53
Petricolidae	12
Mactridae	50
Tellinidae	44
Solenidae	50
Corbulidae	50
Myacidae	75
Pandoridae	42
Thraciidae	25
Periplomatidae	13
Pholadidae	58

Exclusive of the cephalopods, nudibranchs, sea hares and the pteropods, the remaining groups of Panamic-Pacific mollusks have been conservatively estimated at about 2200 species. This estimate compiled some time ago is as follows:

Gastropoda	1662 species
Pelecypoda	496 species
Scaphopoda	14 species
Amphineura	27 species
Total	2199 species

Gastropoda

As would be expected, this class of the Mollusca contains the largest number of species, about three times all others combined. The number estimated above will no doubt be increased when such large families as the Turridae, Columbelloidae, Caecidae, and Pyramidelloidae are fully known. Other families may be reduced in the number of valid species attributed to them after revisional studies are made.

The gastropods include some of the finest and most interesting of Panamic mollusks. The Cancellariidae are well represented (about 33 species) with such fine species as *C. (Pyrucilia) solida*, probably the largest

species of the genus attaining a length of nearly three inches; the group of *C. (Euclia) cassidiformis*, also of large size; and the small *C. (Aphera) tessellata*, these three species have closely related forms amongst the Caribbean Miocene fossils. Other interesting and striking cancellarids are: *C. (Ovilia) cumingiana*, *C. (Narona) clavatula* and the mitralike *C. (Hertleimia) mitrifomis*. Of special interest is the rare *C. (Perplicaria) clarki* described by Maxwell Smith from Venado Beach, in the Canal Zone, the only other known species in the subgenus is *C. perplexa* from the Caloosahatchee Pliocene of Florida. Species of the Terebridae (about 35 species) are plentiful throughout the province, some species have a great range, others are more restricted; two of the largest species, *T. robusta* and *T. strigata*, are common on mud flats. *T. luctuosa*, related to *T. cinerea* of the Caribbean, is plentiful on sandy beaches; of a similar habitat is *T. aciculata*, common in Peru. The family Olividae (with about 28 species) contains a large number of interesting forms distributed amongst three main genera. The largest and finest species of the family is the *Oliva porphyria* (the Panama Tent Olive), quite localized in its distribution but ranging from the Gulf of California to Panama and the Galapagos Islands. Another large Olive is *Oliva incrassata (angulata)* found on sand bars exposed at low tide; this species has closely related forms in the Caribbean Miocene. *Oliva spicata (O. polpasta)* and several other names) is the commonest species at most localities. Abundant at many places in Panama and Ecuador is the small *Oliva undatella*, usually with a varied color pattern, and because of its size, often referred to *Olivella* but with the shell and radular characters of *Oliva*. *Agaronia* with two or more closely similar species is often seen along beaches at low tide feeding on the smaller Olivellas. *Olivella* has many species, many of which are local. *Olivella (Lamprodoma) volutella* is especially common in Panama on slimy mud flats and exhibits a wide range of coloration from pure white to nearly black. *Olivella (Pachyoliva) columellaris* and *O. semistriata* are typically open beach species and may occur in countless numbers at favorable localities. The Conidae are represented by about 33 species. *Conus fergusonii* and *C. patricius* are the largest forms, each often reaching a length of four inches or more; both species have fossil relatives in the Caribbean region. *C. purpurascens* is the commonest of all Panamic cones and has the widest range, extending into northwestern Peru: in the Caribbean, this species is represented by the similar *C. ranunculus*. *C. dalli* is a relatively rare species, the only member of the *C. textilis* group and probably a recent arrival from the Indo-Pacific region; it has no fossil relatives in the American Tertiary. The turrids, because of their large number, are the poorest known of all Panamic gastropods, and new species can be expected in any dredge haul taken at new localities. The genus *Polystira* is represented by two species, *P. picta* and *P. oxytropis*, both fairly common from dredgings in waters of a few fathoms depth; both species have allied forms as fossil in the Pacific and Caribbean zone. Characteristic of the Panamic fauna are the dark-colored species of *Crassipira* found abundantly

under rocks at low tide. A large variety of turrids can generally be found along Amador and Farfan Beach where they have been washed out of the mud dredged from the ship channel and pumped onto the neighboring shore. The Nassariidae is a large family with an indefinite number of species (present estimate about 51); they include *N. myristicata*, *N. luteostoma*, and *N. pagoda*, all common at Panama. Amongst the buccinids, there is the curious *Northia northiae* which at night can often be seen plowing its solitary way just below the surface with only the tip of its siphon showing. It has related forms in the Caribbean Miocene. *Phos* or its allied genera are represented by several fine species; the largest is *Cymatophos panamensis (clarki)*, first described as fossil, later found in the Recent fauna. The Mitridae are well represented and include some of the most sought for species (about 20); they include the magnificent *M. belcheri*, often dredged off the Pearl Islands and which has lately shown up in the Gulf of California; in Peru, *M. swainsoni* is often cast up on the beach; it has a nearly smooth surface and a dark-colored periostracum. The commonest of the shore Mitras are *M. lens* and *M. tristis*, both found under rocks at low tide. Amongst the Muricidae (about 75 species in its widest meaning) are several showy species, often common at favorable localities. *Murex elensis*, *Muricanthus radix*, and *M. nigrinus*, *Hexaplex brassica* and *H. regius* are often taken in large numbers by the fishermen at Santa Elena, Ecuador, the conchs entangled in the nets set out for crayfish (langosta). The Cypraeidae contain relatively few species and most of these are small; the largest, *C. cervinetta* is perhaps best considered as only a sub-species of the Caribbean *C. zebra (exanthema)*. Characteristic amongst *Cypraea*-like shells are *Trivia radians* and *Jenneria pustulata*, both found under rocks. Amongst the Cymatiidae are two species of *Distorsio (decussatus and constrictus)* with similar forms in the Caribbean, the large *Cymatium tigrinum*, formerly common in Panama, and several *Bursa*. With the exception of the Scotch bonnet, the *Semicassis centiquadrata*, the other members of the family Cassididae are relatively uncommon. Special mention should be made of *Malea ringens*, one of the most characteristic of present-day Panamic gastropoda, but represented in the Caribbean Miocene by hardly distinguishable forms. This species extends south to the Lobos Islands in Peruvian waters where it grows to a large size. Along the Ecuadorian coast, *M. ringens* is relatively rare, replaced by the smaller, heavier shelled *M. crassilabris* Val., which the author regards as a good species.

Pelecypoda

The pelecypods are probably the best known of Panamic-Pacific mollusks, and in addition to this study, the class has been revised by Hertlein and Strong in a series of excellent papers published in *Zoologica* between 1940 and 1950. Two other important papers have also appeared, one

on the Mytilidae by Tron Soot-Ryen and the other on the Arcidae by Helen Rost, both papers reporting on collections of the Allan Hancock Pacific Expeditions. Several families of the bivalves, such as the Arcidae (31 species), Mytilidae (25 species), Veneridae (62 species), Tellinidae (54 species), and Donacidae (36 species) have more species than they do in the Western Atlantic.

As this class of the Mollusca will be treated at some length in the systematic section of this work, only a few of the more striking features of Panamic bivalves will be noted here. Many species could be cited as being characteristic of the Panamic-Pacific fauna as known today, but as in the case of the gastropods, the larger number of these forms have identical or closely related species in the Tertiary faunas of the Caribbean and West Indian region.

The Nuculacea of the Panamic region, as elsewhere, comprise a large number of small forms of no particular interest with the exception of the following: the genus *Adrana* with its peculiar, flattened, bladelike shell (some of which attain large size) are particularly characteristic of the Panamic fauna, and several species appear in numbers on certain favorable, sandy beaches; *Nuculana* (*Politoleda*) *polita*, notable for its large size and curious surface markings, is always common on the beach at Old Panama. Among the true taxodont mollusks, the Panamic Arcidae deserves notice; its species are numerous and occupy a wide variety of ecological stations. Amongst the true arks, *Arca pacifica* and *A. mutabilis*, are relatively less common than their twin forms in the Caribbean fauna. The most important of all Panamic bivalves in the food economy of the region are the two Anadaras, *A. tuberculosa* and *A. grandis*. Both species are intimately associated with a mangrove mud environment. *A. tuberculosa*, and its near ally *A. similis*, live buried in the mud amongst the mangrove roots; *A. grandis* in the nearby esteros or mud banks just outside. The range of *A. grandis* and *A. tuberculosa* is, therefore, coextensive with that of the mangrove itself (*Rhizophora mangle*). The most interesting of all Panamic arks is *Litharca lithodomus*, a true rock borer, in which the shell has become greatly lengthened or pholad in shape. The anterior side is much the longer, wedge-shaped at the end while the posterior side towards the open end of the bore is short. This ark drills circular holes in hard layers of sandstone, often six inches or more deep. This curious species is a member of the true Arcinae. Although discovered by Cuming nearly 150 years ago, it long remained one of the rarest and least known of Panamic mollusks. Restricted to the Pacific Coast today, is the unsymmetrical *Noetia reversa* but with almost identical forms in the Miocene of the Caribbean region. Another *Noetia* is *N. olssoni* which is closely allied to *N. centrota* of the Caribbean. As an additional illustration of the close alliance of the present-day Pacific molluscan fauna with that of the Miocene Caribbean mention may be made of the rare *Sheldonella delgada* of which the only other known species is *S. maoica*, common in the Miocene of Santo Domingo. As in most tropical faunas, the Pectens are comparatively few in number. Of these, the only

common one is *Aequipecten circularis* which shows a wide range of coloration. *A. purpuratus*, so common in Peruvian waters, has been recorded on good authority from Panama and elsewhere but is rare, and its distribution irregular. *Pecten vogdesi*, although first described under the name *P. dentatus*, presumably from Santa Elena, Ecuador, appears to be largely restricted to the Gulf of California. Like the Pectens, the oysters are relatively unimportant in the faunal makeup, although some interesting species are represented. Amongst them is *Ostrea iridescens*, a purely marine form which sometimes grows to a large size. It is much sought for by the natives, but its flavor is strong, probably due to a high iodine content. Another purely marine species is the *Ostrea fischeri*, a pycnodonta, with a peculiar, porous, or honey-combed texture, relatively rare but widely distributed through the whole faunal province. The smaller *O. columbiensis* is often seen in the markets of Ecuador. The most interesting of the Anomiidae is the large *Placuanomia cumingii*, similar to the *P. plicata* of the Miocene of the Carolinas. As presently interpreted, *Spondylus* appears to have three species in the Panamic fauna but the distinctions between them are ill-defined due to incomplete data and the great variability of its characters due to fixation. In contrast with the Caribbean fauna, the Lucinidae are poorly represented in the Pacific zone either in the Recent or fossil state. *Codakia* has two fine species but both rare. *C. distinguenda* attains a much larger size than any species of the genus in the Caribbean. Of unusual interest is *D. punctata*, an Indo-Pacific species recorded from the Pearl Islands and from the Galapagos. There are two species of *Anodontia*, but they are rare and have been seldom collected. Amongst the Crassatellidae and Carditidae are several fine species which give color and character to the Panamic fauna. *Eucrassatella gibbosa*, with its coarse, heavy shell, is common at some localities. *Cardita tricolor* is the commonest member of its family and shows a wide range of coloration. Conspicuous because of their large size are the relatively rare *C. cuvieri* and *C. megastrophia*. There are two species of *Carditamera*. *C. radiata*, largely restricted to Panama, is a form closely related to *C. arata* of the East Coast or Atlantic Miocene. As in most warm water or tropical faunas, the Tellinidae are represented by a large number of species, and other new ones will no doubt be discovered with further exploration. Some of these tellinids are brightly colored, as for instance, those belonging to the genus *Tellinidella*. Conspicuous in the fauna are the several species of *Florimetis* and especially the numerous forms of *Eurytellina*. Of special interest is *Psammothalia cognata*, a species fairly common in Panama and extending to Peru, nevertheless, it has remained rare in most collections; a few years ago, specimens were obtained in dredgings off the gulf coast of Spanish Honduras which appeared to be identical with typical *P. cognata* from the Pacific Ocean. To the Donacidae belong some of the finest species of the family; *Iphigenia altior*, found in more or less brackish-water situations, is closely allied to the West Atlantic *I. brasiliensis*; several species of *Donax*, common on sandy beaches such as *D. asper*, *D. peruviana*, and *D. panamensis*, are current items of food amongst the native population;

Indian graves or huacos in coastal Peru are thickly covered or literally snowed under a blanket of whitened shells of *D. peruviana*. The Veneridae, with about 62 species, ranks as the largest family of Panamic bivalves, and such species that are sufficiently abundant, are much sought for as food along the entire coast. Perhaps the largest and finest species in the family is *Periglypta multicosata*, and in a few places, as in the Pearl Islands, it is sufficiently common to be gathered for food. Another large clam, but rare at most localities, is *Ventricolaria isocardia*, similar to *V. rigida* of Florida. *Tivela hians* is plentiful in northwestern Peru on sandy beaches and is gathered in large numbers by the natives. It is often commensal with a small sea anenome. The genus *Hysteroconcha*, with but one species in the Caribbean, has four in the Pacific zone, the largest and commonest is *H. lupanaria* with long spines and usually purplish coloration, while in *H. brevispinosa*, the spines are short, often reduced to mere stumps, and the color is white. Amongst the Chiones, *C. compta*, a large, thick-shelled species, like an overgrown *C. cancellata*, is most common in the south. In the allied genus *Chionopsis* are several fine species such as *C. amathusia*, *C. gnidia*, *C. jamaniana*, and *C. ornatisima* with highly intricate surface sculpture. Other equally characteristic Panamic venerids are *Notochione columbiensis*, a thick-walled shell with coarse ribbing and variable color markings and the *Nioche asperrima* with a fine cancellate sculpture like that seen on some Codakias. *Protothaca grata*, showing an endless variation in coloration, is collected in quantities from gravel bars exposed at low water along the coast of Ecuador. *Dosinia ponderosa*, the largest species of the genus and a hangover from the Miocene, is common at many places and ranges throughout the whole province and southward into the Peruvian. The Mactridae have several fine species; *Harvella elegans* and *Tumbezi-concha trachoides* have thin fragile valves marked with strong, concentric or oblique undulations, and appear to range through the entire province wherever suitable conditions of environment occur. Another thin-shelled, fragile species is the *Raeta undulata*, common along the coast of northwestern Peru and ranging far southward into the Peruvian Province; elsewhere the species is rather rare but extends northward to the Gulf of California. *Mactrellona alata* and *M. exoleta*, together with *M. clisea*, are met with along sandy beaches, the two former species also living in the Caribbean region. The Micromactras form a group of several species, often difficult to separate properly from each other. Rock boring mollusks such as the Lithophagas and the Pholadidae are especially common along certain parts of the coast of Ecuador, and in some stretches where the shore is formed of soft rock formations, they thereby contribute substantially to shore line erosion. Amongst the Corbulidae, may be mentioned the large *Panamiorbula inflata* with subequal, convex valves, and a hinge showing vestigial lateral teeth; it is found principally in muddy, brackish-water situations. Other interesting species of the family are *Caryocorbula ovulata*, *C. ameystina*, *Tenuicorbula tenuis*, and the curious *Serracorbula tumaca* with serrated margins.

Scaphopoda

Of the classes of the Panamic Mollusca, the scaphopods with about 14 species are the least known (*Dentalium*, 11 species and *Cadulus*, 3 species). As noted by Pilsbry and Sharp (1897), the shallow-water Scaphopoda of the eastern Pacific are closely related to forms from the Antillean Tertiary and Recent faunas, whereas, the offshore, deep-water species belong mainly to what seems to be endemic West American, and have no allies in Antillean or Oriental seas. Characteristic of the West Coast species are Dentaliums of the subgenus *Tesseracme*, unknown by any living species in the present-day West Atlantic. They were well represented there during the Miocene and Pliocene periods. A *Dentalium* related to *D. pretiosum* (*Antalis* group) is encountered in beach drift along the Santa Elena Peninsula in Ecuador. Only two scaphopods are known so far from north-western Peru, namely *D. (Graptacme) splendidum* and *Cadulus (Gadilia) perpusillus*; both species are also found in Ecuador.

Amphineura

The chiton fauna of the Panamic-Pacific Province seems relatively small in the number of species, probably because of incomplete exploration. The common large chiton along the surf line in Panama and Ecuador is *C. stokesi*, gathered by the natives for food and bait. Other shore species in Panama are *Chaetopleura lurida*, *Ischnochiton adamsi*, and the lovely *Tonicia crenulata*. *Acanthochites hirundiniformis* has been obtained at Manta and Santa Elena. *Acanthopleura echinata*, primarily a cold-water species of the Peruvian Province, occurs as far north as Cabo Blanco.

THE PERUVIAN PROVINCE
ITS LIMITS AND FAUNAL CHARACTERISTICS

The Panamic-Pacific and the Peruvian faunal provinces border along the northwest coast of Peru between the Gulf of Guayaquil and Punta Aguja at the end of the Illescas Peninsula (about lat 5° 40' S.). In this region, the continent of South America projects the furthest west forming a series of massive headlands separated by deep re-entrants or bays. There are three of these coastal bulges, namely, Cabo Blanco-Punta Parinas in the north; the smaller peninsula of Paita in the middle; and the Illescas Peninsula in the south, the whole spread over a distance of about 120 nautical miles. The bays between these headlands, two in number (Paita and Sechura) are asymmetrical in shape and widely open to the north. The bays of Manta and Santa Elena along the Ecuadorian Coast are similarly shaped. Geologically, the headland areas are structural highs, the bays between them synclinal. Cabo Blanco-Parinas bulge is underlain by Tertiary rocks, while the peninsulas of Paita and Illescas by more ancient rocks, the two latter, represent the deeply eroded cores of old mountain uplifts. The sea lying off this portion of the Peruvian coast is the meeting ground of two major oceanic currents; that of the Equatorial Counter Current from the north, which after bathing the coasts of western Colombia and

Ecuador with its warm water is here deflected westward into the open Pacific, and the mighty Peruvian or Humboldt Current streaming up from the south is similarly deflected on a more westerly course. As a result, the waters off the coast of northwestern Peru are in a constant tumult or conflict, as the drift of the two streams meet and join, the mixing zone shifting its position continually, sometimes to the south or far to the north. At times, the Equatorial stream is the more powerful and is able to push its way southward bringing waters warmer than usual into the coastal zone. This disturbance is known to the Peruvians as "El Niño" since it commonly appears during the Christmas season or simply as "the Aguaje". Although the El Niño is felt somewhat each year, its duration is usually short but at more or less cyclic intervals, it can be very severe, upsetting the normal climatic conditions of the coastal land and bringing catastrophic destruction to life in the sea. The winds which blow normally from the sea or from the southwest, then become northerly or easterly, bring heavy, torrential rains, converting the dry quebradas into rushing streams and covering the otherwise dry and barren land with a lush growth of vegetation. The most severe of the El Niño disturbances in recent years was in 1925: a lesser one in 1953.

Although the Peruvian Province extends well into the tropics and within a few degrees of the equator, its fauna is essentially one of cool or temperate waters, maintained partly by the Peruvian Current and by strong, inshore upwellings from depths. The Peruvian Current (or Humboldt Current) is one of the most remarkable of oceanic streams if judged by the influence which it exerts on the coastal lands along which it flows and by the profusion of marine life which it supports in its waters. The source of this mighty stream lies in the high southern latitudes of the westerly winds which propel it eastward to impinge upon the coast of southern Chile near the island of Chiloe, south of Concepcion. At this place, the stream divides into two branches, one turns to the south, flows to and around Cape Horn, the other and major branch is diverted to the north and skirts the coast of Chile and Peru. Near the city of Chiclayo (lat 6° 30' S.) the coast bends sharply towards the west, thereby turning and driving the Peruvian Current out into the open Pacific at Punta Aguja. Surface temperatures in the stream off the coast of southern Chile in the month of August average about 45° Fahrenheit and between 60 and 65° in the northern sector. The most significant feature of the Peruvian stream is its lower temperatures inshore and higher ones offshore. The maintenance of the lower temperature along the inner course of the stream is mainly due to strong upwellings rather than a direct transport of identical masses of cold water from far southern latitudes. This phenomenon of upwellings appears to be strongest in the northern part of the stream where it flows over the shallower platform areas which prevail there rather than in the south where the shelf zone is narrower and the dip-off into deep water is more abrupt. Research, mainly by the Schott Expedition, has shown that this rise of cold submarine water to the surface comes from relatively shallow depths of 30 to 400

meters only. It brings to the surface an abundant supply of mineral salts and nitrogenous compounds favorable to the growth of an extraordinarily rich planktonic fauna and flora which in turn gives support to vast schools of anchovies and other small fish. These are the main source of food for the vast swarms of guano birds seen along the Peruvian coast south of Sechura. Through most of the year conditions in the path of the Peruvian Current are fairly stable but during the summer months of the Southern Hemisphere upsets in circulation may occur, the upwellings may diminish or cease entirely, and the invasion of a southward flowing, inshore current, the "El Niño" and the accompanying phenomenon known as the "Aguaje" or Callao Painter sets in as already mentioned. In most years, the effects of the El Niño are relatively unimportant and of short duration but during some years, spaced roughly at 7 and 35 year intervals, the climatic upset of the El Niño may be great. In the Aguaje of 1925, the temperature of the surf at Negritos in northwestern Peru rose sharply from an average of about 65° to about 80° and remained so for several weeks. At the same time, surface water temperatures in the harbor of Callao were reported as high as 80 degrees. Such a sharp rise in the temperature of the sea water, if prolonged, results in a catastrophic destruction of most forms of marine life along large parts of the Peruvian coast as well as an upset in the climatic pattern on land. At such times, the decomposition of the vast quantity of dead marine life, much of it cast upon the beach, generates volumes of hydrogen sulphide that blackens the walls of houses and hulls of ships which are painted with white lead (the Callao Painter). Evidence of the southward flowing El Niño current in 1925 was demonstrated by the large numbers of sea-snakes stranded on the beach at Negritos and of mangrove seedlings rooted in tidal lagoons and flats as far south as Sechura.

An estimate of the size of the molluscan element in the Peruvian fauna is still difficult to make as many records in the literature cannot be relied upon with full confidence. Fully half of the species so far known from Peru and middle Chile are littoral forms such as the limpets, chitons, and other rock perching types and show that the offshore species are known only in an imperfect manner. The first compilation of the mollusks of Peru and Chile was made by Alcide d'Orbigny and published in the "Voyage dans l'Amérique Méridionale" (1835-1843). In this list D'Orbigny recorded 251 species as living along the coast from southern Chile to the Peruvian-Ecuadorian border. Of this number, 89 species were listed from Paita or from Tumbes, and of which only one species was also known to occur at Callao. These northern species are members of the Panamic-Pacific and the Paita Buffer Zone, leaving only 163 species for the restricted Peruvian fauna as then known. In 1909, our knowledge of the Peruvian fauna was greatly advanced by Dall through his work on the Coker Collection as noted in an earlier section of this paper.

The compilation following was prepared largely for this occasion and is based on our own collections and observations and on such records in

the literature which seem acceptable. Only the shell-bearing types of mollusks are included in this analysis.

Total number³ of species of mollusks known at the present time along the coast of Peru southward to the Island of Chiloe, Chile.

Gastropods	274 species
Pelecypods	248 species
Scaphopods	2 species
Chitons	45 species
	<hr/>
Total	569 species

This total of 569 species may be broken down as follows:

Species found in northwestern Peru (largely Panamic-Pacific and Paita Buffer species) which do not range south of Punta Aguja, and of these the majority of which do not pass Cabo Blanco.

Gastropods	121 species
Pelecypods	178 species
Scaphopods	2 species
Chitons	2 species
	<hr/>
Total	303 species

Panamic-Pacific and Paita Buffer species ranging south of Punta Aguja.

Gastropods	57 species
Pelecypods	32 species
Chitons	5 species
	<hr/>
Total	94 species

Species restricted to the Peruvian Province as a whole.

Gastropods	167 species
Pelecypods	80 species
Chitons	45 species
	<hr/>
Total	292 species

Species known only from Peru.

Gastropods	133 species
Pelecypods	60 species
Chitons	26 species
	<hr/>
Total	219 species

³ The above compilation is the best possible at the present time. Additions to the mollusks of northwestern Peru may be expected as the families of some small gastropods are worked up, of which good collections are at hand.

At the present time nearly 600 species of shell-bearing mollusks are known from the coastal waters of Peru and Chile. Of this number, about 397 species or roughly 69 percent are Panamic-Pacific species which range southward into Peruvian waters, the majority of which (about 53 percent) do not pass Punta Aguja. The overflow of some of these northern forms south of Punta Aguja into the Peruvian faunal province is small and most of these species are known only from its northern sector. Shells collected at Lobos de Tierra, the most northerly of the two guano islands just south of Punta Aguja, are largely the same species as found in Sechura Bay at Bayovar. Lobos Island fauna, therefore, must be considered an outlier of the Paita Buffer Zone. Several Panamic species occur at Lobos Island and probably find their southern limit of range at that place, such as *Malea ringens*, *Fusinus dupetitihoursi*, *Cancellaria chrysostoma*, and *Cypraea cervinetta*. It seems likely that these species do not extend much further south. *Mexicardia procera* and *Raeta undulata* range south to Bahia de la Independencia (lat 14° 15' S.) below Paracas. These vigorous northern species are much larger in size than they attain along the coasts of Ecuador and Panama. *Semele corrugata*, common at Paracas and Bahia, is also common in the Paita Buffer Zone. *Pecten purpuratus*, the common scallop of the Peruvian markets, is plentiful in Sechura Bay but is rare north of the Gulf of Guayaquil. *Concholepas concholepas* is perhaps the most characteristic species of the Peruvian Province. It seems to find its northern limits at Lobos de Tierra, but all the specimens seen from there are small. *Oliva peruviana*, *Thais chocolata*, and *Turbo magnificus* are wide spread and find their northern limits in the Paita Buffer Zone or in the Gulf of Guayaquil. Amongst other characteristic Peruvian mollusks are *Trochita trochiformis*, several large mytilids (*Aulacomya*, *Choromytilus*, *Semimytilus*), and clams (*Protothaca thaca* and *P. dombeyi*). The chitons are numerous in the south, *Acanthochiton echinata* and *Enoplochiton niger* are especially common, the former known also from Paita. Amongst the other invertebrates are several species of barnacles, of which *Balanus laevis* is especially common in the south, bunched in large clusters on boulders or perched on the shell of *Concholepas* in a crowded mass. Of special interest also along the coast of middle Peru is a colonial polychaete worm (*Gunnarea*) which forms large encrustations of closely packed, vertical, calcareous tubes. Such reeflike masses, often mistaken for coral heads, are found in the Mancora tablazo at Paita and Cabo Blanco in northern Peru, far north of their present-day known occurrence and show that these Pleistocene deposits were laid down in waters as cool as those which now wash the shore of Peru much further south.

The deficiencies in the Peruvian fauna amongst the mollusks are as striking as some of its redundances. There are no Tellinidae or Lucinidae. Species of *Conus* and *Terebra* are lacking although a few forms are known from Panama-Pacific and Paita Buffer Zones in northwestern Peru.

The fauna of the Peruvian Province is one of temperate or relatively cool waters and its penetration along the coast northward into the tropical

zone is due entirely to presence of the Peruvian Current. A cessation of the flow of this stream or of the submarine upwellings which accompany it, would permit the southward invasion of much warmer waters from the west or the open Pacific and from the north. The Peruvian fauna would be forced to retreat southward and the more aggressive, Panamic-Pacific species would move in to take its place. This faunal shift, back and forth, has occurred repeatedly.

THE PAITA BUFFER ZONE WITH A LIST OF ITS PRINCIPAL SPECIES

As seen from the previous discussion, the northern or Panamic-Pacific and the southern or Peruvian faunas meet and to a certain extent intermingle along the coast of northwestern Peru between Cabo Blanco at the south end of the Gulf of Guayaquil and Punta Aguja at the western tip of the Bay of Sechura. This is an overlap region of about two degrees of latitudinal spread or about 120 nautical miles. The marine species of this overlap region belong properly neither to the Panamic or the Peruvian faunal provinces, hence the name of the "Paita Buffer Zone" is here proposed, its name taken from the city or bay of Paita located in its central portion. Both on land and in the sea, this is truly a transitional region. At Tumbes, and throughout most of southwestern Ecuador, the country is covered with a good growth of small trees, bushes, and cacti. Along the banks of the many esteros or inlets, there are stands of tall mangrove, a flora maintained by a fairly heavy and regular rainfall during the summer months. Further south in Peru, this zone of semiarid vegetation retreats deeper inland, following the base of the Amotape Mountains or retained only on some of the higher hills. In the vicinity of the coast, the climate, tempered by the winds blowing in from a colder sea, are dry and desiccating, the rainfall sparse and irregular in normal years. Beyond Cabo Blanco, desert conditions set in rapidly and plant growth becomes less plentiful or confined largely to river and quebrada bottoms where some moisture remains in the subsoil. At Paita, Sechura, and points further south, desert conditions become more strongly intensified.

Interesting accounts of the bird life along this transitional zone in northwestern Peru have been given by R. C. Murphy in several papers and books. Some of the northern or tropical sea birds which find their southern limits of range in the Paita Buffer Zone are: The West Indian Pelican (*Pelecanus occidentalis*), the Caribbean Man-O-War bird (*Fregata*), the Roseate Spoonbill, and several others. The common gannet in the Paita Buffer Zone is the Blue-Footed Booby (*Sula nebouxii*) but which ranges somewhat further south, nesting in large numbers on the islands of Lobos de Tierra. Regular visitors in the Paita Buffer Zone from the south, especially in the early months of the year, are the large Peruvian pelican (*Pelecanus thagus*), a strictly marine species, the Piquero (*Sula variegata*), the White-breasted Cormorant or Guanay (*Phalacrocorax bougainvillei*), and the Kelp Gull (*Larus dominicanus*). The Peruvian Penguin (*Spheniscus humboldti*) is rare in the Paita Buffer Zone but has been observed in the Bay of Sechura. The sea lion (*Otaria jubata*) was formerly common at

Balcones Point near Negritos but has been driven away by being constantly shot at by trigger happy sportsmen. Among fishes, the Black Marlin (*Makaina marlina*) and the Sailfish (*Istiophorus greyi*) do not normally extend south of this region.

Below is given a list of the principal species of mollusks of the Paita Buffer Zone. The species marked with an asterisk (*) are southern forms from the Peruvian Province; unmarked species are Panamic, the latter predominating greatly in number. The island of Lobos de Tierra, the largest and most northerly of the guano islands along the coast of Peru and lying about 80 kilometers south of Punta Aguja, although in the middle of the Peruvian stream, has a molluscan fauna similar to that of the Bay of Sechura. For this reason it is considered an outlier of the Paita Buffer Zone.

<i>Rictaxis venustus</i> (d'Orbigny)	.....Paita, also Mancora
<i>Bullaria aspersa</i> (A. Adams)	.....Negritos, Paita, Bayovar, Lobos de Tierra, also Paracas Peninsula
<i>Umbraculum ovalis</i> (Carpenter)	.....Bayovar
<i>Cancellaria cassidiformis</i> Sowerby	.....Negritos
<i>Cancellaria chrysostoma</i> Sowerby	.....Negritos, Lobos de Tierra
* <i>Oliva peruviana</i> Lamarck	.....Negritos, Paita, Bayovar, Lobos de Tierra
<i>Olivella columellaris</i> Sowerby	.....Negritos, Paita, Bayovar
* <i>Marginella curta</i> Sowerby	.....Negritos, Paita, Bayovar, Lobos de Tierra
<i>Mitra swainsoni</i> Broderip	.....Yasila, Paita
<i>Cantharus (Triumphis) distortus</i> (Gray)	.....Lobitos, Paita
<i>Cantharus vibex</i> Broderip	.....Lobitos
<i>Columbella paytensis</i> Lesson	.....Negritos, Paita, Bayovar
<i>Hexaplex brassica</i> (Lamarck)	.....Bayovar, Lobos de Tierra
<i>Murex squamosus</i> (Broderip)	.....Bayovar, Lobos de Tierra, Paita
* <i>Concholepas concholepas</i> (Bruguière)	.....Lobos de Tierra
* <i>Thais chocolata</i> (Duclos)	.....Negritos, Paita, Bayovar, Lobos de Tierra
<i>Thais haemastoma</i> (Linné) (<i>biserialis</i> Blainville)	Negritos, Paita, Bayovar
<i>Thais callaensis</i> (Gray)	.....Negritos, Paita, Bayovar, Lobos de Tierra
<i>Purpura patula pansa</i> Gould	.....Lobos de Tierra
<i>Fusinus dupetithouarsi</i> (Kiener)	.....Bayovar, Lobos de Tierra
<i>Fusinus panamensis</i> Dall	.....Lobitos, Bayovar
<i>Epitonium statuminatum</i> (Sowerby)	.....Paita
<i>Cymatium parthenopeum</i> (von Salis) [<i>costatum</i> Born]	.....Bayovar, Lobos de Tierra
<i>Cymatium wiegmanni</i> (Anton)	.....Bayovar
<i>Bursa ventricosa</i> (Broderip)	.....Bayovar, Lobos de Tierra, also Paracas
<i>Cypraea (Trona) exanthema</i> Linné	.....Lobos de Tierra, Bayovar, Negritos
<i>Trivia radians</i> (Lamarck)	.....Negritos, Lobos de Tierra
<i>Malea ringens</i> (Swainson)	.....Negritos, Paita, Bayovar, Lobos de Tierra
<i>Ficus decussatus</i> (Wood)	.....Negritos
<i>Turritella goniostoma</i> Valenciennes	.....Bayovar, Paita, Negritos, Lobos de Tierra

- **Turritella broderipiana* d'OrbignyPaita, Yasila, Bayovar
Architectonica nobilis RödingNegritos
Crucibulum scutellatum (Wood)Bayovar, Lobos de Tierra
Crucibulum spinosum (Sowerby)Paita, Negritos, Bayovar
Crepidula onyx Sowerby [*arenata* Broderip]Bayovar, Paita,
 Lobos de Tierra
Polinices panamensis (Recluz)Bayovar, Negritos
Sinum concavum (Lamarck)Bayovar, Lobos de Tierra
 **Acmaea viridula* (Lamarck) Lobos de Tierra
 **Turbo magnificus* JonasNegritos, Paita, Bayovar, Lobos de Tierra
Chlorostoma melaleucos (Jones)Bayovar
 **Fissurella peruviana* LamarckLobitos, Bayovar
Fissurella macrotrema LamarckPaita, Tortuga, Lobos de Tierra
Diodora inaequalis (Sowerby)Negritos, Lobitos
Nucula paytensis A. AdamsNegritos, Paita, Bayovar
 **Glycymeris ovata* (Broderip)Bayovar, Lobos de Tierra
Axinaetis inaequalis (Sowerby)Bayovar, Lobos de Tierra
Ostrea (Alectryonia) megodon HanleyBayovar, Lobos de Tierra
Anomia peruviana d'OrbignyBayovar, Paita, Lobos de Tierra
Aequipecten purpuratus (Lamarck)Negritos, Paita, Bayovar,
 Lobos de Tierra
Aequipecten circularis (Sowerby)Negritos, Paita, Bayovar,
 Lobos de Tierra
Pteria sterna (Gould)Negritos, Paita, Bayovar
Mytella speciosa (Reeve)Negritos
 **Semimytilus nonuranus* Pilsbry and OlssonNonura Bay (P. Aguja),
 Paita, Negritos
Modiolus pacificus OlssonPaita
Adula soleniformis (d'Orbigny)Mancora, Paita
Chama pellucida SowerbyBayovar
Mexicardia procera (Sowerby)Negritos, Paita, Bayovar, Lobos de Tierra
Dosinia ponderosa (Gray)Negritos, Paita, Bayovar
Cyclinella subquadrata (Hanley)Bayovar
Tivela hians (Philippi)Negritos, Paita, Yasila, Bayovar
Hysteroconcha lupanaria (Lesson)Negritos, Paita, Yasila, Bayovar
Chione compta (Broderip)Bayovar
Ilioconche subrugosa (Wood)Negritos, Paita, Bayovar
Nioche asperrima (Sowerby)Bayovar
Petricola denticulata SowerbyPaita, Bayovar, Negritos
Mactra velata PhilippiNegritos, Paita, Bayovar
Raeta undulata (Gould)Negritos, Bayovar, also Paracas
Donax peruvianus DeshayesNegritos, Paita, Yasila, Bayovar
 **Tagelus dombeii* (Lamarck)Negritos, Paita, Bayovar, Lobos de Tierra
 **Semele corrugata* (Sowerby)Bayovar, Lobos de Tierra, also Paracas
Cryptomya californica (Conrad)Negritos
Periploma planiuscula SowerbyNegritos

- Entodesma (Agriodesma) sechurana* Pilsbry and OlssonBayovar
 **Acanthopleura echinata* (Barnes).....Negritos, Yasila, Paita, Lobos de Tierra

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PART II. PANAMIC-PACIFIC PELECYPODA

Phylum MOLLUSCA

Class PELECYPODA

GENERAL STATEMENT

The Mollusca as a separate branch or phylum of the Invertebrata is divided into six smaller groups called Classes of which the Pelecypoda is one. All members of the Pelecypoda are aquatic, living in fresh, brackish, or marine waters, at all depths, and under many environmental conditions. Of the marine sorts, the many kinds of hard-shelled clams (venerids), the soft-shelled clams (myads), the mussels (mytilids), the scallops (Pec-

tens) may be cited as examples. From all other classes of the Mollusca, the pelecypods are distinguished by their bivalved shell, formed of two, calcareous valves placed on the sides and thus enclosing and protecting the soft, vital organs of the animal within. The two valves are joined in a flexing, hingelike fashion along their dorsal margins. They differ from most other mollusks in the absence of a true head and of a mouth provided with biting parts, the pelecypods being wholly plankton and detritus feeders.

As in all other mollusks, the shell of the Pelecypoda is secreted by a fleshy sheet or *mantle* which covers the soft parts of the animal within. This mantle arises from the back in the shape of two lobes, one on each side, each lobe being closely applied to the inner surface of the valve and directly attached to it along a line near the ventral margin; this is the *pallial line*, usually indicated by a more or less continuous linear impression extending from one adductor scar to the other. Each lobe of the mantle functions in the secretion of the shell through the addition of thin, individual layers to its inner surface thus increasing its thickness and weight, and by similar secretions around the ventral margin adding to its size; therefore, the oldest and thickest part of the shell is located at the beaks while its growth in size is shown by the many small concentric lines (*growth lines*) which cover its surface, sometimes uniformly distributed, or in concentric bands or ribbons set apart by deeper impressed lines or by thickened ribs or varices which indicate halts or interruptions in shell growth (*resting marks*.)

The teethlike projections along the dorsal margin, together with the elastic ligament, hold the valves together and form a hingelike structure. The ligament may be considered as a fundamental character of the Pelecypoda (possessed by no other group of the Mollusca) universally present amongst them, although in some cases in a modified or degraded form. The primary function of the ligament is to open or to spread apart the ventral margins of the valves which takes place on relaxation of the adductor muscles. Structurally the ligament is composed of two bands which differ in composition and in the mechanics of operation. In the Veneridae and Tellinidae, these two bands are united in a single structure forming an inner and outer layer. In this case, the ligament is spoken of as "*external*" and it is visible from the outside just behind the beaks. Therefore, the position of the ligament generally behind or in the rear of the beaks furnishes a means of orientation of the whole shell or of an individual valve. In some other families, such as the Mactridae, Myacidae, and the Corbulidae, the two bands of the ligament are widely separated and attached to different parts of the hinge plate. In this case, the upper band of the ligament (here called the *tensilium*) is much diminished in size and its importance in the opening of the valve much reduced. The scar of the *tensilium* in this case is placed high on the hinge plate well above the hinge teeth. The larger part of the ligament is now formed by the inner layer or *resilium*, and its attachment to the hinge plate is placed lower, between the hinge teeth, generally in a special groove or pit called the *resilifer* or *chondrophore*. The

latter name is used if the resilifer has the shape of a spoon or a projecting armlike process. The ligament is now considered "internal" since it lies concealed within the hinge plate. In the case of the Mactridae, the resilifer has the shape of a large, pear-shaped depression or cup in the middle of the hinge plate, between the cardinal teeth, and below the main fulcrum of the hinge. This internal position places the resilium under compressional strain while the valves are held shut by the pull of the adductor muscles. In structure, the resilium is fibrous or lamellar, often showing a pearly or silky luster along a fractured surface; it is always impregnated with lime giving to it a grayish color and resistance towards alkaline solutions; in some families of the Anomalodesmacea, particularly, the Lyonsiidae and Periplomidae, the middle portion of the resilium is often replaced so completely with lime as to form a shelly plate (the *lithodesma*), its purpose is to strengthen the whole. The outer band or tensilium is usually much thinner, often a mere skinlike membrane, brown in color, and of a chitinous or hornlike nature. Like the periostracum, of which it is a continuation, it is acted upon by strong, alkaline solutions. The mechanical action of the outer layer of the ligament is mainly tensional or by its contraction pulls the valves open by a shortening of the space above the fulcrum of the hinge. The name "*tensilium*" is here proposed for this outer part of the ligament, to complement or conform in principle of naming with the *resilium* (Dall), whose mechanics of operation is resistance to compression. Hence, the ligament is under both tensional and compressional strain when the valves are tightly closed.

In most pelecypods, the dorsal margin of the valves bears small rough projections or teeth which fit into sockets and form a swinging or hinge union. These structures are called *hinge teeth*, and their shape and distribution forms a set pattern characteristic for each family and genus. Illustrations of various hinge patterns will be found amongst the plates of this work. The teeth set under the beaks and which appear to radiate out from there are called *cardinal teeth*; those more removed or placed along the sides are known as *lateral teeth*. In some families, the teeth may degenerate, become partially or wholly obsolete as in some genera of the Lucinidae. A *taxodont* hinge is one composed of many small teeth arranged in a more or less unbroken series (Nuculidae, Arcidae); this type of hinge has sometimes been considered as the more primitive. A *cyclodont hinge* is one without a definite plate, the teeth arising as hooks or prongs from the margin; this type of hinge generally shows evidence of torsion (Cardiidae). The most advanced type of hinge is found in the Mactridae and Veneridae and is known as *teleodont*; this type has well-developed cardinal and lateral teeth seated on a definite platform-like plate. Some groups have an edentulous hinge or one without any teeth; this type is characteristic of some borers.

On the inside of the valve, there are several impressions which represent the attachment scars of various muscles. Most pelecypod shells have two adductor muscle scars (*Dimyarian*) located at the anterior and posterior ends of each valve. The two adductor scars may be of nearly equal size,

or the posterior one is much larger (*Heteromyarian*). In some other forms, such as the scallops and oysters, there is but one adductor scar (*Monomyarian*); observation will show that this scar is not exactly in the middle but nearer the posterior side and hence is an aid in deciding whether the valve is right or left. The *pallial line*, already mentioned, is a more or less continuous linear scar or series of small impressions marking the line of attachment of the mantle to the valve. It is generally placed close to the ventral margin. The pallial line may be developed as a simple, curved line between the adductor scar (an *entire pallial line*), or it may show an inflexion at the posterior end (*pallial sinus*). A large pallial sinus indicates that the clam possessed large, extrudable siphons such as in *Mya*.

ARTIFICIAL KEY TO THE PRINCIPAL FAMILIES OF
PANAMIC-PACIFIC PELECYPODA.⁴

- I. *Monomyarian*. Each valve with a single adductor scar only; this scar is placed slightly behind or posterior of the middle.
- A. Shell permanently attached to the substratum (sea bottom, rocks, other shells) either by direct cementation or anchored by a byssal plug or by byssal threads.
- a. Attachment by direct cementation by the umbone or beak, the attachment area producing a distinct scar.
1. Attachment by the left valve which is generally the larger, the shape usually irregular due to distortion, the valves alike or unlike in surface sculpture. No teeth or other interlocking devices along the hinge margin.
- Ostreidae
2. Valves pectiniform, attached generally by the right valve, often with a ribbed or spinous sculpture. Hinge provided with stout, interlocking teeth or crura on each side of a deep, resilifer.
- Spondyliidae
- b. Attachment by means of a solid byssal plug passing through a slit or circular hole (foramen) in the beak and umbone of the right valve; this opening sometimes closed off by later calcification, the shell becoming free.
3. Valves irregular, ostreiform, but with a subnacreous, platty or micaceous texture, and a subtranslucent or silvery luster.
- Anomiidae
- c. Shell anchored by a byssus or a bundle of horny or silky threads passing through a gap or notch along the anterior margin of the right valve. Shell often aviculiform or with the ends unequally winged or emarginated. Inner layer pearly.

⁴A few small families are not included in this key, as they are unimportant, their characters are obscure so that their inclusion would make the key too complex for general use.

4. Hinge line straight, the cardinal area grooved by a series of vertical pits for the attachment of the ligament.

Isognomonidae

5. Hinge line straight, the cardinal area narrow, elongated and simple, with a single resilifer under the beak.

Pteriidae

- B. Shell free or attached only in the earlier stages of growth. Porcellaneous, never pearly.

6. Valves almost bilaterally symmetrical, and nearly equilateral, pectiniform, with well-developed anterior and posterior ears. Hinge line straight, the resilifer a pit under the beak. Surface smooth or with radial ribs; often brightly colored.

Pectinidae

7. Valves oblique, inequilateral and often gaping on the sides, the lateral wings less perfectly developed. Color usually white, smooth or with radial ribs, often scabrous.

Limidae

- II. *Dimyarian*. Each valve has two adductor scars placed near the anterior and posterior ends of the shell.

- C. The adductor scars are of unequal size (*Anisomyarian*), the anterior one is always small and sometimes partly effaced by the advancing or growing margin of the hinge area. Byssiferous.

8. Shells usually growing in clusters, attached to rocks, piling. Valves mytiliform or modioliform, the beaks small and placed at or close to the anterior end, the surface plain or ribbed, white, brown or bluish-black, covered with a smooth or bristly periostracum. Interior pearly.

Mytilidae

9. Shell elongate, narrowed, and pointed anteriorly, fan-shaped, brown or horn-colored, flexible around the wide margins. Sedentary forms buried in sand or gravel, the shell held in a vertical position by the byssus.

Pinnidae

- D. Adductor scars are more or less alike in size and shape.

- Da. Hinge structure formed by numerous, small vertical or >— shaped teeth, on one or both sides of the beak, continuous or interrupted in the middle (taxodont).

- Daa. No cardinal area. The ligament attached to a central resilifer under the beak.

10. Shell rounded or ovate (nuculiform). Interior pearly. Ligament internal.

Nuculidae

11. Shell elongated, the posterior side narrowed and rostrated, porcellaneous. An external ligament is present.

Nuculanidae

Dab. Cardinal area well developed. Substance of shell porcellaneous, the surface with plain or strong sculpture. With or without an anchoring byssus.

Daba. Shell inequilateral and often inequivalve. Hinge line straight.

12. Surface with ribbed sculpture, often unequally developed in the two valves.

Arcidae

Dabb. Valves nearly symmetrical, the sides subequal. Hinge line arched or curved.

13. Ligament spread over the greater part of the cardinal area.

Glycymeridae

14. Most of the cardinal area bare, the small ligament internal and lodged in a triangular pit or resilifer under the beak.

Limopsidae

Db. Hinge concentrated, usually composed of a few, strong teeth which fit into sockets.

Db. Hinge torsional, the teeth hook-shaped, curving outward from below the beaks. Cyclodonta.

15. Shell cordate or heart-shaped, convex, the valves equal. Surface smooth or ribbed.

Cardiidae

Dbb. Hinge not torsional, the teeth seated on a platform along the margin. The teeth below the beak are called *cardinals*; those spaced along the margins are known as *laterals*. Teleodonta.

Dbba. The ligament is external, usually placed behind the beaks.

Dbbaa. Interior of the shell showing a deep pallial sinus.

16. Shell cordate or heart-shaped, the valves alike in sculpture and convexity, the umbones usually prominent, ending in prosogyrate beaks, the anterior side usually shorter.

Veneridae

17. Shell lenticulate, elongated, thinner and generally inequivalve, the umbones flattened, inconspicuous, the posterior end of shell shorter, flexed, and sometimes rostrated. Surface smooth, with concentric growth incrementals, more rarely radially ribbed. Pallial sinus deep, the margin of the valves usually smooth.

Tellinidae

18. Similar to the last but the shell often razor-shaped, thin or of medium weight, generally equivalved, gaping posteriorly (except *Heterodonax*). Color white, pink, or maculated and rayed with purple, the periostracum coarse and thick. Ligament external, attached to a stout *nymphal plate* which rises prominently behind the beaks.

Sanguinolariidae

19. Shell wedge-shaped, the posterior side shorter, often flattened and with subtruncated margin, the texture solid. Surface smooth and polished, usually showing fine radials which crenulate the margins. Mostly beach shells.

Donacidae

20. Shell elongated, razor-shaped, the beaks submedian or close to the anterior end. Surface with growth line sculpture, sometimes cut by oblique lines.

Solenidae

21. Mostly rock borers with subovate to subelongate valves, often deformed. Surface with ribbed or concentric sculpture, sometimes with zigzag markings. Hinge similar to the Veneridae.

Petricolidae

Dbbab. Pallial line entire, no sinal inflexion.

Dbbaba. Shell permanently attached to the substratum. Hinge with large, irregular-shaped teeth.

22. Shell solid, porcellaneous, generally irregular in shape, attached by the umbone of either valve. Sculpture formed by ribs and concentric lamellae. Generally strongly colored.

Chamidae

Dbbab. Shell free not attached at any time.

Dbbabba. Mostly fresh-water or brackish species, the surface covered by a thick, coarse periostracum, generally destroyed over the beaks and umbones which are deeply corroded and chalky.

23. Shell generally cordate or rounded, equivalve, with anterior beaks and umbones, the hinge provided with both cardinal and lateral teeth. Pallial line mostly entire, sometimes with a small posterior sinus. Color white, often with pink or purple shading.

Corbiculidae

Dbbabbb. Marine species, the surface of the umbones and beaks generally not corroded.

24. Shell cordate, veneriform, equivalve with prominent umbones and recurved, prosogyrate beaks, solid. Surface often with ribbed sculpture and fluted margins.

Carditidae

25. Shell subovate, cordate, convex to depressed. The dorsal areas are frequently set-off by differences in contour and sculpture. Hinge teeth variable, often become obsolete. The anterior adductor scar is generally long and narrow, lying within the circumference of the pallial line.

Lucinidae

26. Shell similar to the Lucinidae in shape but generally smaller and thinner. Cardinal teeth conspicuously double or bifid. Adductor scars of equal size.

Diplodontidae

Dbbb. Ligament almost wholly internal and divided into two unequal parts, the larger section or resilium lodged in a chondrophore (resilifer) or an excavated, cup-shaped pit in the hinge plate between the hinge teeth or carried on a projecting arm.

Dbbba. Pallial line entire, no posterior sinus.

27. Shell elongated or subrectangular, solid, the posterior side often pointed, rostrated.

Crassatellidae

Dbbbb. Pallial sinus strong.

28. Shell ovate or trigonal with high, full umbones and prosogyrate beaks, thin or solid, the color generally white. Resilifer is a deep, cup-shaped chondrophore in the middle of the hinge plate between the cardinal teeth. Posterior-dorsal area usually well defined by an angle, ridge or elevated frill. Valve margins smooth.

Mactridae

29. Shell subcircular to subelliptical, convex or depressed, the posterior side sometimes flexed. Surface smooth or with elaborate sculpture of ribs, lamellae. Pallial sinus large and deep. Resilifer an oblique groove in the hinge plate, similar in both valves.

Semelidae

Dc. Hinge structure relatively simple, the teeth small, irregular in shape or wholly wanting.

Dca. Substance of the shell porcellaneous, the ligament either external or internal; if internal, the resilium is attached to a spoon-shaped chondrophoral arm often simulating a large tooth which projects outward from the hinge plate in the left valve (asthenodont). Nestlers, rock borers or living buried in sand or mud.

Dcaa. Ligament external.

30. Species with both large or small shells, the valves gape strongly behind, the surface sculptured with crude or wrinkled concentric lines, occasionally rayed. Borers or nestlers in rock, shell, or coral.

Saxicavidae

Dcab. Ligament internal. Resilifer carried on a chondrophoral arm in the left valve which fits into a wide gap in the right valve, with the resilifer scar within, under the umbone.

31. Valves more or less equal in size, shape and convexity, the umbones rather low. Pallial sinus usually large and deep.

Myacidae

32. Shell usually small, the valves alike or unequal in size, often rostrated or pointed posteriorly. Chondrophoral plate resembles a cardinal tooth.

Corbulidae

Dcb. Shell typically nacreous, rarely subporcellaneous, the surface layer often earthy, chalky, or granulose. Ligament internal, the resilium lodged in a chondrophore which is similar in both valves. (Anomalodesmacea).

Dcba. Shell generally small, rounded to corbuliform, rostrated, the pallial line simple. Chondrophore small.

33. Shell small, rounded or depressed, with noded radial riblets. Interior bright and pearly.

Verticordidae

34. Shell corbuliform, elongated, the anterior side short, rounded and convex, the posterior side narrowed, produced, and pointed.

Cuspidariidae

Dcbb. Shell small or medium-sized, the chondrophore larger, the pallial sinus sinuous. A lithodesma often present.

Dcbba. Mostly nestlers, the shell often quite irregular in shape.

35. Shell sometimes paper thin or heavy, generally with a peeling periostracal cover.

Lysonidae

Dcbbb. Not nestlers, the shell with a more regular form, the periostracum more closely adherent.

36. Shell subporcellaneous and often quite thin, inequivalve, the right valve larger, surface with rude sculpture, earthy, or pustulose.

Thraciidae

37. Valves hatchet-shaped, generally depressed, with a pearly surface. Hinge with strong crural ridges.

Pandoridae

38. Shell usually rounded, the right valve larger and convex, the left smaller and depressed, pearly. Hinge without crural ridges, the chondrophore a large, spoon-shaped process.

Periplomatidae

Dd. Hinge margin without any teeth, and the ligament is atrophied or obsolete. Dorsal margin smooth, reflected, or rolled over the umbone to which it may be closely appressed. Borers in rock, wood, shell, or burrowing deeply in a sand or clay bottom. (Adesmacea). The shell is generally white, thin, open or gaping at the ends and along the dorsal and ventral margins or these spaces may be covered by accessory calcareous plates. There is generally within the umbonal cavity a slender projecting arm or myophore (apophysis) to which the foot muscles were attached.

39. Typically borers in wood, the shell small and much reduced in size. Bore lined with a heavy calcareous, wormlike tube, generally much contorted.

Teredinidae

40. Shell larger and more perfectly formed, with open gaps or these spaces covered with accessory plates. Shell thin, the surface marked with coarse, scabrous ribs usually set apart in well-defined areas. Borers in rock, wood, shell, or simply in the sea bottom.

Pholadidae

GLOSSARY OF SOME COMMON TERMS USED IN PELECYPOD DESCRIPTIONS

Adductors. The valves of a pelecypod are closed by the pull of a special set of internal muscles known as adductors; the attachment of these muscles to the inside of the valve leave rounded or elongated impressions or scars (adductor scars), one or two in number; if there is only one scar (*monomyarian*) as in *Ostrea* or *Pecten*, this impression is placed slightly behind the middle; if there are two scars (*dimyarian*), they are located at the anterior and posterior ends (*anterior* and *posterior adductor scars*).

Amphidectic. With the ligament developed on both sides of the beaks.

Anisomyarian. With two adductor scars, of which the anterior one is much smaller than the other (*Heteromyarian*)

Beak. The tip or oldest part of the shell above the hinge margin; generally pointed and often coiled or curved.

Byssus. A bunch of horny threads, loose or in compact form, secreted by a special gland of the foot and by means of which some species are anchored to the sea floor or other objects.

Cardinal area. The surface of the valve between the beak and the hinge margin, often of a triangular shape and partly or wholly covered by the ligament. *Ostrea*, *Arca*.

Cardinal teeth. The middle members of the hinge teeth and which lie under the beak and seem to radiate out from there.

Cartilage. Obsolete name for the resilium; extensively used in French works on conchology.

Conchiolin. The organic constituent of the shell; left after the lime has been dissolved away by acid.

Cordate. Shaped like a heart. Often applied to such shells as *Cardium*, *Cardita*, *Venus*.

Dimyarian. With two adductor muscle scars.

Dorsal area or slope. The upper surface of the shell between the dorsal margin and the umbonal slope; it is best differentiated if the posterior umbonal slope is carinate or by marked differences in sculpture.

Edentulous. Hinge line without teeth.

Equilateral. Valve with both ends alike.

Equivalve. A shell with both valves alike in shape, convexity and sculpture.

Escutcheon. A depressed or flattened area (shield-shape) along the posterior dorsal side, on one or both valves, and set off from the rest of the shell surface by a ridge or line, or by a change of sculpture.

External ligament. The visible part of the ligament, usually shows as a rounded, brown mass just behind the beaks.

Foramen. A round hole or fissure in the lower valve for the passage of the byssal plug. *Anomia*.

Heterodont. Hinge with both cardinal and lateral teeth.

Heteromyarian. Same as *Anisomyarian*.

- Hinge.** The section of the dorsal margin, held together by interlocking teeth.
- Hinge plate.** An inward widening of the margin below the beak and on which the hinge teeth are placed and sometimes the internal ligament.
- Hinge teeth.** Toothlike projections along the hinge line.
- Inequilateral.** The two ends of the shell unlike in shape and sculpture.
- Inequivalve.** Shell with unlike or unequal valves.
- Internal ligament.** Ligament when placed largely or wholly within the hinge plate and not easily seen from the outside.
- Isomyarian.** With two subequal adductor scars; same as homomyarian.
- Lateral teeth.** Hinge teeth in a lateral position, in front or behind the cardinal teeth or the ligament.
- Ligament.** An element of the hinge, whose elastic reaction from compression, in opposition to the pull of the adductor muscle force the valves to open or spread apart.
- Lithodesma.** A calcified plate placed internally or under the middle portion of the ligament. Characteristic of some genera of the Anomalodesmacea.
- Lunule.** A lenticular or heart-shaped area lying below and in front of the beaks, usually weakly or strongly outlined by an impressed line or indicated as a more deeply impressed or sunken area. The lunule may be equally developed in both valves as in the Veneridae, or in one valve only.
- Mantle.** The fleshy sheet which envelops the vital organs of the animal within the shell. It is attached to the shell directly along the pallial line and its secretion forms the shell itself.
- Monomyarian.** With a single adductor muscle scar in each valve.
- Myophore.** An armlike process or apophysis rising from the interior of the shell, usually from the umbonal cavity and serves for the attachment of the foot muscles. Found in Pholadidae.
- Nacreous.** Shell with the interior having the luster of pearl resulting from the interference of light rays reflected from the surface of many, thin layers with different indices of refraction.
- Nymph.** A ridge or lamella of shell placed above the hinge teeth, platelike or with a rugose surface and to which the external ligament is attached.
- Opisthodontic.** Behind or facing backwards; applied mostly to the position of the ligament lying behind the beaks.
- Opisthogyrate.** Refers mostly to the backward coil of the beaks so that they point backwards or posteriorly.
- Pallial line.** The line of adhesion of the mantle to the shell near and generally parallel or concentric with the ventral margin.
- Pallial sinus.** An inflexion of the pallial line at the posterior end, its size usually an indication of the size of the siphons or tubular extensions of the mantle which protrude at the posterior end of

the shell when open and through which water is taken in for aeration and feeding, and afterwards expelled.

Periostracum

(epidermis). The periostome or the protective external covering of shell composed mostly of organic tissue or chitin with little or no lime added to it, often having a smooth, wrinkled or bristly surface. Dissolved by alkalines. The periostracum is most heavy in fresh-water mollusks and in some deep-water species as a protection against the corrosive action of acid waters.

Porcellaneus. A smooth, porcelain-like surface as the interior of some shells (contrasted with nacreous).

Prodissoconch. The embryonic shell as it emerges from the egg capsule. The shell is usually small, smooth, and is often preserved on the tip of the beaks.

Prosogyrate. In front or facing forward: the forward coil of the beak so that it faces or points forward or anteriorly.

Resilifer. The attachment area of the resilium. In the Mactridae, the resilifer is a cup-shaped depression in the middle of the hinge plate. In the Myacidae and Corbulidae, the resilifer is carried on a projecting arm or lamina.

Resilium. The inner band of the ligament, more or less fibrous in structure and composed of conchiolin charged with lime. Opens the valves through compressional release.

Tensilium. The outer band of the ligament. Composed of conchiolin but without lime. Usually with a conchoidal fracture, horny. Tensional.

Umbone. The surface of the valve immediately behind the beak, generally convex.

Umbonal slope. The line of greatest convexity which can be traced from the beak to the anterior or posterior ventral corners of the valve.

SYSTEMATIC TREATMENT

Subclass PROTOBRANCHIA

Order PALAEOCONCHA

Superfamily SOLEMYACEA

Family SOLEMYIDAE

The shell is elongate, soleniform, thin or moderately thick, equivalve and gaping widely at both ends, the dorsal and ventral margins straight and parallel, the anterior side longer, the surface covered by a glossy, brown to black periostracum extending beyond the free margins of the valve as conspicuous, frill-like laps. Hinge margin without teeth, the ligament internal or partly external. Pallial impressions usually weak, the posterior adductor scar bordered in front by a thickened ray. Surface smooth, plain, or radially rayed.

Genus SOLEMYA Lamarck, 1818

Type species by subsequent designation, "*Solenomya*" *mediterranea* Lamarck (= *Solemya mediterranea* Lamarck = *Tellina togata* Poli, 1791) (see Vokes, 1955, Jour. Paleont., vol. 29, No. 3, p. 534).

With the characters of the family. The genus is divided by Dall into three subgenera as follows:

- I. Ligament amphidetic, along both sides of the beak, chiefly internal, in advance of the chondrophore.

Subgenus *Solemya*, s. s.
- II. Ligament opisthodontic, internal, not exposed in front of the chondrophore.

Subgenus *Petrasma*
- III. Ligament opisthodontic, wholly internal, visible internally only where it crosses the gap between the valves.

Subgenus *Acharax*

The genus *Solemya* comprises relatively rare shells, seldom collected except by dredging, the fragile shell being easily damaged by drying out, the periostracum becoming separated from the layer beneath. Most species are deepwater but one form, *S. (Petrasma) panamensis* may sometimes be encountered on mud flats at extreme low water. *Solemya* is known by several fossil species in the Oligocene and Miocene of Peru, Ecuador, Colombia, and Panama.

Subgenus ACHARAX Dall, 1908

Type species by original designation, *S. johnsoni* Dall.**Solemya (Acharax) johnsoni** Dall

Plate 1, figure 5

Solemya johnsoni Dall, 1891, Proc. U. S. Nat. Museum, vol. 14, p. 189.—Dall, 1895, *op. cit.*, vol. 17, p. 712, pl. 25, fig. 1.

Solemya (Acharax) johnsoni Dall, Hertlein and Strong, 1940, Zoologica, vol. 25, pt. 4, p. 376.—Maxwell Smith, 1944, Panamic Marine Shells, p. 47, fig. 612.

Solemya (Acharax) agassizii Dall, 1908, Bull. Mus. Comp. Zool., vol. 43, No. 6, p. 365, pl. 16, fig. 10.—Hertlein and Strong, 1940, *op. cit.*, pp. 375, 376.—Maxwell Smith, 1944, *op. cit.*, p. 47, fig. 613.

Solemya (Acharax) johnsoni Dall and *S. (A.) agassizii* Dall, Vokes, 1955, Jour. Paleont., vol. 29, No. 3, p. 538.

This is a deepwater species with valves reaching a length of 150 mm.,

thus equalling in size some of the fossil forms. The surface is marked with from 7 to 12 wide flat rays between deep channels which show on the inside as prominent radial ribs.

Woodring⁵, who has examined the types of *S. johnsoni* and *S. agassizii*, questioned whether there are two species in the lot as the characters mentioned by Dall as to the number of rayed channels is variable and their count a matter of personal judgement. The type of *S. johnsoni* is a specimen taken off the coast of Lower California in 1,005 fathoms, that of *S. agassizii* from the Gulf of Panama in 1,672 fathoms.

Range—In deep water from Oregon to Punta Aguja, Peru.

Subgenus PETRASMA Dall, 1908

Type species by original designation, *Solemya borealis* Totten.

Solemya (*Petrasma*) *panamensis* Dall

Solemya panamensis Dall, 1908, Nautilus, vol. 22, No. 1, p. 2.

Solemya (*Petrasma*) *panamensis* Dall, 1908, Bull. Mus. Comp. Zool., vol. 43, No. 6, p. 366 Panama Bay in 29½ fms.—Hertlein and Strong, 1940, Zoologica, vol. 25, pt. 4, pp. 377, 378.

Solemya panamensis Dall, Pilsbry and Lowe, 1932, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, p. 141 on mud flats at extreme tide, rare, La Paz.

Length of valves exclusive of periostracum 39 mm., the shell thin, elongate-oval, the posterior end more pointedly and the anterior end more bluntly rounded. Periostracum brown, glossy, recurved over the margins of the valves, not produced into long processes, though more or less broken up beyond the margins. Anterior surface of valves radiately marked with eight or nine obscure rays, the middle zone with few sparse rays, the posterior with six or seven, more closely spaced, followed by a smooth area behind the beaks.

This is a smaller, more expanded, and less sharply truncate anteriorly than *S. agassizii* of the same length. Also easily separated by hinge differences. A shallow water species, sometimes encountered on mud flats at extreme low tide.

Range—Panama Bay northward to California.

Order PALAEOTAXODONTIDA

Superfamily NUCULACEA

Family NUCULIDAE

The shells of this family are usually small, ovate to subtrigonal, with a shiny, pearly or nacreous interior, equivalve but inequilateral, the anterior side being longer than the posterior. Surface smooth, often polished or marked with radial or concentric threads or riblets, sometimes finely cancellate, the pattern often divaricate. Hinge plate generally heavy, curved or bent in the middle with a central resilifer or chondrophoral pit bordered on the sides by an anterior and posterior series of small but numerous taxodont teeth. Ventral margin of valves smooth or crenulate.

Mostly small shells, often known as "Nut Shells". They are widely distributed in all seas, occurring most plentifully on a mud bottom.

⁵Woodring, W. P., 1938, Prof. Paper 190, U. S. Geol. Sur., p. 27.

Key to genera of Panamic Nuculidae

- I. Surface smooth or with radially cancellate sculpture. Genus *Nucula*
- II. Surface with divaricate sculpture. Genus *Acila*

Genus **NUCULA** Lamarck, 1799

Type species by monotypy, *Arca nucleus* Linné.

Recent in the European Seas

Shell generally small, with closed margins, not gaping, ovate-trigonal to subcircular, with small, appressed, opisthogyrate beaks. Interior white and usually brilliantly pearly. Surface smooth but in some cases showing faint to quite strong, subcutaneous radial lineation, stronger ventrally and giving rise to a pectinate or crenulate margin. Escutcheonal area usually somewhat elevated and pouting. Hinge taxodont, with two series of crowded chevron-shaped teeth, the anterior row longer and arched, the posterior row shorter and with fewer teeth. Chondrophore narrow, inclined obliquely forward. Pallial line simple.

About 13 species of *Nucula* have been recorded from the Pacific coasts of northern South America, Central America, and Mexico or its adjacent waters. About half of these species are abyssal and hence do not properly belong to the Panamic-Pacific fauna. Reference to these off-shore species will be found in Hertlein and Strong.

The genus *Nucula* is commonly divided into two sections or subgenera on basis of a smooth or crenulate ventral margin.

Subgenus **NUCULA** s.s.

Inner layer of shell with radially ribbed structure which may show on the surface either strongly or weakly as fine radial striations. Inner ventral margin of valves crenulate or denticulate.

Subgenus **ENNUCULA** Iredale, 1931

Inner layer of shell without a radial structure and the ventral margin of valves without crenulations. Surface smooth except for growth incrementals.

Key to species of *Nucula*

- I. Inner margin of valves crenulated; the finely ribbed structure of the inner layer transmitted to the surface and showing plainly or indistinctly. Subgenus *Nucula*, s.s.
- A. Shell very large (30 mm. or more in length).
1. Surface smooth or finely radially striate, the umbones more strongly sculptured with narrow, wavelike, concentric riblets cut by fine radial striation. *N. iphigenia*
- B. Shell smaller.
- a. Surface smooth or finely radially striated. Inner margin of valves finely crenulated.
2. *N. declivis* and subspecies
- b. Surface with stronger sculpture, cancellated with both concentric and radial riblets. Inner margin coarsely crenulated.

3. Shell very small, subcircular to subovate, depressed with low umbones.
N. schencki
 4. Shell larger, plump, strongly inequilateral with high, swollen umbones.
N. exigua and *N. paytensis*
- II. Ventral margin smooth.
- Subgenus *Ennucula*
5. Surface smooth
N. colombiana

***Nucula (Nucula) iphigenia* Dall**

Nucula iphigenia Dall, 1895, Proc. U. S. Nat. Museum, vol. 18, No. 1034, p. 15.—Dall, 1908, Bull. Mus. Comp. Zool., vol. 43, No. 6, p. 369, pl. 7, figs. 1, 4.—Hertlein and Strong, 1940, Zoologica, vol. 25, pt. 4, p. 386.

Shell large (length 30 to 35 mm.), solid, elongate-ovate, the anterior end produced, rounded, the posterior end obliquely truncate. Surface smoothish over parts of the shell or with feeble, narrow, irregular concentric wrinkles, strongest on the umbones, crossed by fine, radial striations. Lunule narrow, elongate, the escutcheon small, generally limited by a line from the large posterior area, the margin somewhat projecting or elevated in the middle, smoothish. Interior brilliantly nacreous with a strong pallial line and deeply impressed adductor scars. Hinge with numerous teeth, the anterior set twice as many as the posterior. Ventral margin denticulate.

Length 35 mm.; height 22.5 mm.; diameter 16 mm. (Dall).

One of the largest of known *Nuculas*. Dredged in Panama Bay, off Punta Piñas, in 259 fathoms. A closely related subspecies (*N. iphigenia azulensis* Olsson⁶ Pl. 2, figs. 9, 9a) is common as fossil in the Pliocene of the Burica Peninsula, Panama.

***Nucula (Nucula) declivis* Hinds**

Plate 1, figures 4, 4a

Nucula declivis Hinds, 1843, Proc. Zool. Soc. London, p. 98.—Hinds, 1844, Zool. Voy. Sulphur, Moll., pt. 3, p. 63, pl. 18, fig. 8. (Habitat—?).—Hanley, 1860, in Sowerby, Thes. Conch., vol. 3, Nuculidae, p. 154, pl. 230, fig. 147.

Nucula (Nucula) declivis Hinds, Hertlein and Strong, 1940, Zoologica, vol. 25, pt. 4, p. 380, pl. 1, figs. 1, 2, 3, 6, 7.

Shell small (length 5 mm.), solid, inequilateral, the posterior side short, its margin abruptly truncate, relatively convex. Surface smooth with deep, irregularly spaced concentrics and fine radial striation.

Length 5 mm., height 4 mm., diameter (both valves) 2.9 mm.—(Hertlein and Strong).

Nucula declivis was described without indication of locality and because of this and the small size of the original figures, there is some doubt as to its identification.

Strength of the surface radial striation appears to be variable, depending to some extent upon the degree of weathering and wear to which the shell has been exposed. Some of our shells from Ecuador have a smooth surface on which the radial striations hardly show.

Range—Gulf of California to northern Peru. Ecuador: Manta. Peru: Zorritos. Other records are given by Hertlein and Strong.

⁶Olsson, A. A., 1942, Bull. Amer. Paleont., vol. 27, No. 106, p. 176, pl. 4, figs. 2, 5, 7.

***Nucula (Nucula) exigua* Sowerby** Plate 1, figures 2, 2a, 2b, 10, 10a

Nucula exigua Sowerby, 1833, Proc. Zool. Soc. London for 1832, p. 198.—Sowerby, 1833, Conch. Illust., Nuculae, p. 6, pl. 16, figs. 24, 24*.—Hanley, 1860, in Sowerby, Thes. Conch., vol. 3, Nuculidae, p. 50, No. 17, pl. 299, fig. 136.

Nucula (Nucula) exigua Sowerby, Schenck, 1939, Jour. Paleont., vol. 13, No. 1, p. 36, pl. 6, figs. 1-8, 11.—Hertlein and Strong, 1940, Zoologica, vol. 25, pt. 4, No. 25, p. 381, pl. 1, figs. 4, 5.—Hertlein and Strong, 1955, Bull. Amer. Mus. Nat. Hist., vol. 107, art. 2, p. 169; Palmer, 1958, Mem. Geol. Soc. America, No. 76, p. 61, pl. 1, figs. 6, 7.

Generally small, length about 6 mm., or less, plump, with high, wide umbones, and with a more or less reticulate surface sculpture formed by strong, fairly wide, concentric riblets and radially threaded interspaces. The radial threads of the interspaces are strongest on the lateral slopes of the shell, sometimes quite indistinct on the umbones. The concentric riblets are generally much stronger than the radial reticulation and on the umbones, the concentric riblets are often close-set, and with smooth summits. The dorsal areas are both well marked, strongly sculptured, each set off sharply by a changed direction of the concentric riblets, the posterior-dorsal area large, cordate, flatly depressed; there is no recognizable lunule within the anterior-dorsal area. Hinge with about 18 teeth in the anterior set and about nine in the posterior.

A common and widely distributed species, perhaps intergrading with *N. paytensis* in the border zone.

Range—Lower California to Peru. Ecuador: Manta; Santa Elena. Peru: Zorritos.

***Nucula (Nucula) paytensis* A. Adams** Plate 1, figures 1, 1a, 1b

Nucula paytensis A. Adams, 1856, Proc. Zool. Soc. London, p. 51.—Reeve, 1870, Conch. Icon., vol. 18, *Nucula*, pl. 3, fig. 23 Payta, Peru.

Nucula crenulata A. Adams, var. *paytensis* A. Adams, Hanley, 1860, in Sowerby, Thes. Conch., vol. 3, Nuculidae, p. 50, No. 16, pl. 230, figs. 160, 161.

Like *N. exigua* but larger, more ovate, less convex, the umbones being less prominent, the sculpture is finer and more uniformly reticulate. Dorsal areas are strongly sculptured.

Range—Northern Peru. Peru: Paita; Bay of Sechura.

***Nucula (Nucula) schencki* Hertlein and Strong** Plate 1, figure 6

Nucula (Nuculopsis) schencki Hertlein and Strong, 1940, Zoologica, vol. 25, pt. 4, p. 384, pl. 1, figs. 8, 9, 10.

Shell small (length 2 mm.), thin, polished and rather compressed. Dorsal margin in front of beaks elevated and broadly rounded, the anterior end more acutely rounded, the posterior and ventral margins broadly rounded. Sculpture is formed by closely spaced concentric riblets crossed by faint radial striation, weakest on the umbones. Dorsal areas weakly defined. Interior with faint crenulations along the margin, the hinge teeth well developed with nine in the anterior set and five in the posterior.

Length 2 mm., height 1.7 mm., diameter (both valves) 1 mm.—(Hertlein and Strong).

Dredged off Port Guatulco, Mexico, in seven fathoms.

Range—Mexico.

Subgenus ENNUCULA Iredale, 1931

(*Nuculopsis* Woodring, 1925. Not *Nuculopsis* Girty, 1911).

Type species by subsequent designation, Singleton, 1932, *N. obliqua* Lamarck.

Shell ovate, inequilateral, the opistogyrate beaks placed nearer the posterior end, the posterior end hence shorter, its margin subtruncated. Anterior side usually much longer, its dorsal margin gently arched, narrowly rounded at the end. Surface smooth, the lines of growth indistinct, porcellaneously white. Inner ventral margin smooth. Hinge with the posterior set of teeth shorter and fewer in number than the anterior. Chondrophore narrow and strongly oblique.

Nucula (Ennucula) colombiana Dall

Plate 1, figures 3, 3a

Nucula colombiana Dall, 1908, Bull. Mus. Comp. Zool., vol. 43, No. 6, p. 371.—Hertlein and Strong, 1940, Zoologica, vol. 25, pt. 4, p. 385.

Shell small (length 4 to 5 mm.), subsolid, inequilateral, the posterior side short, sharply descending, subtruncate and with the margin pouting a little in the middle of the flattened area. Anterior side longer, its dorsal margin somewhat arched, slightly narrowed and rounded towards the end. Umbone wide. Surface porcellaneous white, shiny, very smooth except for one or more shallow, concentric undulations, the growth lines not visible. Interior of shell pearly and with the ventral margin of the valve smooth. Hinge with about seven teeth in the posterior series and about 14 in the anterior.

Length 4.5 mm., height 3 mm., max. diameter 2.2 mm.

This is a small, simple species dredged in Panama Bay and off Manta, Ecuador, in waters ranging from 29 to 41 fathoms. It resembles *Nucula declivis* but its ventral margin is smooth. Dall recorded this species off the coast of Chile in waters as deep as 401 fathoms.

Range—From Panama southward. Panama: Panama Bay. Ecuador: off Manta.

Genus ACILA H. and A. Adams, 1858

Type species by subsequent designation, Stoliczka, 1871, *Nucula divaricata* Hinds.

Like *Nucula* but often larger (max. length about 50 mm.), the surface sculptured with a characteristic pattern of parallel divaricating and more or less radial riblets which appear as if stacked or packed close together the main line of divarication extending from the umbo across the middle of the shell disk to the ventral margin, the peaks of their inverted V's forming a line of sharp, acute angles pointing towards the beak. A secondary line of reversed divarication may be developed along the posterior rostral side which often forms a shallow sinus ending in a slight bulge or pout at the margin.

Acella (Acella) divaricata burica Olsson

Plate 17, figures 9, 9a

Acella isthmica burica Olsson, 1942, Bull. Amer. Paleont., vol. 27, No. 106, pp. 177, 178, pl. 1, figs. 2, 6, 8, 9.

Acella has not been reported as living in Panamic waters, however a large species is plentiful as fossil in the Pleistocene-Pliocene beds along the Burica Peninsula of southwestern Panama. Some of the fossils bear a striking resemblance to the figures of *A. divaricata submirabilis* Makiyama (Schenck, 1936, Geol. Soc. America, Special Papers, No. 4, pp. 88, 89, pl. 14, figs. 8, 11) from the upper Pliocene of Sasage, Kazusa, Japan, but also known to be living off Japan and the Celebes. It seems possible that *A. divaricata burica* may still be living in Panamic waters.

Family NUCULANIDAE (Ledidae)

Shell small or medium-sized, mostly porcellaneous, elongate, the posterior side longer, narrower and often rostrate at the end, the anterior side shorter, rounder and convex. Hinge and ligament as in the Nuculidae, the chondrophoral pit usually internal but sometimes migrating upwards to the dorsal margin to become partly external. Pallial line more or less sinuous.

Two genera may be recognized.

- I. Shell with the posterior side much narrowed, often arcuate and pointed at the end, the anterior side higher, rounded at the end and often convex. Posterior-dorsal submargin, subelliptical in shape, flattened or concave (rostrum).

Genus *Nuculana*

- II. Shell elongate, lanceolate, depressed, the posterior side not strongly rostrate. Rostrum absent or very narrow.

Genus *Adrana*

Genus NUCULANA Link, 1807

Type species by monotypy, *Arca rostrata* Chemnitz (= *Mya pernula* Müller). Recent, seas of Europe.

Shell with the posterior side narrowly elongate, arcuate, rostrate; anterior side shorter, higher and rounder. Rostrum more or less bicarinate, subtruncate at the end which may show a slight gap, beaks small, opisthogyrate. Escutcheon distinct, elliptical, the lunule indistinct and small. Hinge teeth numerous, arranged in two series, the posterior set almost twice as long as the anterior. Chondrophore small, triangular, inclined backwards; pallial sinus small, shallow. Sculpture of concentric threads, evenly spaced on the umbo, crowded together ventrally.

The genus *Leda* Schumacher, 1817 of the older writers has the same type species.

The genus *Nuculana* has been divided into many subgenera on small differences, characters which cannot be easily expressed in a key. The following subgenera have species regional in the Panamic-Pacific Province.

Subgenera of *Nuculana*

- I. Shell having the posterior side longer than the anterior. The posterior set of hinge teeth nearly twice as long as the anterior.

1. Posterior side with a double keel or bicarinate. Surface marked with growth lines only.

Subgenus *Nuculana*, s.s.

2. Posterior side nodosely bicarinate. Surface with strong concentric sculpture.

Subgenus *Costelloleda*

3. Posterior side much narrowed, attenuated and straight. Shape and sculpture suggestive of a crassatellid.

Subgenus *Thestyleleda*

- II. Shell with the anterior and posterior sides subequal in length, the anterior side high, inflated and rounded, the posterior side pointed at the end.

- A. Shells relatively small.

4. Posterior side sharply rostrated, the rostrum concave or flattened, bordered by an angle or ridge.

Subgenus *Saccella*

5. Shape corbuliform, the rostrum not clearly defined or without a sharp border or rib.

Subgenus *Jupiteria*

- B. Shell large.

6. Surface polished and marked by concentric and oblique lines on the two sides.

Subgenus *Politoleda*

Subgenus **SACCELLA** Woodring, 1925

(*Ledina* Sacco, Dec. 1898, not *Ledina* Dall, April 1898.)

Type species by original designation, *Arca fragilis* Chemnitz (= *Leda commutata* Philippi). Miocene to Recent, Mediterranean.

Shell generally small, the posterior side much narrowed, sharply pointed at the end, the rostrum concave, wide, unicarinate or bordered by a sharp ridge or rib. Hinge with the anterior and posterior set of teeth of nearly equal length. Surface sculptured with fine or coarse concentrics. Posterior end with a small, open gap.

Thiele considered *Saccella* as a synonym of *Jupiteria* Bellardi 1875, the type species of which [*N. concava* (Born)] is a Miocene fossil from Italy. *Jupiteria* is closely similar to *Saccella* differing mainly by its more *Corbula*-like shape and in having the rostrum less well defined, bordered simply by a blunt or weak ridge. Several of our Pacific species could be allocated to either section with equal reason.

Key to Panamic-Pacific species of *Saccella*

- I. Shell strongly inequilateral, the posterior side much the longer, narrowed and contracted, and produced into a sharply pointed end.
- A. Mostly quite small species (length 12 mm. or under), the anterior side generally cut into by an impressed ray.
- a. Sculpture generally fine and uniform.
1. Concentric riblets continuous over the whole surface from the anterior submargins to the edge of the rostral keel.
N. ornata (Pl. 2, fig. 3, 3a)
2. Concentric riblets not quite continuous over the whole surface, often partially smooth near the rostral keel.
N. acrita (Pl. 2, fig. 7)
- b. Sculpture coarser and unequal.
3. Shell rather depressed, the concentric riblets much larger, heavier and more widely spaced in the middle zone.
N. impar (Pl. 2, fig. 6)
- II. Shell higher, the two ends more nearly alike in length, the posterior side appearing short and stubby.
- B. Shell relatively large, 20 mm. or more in length.
4. Sculpture formed by uniform, rounded, close concentrics between deeply grooved interspaces. An anterior ray is often present.
N. fastigata
- C. Shell smaller, 20 mm. or less in length.
- c. Concentric riblets are uniformly developed over the whole surface.
- ca. Concentric riblets low, rounded and appressed, separated by incised lines only.

5. Average length about 15 mm. Rostrum is narrowly elliptical in shape.
N. eburnea
- cb. Concentric riblets raised and separated by wider and deeper interspaces.
 cba. Rostral keel bordered in front or below by a deeply indented ray, thus the posterior end of the shell may appear double-pointed.
6. Shell subelongated, the concentric riblets coarse, separated by interspaces, wider than the riblets.
N. dranga (Pl. 2, fig. 5)
7. Shell shorter, higher and stubbier. Concentrics close. Anterior ray lacking or weak.
N. elenensis elenensis
8. Anterior and posterior rays are both well developed.
N. elenensis crispa
- cbb. Posterior ray is absent or very weak.
9. Concentric riblets relatively fine. Rostral keel rounded.
N. callimene
10. Concentric riblets stronger, the rostrum more sharply defined.
N. acapulensis (Pl. 2, figs. 8, 8a)
11. Shell quite small, the concentric riblets strong. Anterior slope with an indented ray or fold.
N. hindsii
12. Shell small, concentric riblets strong. Rostrum is deeply concave bordered by a coarsely noded keel. Anterior ray is also developed.
N. excavata

Nuculana (Saccella) ornata (d'Orbigny)

Plate 2, figures 3, 3a

Leda ornata d'Orbigny, 1846, Voy. Amér. Mérid., vol. 5, p. 546, pl. 82, figs. 4, 5, 6; Hanley, 1860, in Sowerby, Thes. Conch., Nuculidae, p. 24, No. 41, pl. 228, figs. 97, 98.

Nuculana ornata (d'Orbigny), Hertlein and Strong, 1940, Zoologica, vol. 25, pt. 4, No. 25, p. 405.

Smaller than *N. elenensis* with a longer, more attenuated posterior side terminating in a sharply pointed end. The anterior slope is crossed by a wide, flat ray extending from the beak to the margin in front of which the surface is sharply raised, its edge often more or less beaded by the concentric sculpture. The sculpture is neat and regular, formed by concentrics of medium strength and regularly spaced over the whole surface. Posterior or rostral keel strong, elevated, the enclosed rostral area wide, finely sculptured with the continuation of the external concentrics of the disk but more closely spaced.

Fossil in the Pliocene of Ecuador.

Range—Coasts of Peru and Ecuador. Peru: Bayovar, Bay of Sechura. Paita. Ecuador: Manta.

Nuculana (Saccella) acrita (Dall)

Plate 2, figure 7

Leda (Jupiteria) acrita Dall, 1908, Bull. Mus. Comp. Zoology, vol. 43, No. 6, pp. 374, 375 "Panama Bay".

Leda laeviradius Pilsbry and Lowe, 1932, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, p. 106, pl. 17, fig. 7 "Guaymas".

Nuculana (Saccella) laeviradius (Pilsbry and Lowe), Hertlein and Strong, 1940, Zoologica, vol. 25, pt. 4, pp. 396, 397, pl. 2, figs. 4, 7.

Shell small (length 6 to 7 mm.), white or translucent, with a thin, pale straw-colored periostracum, subequilateral, the anterior side swollen, the posterior narrowly rostrate and acute at the end. Anterior dorsal margin

gently arcuate; the posterior slope straight, the opposed margins of the valves slightly pouting in the middle of a longitudinally striate, depressed rostral area bounded on each side by a rounded angle; these terminate at the slightly gaping end. A shallow, flattened ray of variable strength extends from the beak to the anterior basal margin; the edge in front of this ray is more or less crested by the concentric sculpture. Middle of valve sculptured with strong concentric ripples but which fade out or become obsolete leaving a smooth ray in front of the posterior rostral angle.

Fresh specimens have a pale or subtranslucent straw-color and a thin periostracum; such specimens usually show faint radial streaks, seen best on the posterior side. Dead valves are porcellaneous white or yellow and show no radial markings. The anterior ray is strong in most shells. The sculpture is variable, typically with strong, rounded concentric riblets with wide interspaces and this sculpture covers most of the disk except for a narrow band below the rostral carina. As noted by Dall, an occasional specimen may occur which is smooth over most of the surface.

Range—Lower California to Ecuador. Mexico: Lower California; Guaymas. Costa Rica: Port Parker (Hertlein and Strong). Panama: Bay (Dall). Ecuador: Off Esmeraldas.

Nuculana (Saccella) impar (Pilsbry and Lowe)

Plate 2, figure 6

Leda impar Pilsbry and Lowe, 1932, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, pp. 106, 107, pl. 17, figs. 3-6 "Guaymas".

Nuculana (Saccella) impar (Pilsbry and Lowe), Hertlein and Strong, 1940, Zoologica, vol. 25, pt. 4, p. 396, pl. 2, fig. 6.

The shell is of medium size (length about 10 mm.), narrowly elliptical, inequilateral, the beak located a little in front of the middle, the disk weakly convex to depressed. Anterior side higher, somewhat elongated, its margin obliquely rounded; the posterior side is somewhat longer, rostrate, concave above, sharply pointed at the end and with a smaller point below, its margin, therefore, appearing somewhat bicarinate. The posterior-dorsal area is narrowly depressed and strongly sculptured longitudinally, bordered by a strongly noded rostral cord. Below the rostral cord, there is a narrow, depressed zone across which the concentric riblets of the sculpture extend with diminished strength. Surface sculpture consists of 10 or more strong, narrow, concentric riblets between wide, flattened interspaces; these concentrics are heaviest and most widely spaced over the middle of the disk, closer together on the surface of the umbone and near the ventral margin. Hinge with the anterior and posterior set of teeth of nearly equal length, the resilifer between them quite small; there are 14 teeth in the posterior row, all strong and nearly equal in size, except the first two on the inner side; there are 18 teeth in the anterior row, the first eight at the inner end being much smaller, the others increase rapidly in size towards the front. Pallial line and sinus indistinct. The lunule is a small, narrow, depressed area, transversely marked as if by the images of the teeth below. The rostral carina is flatly noded by the ends of the concentric riblets and where these are far apart, there may be one or two subsidiary nodes. Ventral margin finely crenulate except at the extreme posterior end.

Length 10.2 mm., height 5 mm., semidiameter 2mm. (a left valve USNM). Off lower California, sta. 2822 in 21 fathoms U. S. Fish Com.

Length 12 mm., height 6.2 mm., diameter 4.6 mm. (Pilsbry and Lowe).

A well-marked species characterized by its strong sculpture and in having minute crenulations along its inner ventral margin.

Range—Lower California to Costa Rica. Mexico: Lower California; Punta Penasco (Lowe); Guaymas (Pilsbry and Lowe). Costa Rica: Port Parker (Hertlein and Strong).

Nuculana (Saccella) fastigata Keen Plate 2, figures 2, 2a; Plate 3, figure 9

Nucula gibbosa Sowerby, 1833, Proc. Zool. Soc. London for 1832, p. 198 "Tumbez".—Sowerby, 1833, Conch. Illust., Nuculae, p. 4, pl. 15, fig. 9. Not *N. gibbosa* of Fleming, 1828.

Leda gibbosa Hanley, 1860, in Sowerby, Thes. Conch., vol. 3, Nuculidae, p. 120, sp. 28, pl. 228, fig. 79.

Nuculana (Saccella) gibbosa (Sowerby), Hertlein and Strong, 1940, Zoologica, vol. 25, pt. 4, pp. 395, 396, pl. 2, figs. 5, 8.

Nuculana (Saccella) fastigata Keen, 1958, Bull. Amer. Paleont., vol. 38, No. 172, p. 240, pl. 31, figs. 1, 2. New name for *N. gibbosa* Sowerby, 1833.

Shell often quite large (max. length about 31 mm.), elongate-subovate, convex and rather solid, white, often chalky, under an olive-brown periostracum, the anterior side rather long with straight dorsal margin, the posterior side narrowed and rostrated. Sculpture is formed by strong, narrowly rounded concentric riblets, their intervals as wide and flat-bottomed; this sculpture is nearly uniform over the whole surface. Anterior slope has a slightly depressed ray which hardly affects the sculpture but may sinuate the ventral margin to a small degree. Anterior-dorsal area depressed, longitudinally sculptured, the small lunule within smooth. Rostrum is quite large, elliptical, strongly sculptured, the rostral ridge low. Pallial sinus is large.

Length 31 mm., height 17 mm., diameter 12.8 mm.

Range—Mexico to Peru. Peru: Tumbez; Zorritos.

Nuculana (Saccella) eburnea (Sowerby) Plate 2, figures 4, 4a; Plate 3, figure 10

Nucula eburnea Sowerby, 1833, Proc. Zool. Soc. London for 1832, p. 198.—Sowerby, 1833, Conch. Illust., Nuculae, pp. 4, 6, pl. 15, fig. 10.

Leda eburnea Hanley, 1860, in Sowerby, Thes. Conch., vol. 3, Nuculidae, p. 124, No. 33, Pl. 228, fig. 90.—Sowerby, 1871, Reeve, Conch. Icon., vol. 18, *Lacda*, pl. 5, fig. 29.

Nuculana (Saccella) eburnea (Sowerby), Hertlein and Strong, 1940, Zoologica, vol. 25, pt. 4, No. 25, p. 395, pl. 2, figs. 1, 2, 3.

Shell of medium size (length up to about 16 mm.), about twice as long as high, semi-elliptical, the umbones and beaks submedian, convex. Posterior side narrowed, attenuate, the dorsal margin concave, the end pointed, the anterior side narrowly rounded. Lunule distinct, elliptical, a trifle more than half the length of the anterior side. Posterior-dorsal or rostral area wide, as long as the posterior side, sculptured with straight, parallel lines and defined by an outer angle. Surface is sculptured with evenly spaced, incised lines forming concentric ribbons, uniformly developed over most of the surface except for a narrow, smooth ray sometimes present just below the posterior angle.

The commonest species of *Nuculana*, easily recognized by its plain sculpture of even, smooth concentrics, and well-defined lunule.

Range—Gulf of Fonseca, El Salvador southward to northern Peru. Panama: Búcaro. Canal Zone: Venado Beach; Colombia; Isla del Gallo. Ecuador: Santa Elena; Punta Blanca; Galeras. Peru: Zorritos.

Nuculana (Saccella) dranga, new species

Plate 2, figure 5

Shell of medium size (length about 12 mm.), subelliptical, the length about twice the height, the beak and umbone placed nearly in the middle. There is a deeply indented ray along the lower side of the posterior or rostral keel which sharply bends or in some cases slightly dislocates the sculptural lamellae which cross it; the anterior ray is much weaker or wholly absent, the lines of sculpture being merely depressed, or weakly flexed by it. The posterior end is pointed, occasionally with a smaller point below it on the lower side of the indented ray. Sculpture is strong and on most specimens quite uniform; it is formed by strong, triangular, concentric lamellae or riblets, their dorsal side a trifle shorter and steeper, sometimes with a small overhang between deeply grooved or wavelike interspaces of the same width. The concentrics are generally of uniform size across the middle of the disk (20 or more), a little smaller on the surface of the umbone and somewhat more crowded together near the ventral margin; an occasional one is deeper and marks a rest period. The rostrum is large, set apart by the posterior or rostral angle, which is nodose or serrated by the concentrics; its shape is narrowly elliptical and marked with fine, parallel lamellae. The lunule is small and narrow, flat, with cross sculpture formed by the roots of the hinge teeth. Hinge provided with strong teeth, in an equal series, about 18 teeth in the anterior row and about 16 in the posterior row, the middle ones extremely small.

Length 12 mm.; height 6 mm.; diameter 2.3 mm.

Esmeraldas, Ecuador. Holotype ANSP 218926.

This may be a widely distributed species, often identified with *N. elenensis* (Sowerby) from which it is separated by its greater length in ratio to its height and sharper sculpture. Relations are also indicated with *N. acapulcensis* Pilsbry and Lowe.

The species is named for the late Mr. Ted Dranga, well-known shell collector and who accompanied the author on his Ecuadorian expedition of 1955.

Range—Off Ecuador but probably north to Mexico. Ecuador: Esmeraldas.

Nuculana (Saccella) elenensis (Sowerby)

Plate 1, figure 9

Nucula elenensis Sowerby, 1833, Proc. Zool. Soc. London for 1832, p. 198.—Sowerby, 1833, Conch. Illust., Nuculae, p. 4, No. 19, pl. 15, fig. 14 "Tumbez".

Leda elenensis Hanley, in Sowerby, 1860, Thes. Conch., Nuculidae, p. 121, No. 29, figs. 70-72. (Fig. 70 is considered as the typical form).

Nuculana (Saccella) elenensis (Sowerby), Hertlein and Strong, 1940, Zoologica, vol. 25, pt. 4, pp. 393, pl. 1, figs. 17, 18, 19 (copied from Hanley); the others are *N. acapulcensis* Pilsbry and Lowe. Not *N. elenensis* Maxwell Smith, 1944, Panamic Marine Shells, fig. 626B.

The shell is small or medium-sized (length 12-13 mm.), short, stubby, solid and convex, with nearly central beaks, rounded anterior side and a narrowed, pointed posterior end, deeply concave on the dorsal margin. The sculpture is formed by subequal, coarse, concentric riblets between deeply grooved, sometimes pitted interspaces. There is usually an impressed zone extending from the beak to a point near the anterior-ventral margin causing a slight flattening or flexing of the concentric riblets. On the posterior side, there is a wider and more deeply impressed ray just below the keel which

may deeply emarginate the posterior-ventral end so that it appears double pointed. There is a small, narrowly linear lunule and a much larger, well-sculptured rostrum covering the whole length of the posterior area between the dorsal margin and the keel.

This species is variable and several subspecies or races could easily be recognized. The typical form of *N. elenensis* is shown by figure 14 in Sowerby's Conchological Illustrations and by Hanley's figure 70 in his monograph of the Nuculidae. To this shell, Hanley proposed the varietal name of *gibbosa* and described it as follows:

Beaked-ovate, very ventricose, the anterior indented ray not very conspicuous; ribs scarcely so broad as their intervals; front extremity only slightly narrowed; rostrum much recurved, its tip above the middle; ventral margin remarkably arched in front, and much rising behind.

This species is relatively rare at most localities, generally small and seldom exceeding 12 mm. in length. Although variable in its convexity, the species is easily distinguished by its rather stubby form, strong sculpture and by its well-marked posterior rib so that the posterior end appears as if double pointed. The anterior ray is weak or strong, and it often forms a slight flexure across the anterior slope.

Range—Coast of northern Peru and Ecuador. Ecuador: Esmeraldas; Manta; Santa Elena; Ancon. Peru: Bay of Sechura.

Nuculana (Saccella) elenensis crispa (Hinds)

Nucula crispa Hinds, 1843, Proc. Zool. Soc. London, p. 100 (Hab. Gulf of Nicoya; from 36 fm.—Hinds, 1844, Zool. Voy. Sulphur, Moll. pt. 3, p. 64, pl. 13, fig. 14.

Leda crispa (Hinds), Hanley, 1860, in Sowerby, Thes. Conch., vol. 3, Nuculidae, p. 134, sp. 50, pl. 229, figs. 107, 108.

Nuculana crispa (Hinds), Hertlein and Strong, 1940, Zoologica, vol. 25, pt. 4, p. 403.

Shell small, (length about 6.5 mm.), stubby, coarsely concentrically costellated throughout, the riblets somewhat shelving and about as broad as their intervals which are radiatingly lirated at the posterior end. The posterior end is sharply rostrate, bordered by a deeply indented ray below, the rostrum large, with close concentric lines bordered by a coarsely costellated keel.

This form was described as a species by Hinds. It is here considered as a subspecies of *N. elenensis* in which the anterior indented ray is strongly developed.

Range—Panama southward to Ecuador.

Nuculana (Saccella) callimene (Dall)

Plate 1, figures 7, 7a, 7b

Leda (Jupiteria) callimene Dall, 1908, Bull. Mus. Comp. Zool., vol. 43, No. 6, p. 372, pl. 17, figs. 3, 4 "Gulf of Panama, 259 fathoms".

Nuculana (Saccella) callimene (Dall), Hertlein and Strong, 1940, Zoologica, vol. 25, pt. 4, p. 393, pl. 1, fig. 13.

Shell small (average length, 15 to 16 mm.), solid, plump, white or yellowish brown, equi-valve and inequilateral. No escutcheon but the posterior-dorsal area is wide, bounded by a rostral angle; there is an elongated, narrow lunule poorly defined by a slight change of sculpture. Sculpture consists of numerous, small, concentric riblets between somewhat wider, grooved interspaces, uniformly developed over the whole surface except for a narrow,

smoothish space along the rostral carina. On the anterior, rounded slope, the concentric riblets are flexed slightly by an impressed ray. Interior of the shell shows its solid build, the adductor scars being deeply impressed, the pallial line also impressed and showing a small, shallow sinus. Hinge plate is relatively large and stout, the hinge teeth strong and with approximately the same number in each set.

Length 15.5 mm., height 10.5 mm., diameter 7 mm.

This is a deepwater species from the Gulf of Panama. The posterior-dorsal side is nearly straight, the two ends of the shell appearing subequal. Sculpture is fine and close. A similar species (*N. chiriquiana* Olsson) occurs in the Pliocene of the Burica Peninsula.

Range—Panama.

Nuculana (Saccella) acapulcensis (Pilsbry and Lowe) Plate 2, figures 8, 8a

Leda (Saccella) acapulcensis Pilsbry and Lowe, 1932, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, p. 107, pl. 17, figs. 1, 2 Acapulco, Mexico in 20 fathoms.

Nuculana (Saccella) elenensis (Sowerby), Hertlein and Strong, 1940, Zoologica, vol. 25, pt. 4, No. 25, pp. 393, 394, pl. 1, figs. 12, 14, 15, 16, 22. (Not *N. elenensis* Sowerby, 1833.)

The shell is rather solid, plump, white under a thin light grayish-olive periostracum. Anterior end rounded but with somewhat uneven outline, posterior end produced, rostrate, tapering to a narrow point, the dorsal slope concave behind, the edges of the valves projecting very little above the posterior keel. Ventral margin strongly arcuate, straight or even slightly concave close to the posterior point. Lunule not sunken, very narrowly lanceolate, transversely costulate; posterior dorsal area broadly lanceolate, bounded by a rounded rib in each valve, a little convex in the middle, concave along the ridges, longitudinally costate in continuation of the external concentric ridges, which are a little enlarged as they pass over the posterior rounded rib or keel. Sculpture of regular concentric costae about as wide as their intervals. Towards the ventral margin the ridges have abrupt lower margins. The interior is white. Hinge with about 14 well-developed teeth on each side of the broadly triangular resilium, and with a group of about six minute, narrow teeth behind, and about 10 before the resilium. Pallial sinus small, rounded at the end.

Length, 13.2 mm., height 7.0 mm., diam. 5.0 mm.

Length, 15.3 mm., height 8.3 mm., diam. 6.3 mm.—(Pilsbry and Lowe.)

This form was united with *N. elenensis* by Hertlein and Strong (followed also by Myra Keen) but it appears to be a distinct species, differing from *N. elenensis* by its longer form, less convex valves, and by its more regular and sharper sculpture. The anterior slope bears sometimes a weakly indented ray.

Range—Mexico to Ecuador. Mexico: Acapulco. Ecuador: Esmeraldas.

Nuculana (Saccella) hindsii (Hanley)

Leda hindsii Hanley, 1860, Proc. Zool. Soc. London, p. 440 Nicoya.—Hanley, in Sowerby 1860, Thes. Conch., vol. 3, Nuculidae, p. 135, sp. 51, pl. 229, fig. 102.

Nuculana hindsii (Hanley), Hertlein and Strong, 1940, Zoologica, vol. 25, Pt. 4, p. 404.

Nuculana (Saccella) hindsii (Hanley), Tucker Abbott, 1954, American Seashells, p. 339

Shell small (length about 8 mm.), light yellowish brown, ovate-oblong, inequilateral, more or less ventricose with a conspicuous indented ray on the anterior slope. The sculpture of closely spaced concentric riblets cover

the external surface except for a smooth space below the rostral keel; these riblets are numerous and regular, scarcely as wide as their intervals.

Tucker Abbott reported this *Nuculana* as common along the west coast of the United States where it has generally been identified in the past as *N. acuta* Conrad, an Atlantic Coast species.

Range—Alaska to Panama.

Nuculana excavata (Hinds)

Nucula excavata Hinds, 1943, Proc. Zool. Soc. London, p. 100 Panama in 30 fm.—Hinds, 1844, Zool. Voy. Sulphur, Moll., pt. 3, p. 64, pl. 18, fig. 17.

Leda excavata (Hinds), Hanley, 1860, Thes. Conch., vol. 3, Nuculidae, pp. 31, 32, sp. 52, pl. 229, figs. 104, 105.

Nuculana excavata (Hinds), Hertlein and Strong, 1940, Zoologica, vol. 25, pt. 4, p. 404. Keen, 1958, Bull. Amer. Paleont., vol. 38, No. 172, p. 239.—Keen, 1958, Sea Shells of Tropical West America, p. 20, fig. 19.

A small, rather oblique, sharply beaked shell, short ovate, plump. The posterior or rostral ridge is large and scabrously noded by the sculpture which consists of numerous, sublamellose concentric riblets, regularly disposed over the whole surface except on the dorsal areas. The beak is in the middle, the anterior end rounded, the posterior with a sharp beak, its tip narrow and curved upward.

This species has not been recorded since its discovery and is known only from its original figures and imperfect description. As Myra Keen has recently noted, the name "*excavata*" is preoccupied (by Goldfuss, 1837) and will need replacement if and when the types or authentically identified specimens are found.

Range—Panama.

Subgenus **POLITOLEDA** Hertlein and Strong, 1940

Type species by original designation, *Nucula polita* Sowerby.

Shell relatively large, elongate subelliptical, the posterior end sharply pointed. Posterior-dorsal area narrow, as long as the posterior side and neatly sculptured with small, parallel incised lines. Surface white, polished or glazed, with minute growth lines and sculptured with strong, quite widely spaced incised lines which on the posterior side pass upwards obliquely across the umbonal slope, usually fading out on the surface of the mid-umbones to appear again more widely spaced on the anterior side. Pallial sinus large, widely rounded and reaching to a line under the beak.

Nuculana (*Politoleda*) *polita* (Sowerby)

Plate 2, figures 1, 1a

Nucula polita Sowerby, 1833, Proc. Zool. Soc. London for 1832, p. 198.—Sowerby, 1833, Conch. Illust., Nuculae, p. 4, pl. 15, fig. 11.

Leda polita Hanley, in Sowerby, 1860, Thes. Conch., vol. 3, Nuculidae, p. 125, sp. 36, pl. 228, fig. 68.—Sowerby, 1871, Reeve, Conch. Icon., vol. 18, *Laeda* pl. 3, fig. 16.

Nuculana polita (Sowerby), Maxwell Smith, 1944, Panamic Marine Shells, p. 48, figs. 622, 626C.

Nuculana (*Politoleda*) *polita* (Sowerby), Hertlein and Strong, 1940, Zoologica, vol. 25, pt. 4, pp. 397, 398, pl. 2, fig. 9.

This species is easily recognized by its large size and characteristic sculpture. It is especially common on the beach at Old Panama.

Range—Guatemala to Panama. Panama: Old Panama; Panama City; San Carlos. Canal Zone: Palo Seco; Venado Beach. For other records see Hertlein and Strong.

Subgenus **COSTELLOLEDA** Hertlein and Strong

Type species by original designation, *Nucula costellata* Sowerby.

Shell elongate with strong concentric sculpture.

Nuculana (*Costelloleda*) *costellata* (Sowerby) Plate 3, figure 8

Nucula costellata Sowerby, 1833, Proc. Zool. Soc. London for 1832, p. 198 (*Hab. ad Panamam*).—Sowerby, 1833, Conch., Illust., *Nuculae*, p. 4, pl. 15, fig. 8.—Reeve, 1841, Conch. Icon., vol. 1, *Nucula*, pl. 85, fig. 8.

Leda costellata Hanley, in Sowerby, 1860, Thes. Conch., vol. 3 *Nuculidae*, p. 111, sp. 11, pl. 228, fig. 59.

Nuculana (*Costelloleda*) *costellata* (Sowerby), Hertlein and Strong, 1940, *Zoologica*, vol. 25, pt. 4, pp. 398, 399, pl. 2, fig. 10.

Shell elongate, rather thin, compressed, white, under a pale olivaceous or ash-colored epidermis, occasionally iridescent, the surface sculptured with distant, erect concentrics which terminate just below the posterior-umbonal angle formed by two nodose or squamose ridges enclosing between them a flat, smooth area; interval between the concentric lamellae smooth; posterior-dorsal area or rostrum large, smooth, concave, its margins pouting; lunule linear. A more or less subobsolete anterior ray is generally present.

Length 22 mm., height 8 mm., diameter (both valves) 4.4 mm.—(Hertlein and Strong).

Generally rare.

Range—Lower California to Panama.

Nuculana (*Costelloleda*) *marella* Hertlein and Strong

Nuculana (*Costelloleda*) *marella* Hertlein and Strong, 1940, *Zoologica*, vol. 25, pt. 4, pp. 399, 400, pl. 2, figs. 12, 13.

Much like *N. costellata* (Sowerby) but is larger, more rostrate, and has finer concentric sculpture.

Rare.

Range—Gulf of California to Panama. Panama: Gulf of Chiriqui in 35 to 40 fathoms.

Subgenus **THESTYLEDA** Iredale, 1929

Type species by original designation, *Leda ramsayi* E. A. Smith. New South Wales.

Shell small or of medium size, thin, the anterior side wide, rounded, the posterior side nearly twice the length of the anterior, sharply narrowed, attenuated and squarely truncated at the end. Surface sculptured with strong, concentric rugae which turn sharply upward as they cross the posterior or rostral ridge. Two radial ridges form keels along the rostrum. Chondrophore large.

This subgenus is based on an Australian species, but the following appears to belong to it also.

Nuculana (*Thestylelda*) *hamata* (Carpenter)

Leda hamata Carpenter, 1864, Rept. Brit. Assoc. Adv. Sci. for 1863, pp. 612, 644. Santa Barbara, Calif.—Sowerby, 1871, Conch. Icon., vol. 18, *Laeda*, sp. 56, pl. 9, fig. 56.—Dall, 1902, Proc. U. S. Nat. Museum, vol. 24, p. 558, pl. 40, fig. 9.

Nuculana hamata (Carpenter), Grant and Gale, 1931, Mem. San. Diego Soc. Nat. Hist., vol. 1, p. 125, pl. 1, figs. 14, 15.

Nuculana (*Thestylelda*) *hamata* (Carpenter), Hertlein and Strong, 1940, *Zoologica*, vol. 25, pt. 4, pl. 2, fig. 14.—Tucker Abbott, 1954, *American Seashells*, p. 339, fig. 26d.—Palmer, 1958, Mem. Geol. Soc. America, No. 76, p. 61, pl. 2, figs. 4-6.

Generally less than 15 mm. in length, compressed, of a dark chestnut-brown color, its shape and sculpture like that of a small crassatellid, the posterior side much longer than the anterior, narrowly attenuated and squarely truncated at the end.

This is a common species off the coast of California, often dredged in waters of 20 to 200 fathoms. Hertlein and Strong record the species off the Mexican coast (east of Cedros Island). Dall (1921) gave its range as from Puget Sound to Panama, but the species is probably not a member of the Panamic-Pacific fauna.

Genus *ADRANA* H. and A. Adams, 1858

Type species by subsequent designation, Stoliczka, 1871, *Nucula (Adrana) lanceolata* Lamarck. No locality cited. (See Hertlein and Strong, 1840, p. 406).

Shell elongate or narrowly lanceolate, compressed, the dorsal margin nearly straight with small, subcentral beaks, the ventral margin rounded and often sinuate near the ends. No rostral area but a narrow, flattened lunule and escutcheon is usually well developed, bounded by a rounded, often crenate umbonal ridge. Ligament internal and attached to a wide, often weakly bilobed chondrophore placed under the beak and directed anteriorly. Hinge teeth numerous and arranged in an anterior and posterior series. Pallial sinus rounded and of moderate size. Sculpture smooth or composed of threadlike, concentric ridges, sometimes becoming oblique posteriorly.

Drift valves of these lovely shells are often common on some sandy beaches. About six valid species are recognized in this review and as shown in the keys belong to two well-marked groups.

Key to species of *Adrana*

- I. The dorsal margin is nearly straight, the lower or ventral margin is commonly sinuated towards the anterior end.
 - A. Shell relatively narrow and slender, the ratio of height to length about 1 to 5.
 1. *A. sowerbyana*
 - B. Shell higher, ratio of height to length about 1 to 4 or less.
 2. Length about 38 mm, the beaks placed near the anterior one-third. Gulf of California. Pl. 3, fig. 7.
 3. Average length about 60 mm. The beak is placed a little anterior of the middle.
 4. Shell larger, often exceeding 100 mm. in length. Beaks placed quite close to the middle.
 - *A. cultrata*
 - *A. suprema*
 - II. Dorsal margin arched at the beak, concave behind.
 - C. Concentric sculpture developed over the whole surface of shell.
 5. Shell length about 35 mm. The lines of sculpture are relatively fine and developed uniformly over the whole disk.
 - *A. crenifera*
 6. Shell smaller, the lines of sculpture heavy and coarse on the anterior side.
 - *A. tonosiana*

D. Sculpture lines varied, concentric on the anterior side and more or less oblique on the middle and posterior zones. A smooth ray generally borders the posterior carina.

7. *A. exoptata*

Adrana cultrata Keen

Plate 3, figures 1, 2

Nucula elongata Sowerby, 1832, Proc. Zool. Soc. London, p. 197 (Xipixapi).—Sowerby, 1833, Conch. Illust., Nuculae, pl. 14, fig. 2.—Reeve, 1841, Conch. Icon., *Laeda* vol. 1, p. 110, pl. 84, fig. 2. Not *N. elongata* Bosc, 1801, or DeFrance, 1825.

Leda elongata Hanley, in Sowerby, 1860, Thes. Conch., vol. 3, Nuculidae, p. 106, sp. 1, pl. 227, fig. 39.

Adrana elongata (Sowerby), Hertlein and Strong 1940, Zoologica, vol. 25, pt. 4, p. 409, pl. 2, fig. 16.—Hertlein and Strong, 1955, Bull. Amer. Mus. Nat. Hist., vol. 107, art. 2, p. 170.

Adrana cultrata Keen, 1958, Bull. Amer. Paleont., vol. 38, No. 172, pp. 240, 241. New name for *N. elongata* Sowerby, preoccupied.

Blade-shaped, highest under the beak which is nearly central, the posterior-ventral margin evenly curved, the anterior-ventral margin slightly sinuated. The shell is rather thin, semitransparent, gaping at both ends, white, under an excessively thin, brown or olivaceous periostracum, the surface sculptured with fine, threadlike striae, so fine above as to appear almost wanting, close and regular in the middle, more remotely spaced in front. Average length, 50 mm.

Range—Mexico to Ecuador.

Adrana suprema (Pilsbry and Olsson)

Plate 3, figure 5

Nuculana (Adrana) suprema Pilsbry and Olsson, 1935, Nautilus, vol. 48, No. 4, p. 117, pl. 6, fig. 1.

Adrana suprema (Pilsbry and Olsson), Hertlein and Strong, 1940, Zoologica, vol. 25, pt. 4, No. 25, p. 411.

The shell is long, strongly compressed, subequilateral, with dark olive-brown epidermis (largely or wholly lost in specimens seen); glossy. The dorsal outline is nearly straight, the ventral margin gently convex, straightened or slightly concave towards the posterior end, the greatest height being about the anterior third of the length. Anterior end more obtuse than the posterior. Dorsal areas extremely narrow, bounded by inconspicuous angles. Sculpture of weak growth lines and excessively fine and clear-cut longitudinal striae, obliquely crossing the lines of growth posteriorly, mainly curving with them in the anterior half. They are wanting in a band along the dorsal side, but extend nearly to the ends. Interior white, the pallial sinus occupying more than one-third of the total length, truncate at the end. Tooth-row long, occupying 60% of the whole length, anterior and posterior series of about equal length, teeth very small V-shaped. Cartilage pit very shallow, about 10 mm., long in the type. Length 107 mm., height 23.5 mm., semi-diameter 4.6 mm.—[Pilsbry and Olsson, 1935].

This is the largest *Adrana* and is distinguished by the nearly central beaks, those of *A. cultrata* are a little more anterior.

Range—Panama. Panama: Beach between Port Guanico and the Guanico River, Los Santos Province.

Adrana sowerbyana (d'Orbigny)

Plate 3, figures 3, 3a

Nucula lanceolata Lamarck, Sowerby, 1833, Conch. Illust., Nuculae, p. 3, pl. 14, fig. 1.

—Hanley, 1846, Cat. Bivalve Recent Shells, Suppl. pl. 19, fig. 49. (Not *Nucula lanceolata* Lamarck, 1819.)

Leda sowerbiana d'Orbigny, 1846, Voy. Amér. Mérid., vol. 5, p. 544. (New name for *N. lanceolata* Sowerby, 1833, not Lamarck, 1819.)

Leda sowerbiana d'Orbigny, Hanley, 1860, in Sowerby, Thes. Conch., vol. 3, Nuculidae, p. 107, No. 2, pl. 227, fig. 33.

Adrana sowerbyana (d'Orbigny), Hertlein and Strong, 1940, Zoologica, vol. 25, pt. 4, No. 25, pp. 410, 411.

Shell elongate, compressed, white or translucent, nearly five times as long as high, the beaks flattened and small, placed a little anterior of the middle. The dorsal margin is straight except for a slight upturn at the extreme posterior end. The ventral margin has a uniform gentle curve except for a small sinuation near the anterior end, and a much milder one at the posterior end. Lunule long and narrow, no rostral area, the escutcheon extremely narrow, long and smooth. Sculpture over most of the surface consists of fine, close concentric incised lines forming narrow ribbons, occasionally smoothing out on the posterior slope, becoming coarser and wider as they bend backwards along the anterior or lunular margin, and strongly sinuated by the bend in the anterior-ventral margin. There is a smooth ray just below the posterior-dorsal margin.

Length 60.5 mm, height 12.5 mm., diameter 21 mm. right valve.

Isla del Gallo, Colombia.

Certain nomenclatural problems connected with this species have been discussed in some detail by Hertlein and Strong. My shell from Isla del Gallo, Colombia, agrees in shape well with that shown by Sowerby (as *lanceolata*) in his Conchological Illustrations, plate 14, figure 1.

Range—Panama to Ecuador. Colombia: Isla del Gallo. Ecuador: Xipixapi (Puerto Callo), (Sowerby).

***Adrana crenifera* (Sowerby)**

Plate 3, figures 4, 4a, 4b

Nucula crenifera Sowerby, 1833, Proc. Zool. Soc. London for 1832, p. 197.—Sowerby, 1833, Conch. Illust., Nuculae, p. 3, No. 4, pl. 14, fig. 3.

Leda crenifera (Sowerby) Hanley, 1860 in Sowerby's Thes. Conch., vol. 3, Nuculidae, p. 110, sp. 8, pl. 227, figs. 37, 38.

Laeda arcuata Sowerby, 1871, Reeve, Conch. Icon., vol. 18, *Laeda*, pl. 4, fig. 20.

Nuculana arcuata (Sowerby) Pilsbry and Olsson, 1935, Nautilus, vol. 48, No. 4, p. 118, pl. 6, figs. 2, 3.

Adrana crenifera (Sowerby), Hertlein and Strong, 1940, Zoologica, vol. 25, pt. 4, No. 25, p. 408.

Shell elongate-lanceolate, dull white, slightly convex, the length about four times the height. Beaks small, not quite in the middle, the posterior side being a little longer than the anterior. The dorsal margin is not straight, sloping down slightly on each side of the beak and with the posterior extremity turned up somewhat. The ventral margin is well rounded except near the posterior end which is drawn out and attenuated. Lunule is as long as the anterior side, narrow, bounded externally by a coarse, rounded rib; the escutcheon is similar, its bounding rib finely crenate. Sculpture consists of fine, sharp, concentric threads, evenly developed over the whole surface. There is a distinct, flattened ray below the posterior-umbonal angle.

This species is locally plentiful along the coast of Ecuador and Peru. *A. arcuata* (Sowerby), described without indication of locality, appears

to be the same species, as confirmed by J. R. Le Brocton Tomlin after examination of the type at the British Museum (Natural History).

Range—Coast of Ecuador and northwestern Peru. Peru: Punta Picos; Zorritos; Tumbez. Ecuador: Ancon Point; Santa Elena; Punta Blanca; Canoa.

Adrana exoptata (Pilsbry and Lowe)

Plate 3, figure 6

Leda (*Adrana*) *exoptata* Pilsbry and Lowe, 1932, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, p. 107, pl. 17, figs. 8, 9.

Adrana exoptata (Pilsbry and Lowe), Hertlein and Strong, 1940, Zoologica, vol. 25, pt. 4, pp. 409, 410, pl. 2, fig. 11.—Hertlein and Strong, 1955, Bull. Amer. Mus. Nat. Hist., vol. 107, art. 2, pp. 170, 171, pl. 3, figs. 6, 7.

Shell small (length usually less than 20 mm.), elongate, compressed, the anterior side somewhat higher and shorter. Dorsal margin is not quite straight. Sculpture is formed by fine, threadlike ridges concentrically arranged on the anterior part, straightening out and sloping towards the ventral margin and crossing the lines of growth obliquely on the middle and posterior sides. A smooth radial band lies below and in front of the posterior carina; this smooth zone may be narrow with the sculpture ending sharply against it or the band may be wider if the sculptural ridges fade out towards it in a more irregular manner.

This is a small species seldom exceeding 17 mm. in length and easily recognized by the sculpture becoming oblique on the middle and posterior sides of the disk. The smooth band below the posterior carina is variable in its development and in some shells may be lacking.

Range—Mexico southward to Ecuador. Mexico: Guaymas; Tangola-Tangola. Panama: Pearl Islands; Pina Bay; (Hertlein and Strong). Colombia: Ardita Bay; Aquacata (Hertlein and Strong). Ecuador: Off Cabo Pasado (Hertlein and Strong); Esmeraldas.

Adrana tonosiana (Pilsbry and Olsson)

Plate 3, figures 11, 11a

Nuculana (*Adrana*) *tonosiana* Pilsbry and Olsson, 1935, Nautilus, vol. 48, No. 4, pp. 117, 118, pl. 6, fig. 4.—Hertlein and Strong, 1940, Zoologica, vol. 24, pt. 4, No. 25, p. 412, pl. 2, fig. 15.

This species closely resembles *A. crenifera* (Sowerby), which it seems to replace to the northward of Ecuador. *A. tonosiana* is much smaller, proportionately shorter and higher, with coarser sculpture on a band below the anterior-dorsal angle, the concentric threads spreading apart, dividing and with an intercalary threadlet appearing between them along the umbonal-lunular angle.

Range—Off Mazatlan to Panama. Panama: Búcaro; Gulf of Chiriqui (Hertlein and Strong). For Guatemala, El Salvador, and Nicaragua records see Hertlein and Strong.

Family NUCINELLIDAE

Shells mostly minute, obliquely oblong, subtrigonal or egg-shaped, the anterior side short, porcellaneous. Ligament internal seated in a small resilifer bordered by a few, relatively large subtaxodont teeth.

Genus *NUCINELLA* Wood, 1851

Pleurodon Wood, 1840, not of Harlan, 1831 (Mammalia); *Nuculina* d'Orbigny, 1844, not of "Felippi" Porro, 1837; *Cyrrillona* Iredale, 1829; *Neopleurodon* Hertlein and Strong, 1940. (See Vokes, 1956, Jour. Paleont., vol. 30, No. 3, pp. 652.)

Type species by monotypy, *Pleurodon ovalis* Wood.

The shell is usually small, resembling *Nucula* but with a non-nacreous structure, its shape oval, subtrigonal to obliquely egg-shaped, the anterior side being shorter and more sharply descending, the posterior side hence longer and often a little expanded. Hinge plate relatively short and wide, somewhat angulated under the beak, in the angle of which lies a small resilifer, bordered on each side by a few, relatively large teeth; the left valve has a prominent, posterior lateral tooth which is received in a depression in the opposite valve. Surface smooth or with fine concentrics.

There is some uncertainty as to the orientation of the valves of *Nucinella* (see Vokes, p. 656) which must await fuller knowledge of the internal anatomy and the study of the ligament from fresh specimens. Vokes considered the ligament as external, Dall and some other authors as internal. In the above description, I have considered the ligament as being internal and the shorter side as anterior.

Nucinella subdolos (Strong and Hertlein)

Plate 17, figure 12

Pleurodon subdolos Strong and Hertlein, 1937, Proc. California Acad. Sci., 4th ser., vol. 22, No. 6, p. 162, pl. 35, figs. 14, 18, 19. About 5 miles west of Mazatlan, Mexico, 12 fm.

Cyrrilla (*Neopleurodon*) *subdolos* (Strong and Hertlein), 1940, Zoologica, vol. 25, pt. 4, p. 420.

Nucinella subdolos (Strong and Hertlein), Vokes, 1956, Jour. Paleont., vol. 30, No. 3, p. 666.

Shell minute, obliquely ovate, smooth, white, translucent; beaks prominent, hinge line short, straight, forming a small, flaring projection at each end; hinge plate broad, continued as a shelf along more than half of the posterior side of each valve, the inner margin turned up and, in the left valve, ending in a lateral tooth; cardinal teeth small, indistinct, divided into a posterior and anterior series, three or four in each, which meet at an angle, those in the posterior series being larger and wider spaced. The type measures: length 1.85 mm., height 2.5 mm.—[Strong and Hertlein, 1937].

Although known from only a few specimens dredged off Mazatlan, Mexico, this small species may prove to have a wide distribution through the Panamic Province. A few imperfect specimens, probably this species, are known from the Pliocene of Quebrada Camarones, Ecuador. *Nucinella adamsi* (Dall) from the Florida Straits is a similar species.

Subclass FILIBRANCHIATA

Order EUTAXODONTIDA

Superfamily ARCACEA

Family ARCIDAE

To this great family belong the Ark shells, sometimes conservatively referred to a single genus, *Arca*. For our purpose, the arks are divided into three groups or subfamilies, the Arcinae, Anadarinae, and the Noetinae. The Arcinae comprise the true Arks; they are mostly nestlers living under stones or clustered together in cracks and crevices, the shell anchored by its byssus which passes through a narrow or wide opening between the ventral margins of the valves. The Anadarinae and Noetinae are mostly free without a functional byssus or if a byssus is present, it is usually short, the margins of the valves showing little or no gap and fit together closely. The arcoid hinge is taxodont or composed of many small teeth and sockets arranged in a more or less continuous series along a straight hinge line. The ligament is external, attached to a narrow or high cardinal area, usually of triangular shape. Most species are marine but several are brackish and live habitually buried in the soft mud of mangrove swamps and similar situations or at the mouths of rivers emptying into the sea. Such brackish-water species have a coarse, heavy periostracum as protection against the corrosive action of acid waters.

The ligament of the Arcidae is always external. In most genera of the family, the ligament covers most of the cardinal area or the space between the hinge line and the lateral margins of the umbone and the beak. This elastic structure is made up of two distinct layers; the upper or top layer, usually brown in color, is chitinous in composition, usually thin and functionally corresponds to the *tensilium* of other pelecypods; it is underlain by a second or heavier layer composed of vertical, closely packed fibers generally showing a gray or silky luster and color. This lower layer represents the *resilium* although it lies entirely above the axial fulcrum of the hinge. The area covered by the ligament is set apart on each side by a deep groove into which the *tensilium* dips and is attached directly to the wall of the shell. Often the surface of the ligament and of the cardinal area beneath it may be plain and smooth (*Cunearca*) but more often it is cut into by deep lines; in most of the Arcinae and Anadarinae, these incisions are in the form of transverse grooves forming more or less trigonal or tent-shaped markings; in the Noetinae, these markings are vertically arranged. These grooves serve for the attachment of ribbons of *tensilium* which like rubber bands are stretched across the space above the hinge line and through their combined action aid greatly in the operational efficiency of the whole ligament. The cardinal area may be fully or but partly covered by the ligament. The extent of the ligamental coverage should be noted as it is often an important character helpful in identification of a specimen in hand.

Subfamily ARCINAE Lamarck, 1809 or Fleming, 1828

Shell generally a nestler, more rarely a rock borer, attached by a byssus

passing through a gap along the middle of the ventral margin. Valves often distorted and irregular in shape. Sculpture more or less decussated, formed by small or medium-sized radial riblets and concentric threads. Ventral margins of the shell smooth, not crenulated or fluted by the ribbed sculpture.

Subfamily ANADARINAE Reinhart, 1935

Shell mostly free, the byssus small, the margins of the valves fitting tightly. Beaks are generally prosogyrous. Sculpture typically formed by strong, coarse, radial ribs, smooth or noded which form strong flutings along the ventral margins.

Subfamily NOETINAE Stewart, 1930

Shell mostly free, with or without a byssal gap. Beaks opisthogyrous. Cardinal and ligamental area wholly or mostly anterior of the beaks, and generally marked with vertical grooves. Sculpture of fine or strong, often flattened ribs which flute or crenulate the margins. Posterior adductor scar bordered by a flange.

Subfamily STRIARCINAE ⁷

KEY TO THE GENERA OF ARCIDAE IN THE PANAMIC-PACIFIC REGION

- I. Arcinae. Nestlers and borers, the shape of the shell regular or distorted, the ventral margin with a byssal gap placed a little anterior of the middle. Surface sculpture composed mostly of fine radial riblets or threads, noded or decussated by concentrics. Inner, ventral margins of the valve smooth, little affected by the external ribbed sculpture.
 - A. The ligament covers the whole of the cardinal area, usually on both sides of the beak.
 - a. The major part of the ligamental coverage lies behind the beaks; the posterior section of the hinge line the longest.
 1. Shell rectangular, often expanded or winged posteriorly and with a prominent umbonal angle. Sculpture formed by numerous, somewhat irregular riblets. Cardinal area is relatively high and wide, the ligamental grooves forming tent-shaped incisions, usually few in number and irregular in their development. Color brown, often with zigzagged markings.

Genus *Arca*
 2. Shell not conspicuously winged or emarginated and the umbonal angle rounded. Sculpture finely ribbed and decussated. Cardinal area elongated, thickly covered by tent-shaped, ligamental grooves.

Genus *Barbatia*
 - b. The major part of the ligament lies in front or anterior of the beaks, the anterior section of the hinge also much longer.

⁷ A fourth subfamily, the Striarcinae may be recognized and would include the genus *Arcopsis*. Most genera of the Striarcinae are fossil. They resemble the Arcinae by their external sculpture and in having a ventral byssus, sometimes resulting in a gap, but they have a vertically striated ligament and the raised or flanged adductor scars of the Noetinae.

3. Shell narrowly elongated, pholadiform, rounded in cross-section, the anterior side much drawn out and wedged-shaped at the end, the posterior side greatly shortened and carinated.
Genus *Litharca*
- B. The ligament with the resilium (generally with grooves) does not cover the whole surface of the cardinal area.
- c. Cardinal area relatively narrow, the ligament with the resilium developed mainly over its posterior portion; the anterior portion short, without transverse grooves, bare or covered by the periostracum only. The radial and concentric riblets finely or coarsely beaded by their intersection.
- ca. The posterior-umbonal slope is strongly angled.
4. Sculpture more or less uniform and similar over the whole surface. Periostracum thin or lacking, white.
Genus *Acar*
5. Radial riblets very unequal in size, those on the posterior-umbonal slope, large, highly elevated and coarse, the others low and flat.
Genus *Calloarca*
- cb. The posterior-umbonal slope is low and rounded.
6. Shell relatively thin, white, under a coarse, pilose, brown periostracum, the radial riblets fine and numerous.
Genus *Fugleria*
- d. The cardinal area relatively high with the ligament restricted to a small, inverted V-shaped area under the beak; the ligament area is vertically grooved or striated.
7. Shell small, solid, convex, boat-shaped, the sculpture formed by fine beaded, radial riblets.
Genus *Arcopsis*
- II. Anadarinae. The shell is usually free in the adult stage or if held by a short byssus, the valves show no byssal gap along the ventral margin. The beaks are prosogyrous, facing forward over a cardinal area of variable size. The ligament is mainly developed behind or posterior of the beak, its area smooth or with transverse tent-shaped grooves originating under the tip of the beak. The external sculpture is typically formed by strong radial ribs which produce deep flutings along the inner side of the ventral margin.
8. A cardinal area is well developed, often quite high, and generally equally formed on both sides of the beak.
Genus *Anadara*
9. The cardinal area is narrow and almost lacking so that the beaks are closely adjacent to the hinge margin. Ligament largely restricted to the posterior side, the posterior set of teeth hence the longest.
Genus *Lunarca*
- III. Noetinae. Shell for the most part free. Beaks opisthogyrate or coiled backwards above the cardinal area. Ligament and cardinal area mostly or wholly anterior in position, vertically grooved or striated. Surface sculptured by rounded or flattened ribs, the interspaces often with interstitials. Posterior adductor scar bordered by a strong flange.

10. Shell with a solid built, subrhomboidal to subtrigonal shape with prominent umbones often bordered by a sharp, posterior, umbonal angle, the posterior side hence appearing as if sharply truncated.
Genus *Noetia*
11. Shell thinner, modioliform, the posterior side much expanded. Riblets small.
Genus *Sheldonella*

Subfamily ARCINAE

Genus ARCA Linné, 1758

Type species defined by Opinion 189, International Commission on Zoological Nomenclature, *Arca noae* Linné.

Shell of moderate size, subelongate, obscurely winged and generally with an umbonal angle and sharp beaks placed above a wide, flattened cardinal area. Middle of disk crossed by a wide depressed zone which more or less emarginates the ventral margin to form an open byssal gap. Sculpture radial, formed by alternating and generally irregular ribs. Cardinal area usually large, as long as the greatest length of the shell, wide and covered by the ligament, marked by scattered tent-shaped grooves radiating from the vicinity of the beaks. Hinge long and narrow, the teeth small and numerous, the posterior set the longest. Periostracum usually heavy and coarsely pilose.

Arca (Arca) pacifica (Sowerby)

Plate 4, figures 2, 2a-2d;
Plate 86, figure 6

Byssarca pacifica Sowerby, 1833, Proc. Zool. Soc. London, p. 17.

Arca pacifica (Sowerby), Reeve, 1844, Conch. Icon., *Arca*, pl. 11, fig. 75.—Maury, 1922, Paleont. Amer., vol. 1, No. 4, pl. 4, pl. 1, fig. 15.

Arca (Arca) pacifica (Sowerby) Hertlein and Strong, 1943, Zoologica, vol. 28, pt. 3, p. 155.—Reinhart, 1943, Special Paper, Geol. Soc. America, No. 47, pp. 26, 27, pl. 14, figs. 3, 4.—Rost, 1955, Allan Hancock Pacific Expeditions, vol. 20, No. 2, p. 179.

This species is distinguished from its allied West Indian and Caribbean *A. zebra* Swainson (*A. occidentalis* Philippi) by its much wider, flatter cardinal area covered by a dark-brown to black ligament; by its generally more distorted form; wider, more expanded posterior side; by its larger byssal gap and coarser sculpture. Judging from specimens we have from Bocas Island, Panama, *A. pacifica* is apparently also living along parts of the Caribbean coast of Central America. Full grown specimens are usually heavily encrusted with marine growth. The surface of the shell below the periostracum is colored a rich mahogany brown or marked with zigzag strips of brown on a light-colored or white base.

Length 65.4 mm., height 32 mm., diameter 46.3 mm. Punta Patilla, Panama City.

Range—Lower California to northern Peru and the Galapagos Islands. Panama: Panama City; Búcaro; Burica Peninsula; Pearl Islands. Ecuador: Esmeraldas; Charapota; Manta; Santa Elena. Peru: Tumbes; Boca Pan; Mancora; Lobitos; Paita.

Arca (Arca) mutabilis (Sowerby)

Plate 4, figures 3-3b;
Plate 6, figures 2-2d

Byssarca mutabilis Sowerby, 1833, Proc. Zool. Soc. London, p. 17.

- Arca mutabilis* (Sowerby) Reeve, 1844, *Conch. Icon.*, vol. 2, *Arca*, pl. 13, fig. 85.—Maury, 1922, *Paleont. Amer.*, vol. 1, No. 4, p. 167, pl. 1, fig. 5.—Maxwell Smith, 1944, *Panama Shells*, fig. 648.
- Arca (Arca) mutabilis* (Sowerby), Reinhart, 1943, *Special Paper*, Geol. Soc. America, No. 47, p. 26, pl. 11, figs. 8-10.—Hertlein and Strong, 1943, *Zoologica*, vol. 28, pt. 3, p. 154.—Rost, 1955, *Allan Hancock Pacific Expeditions*, vol. 20, No. 2, p. 180, pl. 11, figs. 1, 2; text-figs. 79, 80 a-c.—Hertlein and Strong, 1955, *Bull. Amer. Mus. Nat. Hist.*, vol. 107, art. 2, p. 171.

Shell generally small, oblong, subrhomboidal, ventricose, often irregular or distorted, the ventral margin carrying a fairly large byssal gap. Umbones wide, often worn, and ending in slightly inrolled beaks and bordered posteriorly by a sharp umbonal ridge. Cardinal area elongate, subrhomboidal, high, concave, colored uniformly brown, with a few triangular or lozenge-shaped ligament grooves on the anterior portion. Sculpture consists of fine, more or less scabrous riblets over the main portion of the surface except on the posterior slope where they are much coarser. The periostracum when well preserved is quite dense, yellowish-brown in color and along the umbonal keel forms a high, deeply serrated fringe.

This species is similar to *Arca umbonata* Lamarck of the Atlantic and Caribbean but seems smaller, the largest specimen seen having a length of about 40 mm.

Range—Gulf of California to Ecuador. Panama: Panama City; Búcaro; Ocones; Burica Peninsula. Ecuador: Puerto Callo; Isla la Plata; Santa Elena.

Arca (Arca) truncata (Sowerby)

Plate 4, figure 1

Byssarca truncata Sowerby, 1832, *Proc. Zool. Soc. London*, p. 19.

Arca truncata (Sowerby), Reeve, 1844, *Conch. Icon.*, vol. 2, *Arca*, pl. 11, fig. 74.—Maury, 1922, *Paleont. Amer.*, vol. 1, No. 4, p. 169, pl. 1, fig. 2.

This is a Galapagos Island species, unknown elsewhere. Distinguished from *A. pacifica* by its longer, more rectangular form, uniform dark-brown color with obscure markings on the sides only, and with a narrower byssal gap. The type lot in the British Museum (*Nat. Hist.*) consists of three double-valve specimens. Photographs of the type in the British Museum are presented on Plate 4.

Range—Galapagos Island.

Genus LITHARCA Gray, 1842

Type species by subsequent designation, Gray, 1847, *Byssarca lithodomus* Sowerby.

A rock borer. The shell in the adult reaches a length of nearly 100 mm., elongately cuneiform in shape, subequivalve and strongly inequilateral, the anterior side being much longer, appressed and rounded at the end, the posterior side much shorter, with an angled or carinated umbonal ridge. There is a narrow byssal gap along the middle section of the ventral margin, the byssus itself being a narrow, wedge-shaped plug of a greenish-black color by means of which the shell is attached to one wall of its bore. The beaks are probably prosogyrate in the young but in all the specimens seen the umbones are deeply worn. The cardinal area is long, unsymmetrical wedge-shaped, highest under the beak, narrowed anteriorly and

of a nearly black or purple-black color; it is unequally divided into two sections by an incised line starting at the beak and running obliquely downward and in an anterior direction to the hinge line (divisional ligamental line); on the posterior side of this line, the cardinal surface is striated horizontally and smooth, while on its longer anterior side it is crossed by a series (often 14 or more) of evenly spaced oblique slits to which threads of the tensilium are attached. The hinge line is long, narrow and straight, its teeth small and numerous, vertical or inclined, divided into an anterior and posterior set by the incised line mentioned above; in an average specimen, there are 28 small teeth in the posterior set and about 75 in the anterior set. The sculpture is nearly always destroyed by wear, especially on the umbones and across the mid-surface of the valves but small patches usually remain along the ventral side and on the posterior slope; in the spots where the sculpture is still retained, it is seen to consist of fine, radial riblets crossed by crowded concentric layers producing a pattern of lacelike, scalloped teeth, their interspaces retaining small tufts of a straw-colored periostracum. Interior of shell porcellaneous, the pallial line lying quite close to the ventral margin. Adductor scars distinct, the ventral margin plain.

This is a curious genus, represented by a single known species (*Litharca lithodomus*) ranging from Ecuador northward to Panama and Costa Rica. It was assigned by Frizzell to a separate subfamily the "Litharcinae" but anatomical observations made possible by the discovery of living specimens, show that the genus is closely allied to *Arca sensu stricto*. The elongated form of the shell is merely an adaption to a rock-boring habit in which the anterior end of the shell and not the posterior became drawn out and lengthened.

The longer side of the shell is anterior and assumes a flattened, wedge-like form at its end; the much shorter and carinate side is posterior and is often more or less covered with extraneous marine growth. The beaks and umbones are always worn but commencing at a point below the assumed position of the beak, a faintly engraved line (divisional ligament line of Frizzell) passes obliquely across the cardinal area to the hinge line, dividing the area and the line of the hinge teeth into two unequal sections. The dip of this line is usually about 30 degrees or somewhat less depending upon the size of the specimen in hand. In the larger of the specimens figured (length 93 mm.), the hinge has 27 teeth in the posterior set and about 94 in the anterior set. The lengthening of the shell of *Litharca*, so as to accommodate itself to the narrow confines of a straight bore, was accomplished by a flattening of the umbones and a pulling out or lengthening of the axis of the shell mainly along the anterior side. As a consequence of this downward squeeze, the umbones and the beaks were pushed backwards thus causing the ligamental line to slant down sharply, its inclination lowering as the elongation of the shell increased. Our smallest specimen has a length of 13 mm. This shell has 12 hinge teeth in the posterior set and 18 in the anterior. The umbone is already so deeply worn that the shape of the beak has been destroyed.

Litharca lithodomus (Sowerby)

Plate 5, figures 1, 1a-1f

Byssoarca lithodomus Sowerby, 1833, Proc. Zool. Soc. London, p. 16.

Arca lithodomus (Sowerby), Reeve, 1844, Conch. Icon., vol. 2, *Arca*, pl. 12, fig. 76.

Arca (Litharca) lithodomus (Sowerby), Maury, 1922, Paleont. Amer., vol. 1, No. 4, pp. 169, 170.—Reinhart, 1935, Mus. royal d'Histoire nat. Belgique, Bull., tome 11, No. 13, p. 18. Reinhart, 1943, Special Paper, Geol. Soc. America, No. 47, p. 27, pl. 11, figs. 1, 2, 3.

Litharca lithodomus (Sowerby), Frizzell, 1946, Jour. Paleont., vol. 20, No. 1, pp. 45-50, pl. 10, figs. 1-5; text figures 2, 6.

There are four double-valve specimens in the British Museum (Nat. Hist.) of which three have been placed apart in the type lot. These specimens have the locality label of Monte Christi (the name of a town inland from Manta). These specimens were apparently collected alive. The largest specimen in the type lot measures 86.6 mm.

Litharca lithodomus is fairly common at Manta, and loose valves can generally be found along the beach to the west of the city. It appears to be fairly well known to some of the fishermen who gather it along with the larger Lithophagae, Chamas, and other mollusks for food and bait. *Litharca lithodomus* is a true rock borer, the opening of its bore showing on the surface of rocky ledges as a deep, rounded, or lens-shaped hole, often an inch to an inch and a half across. At Manta, these bores are found principally on the under surface of projecting ledges of massive sandstones, avoiding the softer layers. In cross-section, the bore is usually lenticular rather than circular, its sides polished and tapering to a flat wedge at the end, the mollusks being attached by its narrow, green byssus to one wall but loose enough so that considerable movement backward and forward along the bore is still possible. When feeding, the ark lies with its short posterior end close to the open end of the bore but it pulls back quickly when disturbed, its flattened, anterior end fitting snugly against the walls of the bore but a narrow space above the umbones is open, often occupied by a nestling *Acar*. This sliding movement along the bore results in heavy wear of the sides and umbones of the shell which is thus often reduced to a paper thinness, only small patches of the original bristly periostracum being retained along the posterior side and along the ventral margin.

Range—Panama southward to Santa Elena, Ecuador. Panama: Búcaro; Burica Peninsula. Ecuador: Esmeraldas; Bahia; Manta; Manglaralto; Santa Elena.

Genus BARBATIA Gray, 1847

Type species by original designation and tautonymy, *Arca barbata* Linné. Recent, Mediterranean Sea.

The shell is subquadrate to subelliptical in shape, subequivalve and inequilateral, the ventral margin straight or with a wide, open byssal gap or notch, the posterior-umbonal slope rounded or angled. The cardinal area is low or high, longer on the posterior side, covered by the ligament and with obliquely transverse, sometimes tent-shaped grooves which begin under the beak; the ligamental grooves may be developed on both sides of the beak or only on the posterior portion; in the latter case, the anterior section of the cardinal area is bare or covered only by an extension of the periostracum. The sculpture is formed principally by small, close-set radial rib-

lets, noded or cancellated by the concentrics. The periostracum is profuse, pilose and dark-colored, the color of the shell underneath being white or brownish. Hinge line long and straight, with numerous small teeth, the posterior set being much the longer, the distal members enlarged and set obliquely.

Two subgenera are regional.

- I. The shell is fairly regular in shape, the color of the surface below the periostracum brownish. Sculpture is formed by small, radial, threadlike riblets, the smaller spaced between larger ones so that the pattern appears rayed. Cardinal area is low and narrow, the ligamental grooves few in number.

Subgenus *Barbatia*, s.s.

- II. Shell generally much distorted, the ventral margin deeply sinuated by a large, open, byssal gap. Color of shell beneath the periostracum is white. Sculpture formed by rather coarse, beaded, radial riblets, not in rayed pattern. Cardinal area is generally quite high and closely covered with tent-shaped ligamental grooves.

Subgenus *Cucullaearca*

Barbatia (*Barbatia*) *lurida* (Sowerby)

Plate 6, figure 4

Byssosarca lurida Sowerby, 1833, Proc. Zool. Soc. London, p. 19 Santa Elena, Ecuador.

Arca lurida Reeve, 1844, Conch. Icon., vol. 2, *Arca*, pl. 14, fig. 95.

Barbatia (*Barbatia*) *lurida* (Sowerby), Maury, 1922, Paleont. Amer., vol. 1, No. 4, p. 174.—Rost, 1955, Allan Hancock Pacific Expeditions, vol. 20, No. 2, pp. 182-184, pl. 11, figs. 3 a-b; text figs. 81 a-c.

Byssosarca vespertilio Carpenter, 1856, Cat. Mazatlan Shells, Brit. Mus. p. 140, No. 192, Mazatlan, Mexico.

Barbatia (*Barbatia*) *vespertilio* (Carpenter), Maury, 1922, *op. cit.*, pp. 174, 175.

Shell small or of medium size, obliquely oblong, convexly humped, highest along the posterior-umbonal slope, the anterior side somewhat narrower than the posterior. Umbones are wide and full, sometimes slightly sulcated. The sculpture is similar to that of *B. barbata*, being composed of small, threadlike radials, the posterior set interspersed with larger or deeper ones so as to give a banded or rayed appearance. Color dark-brown on the posterior half and a lighter brown on the anterior. The hinge line is shorter than the full length of the shell, the teeth small in the middle zone, the distal members much larger. Interior white in the anterior section, brown in the posterior, the anterior-ventral margin sinuated by the byssal gap.

Although *B. lurida* and *B. vespertilio* are here placed together as a single species, fresh specimens with the periostracum intact may show them to be distinct. Worn beach specimens of *B. lurida* from Santa Elena, Ecuador, and northwestern Peru, have a slightly distorted shell with the beaks placed a little in front of the middle and the posterior-umbonal slope is higher and more convex. The cardinal area is like that of *B. barbata* of Europe and generally covered completely with strong ligamental grooves on both sides of the beaks. The sculpture is rayed. The type of *B. vespertilio* examined at the British Museum is a perfect specimen, covered with periostracum, and the two valves spread open and glued onto a glass plate; its dimensions are: length 33.5 mm., height 16 mm.

B. cancellaria (Lamarck), 1819 (Pl. 6, fig. 5) from the Caribbean and western Atlantic is not closely related to either *B. lurida* or *B. barbata*, although it was generally identified with the European species by past authors (Dall, Sheldon, Maxwell Smith). The Caribbean shell has lower, more anterior beaks, and the ligament covers only the posterior part of the cardinal area, the short anterior portion remaining bare except for a thin extension of the periostracum over it.

Range—Coast of Mexico southward to northern Peru. Panama: Río Ocones beach. Colombia: Isla del Gallo. Ecuador: Peurto Callo; Isla la Plata; Santa Elena. Peru: Zorritos; Caletto Sal.

Subgenus *CUCULLAEARCA* Conrad, 1865

Type species by subsequent designation, Stoliczka, 1871, *Byssarca lima* Conrad, 1847=*C. cuculoides* Conrad, 1833. Eocene and Oligocene of the Gulf States of United States.

Shell elongate to obliquely subquadrate, subequivalve but usually distorted, white under a copious, heavy periostracum. Basal margin sinuated by a wide, byssal gap. Sculpture is formed by fine to coarse, more or less sharply beaded riblets. Hinge long, straight, the teeth in a continuous series in the young but sometimes interrupted later, the distal members larger and oblique. Cardinal area large, high, elongate and subtrigonal, densely covered by wavy or tent-shaped grooves, and completely covered by the ligament on both sides of the beaks.

Barbatia (*Cucullaearca*) *reeveana* (d'Orbigny) Plate 4, figures 4, 4a, 4b

Arca helblingii Bruguière, Reeve, 1844, Conch. Icon., vol. 2, *Arca*, pl. 14, fig. 90. (Not *Arca helblingii* Bruguière, 1789).

Arca reeveana d'Orbigny, 1846, Voy. Amér. Mérid., vol. 5, pt. 3, Mollusques, pp. 635, 636. (New name for *A. helblingii* in Reeve.)

Arca (*Barbatia*) *reeveana* d'Orbigny, Hertlein and Strong, 1943, Zoologica, vol. 28, pt. 3, No. 19, pp. 158, 159.—Hertlein and Strong, 1955, Bull. Amer. Mus. Nat. Hist., vol. 107, art. 2, p. 173.

Barbatia (*Calloarca*) *reeveana* (d'Orbigny), Maury, 1922, Paleont. Amer., vol. 1, No. 4, pp. 175, 176, pl. 2, fig. 13.

Barbatia (*Cucullaearca*) *reeveana* subsp. *reeveana* (d'Orbigny), Reinhart, 1943, Special Paper, Geol. Soc. America, No. 47, pp. 33, 34, pl. 15, figs. 1-3.

Barbatia (*Cucullaearca*) *reeveana* (d'Orbigny), Rost, 1955, Allan Hancock Pacific Expeditions, vol. 20, No. 2, p. 185, pl. 11, figs. 4, 5, 9; text-figs. 82 a-c.

Shell subrectangular but often irregular and distorted, relatively large (up to 100 mm.), subequivalve, depressed to slightly convex, with low, flat umbones and with the beaks placed centrally above the hinge line. The posterior side is usually somewhat extended, higher, obtusely rounded at the end. The left valve has a large, byssal gap along its anterior-ventral margin; the right valve is unaffected or merely shows a slight insinuation. The sculpture is formed by numerous, small riblets between somewhat wider interspaces and fairly uniform over the whole disk. Color white under a rather copious periostracum, generally worn on the umbones, and consisting of short, flattened brown fronds, resembling that of sea-weed, sometimes united or separated into short fronds with spinelike ends.

Contour of specimens varies according to the conditions under which they have grown. An average specimen has the following measurements: length 80 mm., height 44 mm., diameter of closed valves 33 mm.

Isla la Plata, Ecuador.

Good figures of this species have been given by Maury and by Reinhart. The valves are often much distorted because of its nestling habit. The varietal names of *velataformis* and *lasperlensis* were given by Sheldon and Maury to such growth forms. *Barbatia candida* (Gmelin) from Florida waters is similar but usually smaller; larger specimens of *B. candida* from the north coast of Colombia are at times indistinguishable from the Pacific shell.

Range—Lower California to northern Peru and the Galapagos Islands. Panama: Panama City; Pearl Islands; Búcaro. Colombia: Isla del Gallo. Ecuador: Galeras; Cabo Pasados; Manta; Isla la Plata; Santa Elena. Peru: Zorritos; Boca Pan; Caletto Sal; Lobitos.

Genus ACAR Gray, 1857

Type species by subsequent designation, Stoliczka, 1871, *Arca divaricata* Sowerby.

Shell a nestler, hence often variable in shape, from short subquadrate to elongated pholadiform, the valves often distorted and usually with a solid texture. The posterior side is the longer one, crossed obliquely by a sharply angulated umbonal ridge. Sculpture is produced by fine or coarse, radial riblets, beaded or cancellated by the concentrics, their edges of intersection often sharply serrated. Periostracum is exceedingly thin, the color of the whole shell white or cream. Hinge similar to *Barbatia*, the teeth numerous, in a more or less continuous series, the distal teeth large and divergent. The cardinal area is narrow, with the brown-colored ligament and ligamental grooves restricted largely to the posterior portion, the remaining anterior portion small, bare and white. The color of surface below the inconspicuous periostracum is white.

Acar gradata (Broderip and Sowerby)

Plate 6, figures 6, 6a, 6b

Arca gradata Broderip and Sowerby, 1829, Zool. Jour., vol. 4, p. 365.—Gray, 1839, Zool. Beechey's Voyage, p. 152, pl. 43, fig. 1.—Reeve, 1844, Conch. Icon., vol. 2, *Arca*, pl. 14, fig. 92.

Arca (Acar) gradata (Broderip and Sowerby), Hertlein and Strong, 1943 Zoologica, vol. 28, pt. 3, p. 155.—Hertlein and Strong, 1955, Bull. Amer. Mus. Nat. Hist., vol. 107, art. 2, p. 174.

Arca (Byssarca) pholadiformis C. B. Adams, 1852, Ann. Lyceum Nat. Hist. New York, vol. 5, pp. 484, 545, No. 419. (Not D'Orbigny, 1844).

Barbatia (Acar) gradata (Broderip and Sowerby), Maury, 1922, Paleont. Amer., vol. 1, No. 4, pp. 180, 181, pl. 2, figs. 4, 6, 9.—Reinhart, 1939, Trans. San Diego Soc. Nat. Hist., vol. 9, No. 10, pp. 39-41, pl. 3, figs. 1, 2.—Reinhart, 1943, Special Paper, Geol. Soc. America., No. 47, p. 35, pl. 11, figs. 11, 12.

Acar gradata (Broderip and Sowerby), Bartsch, 1931, Proc. U. S. Nat. Museum, vol. 80, art. 9, pp. 2, 3, pl. 1, five top figures.—Rost, 1955, Allan Hancock Pacific Expeditions, vol. 20, No. 2, pp. 189, 190, pl. 12, figs. 11, 12.

Acar panamensis Bartsch, 1931, *op. cit.*, pp. 3, 4, pl. 1, five bottom figures.

Barbatia (Acar) rostrata S. S. Berry, 1954, Leaflets of Malacology, No. 1, No. 12.

The shell is small to medium-sized (length 33 mm.), oblong, subrhomboidal to quite elongated, often much distorted and frequently showing worn spots along the sides caused by abrasion against the wall of the

cavity or crevice in which the shell once nestled. The valves are often heavily encrusted with marine growth. Color white. When in good condition, the surface sculpture is quite elaborate and formed by strong, concentric ridges and smaller cordlike radials, their intersection forming sharp, rasplike nodes. Along the posterior umbonal slope, the concentrics are elevated, forming a sharply crenulated or fluted lamina.

The holotype of the species has been illustrated by Reinhart.

The species is closely related to *A. reticulata* (Gmelin) from the Caribbean. Common under stones or nesting in abandoned worm burrows, crevices, and the like.

Range—Lower California to northern Peru and the Galapagos. Panama: Panama City. Canal Zone: Venado Beach. Ecuador: Santa Elena; Isla la Plata; Manta; Cabo Pasados; Mompiche; Galeras; Esmeraldas. Peru: Tumbes; Zorritos; Boca Pan; Caletto Sal; Mancora; Lobitos; Negritos; Paita.

Genus **FULGERIA** Reinhart, 1937

Type species by original designation, *Barbatia (Fulgeria) pseudoillota* Reinhart, 1937. Pliocene of Florida. California [See *crenatum* ... 594]

Shell subequivalve, convex, thin, white under a black or brown subpilose or foliated periostracum. Cardinal area like that of *Acar* with the ligament narrow and developed principally on the posterior side, the anterior section bare. Hinge that of *Barbatia*, the posterior set of teeth well developed or subobsolete. The sculpture is formed by small, threadlike ribs, weakly cancellated by concentrics.

The Recent species of this subgenus have a thin, white shell under a black or brown, subpilose or foliated periostracum, generally thinly developed over the umbones, more profusely so around the ventral margin where it may form into thin, loose, leaflike ribbons, finely serrated at the ends.

Fulgeria illota (Sowerby)

Plate 6, figures 1, 1a, 1b

Byssarca illota Sowerby, 1933, Proc. Zool. Soc. London, p. 18 Gulf of Nicoya.

Arca illota (Sowerby), Reeve, 1844, Conch. Icon., vol. 2, *Arca*, pl. 12, fig. 78.

Arca (Byssarca) Tabogensis C. B. Adams, 1852, Ann. Lyceum Nat. Hist. New York, vol. 5, pp. 486, 545, No. 424.—Turner, 1956, Occas. Papers on Mollusks, Mus. Comp. Zool., vol. 2, No. 20, p. 90, pl. 19, figs. 7, 8.

Barbatia (Acar) illota (Sowerby), Maury, 1922, Paleont. Amer., vol. 1, No. 4, pp. 182, 183, pl. 2, figs. 8, 14.

Barbatia (Fulgeria) illota (Sowerby), Reinhart, 1943, Special Paper, Geol. Soc. America, No. 47, p. 37.—Rost, 1955, Allan Hancock Pacific Expeditions, vol. 20, No. 2, pp. 187, 188, pl. 11, figs. 6-8; text-figs a-c.

The shell is small or of medium size (length 37 mm.), subquadrate to trapezoidal, generally thin, convex, with a shallow sulcus across the middle to the ventral margin. Color of shell beneath the brownish periostracum is white. Ribs are small, threadlike, finely cancellated by the concentrics. The periostracum is quite copious, covering the whole disk, except the umbones which are sometimes bare, and consists of broad, thin, leaflike filaments, finely serrated at the end, and most heavily developed along the ventral margin.

Length 32.3 mm., height 22 mm., diameter 14 mm.

Palo Seco, Canal Zone.

This is a common species at Panama living under stones. *B. tenera* (C. B. Adams), a Recent West Indian species and *B. millifilia* Dall, a Pliocene fossil from Florida are both similar to the Pacific form.

Range—Gulf of California to northern Peru. Panama: Búcaro; Panama City. Canal Zone: Palo Seco; Venado. Ecuador: Isla la Plata, Manta; Puerto Callo; Santa Elena. Peru: Caletto Sal; Lobitos.

Genus CALLOARCA Gray, 1857

Type species by monotypy, *Byssoarca alternata* Sowerby. Recent, Panama.

Shell elongately subquadrate, relatively thin, with a strong, umbonal angulation. Cardinal area as in *Acar*, the ligament nearly or wholly posterior of the beak. Umbones and the middle of the valves with a shallow sulcation. Sculpture is formed by fine, flattened riblets in raylike groups on the anterior and middle surface but become much enlarged along the umbonal angulation.

Calloarca alternata (Sowerby)

Plate 4, figures 5, 5a

Byssoarca alternata Sowerby, 1833, Proc. Zool. Soc. London, p. 17.

Arca alternata (Sowerby), Reeve, 1844, Conch. Icon., vol. 2, *Arca*, pl. 13, fig. 88.

Barbatia (Cucullarca) alternata (Sowerby), Maury, 1922, Paleont. Amer., vol. 1, No. 4, p. 184, pl. 30, fig. 11.

Barbatia (Calloarca) alternata (Sowerby), Reinhart, 1943, Special Paper, Geol. Soc. America, No. 47, p. 30, pl. 11, figs. 5-7.—Durham, 1950, Mem. Geol. Soc. America, No. 43, p. 55, pl. 1, fig. 14.—Rost, 1955, Allan Hancock Pacific Expeditions, vol. 20, No. 2, p. 186.

Arca (Calloarca) alternata (Sowerby). Hertlein and Strong, 1943, Zoologica, vol. 28, pt. 3, No. 19, p. 159.

This is an elegant species with the characters given above for the subgenus. It is relatively common at Panama, particularly at Palo Seco, Canal Zone, elsewhere it appears to be rare. Cuming's specimens were dredged in 12 fathoms of water, attached to stones, West Colombia. Hertlein and Strong recorded it from localities in Costa Rica, Nicaragua, and the Gulf of California. It occurs as a Pleistocene fossil in Lower California. The periostracum appears to have been thin, brown, membraneous, with short, frondlike filaments, expanded at the end, set along the interspaces.

Length 46.6 mm., height 24 mm., diameter 22 mm.

Palo Seco, Canal Zone.

Range—Gulf of California to Ecuador. Canal Zone: Palo Seco; Fort Amador. Panama: San Carlos; Guanico. Ecuador: West Colombia (Cuming).

Genus ARCOPSIS von Koenen, 1835

Type species by subsequent designation, Reinhart, 1935, *Arca limopsis* von Koenen. The type species is from the Paleocene of Denmark. (*Fossularca* Cossmann, 1887).

The shell is generally small, solid, plump, byssiferous, oblong to subquadrate, subequilateral with high, full, subcentral umbones and prosogyrate beaks, and nearly square, blunt ends. Hinge taxodont, the teeth interrupted

in the middle, the posterior set longer, the sides of the teeth finely grooved. Cardinal area longer than high, the ligament, vertically grooved, and restricted to a triangular area under the beak. Adductor scars large, subequal, bordered on the inner side by a raised edge or flange. Sculpture consists of numerous, fine, threadlike riblets between wider interspaces, generally decussated by concentrics. Surface covered by a hairy or bristly periostracum. Valve margin smooth or nearly so.

Arcopsis solida (Sowerby)

Plate 6, figures 3, 3a, 3b

Byssarca solida Sowerby, 1833, Proc. Zool. Soc. London, p. 18 "Paytam Peruviae".

Arca solida (Sowerby), Reeve, 1844, Conch. Icon., vol. 2, *Arca*, pl. 16, fig. 106.

Barbatia (Fossularca) solida (Sowerby), Maury, 1922, Paleont. Amer., vol. 1, No. 4, pp. 21, 22, pl. 2, figs. 7, 12.

Arca (Arcopsis) solida (Sowerby), Hertlein and Strong, 1943, Zoologica, vol. 28, pt. 3, p. 158.

Arcopsis solida (Sowerby), Rost, 1955, Allan Hancock Pacific Expeditions, vol. 20, No. 2, pp. 192, 193, pl. 12, fig. 10.

Shell small (length to about 20 mm.), white or cream-colored and generally encrusted with marine growth. Sculpture is formed by small, radial threads or riblets, finely or coarsely beaded, the surface often worn smooth. *Arcopsis adamsi* (E. A. Smith) from the Caribbean is a closely similar species but is generally smaller, thinner, and less convex.

Range—Lower California to northern Peru, and the Galapagos. Panama: Búcaro; Panama City. Colombia: Isla del Gallo. Ecuador: Esmeraldas; Manta; Puerto Callo; Santa Elena. Peru: Zorritos; Mancora; Lobitos; Paita; Yasila; Chimbote.

Subfamily ANADARINAE

Genus ANADARA Gray, 1847

Type species by original designation, *Arca antiquata* Linné (*Arca scapha* Meuschen (= *maculosa* Reeve). Recent, Red Sea.

Shell of medium or large size, obliquely subovate to elongate, moderately solid. Valves convex between tightly closed margins, subequal in size and sculpture. Umbones wide and prominent, terminating in small, prosogyrate beaks placed over a rather wide, unsymmetrical cardinal area. Cardinal area smooth or nearly so, covered completely by the ligament. The sculpture is nearly similar in both valves and consists of numerous (about 34), close-set ribs, simple, smooth at first but often dividing and becoming bi- or quadruplicate at the ends. Hinge with the teeth arranged in a continuous series, small and vertical in the middle zone, enlarged and divergent at the ends.

The above description is based on the type specimen of *Arca antiquata* preserved at the Linnean Society of London, supplemented by a few other shells at the British Museum (Nat. Hist.) believed to represent the same species. As indicated by Hanley, the original of Linné's *antiquata* is a small, somewhat worn left valve which bears the number 144 corresponding to the numeration in the 10th and 12th edition of the *Systema Naturae*. An external view shown natural size was illustrated by Hanley, plate 3, figure 4. Photographs of the same specimen were also furnished Woodring by the Linnean Society and were reproduced by that author in his Bowden monograph. A second, larger, unworn specimen with both valves was also found

by Hanley in the same tray as the type. This second specimen was thought by Hanley to have been subsequently added by Sir J. Smith, the purchaser of the Linnean collection in order to further elucidate the species. Cuming identified this specimen as *Arca maculosa* Reeve. It is the opinion of this author, that this second specimen represents Linnaeus species and proves *antiquata* a Red Sea or Indian Ocean species.

A broader definition of the genus is as follows:

Shell small or large, solid or of medium texture, porcellaneous, rhombic to elongated, with equal valves or if unequal, the left valve is larger, its margin overlapping the other, and the sculpture of the two valves may be somewhat discrepant. Umbones prominent, anterior of the middle, with the small, prosogyrate beaks pointing inward or inrolled over a cardinal area of variable height, low or high trigonal in shape and extending on both sides of the beaks. The surface of the ligamental and cardinal area may be smooth or grooved by tent-shaped, or more rarely, by straight longitudinal lines. Hinge line straight, with numerous teeth in a graduated series, small or minute in the middle, larger and divergent at the extremities. Surface sculptured by strong ribs which are plain, noded, or divided, the interspaces deeply grooved. Sculpture of the two valves similar or more or less discrepant.

Key to the subgenera of *Anadara*

- I. Cardinal area covered completely by the ligament.
 - A. Cardinal area is elongate and rather narrow, smooth or grooved with tent-shaped lines. Shell ovate to elongated, equivalve as to shape, convexity, and sculpture.
 1. Cardinal area smooth or vertically striated, the ligamental grooves generally absent or of erratic development. Ribs bi- or quadruplicate in the adult.

Subgenus *Anadara*, *sensu stricto*
Red Sea and Indo-Pacific.
 2. Cardinal area covered by tent-shaped ligamental grooves.
 - 2a. Posterior side not depressed, winged, or emarginated.

Subgenus *Diluvarca*
 - 2b. Posterior side more or less impressed, emarginated.

Subgenus *Rasia*
 - B. Cardinal area high, trigonal, set-off by deep, marginal grooves.
 3. Shell solid, equivalve. Internal margins strongly fluted.
 - 3a. Ribs relatively few and wide. Beaks large, strongly coiled, *Cardita*-like. Periostracum coarse, black.

Subgenus *Senilia*
African
 - 3b. Ribs quite numerous, noded, the beaks normal.

Subgenus *Larkinia*
 - 3c. Ribs less numerous, mostly smooth.

Subgenus *Grandiarca*, new subgenus

4. Shell thinner, inequivalve, with discrepant sculpture. Cardinal area smooth or with the ligamental groove sparingly developed.
Subgenus *Cunearca*
- II. Cardinal area usually not fully covered by the ligament, the anterior portion wholly or partly bare (in some species, the ligamental grooves encroach more widely in large, gerontic specimens).
- C. Cardinal area elongate or narrowly subtriangular, much longer than high. Shell elongated or subelliptical in shape.
5. Posterior side not winged or deeply emarginated.
- 5a. Shell inequivalve, thin, fluted within, the ribs simple, smooth or weakly noded.
Subgenus *Scapharca*
Not regional.
- 5b. Shell equivalve, solid, the ribs generally mesially grooved in the adult.
Subgenus *Sectiarca*, new subgenus
6. Posterior side winged or deeply emarginated, the ribs plain or noded.
Subgenus *Caloosarca*, new subgenus
- D. Cardinal area subtriangular, high. Shell subovate, elevated, inflated and often quite thin. Ribs plain or noded, separated by flat interspaces.
Subgenus *Esmerarca*, new subgenus

Subgenus **DILUVARCA** Woodring, 1925

Type species by original designation, *Arca diluvii* Lamarck. Miocene, Europe.

Shell subequivalved, the margins closed, moderately solid. Cardinal area long and relatively narrow, covered by the ligament on both sides of the beak and deeply engraved with crowded transverse or chevron-shaped grooves. Sculpture more or less similar in the two valves and formed by numerous rounded smooth or coarsely noded ribs. Periostracum coarse and of a dark color.

Diluvarca was proposed by Woodring in 1925 as a subgenus of *Barbatia* and believed to differ from *Anadara* in having a closed ventral margin. The weakly sinuated margin shown by Linnean type of *Anadara antiquata* is probably due to wear and not a natural byssal gap. Nevertheless, typical *Anadara* as defined in the key does not seem to occur in our American Tertiary and Recent faunas. For the American species, most clearly related to *Anadara*, *sensu stricto*, the name "*Diluvarca*" will be used.

Anadara (*Diluvarca*) *tuberculosa* (Sowerby) Plate 7, figures 3, 3a

Arca tuberculosa Sowerby, 1833, Proc. Zool. Soc. London, p. 19 Real Llejos, Nicaragua; mangrove roots.—Reeve, 1844, Conch. Icon., vol. 2, *Arca*, pl. 3, fig. 18.

Arca (*Scapharca*) *tuberculosa* Sowerby, Dall, 1910, Proc. U. S. Nat. Museum, vol. 37, No. 1704, pp. 154, 253, pl. 27, fig. 4.

Scapharca (*Scapharca*) *tuberculosa* (Sowerby), Maury, 1922, Paleont. Amer., vol. 1, No. 4, pp. 26, 27, pl. 1, fig. 12.

Anadara (*Anadara*) *tuberculosa* (Sowerby), Reinhart, 1943, Special Paper, Geol. Soc. America, No. 47, p. 63.—Rost, 1955, Allan Hancock Pacific Expeditions, vol. 20, no. 2, p. 195, pl. 13, figs. 17 a-b.

Shell obliquely ovate, rather solid, broadly convex, slightly more so along the posterior-umbonal slope, equivalve. When living, the shell is

covered by a heavy, brown to black, strongly wrinkled periostracum, the umbones often corroded and showing the white shell. Ribs are numerous, (33 to 37 in number), relatively large, rounded, close set and separated merely by a groove or narrowly lined interspaces, usually with a scattering of nodes or tubercles along their summits. Umbones wide and prominent, often weakly sulcated. Cardinal area is narrow in the shape of a depressed or flattened triangle and engraved with three or more tent-shaped grooves, the whole area covered by the ligament.

Length 54.6 mm., height 39.6 mm., diameter 32.4 mm.

Guayaquil, Ecuador (market).

This is a common and widely distributed species, living buried in the soft mud amongst the roots of mangrove trees. "As reported by Coker (Dall, 1909, p. 154), among the first phenomena to catch one's attention on entering the mangrove swamps is a sound heard repeatedly on every side, as of nuts falling into the water or soft mud. Tracing the sound with some care, it is found to come from the watery hollows in the mud occupied by the concha prieta, and is presumably made by the sudden closing or opening of its valves under water by the mollusks". The common name of this ark is "Concha Prieta", in allusion to its black color. It is a common article of shell food, and on sale in market places throughout its range.

Range—Lower California to Peru. Numerous records. Peru: Tumbes, (its most southerly occurrence).

Anadara (Diluvarea) similis (C. B. Adams)

Plate 7, figures 2, 2a

Arca similis C. B. Adams, 1852, Ann. Lyceum Nat. Hist. New York, vol. 5, pp. 485, 486, 545, No. 422 Panama.—Turner, 1956, Occas. Papers on Mollusks, Mus. Comp. Zool., vol. 2, No. 20, pp. 85, 86, pl. 23, figs. 1, 2.

Arca (Anadara) similis C. B. Adams, Hertlein and Strong, 1943, Zoologica, vol. 28, pt. 3, p. 157, pl. 1, figs. 2, 5.

The shell is ellipsoidal, slightly oblique posteriorly, relatively thin. Surface covered by a brown or black, wrinkled periostracum, often scaly and when worn away showing a white-colored shell beneath. Ribs numerous (40 to 44), small, narrow, separated by rather wide interspaces, the ribs more or less strongly tuberculated, especially near the ventral margin. Hinge is narrow and straight, the teeth small and numerous, arranged in an uninterrupted series.

Length 51 mm., height 33.5 mm., diameter 27.8 mm.

Limones, Ecuador.

Similar in shape to the common *A. tuberculosa* but with a more elliptical shape, more numerous ribs, and thinner shell.

Range—Nicaragua to the Gulf of Guayaquil. Costa Rica: Punta Arenas (Hertlein and Strong). Panama: vicinity of Panama City. Ecuador: Limones; Guayaquil (market).

Anadara (Diluvarea) cepoides (Reeve)

Plate 9, figures 7, 7a

Arca cepoides Reeve, 1844, Proc. Zool. Soc. London, p. 47.—Reeve, 1844, Conch. Icon., vol. 2, *Arca*, pl. 10, fig. 66.

Scapharca (Scapharca) cepoides (Reeve), Maury, 1922, Paleont. Amer., vol. 1, No. 4, p. 193, pl. 3, fig. 6.

Arca (Scapharca) cepoides Reeve, Hertlein and Strong, 1943, Zoologica, vol. 28, pt. 3, No. 19, p. 162.

Shell large, broadly subovate or roundly quadrate, ventricose, the umbones being full, wide and placed a little anterior of the middle, the terminating beaks weakly sulcated. The valves are slightly unequal, the ventral margin of the left valve overlapping that of the right but the rounded convexity of each valve is almost the same. The substance of the shell is so light and so thin that the furrows of the external ribs show into the interior almost throughout. Ribs number 33 to 34, of which 8 are found on the posterior slope; these ribs are square or rectangular in section, smooth and flat-topped, almost alike in each valve, their interspaces flat and somewhat narrower. The cardinal area is broadly, obliquely subtrigonal in shape, and of medium height; it is covered completely by the ligament and cut into by three or four transverse grooves. The periostracum is dark in color, usually brown, and a little scaly. Hinge narrow, straight, the teeth small and arranged in a continuous series.

Length 90 mm., height 85 mm., diameter 77.3 mm.

South America. Dr. T. B. Wilson, ANSP 4292.

Length 70 mm., height 60 mm., diameter 46 mm. Panama, Amer. Museum, specimen measured by Maury, 1922.

There are several specimens of this large species in the collection of the Academy of Natural Sciences in Philadelphia labelled simply South America, Dr. T. B. Wilson. Reeve cited San Miguel, Panama, which is probably the San Miguel, Rey Island of the Pearl Island group. Hertlein and Strong recorded this species from Ceralbo Island, Gulf of California.

Range—Gulf of California to Panama. Mexico: Ceralbo Island, Gulf of California. Panama: San Miguel, Rey Island, Pearl Islands.

Anadara (Diluvarea) obesa (Sowerby)

Plate 8, figures 8, 8a

Arca obesa Sowerby, 1833, Proc. Zool. Soc. London, p. 21 (Atacames).—Reeve, 1844, Conch. Icon., vol. 2, *Arca*, pl. 1, fig. 3.

Arca (Scapharca) obesa Sowerby, Hertlein and Strong, 1843, Zoologica, vol. 28, pt. 3, p. 163.

Scapharca (Scapharca) obesa (Sowerby), Maury, 1922, Paleont. Amer. vol. 1, No. 4, pp. 189, 190, pl. 3, figs. 4, 5

Anadara (Scapharca) obesa (Sowerby), Rost, 1955, Allan Hancock Pacific Expeditions, vol. 20, No. 2, p. 205, pl. 16, figs. 28 a-b; text-figs. 90 a-c.

Shell of medium size (length up to about 40 mm.), subequivalve, ovate, with wide, convex, and nearly central umbones. Cardinal area narrow, much longer than high, nearly covered by the ligaments and marked with wide, tent-shaped grooves. Ribs numerous (42 to 44), narrow, rectangular, between flat-bottomed interspaces, their summits smooth or weakly noded. Anterior side obliquely rounded, the posterior slope subtruncate, the umbonal slope weakly angled, its margin straight, cuneate at its ventral corner.

Length 39 mm., height 28.7 mm., diameter 25.6 mm.

Tumbez, Peru.

This is a relatively common species in northern Peru and along the coast of Ecuador. As noted by Maury, there are no allied species in the living Caribbean fauna but several fossil forms are known from the East Coast Miocene.

Range—Mexico to northern Peru. Panama: Búcaro; San Carlos. Ecuador: Sua; Galeras; Charapota; Manta; Punta Blanca; Santa Elena. Peru: Tumbez; Zorritos; Boca Pan; Mancora.

Anadara (Diluvarca) adamsi, new species

Plate 6, figures 7, 7a, 7b

The shell is relatively small (length 23 mm. or less), subrectangular, with wide umbones ending in small, slightly sulcated beaks placed near the anterior one-fourth, this line is also the zone of greatest height and convexity; posteriorly the height narrows as the ventral margin advances slightly upward, its posterior-ventral corner being slightly produced and angular. The hinge line is straight, about half the length of the shell and bears a continuous series of small teeth, numbering about 15 in the anterior set and about 20 in the longer posterior set; the teeth are finely striated on the sides. Cardinal area is of medium height, almost wholly covered by the ligament which generally carries a single, transverse groove on the posterior side. The surface is sculptured with small ribs, about 30 in number, and similar over the whole disk; on some specimens, the ribs are strongly noded, especially over the anterior side; in others, the ribs are weakly noded to smooth. The umbones are slightly sulcated. Color white, the periostracum thin and showing generally only as crossthreads in the interspaces of the ribs.

Length 23 mm., height 16 mm., diameter 14.6 mm.

Palo Seco, Canal Zone. Mr. Lee R. Beil Coll.

Holotype, ANSP 218916.

This is a small species, fairly common at Palo Seco, Canal Zone. The posterior-ventral side is slightly impressed.

Range—Panama. Panama Canal Zone: Palo Seco.

Anadara (Diluvarca) labiosa (Sowerby)

Plate 84, figures 10, 10a

Arca labiosa Sowerby, 1833, Proc. Zool. Soc. London, p. 21 Tumbes, Peru.—Reeve, 1844, Conch. Icon, vol. 2, *Arca*, pl. 10, fig. 67.

Scapharca (Scapharca) labiosa (Sowerby), Maury, 1922, Paleont. Amer., vol. 1, No. 4, pp. 192, 193, pl. 31, figs. 1, 3.

Anadara (Scapharca) labiosa (Sowerby), Reinhart, 1943, Special Paper, Geol. Soc. America, No. 47, p. 74.—Keen, 1958, Sea Shells of the Tropical West America, p. 38, fig. 63.

The shell is broadly rectangular, with wide, low umbones, the valves slightly unequal, that of the left being a trifle larger so that the posterior-ventral margin overlaps and slightly embraces the other. The posterior margin is obliquely truncate, its dorsal corner set at an angle about 120 degrees. Ribs numerous, about 39 in number, relatively narrow and flat-topped, the periostracum thin and of a brown color.

Length 56.4 mm.; height 35.9 mm.; diameter 26.9 mm. Holotype, British Museum (Natural History).

In the type lot at the British Museum there are three complete specimens and one small valve. The above description is based largely on the type material. This is apparently a rare species and has been collected only on a few occasions.

Range—Lower California to northern Peru. Mexico: Gulf of California and Acapulco. Peru: Tumbes.

Subgenus *RASIA* Gray, 1857

Type species by subsequent designation, Stewart, 1930, *Arca formosa* Sowerby. (*Cara* Gray, 1857, type species by subsequent designation, Stewart, 1930, *Arca aviculoides* Reeve, 1844 (young of *Arca formosa* Sowerby).

Shell elongate-subrectangular, flat or moderately convex, generally with the dorsal-posterior side somewhat depressed, often more or less aviculoid or emarginate, especially in the young. Umbones wide, full, passing over gradually into the normal inflation of the valves, the beaks small, and prosogyrate. The cardinal area is long and narrow, covered entirely by the ligament, and marked with numerous V-shaped or chevron-like grooves. Sculpture formed by numerous, flattened ribs between narrower interspaces, the anterior set of ribs noded or divided mesially. Hinge formed by numerous, small teeth continuous along the entire hinge line.

Cara Gray, 1857 is considered to be a synonym of *Rasia* since its type species, the *Arca aviculoides* of Reeve is but the young form of *Arca formosa* Sowerby.

Anadara (*Rasia*) *formosa* (Sowerby)

Plate 7, figure 4

- Arca formosa* Sowerby, 1833, Proc. Zool. Soc. London, p. 20 Gulf of Tehuantepec.—Reeve, 1844, Conch. Icon., vol. 2, *Arca* pl. 2, fig. 10.
Arca (*Anadara*) *formosa* Sowerby, Hertlein and Strong, 1943, Zoologica, vol. 28, pt. 3, p. 156.
Scapharca (*Scapharca*) *formosa* (Sowerby), Maury, 1922, Paleont. Amer., vol. 1, No. 4, pp. 28, 29, pl. 2, fig. 11.
Anadara (*Anadara*) *formosa* (Sowerby), Reinhart, 1943, Special Paper, Geol. Soc. America, No. 47, p. 62, pl. 15, figs. 4-6.
Arca aviculoides Reeve, 1844, Conch. Icon., vol. 2, *Arca*, pl. 10 fig. 63.
Scapharca (*Scapharca*) *aviculoides* (Reeve), Maury, 1922, Paleont. Amer., vol. 1, No. 4, pp. 24, 25, pl. 2, fig. 2.

Shell large, oblong, rectangular, the hinge line and ventral margin straight but not quite parallel, divergent slightly on the posterior side. Color white but fresh specimens are covered with a dense, pilose, brown periostracum. Ribs strong, numerous, generally about 33 in number, the anterior set narrow and with a medial groove, the posterior ones wider and simple.

Length 102 mm., height 58 mm., diameter 52.7 mm.

Pearl Islands.

This is a widely distributed species, seldom common at any locality. Young shells are more strongly auriculated than the adult; a specimen of this kind from Santa Elena was named *aviculoides* by Reeve.

Range—Lower California to northern Peru. Panama: Pearl Islands; Búcaro. Ecuador: Manta; Isla la Plata; Santa Elena. Peru: Zorritos; Mancora; Yasila near Paita.

Anadara (*Rasia*) *emarginata* (Sowerby)

Plate 8, figures 6, 6a

- Arca emarginata* Sowerby, 1833, Proc. Zool. Soc. London, P. 20.—Reeve, 1844, Conch. Icon., vol. 2, *Arca*, pl. 4, fig. 26.
Scapharca (*Scapharca*) *emarginata* (Sowerby), Maury, 1922, Paleont. Amer., vol. 1, No. 4, p. 23, pl. 2, fig. 5.
Arca (*Cara*) *emarginata* (Sowerby), Hertlein and Strong, 1943, Zoologica, vol. 28, pt. 3, p. 159.
Anadara (*Scapharca*) *emarginata* (Sowerby), Rost, 1955, Allan Hancock Pacific Expeditions, vol. 20, No. 2, pp. 203, 204, pl. 14, fig. 22; text-figs. 89 a-c.

Shell of medium size (up to 50 mm.), thin, often irregular, subequivalve, elongate, subquadrate, the dorsal and ventral sides straight, subparallel, the anterior end slightly narrower. Anterior side short, rounded, the posterior side much longer, emarginate or with a deep notch below the

hinge line. Beaks small, placed at the anterior one-third and usually with a small black stain, weakly sulcated across the umbones. Ribs 28 to about 30, flat between squarish interspaces, wider posteriorly, the anterior ribs usually finely noded. Cardinal area long and narrow, completely covered by the ligament.

Length 38.6 mm., height 17.5 mm., diameter 15.2 mm.

Zorritos, Peru.

Range—Lower California to northern Peru. Panama: Panama City, Búcaro. Ecuador: Mompiche; Sua; Santa Elena. Peru: Tumblez; Zorritos; Lobitos; Paita.

Subgenus *LARKINIA* Reinhart, 1935

Type species by original designation, *Anadara larkinii* (Nelson).

Shell subtrigonal, nearly as high as long, solid and heavy, with high, prominent umbones and small prosogyrate beaks. Posterior side subtruncate, flattened to deeply impressed, generally with the umbonal angle prominent. Cardinal area high, subtrigonal, covered by the ligament, and marked off by a deep groove on each side, its surface smooth or covered with transverse, ligamental grooves. Ribs numerous, narrow, between square- or steep-walled interspaces, the summit of the ribs beaded with coarse or scabrous nodes. Hinge teeth numerous, continuous, vertical in the middle, oblique, and divergent at the ends.

Anadara larkinii is a fossil species from the upper Miocene and Pliocene of Peru and Ecuador. It has a coarse, solid shell with high central umbones and small beaks placed above a high cardinal area, which is at first smooth, later becoming marked with crowded, transverse grooves. The subgenus is well represented by numerous fossil species in the Caribbean Miocene (*A. chiriquiensis* Gabb).

Anadara (*Larkinia*) *multicostata* (Sowerby) Plate 7, figure 5; Plate 9, figure 6

Arca multicostata Sowerby, 1833, Proc. Zool. Soc. London, p. 21 Gulf of Tehuantepec.—Reeve, 1844, Conch. Icon., vol. 2, *Arca*, pl. 4, fig. 23.

Scapharca (*Scapharca*) *multicostata* (Sowerby), Maury, 1922. Paleont. Amer., vol. 1, No. 4, p. 195.

Arca (*Larkinia*) *multicostata* Sowerby, Hertlein and Strong, 1943, Zoologica, vol. 28, pt. 3, p. 162.

Anadara (*Larkinia*) *multicostata* (Sowerby), Reinhart, 1943, Special Paper, Geol. Soc. America, No. 47, p. 66, pl. 8, figs. 9-11.—Durham, 1950, Mem. Geol. Soc. America, No. 43, p. 54, pl. 1, figs. 15, 16, 17.—Rost, 1955, Allan Hancock Pacific Expeditions, vol. 20, No. 2, p. 196, text-figs. 84 a-d.

Shell large, subquadrate or squarish, solid, with wide, prominent and nearly median umbones terminating in small, prosogyrate beaks above a medium-height cardinal area. Posterior umbonal slope subangular, the posterior margin straight as if truncated. Anterior side short, rounded at the margin and somewhat shortened at the hinge as if slightly auriculate. Cardinal area fully covered by the ligament and carved with one or more chevron-shaped grooves. Valves are nearly alike, convex, the beaks not sulcated, the ventral marginal overlap almost lacking. Ribs numerous (about 33), narrowly rounded, and of about the same width as their interspaces, smooth except along the anterior umbonal slope where they are finely and sharply noded. Periostracum brown, rather copious and neatly con-

centrically marked, its concentric rings bearing small, spinelike denticulations, the points of which are directed dorsally, both over the summit of the ribs and in the depths of the interspaces.

This is quite a different species from *Anadara grandis*, distinguished easily by its more rhombic form, more numerous ribs and by the peculiar markings of its periostracal layer. The range of the species as given by Hertlein and Strong is from California to Panama, but I have not seen specimens south of Mexico.

Range—Newport Bay, California, south to Panama, and the Galapagos Islands.

Subgenus **GRANDIARCA** new subgenus

Type species *Arca grandis* Broderip and Sowerby.

Shell large, high trigonal, equivalve, solid, often becoming heavy and ponderous in the adult. Umbones wide and prominent, central, and usually feeble sulcate, bordered posteriorly by the umbonal ridge at first relatively sharp or angled, later becoming lower and rounded. Beaks small, curved in over a wide, triangular cardinal area. Ligament coarse and heavy, covering the cardinal area completely, the surface of the cardinal area striated with faint, vertical lines and marked with few to many deep, triangular to lozenge-shaped ligamental grooves. Ribs strong, rectangular in section between deeply grooved interspaces, the summit of the ribs smooth or concentrically wrinkled except on the most anterior ones which are crudely noded. Interior of shell widely and deeply fluted by the ribs around the ventral margin. Hinge teeth small, vertical, in a continuous series. Surface of shell protected by a thick, smooth, black periostracum.

Like *Larkinia* but differing by its less truncated posterior side and fewer, plainer ribs.

Anadara (Grandiarca) grandis (Broderip and Sowerby)

Plate 7, figures 1, 1a-1c

Arca grandis Broderip and Sowerby, 1829, Zool. Jour., vol. 4, p. 365.—Reeve, 1844, Conch. Icon., vol. 2, *Arca*, pl. 1, fig. 4.

Arca (Anadara) grandis Broderip and Sowerby, Dall, 1910, Proc. U. S. Nat. Museum, vol. 37, No. 1704, pp. 154, 253, pl. 25, figs. 9, 10.

Scapharca (Scapharca) grandis (Broderip and Sowerby), Maury, 1922, Paleont. Amer., vol. 1, No. 4, p. 194, pl. 3, fig. 13.

Anadara (Larkinia) grandis (Broderip and Sowerby), Reinhart, 1943, Special Paper, Geol. Soc. America, No. 47, pp. 65, 66, pl. 13, figs. 4-6.—Hertlein and Strong, 1943, Zoologica, vol. 28, pt. 3, pp. 161, 162.—Frizzell, 1946, Jour. Paleont., vol. 20, No. 1, pp. 41-44.—Rost, 1955, Allan Hancock Pacific Expeditions, vol. 20, No. 2, pp. 195, 196.

Shell with the characters described for the subgenus. Ribs about 26 or 27, typically square in section, elevated, mostly smooth except on the anterior slope where they are crudely noded, their interspaces deep and flat and of the same width as the ribs. Living specimens have a thick black periostracum as protection against acid waters.

An average specimen measures: length 105 mm., height 85 mm., diameter 85 mm. Tumbes, Peru.

This is a common, widely distributed species and often used as food in parts of northern Peru, Ecuador, and Panama, where it is known to the fishermen as "Pato de Buro". Although drift shells may occasionally be

picked up on some open beaches, its usual habitat is lying deeply buried in soft mud banks which border mangrove swamps; hence, its distribution coincides closely with that of the mangrove. The southern limit⁸ of both living *Anadara grandis* and of the mangrove is at the mouth of the Tumbes River in northwestern Peru although fresh-looking shells of this ark washed out of Pleistocene tablazo deposits occur as far south as Sechura Bay near the northern border of the Peruvian faunal province. C. B. Adams, who collected so extensively in Panama and carefully noted the ecological conditions under which each species lived, recorded that this ark was found living half buried in the mud and algae under trees a little above half tide level. As fossil, *Anadara grandis* extends back into the Miocene at which time, it spread into the Caribbean, generally occurring in beds with other brackish-water species, often associated with lignites.

Range—Lower California to Tumbes, Peru. Panama: San Miguel Bay; mouth of the Río Chepo. Canal Zone: Farfan Beach. Colombia: Buena-ventura; Tumaco. Ecuador: Limones; Cojimenes; Manglaralto; mouth of the Guayas River and adjacent shoreline southward to the Peruvian border. Peru: Tumbes.

Subgenus CUNEARCA Dall, 1898

Type species by subsequent designation, Gardner, 1926, *Arca incongrua* Say.

Shell trigonal, inflated, with full umbones and small, submedial and slightly prosogyrate beaks over a high, triangular cardinal area covered completely by the ligament. The cardinal area bared of the ligament is smooth or marked obscurely with normal or longitudinal lines, the area outlined by deep, side grooves to which the edges of the tensilium were once attached. Hinge with numerous taxodont teeth in a continuous series, small in the middle zone, larger at the ends. Valves slightly unequal, the left valve being larger, its ventral margin overlapping, the external sculpture discrepant, the ribs of the left valve larger, and more coarsely noded. Valve margins strongly fluted.

Anadara (Cunearca) bifrons (Carpenter) Plate 9, figures 3, 3a, 3b

Arca cardiiformis Sowerby, 1833, Proc. Zool. Soc. London, p. 22 San Blas, Gulf of California.—d'Orbigny, 1846, Voy. Amér. Mérid., vol. 5, p. 634. Not *A. cardiiformis* Basterot, 1825.

Arca bifrons Carpenter, 1856, Cat. Mazatlan Shells, Brit. Mus., p. 134, No. 184.

Scapharca (Cunearca) bifrons (Carpenter), Maury, 1922, Paleont. Amer., vol. 1, No. 4, pp. 197-199, pl. 3, fig. 12.

Anadara (Cunearca) bifrons (Carpenter), Reinhart, 1943, Special Paper, Geol. Soc. America, No. 47, p. 70.

Arca (Cunearca) bifrons (Carpenter), Hertlein and Strong, 1943, Zoologica, vol. 28, pt. 3, p. 160.

Arca (Scapharca) corculum Mörch, 1861, Malak. Blätter, bd. 7, p. 205. New name for *Arca cardiiformis* Sowerby.

Arca brasiliiana Reeve, 1844, Conch. Icon., vol. 2, *Arca*, pl. 3, fig. 17. Not of Lamarck. The shell figured is apparently *A. cardiiformis* from San Blas, Bay of California, and not the West Atlantic form.

⁸ *Anadara grandis* was reported as living in Sechura Bay by Frizzell. This record is based either on fossil specimens washed out of tablazo beds such as found at Bayovar or Recent specimens brought from the north by fishermen.

The shell is generally large (up to 55 mm.), convex, subquadrate, inequivalve, with full, nearly medial umbones and usually quite thin. The posterior submargin is strongly flattened as if truncated almost at right angles. The left valve has 28 to 30, large ribs, flat, smooth and separated only by lined interspaces on the middle and posterior surfaces, strongly noded and with wider interspaces on the anterior portion; the ribs on the umbone are finely beaded throughout. Right valve is similar but the ribbed interspaces are wider. Cardinal area is longer than high, smooth.

Carpenter's type of *A. bifrons* in the British Museum (Nat. Hist.) is herein figured; its dimensions are as follows: length 37.9 mm., height 30.8 mm. diameter of the closed valves 27.5 mm. *A. bifrons* is a larger species than *A. aequatorialis*, and of a more rhombic form, the posterior side so strongly impressed or flattened so as to appear as if cutoff sharply, the ventral and anterior margins meeting to form a right angle. Allied closely to *A. brasiliana* Lamarck (*incongrua* Say) of the western Atlantic, the Pacific shell is generally smaller, more rhombic in shape, and the sculpture is smoother.

Range—Gulf of California to northern Peru. Panama: Guanico; Búcaro. Colombia: Isla del Gallo. Ecuador: Galeras; Mompiche. Peru: Tumbes; Zorritos; Paíta (D'Orbigny).

Anadara (*Cunearca*) *aequatorialis* (d'Orbigny) Plate 9, figures 4, 4a, 5, 5a

Arca ovata Reeve, 1844, Conch. Icon., vol. 2, *Arca*, pl. 8, fig. 49. Santa Elena, Ecuador. Not *A. ovata* Gmelin, 1791.

Arca aequatorialis d'Orbigny, 1846, Vol. Amér. Mérid., vol. 5, p. 636. New name for *A. ovata* Reeve, not of Gmelin, 1791.

Scapharca (*Cunearca*) *aequatorialis* d'Orbigny, Maury, 1922, Paleont. Amer., vol. 1, No. 4, p. 34, pl. 3, figs. 2, 9.—Hertlein and Strong, 1943, Zoologica, vol. 28, pt. 3, p. 160.

Anadara (*Cunearca*) *aequatorialis* (d'Orbigny), Reinhart, 1943, Special Paper, Geol. Soc. America, No. 47, pp. 69, 70.—Rost, 1955, Allan Hancock Pacific Expeditions, vol. 20, No. 2, pp. 206, 207, pl. 15, figs. a-c; text-figs. 92 a-c.

Arca subelongata Nyst, 1848, Mem. Acad. Royale Sci., Lettres, Beaux-Arts Belgique, t. 221, p. 70.

The shell is of medium size, relatively thin to slightly thickened, subovate and slightly inequivalve, the anterior side rounded and somewhat produced, the posterior side flattened, its margin appearing obliquely truncated, its end somewhat pointed. Umbones wide and prominent with a slight depression extending along the front of the umbonal angle towards the ventral margin. Ribs on the left valve number 30, the anterior set of 10 are rather coarsely noded throughout, the rest finely noded or smooth. The ribs on the right valve are narrower and separated by wider interspaces, the anterior ones noded, the rest plain.

The shell is relatively thin at first becoming heavier with age. Our largest specimen, a shell from Sua, Ecuador, has a length of nearly 44 mm. and is heavy. This species with *bifrons* seem to form an intergradational series and at times specimens are difficult to separate. *A. aequatorialis* seems to be more common south of Panama.

Range—Panama southward to Peru, perhaps northward to the Gulf of California. Panama: Búcaro. Ecuador: Sua; Mompiche; Limones; Manta; Santa Elena. Peru: Tumbes; Zorritos; Boca Pan.

Anadara (Cunearca) perlabiata (Grant and Gale)

Plate 9, figures 2, 2a

Arca labiata Sowerby, 1833, Proc. Zool. Soc. London, p. 21.—Reeve, 1843, Conch. Icon., vol. 2, *Arca*, pl. 1, fig. 7. Not *A. labiata* Solander, 1786 "Hab. ad Real Llejós et ad Tumbez."

Arca (Arca) perlabiata Grant and Gale, 1931, Mem. San Diego Soc. Nat. Hist., p. 141. New name for *A. labiata* Sowerby.

Arca (Cunearca) perlabiata Grant and Gale, Hertlein and Strong, 1943, Zoologica, vol. 28, pt. 2, p. 161.

Anadara (Cunearca) perlabiata (Grant and Gale), Reinhart, 1943, Special Paper, Geol. Soc. America, No. 47, p. 70, pl. 14, figs. 1, 2, 6.

Shell small or of medium size (up to about 36 mm.), nearly equivalve (the left valve a trifle larger than the right), subquadrate, the anterior-ventral side convex and rounded, the posterior-ventral margin slightly inflexed because of a weak surface depression extending downward from the beak to the ventral margin. Umbones prominent and nearly central terminating above in small, narrow, pointed beaks curved over a high, triangular, ungrooved, cardinal area. Sculpture discrepant on the two valves, the ribs of the left valve being neatly beaded over the umbone and anterior umbonal slope, later becoming smooth ventrally, the ribs of the right valve being narrower and smooth from the first, only a few of the ribs on the anterior slope below the beak being noded. The ribs number between 26 to 28, of which 9 are placed on the posterior slope. Surface white under a thin, black periostracum which scales off easily and on beach shells is preserved only in patches; when well preserved the periostracum shows cross scales in the intervals on both valves. Hinge line shorter than the length of the shell, the teeth small and in a continuous uninterrupted series.

Length 33.2 mm., height 33.1 mm., diameter 32 mm. Puerto Pizarro, Tumbez, Peru.

Length 36 mm., height 36.4 mm., diameter of a left valve 16 mm. Tumaco, Colombia.

This is a mud-flat species, often found in the mouth of rivers where it occurs with *Anadara grandis*, *Chione (Iliochione) subrugosa*, *Dosinia dunkeri* and *Diplodonta*. It is especially common at Tumaco, Colombia, and at Puerto Pizarro in the mouth of the Tumbez River, Peru.

Range—Lower California to northern Peru. Panama: San Miquel, Pearl Islands. Colombia: Tumaco. Ecuador: Manta; Puerto Palmito, Santa Elena. Peru: Puerto Pizarro, Tumbez River.

Anadara (Cunearca) nux (Sowerby)

Plate 9, figures 8, 8a

Arca nux Sowerby, 1833, Proc. Zool. Soc. London, p. 19 Xipixapi.—Reeve, 1843, Conch. Icon., vol. 2, *Arca*, pl. 1, fig. 1.

Scapharca (Cunearca) nux (Sowerby), Maury, 1922, Paleont. Amer., vol. 1, No. 4, p. 196, pl. 3, figs. 7, 8.

Arca (Cunearca) nux Sowerby, Hertlein and Strong, 1943, Zoologica, vol. 28, pt. 3, p. 161.—Hertlein and Strong, 1955, Bull. Amer. Mus. Nat. Hist., vol. 107, art. 2, p. 173.

Anadara (Cunearca) nux (Sowerby), Rost, 1955, Allan Hancock Pacific Expeditions, vol. 20, No. 2, pp. 205, 206, pl. 16, figs. 20 a-c; text-figs. 91 a-c.

Shell small, cordate, convex, subequivalve, the umbones wide and terminating in small, incurved beaks placed at the anterior one-third and separated by a fairly high, cardinal area longer than wide. The sculpture of the two valves is somewhat discrepant, the ribs on the left valve being

noded for the most part while those of the right valve have nodes only on the anterior seventh or eighth, the others are smooth. Ribs number about 22 or 23, are rectangular in section, somewhat wider than their interspaces which are often strongly cross-threaded. Periostracum thin, deciduous, light brown or straw-colored with a row of strong, coarse bristles in the interspaces.

Length 20 mm., height 17.7 mm., diameter 15.1 mm.

Common. This species resembles *A. chemnitzii* (Philippi) of the Caribbean but is generally smaller and with narrower and more oblong umbones.

Range—Gulf of California to northern Peru. Panama: San Carlos. Ecuador: Mompiche; Limones; Galeras; Manta; Montanita; Santa Elena. Peru: Tumbes; Zorritos; Mancora; Lobitos; Negritos.

Subgenus SCAPHARCA Gray, 1847

Type species by original designation, *Arca inaequivalvis* Bruguière. Recent. Coast of southeastern India.

Shell of medium size, oblong to subrectangular, relatively thin, moderately convex with a rounded umbonal slope, the umbones placed at the anterior one-third, flattened or slightly sulcate. The valves are slightly unequal, the left valve being a trifle larger, its margin overlapping that of the right. Sculpture is similar in each valve and consists of smooth ribs, rectangular in section and separated by flattened interspaces of the same width, the interspaces interlaced by strong cross threads. The cardinal area is elongate, narrow, marked with one or two ligamental grooves; ligament covers the area except for a narrow marginal zone on the anterior side. Teeth numerous, arranged in a continuous series, divergent at the ends.

In the type species, the shell is relatively thin so that the ribs show through into the interior as strong flutings. Sculpture is similar on both valves. The ribs are smooth and separated by flattened interspaces.

Subgenus SECTIARCA new subgenus

Type species, *Anadara floridana* Conrad (*A. secticostata* Reeve of some American authors). Plate 8, figure 2.

Shell elongately subrectangular, subequivalve, moderately convex and heavy. Umbones wide, the beaks small, prosogyrous. Cardinal area elongate, much longer than wide, the ligamental grooves mainly developed over the posterior portion, the anterior portion wholly or partially bare. Ribs numerous, narrower than their flat interspaces, typically lined or grooved in each valve. Hinge long, narrow with small, numerous teeth in a continuous series. Posterior side oblique but not winged or emarginated.

Sectiarca is similar in shape to *Scapharca* but has a heavier shell and the valves are alike, without an overlapping margin. Ribs are typically grooved in each valve. Coverage of the cardinal area is variable. In *A. floridana*, the anterior portion of the cardinal area is often completely bare (Pl. 8, fig. 2) in some specimens, partly covered in others. The Pliocene *A. lienosa* (Say) has strong groovings over the whole area, except for a small bare space along the dorsal margin.

Anadara (Sectlarca) concinna (Sowerby)

Plate 8, figures 1, 1a

- Arca concinna* Sowerby, 1833, Proc. Zool. Soc. London, p. 20.—Reeve, 1844, Conch. Icon., vol. 2, *Arca*, pl. 6, fig. 34.
- Arca (Scapharca) concinna* Sowerby, Hertlein and Strong, 1943, Zoologica, vol. 28, pt. 3, pp. 162, 163.—Hertlein and Strong, 1955, Bull. Amer. Mus. Nat. Hist., vol. 137, art. 2, p. 172, pl. 2, fig. 20.
- Scapharca (Scapharca) concinna* (Sowerby), Maury, 1922, Paleont. Amer., vol. 1, No. 4, p. 25, pl. 1, fig. 10.
- Arca cumingiana* Nyst, 1948, Mem. Acad. Roy. Sc. Lett. Beaux-Arts, vol. 22, p. 22. (New name for *concinna* Sowerby, non *concinna* Phillips 1829, as *Cucullaea*).

Shell of medium size, elongately ovate, somewhat cylindrical and evenly convex, the ratio of height to length about 1 to 2, the dorsal and ventral margins straight and nearly parallel, the two ends obliquely rounded. Sculpture consists of about 28 to 31 ribs, the anterior divided by a medial groove and strongly noded, their interspaces laced by finer cross concentrics; the other ribs are simple and smooth. The anterior section of the cardinal area is smooth, the posterior section traversed by 1 to 3 oblique grooves.

Length 33.5 mm., height 19 mm., diameter 15.6 mm.

Fort Amador Beach, Balboa, Canal Zone.

This species appears to be locally common in waters of 10 fathoms or more but is rarely found on the beach. It is especially common in the mud dredged from the entrance of the Panama Canal at Balboa and Palo Seco. This species is similar to several fossil forms from the Miocene such as *A. inaequilateralis* Guppy from Jamaica and Santo Domingo and *A. dariensis* Brown and Pilsbry from Panama. It occurs as a Pliocene fossil in Ecuador.

Range—Gulf of California to Ecuador. Costa Rica: Gulf of Nicoya. Panama: Búcaro; Burica Peninsula; Canal Zone: Palo Seco; Fort Amador. Ecuador: Off Esmeraldas; Off Cabo Pasados; Charapota; Punta Blanca.

Subgenus **CALOOSARCA**, new subgenus

Type species, *Anadara rustica* (Tuomey and Holmes). Pliocene of South Carolina and Florida.

Shell broadly elongate, moderately heavy, equivalve, convex. Cardinal area elongate, rather low or narrow, not covered fully by the ligament, the small portion anterior to the beaks usually bare. Posterior side deeply impressed, often winged or emarginated. Ribs simple, plain or heavily noded and often differing considerably in size, the anterior set sometimes mesially grooved. Hinge teeth small, numerous and in a continuous series.

In the average specimen of *A. rustica*, the cardinal area in front of the beak is bare, but in gerontic specimens the anterior area may be partly covered or furrowed with ligamental grooves. In *A. notabilis* of the Caribbean, the cardinal area has essentially the same characters as in *A. rustica* (see Plate 8, fig. 3).

Anadara (Caloosarca) biangulata (Sowerby)

Plate 8, figures 5, 5a, 5b

Arca biangulata Sowerby, 1833, Proc. Zool. Soc. London, p. 21. (Atacames).

- Arca Sowerbyi* d'Orbigny, 1846, Voy. Amér. Mérid., vol. 5, pt. 3. Mollusques, p. 637. (Name changed because of *A. biangulata* Lamarck, not *A. Sowerbyi* Sowerby, 1840.)
- Arca (Scapharca?) biangulata* (Sowerby), Maury, 1922, Paleont. Amer., vol. 1, No. 4, pp. 191, 192.
- Arca (Anadara) biangulata* Sowerby, Hertlein and Strong, 1843, Zoologica, vol. 28, pt. 3, No. 19, pp. 155, 156, pl. 1, fig. 3.
- Anadara (Scapharca) biangulata* (Sowerby), Rost, 1955, Allan Hancock Pacific Expeditions, vol. 20, No. 2, p. 201, text figs. 86, 87 a-c.
- Arca gordita* Lowe, 1935, Trans. San Diego Soc. Nat. Hist., vol. 8, No. 6, p. 16, pl. 1, fig. 1.

The shell is short, oblong, ventricose with full, wide umbos, the maximum inflation of the valves placed in the anterior-middle half of the shell, the posterior side narrowed and subacuminate. Cardinal area of medium height, wholly covered by the ligament on the posterior side and partly so on the anterior side. Ribs, about 30 in number, are relatively narrow and of the same width as their interspaces. The ribs are smooth or finely beaded and connected by strong cross threads in the interspaces.

Sowerby's *biangulata* was not figured by its author and the types were not located at the British Museum. The species was described from a single specimen dredged by Cuming at Atacames, Ecuador. Several dead valves were dredged off Esmeraldas by Olsson and Dranga in 1955. A small, left valve was dredged by Dr. G. Petersen off Zorritos in northern Peru. D'Orbigny's specimen of *biangulata* (name changed to *Sowerbyi*) was obtained by M. Fontaine in the Guayaquil area. This specimen is presented in the D'Orbigny Collection at the British Museum. It is a large, double-valved shell and measures 67.5 mm. in length.

Range—Lower California to northern Peru and the Galapagos Islands. Mexico: Gulf of California. Ecuador: Esmeraldas; Atacames (Cuming). Peru: Off Zorritos and in the Gulf of Guayaquil. Galapagos: Galapagos (Hertlein and Strong).

Subgenus **ESMERARCA** new subgenus

Type species, *Anadara reinharti* (Lowe).

Shell with slightly unequal, convex valves and somewhat discrepant sculpture. Cardinal area is high, trigonal, flat or nearly so, largely covered by the ligament except for a narrow space along the anterior side, and cut into by two or more tentlike incisions. Periostracum thin, with a row of bristles along the ribbed interspaces.

The type species *Anadara reinharti* has been referred by most authors to *Scapharca* although often with much uncertainty. Rost noted a resemblance to species of *Cunearca* and to *Larkinia*. The approach of *Esmerarca* to *Cunearca* is quite marked, especially by its somewhat unequal valves and slightly discrepant sculpture, the greatest difference is in the characters of the cardinal and ligamental areas. In *Cunearca*, the cardinal area is usually quite high and trigonal, smooth and the ligamental coverage is complete as well as lacking the tentlike incisions.

Anadara (*Esmerarca*) *reinharti* (Lowe)

Plate 8, figure 4; Plate 9, figure 1; Plate 10, figures 4-4d

Arca (*Anadara*) *reinharti* Lowe, 1935, Trans. San Diego Soc. Nat. Hist., vol. 8, No. 6, p. 16, pl. 1, figs. 3a, 3b, 3c "Guaymas".—Hertlein and Strong, 1943, Zoologica, vol. 28, pt. 3, p. 157.

Anadara (*Scapharca*) *reinharti* (Lowe), Reinhart, 1943, Special Paper, Geol. Soc. America, No. 47, p. 74.—Rost, 1955, Allan Hancock Pacific Expeditions, vol. 20, No. 2, pp. 198-200, pl. 13, figs. 18 a-c, 19 a-b; pl. 14, figs. 20 a-c; text-figs. 85 a-d.

The shell is large, rhomboid, whitish, with full, convex umbones ending in small, prosogyrate beaks, anterior of the middle and inrolled a little over a rather wide, obliquely triangular cardinal area. Usually, the valves are moderately thin so that the ribs show on the inside as shallow furrows which end as deeper, sharp-edged flutes at the margin. The valves are slightly unequal in size, the margin of the right valve extending beyond the other a trifle and the external sculpture is likewise somewhat discrepant as in *Cunearca*. Ribs number about 25, there are 17 ribs in front of an ill-defined posterior umbonal angle and 7 or 8 smaller, less well-defined ribs behind. The ribs of the left valve are a little stronger, subrectangular in section, and more or less transversely noded, especially anteriorly, their interspaces narrower and flattened; in the right valve, the ribs are narrower and as wide as their interspaces, the latter with some distant cross threading. Periostracum thin, deciduous, with bristles set in the interspaces.

An average specimen measures: length 56.1 mm., height 51.3 mm., diameter 44.5 mm.

This species was described by Lowe from a small shell with a length of only 27.7 mm and of solid texture. When full-grown, the shell reaches a size more than twice as large and the valves are generally quite light in weight. The young shell has been compared with that of *A. multicostata* but none of our specimens show much resemblance to that species. Its slightly discrepant sculpture and size of the umbones of the valves recalls species of *Cunearca* but the nodding of the right valve is not so pronounced. It is best distinguished by the characters of the ligament and cardinal area as described above for *Esmerarca*.

Apparently a common species locally, although seldom or ever obtained on the beach. According to Mr. Harry Johnson, it is the commonest shell obtained by the shrimpers off the coast of Panama.

Range—Gulf of California to Ecuador.

Genus LUNARCA Gray, 1857

(*Argina* Gray, 1842, not *Argina* Huebner, 1918, in Lepidoptera)
(*Arginarca* McLean, 1951 type *Arca* (*Arginarca*) *campechiensis* Gmelin)

Type species by monotypy, *Arca costata* Gray, 1857 (believed to be a deformed specimen of *A. pexata* Say)=*A. campechiensis* Gmelin.

Shell medium-sized to large, ovate-oblong, subequivalve, inflated, the umbones and beaks placed at the anterior one-quarter. The cardinal area is long and narrow, placed entirely behind the beaks and covered completely

by the ligament. Hinge teeth divided into two series, the anterior set being short and irregular, the posterior set much longer, regular. Tip of the beak often stained with black.

Lunarca brevifrons (Sowerby)

Plate 8, figures 7, 7a-7c

Arca brevifrons Sowerby, 1833, Proc. Zool. Soc. London, p. 22.—Reeve, 1844, Conch. Icon., vol. 2, *Arca*, pl. 1, fig. 6.

Scapharca (Argina) brevifrons (Sowerby), Maury, 1922, Paleont. Amer., vol. 1, pt. 4, p. 200.

Argina brevifrons variety *bucaruana* Sheldon and Maury, 1922, *op. cit.*, pp. 200, 201, pl. 2, fig. 16; pl. 3, fig. 10.

Lunarca brevifrons subsp. *brevifrons* (Sowerby), Reinhart, 1943, Special Paper, Geol. Soc. America, No. 47, p. 75.

Lunarca brevifrons subsp. *bucaruana* (Sheldon and Maury), Reinhart, 1943, *op. cit.*, p. 75, pl. 7, figs. 5-7.

Arca (Argina) vespertina Mörch, 1861, Malak. Blätter, vol. 7, p. 204.

Lunarca vespertina (Mörch), Rost, 1955, Allan Hancock Pacific Expeditions, vol. 20, No. 2, pp. 209, 210, pl. 15, figs. 24 a-b; text-figs. 93 a-c.

The count of 22 or 23 ribs as given by Reeve for this species is incorrect as the type examined in the British Museum has 35 ribs in the left valve. All our specimens of *L. brevifrons* from Peru have 30 or more ribs. *Arca (Argina) vespertina* Mörch and *Arca (Barbatia?) melancoderma* Pilsbry and Lowe are forms of *L. brevifrons*. The beak is commonly stained with a black streak.

Range—Lower California to northern Peru. Panama: Old Panama; San Carlos; Búcaro. Ecuador: Mompiche; Galeras; Manta; Santa Elena. Peru: Tumbez; Zorritos; Punta Picos; Mancora; Negritos.

Subfamily NOETINAE

Genus NOETIA Gray, 1857

Type species by monotypy, *Noetia triangularis* Gray = *N. reversa* (Sowerby). Recent, Panama-Pacific province.

Shell subrhomboidal to subtrigonal, its posterior side flattened or impressed, its end pointed or produced. Beaks opisthogyrate, varying in position from nearly central to strongly posterior. Cardinal area high or narrow, covered by the ligament, and vertically grooved or striated, the ligament largely or wholly confined to the anterior side. Adductor scars large and distinct, the posterior one usually with a raised edge or flange below. Surface covered with a dense, scaly to pilose periostracum.

Noetia (Noetia) reversa (Sowerby)

Plate 10, figures 1, 1a, 1b

Arca reversa Sowerby, 1833, Proc. Zool. Soc. London, p. 20. Tumbez, Peru.—Reeve, 1843, Conch. Icon., vol. 2, *Arca*, pl. 1, fig. 5

Noetia reversa (Gray), Sowerby, Maury, 1922, Paleont. Amer., vol. 1, No. 4, p. 171, pl. 1, figs. 7, 11.

Noetia reversa (Sowerby), H. and A. Adams, MacNeil, 1938, Prof. Paper 189-A, U. S. Geol. Survey, pp. 38, 39, pl. 6, figs. 7, 22, 23.

Noetia (Noetia) reversa (Sowerby), Reinhart, 1943, Special Paper, Geol. Soc. America, No. 47, p. 77, pl. 14, figs. 5, 7, 8.—Hertlein and Strong, 1943, Zoologica, vol. 28, pt. 3, p. 163.—Rost, 1955, Allan Hancock Pacific Expeditions, vol. 23, No. 2, p. 211, text-figs. 94 a-c.

Arca Hemicardium Koch in Philippi, 1843, Abbild. und Beschreib. Conchylien, vol. 1, p. 43, *Arca*, Tafel 1, fig. 1.

Noetia triangularis Gray, 1857, Annals Mag. Nat. Hist., 2d ser., vol. 19, p. 371.

Shell of medium size (largest about 50 mm.), convex and solid. Posterior side short, sharply truncated, usually flat, its margin straight, occa-

sionally flexed, its end produced and pointed. Anterior side longer, rounded to subquadrate in shape. Ribs, which number usually about 25, are flat and rather broad, close-set and wider anteriorly, narrower and more widely spaced posteriorly. The ligament lies wholly anterior of the beaks. Periostracum coarse and heavy, concentrically scaly, pilose, and of a velvety, dark-brown color.

Several names have been given to fossil forms of *Noetia* from the late Tertiary beds of the Pacific and Caribbean coastal lands of Central America and northern South America, many of which are so similar to *N. reversa* that they could well be considered as subspecies of the Recent shell. Some fossil *Noetias* attain a much larger size (up to 85 mm.), than the Recent shell. Most specimens of *N. reversa* are quite regular in shape but some shells from Sua, Ecuador, are strongly produced posteriorly and resemble the Miocene *N. macdonaldi* Dall from the northeast coast of Costa Rica.

Range—Lower California to northwestern Peru. Panama: San Carlos; Búcaro; Chepo. Colombia: Isla del Gallo; Choco. Ecuador: Galeras; Sua; Manta; Isla la Plata; Santa Elena. Peru: Tumbes; Zorritos; Boca Pan; Mancora.

Subgenus EONTIA MacNeil, 1938

Type species by original designation, *Arca ponderosa* Say. Recent, East Coast of the United States, Massachusetts to northern South America.

Ligament not wholly restricted to the anterior side, a small segment not vertically grooved, present on the posterior side. Ribs less flattened and divided by wider interspaces.

An East American group but with one species on the Pacific Coast.

Noetia (*Eontia*) *olssoni* Sheldon and Maury Plate 10, figures 2, 2a

Noetia olssoni Sheldon and Maury, 1922, *Paleont. Amer.*, vol. 1, No. 4, pp. 10, 11, pl. 1, fig. 9.

Eontia olssoni (Sheldon and Maury), MacNeil, 1939, Prof. Paper 189-A, U. S. Geol. Survey, p. 13, pl. 1, fig. 19, 20.

Noetia (*Eontia*) *olssoni* Sheldon and Maury, Reinhart, 1943, Special Paper, Geol. Soc. America, No. 47, p. 77, pl. 2, figs. 13, 14.

Shell small, (the largest seen, about 27 mm.), elongate-subtrigonal, the umbones high, convex, nearly central, ending in a small, narrow, curved, pointed beak seated above the cardinal area. The umbonal angle is strong and sharp, extending to a pointed posterior end. Anterior side is long, narrowed, rounded at end. Sculpture consists of numerous, small, narrow beaded riblets separated by interspaces carrying an interstitial thread. Cardinal area an unequal-sided triangle, the short side posteriorly, the longer anterior portion vertically grooved. Ligament completely covers the cardinal area, the larger part on the anterior side. Surface covered by a thin periostracum, generally worn off in beach shells. Ventral margin sinuous, toothed on the anterior and posterior sides. Beaks usually colored pink.

This species is closely related to *N. centrota* (Guppy) from the southern Caribbean but has smaller, narrower umbones and a more compressed posterior side. Both the Caribbean and Pacific species have the umbones colored pink.

Range—Panama southward to Peru. Panama: Burica Peninsula;

Búcaro. Colombia: Isla del Gallo. Ecuador: Esmeraldas; Sua; Cabo Pasados; Manta; Manglaralto; Santa Elena; Ancon. Peru: Zorritos; Punta Picos; Mancora; Negritos.

Genus **SHELDONELLA** Maury, 1917

Type species by monotypy, *Noetia (Sheldonella) maolica* Maury. Miocene of Santo Domingo.

Shell small, modioliform, thin or subsolid, the posterior side widely expanded. Posterior-umbonal slope is strongly convex or vaulted, the ventral side below it usually impressed. Beaks small, nearer the anterior end, slightly opisthogyrate. Cardinal area is an elongate, flat zone of moderate width distributed along the hinge line; the ligament itself being restricted to a triangular area under the beak almost equally divided between the anterior and posterior sides, the extreme posterior half of the cardinal area being bare. The area of the ligament is vertically grooved. Sculpture is formed of numerous, small ribs, their interspaces with a smaller interstitial riblet. Ventral margins closed, without a byssal gap.

The smaller species of *Eonotia* such as *N. olsoni* and *N. centrotata* bear resemblance to *Sheldonella* in their hinge characteristics and sculpture but they differ notably in shape and in possessing a strong, umbonal angle.

Sheldonella delgada (Lowe)

Plate 10, figures 3, 3a

Arca delgada Lowe, 1935, Trans. San Diego Soc. Nat. Hist., vol. 8, No. 6, p. 16, pl. 1, fig. 2.

Noetia (Sheldonella) delgada (Lowe), Reinhart, 1943, Special Paper, Geol. Soc. America, No. 47, pp. 77, 78, pl. 12, figs. 3-5.—Hertlein and Strong, 1943, Zoologica, vol. 28, pt. 2, p. 163.

Rare and local. This species is similar to *S. maolica* Maury from the Miocene of Santo Domingo. The Panama specimens were obtained from shell drift collected along the east shore of the Burica Peninsula.

Range—Mexico southward to Panama. Mexico: Manzanillo (Lowe), also Hertlein and Strong. Panama: near Punta Piedra south of Puerto Armuelles.

Family **GLYCYMERIDAE**

Shell usually solid, porcellaneous, equivalve, with subcentral umbones and small prosogyrous or opisthogyrous beaks above a well-defined cardinal area, the valves generally quite convex, subcircular, subovate to subtriangular in shape, generally slightly inequilateral, the anterior side is usually more evenly rounded while the posterior side is often somewhat narrowed and angulated, the valve margins closing tightly. The hinge plate is arched and bears numerous chevron-shaped taxodont teeth on each side, the teeth smaller in the middle zone and often partly or completely obliterated there by the downward spread of the cardinal area. The cardinal area may be narrow or high, subtriangular in shape, usually more or less equally developed on each side of the beak, or the posterior side may be much longer, its surface deeply engraved by tent-shaped grooves, the whole covered by a dark-brown ligament. Adductor scars usually well marked, subequal, often elevated and connected by an entire pallial line lying just within the ventral margin. Surface smooth or radially sculptured, the ventral margin smooth but more often furrowed. Periostracum thin or almost absent or heavy and densely pilose.

Recent species appear to belong to three generic groups distinguished as follows:

- I. Shell subovate, subcircular or slightly subelliptical, nearly equilateral, the anterior side more evenly rounded, the posterior often somewhat narrower and angulated at the end. Beaks nearly medial above the cardinal area and but slightly opisthogyrous.
- A. Surface with relatively weak sculpture, the riblets low, often indistinct, smoothish, or if radial riblets are present, they are usually overrun by fine longitudinal threads or striations. Periostracum coarse and heavy, dark in color and densely pilose.

Genus *Glycymeris*

- B. Sculpture more strongly emphasized, the ribs well formed, smooth or concentrically wrinkled but without superimposed radial threads or striations. Periostracum weakly developed or wanting.

Genus *Tucetona*

- II. Shell decidedly inequilateral, the anterior side being the longer, well rounded, the posterior side flattened or impressed. Beaks strongly opisthogyrous, placed near the anterior end of the cardinal area.

Genus *Axinactis*

General Key to Panamic and Peruvian species

- I. Surface with relatively weak sculpture formed by low, inconspicuous ribs, generally overrun by threadlike subsidiaries or the surface may be nearly smooth.

Glycymeris

- A. Shell small or of medium size (seldom above 45 mm.), ovate-subcircular in shape. Cardinal area small, short, triangular.

- 1. Shell ovate in shape, the height often appearing slightly greater, surface generally appearing almost smooth except for underlying sub-obsolete radial ribs, the coloration brownish or cream, plain or lightly rayed, the interior white. Peruvian.

G. ovata

- B. The shell larger and the sculpture generally more pronounced. Panamic.

- Ba. Shell relatively large, subcircular in shape, nearly equilateral, the posterior side differing only slightly in shape from the anterior.

- 2. Shell large (up to about 100 mm.), the surface beneath the coarse periostracum finely marked with transverse wavy or zigzag lines, especially over the umbones. Gulf of California.

G. gigantea

- 3. Shell smaller, the surface marked more densely with brown spots or streaks.

G. maculata

- Bb. Shell of medium size, subelliptical in shape, inequilateral, the posterior side somewhat longer and produced.

- 4. Surface finely sculptured by low ribs overrun by linen-like subsidiaries. Color more uniformly brown or cream; spots if developed are more sparingly distributed.

G. lintea

II. Surface ribbing strongly emphasized.

Tucetona

C. Ribs rounded, simple, separated by wide or merely narrowly lined interspaces. Subsidiaries lacking or consisting of concentric wrinkles only.

Ca. Shape subcircular, the submargins not strongly impressed or flattened. Ribs numerous (35-40).

5. Average size about 38 mm., with high convex umbones and beaks. General color white, lightly or heavily maculated with brown.

T. multicosata

Cb. Shape subtrigonal with the anterior and posterior submargins impressed and flattened, the cardinal area narrower. Ribs fewer, not over 30.

6. Average size about 30 mm.

T. strigilata

7. Average size larger with broader and flatter ribs.

T. strigilata canoa

D. Ribs relatively few, large, and covered by strong, cordlike subsidiaries. Shell decidedly inequilateral, the beaks opisthogyrous.

Genus *Axinactis*

8. Ribs about 6 in number.

A. inaequalis

9. Ribs 10 to 12 in number.

*A. delessertii*Genus *GLYCYMERIS* Da Costa, 1778

Type species by tautonomy, *Glycymeris orbicularis* Da Costa, 1778 (= *Arca glycymeris* Linné 1758). Europe.

Shell usually solid, suborbicular to subcircular, equilateral or nearly so, equivalve, closed, with prominent central umbones ending in small, approximate beaks. Ligament external, covering the cardinal area which may be amphidetic (along both sides of the beak) or entirely anterior, the beaks then becoming opisthogyrate, the cardinal area usually heavily marked with chevron-shaped ligamental grooves. Hinge plate arched, the teeth arranged in a continuous series or the middle zone obliterated by the downward migration of the cardinal area, the lateral teeth always largest. Sculpture principally radial, formed by fine threads, sometimes almost obsolete, the surface then approaching smoothness, or with large, strong ribs. An umbonal ridge running from the beak and angulating the posterior margin is sometimes faintly indicated. Muscle scars distinct, situated high in the valves. Ventral margins of the valve fluted. When fresh, the surface is covered with a dark-colored, soft, velvety periostracum.

Glycymeris (Glycymeris) ovata (Broderip)

Plate 11, figures 6, 6a

Pectunculus ovatus Broderip, 1832, Proc. Zool. Soc. London, p. 126 *Hab.* ad insulam Lobos.—Reeve, 1843, Conch. Icon., vol. 1, *Pectunculus*, pl. 1, fig. 2.

Pectunculus intermedius Broderip, 1832, Proc. Zool. Soc. London, p. 126 *Hab.* ad Iquiqui.—Reeve, 1843, *op. cit.*, pl. 1, fig. 1.

Shell of medium size (length about 44 mm.), obliquely subovate, solid. Surface beneath the brown epidermis white and when well preserved minutely decussate but without the usual fine riblets. Epidermis ashy to dark brown.

This is a species of the Peruvian faunal province not ranging north of Paita. It is often a common fossil in the Peruvian tablazos. Beach specimens are usually worn smooth. The typical form of *ovata* is rounded subovate, the more elongate elliptical form is that named *intermedia* and if fairly constant may perhaps be separated as a subspecies.

Range—Paita southward to Chile. Peru: Paita Peninsula; Bay of Sechura; Lobos Islands; Callao.

Glycymeris (Glycymeris) maculata (Broderip) Plate 11, figures 2, 5

Pectunculus maculata Broderip, 1832, Proc. Zool. Soc., p. 126.—Reeve, 1843, Conch. Icon., vol. 1, *Pectunculus*, pl. 1, fig. 4.

Glycymeris (Glycymeris) maculata (Broderip), Hertlein and Strong, 1943, Zoologica, vol. 28, pt. 2, p. 150.

The shell is often large (length 80 mm.), convex, heavy, nearly circular, the posterior side with a low, obscure angulation. Surface smoothish but when fresh showing a submicroscopic sculpture of low, rounded riblets on the umbones crossed by small, equidistant concentrics becoming gradually replaced ventrally by fine, raised radial threadlets which are evenly distributed and not bunched together in riblike groups. Hinge plate solid, the teeth relatively few, the laterals large, the middle series continuous or broken. Ground color white, thinly or thickly speckled with brown streaks, more or less arranged in a zigzagged pattern. Interior of shell white, the umbonal cavity and the beaks tinged with violet or brown.

Length 69.5 mm.; height 70.2 mm.; diameter 46.4 mm.

Punta Blanca, Ecuador.

Range—Lower California to northern Peru. Panama: Pearl Islands; Guanico. Ecuador: Sua; Isla la Plata; Manta. Peru: Zorritos.

Glycymeris (Glycymeris) gigantea (Reeve) Plate 11, figure 1

Pectunculus giganteus Reeve, 1843, Conch. Icon., vol. 1, *Pectunculus*, pl. 1, figs. 3a, 3b Guaymas.

Glycymeris (Glycymeris) gigantea (Reeve), Hertlein and Strong, 1943, Zoologica, vol. 28, pt. 3, p. 150.

Glycymeris gigantea (Reeve), Durham, 1950, Mem. Geol. Soc. America, No. 43, p. 56, pl. 2, figs. 1, 8.

Similar to *G. maculata* but larger (max. about 100 mm.), and more distinctly marked with waved or zigzagged brown bands. Periostracum coarse and dark-brown in color.

This large glycymerid seems to be restricted in its distribution to the Gulf of California. It differs principally from *G. maculata* by its larger size and color markings, the brown spots arranging themselves in a more definite zigzag pattern, and perhaps it should be accorded only a subspecific standing.

Range—Gulf of California. Mexico. Guaymas.

Glycymeris (Glycymeris) lintea, new species Plate 11, figures 4, 4a

Shell of medium size (length to about 60 mm.), broadly subelliptical, longer than high, the posterior side is longer, somewhat produced and pointed at the end. The sculpture is fine, formed over the middle of the valve by numerous, low, rounded riblets, the whole closely overrun by fine, threadlike longitudinals producing a subsidiary sculpture like that of fine linen; this fine sculpture covers the whole surface evenly but the

larger ribs fade-out over the anterior and posterior submargins. Color light-cream or whitish, plain or lightly maculated with brown, the tip of the beak and the adductor scars more darkly colored. Hinge plate long and narrow, the teeth usually in an unbroken series. Inner margin finely furrowed.

Length 57.7 mm., height 48.2 mm., semidiameter 16.5 mm., Holotype, Coast between Punta Blanca and Puerto Callo, Ecuador. ANSP 218915.

Distinguished from *G. maculata* by its more elliptical form and produced posterior side, generally lighter and more uniform coloration and fine sculpture. This species seems related to *G. spectralis* Nicol of the Caribbean but is much larger.

Range—Panama to northern Peru. Panama: Guanico, Pearl Islands. Ecuador: Punta Blanca, Punta Carnero near Santa Elena. Peru: Zorritos.

Genus TUCETONA Iredale, 1931

Type species by original designation, *Pectunculus flabellatus* Tenison-Woods.

Surface sculptured with strongly emphasized radial ribs between shallow or deep interspaces, the ribs simple or divided terminally and crossed by concentric wrinkles or striations. Periostracum thin or wanting.

Tucetona multieostata (Sowerby)

Pectunculus multieostata Sowerby, 1833, Proc. Zool. Soc. London, p. 195.—Reeve, 1843, Conch. Icon., vol. 1, *Pectunculus*, pl. 5, figs. 2, 6.

Glycymeris (Tuceta) multieostata (Sowerby), Hertlein and Strong, 1943, Zoologica, vol. 28, pt. 2, p. 151.

Shell of medium size (length 40 mm.), subcircular, a trifle higher than long, convex, solid, the umbones wide, oblique, subcarditiform. Ribs between 35 to 40, narrow, rectangular, between deep square grooves of nearly the same size, uniform through the middle, smaller on the sides, the ribs and interspaces coarsely cross-threaded. Hinge teeth relatively few and large, the cardinal area subamphidetic, the anterior side longest. Color white, maculated with brown, the interior white or with a brown stain over the posterior portion.

Range—Coast of Mexico to Ecuador. Ecuador: Isla la Plata, Manta. Colombia: Gorgona Island. Panama: Pearl Islands, Bahia Honda (Hertlein and Strong).

Tucetona strigilata (Sowerby)

Plate 11, figure 3

Pectunculus strigilatus Sowerby, 1833, Proc. Zool. Soc. London for 1832, p. 196. "Hab. ad Sanctam Elenam".—Reeve, 1843, Conch. Icon., vol. 1, *Pectunculus*, pl. 6, fig. 31.

Glycymeris (Tuceta) tessellata strigilata (Sowerby), Hertlein and Strong, 1943, Zoologica, vol. 28, pt. 3, pp. 152, 153.

Glycymeris tessellata strigilata (Sowerby), Hertlein and Strong, 1955, Bull. Amer. Mus. Nat. Hist., vol. 107, art. 2, p. 175, pl. 3, figs. 25-28.

Pectunculus tessellatus Sowerby, 1833, Proc. Zool. Soc. London for 1832, p. 196 "Monte Christe and in the Bay of Xipixapi".

Glycymeris (Tuceta) tessellata (Sowerby), Hertlein and Strong, 1943, *Zoologica*, vol. 28, pt. 3, pp. 151, 152.

Pectunculus minor d'Orbigny, 1846, *Voy. Amér. Mérid.*, vol. 5, pt. 3, Mollusques, p. 628, No. 709. (Not *P. minor* I. Lea 1833)

Glycymeris chemnitzii Dall, 1909, *Proc. U. S. Nat. Museum*, vol. 37, No. 1704, p. 253. New name for *P. minor* d'Orbigny.

Shell orbicular, triangular, rounded or expanded ventrally, narrowed inward dorsally, the submargins somewhat appressed, straight, the anterior margin rounded, the posterior more produced and angled at the end, especially if viewed from within. Surface sculptured with 22 to 25 ribs, generally square or rectangular in section separated by flattened interspaces, the ribs larger along the middle, smaller and crowded on the sides, both ribs and interspaces crossed by fine, raised concentric threads. Cardinal area small, triangular surmounted by the small beaks placed slightly posterior of the mid-point. Internal margin coarsely furrowed in the middle zone, the marginal furrows small or absent. Coloration white, irregularly splotted with brown, or entirely ashy white with a brownish cast.

Length 29.4 mm., height 30 mm., semidiameter 9 mm. Left valve, Zorritos.

T. tessellata and *T. strigilata* were described by Sowerby at the same time and on the same page, the former placed first; both seem to represent variations of each other, *T. strigilata* is the commonest and most typical form, for that reason I have given it precedence over the other. *T. strigilata* appears closely related to *T. arata* Conrad from the Miocene of North Carolina. *Pectunculus pectenoides* Deshayes from Panama is perhaps equivalent.

Range—Lower California to northern Peru. Ecuador: Manta, Santa Elena. Peru: Zorritos.

Tucetona strigilata canoa (Pilsbry and Olsson)

Glycymeris canoa Pilsbry and Olsson, 1941, *Proc. Acad. Nat. Sci. Philadelphia*, vol. 93, p. 54, pl. 13, figs. 2, 2a Pliocene, Punta Blanca, Ecuador.

Glycymeris (Tuceta) tessellata canoa Pilsbry and Olsson, Hertlein and Strong, 1943, *Zoologica*, vol. 28, pt. 3, p. 152.

This form was first described as a fossil from the Pliocene of Ecuador. It has been reported from the Recent fauna by Hertlein and Strong who considered it as a giant form or subspecies of *T. tessellata*. According to these authors, it differs from *T. tessellata (strigilata)* by its much larger size, extremely broad ribs, and in that the color markings are arranged in concentric zigzag lines rather than in the shape of large spots.

Range—Gulf of California and perhaps southward to Ecuador. Known living only at Arena Bank, in the southern end of the Gulf of California (Hertlein and Strong).

Subgenus AXINACTIS Mörch, 1861

Type species by subsequent designation, Hertlein and Strong, 1943, *Axinaea (Axinactis) inaequalis* (Sowerby).

Shell solid, rounded to obliquely subtriangular or cardiform, the umbones

and beaks with a strong posterior curve, opisthogyrate, with the larger portion of the cardinal area lying on the anterior side. Ribs through the middle zone of the disk are large and relatively few in number (6 to 10) fading out on the appressed submargins into cord or threadlike radials.

Two species.

Key to species *Axinactis*

- I. Ribs relatively few (about 6), large in the middle, the valves convex with appressed submargins. *G. inaequalis*
- II. Ribs more numerous (about 10), valves rounder. *G. delessertii*

Axinactis inaequalis (Sowerby)

Plate 11, figures 8, 8a, 8b

Pectunculus inaequalis Sowerby, 1832, Proc. Zool. Soc. London, p. 196.—Reeve, 1843, Conch. Icon., vol. 1, *Pectunculus*, pl. 4, fig. 16 Bay of Panama and Real Llejos.

Pectunculus assimilis Sowerby, 1832, Proc. Zool. Soc. London, p. 196 dredged in sandy mud and gravel, in from eight to twelve fathoms at Puerto Portrero and in the Bay of Guayaquil.—Reeve, 1843, *op. cit.*, pl. 4, fig. 15.

Glycymeris inaequalis (Sowerby), Hertlein and Strong, 1943, Zoologica, vol. 28, pt. 2, p. 153.

Shell coarse, obliquely trigonal to flatly cardiform, the umbones strongly curved posteriorly. Beaks small, opisthogyrate, with the cardinal area lying almost wholly on the anterior side of the beaks. Ribs in the middle zone of the valve large, few (six or seven) becoming small on the submargins or replaced there by the strong longitudinal threads which overrun them. Hinge teeth in an arch, large and relatively few in number. Color sometimes nearly white but generally with a pattern of transverse, zigzag brown bands, closely or widely spaced.

Length 40.3 mm., height 44.4 mm., diameter 30 mm.

Punta Mambri, Ecuador.

Range—Gulf of California to northern Peru. Panama: Panama City; Pearl Islands; Burica Peninsula. Canal Zone: Venado Beach. Ecuador: Esmeraldas; Limones; Manta; Isla la Plata; Santa Elena; Punta Mambri. Peru: Zorritos; Mancora; Sechura.

Axinactis delessertii (Reeve)

Plate 11, figures 7, 7a

Pectunculus delessertii Reeve, 1843, Conch. Icon., vol. 1, *Pectunculus*, pl. 9, fig. 52.

Hab—? Reeve, 1843, Proc. Zool. Soc. London, p. 190.

Glycymeris (Axinactis) delessertii (Reeve), Hertlein and Strong, 1943, Zoologica, vol. 28, pt. 3, p. 153.

Shell like *A. inaequalis* but larger, rounded, the ribs more numerous. Interior white stained with brown on the posterior side.

Range—Mexico to Panama. Mexico: Tres Marias Is. (ANSP 160732. H. N. Lowe). Panama: Panama. (ANSP 7953. T. B. Wilson).

Family LIMOPSIDAE

The shell is small or of medium size, glycymerid in shape, sometimes nearly symmetrically rounded or trigonal, or strongly obliquely suborbicular, the anterior side then shorter than the other, equivalve. Umbones are subcentral with the beaks rising a little above the hinge and cardinal area.

Cardinal area as in *Glycymeris* is generally low, triangular but with the ligament restricted to a small, central pit under the beak of triangular shape. Surface sculpture is varied, sometimes smooth or with concentric markings only, or with radial costae and threads in different strength, the whole covered by a brown-colored periostracum generally tufted. Hinge as in the Glycymeridae consists of a series of obliquely set taxodont teeth on both sides of the beak usually in a curved or arched form.

Genus **LIMOPSIS** Sacco, 1827

Type species by monotypy, *Arca aurita* Brocchi. Miocene and Pliocene of Italy.

With the general characters of the family.

The genus *Limopsis* has been divided into several smaller groups on basis of sculpture and whether the ventral margins are smooth or crenulated, characters poorly expressed in some species, intergradational in others. Most species of *Limopsis* live in deep water or in cold, northern seas.

Limopsis zonalis Dall

Plate 1, figure 8

Limopsis zonalis Dall, 1908, Bull. Mus. Comp. Zool., vol. 43, No. 6, pp. 393, 394, pl. 7, figs. 6, 9.

Shell relatively large for the genus, obliquely ovate, slightly convex or compressed, white or cream-colored under a brown, villous periostracum, the tufts of long hair arranged in neat radial rows.

Height 25 mm., length 27 mm., diameter 10 mm.

Gulf of Panama in deep water.

This is a deep-water shell dredged by the steamer *Albatross* at depths ranging from 555 to 782 fathoms in the Gulf of Panama. It has been included here for the sake of completeness and in the expectation, that since it is a fairly common species in the proper depth environment, it may yet be obtained by shrimp and fish trawlers operating off the coast of Panama. This species or an allied form is common as fossil in the upper Miocene of northern Ecuador.

Range—Panama. Panama: Gulf of Panama. USNM.

Order DYSODONTIDA (Anisomyaria)

Superfamily MYTILACEA

Family MYTILIDAE

Shell elongately ovate, bullet to wedge-shaped, often with an oblique axis, the valves equal. Beaks small, prosogyrate, placed usually near the anterior end, the umbonal slope posteriorly, often prominent and vaulted. Hinge line posterior of the beaks usually straight, plain or with a crenulated margin in harmony with a ribbed external sculpture, edentulous, or with small dysodont teeth on the anterior lunular margin below the beaks. Ligament subinternal, attached to an elongated calcified resilifer, usually white in color, compact or with a pitted or cellular basal foundation. Typically bimarian, the anterior adductor scar is always much smaller than

the other and sometimes wholly eliminated in the adult, hence the posterior adductor scar is large and sometimes confluent with that of the posterior retractor. Surface smooth or with radial riblets; the sculpture is usually much stronger on the posterior-dorsal side, finer on the ventral side of the umbonal slope. Inner layer of the shell is ordinarily nacreous, the outer layer thinner, darker, and covered by a thin or heavy, yellow, brown, green or black periostracum, hairy or bristly, often peeling off from dead valves.

Marine, brackish to fresh water. Most species live in colonies, the shell anchored by its byssus to rocks, piling or to sea-weeds. Some species form nests of byssus in which they lie buried. Some species are rock borers such as the *Lithophagas* and *Adula*.

Earlier authors distributed the species of this family amongst two key genera, *Mytilus* and *Modiolus*, principally from the position of the beaks, whether entirely terminal, the anterior end of the shell therefore more or less pointed, or with the beaks more remote, the anterior margin projecting a space in front of them. All transitional forms occur between these two types and many species have, at different times and by the same author, been referred to both genera.

The reader is referred to the recent important paper of Tron Soot-Ryen, 1955, *A Report on the Family Mytilidae*: Allan Hancock Pacific Expeditions, vol. 20, No. 1 for much additional information on this family.

Key to Panamic-Pacific genera

- I. Resilifer lined with a chalky white layer, its basal part cellular, hence showing as a line of pores or pits on its exposed edge.
 1. Shell mytiliform, the beaks strictly terminal, pointed. Anterior or lunular side below the beaks with a few, short, riblike folds terminating in strong teeth within the margin. Mostly cold water and northern.
Genus *Mytilus*
 2. Shell modioliform, the beaks a little removed from the end, the anterior margin projecting beyond them. No folds or teeth on the anterior side and margin.
Genus *Mytella*
- II. Resilial layer white, compact and showing no pores or pits on the side.
 - A. Surface smooth or marked with concentric growth lines (except *Aulacomya*, which has variable ribs on umbones), the margin of the valves plain or smooth.
 - a. Individuals free or nestlers, *not boring* into rock, coral or shell.
 - aa. Shell mytiliform, the beaks terminal and pointed.
 3. Often large, externally like *Mytilus*, the anterior adductor scar obsolete and the hinge teeth reduced to a single, riblike tooth.
Genus *Choromytilus*
 4. Similar but with a persistent anterior adductor scar and generally with a series of low, radial ribs or streaks on the umbones. Peruvian.
Genus *Aulacomya*

ab. Shell partly modioliform, the beaks not quite terminal. Anterior side very short, externally outlined by a faint lunular line, its inner margin smooth or weakly toothed.

5. Shell elongately wedge-shaped, dark brown to black, glossy and with a satiny sheen, internally white or vinaceous.

Genus *Semimytilus*

ac. Shell modioliform, the anterior margin short, projecting but without a lunular line, no hinge teeth.

6. Shell elongate to hatchet-shaped, the ventral side often deeply impressed. Periostracum smooth, scaly or bearing bristles.

Genus *Modiolus*

b. Borers in rock, coral or shell.

7. Surface smooth or with concentric lines of growth, the periostracum dark brown to black, and without secondary lime incrustation.

Genus *Botula*

8. Surface incrustated with a secondary coating of lime (except *Lithophaga, sensu stricto*). Shell typically elongated, cylindrical or bullet-shaped.

Genus *Lithophaga* several subgenera

B. Surface sculptured with radial riblets, strong or partly obsolete, the inner margins crenulated by the external ribbing at least in some groups. Dysodont teeth present in most cases.

c. Shell ovate to obliquely subcircular, the longer axis nearly vertical. Sculpture with small divaricating riblets.

9. Shell small, subnacreous, the hinge teeth strong.

Genus *Crenella*

d. Shell elongate, mytiliform to modioliform.

da. Individual, free or nestlers.

daa. Cavity of the beak bearing a small, shelflike platform or septum on which the anterior adductor scar is placed.

10. Shell generally small, mytiliform, with ribbed sculpture, often with lines of bristles.

Genus *Septifer*

dab. Cavity of the beak without a septum, the anterior adductor scar placed on the shell wall itself.

daba. Ligament relatively short, only about half the length of the hinge line.

11. Margins of the shell strongly crenulated all around. Dysodont teeth strong along the anterior margin.

Genus *Brachidontes*

dabb. Ligament as long as the hinge line or nearly so.

dabba. Ligament extending forward to the tip of the beak.

12. Anterior end of shell full, its margin well rounded, and with small normal crenulations only. The posterior adductor scar is quite large, confined to the dorsal side.

Genus *Hormomya*

13. Anterior end of shell narrowed and pinched, its dysodont teeth large and coarse. Posterior adductor scar circling the posterior end of the valve on the inside.

Genus *Scolimytilus*

dabbb. Anterior margin turned in dorsally so as to lie closely under the beaks and ends in a sharp, cutlike break, the ligament does not extend forward of this point.

14. Shell full, convex, fan-shaped, coarsely ribbed but with the surface usually eroded. Color deep purple or black.

Genus *Perumytilus*

db. Borers in rock or coral growth.

15. Shell cylindrical, bullet-shape, the beaks terminal. Surface smooth or encrusted but not corroded.

Genus *Lithophaga*

16. Shell elongated, irregular, the beaks near the middle, the umbones and midzone often deeply corroded.

Genus *Adula*

17. Shell modioliform, sculpture with fine radials except in the midzone which is smooth, the periostracum covered with bristles.

Genus *Gregariella*

Genus **MYTILUS** Linné, 1758

Type species by subsequent designation, Anton, 1839, *Mytilus edulis* Linné. North Atlantic.

Shell mytiliform or ovate-oblong, usually with a strong, oblique axis. Beaks placed at the extreme anterior end are small, the posterior side wide and rounded, convexly vaulted along the umbonal arch extending from the beak to the posterior-ventral corner. Hinge with a series (about four to six), small, dysodont teeth on the anterior margin or narrow plate below the beak. Ligament subinternal, narrowly linear in shape, within the dorsal margin, and attached to a whitish chalky resilifer, the basal foundation of which is finely pitted. Anterior adductor scar small, lying in the cavity of the beak and connected with the pallial line which lies as a gradually widening band within and parallel to the ventral margin; posterior adductor and retractor scar united and forming an irregular pipe-shaped impression. Cold water.

M. edulis is typically a North Atlantic species but various closely related forms or subspecies have been named from the Southern Hemisphere. *M. edulis* Linné, Plate 12, figure 6.

Mytilus arciformis (Dall)

Plate 12, figures 4-4b

Modiolus arciformis Dall, 1939, Proc. U. S. Nat. Museum, vol. 37, No. 1704, pp. 152, 258, pl. 28, fig. 2 Huaquilla, Ecuador.

Volsella (Volsella) arciformis (Dall), Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 2, p. 72, pl. 1, fig. 5 Monypenny, Nicaragua.

Shell narrowly elongated, decidedly arcuate, the base being strongly inflected and the dorsal margin arched. The ventral side is flattened, thereby emphasizing the angled edge of the umbonal slope. Color an olive-brown, the periostracum thin, smooth, often worn-off in spots, the surface beneath with strong concentrics. The small beaks are almost terminal, the short anterior margin below folded so as to form 3 or more weak teeth and shallow pits. Resilifer is nearly as long as the arched dorsal margin, narrowly linear, white, its basal edge strongly pitted. Posterior adductor scar pipe-shaped, the upper arm long and narrow, confluent with the retractor scar at its end. The anterior adductor scar present.

This recognizable species was referred to *Mytella* and placed in the synonym of *M. falcata* (d'Orbigny) by Soot-Ryen but its relations lie closely with *Mytilus*. It is apparently a mud-flat species, especially common along the mangrove-fringed shores of the Gulf of Guayaquil.

Range—Salvador to the Gulf of Guayaquil. Salvador: Gulf of Fonseca (Hertlein and Strong). Nicaragua; Monypenny Point (Hertlein and Strong). Ecuador: Huaquilla (Dall); Posorja; Puna Island; Santa Elena.

Genus **SEMIMYTIUS** Soot-Ryen, 1955

Type species by original designation, *Mytilus algosus* Gould, 1850.

Shell small or of medium size, mytiliform, the beaks almost terminal, the dorsal margin almost straight with the ligament along it narrow and linear. Anterior end short, reflexed below the beak, and extended forward forming a short, slightly pouting extremity, its rolled over margin smooth or rarely weakly denticulated, its external surface forming a small lunule circumscribed by a line. Anterior adductor scar very small, continued into the irregular pallial line which follows the ventral margin closely, the posterior adductor and retractor joined forming an irregular, pipe-shaped scar. Surface smooth or with undulated concentrics, the periostracum thin, brown or black, shiny or with a silky sheen.

Two species.

Key to species of *Semimytillus*

1. Length about 45 mm; anterior end quite narrow, the posterior narrow to medium well rounded; pallial and muscle impression usually distinct. Peruvian faunal zone.

S. algosus

2. Shell smaller and more stubby, the posterior end more widely rounded; pallial and muscle impression weakly marked. Paita Buffer Zone.

S. nonuranus

Semimytillus algosus (Gould)

Plate 14, figure 8

Mytilus algosus Gould, 1850, Proc. Boston Soc. Nat. History, vol. 3, p. 344.—Gould, 1852, United States Exploring Expedition, vol. 12, p. 450, atlas, 1856, pl. 41, figs. 566, 566a.

Semimytillus algosus (Gould), Soot-Ryen, 1955, Allan Hancock Pacific Expeditions, vol. 20, No. 1, pp. 25, 26, pl. 4, fig. 17; text-figures 8, 9, 14, 15, 16.

Mytilus dactyliformis Hupé, 1854, Gay, Hist. Chile, Zool., vol. 8, p. 310, pl. 5, fig. 6.

The type locality as given by Gould is the Fiji Islands which is probably incorrect. Valparaiso, Chile, was selected as type locality by Soot-Ryen.

This species, as here understood, is probably confined largely to the South American coast washed by the Humboldt Current. It is extremely abundant to the south of Lima, at Paracas, and the Bahia de la Independencia.

Semlmytilus nonuranus (Pilsbry and Olsson) Plate 17, figure 10
Modiolus (Modiolus) nonuranus Pilsbry and Olsson, 1935, *Nautilus*, vol. 49, No. 1, p. 16, pl. 1, fig. 3.

Shell small (generally less than 40 mm.), the small beaks terminal, the short anterior margins hardly passing beyond them. Valves strongly convex, the umbonal slope straight, the ventral margins but little impressed. The periostracum is thin, smoothish, colored brown on the ventral side and a rich black or green-black on the posterior slope, often with a satiny luster. Interior cream-white with a ray of vinaceous of varying intensity under the umbonal slope.

Length 39.00 mm., height 19.50 mm., diameter 16.50 mm.

This seems to be a good species, smaller than *S. algosus*, of a different shape, the posterior side much wider and more rounded, and its range more northerly. It is a common species between Sechura Bay and Lobitos, usually attached to rocks, swept by strong surf waves, which it thickly covers.

Range—Coast of northwestern Peru. Peru: Nonura Bay and Punta Aguja at the southwestern end of Sechura Bay; Punta Capullana between Talara and Lobitos.

Genus *CHOROMYTILUS* Soot-Ryen, 1952

Type species by original designation, *Mytilus chorus* Molina. Coasts of Chile and southern Peru.

Often large, strongly obliquely ovate-oblong, of a deep blue or purple-black color, the surface smooth and covered by a coarse, black periostracum. Interior white except for the margins which are dark.

Choromytilus chorus (Molina) Plate 12, figure 10

Mytilus chorus Molina, 1782, *Saggio sulla Storia Naturale del Chile*, p. 202.—Reeve, 1857, *Conch. Icon.*, vol. 10, *Mytilus*, pl. 2, fig. 4.—Dall, 1909, *Proc. U. S. Nat. Museum*, vol. 37, No. 1704, pp. 151, 257, pl. 25, fig. 1.

Choromytilus chorus (Molina), Soot-Ryen, 1955, *Allan Hancock Pacific Expeditions*, vol. 20, No. 1, p. 31, pl. 2, figs. 7, 8; text-fig. 5.

With general characters of the genus. According to Dall (1909), this is the largest of the mussels along the Chilean and southern Peruvian coast and generally regarded as the best of the edible shell fish. It is known as Choro de Concepcion after Conception Bay in Chile where it abounds.

Range—Coast of Peru and Chile from Pacasmayo to Tierra del Fuego.

Choromytilus palliopunctatus (Carpenter) Plate 12, figures 7, 7a

Mytilus palliopunctatus Dunker in Carpenter, 1855, *Cat. Mazatlan Shells*, *Brit. Mus.*, p. 118, No. 167 Mazatlan, Mexico.—Reeve, 1857, *Conch. Icon.*, vol. 10, *Mytilus*, pl. 19, fig. 5.

Mytilus (Chloromya) palliopunctatus (Dunker), Hertlein and Strong, 1946, *Zoologica*, vol. 31, No. 2, p. 70.

Choromytilus palliopunctatus (Carpenter), Soot-Ryen, 1955, *Allan Hancock Pacific Expeditions*, vol. 20, No. 1, pp. 31, 32, pl. 1, fig. 5; text-figs. 4, 13.

Shell long, swollen, rather straight, pointed, almost always rubbed at various angles, but when perfect exhibiting fine radiating stria and sometimes much stronger concentric lines of growth. Shell reddish purple in color, often white gray on the surface. Interior of a lustrous dark purple, white near the byssal gap and often finely punctate. The beak is terminal, with the anterior margin deeply impressed below to produce a folded hinge structure above it. The posterior adductor is relatively large, pipe-shaped, the retractor scar placed under the resilifer about half way towards the beak. No anterior adductor scar.

Range—Lower California to Panama. Mexico: Mazatlan; Acapulco. Nicaragua: Corintho (Hertlein and Strong).

Genus *Aulacomya* Mörch, 1853

Type species by subsequent designation, Von Ihering, 1900, *Mytilus magellanicus* Chemnitz, 1785 (= *Mytilus ater* Molina, 1782). Straits of Magellan and northward to middle Peru.

Shell large, mytiliform and often coarse, the surface marked with strong, radiating striae over most of its disk or confined to the umbonal slope. Beaks small and terminal. The hinge which is placed below and behind the beak is formed by a plate continued in from an obscure lunule and consists of a strong rib or fold in the right valve and a flattened furrow in the left valve. The resilifer is long, narrow, chalky, and compact or with an unpitted foundation. Anterior adductor scar eliminated in the adult. Cold waters of the Southern Hemisphere.

Aulacomya ater (Molina)

Plate 14, figure 9

Mytilus magellanicus Chemnitz, 1785, in Martini and Chemnitz, Neues Syst. Conchyl.-Cabinet, vol. 8, p. 162, t. 83, fig. 742.—Lamarck, 1819, Anim. s. Vert., vol. 6, pt. 1, p. 119.—Lamarck, Encyclop. Meth., pl. 217, fig. 2.—Dall, 1909, Proc. U. S. Nat. Museum, vol. 37, No. 1704, pp. 151, 258, pl. 25, fig. 4.

Mytilus decussatus Lamarck, 1819, Anim. s. Vert., vol. 6, pt. 1, p. 120.—Hidalgo, 1879, Moluscos del Viaje al Pacifico, p. 52, pl. 3, fig. 4.

Mytilus americanus d'Orbigny, 1846, Voy. Amér. Mérid., vol. 5, Mollusques, p. 648.

Mytilus ater Molina, 1782, Saggio sulla Storia Naturale del Chili, p. 202.

Aulacomya ater (Molina), Soot-Ryen, 1955, Allan Hancock Pacific Expeditions, vol. 20, No. 1, pp. 33, 34, pl. 1, fig. 6; text-figs. 17-18.

Along the Peruvian coast, this species has been reported as far north as Callao. It appears to be plentiful at Paracas and southward. Fresh shells have a dark-brown, polished periostracum which in old shells peels off, revealing a purplish-white surface streaked with radial lines of purple over the whole disk or confined to the umbonal slope; interior pearly white.

Range—Southern half of the South American continent on both coasts, and on the Pacific side as far north as Callao.

Genus *PERUMYTILUS* new genus

Type species *Modiola purpurata* Lamarck.

Shell of medium size, with obliquely elongated, convex valves, the beaks nearly terminal. Sculpture produced by relatively large, crude radial

ribs, usually corroded, producing rather coarse crenulation around the posterior margin, finer ones along the ventral margin and often becoming obsolete there. Surface color usually purplish over the posterior surface and white on the anterior-ventral side. Dorsal margin above the ligament not crenulated. The anterior margin below the beak is turned backwards along the hinge and terminates in a sharp stump as if cut off abruptly; it marks the forward end of the ligament. The rounded end of the anterior margin in front of the beak has several small teeth or crenulations. Posterior adductor scar rounded, joined with the narrow, linear retractor scar, together forming a pipe-shaped impression.

The type species has been referred to *Brachidontes* but it differs by important hinge characters as well as in other features.

Perumytilus purpuratus (Lamarck) Plate 12, figure 1; Plate 14, figures 1-1b

Modiola purpurata Lamarck, 1819, Anim. s. Vert., vol. 6, p. 113.

Mytilus ovalis Lamarck, 1819, *idem.*, p. 121.—Encyclop. Méth., pl. 219, figs. 3a, 3b.—d'Orbigny, 1846, Voy. Amér. Mérid., vol. 5, p. 648.

Modiolus purpuratus (Lamarck), Dall, 1910, Proc. U. S. Nat. Museum, vol. 37, No. 1704, pp. 153, 258.

Brachidontes purpuratus (Lamarck), Soot-Ryen, 1955, Allan Hancock Expeditions, vol. 20, No. 1, p. 45, pl. 4, fig. 18, text-fig. 30.

Shell small or of medium size (length up to about 40 mm.), elongately ovate, convex, narrowed and sometimes deeply compressed along the anterior-ventral side. The sculpture is formed by coarsely wrinkled radial riblets, rather large on the rounded posterior slope, finer on the ventral side. Color is a dark purple to nearly black over the posterior surface, often white on the anterior part. The umbonal slope is often worn nearly smooth by exposure to the heavy surf waves.

This is a common species of the cooler Peruvian coastal fauna from Callao southward; northward it seems to be much rarer as well as smaller in size. A few specimens were collected on the island of Lobos de Tierra and at Yasila near Paita. Dall has recorded the species from Estero Zarumilla on the Ecuadorian border near Capon but we have never seen specimens from so far north.

Range—Gulf of Guayaquil southward to Chile. Ecuador: Estero Zarumilla (Dall). Peru: Yasila near Paita; Lobos de Tierra; Callao and southward (common).

Genus BRACHIDONTES Swainson, 1840

Type species by monotypy, *Modiola sulcata* Lamarck, 1819 (Encyclop. Méth., pl. 220, figs. 2a, 2b).

Shell small or of medium size, mytiliform, with the small beaks not quite terminal and from which there extends posteriorly an umbonal inflation and along which lies the long axis of the shell. Posterior-dorsal or hinge margin straight or weakly curved, usually ending distally in a small angle, and more or less strongly crenulated along its whole length. Hinge margin on the short anterior side has two or more, small, dysodont teeth. Ligament subinternal, its *resilifer* forming a narrow scar about half the length of the posterior-dorsal margin. The adductor scars are distinct, the

anterior one small and rounded, the posterior longer, pipe-shaped connected with the retractor scar. The pallial line not enlarged. Surface with ribbed sculpture.

There is some question as to the identification of Lamarck's *M. sulcatus* and whether it represents an Atlantic or Indo-Pacific species. The above description is based largely on *M. citrinus* Roeding from Florida. (See Olsson and Harbison, 1953, Mon. No. 8, Acad. Nat. Sci. Philadelphia, pp. 61, 62.) *Brachidontes citrinus* (Roeding) (= *Arca modiolus* Linné, 1767), Plate 12, figure 3.

Genus **HORMOMYA** Mörch, 1853

Type species by subsequent designation, Jukes-Brown, 1905, *Mytilus exustus* Linné.

Shell small or medium-sized, mytiliform, with the small beaks near but not quite terminal, the valves vaulted, convex or angulated along the long, umbonal axis, often deeply impressed on the ventral side. Dorsal margin straight or slightly convex, curving into the posterior margin, the *ligament* and *its scar narrow and lying along nearly its whole length*. Posterior and ventral margins strongly crenulated by the external sculpture, the short, anterior margin with similar small crenulations and not the larger and stronger dysodont teeth. Anterior adductor scar relatively large, ovate, the pallial line distinct, the posterior adductor scar, large, pipe-shaped and often covering a large part of the inner posterior surface. External surface ribbed, sometimes much reduced or subobsolete over the impressed ventral portion.

Like *Brachidontes*, but differs by its longer ligament which extends along most of the dorsal margin; the dorsal margin not normally crenulated above the ligament; also by the larger posterior adductor scar.

Hormomya exustus (Linné)

Plate 12, figure 2

Genus **SCOLIMYTILUS**, new genus

Type species *Modiolus (Brachydontes) playasensis* Pilsbry and Olsson.

Shell small, mytiliform or modioliform, the beaks placed almost terminal, the valves elongated with the longer, oblique axis lying along the convex or sharply arched umbonal slope, the ventral side commonly flattened or deeply impressed. The surface sculpture is formed by radial riblets which may be weak or coarse. The posterior adductor scar is fused with that of the retractor and with a part of the pallial impression forming a single, large, lobate-shaped or ribbon-like band within the posterior margin. Ligament, as in *Hormomya*, is nearly as long as the posterior-dorsal margin. Hinge with one to three, fairly large, strong, dysodont teeth under the beak. The valve margin is crenulated throughout except for a short space along the impressed ventral side where the fluting of the riblets is weak or obsolete.

A group of small species combining some of the characters of *Brachydontes* and *Hormomya* but sufficiently distinct to warrant generic separation. Two subgenera may be recognized.

Key to subgenera *Scolimytilus*

- I. Umbonal slope convex or rounded, the surface ribbing rather fine and fairly uniform. Posterior adductor and pallial line impression, fused and lobate in shape.

Subgenus *Scolimytilus s.s.*

- II. Umbonal slope often strongly arched, the ribbed sculpture divided, coarse on the dorsal side. Adductor and pallial impression narrow and ribbon-like.

Subgenus *Aeidimytilus*

Scolimytilus (*Scolimytilus*) *playasensis* (Pilsbry and Olsson)

Plate 13, figures 2-2c

Modiolus (*Brachydontes*) *playasensis* Pilsbry and Olsson, 1935, *Nautilus*, vol. 49, No. 1, p. 17, pl. 1, fig. 4 Playas, Ecuador.

Shell with an average length of about 20 mm., medium-elongate, obliquely wedge-shaped, with nearly terminal beaks and a straight dorsal margin, forming with the posterior margin a corner angle of about 120 degrees. The ventral side is flattened or impressed, rounding above into a fairly pronounced umbonal slope, highest in the middle zone and from there sloping downward to form a rounded posterior end. Ligamental scar linear, narrow, straight, as long as the dorsal margin, the small beak at its anterior end, with one or more medium-sized teeth below it and a few small crenulations on the anterior margin which project a little beyond it. Sculpture is produced by low, smoothish, radial riblets of nearly uniform strength over the whole surface except along the middle part of the umbonal slope which may be smooth. Inner margins of valves crenulate conforming to the outside ribbed sculpture. Periostracum of a rich brown color, glossy and where peeled off, the color underneath is a purple-brown. Interior of shell of a pale brown, the pallial and muscle impressions distinct, and generally as figured.

The type measures: length 20.7 mm., height 9 mm., diameter 8.7 mm., ANSP 164617.

This is a local species, probably restricted to the inner shores of the Gulf of Guayaquil. From other species of the genus, it will be separated by the rich brown color of its glossy periostracum, its lower riblets, nearly uniformly developed over the whole disk, and by its wider, wedge shape, its ventral margin straight or but little impressed. Pallial and adductor impressions are generally well marked.

Range—Shores of the Gulf of Guayaquil, Ecuador and Peru. Ecuador: Playas; Posorja.

Scolimytilus (*Scolimytilus*) *esmeraldensis*, new species Plate 13, figures 1-1b

Shell of medium size (length from 14 to 17 mm.), elongate, mytiliform, the beaks anterior and placed nearly at the end, the anterior end itself being short, narrowed, and pinched. The dorsal or ligamental margin is long, usually a little bowed in the middle, the scar of the ligament below it white, enameled and extending nearly its whole length. Beyond the dorsal or ligamental margin, the posterior side descends obliquely and is broad, appearing as if narrowly rounded or subtruncated at the end. The ventral side is usually flattened or impressed in the middle, sometimes strongly

so. In fresh shells, the periostracum is thin, vernicose and dark olive-brown to nearly black in color with some lighter streaks showing through. Beneath the periostracum, the color of the shell is variable, in some specimens, it is white or grayish white; others are grayish purple flecked and rayed with lighter patches. Sculpture consists of numerous, small, radial riblets, developed uniformly over the surface except in the middle ventral zone which is smoothish. Inner margin of the valves crenulated all around except for a small space along the ventral side which is smooth; the ligamental margin is always strongly crenulated. Extreme anterior or lunular side has a few, small, strong riblets forming crenulations at the margin. Impression of the adductor and retractor muscles as described for the genus.

Length 14.1 mm.; height 9.6 mm.; diameter 5.6 mm. Esmeraldas, Ecuador. Holotype ANSP 218929.

Length 17 mm.; height 11 mm.; diameter 7.4 mm. Esmeraldas, Ecuador. Paratype ANSP 218930.

Range—Ecuador. Ecuador: Esmeraldas.

Scolimytilus (Scolimytilus) aequatorialis, new species Plate 12, figures 9-9b

The shell is small (length about 10 mm.), obliquely elongated, with anterior, almost terminal beaks. The posterior-umbonal axis is slightly curved, convex and high along the middle zone; the ventral side is flattened or moderately impressed, the shape of the shell therefore somewhat arcuate. Hinge line straight and about half the length of the shell, the ligament nearly as long; beyond the end of the ligament or its scar, the posterior margin turns downward at an angle of 150 degrees, continues straight for a distance and then curves evenly forming a rounded end, or it may bend more sharply so that the end of the shell appears truncated. The periostracum is thin, vernicose, and imparts to the surface a glossy, varnished appearance. External color of the shell is two-toned, dark purplish-brown to nearly black on the dorsal side of the umbonal ridge and a lighter olive-yellow on the ventral side, these two zones of color showing through into the interior. Beneath the periostracum, the sculpture is plain or smooth except for some weak riblets generally present on the posterior-dorsal surface. The inner margins of the valve is smooth except for crenulations present above the ligament. Hinge teeth small, confined to the space below the beaks supplemented by weak crenulations along the short, anterior margin. Posterior adductor scar of medium size, pipe-shaped.

Length 10.1 mm.; height 6.8 mm.; diameter 6 mm. Punta Centinella, Santa Elena Peninsula, Ecuador.

Holotype, ANSP 21927; paratype, ANSP 21928.

Range—Coast of Ecuador and northwestern Peru. Ecuador: Punta Centinella, Santa Elena, on rocks at medium tide level. Peru: Paita.

Subgenus **AEIDIMYTILUS**, new subgenus

Type species *Mytilus adamsiana* Dunker.

Shell small, mytiliform with ribbed sculpture, usually divided, the ribs on the posterior-dorsal side of the umbonal ridge much coarser. Ventral side usually strongly impressed resulting in a high, angular umbonal ridge and often a distorted appearance to the whole shell. Adductor and pallial impressions united, but smaller and narrower than in *Scolimytilus*.

Scolimyltilus (Aeidimyltilus) adamsianus (Dunker)Plate 12, figure 5;
Plate 13, figures 4, 4a, 6*Mytilus adamsiana* Dunker, 1856, Proc. Zool. Soc. London, vol. 24, p. 360. (issued May, 8, 1857). Panama.—Reeve, 1858, Conch. Icon, vol. 10, *Mytilus*, pl. XI, fig. 55.*Brachidontes (Hormomya) adamsianus* (Dunker), Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 2, pp. 70, 71.*Hormomya adamsiana* (Dunker), Soot-Ryen, 1955, Allan Hancock Pacific Expeditions, vol. 20, No. 1, pp. 37-40, pl. 3, fig. 11, text-figs. 22, 25, 31.

The shell is small (length to about 16.5 mm.), generally narrow and elongate, the umbonal ridge high, angled and vaulted, the ventral side flattened or impressed. The beaks are small and nearly terminal in position. The dorsal side of the umbonal ridge is coarsely sculptured with large radial ribs, few in number near the beak but increase by forking or addition distally and on the successive growth disks, each set off by a shelf or a deep resting mark; ribs on the ventral side much smaller. Color of surface is some shade of purple on the dorsal side and white on the ventral side. Dorsal or hinge margin crenulated above the scar of the ligament.

Length 15.6 mm.; height 9.3 mm.; diameter 6.6 mm.

Punta Banda, Lower California, Mexico. Mr. T. Burch.

Length 15.2 mm.; height 8 mm.; diameter 8 mm.

Jipijapa (Puerto Callo), Ecuador.

Range— Lower California to Ecuador. Panama: Panama (Dunker). Ecuador: Santa Elena; Puerto Callo (this is the port of Jipijapa, the Xipijapa of Cuming).

Scolimyltilus (Aeidimyltilus) puntarenensis (Pilsbry and Lowe)

Plate 13, figures 5, 5a

Mytilus (Hormomya) puntarenensis Pilsbry and Lowe, 1932, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, p. 104, pl. 10, fig. 6 Puntarenas, Costa Rica (Lowe).*Brachidontes puntarenensis* (Pilsbry and Lowe), Soot-Ryen, 1955, Allan Hancock Pacific Expeditions, vol. 20, No. 1, pp. 46, 47, pl. 3, fig. 14; text-fig. 29.

Shell small (length from 10 to about 18 mm.), generally broadly modioliform, high or wide posteriorly, narrower anteriorly, the small beaks much pinched and placed at the extreme end, and when perfect, the umbonal region bearing several nepionic caps, of which the first is extremely small and smooth, the others with ribbed sculpture. The ventral side is flattened to deeply impressed, the umbonal slope running prominently from the beaks to the posterior-ventral corner and rises as a high, rounded or subangulate ridge; some specimens are almost as long as high. The sculpture is costate, formed by small, radial riblets divided generally into two sets by the umbonal ridge, those on the dorsal side being larger, neatly granulated and quite uniform, the others below the umbonal ridge much finer and smoother. Anterior margin below the beak has a large external rib or ridge which passes into the hinge and forms there a large, knoblike tooth. External color a uniform dark-brown or deep purple, heaviest over the posterior-dorsal slope grading into a lighter shade or white on the ventral side.

Length 17 mm.; height 8 mm.; diameter 8.7 mm. (Type, Puntarenas, Costa Rica, ANSP 155629). Length 11.7 mm.; height 9 mm.; diameter 8 mm. Punta Carnero, Santa Elena, Ecuador.

Specimens from Ecuador agree well with the figure of *S. puntarenensis* given by Soot-Ryen, based on a paratype in the San Diego Museum (Chace Coll.). My shells show much variation in shape and in coarseness of sculpture and in some cases approach *S. adamsianus* quite closely. *S. houstonius* Bartsch and Rehder, 1939 from Galapagos Islands is also similar.

Range—Costa Rica to Ecuador and northern Peru. Ecuador: Jipijapa (Puerto Callo). Peru: Yasila, Paita.

Scolimyltilus (*Aeldmlytilus*) *multiformis* (Carpenter)

Plate 17, figure 11

Mytilus multiformis Carpenter, 1855, Cat. Mazatlan Shells, Brit. Mus., pp. 118-120, No. 168 Mazatlan.—Hertlein and Strong, 1946, *Zoologica*, vol. 31, pt. 2, p. 70 discussion with *adamsianus*.

Brachidontes multiformis (Carpenter), Soot-Ryen, 1955, Allan Hancock Pacific Expeditions, pp. 44, 45, pl. 3, fig. 13; text-fig. 28.

Because *S. multiformis* was not figured by Carpenter, its identification is not entirely certain. In his remarks on the species, Carpenter emphasized the extreme variability of the shell both in shape and sculpture. His unpublished manuscript drawings at the U. S. National Museum comprise about 11 sketches, all of which are based on small or immature specimens. These drawings show a small, short, fan-shaped shell with a large, smooth, nepionic area followed by two or more sculptured areas setoff sharply from each other and the nepionic disk by resting lines; the umbonal ridge is low, rounded, not angular, and the ventral side is not noticeably impressed; the scar of the ligament is only about half the length of the dorsal margin which is strongly crenulated. The largest specimen measured by Carpenter has a length of .45 inches or 11.4 mm.; this is probably the specimen numbered 551 and is here selected as the lectotype; a new figure based on Carpenter's drawing is here given.

A few of the Ecuadorian shells are tentatively identified with Carpenter's species but they differ by the smaller nepionic area, which in some cases can be seen only on high magnification. General color black or dark-brown, not green.

Range—Lower California to northern Peru. Mexico: Mazatlan (Carpenter). Ecuador: Punta Callo; Santa Elena. Peru: Yasila.

Genus *SEPTIFER* Recluz, 1848

Type species by subsequent designation, Stoliczka, 1871, *S. bilocularis* Linné.

Shell generally short, modioliform, with a high umbonal angle, the external surface sculptured with small radial riblets, often with bristles. Hinge and posterior margins strongly crenulated, the short anterior side with small dysodont teeth as in *Brachidontes* and with a small deck or platform placed like a shelf in the umbonal cavity below the beaks.

Septifer zeteki Hertlein and Strong

Plate 13, figures 7, 7a

Septifer cumingii Recluz. As cited by authors from West America localities but not the true *S. cumingii* described from the island of Annaa.

Septifer zeteki Hertlein and Strong, 1946, *Zoologica*, vol. 31, pt. 2, No. 5, p. 71, pl. 1, figs. 1, 2. (Holotype from Taboga Island, Panama).

Shells quite small, modioliform, widely expanded on the posterior side, impressed along the ventral side and narrowed anteriorly, the valves therefore having an oblique trigonal form. Sculpture is formed by small radial ribs which may branch at the ends, finely noded by concentrics, much finer on the ventral slope. Color green, mottled with brown, the umbonal angle carrying a row of large bristles. Margins continuously crenulate all around, the beak with a small septum or decklike floor in the tip of the umbonal cavity.

Length 6.8 mm., greatest height 4.1 mm., diameter 3.5 mm. (Hertlein and Strong).

Range—Gulf of California to Peru and the Galapagos Islands. Ecuador: Puerto Callo. Santa Elena. Panama: Taboga Island. (Hertlein and Strong). Lagartillo. Peru: Bayovar, Sechura Bay.

Genus **MYTELLA** Soot-Ryen, 1955

Type species by original designation, *Modiola guyanensis* Lamarck.

Shell elongate, modioliform, often thin, the beaks and umbones placed near the anterior end. Posterior-dorsal margin straight, curved, or angulated at the end, the ligament and its scar nearly as long. Resilifer long and narrow, white, with a narrow pitted foundation. Anterior end relatively short, its margin smooth. Anterior adductor scar distinct, small and of an oblong, irregular outline, the posterior adductor confluent with the retractor and forming a club or pipe-shaped impression. Valves convex or vaulted along the umbonal slope, the dorsal-posterior side usually of a darker color, often with a greenish shade. Periostracum thin, the umbones of the shell commonly corroded.

Three species.

- I. Shell broadly wedge-shaped, the ventral side often deeply impressed. Ratio of length to height, about 7 to 4.

M. guyanensis

- II. Shell longer, often razor-shaped and very thin.

1. Shell exceedingly long, *Solen*-like and very thin. Length to height about 4 to 1.

M. speciosa

2. Shell shorter, the length to height about 2.4 to 1.

M. tumbezensis

Mytella guyanensis (Lamarck)

Plate 12, figures 8, 8a

Modiola guyanensis Lamarck, 1819, *Anim. s. Vert.*, vol. 6, p. 112.—Delessert, 1841, *Rec. Coq. décrites par Lamarck*, pl. 13, fig. 9.

Modiolus guyanensis (Lamarck), Maxwell Smith, 1944, *Panamic Marine Shells*, p. 53, fig. 692H.

Modiola brasiliensis Reeve, 1857, *Conch. Icon.*, vol. 10, *Modiola*, pl. 4, fig. 17 Guayaquil; pl. 6, fig. 31 Brazil.

Volsella (Volsella) guyanensis (Lamarck), Hertlein and Strong 1946, *Zoologica*, vol. 31, pt. 2, pp. 72, 73.

Mytella guyanensis (Lamarck), Soot-Ryen, 1955, Allan Hancock Pacific Expeditions, vol. 20, No. 1, pp. 53-55, pl. 5, figs. 22, 23; text-figs. 36, 41-44.

The shell is oblong, obliquely wedge-shaped, relatively thin, the hinge margin is straight, more than half the total length, the basal margin descends straight or is deeply impressed. The sculpture is produced by well-developed, raised, regular concentrics along the posterior slope and finer, smoother growth lines on the ventral side. The periostracum is thin, its coloration divided into two contrasting zones; on the posterior portion, the color is a dull or satiny greenish black, generally with a fine pattern of zigzagged or divaricating lines of green showing through; on the ventral slope the color is typically a glossy brown. There is often a ray of brown along the lower side of the umbonal slope which because of its dull luster contrasts sharply with the polished brown surface behind it. The umbones are usually eroded.

Length 70 mm.; height 44 mm.; diameter 32.8 mm.

Guayaquil, Ecuador, market.

Shells from Ecuador and northern Peru have the ventral side flattened or deeply impressed and the umbones are so badly eroded as to expose the pearly inner layer over a wide area; the habitat of this mussel is along the mud flats in front of mangrove swamps or in the adjacent estuaries and esteros. In Ecuador, this mussel is highly esteemed as food and appears in the markets and is served regularly in hotels and restaurants.

Range—Lower California to northern Peru; also along the Caribbean coasts of Venezuela southward to Brazil. Panama: Pearl Islands; Garachine. Canal Zone: Venado Beach. Ecuador: Esmeraldas; Cojimenes; Guayaquil. Peru: Tumbes.

Mytella speciosa (Reeve)

Plate 14, figure 6

Modiola speciosa Dunker in Reeve, 1857, *Conch. Icon.*, vol. 10, *Modiola*, pl. 7, fig. 35
Tumbes.

Modiolus speciosus (Dunker), Maxwell Smith, 1944, *Panamic Marine Shells*, p. 53,
fig. 698.

Volsella (Amygdalum) speciosa (Dunker), Hertlein and Strong, 1946, *Zoologica*, vol. 31, pt. 2, p. 73.

Shell elongate and slender, very thin, smooth, the dorsal and ventral margins straight, not quite parallel but diverging at an angle of about 9 degrees. Beaks very small, not quite terminal, the widely rounded anterior end extending beyond them shortly. Posterior margin oblique, sloping downward, its dorsal junction widely rounded, more narrowly rounded or attenuate at the ventral end. Periostracum is very thin, overlying a dull-white surface. The posterior slope is generally colored in various shades of green or green-brown, often concentrically banded or minutely flecked with brown, the long, ventral slope is brown. Interior nacreous, iridescent.

Remarkable for its slender, thin shell and beautiful coloration. Generally rare. Very young shells (length 36 mm.) have the same shape as the adult. Large specimens may attain a length of over 100 mm.

Range—Lower California to northern Peru. Mexico: Magdalena Bay,

Lower California (Hertlein and Strong). Nicaragua: Bay of Fonseca. Ecuador: Canoa; Atacames; Santa Elena. Peru: Tumbes; Zorritos; Punta Picos; Negritos.

Mytella tumbezensis (Pilsbry and Olsson)

Plate 14, figure 7

Modiolus (Modiolus) tumbezensis Pilsbry and Olsson, 1935, *Nautilus*, vol. 49, No. 1, pp. 16, 17, pl. 1, fig. 5.

Mytella speciosa Soot-Ryen, 1955, *Allan Hancock Pacific Expeditions*, vol. 20, No. 1, pp. 52, 53, pl. 5, fig. 25; text-fig. 37 (not of Reeve, 1857).

Shell about 40 to 45 mm. long, thin and much compressed. The beaks are small. In a specimen 43 mm. long, the beak is about 6 mm. from the end which is obliquely rounded. The posterior side is somewhat expanded, its margin straight, rounded into the dorsal and ventral ones. The surface is marked with small, regularly incised growth lines on the ventral slope, much smoother on the posterior-dorsal side. Color of the shell is brown or tan on the anterior-ventral side becoming green or olive minutely flecked with chocolate on the posterior side.

Length 41 to 44.5 mm.; height 18.5 to 21.5 mm.; diameter of a single valve 4.25 to 4.5 mm. Tumbes, Peru.

This is a small, thin, delicate species common along the tidal mud flats of the river Tumbes in northern Peru. It is distinguished from *M. speciosa* by its shorter and smaller shell.

Range—Lower California to northern Peru. Mexico: Bahía de Magdalena (Soot-Ryen). Peru: Tumbes.

Genus *MODIOLUS* Lamarck, 1799

Nomen conservandum, Opinion 325, International Com. Zool. Nomen.

Type species by monotypy, *Mytilus modiolus* Linné. Recent, North Atlantic.

The name "*Volsella*" Scopoli, 1777, which has been in general use in late years for this genus, has been suspended by a ruling of the International Commission of Zoological Nomenclature (Opinion 325, dated Jan. 7th, 1955).

Shell variable in size, ovate, oblong or obliquely elongated, the small beaks adjacent and almost terminal, convex, the surface covered by a thin or heavy, green, brown to nearly black periostracum, smooth or coarsely pilose and often peeling off from dead shells. Surface under the periostracum usually smooth except for growth lines. Dorsal margin curved, the hinge edentulous except for a small projection near the anterior end of ligament. Ligament subinternal, attached to a rather long, broad, curved, inset resilifer. Interior of valves white to purple, the ventral margin with a small byssal gap. Some species build a nest of pebbles and fragments of shell held together by the threads of the byssus.

Key to Panamic *Modiolus*

- I. Surface of shell is covered with a coarse, peeling periostracum, dark-brown in color and carrying over its posterior portion a dense growth of coarse bristles, the individual bristles being compound or serrated

along their sides. Axis of shell is oblique, hatchet-shaped, its ventral margin deeply impressed. Color beneath the periostracum is pink or rose-red.

M. capax

II. Periostracum smooth or if provided with bristles, these are more sparingly developed; the individual bristles simple, flattened but not serrated along their sides. Axis of shell not so strongly inclined.

a. Dorsal and ventral margins are nearly straight and parallel, the posterior end attenuated and narrowly rounded. Color on the posterior slope is a reddish purple, the anterior-ventral slope white.

M. eiseni

b. Shell obliquely ovate to subtriangular, the anterior side short and quite high, rounded. Color brown with a lighter ray across the middle. Periostracum thin, like patches of flattened seaweed.

M. pseudotulipus

c. Shell larger, narrower and more elongated. Color dark-brown or black, the surface beneath white. Periostracum smooth. Anterior end short and narrowly rounded.

M. pacificus

Modiolus capax (Conrad)

Plate 14, figures 4, 4a

Modiola capax Conrad, 1837, Jour. Acad. Nat. Sci. Philadelphia, vol. 7, p. 242 San Diego, California.—Reeve, 1857, Conch. Icon., vol. 10, *Modiola*, pl. 3, fig. 11.

Volsella (Volsella) capax (Conrad), Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 2, p. 72.

Modiolus capax Conrad, Soot-Ryen, 1955, Allan Hancock Pacific Expeditions, vol. 20, No. 1, pp. 60-62, pl. 6, fig. 30; text-figs. 50, 53a-b, 54, 55.

Shell of medium or large size (height 85 mm.), heavy, generally oblique, hatchet-shaped, the height often exceeding the length. Dorsal margin straight, merging smoothly into the posterior margin, the two set at angles of 90 to 120 degrees, the posterior-ventral margin rounded to subtruncated. Anterior-ventral side is usually deeply impressed, more markedly so in southern shells. Fresh specimens have a chestnut-colored periostracum, the posterior portion of which is densely covered with long serrated hairs. Dead shells from which the periostracum has exfoliated, are usually colored a bright rose-red over the posterior surface, white on the impressed ventral side. The resilifer is a wide, deeply excavated pit bordered on the lower side by a strong ridge.

This is a widely distributed species easily distinguished by its high, arcuate form, and coarsely pilose periostracum overlying a red or pink-colored shell. Dead shells have usually lost most of the periostracum, or it is retained only over the posterior portion.

Range—California southward to Peru and the Galapagos Islands. Panama: Búcaro; Tobago. Canal Zone: Venado Beach. Ecuador: Sua; Manta; Manglaralto; Isla la Plata; Santa Elena. Peru: Tumbes; Paita; Yasila; Sechura Bay.

Modiolus eiseni Strong and Hertlein

Plate 14, figures 5, 5a

Modiolus eiseni Strong and Hertlein, 1937, Proc. California Acad. Sci., ser. 4, vol. 22, p. 160, pl. 34, figs. 11, 14-16 off Mazatlan, Mexico.—Hertlein and Strong, 1955,

Bull. Amer. Mus. Nat. Hist., vol. 107, art. 2, pp 178, 179, pl. 2, figs. 9, 11.—Soot-Ryen, 1955, Allan Hancock Pacific Expeditions, vol. 20, No. 1, p. 64, pl. 6, fig. 29.

Shell of medium size (length about 50 mm.), relatively thin, elongate. Dorsal and ventral sides straight and subparallel, the posterior side long, inclined towards the base about 30 degrees, forming a produced and narrowly rounded end. The anterior side extends a short way beyond the tip of the beak and is obtusely pointed at the tip. A narrowly rounded umbonal slope begins at the beak and extends obliquely backwards to the posterior end, the surface in front and below it a little depressed. Surface smooth except for fine growth lines. Color is pearly white on the anterior one-half and a violet-pink on the posterior side, the division line between the two areas of color lying just below the umbonal angle. Interior pearly white with the darker color of the posterior surface showing through slightly.

Length 50.5 mm., height 19.5 mm., semidiameter 9.3 mm.
Manta, Ecuador.

This is a rare species. No trace of a periostracum is shown on any of our specimens.

Range—Gulf of California to Ecuador. Mexico: Off Mazatlan (Hertlein and Strong). Ecuador: Off Cabo Pasados (Hertlein and Strong); Manta.

***Modiolus pseudotulipus*, new species**

Plate 14, figures 2, 2a

Modiolus americanus Soot-Ryen, 1955, Allan Hancock Pacific Expeditions, pp. 67, 68, pl. 6, figs. 27, 28; text-figs. 56. (Not of Leach, 1815—*Modiola tulipa* Lamarck, 1819.)

Shell oblong, of medium-weight, the umbonal slope full and convex, extending obliquely along the longer axis of the valves from the beaks to the rounded posterior end, the posterior-dorsal and ventral slopes slightly impressed. Anterior side extends a short way in front of the beaks, rather widely rounded at the end. The posterior-dorsal and hinge margins are of nearly equal length, both are straight and set at an angle of about 120 degrees to each other. General surface color is a rich brown, deepest on the anterior-ventral surface and on the posterior-dorsal slope with a zone of lighter color extending from the beaks to the middle of the ventral margin. Interior a pearly white tinged with vinaceous.

Length 64.5 mm.; height 38 mm.; diameter of one valve 13.6 mm.
Punta Blanca, Ecuador. Holotype ANSP 218956.

This species resembles the Atlantic Coast *M. americanus* (Leach), but the posterior side is longer, narrower, the color banding not so sharply defined. From *M. pacificus*, the species differs at all growth stages by its shorter and higher shell and by its more widely rounded anterior end.

Range—Gulf of California southward to Peru. Mexico: Magdalena Bay, Lower California, Mazatlan. Ecuador: Isla la Plata. Punta Blanca. Peru: Negritos; Paita; Yasila.

***Modiolus pacificus*, new species**

Plate 14, figures 3, 3a

Shell rather large, elongate modioliform, covered with a black brown periostracum which worn off in patches reveals a nearly white shell un-

derneath. Umbones low with the small, adjacent beaks placed a short distance behind the anterior end. Anterior side is short, not auriculate, its margins thickened. Dorsal margin carrying the ligament scar is straight, the more posterior portion of the dorsal margin longer, descending at an angle of about 30 degrees. Umbonal slope well rounded, its axis straight and nearly as long as the length of the shell itself, the posterior end narrowly rounded. There is a slight inflexion from the beak to the ventral margin. Interior of valves nacreous and of a dull lead-white color.

Length 93 mm., height 53 mm., semidiameter 15 mm. (a right valve).

Resembles *Modiolus rectus* (Conrad) of the California Coast but has a straighter shell and a shorter, nonauriculate anterior side.

Range—Northern Peru. Peru: Salinas on the Bay of Sechura to the northeast of Bayovar. Païta.

Genus **MUSCULUS** Roeding, 1798

(*Modiolaria* Beck, 1838; *Lanistes* (Humph.), Swainson, 1840).

Type species by subsequent designation, Iredale, 1915, *Mytilus discors* Linné.

Musculus Roeding has been considered preoccupied by *Musculus* Martyn, 1787 but Martyn's names are unavailable.

Shells comparatively small, rhomboidal, modioliform, inflated, moderately thin and with a pearly interior. Umbones prominent with the small beaks not quite terminal. Sculpture of surface divided into three areas, the anterior and posterior portions are marked with small radial threadlets, the middle zone smooth. Ligament subinternal and attached to a narrow, inset area under the hinge margin. Hinge edentulous.

Subgenus **GREGARIELLA** Monterosato, 1884

(*Botulina* Dall, 1889; *Trichomusculus* Iredale, 1924; *Tibialectus* Iredale, 1939).

Type species by subsequent designation, Crosse, 1885, *Modiolus sulcatus* Risso, 1826 (not of Lamarck, 1805, 1819) = *Modiolus barbatellus* Cautainne, 1835 = *Modiolus opifex* Say, 1825.

Shell modioliform, straight, convex, the beaks almost terminal, the anterior margin below not passing beyond them or but slightly. Posterior side long, often somewhat attenuated at the end, the umbonal slope narrowly vaulted to subangulated, with the radial riblets divaricating along it. Surface marked with fine, radial riblets (decussated on the dorsal side) over the whole posterior and mid-posterior slopes, also the anterior slope but with the anterior-middle-ventral zone smooth; the whole covered by a brown, skinlike periostracum, bearing a mat of hairs mixed with grains of sand along the posterior-umbonal slope, often terminating in a tuft at the end. Inner margins of valves finely crenulated by the ends of the radial riblets, except along the anterior-middle portion. Resilifer narrow and linear, a trifle less than half the length of the dorsal margin and at the forward end passing between the reflexed end of the anterior margin and the beaks.

Anterior reflex margin ends rather sharply a short distance behind the beaks, usually with a few small dysodont teeth along it and which grade into the normal crenulations forward. Anterior adductor scar large, ovate, the posterior indistinct in my specimens. Borers.

Musculus (Gregariella) coarctatus (Carpenter) Plate 16, figures 4-4d

Crenella coarctata Dunker, Carpenter, 1855, Cat. Mazatlan Shells, Brit. Mus. p. 123, No. 172.

Lithodomus coarctata Dunker, Reeve, 1857, Conch. Icon., vol. 10, *Lithodomus*, pl. 3, fig. 14.

Lithophaga coarctata Dunker, 1883, Conch. Cab., 2d ed., pp. 28, 29, pl. 5, figs. 2, 3.

Modiolaria (Gregariella) coarctata (Dunker), Lamy, 1937, Jour. de Conchyl., vol. 81, p. 42.

Gregariella coarctata (Carpenter), Soot-Ryen, 1955, Allan Hancock Pacific Expeditions, vol. 20, No. 1, pp. 77, 78, pl. 9, fig. 48; text-fig. 64.

Average size about 27 mm., elongately modioliform, with a wide umbone weakly sulcated across the middle. The small coiled beak is placed near the anterior end, the posterior end of the valve narrowly rounded to pointed, tufted with periostracal hairs and flexed slightly towards the right. Periostracum thin, brown over a thin pearly layer. Surface sculpture is formed by fine threadlets radiating from the beak and divaricated along the keeled umbonal slope, except on the anterior-middle zone which is smooth. Inner margins of the valve minutely crenulate except in the mid-zone. Hairs of the periostracum rather sparse and confined to the umbonal keel, forming a tuft at the end.

Length 28 mm.; height 11 mm.; diameter 10.8 mm.

Manta, Ecuador.

This is a true rock borer forming smooth-walled, bullet-like holes. It is fairly common at Manta associated with *Lithophagas*. Resembles *M. coralliophaga* Gmelin of the West Indies but is more slender and less pointed at the posterior end.

Range—Lower California to Ecuador. Panama: Taboga Island (Soot-Ryen). Ecuador: Manta.

Musculus (Gregariella) chenui (Recluz)

Mytilus chenui Recluz, 1842, Revue Zool., vol. 5, p. 306.

Gregariella opifex Dall, 1921, Bull. 112, U. S. Nat. Museum, p. 22. (Probably not of Say, 1825 *fid* Soot-Ryen).

Gregariella chenui (Recluz), Soot-Ryen, 1955, Allan Hancock Pacific Expeditions, vol. 20, No. 1, p. 78, pl. 8, fig. 40; text-fig. 65.

This is typically an East American species but has been recorded from the Pacific Coast by Dall and Soot-Ryen. I have seen no specimens from the Panamic zone. According to Soot-Ryen, the Hancock collections contain many samples of dead specimens taken in depth ranging from 16 to 50 fathoms.

Range—Southern California to the Bahia de la Independencia, Peru. (Soot-Ryen).

Genus CRENELLA Brown, 1827

Type species by monotypy, *Mytilus decussatus* Montagu. Recent, North Atlantic.

Shell small, often minute, obliquely ovate, convex, with small, incurved, prosogyrate beaks. Prodissoconch often well preserved, smooth. Interior pearly, the outer surface covered when fresh by a thin, closely adhering periostracum. Hinge mytiloid, with small toothlike knobs on the anterior margin bordered on the posterior side by a deep, furrow-like pit for the attachment of the ligament which is wholly internal. Surface sculpture composed of fine radials crossed and decussated by concentrics, often divaricated along the middle line of the umbonal slope. Inner margin finely crenulated by the ends of the external riblets all around, sometimes extending into the hinge itself to produce a pseudotaxodont pattern there.

Three species appear regional.

Key to species of Panamic-Peruvian species of *Crenella*

I. Shell large, height 25 mm.

Crenella megas. Panama Bay in 33 fathoms.

II. Shell small, minute, height not over 4 mm.

1. Valves nearly oval in shape, the dorsal and ventral sides nearly alike.

Crenella ecuadoriana

2. Shell subcircular to rhombic, the dorsal and ventral sides unlike. Posterior-dorsal margin straight.

Crenella caudiva, new species.

Crenella ecuadoriana Pilsbry and Olsson

Plate 17, figures 7, 7a

Crenella ecuadoriana Pilsbry and Olsson, 1941, Proc. Acad. Nat. Sci. Philadelphia, vol. 93, pp. 55, 56, pl. 13, figs. 2, 3.

Crenella divaricata d'Orbigny, Hertlein and Strong, 1946, Zoologica, vol. 31, pl. 2, No. 5, pp. 75, 76, pl. 1, figs. 12, 13 (in whole or part).

Shell small, the average length about 3.25 mm., plump, elongately oval, nearly symmetrical, a line through the middle of the umbonal slope divides the surface into nearly equal halves. Surface sculpture consists of small, weakly decussated riblets which increase along the umbonal slope and near the ventral margin by occasionally forking and by the addition of intercalaries between their branches. In addition, the sculpture is divided into three contrasting areas by straight lines extending from the beaks to the margins and against which the small, simple (not forking) riblets abut sharply.

This small species is locally plentiful in beach drift at Santa Elena. As fossil, it occurs in the Pliocene of Panama and Ecuador. Some authors have considered this small *Crenella* as the same as *C. divaricata* d'Orbigny described from Cuba. The Caribbean-West Indian *Crenellas* have not been thoroughly worked over but a comparison of *C. ecuadoriana* with the specimens from Bocas del Toro, Panama, show that the Caribbean shell is thinner, less symmetrical in shape, usually with a larger, more conspicuous prodissoconch and with weaker sculpture.

Range—Lower California to northern Peru.

Crenella caudiva, new species

Plate 17, figure 2

The shell is small, moderately convex but not plump, unsymmetrical, the shape is irregularly subrhomboidal, the posterior side higher than the

anterior, hence, the dorsal and ventral margins appear to slant in towards each other anteriorly. Beaks almost terminal, and from which the umbonal axial slope extends full and convex to the posterior-ventral corner of the valves. The posterior-dorsal margin is long and straight, the posterior margin widely rounded, the ventral margin narrow and nearly straight. Surface sculpture consists of small riblets separated by narrow, cancellate interspaces, the riblets divaricating along the umbonal axis, simple on the anterior-umbonal slope; there is in addition a line of demarcation separating the central zone of sculpture from that on the anterior-ventral side and another line of separation from the posterior-dorsal zone.

Length 2.2 mm., height 2.3 mm.

Distinguished easily from *C. ecuadoriana* by its unsymmetrical valves and subrhombic shape.

Range—Ecuador. Ecuador: Santa Elena.

Genus *BOTULA* Mörch, 1853

Type species by subsequent designation, Dall, Bartsch and Rehder, 1938. *Mytilus fuscus* Gmelin. Caribbean.

The shell is small or of medium size, oblong, subrhomboidal, arcuate, modioliform, convex, the surface covered by a glossy brown periostracum. The umbones are prominent and full, ending in small, coiled beaks removed slightly from the anterior margin and projecting beyond them. Surface sculpture is formed principally by weak concentric growth lines or their derivatives, interrupted by deeper resting marks, and occasionally by a few obscure radials over the middle ventral zone. Hinge line straight, edentulous, the resilifer internal and showing as a long scar nearly the length of the hinge line. Interior bluish nacreous. Adductor scars subequal in size, rounded or gourd-shaped, placed low within the shell and near the margins.

Botula fusca (Gmelin)

Plate 16, figures 5-5c

Mytilus fuscus Gmelin, 1791, Systema Naturae, ed. 12, p. 3359.

Lithophagus cinnamomeus (Chemnitz), Carpenter, 1857, Cat. Mazatlan Shells, Brit. Mus., p. 129 Mazatlan, Mexico. Not of Lamarck, 1819.

Botula cinnamomeus (Chemnitz), Strong and Hanna, 1930, Proc. California Acad. Sciences, ser. 4, vol. 19, No. 3, p. 15 Tres Marias Islands, Mexico.

Lithophaga (Botula) fusca (Gmelin), McLean, 1951, Scien. Survey of Porto Rica and the Virgin Islands, New York Acad. Sciences, vol. 17, pt. 1, p. 43, pl. 8, fig. 3.

Botula fusca (Gmelin), Soot-Ryen, 1955, Allan Hancock Pacific Expeditions, vol. 20, No. 1, p. 86, pl. 9, fig. 52; text-figs. 70-72.

Shell as described for the genus. A single specimen was obtained at Manta where it was found in a rock burrow and like *Musculus coarctata*, is possibly a true rock borer. The two species live in the same environment. My specimen agrees well with typical *B. fusca* from the Caribbean. It agrees also with the figure of *B. hawaiiensis* Dall, Bartsch, and Rehder as illustrated in their Hawaiian paper. The color of the surface is a dark brown to nearly black.

Length 22.5 mm.; height 10.5 mm.; diameter 9.6 mm.

Manta, Ecuador.

Range—Mostly West Indies and the Caribbean; on the Pacific Coast from Mexico to Ecuador (rare). Ecuador: Manta.

Genus *ADULA* H. and A. Adams, 1857

Type species by original designation, *Mytilus soleniformis* d'Orbigny.

Rock borers. Shell elongated with closed valves, subcylindrical but generally curved, the ventral margin being broadly impressed along the midzone. The beaks small, flattened and placed slightly in front of the middle and usually so deeply corroded that the pearly inner layer is exposed. Posterior end of valves a little wider, with an umbonal angulation generally covered by a thick crust of agglutinated grains of sand forming a plug or subtruncated stump. Small shells have the shape of a straight *Modiolus* with a sharply angled umbonal ridge more than half the length of the shell and the surface sculptured with fine, radial riblets; the periostracum thin and of a brown or golden-yellow color. Hinge edentulous, the ligament narrowly linear and subinternal. Inner margins of the valves finely crenulated except along a part of the ventral side. Inner layer of shell pearly, the outer layer thin, and covered by a brown periostracum which is usually retained only along the ventral side and under the cover of agglutinated sand grains at the posterior end.

The typical species of *Adula* are rock borers. A large colony of *A. soleniformis panamensis* was found near Las Tablas, Panama, boring into a volcanic, tuffaceous agglomerate, mostly along the softer layers. The bores are small, deep shafts in which the small clam fits snugly when retracted, closing off the entrance by its bilobed stump of agglutinated sand grains covering the posterior end. The umbones of these shells are deeply worn.

Adula soleniformis (d'Orbigny)

Plate 16, figure 3b

Mytilus soleniformis d'Orbigny, 1846, Voy. Amér. Mérid., vol. 5, p. 649, pl. 85, figs. 17, 18 Païta, Peru.

Adula soleniformis (d'Orbigny), Dunker, 1882, Syst. Conch. Cab., vol. 8, p. 24, tab. 6, figs. 4, 5.—Soot-Ryen, 1955, Allan Hancock Pacific Expeditions, vol. 20, No. 1, p. 90.

Typical specimens of *A. soleniformis* from northern Peru and Ecuador are longer and narrower than Panama examples and also attain a larger size (Manta, length 39.5 mm.). The largest Panama shell has a length of 28 mm., and the valves are shorter and higher posteriorly; these Panama shells are separated as a subspecies *panamensis*. (Pl. 16, figs. 3, 3a) Small shells of *A. panamensis* resemble a small *Musculus* and have a strong umbonal ridge, the ventral side is deeply impressed and the whole surface is covered with fine radial riblets. The posterior ridge bears several long algal-like bristles, but its surface is soon covered with a mass of agglutinated grains of sand which cannot be removed without damage to the shell underneath. The bores of *A. panamensis* consist of small shafts, usually closely crowded together, smaller at the lower end, often appearing more or less bilobate at the entrance which is closed off by the stumplike mass of agglutinated sand grains covering the posterior end of the valves. *Adula* is evidently not rare at localities favorable to its growth.

Range—Panama to northern Peru. Panama: Lagartillo near Las Tablas; Guanico. Ecuador: Manta. Peru: Mancora; Païta.

Genus **LITHOPHAGA** Roeding, 1798

Type species by monotypy, *L. mytuloides* Roeding (= *Mytilus lithophagus* Gmelin).

Borers into rock or thick-walled mollusks, corals, and the like, the shell elongate, subcylindrical, rounded in front, the posterior end often tapered, the beaks strongly anterior. Surface smooth except for lines of growth and sometimes vertical or transverse striations. Hinge narrow, edentulous, the ligament marginal, internal. Inner layer of shell nacreous. Periostracum light brown or chestnut-colored, naked or covered with a calcareous deposit, often becoming much thickened and produced beyond the posterior end of the valves as spurs or blades. Margin of valves closed in the adult.

Like other members of the family, the young *Lithophaga* is fixed by its byssus but it soon begins to bore into the substratum and developing within the rock or a thick-walled shell, a large, often spacious, bullet-shaped chamber, small at the top, the exit to the exterior forming a rounded or key-hole shaped opening. In *Leiosolenus*, there is also an accessory, flattened, calcareous tube which rises 2 to 5 mm., above the surface, its general appearance that of the elevated end of a *Vermetus* or worm-tube. Except in *Lithophaga, s.s.*, the surface of the valves is covered by a calcareous encrustation which often becomes much thickened along the posterior slope, sometimes developing a plumose pattern there, and which may be prolonged beyond the ends of the valves in the form of thickened wedge-shaped blades or solid, rounded spurs. These calcareous extensions serve to close off the entrance to the burrow when the shell is pulled back. In *Rupiphaga*, the upper end of the rock chamber is lined with a secondary, thick-walled, cemented tube as do some of the rock-boring *Pholades* such as *Hastasia*. Excavation of the lithophagoid burrow is accomplished apparently by juices secreted by the animal, the softened debris removed by water currents. The surface of the valves shows generally no abrasive wear as do so many other rock-boring clams.

Key to subgenera of *Lithophaga*

Surface of the valves, smooth, clean and polished, without a coating of lime, the periostracum visible throughout.

Subgenus *Lithophaga, s.s.*

Surface of valves covered by a secondary deposit of lime.

- I. Calcareous encrustation on the surface of the valves only, not prolonged beyond the posterior ends. Orifice of the burrow continued above the surface as an elevated, accessory, calcareous tube, its opening bilobate.

Subgenus *Leiosolenus*

- II. Calcareous coating prolonged beyond the posterior end of the valves as thickened blades or spurs. Orifice of burrow without an accessory tube.

- A. Calcareous extension at the posterior end of one valve only. Rock burrow lined by an inner, thickened, cemented tube.

Subgenus *Rupiphaga*

- B. Calcareous extensions at the posterior end of each valve.

1. Posterior calcareous extension in the shape of alternate, overlapping or twisted blades. Orifice bilobate.

Subgenus *Myoforceps*

2. Calcareous extensions, straight, equal, not twisted or alternate.

- a. Calcareous extensions rectangular or wedge-shaped. Encrustation along the posterior slope, smoothish or merely granulose.

Subgenus *Labis*

- b. Calcareous encrustation along the posterior slope thick and heavy and with a plumose surface pattern.

Subgenus *Diberus*

Subgenus **LITHOPHAGA**, s.s.

Surface of valves without a calcareous encrustation.

No known species in the Panamic-Pacific faunal area.

Subgenus **LABIS** Dall, 1916

Type species by monotypy, *Lithophaga attenuata* Deshayes.

Surface covered by a thin, calcareous incrustation, thickened at the posterior end and prolonged beyond the valve margin into a short, rectangular wedge or blade.

Lithophaga (Labis) attenuata (Deshayes)

Plate 15, figures 3-3c, 4

Modiola attenuata Deshayes, 1836, in Lamarck's Anim. s. Vert., vol. 7, p. 28. "Habite au Perou, au Chile, dans les pierres."—Sowerby, 1824, Gen. Shells, *Lithodomus*, fig. 3.

Lithodomus attenuatus (Deshayes), Chenu, 1862, Manuel de Conchyliologie, vol. 2, bivalves, p. 156, fig. 767.

Lithophaga (Labis) attenuata (Deshayes), Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 2, No. 5, pp. 74, 75.—Soot-Ryen, 1955, Allan Hancock Pacific Expeditions, vol. 20, No. 1, pp. 99, 100, pl. 10, fig. 57; text-fig. 77.

Shell narrowly elongate, subcylindrical, evenly convex over most of its length. Dorsal and ventral margins straight for the most part and parallel except for the posterior half where the dorsal margin descends to form a long-drawn out posterior end tipped by a thick, calcareous wedge or flattened blade. The posterior-umbonal slope is slightly flattened, bordered on the ventral slope and sometimes above by an impressed line, the lines of growth across it showing in a rectangular pattern. Periostracum thin, brownish colored and covered by a calcareous encrustation which is much heavier on the posterior slope, prolonged beyond it, as a heavy flattened blade.

Length 95 mm.; height 19.2 mm.; diameter 18 mm. Manta, Ecuador.

This is a common rock borer at many places and at Manta, Ecuador, it is gathered as a sea-food but is said to have a strong, peppery flavor. The calcareous blades at the posterior end of the valves are coarse and thick, and these protruding slightly at the orifice of the burrow indicate the presence of the clam within; these blades on being touched lightly induce the clam to pull in at once.

Range—Lower California to Chile. Mexico: San Ignacio Lagoon (Hertlein and Strong). Costa Rica: Port Parker (Hertlein and Strong). Panama: Guanico. Ecuador: Palmar near Colonche; Manta; Jaramijo.

***Lithophaga (Labis) peruviana* (d'Orbigny)**

Plate 15, figures 2-2a

Lithodomus peruvianus d'Orbigny 1846, Voy. Amér. Mérid., vol. 5, pt. 3, Mollusques, p. 651.

Modiola attenuata Philippi, 1847, Abbild. und Beschreib, Conchylien, bd. 2, p. 148, pl. 1 (*Modiola*), fig. 6 not of Deshayes.

Lithodomus cumingianus Dunker, 1857, in Reeve, Conch. Icon., vol. *Lithodomus*, pl. 21, figs. 8a-b.—Dunker, 1882, Syst. Conch. Cabinet. *Lithophaga*, p. 5, pl. 2, figs. 9, 10.—Chenu, 1862, Manuel de Conchyliologie, vol. 2, bivalves, p. 156, fig. 769.

Shell often quite large, thin, subcylindrical, the ventral margin and the anterior half of the dorsal margin straight and parallel, the posterior section of the dorsal margin descends strongly towards the end. Whole surface is covered by a thin encrustation which thickens near the posterior end, often forming there a short, wedge-shaped point.

Length 84 mm.; height 22.3 mm.; diameter 23 mm.

Paracas Peninsula, Peru.

Since D'Orbigny gave no illustration of this species, some misunderstanding has existed as to its identification. A photograph of a specimen in the type lot at the British Museum (Nat. Hist.) is given here. It differs from *attenuata* by its shorter, higher shell, and less attenuated posterior end. It appears to be common along the Peruvian coast south of Lima, where it is often found boring into the massive heads of a colonial polychaete worm (*Gunnarea*).

Range—Coast of Peru. Peru: Callao; Paracas Peninsula.

***Lithophaga (Labis) inca* (d'Orbigny)**

Plate 15, figure 1

Lithodomus inca d'Orbigny, 1846, Voy. Amér. Mérid., vol. 5, pt. 3, Mollusques, p. 651 Paita.

The type specimen in the British Museum (Nat. Hist.) is a large shell about 83 mm. in length, thin, with the umbones near the anterior end, convex and full, the anterior margin itself rounded. The posterior side is much elongated, evenly tapering to the end, the umbonal slope bearing a wide band formed between two shallow lines or sulci, that on the dorsal side simple, that on the ventral side double. The whole surface is covered by a thin calcareous encrustation, smoothish or faintly granulose, thickening at the end to form a flattened beak which projects beyond the valve margins.

According to D'Orbigny, this species differs from *L. peruviana* by its more elongate form, more even taper behind, and in having two radiating sulci along its posterior side. The posterior sulci are usually faint but can be found on close examination. The form is questionably distinct from *L. attenuata* but may perhaps differ by its less cylindrical and more evenly tapering outline as well as having a somewhat higher and more rounded anterior end.

Range—Paita (Fontaine, D'Orbigny).

Subgenus *LEIOSOLENUS* Carpenter, 1856

Type species by monotypy, *Leiosolenus spatiosus* Carpenter.

Shell as in *Lithophaga*, *s.s.*, but the surface covered with a thin, calcareous incrustation, not produced beyond the posterior end of the valves. Burrow bullet-shaped, capacious, excavated in thick-shelled mollusks (*Spondylus*, *Chama*) narrowly contracted towards a small orifice at the top and often prolonged above the surface by a flattened, calcareous tube.

This group was proposed by Carpenter largely on the character of the burrow provided with an elevated, external accessory tube and noted that if the animal, when examined, proved to have long, excurrent siphons, it must take generic rank perhaps in the neighborhood of *Mytilimeria* Conrad. Elongated siphons seem, however, common to most species of *Lithophaga*. The thin, fairly uniform encrustation covering the shell without posterior appendages together with the elevated, bilobate accessory tube may be accepted as characters distinguishing this subgenus.

Lithophaga (*Leiosolenus*) *spatiosa* (Carpenter)

Plate 15, figure 7

Leiosolenus spatiosus Carpenter, 1856 (as a subgenus of *Lithophaga*), Cat. Mazatlan Shells, Brit. Mus., pp. 178, 179. appendix, p. 550. (Mazatlan, in shells of *Spondylus*).

Lithophaga (*Leiosolenus*) *spatiosa* (Carpenter), Soot-Ryen, 1955, Allan Hancock Pacific Expeditions, vol. 20, No. 1, p. 102, pl. 10, fig. 59.

Lithophaga abbotti Lowe, 1935, Trans. San Diego Soc. Nat. Hist., vol. 8, No. 6, p. 17, pl. 1, fig. 5 Kino Bay, Sonora.

A specimen assumed to be this species was extracted from the lower valve of a large *Chama buddiana*, which when detached from the rock on which it was fixed, revealed the chamber of the *Lithophaga* with its shell enclosed. The lower part of the lithophagid bore had penetrated the volcanic matrix on which the *Chama* was perched. The opening of the bore at the surface of the chamid shell is relatively small and is continued into a short accessory calcareous tube. There are several other of these small pipes on the same *Chama* rising from 3.5 to 5 mm. above its surface. The lithophagid shell has a length of about 28 mm., thin, obliquely and broadly elongated, the proportion of height to length about 1 to 2.7. The beaks are small, almost terminal, the dorsal margin straight, then descending at the posterior one-third to form a bluntly rounded end. The ventral margin is slightly curved, narrowed somewhat at the obliquely rounded anterior end. The valves are moderately convex, their surface covered completely by a thin, calcareous coating but which does not extend beyond the posterior end. Beneath the encrustation, the periostracum is brownish, molded over the concentric lines of growth. Interior brilliantly pearly, the pallial and adductor impressions showing but faintly. This shell measures as follows: Length 28 mm., height 10.7 mm., diameter 5.5 mm. (right valve).

The type of *L. spatiosa* has not been figured but there seems little doubt that this identification is correct. The type of *L. abbotti* has a length of 62.5 mm. which would indicate that this species may attain a large size.

Range—Gulf of California southward to Panama and possibly Ecuador. Panama: Lagartillo near Las Tablas (boring into *Chama buddiana*).

Subgenus **MYOFORCEPS** Fischer, 1886

Type species by original designation, *Lithodomus caudigerus* Lamarck = *L. aristatus* (Dillwyn).

Surface of shell with a coating of lime which posteriorly is much thickened and produced beyond the ends of the valves so as to form a pair of twisted, alternating or crossed blades (like the blades of a pair of scissors) and which serve to close-off the bilobate orifice of the burrow excavated in rock or thick-walled shell.

Lithophaga (*Myoforceps*) *aristata* (Dillwyn) Plate 16, figures 2-2c

Le Ropan, Adanson, 1757, Hist. Nat. Sénégal Coquillages, p. 267, pl. 19, fig. 2.

Mytilus aristatus (Solander MS.), Dillwyn, 1817, Cat. Recent Shells, I, p. 303.

Modiola caudigera Lamarck, 1819, Anim. s. Vert., 6, p. 116 (after Encyclop. Méth., p. 221, figs. 8a, 8b)—Philippi, 1846, Abbild. und Beschreib. Conchylien, bd. 2, p. 149, pl. 1, *Modiola* fig. 5.

Lithodomus caudigerus (Lamarck), Sowerby, 1824, Genera Shells, *Lithodomus*, fig. 4.—Reeve, 1857, Conch. Icon., vol. 10, *Lithodomus*, pl. 3, fig. 16

Lithophaga (*Myoforceps*) *aristata* (Dillwyn), Dall, 1898, Trans. Wagner Free Inst. Sci. Philadelphia, vol. 3, pt. 4, p. 800.—Dall, 1909, Proc. U. S. Nat. Museum, vol. 37, No. 1704, p. 153.—Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 2, No. 5, p. 74.—Soot-Ryen, 1955, Allan Hancock Pacific Expedition, vol. 20, No. 1, p. 98, pl. 10, figs. 53, 54.

Lithophagus calyculatus Carpenter, 1857, Cat. Mazatlan Shells, Brit. Mus., pp. 124, 125, No. 174. MS. drawing in U. S. National Museum.

Shell small or of medium size (average length about 32 mm.), thin, subcylindrical, modioliform, the beaks nearly terminal, the hinge line about half the length of shell, the posterior half of the dorsal side descending, the ventral margin straight or concave. Periostracum thin, light brown or chestnut, covered by a thin, calcareous incrustation much thickened posteriorly and produced beyond the end of the valves in the shape of two, flattened blades which are straight or twisted so as to pass each other alternately and resemble the blades of a pair of scissors.

Length 36.7 mm.; height 10.5 mm.; diameter 9.5 mm. Manta, Ecuador.

A borer into soft rock or into the thick wall of shells such as *Chama*, *Spondylus*, and *Ostrea*. The opening of the burrow usually shows on the surface as a small, bilobate slit which expands below into a large, bullet-shaped cavity.

Range—California to Peru. Also throughout the West Indies and along the southeast coast of the United States; also West Africa. Panama: Guanico; Pearl Islands. Canal Zone: Fort Amador. Ecuador: Esmeraldas; Manta; Palmar; Santa Elena. Peru: Sechura (Dall).

Subgenus **DIBERUS** Dall, 1898

Type species by original designation, *Lithophaga plumula* Hanley.

Shell with one or more radial sulci extending along the posterior umbonal slope with the calcareous encrustation covering the space between them coarse and heavy, and generally developing a divaricate, plumelike pattern. The calcareous prolongations at the end of each valve has the shape of short wedges.

Lithophaga (Diberus) plumula (Hanley)

Plate 16, figures 1-1b

Lithodomus plumula Hanley, 1844, Proc. Zool. Soc. London, p. 17. Panama in *Spondyli*.—Reeve, 1857, Conch. Icon., vol. 10, *Lithodomus*, pl. 4, fig. 23.

Modiola (Lithodomus) plumula Hanley, 1856, Cat. Recent Bivalve shells, pp. 239, 387, pl. 24, fig. 23 Philippines.

Lithophaga (Diberus) plumula (Hanley), Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 2, p. 75, pl. 1, fig. 10.—Soot-Ryen, 1955, Allan Hancock Pacific Expeditions, vol. 20, No. 1, p. 96, pl. 10, fig. 55.

Shell of medium size, appearing rather stout and highest near the posterior end of hinge, then tapering towards a bluntly rounded end. The whole surface is covered by a calcareous coating which on the posterior slope between the radiating sulci is much heavier, spongy or cellular, usually with its sides incised by deep cuts diverging from the central axis to form a crude plumose pattern likened by Hanley to that of a ruffled flower. The thinner coating of lime on the ventral and anterior side is granulose and wrinkled.

The largest specimen measures: length 49.7 mm., height 15 mm., diameter 12.3 mm. Manta, Ecuador.

Range—Lower California to Peru. Panama: in *Spondyli* (Hanley); Burica Peninsula. Colombia: Gorgona Island (Hertlein and Strong). Ecuador: Manta.

Lithophaga (Diberus) cf. subula (Reeve)

Plate 15, figure 6

? *Lithodomus subula* Reeve, 1857, Conch. Icon., vol. 10, *Lithodomus*, pl. 4, fig. 26, Loc.—?

Lithophaga plumula kelseyi, Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 2, p. 75, pl. 1, figs. 8, 9 San Diego, California.

Lithophaga (Diberus) subula (Reeve), Soot-Ryen, 1955, Allan Hancock Pacific Expeditions, vol. 20, No. 1, p. 97, pl. 10, fig. 56.

There is doubt as to the name which should be applied to my shells from Ecuador. They resemble *L. plumula* but are more delicate and the posterior rib of encrustation is thinner and only slightly furrowed, not developing the coarse plumose pattern of that species. They differ from typical *L. kelseyi* from California in the much deeper radial sulci or broad furrow along the dorsal side of the central posterior zone of heavy encrustation, and the calcareous blades at the end of the valves are longer and heavier.

A specimen measures: length 39.3 mm., height 10.4 mm., diameter 11.4 mm. Manta, Ecuador.

Range—Alaska to California and southward to Peru. Ecuador: Manta.

Subgenus **RUPIPHAGA**, new subgenus

Type species *Lithophaga hastasia*, new species.

The shell, as in *Lithophaga*, *s.s.*, is elongate modioliform, thin, and with a light brown to nearly black periostracum, largely concealed under a calcareous encrustation, thin and light on the anterior portion, thickened along the posterior side so as to form a central rib bordered by furrows and prolonged beyond the end of one valve only (usually that of the right) in a coarse, spikelike prong or blade. Upper portion of bore,

usually in rock, lined with a tapered, auxilliary calcareous tube as in some of the pholads.

Lithophaga (Rupiphaga) hastasla, new species

Plate 15, figures 5-5f

The shell is narrowly elongate, bullet-shaped or modioliform, thin, subcylindrical, evenly convex over most of the length, the anterior end obliquely rounded with the small, low beak placed a short space behind, the dorsal and ventral margins parallel for the most part, the posterior-dorsal half descending to form a tapered end. The greater part of the surface is encrusted with a deposit of lime, relatively thin and filmlike on the anterior portion, coarse and heavy on the posterior side so as to form a thickened rib along its middle bordered on each side by a furrow and prolonged considerably beyond the end of one valve (usually the right) forming a stout, solid spikelike plug. Periostracum is largely concealed by lime deposit but where exposed has a clear brown to dark-brown, nearly black color. Interior is nacreous white.

Length 24.5 mm., height 5.8 mm., diameter 6.6 mm.

Holotype, Esmeraldas, Ecuador, ANSP 218931.

Length 38.3 mm., height 9 mm., diameter 4.3 mm. (right valve).

Paratype, Esmeraldas, Ecuador.

In this species, the calcareous surface encrustation forms along the posterior side a thickened rib which in one valve (usually the right) is prolonged some distance beyond its end in the shape of a stout, spikelike blade, often two-pronged at the tip; on the surface of the valve, this rib is generally bordered on each side by a deep furrow or groove. The upper part of the bore, usually in an argillaceous rock is internally lined with a heavy, pipelike tube, wider below, much heavier and tapered at the top with a small circular orifice. My observations on this structure are limited to the bore and its internal tube. The fragile *Lithophaga* shell within is seldom secured intact when the enclosing rock is broken into.

Range—Panama to Ecuador. Panama: Guanico. Ecuador. Esmeraldas.

Subgenus *STUMPIELLA* Soot-Ryen, 1955

Type species by original designation, *Lithophagus calyculatus* Carpenter.

This subgenus is probably a synonym of *Myoforceps*. An unpublished figure of *Lithophagus calyculatus*, prepared by Carpenter from the type, is that of a shell closely similar to *L. aristata* if not identical with it. The shells figured by Soot-Ryen as *L. calyculata* from the Mexican coast, probably represent another species.

Family DREISENIDAE

This family is represented in America by the genus *Mytilopsis*, a group of fresh- or brackish-water species, both fossil and Recent, and often encountered in beach drift at localities situated near the mouths of fresh-water streams. They are properly speaking, not a part of the marine Panamic-Pacific fauna. A species is common in some rivers of southwestern Colombia and northwestern Ecuador, usually in the swifter portion of the streams, attached in clusters to boulders and pebbles in the bed or living in

small holes or pits in rock walls. These clams have the shape of a small *Mytilus*, with pointed, terminal beaks, a small septum in the beak like *Septifer* and a smooth or concentrically wrinkled surface covered by a dark-colored periostracum. They are gathered by the Cayapas Indians of Ecuador for food. *Mytilopsis adamsi* Morrison⁹ was described from a lagoon at the mouth of Musselshell Creek on San José Island, Pearl Islands, Panama. The same species may also occur on the mainland.

Shell mytiloid, the anterior adductor attached to a shelflike platform or thickened septum in the apical section, sometimes with a small, tooth-like lamina or apophysis below the septum for the attachment of the byssal muscle. Habitat, fresh- or brackish-water.

Genus **MYTILOPSIS** Conrad, 1857

(*Praxis* H. and A. Adams, Dec. 1857)

Type species by monotypy, *M. leucophaeatus* Conrad, 1831. Recent, southeastern coast of the United States.

Shell mytiloid, non-nacreous, with sharply pointed beaks at the extreme anterior end. Hinge line with a furrow for the attachment of the ligament along and within the dorsal margin for most of its length. Adductors two, the posterior one elongate or club-shape, the anterior seated on a flat shelf or septum in the beak roofing over the umbonal cavity which extends well under it. There is a small lamina under the septum for the support of the byssal muscle. Externally the shell is covered with a coarse periostracum, the surface below, smooth or concentrically striated.

Mytilopsis trautwineana (Tryon)

Plate 84, figure 8

Septifer Trautwineana Tryon, 1866, Amer. Jour. Conch., vol. 2, p. 302, pl. 20, fig. 8
Río San Juan (lat. 4° North); New Granada (Colombia).

Praxis Milleri Clessin, Miller, 1879, Malak. Blätter, tome 26, pp. 179, 180, tav. 15, fig. 7
Río Verde, Esmeraldas, Ecuador.

Praxis Ecuadoriana Clessin, Miller, 1879, *op. cit.*, pp. 180, 181, tav. 15, fig. 8
Río Cayapas, Esmeraldas, Ecuador.

Shell narrowly or broadly mytiliform with the general axis inclined about 45 degrees with the hinge line placed horizontally. Hinge line a little shorter than the length of the shell, its posterior margin straight or rounded towards the end, the anterior side weakly impressed so that the umbonal slope appears arched or crudely angular. Internal septum in the beak rather large, excavated, the byssal muscle scar showing plainly on the end of the apophysis below. Periostracum dark-brown to nearly black in color, coarsely, concentrically wrinkled. Interior glossy, bluish-white in color, blotched or streaked with white or black.

Length 16 mm.; height 24.4 mm.; diameter 9.6 mm.

Río Cayapas, Esmeraldas, Ecuador.

This is a fresh-water species. It was observed on several occasions by the author living in parts of the Río Cayapas River system in Ecuador, and

⁹Morrison, J. P. E., 1946, Smith. Misc. Coll., vol. 106, No. 6, pp. 46, 47, pl. 1, figs. 4, 7.

in the Río Guapi in southwestern Colombia; it usually occurs where the river water is clear and flows over a rocky bottom, the mussel attached in clusters to small boulders, submerged trunks of trees or nestling in holes along the bank if the wall is rock. The associated mollusks are a small *Neritina* and *Lithococcus* (Hydrobiidae).

Range—Rivers of western Colombia and northwestern Ecuador. Colombia: Río San Juan; Río Guapi. Ecuador: Río Verdi; Río Cayapas.

Mytilopsis adamsi Morrison and *M. zeteki* Hertlein and Hanna

Plate 84, figures 9, 9a

Two other species of *Mytilopsis* have been described from the Panamic region but because of the lack of representative material, the status of these two species cannot be analysed at this time. *M. adamsi* Morrison, 1946, (Smith. Misc. Coll., vol. 106, No. 6, pp. 46, 47, pl. 1, fig. 4) was described from the uppermost end of a fresh-water lagoon on San José Island, a member of the Pearl Island group in Panama Bay. Its figure shows an elongated shell, twice as long as high, with a relatively large septum and eroded, deformed beak. Morrison related the species with the Atlantic Coast *M. leucophaetus* of Conrad.

Another species of the genus was described by Hertlein and Hanna, as *M. zeteki* from the Miraflores Locks (Hertlein and Hanna, 1949, Bull. 7, Calif. Acad. Sciences, vol. 48, pt. 1, pp. 13-18, pl. 1). In a note from Morrison, he stated that he considered *M. zeteki* close to *M. adamsi* if not a growth-form of that species. A few specimens of a small *Mytilopsis* have been collected from shell drift from Venado Beach, Panama Canal Zone. These specimens are small, hatchet-shaped, the height about equal to their length, the interior with a small septum, and the surface white or lightly shaded with gray or pale black. In their present form, the Venado shells agree well with young specimens of *M. sallei* from Colon, and may indicate a Pacific invasion of that Caribbean species. The two West Atlantic *Mytilopsis* are sometimes difficult to separate; *M. sallei* is generally higher and more hatchet-shaped and the internal apophyses under the septum is smaller, closer to the dorsal wall, whilst *M. leucophaetus* is narrowly elongated, its apophyses larger, often closer to the middle and hence more prominent.

Family JULIIDAE (Opisthobranchia Sacoglossa)

Small or minute, bivalved mollusks, greenish in color and living amongst green algae. In the genus *Julia*, the shell is roughly aviculoid in shape, both valves equal and strongly convex with large, full umbones terminating in small beaks. The higher, longer side is the anterior with a well-rounded end; the shorter side is posterior, pointed at the end with a deep, rounded indentation below the beaks resembling a large, sunken lunule. The hinge is heavy, with a large, stout tooth in each valve and which fits into a corresponding socket in the opposite valve. There is a single, large adductor scar in each valve, more or less medially placed and with one or more, smaller accessory

scars in adjacent position. The valves were probably united by a ligament attached to a linear scar along the dorsal margin just in front of the beaks.

Although *Julia* is now known to belong to the sacoglossate Opisthobranchs, it is mentioned here because of its long association with the Pelecypoda. Single valves of *Julia* have a decidedly Tectibranch-like aspect as some authors have previously noted. For a discussion of these curious, bivalved snails, the reader should consult the following:

S. Kawaguti and K. Baba, 1959, *A preliminary note on a two-valved sacoglossan gastropod, Tamanovalva limax*. Japan. Biological Journal, Okayama University, vol. 5, Nos. 3-4, pp. 177-184; Kawaguti, S., *Formation of the bivalve shell in a gastropod, Tamanovalva limax*. Proc. Japan Academy, vol. 35, No. 10, pp. 607-611, 5 figs.; A. Myra Keen, 1960, *The riddle of the bivalved gastropods*, The Veliger, vol. 3, No. 1, pp. 28-30; J. P. E. Morrison, 1960, *Notes on the bivalved univalves*; W. J. Clench, *The bivalve gastropod and the Opisthobranchs*. (Last two read before American Malacological Union, 1960.)

Genus **JULIA** Gould, 1862

Type species by monotypy, *Julia exquisita* Gould. Recent, Hawaiian Islands.

With characters of the family.

Julia thecaphora (Carpenter)

Plate 17, figure 5

Smaragdinella thecaphora (Nutt.), Carpenter, 1875, Cat. Mazatlan Shells, Brit. Mus., p. 533, No. 692.

Julia equatorialis Pilsbry and Olsson, 1944, Nautilus, vol. 57, No. 3, pp. 86, 87, pl. 9, figs. 10, 11.—Arthur Day Howard, 1951, Nautilus, vol. 64, No. 3, pp. 84-86.

The shell is small or minute, usually between 2 and 3.8 mm. in length. When fresh, the color of the shell is green or greenish yellow, often with brown stripes, but on weathering it soon becomes white. The valves are moderately convex, subquadrate, the short, posterior side pointed at the end. The texture of the valves is heavy, subtranslucent so that the markings of the exterior often show plainly in the interior. The greatest inflation of the valves is placed in front and below the beaks.

Although rare in collections, this species is now known to have a general distribution throughout the Panamic-Pacific faunal province. Because of its small size and often worn appearance it is generally overlooked in picking of shell drift.

A manuscript drawing of *Smaragdinella thecaphora*, after the type specimen by Carpenter in the library of the Department of Mollusks, U. S. National Museum, shows that species to belong to the genus *Julia*. It seems likely, therefore, that *J. equatorialis* represents the same form.

Range—Lower California to northern Peru. Mexico: Mazatlan (Carpenter); Socorro Island and Cape San Lucas (Howard). Panama: Búcaro. Colombia: Isla del Gallo. Ecuador: Puerto Callo; Punta Centinella on Santa Elena Peninsula. Peru: Caletto Sal (types of *J. equatorialis*).

Order ISODONTIDA
Superfamily PTERIACEA
Family PINNIDAE

The adult shell has a narrow, pointed anterior end, while the posterior side may be elongated, expanded or fan-shaped, its margin normally open. The shell is composed of two layers of different composition; an outer, prismatic, more or less flexible, perishable layer, and an inner, nacreous and more durable layer, not formed along the growing ventral margin, consequently, the ventral part of the valves is more or less flexible, and the margins of the valves, normally gaping, can be closed tightly by the pull of the mantle and of the posterior adductor muscle. These clams are sedentary, generally found buried in mud, sand or gravel, the anterior end downward and anchored in a vertical position by the byssus, the posterior margin of the valves level with the surface or projecting slightly above it. Hinge is long, narrowly linear, extending along a straight, dorsal margin, the ligament produced to the end of the inner layer only. Some species of *Pinna* such as *rugosa* attain a length of nearly two feet. The young *Pinna* is said to have a normal, equilateral shell.

Two genera separated by the presence or absence of a longitudinal keel.

Key to the genera of Pinnidae

- I. Shell narrowly triangular, the dorsal and ventral margins nearly straight, the anterior portion carrying a longitudinal carina formed in the outer layer and dividing the inner layer into two lobes. Genus *Pinna*
- II. Shell fan-shaped, the posterior portion expanded. Valves not medially sulcated. Genus *Atrina*

Genus PINNA Linné, 1758

Type species by absolute tautonomy, *Concha pinna* Hasselquist (= *Pinna muricata* Linné; or by subsequent designation, Children, 1823, or by Gray, 1847, *Pinna rudis* Linné).

With the general characters of the family. Surface of valves with a longitudinal ridge due to a deep sulcus dividing the inner or nacreous layer.

The selection of the type species of this Linnean genus is controversial; for the most recent opinion and a discussion of the subject, the reader is referred to Turner and Rosewater, 1958, "The family Pinnidae in the western Atlantic" (Johnsonia, vol. 3, No. 38, pp. 302, 303).

Pinna rugosa Sowerby

Plate 18, figure 1

Pinna rugosa Sowerby, 1835, Proc. Zool. Soc. London, p. 84. Hab. in Sinum Panamensis (Isle of Rey).—Reeve, 1858, Conch. Icon., vol. 11, *Avicula*, pl. 26, fig. 50.—Hertlein and Strong, 1943, Zoologica, vol. 28, pt. 3, No. 19, p. 165.

Elongate, narrowly wedge-shaped, expanding posteriorly in large specimens, the hinge line straight, held by the ligament along its whole length, the resilium comprising about three-fourths of the area. Color brown, amber shading towards black, often greenish near the tip, the median carina showing as a dark line. Young shells are thin, subtranslucent, thickening in the adult, sometimes excessively so. Sculpture formed by 6 to 10 rows of widely spaced, tubular spines, largest along the middle and towards the posterior end, covering the whole width, anteriorly the spines are absent, and

in young shells may not be developed at all. Inner layer white, brilliantly pearly, divided longitudinally in the middle into two sections by the deep sulcus which forms the keel on the surface.

This species has an elongated, trigonal shell ornamented with eight rows of large, tubular spines. Adult specimens have a heavily thickened, coarse shell which may reach a length of nearly two feet.

Range—Lower California to Panama. Panama: Taboga Island; Pearl Islands.

Genus *ATRINA* Gray, 1842

Type species by subsequent designation, Gray, 1847, *Pinna nigra* Dillwyn.

Shell fan-shaped, wider posteriorly, like *Pinna* but the nacreous layer is not divided by a longitudinal sulcus. Arranged in two subgenera on basis of the position of the posterior adductor muscle scar.

Key to species of *Atrina*

I. Posterior adductor scar large, not confined wholly to the nacreous area but its edge extending slightly beyond it.

Subgenus *Atrina*, s.s.

1. Ventral side not straight but contracted and deeply impressed near the anterior end, the posterior side widely expanded. Rows of scales numerous, coarse, convex, or vaulted.

A. tuberculosa

II. Posterior adductor scar lying wholly within the nacreous area.

Subgenus *Servatrina*

2. Ventral side nearly straight, the shell having a fairly uniform tapered form from the beak to the posterior margin. Rows of scales relatively few in number (7 to 10), the dorsal ones large and tubular. Color usually purplish amber.

A. maura

Subgenus *ATRINA*, s.s.

On the inside of the valve, the posterior adductor muscle scar lies close against the hind edge of the nacreous area or protrudes slightly beyond it.

Atrina (Atrina) tuberculosa (Sowerby)

Pinna tuberculosa Sowerby, 1835, Proc. Zool. Soc. London, p. 84.—Reeve, 1858, Conch. Icon., vol. 11, *Pinna*, pl. 25, fig. 48.

Shell broadly trigonal or fan-shaped, the anterior end short, contracted, the posterior side high and widely expanded. Surface sculptured with rows of coarse spines (13 to 16), foliaceous and vaulted. The color dark-brown to nearly black. Specimen figured by Reeve is nearly 200 mm. long.

This species is the Eastern Pacific analogue of the Atlantic *A. rigida* (Solander). Its range is more northerly than *A. maura*, being most plentiful in the Gulf of California.

Subgenus *SERVATRINA* Iredale, 1939

Type species by original designation, *Pinna assimilis* Reeve.

Externally like *Atrina*, s.s. but internally with the posterior adductor muscle scar enclosed within the nacreous area and which generally

covers half of the inside surface of the valve.

Atrina (*Servatrina*) *maura* (Sowerby)

Plate 13, figures 6, 7;
Plate 55, figure 1

Pinna maura Sowerby, 1835, Proc. Zool. Soc. London, p. 84. Panama.—Reeve, 1858, Conch. Icon., vol. 11, *Pinna*, pl. 29, fig. 54.

Pinna [*Atrina*] *maura* Sowerby, Maxwell Smith, 1944, Panamic Marine Shells, p. 50, fig. 672.

Atrina maura (Sowerby), Hertlein and Strong, 1943, Zoologica, vol. 28, pt. 2, p. 165.

Pinna lanceolata Sowerby, 1835, Proc. Zool. Soc. London, p. 84.—Reeve, 1858, Conch. Icon., vol. 11, *Pinna*, pl. 31, fig. 39. Name preoccupied.

The shell is elongate, fan-shaped, sometimes quite large (about 230 mm.), thin, brown, subtranslucent, the posterior end wide, its margin straight, truncated, the ventral margin nearly straight, except for being slightly impressed anteriorly. The sculpture is formed by 8 to 12, nearly straight rows of high, fluted to tubular spines on the middle and dorsal surface, subobsolete along the ventral side.

This species resembles *A. rigida* Dillwyn of the Atlantic but has a narrower form and the anterior-ventral side is less deeply impressed.

Range—Lower California to northern Peru. Panama: Taboga Island. Canal Zone: Venado Beach. Ecuador: Esmeraldas; Cojimenes; Puerto Callo. Peru: Tumbes.

Family PTERIIDAE

To this family belong the Pearl Oysters represented in the fauna by two genera, *Pteria* (*Avicula*) and *Pinctada* (*Margaritiphora*) distinguished by their pearly interiors and aviculoid or wing-shape. The valves are aviculoid to suborbicular in form with a small anterior wing below which in the right valve is a deep notch for the passage of a byssus. Inner layer of shell is brilliantly pearly or nacreous, thin or heavy, the outer layer prismatic and lamellar, often developing a wide, darker colored border to the ventral margins. The dorsal margin or hinge line is straight, edentulous in *Pinctada*; provided with long, lamellae-like teeth in *Pteria*. The ligament is subinternal, the resilium portion attached to a shallow, scarlike depression or to a narrow groove, behind the beaks. External surface usually rayed, often spinous.

Key to genera of Pteriidae

- A. Shell relatively thin, convex, with a long, pointed or widely expanded posterior wing. Hinge provided with one or two, small tubercular teeth below the beak, and one or two long, horizontal, posterior lamellae obliterated in large shells by the growth of the cardinal area.

Genus *Pteria*

- B. Shell heavy, often large, suborbicular without a definite posterior wing. Hinge edentulous at all stages.

Genus *Pinctada*

Genus PTERIA Scopoli, 1777

Type species by monotypy, *Mytilus hirundo* Linné. Recent, Mediterranean Sea.

Shell obliquely aviculoid, the length along the hinge line longer than the height, the ends auriculate, the posterior ear much larger, often pointed, the anterior ear small, that of the right with a notch for the passage of the byssus by which the shell is attached. Cardinal area generally narrow

and linear, covered by the ligament of which the resilium is developed as a narrow wedge for about half its length. Hinge with one or two, small, cardinal-like knobs under the beak and a set of more distant lateral laminae and sockets. Surface of shell usually dark in color and rayed.

Pteria sterna (Gould)

Plate 18, figure 4

Avicula sterna Gould, 1851, Proc. Boston Soc. Nat. Hist., vol. 4, p. 93. (Mazatlan).—Gould, 1853, Jour. Boston Soc. Nat. Hist., vol. 6, p. 404, pl. 16, fig. 7.

Avicula peruviana Reeve, 1857, Conch. Icon., vol. 10, *Avicula*, pl. 14, fig. 53 (Peru).

Pteria peruviana (Reeve), Dall, 1909, Proc. U. S. Nat. Museum, vol. 37, No. 1704, pp. 150, 255, pl. 28, fig. 1.—Maxwell Smith, 1944, Panamic Marine Shells, p. 50, fig. 675.

Pteria sterna (Gould), Maxwell Smith, 1944, *op. cit.*, p. 51, fig. 673.—Hertlein and Strong, 1943, Zoologica, vol. 28, pt. 3, No. 19, p. 164.

Shell variable in shape, the axis inclined, the valves quite convex. Young shells are usually much longer than high, the posterior wing narrow and elongate. Larger and older shells, especially from Peru, become nearly as high as long and the posterior wing is correspondingly smaller. Ground color of worn shells is usually a dark purple, uniform or with narrow rays of a lighter shade, the surface in unworn shell rough and coarse formed by close-set radial spines or scales which near the ventral margin may form large, overlapping, flattened spines as in *Pinctada mazatlanica*.

Length 93 mm.; height 88 mm.; diameter 43 mm. Shell with short posterior wing. Bayovar, Peru.

Length 92 mm.; height 46 mm.; diameter 30 mm. Form with a long posterior wing. Lobitos, Peru.

As suggested by Hertlein and Strong, *P. sterna* and *P. peruviana* are probably forms of a single species although studies in the future may show that the southern or Peruvian shell should be accorded subspecific standing. This species is often common along the shores of northwestern Peru where it has occasionally been fished for pearls and large piles of its discarded shell are to be seen at many places. The shell becomes large (100 mm. or more), nearly as high as long, and the posterior wing is not greatly extended; smaller or immature specimens have the greatly prolonged, narrow wing of typical *P. sterna*.

Range—California to northern Peru. Ecuador: Manta; Santa Elena. Peru: Mancora; Cabo Blanco; Lobitos; Negritos; Paita; Bayovar.

Pteria beillana, new species

Plate 18, figures 5-5c

Shell relatively small (length 37 mm.), inequivalve, the left valve being strongly convex, the right valve less so. The anterior ear is unusually large, set-off rather sharply by a grooved line in the left valve and by a deep, byssal sinus in the right. Dorsal margin straight, equal to the greatest length of the shell, the small beaks elevated slightly above it a little in front of the middle point. Hinge with an elongate, anterior lateral and posterior lateral tooth in the right valve each fitting into a socket in the left valve; the anterior tooth is quite close to the beak, the posterior about midway along the dorsal margin. Resilium is quite long, attached to an elongated scar entirely posterior of the beak, its length about half that of the posterior-dorsal margin. Interior brilliantly pearly with a single, large adductor scar placed on the posterior side of the shell cavity. Externally, the color is a dull brown, smoothish on the umbones and with radially frilled or scalloped concentric lamellae on the ventral sides and on the ears; the outer shell layer forms a narrow band along the ventral margin.

Length 36.8 mm., height 23.4 mm., diameter 14.3 mm.

Venado Beach, Canal Zone. Holotype, ANSP 218932.

This species is characterized by its relatively small size and large anterior ears. It is named to honor Mr. and Mrs. Lee Beil, formerly stationed in the Canal Zone and whose industrious collecting of Panama shells have added so much to our knowledge of the mollusks of that region.

Range—Panama. Canal Zone: Venado Beach.

Genus *PINCTADA* Roeding, 1798

(*Meleagrina* Lamarck, 1819)

Type species by subsequent designation, Iredale, 1915, *Mytilus margaritiferus* Linné.

Shell obliquely subrectangular, as high as long, with a long, straight hinge line, wholly posterior of the beak, a small anterior ear, the valves slightly unequal, the right one usually somewhat more convex, attached by a byssus which passes through a notch under the anterior ear. Hinge edentulous, the area covered by the ligament, the resilifer pit is a shallow, submedial depression. Shell made up of two principal layers, an outer, prismatic layer, generally amber or horn-color and forming a wide marginal band, and an inner, shiny, pearly layer. The adductor scar is large, a little posterior of the middle.

Distinguished principally from *Pteria* which it much resembles, by its shape, often higher than long, and in the absence of a definite posterior wing. To this genus belongs the pearl oyster of the Bay of Panama.

Pinctada mazatlanica (Hanley)

Plate 18, figures 3-3b

Meleagrina mazatlanica Hanley, 1856, Cat. Recent Bivalve Shells, p. 388, pl. 24, fig. 40 (Mazatlan).

Avicula barbata Reeve, 1857, Conch. Icon., vol. 10, *Avicula*, pl. 5, fig. 9 (Panama).

Margaritiphora (Pinctata) mazatlanica (Hanley), Maxwell Smith, 1944, Panamic Marine Shells, p. 51, fig. 674.

Pinctada mazatlanica (Hanley), Hertlein and Strong, 1943, Zoologica, vol. 28, pt. 3, No. 19, pp. 164, 165.—Hertlein and Strong, 1955, Bull. Amer. Mus. Nat. Hist., vol. 107, art. 2, pp. 175, 176.

Young shells are relatively thin and delicate but larger specimens become coarse and heavy. Color generally yellowish-olive shading into brown, the surface often worn and encrusted, the middle of the disk showing concentric rings, the edges of growth layers but perfect, unworn shells are covered by close-set, radial spines, usually overlapping and flattened, especially around the margins.

This is the pearl oyster of the Pearl Islands of the Bay of Panama. *Avicula cumingi* Reeve, described from the Galapagos, is probably the same species.

Range—Gulf of California to northern Peru and the Galapagos Islands. Costa Rica: Puntarenas. Panama: Guanico; Panama City; Pearl Islands. Canal Zone: Venado Beach. Ecuador: Santa Elena; Manta. Peru: Paita.

Family *PHILOBRYIDAE* Bernard, 1897

Shell generally quite small, mytiloid or aviculoid in shape, the valves being alike but inequilateral, the anterior side being short or atrophied, attached by a bundle of byssal threads emerging between the anterior margins of the valves below the beaks; monomyarian, the single or posterior

adductor scar, indistinct and subcentral in position. The beak is generally capped by a small, embryonic shell or prodissoconch with upraised margins, straight or slightly prosogyrous. Hinge line long and straight, aviculoid, the ligament well immersed into the hinge plate, its scar elongated, simple or striated vertically, the ligament itself divided into two parts, the resilium small, dark brown in color and attached to a small, triangular pit near the anterior end, the tensilium longer, of a lighter color, and extending along most of the hinge line behind the beaks. Shell non-nacreous, the surface smooth or marked with weak, radial rays which form short, periostracal extensions at the ends. Animal ovoviviparous.

Some workers place this family near the Limopsidae and Glycymeridae since the soft parts of the animal are said to resemble that of *Limopsis*. I have followed Bernard in considering the Philobryas as closely related to the Pteriidae, which they resemble in the shape of the shell, hinge line, in being monomyarian and having a short byssus emerging from below the beaks.

Genus **PHILOBRYA** Cooper, 1867

(*Bryophila* Carpenter, 1864, not Trietschke, 1825. Lepidoptera.)

Type species by monotypy, *Bryophila setosa* Carpenter. Cape St. Lucas, Lower California.

Main characters as described for the family, the shell being generally very small, mytiloid, inequilateral, the anterior side little developed, if any, the posterior side large, high and expanded. Beaks tipped by a relatively large, flat or depressed prodissoconch with thickened, upraised margins, its surface smooth. Surface with a heavy periostracal layer with low, spinously foliated riblets, strongest on the ventral portion. Hinge line straight, its surface and the cardinal area plain and not marked with distinct crenulations.

Philobrya setosa (Carpenter)

Plate 3, figures 12, 12a

- Bryophila setosa* Carpenter, 1864, Ann. and Mag. Nat. History, 3d ser., vol. 13, p. 314.—Carpenter, 1872, Smith. Misc. Coll., No. 252, p. 212 (reprint of previous paper).
Philobrya setosa (Carpenter), 1872, Smith. Misc. Coll. No. 252, p. 21 of Index of Species at end of book.—Dall, 1895, Proc. U. S. Nat. Museum vol. 18, p. 17.—Bernard, 1897, Jour. de Conchyl., 3d ser., vol. 45, p. 10, fig. 1, no. 4 and pl. 1, fig. 1.—Dall, 1921, Bull. U. S. Nat. Museum, No. 112, p. 17.—Grant and Gale, 1931, Mem. San Diego Nat. Hist., vol. 1, p. 149; Palmer, 1958, Geol. Soc. Amer., Mem. 76, p. 67, pl. 1, figs. 11-16.

This is a small shell, resembling the young of *Pinna*, *Isognomon*, and various mytilids but easily distinguished by its large, flattened embryonic shell capping the beaks, and attached to the surface of dead shells by a bundle of small byssal threads emerging between the valves just below the beaks. It is apparently common where found. The margin of the mantle is found dried to the inside of the valve forming a semicircle ring attached loosely to the pallial line. It shows most commonly as a line of alternating light and dark-colored spots, the pale ones ending in short points or teeth while the dark spots have a small eye-spot in front of each. Closed valves are often found filled with newly hatched embryos and their small, white shells can easily be mistaken for those of ostracods; an average embryonic shell measures; greatest length along the straight hinge line 0.34 mm., greatest height 0.25 mm. Beak indistinct but probably placed a little in

front of middle. The valve is slightly convex, raised around the margin, its surface finely pitted, white, and usually showing a slight iridescence.

Range—Forrester Island, Alaska, to the Gulf of California.

Family ISOGNOMONIDAE

The shell is monomyarian or provided with a single adductor scar in each valve, usually aviculoid in shape, with or without a posterior wing, and attached by byssal threads passing through a sinial gap in the anterior margin below the beaks, the margins of the byssal sinus often much thickened. The shells may be small or of large size, thin or heavy, the left valve being generally somewhat more convex. The beaks are small, pointed, and placed at the extreme anterior end and pointed forward. Hinge line straight, edentulous, and bordered externally by a cardinal area which may be low or high, generally thickened, sometimes excessively so, and traversed by a series of parallel, vertical pits or grooves to which the main part of the ligament is attached. Inner layer of shell nacreous, often brilliant, the outer layer prismatic, lamellar and often forming a dull or horn-colored zone extended widely around the margins of the valves.

One single genus in Panamic waters.

Genus ISOGNOMON Solander, 1786

(*Pedalion* Solander, 1786 MS.; *Melina* Retzius, 1788; *Perna* Bruguière, 1789 and Lamarck, 1799 [not of Retzius, 1788]).

Type species by tautonymy, *Ostrea isognomon* Linné.

With the characters of the family.

isognomon chemnitziana (d'Orbigny) Plate 18, figures 2, 2a

Perna chemnitziana d'Orbigny, 1845, in Sagra, Hist. P'le Cuba, Mollusques, vol. 2, p. 346.

Perna bicolor C. B. Adams, 1845, Proc. Boston Soc. Nat. Hist., vol. 2, p. 9.—Clench and Turner, 1950, Occasional Papers on Mollusks, Mus. Comp. Zool., vol. 1, No. 15, p. 260, pl. 48, figs. 6, 7.

Perna quadrangularis Reeve, 1858, Conch. Icon., vol. 11, *Perna*, pl. 2, fig. 6. Hab.—?

Pedalion chemnitzianum (d'Orbigny), Hertlein and Strong, 1943, Zoologica, vol. 23, pt. 3, pp. 166, 167, pl. 1, fig. 8.

Shell usually small, irregular, seldom over 50 mm. in height, subsolid over the middle of the disk, fragile, and thin in the ventral portion. The outer surface is usually coarsely lamellose, formed by the overlapping of several wide sheets, the final one projecting as a wide rim or tongue beyond the edge of the pearly layer within.

Common as a nestler, living in crevices and in abandoned burrows. *P. quadrangularis* of Reeve, described without knowledge of locality, is probably equivalent. Also common on the Atlantic side of the isthmus.

Range—Mexico to Chile. Atlantic. Canal Zone: Venado Beach. Ecuador: Esmeraldas; Manglaralto; Santa Elena.

Superfamily PECTINACEA

Family SPONDYLIDAE

Shell monomyarian, with convex, unequal, pectiniform or ostreiform valves, attached by the umbonal section of the right valve which is always larger. The single adductor scar is placed a little behind the middle. Hinge line straight with a pair of large, curved or hook-shaped crural teeth and their sockets in each valve. The cardinal area is high and triangular in the right valve, absent in the left. The ligament is almost wholly internal, lodged in a deep pit between the crural teeth. Sculpture formed by strong radial ribs, usually spinous. Warm water.

Genus SPONDYLUS Linné, 1758

Type species by subsequent designation, *Spondylus gaederopus* Linné.
Recent, Mediterranean.

Shell large or of medium size, solid, pectiniform but usually deformed due to fixation, the attachment is generally by the umbone of the right valve. The lower or right valve is generally larger, more inflated than the left with a high, triangular cardinal area. Ligament internal, lodged in a deep, ventral pit, the external growth trace of which shows as a narrow, deep slit or furrow extending upward along the cardinal area of the right valve to the tip of the beak. Hinge line straight, each valve with two, stout, crural teeth and their bordering sockets. The sculpture is principally radial, formed by ribs or riblets of primary, secondary, and tertiary size, often bearing pointed, fluted, or spatulate spines. On the lower valve there is usually a tendency for the sculpture to become concentrically foliaceous. Coloration white, purple, orange or red, the interior of shell cavity white and porcellaneous, often with a wide, strongly colored marginal band.

The size of the attachment area along the umbonal section of the right valve seems to vary amongst different species, as well as greatly controls its general appearance and sculptural development. In general, the sculpture of the lower or attached valve is more strongly concentrically foliaceous, as an aid in attachment, but usually the concentric folios are replaced with spines as the edge of the shell rises and becomes free from the substratum. Some species of *Spondylus* grow to a large size when adult, their shell becoming much thickened and bored into by marine animals; where such shells are common they may be gathered and burned in the production of lime.

Several forms of *Spondylus* occur in the Panamic-Pacific region and to which names were given by the early authors; some of these forms are merely color or growth variants. Considered in a conservative manner, all the Panamic Spondyli could well be grouped together in a single, widespread, plastic species, its main characteristics controlled largely by the sort of surface to which it was attached, or if grown in a confined or in an open space. Until the ecology of the Panamic Spondyli is much better known than at present, the question whether there is one or several species involved cannot be answered. For the purpose of this review, the following arrangement is offered.

Key to species of *Spondylus*

- A. Valves usually regular, pectiniform, seldom much distorted, the attachment scar on the umbone of the lower valves of relatively small size.
 1. Sculpture formed by rows of stout, spikelike spines, closely crowded, the primary interspaces covered completely by secondary and tertiary spines (each interspace has one central row of secondary and usually four rows of tertiary spines, two on each side of middle). Coloration a uniform orange or coral-red.

S. princeps princeps
 2. Sparser surface sculpture, the interspaces wider and more open. Primary spines large, fluted or foliated at the ends and generally light-colored, white or yellow.

S. princeps leucacanthus

3. Primary spines much enlarged, often flattened or fluted between wide, open interspaces (one secondary and two tertiary generally). Valves rounded and symmetrical in shape, convex. Color uniform.

S. princeps unicolor

- B. Shell always much distorted, the valves strongly unsymmetrical, the attachment scar covering a large part of the surface of the lower valve and bordered by a profuse development of foliated concentrics.
4. Spiny ribbing strongest on the posterior slope of the upper valve. Cardinal area and beak generally turned backwards. Color orange to wine-red.

S. calcifer

Spondylus princeps Broderip

Plate 22, figures 4, 5, 6, 8;
Plate 86, figures 1, 1a, 4

Spondylus princeps Broderip, 1833, Proc. Zool. Soc. London, pt. 2, p. 4. (ad Insulam Platam, Columbiae Occidentalis).—Reeve, 1856, Conch. Icon., vol. 6, *Spondylus*, pl. 2, fig. 9.—Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 2, No. 5, pp. 62, 63.

Spondylus dubius Broderip, 1833, *op. cit.*, pt. 2, p. 4.

Spondylus leucacantha Broderip, 1833, Proc. Zool. Soc. London, pt. 2, p. 5. (ad Insulam Platam).—Sowerby, 1848, Thes. Conch., vol. 1, p. 423, No. 14, pl. 87, figs. 35, 36.—Reeve, 1856, Conch. Icon., vol. 6, *Spondylus*, pl. 2, fig. 6.

Spondylus unicolor Sowerby, 1847, Proc. Zool. Soc. London, p. 86.—Sowerby, 1848, Thes. Conch., vol. 1, *Spondylus*, pp. 423, 424, pl. 85, fig. 19.

Spondylus pictorum Sowerby, 1848, Thes. Conch., vol. 1, *Spondylus*, p. 422, No. 13, pl. 86, fig. 28; pl. 86, fig. 45.—Reeve, 1856, Conch. Icon., vol. 6, *Spondylus*, pl. 6, fig. 24 Isla la Plata. Probably not of Chemnitz, 1784.

Spondylus crassisquama of some authors but not of Lamarck, 1819.

Shell of medium or large size, rounded, subcircular, pectiniform, sub-equivalve, attached by the umbone of the lower valve, the attachment scar small or of medium size. Sculpture of the upper valve of widely spaced or closely crowded spines arranged in radial rows of primary, secondary, and tertiary strength, the primary spines often much enlarged, elongate spike-like or flattened or fluted, sometimes divided at the ends. The primary spines are set in six rows; the space between each pair carries a secondary row of spines, in turn bordered on each side by one or two rows of much smaller tertiary spines; if the space between the spines is wide and open, its surface is marked with a minute sculpture like that of the weave of coarse linen. Cardinal area of the lower valve, high, triangular, its tip usually straight. External color varies from white through orange to wine and coral-red, the spines similar or with lighter tints. Interior white, porcellaneous, the ventral margin bordered by a wide, colored band, usually reddish purple.

As noted by Hertlein and Strong, there is some uncertainty as to the earliest name which should be used for this species. In some collections, the species is often labelled *S. crassisquama* but as pointed out by Favre in his work illustrating the Lamarckian types of fossil pelecypoda, the original specimen of *crassisquama* is a fossil shell from Cartagena, Colombia (possibly of Miocene age). The *S. pictorum* of Sowerby (Thes. Conch.) is a typical specimen of *princeps* from Isla la Plata (the type locality). As also noted by Hertlein and Strong, the *pictorum* of Chemnitz, 1784 was based on a badly worn specimen showing little surface sculpture and said to be from the Aegean or Mediterranean seas. *S. unicolor* Sowerby, described without

indication of locality, is probably the name which should be used for the northern or Gulf of California subspecies.

***Spondylus princeps princeps* Broderip**

Plate 22, figures 4, 8;
Plate 86, figures 1, 1a

Spondylus princeps Broderip, 1833; *Spondylus pictorum* Sowerby, 1847.

The typical subspecies.

Shell usually regular in shape, the valves seldom showing much distortion, the attachment area usually small. Valves not strongly convex. Sculpture of crowded, or close-set, short or medium-length, spikelike spines. Primary and secondary spines set in six rows, the tertiary in pairs of two in the space between the primary and central secondary (four in the larger interspaces between the primaries). Inner marginal band wide and deeply colored. External color orange or coral red, the spines colored the same.

Length 130 mm.; height 135 mm.; diameter of both valves 79 mm.

The type of this subspecies, now at the British Museum (Nat. Hist.) was collected by Cuming at Isla la Plata off the coast of Ecuador. The attachment scar on the lower valve is relatively small and is bordered on one side by a few, small, cross foliations. Its color is a uniform coral red.

This is the common *Spondylus* along the coast of Ecuador and is often found in Indian graves in northern Peru far south of its known, present-day range. It is possible that it was used by the aborigines for the carding of wool. The subspecies is readily distinguished by its crowded, spikelike spines, showing no open spaces between them.

Range—Panama southward to northwestern Peru. Ecuador: Manta; Isla la Plata; Santa Elena. Peru: Zorritos; Caletto Sal; Indian graves in the Chira Valley; Chiclayo.

***Spondylus princeps leucacanthus* Broderip**

Plate 22, figure 5;
Plate 86, figure 4

Spondylus leucacantha Broderip, 1833

Shell regular or moderately distorted in shape, the sculpture more open or less crowded together, the primary spines longer, fluted or foliated at the ends, white, yellow and lighter in color than the main body of the shell. Inner margin of valves deeply colored.

Range—Along the coast of Ecuador. Ecuador: Isla la Plata.

***Spondylus princeps unicolor* Sowerby**

Plate 22, figure 6

Spondylus unicolor Sowerby, 1847.

Shell regular in shape, with rounded, symmetrical, pectiniform, subequal valves, strongly convex. Attachment usually by a small area of the beak only, the attachment scar hence small, and the shell possibly becoming free in some cases. External sculpture similar on both valves and usually consists of six rows of large, primary spines, widely separated, each primary interspace with a central line of secondary spines bordered on each side by a much smaller line of tertiary spines; in between the spines, the space is still wide, and shows generally fine, scabrous, linen-like markings. Color ranging from white through orange to coral-red. Interior porcellaneous-white with a deeply colored marginal band.

Figured specimen: length 93 mm.; height 100 mm.; diameter of both valves 53 mm.

Spondylus unicolor was described without indication of locality, but there is little doubt that it represents the common form in the Gulf of California. The subspecies differs from the typical form by its sparser sculpture and wider primary interspaces, each bearing three smaller rows of spines (secondary and tertiary). Many specimens show hardly any attachment scars, and the two valves may be nearly alike in shape, convexity and sculpture, and the colored inner band is often narrow.

Range—Gulf of California and southward. Mexico: Gulf of California.

Spondylus calcifer Carpenter

Plate 22, figures 2, 2a

Spondylus limbatus Reeve, 1856, Conch. Icon., vol. 6, *Spondylus*, pl. 9, fig. 54 Panama and Mazatlan. Not of Sowerby, 1847.

Spondylus radula Reeve, 1856, *op. cit.*, pl. 14, fig. 52 Tehuantepec.

Spondylus calcifer Carpenter, 1856, Cat. Mazatlan Shell, Brit. Museum, pp. 152, 155 Mazatlan.

Spondylus smithi Fulton, 1915, Jour. of Conch., vol. 14, No. 12, p. 357, no. 66. New name for *S. radula* Reeve, not of Lamarck, 1806.

Shell of medium or large size, often becomes coarse and heavy, rounded or much deformed due to fixation and growth, the valves then unsymmetrical in shape and in details of sculpture. Attachment is usually by a major part of the surface of the lower valve, often along one side of the umbonal slope, the free surface covered with foliated concentrics which aid in fixation. Surface of the upper valve sculptured with numerous rows of radial spines, short or of medium length; on the middle of the disk, these spines are largest and of uniform size (not divided into sets of primary, secondary, or tertiary strength) but diminish in strength towards the sides and may be wholly absent from the anterior slope. Radial spaces between the ribs is usually wide and plainly marked with fine and coarse threads, the middle one sometimes bearing small spines. Color usually purple or violet, the inner cavity white, the crural teeth brownish or more darkly stained, the ventral margin bordered by a wide, deeply colored band.

S. calcifer seems to be a distinct species although some shells may not always be readily distinguishable from large, gerontic specimens of the *princeps* group. A small shell figured by Myra Keen as the young of *S. calcifer* is thickly covered with small thin spines and looks very different from young shells of *S. princeps* of the same size. According to Carpenter, Cuming first saw this species on a small island in the Bay of Panama, where the natives dive for them to burn for lime. He broke up many specimens for their contents, but they were too cumbersome for removal, "some of them being more than a foot high and a foot broad".

Range—Gulf of California south to Panama and perhaps to Peru. Mexico: Mazatlan. Panama: Venado Beach; Pearl Islands.

Family PLICATULIDAE

Shell monomyarian, ostreiform, rounded, trigonal or spatulate, often irregular but with the valves more or less equal in shape and sculpture, solid, attached by the umbonal surface of either valve. Sculpture is formed by coarse, radial ribs or sharp plications, sometimes smooth, the ribs irregular, wrinkled by lines of growth and in some species, coarsely scabrous

but never spinous. Ligament is internal, seated in a narrow, deeply grooved, median resilifer or fossette flanked by a pair of large crural teeth, fluted or corrugated on their sides and in their respective sockets.

The Plicatulas have sometimes been referred to the Spondylidae from which they differ by their more irregular, less *Pecten*-like shape, lacking ears or auricles; also by the absence of a cardinal area in one valve and nonspinous sculpture. Much distorted specimens are easily mistaken for small oysters.

Genus **PLICATULA** Lamarck, 1801

Type species by subsequent designation, Anton, 1839, *Spondylus plicatus* Linné or by Gray, 1847, *Plicatula gibbosa* Lamarck.

Shell generally small, irregular or distorted, externally resembling an oyster but internally with the hinge provided with interlocking crural teeth. The valves are subequal, irregular, cemented by the beak or umbone of either valve. The external surface weakly or strongly folded or plicated. The cardinal area is small, subtrigonal, a little larger in the right valve but not showing a persistent slit or groove for the resilifer extending towards the beak as in *Spondylus*. The hinge has two strong, fluted crural teeth which fit into sockets, the teeth in the right valve bordering the resilifer pit. The valve margins may be smooth or pustulate and usually form a narrow or wide band which is the exposed portion of the outer vitreous layer, white in some species, dark-colored in others. The simple pallial line lies a short distance within the ventral margin.

All species of *Plicatula* are distorted due to the irregularities of the surface to which they have been cemented; in forms which show only a small attachment scar, the free surface of the valves is generally strongly sculptured with sharp plications and folds; other shells living in more exposed situations, the area of attachment is large and may cover the whole surface of the lower valve. Although some species of Plicatulas are common, their small shells are often mistaken for small oysters, and if worn and encrusted, do not have a high appeal to the general collector. At the present time, and until larger series of reasonably well-preserved material becomes available, the standing of the few species of *Plicatula* described from the Panamic region cannot be properly assessed.

Plicatula penicillata Carpenter

Plicatula penicillata Carpenter, 1856, Cat. Mazatlan Shells, Brit. Mus. p. 155 Bay of Fonseca, Cuming.—Sowerby, 1873, Conch. Icon., vol. 19, *Plicatula*, pl. 1, fig. 3.—Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 2, p. 63.

Shell variable in size and shape from nearly circular, flattened forms to irregularly humped, elongate-ovate types, the lower valve is usually broadly attached over most of its surface. Upper valve may show a few, irregular, ill-defined riblets around the margin or the whole surface may be flat and plain or with an occasional short, hollow, spinelike elevation rising above it. The outer or upper layer of the shell has a subcellular structure giving to it a slightly subtranslucent luster, colored with a light flush of reddish brown arising from a close sprinkling of small reddish streaks, lines or spots. Interior mostly white, or with a mottling of darker color showing through the porcellaneous inner layer, the teeth colored brown.

Range—Gulf of California to Ecuador. Colombia: Isla la Gorgona. Ecuador: Coast between Punta Blanca and Puerto Callo; Santa Elena.

***Plicatula spondylopsis* Rochebrune**

Plicatula spondylopsis Rochebrune, 1895, Bull. Mus. Nat. Hist. Paris, vol. 1, p. 242 "Laguna des isles de San Jose, Gulf of California".—Lamy, 1939, Jour. de Conchyl., vol. 83, No. 1, p. 23.—Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 2, pp. 63, 64, pl. 1, figs. 15, 16.—Durham, 1950, Mem. Geol. Soc. America, No. 43, p. 69, pl. 15, fig. 2 fossil, Lower California.

Plicatula ostreivaga Rochebrune, 1895, *op. cit.* p. 242.

Shell roughly trigonal in shape, thick, ornamented by coarse radial plicated sculpture, which, however, may be partially or almost wholly absent on some specimens; two hinge teeth in each valve. In perfect shells the exterior is colored purple and the interior white, with dark spots around the corrugated margin. Muscles scar nearer the posterior margin. A very narrow space is occupied by the animal.—(Hertlein and Strong, 1946.)

Differs from *P. penicillata* by its smaller area of attachment, usually thicker, vaulted shell, and strong ribs. Some specimens of *Plicatula* in the U. S. National Museum, probably belonging to this species are sharply plicated and resemble *P. gibbosa* Lamarck of the Western Atlantic.

Range—Gulf of California to Ecuador and Galapagos.

***Plicatula anomoldes* Keen**

Plicatula anomoides Keen, 1958, Bull. Amer. Paleont., vol. 38, No. 172, p. 241, pl. 31, figs. 4, 7, 8.

Shell nearly circular in outline, white, thin, with faint divaricating radial ribs, especially near the beaks; interior shining white, with, on most specimens, one or more greenish blotches. Lower valve firmly cemented to substrate and, therefore, tending to reproduce the irregularities of its surface. Hinge strong, with two serrate crura in either valve, difficult to disengage without damage to the shell. Coalesced adductor muscle scars large and slightly posterior to a line drawn vertically through the beaks. (Keen, 1958.)

Range—Guaymas, Mexico.

Family PECTINIDAE

Shell monomyarian or provided with a single adductor muscle, the scar of which is placed slightly posterior of the middle. Valves subcircular, subtriangular, equilateral or nearly so, the beaks and umbones placed medially, usually with the dorsal submargins below the hinge line, deeply impressed forming triangular wings or ears, the anterior ear of the right valve often cut into by a deep byssal notch. The two valves may be alike in shape, convexity and sculpture, or they may be quite different; in the latter case, the right valve is larger, more convex, the left valve flat and depressed. Surface may be sculptured with large, strong ribs which corrugate the ventral margins, or the surface may be practically smooth or with concentric markings only. Hinge line straight edentulous or with strong crural elements and sometimes striations. Ligament is mainly attached to a resilifer in the shape of a central triangular pit below the beak. The surface of the shell often colored, the pattern highly variable.

This family contains the scallops or Pectens, a large and important

group of monomyarian bivalves, most plentiful and often growing much larger in cool or temperate waters. Their geologic history is long, extending back into the Paleozoic. The Pectens offer special difficulties in their classification and more than a 100 generic and subgeneric names have been proposed for them but complete intergradations seem to occur between all the principal groups. In this work, the Panamic species will be distributed as follows.

Key to Genera and Subgenera

- I. Shell with very unequal valves, the lower or right valve being inflated or convex and with an incurved beak, while the left valve is nearly or quite flat, depressed or concave and fits closely inside the margin of the right valve when shut.

Genus *Pecten*

1. Subgenus *Ewola*. Relatively thin, the surface of the right valve nearly smooth or with low, rounded ribs separated by narrowly grooved or lined interspaces, the upper or left valve more heavily sculptured. Distribution, Caribbean, and West Atlantic; absent from the Panamic-Pacific region.
2. Subgenus *Pecten, sensu stricto*. Shell heavier, both valves strongly ribbed and generally with longitudinally corded or striated subsidiaries.
3. Subgenus *Flabelliptecten*. Similar to *Pecten, s.s.*, but the right valve is typically less convex, and the ribs are flatter, crossed mainly by concentric subsidiaries.

- II. Shell with the valves more or less equal in shape and convexity and if any difference exists, the upper or left valve is the more convex.

- A. Shell with an external sculpture of strong, radial ribs.
 - a. Shell often quite large, the ribs elevated, rounded, the surface of both ribs and interspaces coarsely longitudinally corded or striated.

Genus *Lyropecten*

4. Subgenus *Nodipecten*. Umbonal surface of valves often more or less undulated, the ribs strong, often humped or noded.
 - b. Large or small Pectens with nearly equal valves, the ribs low, rounded or squarish and overrun by relatively fine subsidiaries. Ears are subequal in size, that of the right anterior bearing a byssal notch.

Genus *Aequipecten*

5. Subgenus *Aequipecten, ss.* Generally large or medium-sized shell, the ribs and interspaces more or less roughened by a scabrous sculpture.
6. Subgenus *Plagiectenium*. Medium to large shells, the sculpture formed by squarish ribs and a series of subsidiary concentric threads looped across the ribs and their interspaces.
7. Subgenus *Leptopecten*. Kelp Pectens. Small, thin-textured shells, usually with wide, unsymmetrical valves, squarish ribs and subsidiary concentrics.
8. Subgenus *Paciptecten*. Fairly strong textured Pectens with circular slightly convex, symmetrical valves with numerous rounded or flat-topped ribs. Valves unlike in color, the right valve white, the other dark.
 - c. Large or medium-sized Pectens with high and narrow valves and unequal ears, the anterior one much the larger.

Genus *Chlamys*

9. Subgenus *Chlamys*, s.s. Ribs small, numerous, sometimes cordlike and rendered scabrous by the intersection of strong longitudinals and concentrics. Mostly in cold waters.
10. Subgenus *Flexopecten*. Small shells with relatively few, large, high ribs as if the valves had been sharply folded.
- B. Shell without pronounced external sculpture, the surface often smooth and polished. Valves thin.
- Genus *Amusium*
11. Subgenus *Amusium*, s.s. Shell often large, thin, rounded and disklike, gaping at both ends, both valves smooth, polished but with strong internal simple or paired ribs.
12. Subgenus *Cyclopecten*. Shell very small, thin, with unequal valves and generally discrepant sculpture, the right valve often completely smooth, the left with concentric and faint radials. No internal lirae.

Genus PECTEN Müller, 1776

Type species by subsequent designation, Schmidt, 1818, *Ostrea maxima* Linné.

Shell pectiniform, equilateral or nearly so, with median umbones and beaks, inequivalve, the right valve convex, often deeply so, the left valve flattened or depressed. The single adductor scar is large, rounded and placed slightly posterior of the middle line. Surface sculptured with radial ribs, those of the right valve larger and rounded, those of the left valve usually smaller, narrower, and with wider interspaces; concentrics may also be present. Ears subequal, the anterior ones without a strong byssal notch.

Three species.

Key to species of *Pecten*

- I. Right valve is deep and strongly convex. Ratio of diameter to height about 1 to 3.
1. Shell rather large (length 70 to 100 mm.). Ribs of the right valve rounded, simple; of the left valve flattened, with rather narrow interspaces.
- P. vogdesi*
2. Shell much smaller, thinner, generally less than 40 mm. in length. Ribs of the right valve, more or less deeply grooved ventrally; of the left valve, narrower with wider interspaces carrying an intercalary riblet.
- P. perulus*
- II. Right valve shallow, the convexity rather small. Ratio about 1 to 8.
3. Shell large or of medium size (length 50 to 70 mm.). Ribs of right valve become bi- or tri-carinate at the end; those of the left remain simple.

P. sericeus

Subgenus PECTEN s.s.

Shell large, widely ovate, the right valve moderately convex, the left valve flat with arched submargins and deeply impressed umbone and beak. Sculpture is formed by strong, rounded ribs between concave interspaces, the whole surface overrun by fine corded radials, the intervals between the radial cords further ornamented with the edges of close-set concentrics. Ears are subequal in size without a defined byssal notch. Hinge bearing strongly wrinkled crura.

Pecten (Pecten) vogdesi Arnold

Plate 20, figures 4-4b

- Pecten dentatus* G. B. Sowerby, 1835, Proc. Zool. Soc. London, p. 109 (not *P. dentatus* J. Sowerby, 1829).—Sowerby, 1842, Thes. Conch., vol. 1, *Pecten*, p. 49, No. 11, pl. 15, figs. 105, 106 (Santa Elena, probably incorrectly).
- Pecten (Euvola) cataractes* Dall, 1914, Nautilus, vol. 27, p. 121 (new name for *P. dentatus* G. B. Sowerby).
- Pecten (Pecten) vogdesi* Arnold, 1906, U. S. Geol. Survey, Prof. Paper 47, p. 100, pl. 33, figs. 1, 1a; pl. 34, fig. 1. (Pleistocene, San Pedro, Calif.).—Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 2, p. 57.—Durham, 1950, Mem. Geol. Soc. America, No. 43, p. 61, pl. 8, figs. 4, 6.
- Pecten (Janira) vogdesi* Arnold, Grant and Gale, 1931, Mem. San Diego Soc. Nat. Hist., vol. 1, pp. 228, 229, pl. 3, figs. 3a, 3b.
- Pecten (Pecten) excavatus* Arnold, 1906, *op. cit.*, pp. 134, 135, pl. 46, figs. 1, 1a, 1b (not of Anton, 1839).

Shell large (altitude 70 to 100 mm.), slightly longer than high, inequivalve, the right valve being convex, its umbone projecting above the hinge line, the left valve concave, equilateral, and with more or less serrate margins. Ribs in the right valve about 20; these are wide, low and rounded, broader than high, separated by narrower interspaces, their surface smooth except for incremental lines which loop across them. Ribs in the left valve about 19; these are narrow, squarish, flat-topped, about equal in width to their interspaces, sometimes longitudinally sulcated or ridged, interspaces flat-bottomed, usually with a well-developed mid-rib, the surface sculptured by numerous fine, sharp concentric lines, more marked in the interspaces. Ears subequal, the right anterior with a byssal notch. Color salmon or salmon-pink, the left valve usually darker.

The type of *P. vogdesi* is a shell from the Pleistocene of San Pedro, California. Arnold considered it as distinct from the Recent species which he identified as *P. excavatus* Anton, a Chinese and Japanese species. All later writers agree that the fossil and Recent forms belong to the same species. Although Sowerby described *P. dentatus* as from Santa Elena, this locality citation is perhaps erroneous, due to mixed labels. The present writer has seen no authentic specimens south of Mexico.

Range—Magdalena Bay, Lower California, Gulf of California to Panama. For records see Hertlein and Strong.

Pecten (Pecten) perulus, new speciesPlate 20, figures 3-3c;
Plate 21, figures 3, 3a

The shell is small or of medium size, seldom exceeding 40 mm. in height, thin. The right valve is strongly convex, its curvature nearly that of a half circle whose greatest convexity lies just above the middle, the surface of the umbone sloping downward to an appressed beak. Ribs of the right valve number about 22, almost obsolete near the beak, strengthening across the middle zone and generally mesially grooved on the ventral portion, their interspaces concave and flattened. The left valve is smaller, rather deeply depressed or flattened in the middle, its lateral submargins elevated, flaring and smoothish. Ribs on the left valve are fewer in number, usually 17 or 18; these are narrow, simple above, widening a little ventrally and separated by much wider interspaces, each of which generally carries an intercalary riblet. Surface of both valves, if well preserved, is uniformly covered with close-set, raised concentrics which loop up and down across the ribs and their interspaces. In the interior, the external ribbed sculpture

is shown in the reverse, mostly around the margin but the flutings of the ribs are shallow and do not indent the margin. Color of the valves is mostly wine-red, the umbones, especially of the right valve much lighter, sometimes white. Left valve is generally maculated more strongly than that of the right. The interspaces on the right valve generally finely speckled with white dots. Interior mostly white, except in the umbonal cavity which may be yellow and for a small, narrow, colored margin in the right valve; not developed in the left.

Length 34.6 mm., height 31.5 mm., diameter 10.7 mm. double valves, length of hinge line 18 mm. Venado Beach, Canal Zone.

Length 40.05 mm., height 37.8 mm., diameter 24.3 mm. right valve. Santa Elena, Ecuador.

Length 38.7 mm., height 34.1 mm., diameter 5 mm. left valve. Manglaralto, Ecuador.

This small species has often been confused with the much larger *Pecten vogdesi* Arnold and perhaps most, if not all, records of *P. vogdesi* from Panama southward may be based on this species. In addition to its much smaller size and lighter texture, *Pecten perulus* differs by its lower convexity of the right valve, its lower umbone which does not rise above the hinge margin and by its sulcated or mesially grooved ribs. The left valve differs by its wider, more flaring submargins and especially by its narrower ribs, and much wider interspaces, each carrying an intercalary riblet.

Local but well distributed from Panama southward to northern Peru.

Range—Panama south to northern Peru. Panama: Guanico. Canal Zone: Venado Beach. Ecuador: Santa Elena; Manglaralto; Canoa; Manta. Peru: Mancora; Caleto Mero; Lobitos.

Subgenus FLABELLIPECTEN Sacco, 1897

Type species by original designation and tautonomy, *F. flabelliformis* Brocchi.

Shell generally large or of medium size and of medium weight. Right valve weakly to moderately convex, the left valve flat with arched submargins and flattened or depressed beak and umbone. The sculpture is commonly formed by rather numerous low ribs, rounded in the right valve and spaced between narrower interspaces, while the ribs of the left valve are narrower, their interspaces somewhat wider and often showing an interstitial thread or riblet; in addition, the whole surface is thickly over-run by concentric threads looped over the top of the ribs and across the interspaces; on the left valve, the concentric threads are heavier and show especially well in the interspaces. Ears are subequal in size and shape, the byssal gap small. Hinge area carries strong crura, the right valve having two crural teeth on each side of the ligament pit or resilifer, the left valve with one only, the surface of the crura being finely wrinkled. Interior with the radial flutings extending about a third of the way in from the margin.

This is an important fossil group in rocks of Miocene age. It is represented in Panama and Costa Rica by *Pecten gatunensis* Toula and *Pecten macdonaldi* Olsson. Closely allied to these species in the Recent fauna are *Pecten sericeus* and its close relative *P. diegensis* Dall of Californian waters.

Pecten (Flabellipecten) sericeus HindsPlate 19, figures 3, 3a;
Plate 21, figure 4*Pecten sericeus* Hinds, 1845, Zool. Voy. *Sulphur*, Moll., pt. 3, p. 60, pl. 17, figs. 1, 1a
Bay of Panama.*Pecten (Pecten) sericeus* Hinds, Hertlein, 1935, Proc. California Acad. Sci., ser. 4, vol. 21, No. 25, p. 303, pl. 18, figs. 14, 15; pl. 19, figs. 3, 4.—Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 2, pp. 56, 57.

Shell relatively large, thin, inequivalve, the beaks appressed or flattened at the tip, the right valve of medium convexity, the left valve depressed and flattened. Both valves have about 24 ribs, the end ones small, only about 20 produce flutings on the inner margin; in the right valve the ribs are at first rounded, then trigonal, and finally becoming tricarinated at the ventral margin, their interspaces as wide or wider, round or flat-bottomed; in the left valve, the ribs are narrowly trigonal and low, their intervals much wider and sometimes carrying an intercalated riblet near their ventral margin; whole surface in both valves is overrun with close-set, raised, concentric threads, at first regular, but on the lower half of the disk are more irregular, sometimes crowded together, and divided into bands by resting lines. Interior shows the flutings of the ribs in reverse, the interspaces between the external ribs form flattened ribs, their sides are thickened and raised. Color is a pale light-brown or cream, faintly suffused with red on the umbones. Ears of both valves relatively large and equal.

Length 66.2 mm., height 63.4 mm., diameter 13.2 mm.

Length 58.5 mm., height 56.2 mm., diameter 11.4 mm. Arena Bank, Gulf of California in 50 fathoms. Calif. Acad. Sci. 17715.

I am indebted to Dr. L. G. Hertlein of the California Academy of Sciences for being able to examine and photograph specimens of this fine *Pecten*. Although widely distributed, the species is apparently rare and may be obtained only by dredging.

Range—Gulf of California to Ecuador. Mexico: Arena Bank, Gulf of California; Santa Inez Bay; Gorda Bank; off Clarion Island (all Hertlein and Strong). Costa Rica: Port Parker (H. and S.). Panama: Hannibal Bank west of Coiba Island (H. and S.); near Cocos Island (Dall). Panama Bay (Hinds).

Genus **LYROPECTEN** Conrad, 1862

Type species by subsequent designation, Dall, 1898, *L. estrellanus* Conrad. Miocene of the Pacific coastal states.

Shell large with convex valves, that of the left is slightly more inflated than the right. Ribbed sculpture strong, formed by large, rounded or angular ribs, their summits and intervals overrun by fine or coarse scabrous longitudinal cords. Ears unequal, the posterior one smaller, the right anterior generally with a deep, byssal notch.

Subgenus **NODIPECTEN** Dall, 1898

Type species by original designation, *Pecten nodosus* Linné. Florida and the Caribbean.

Shell usually large and coarse, both valves with nearly equal convexity and similarly sculptured with large, corded ribs, often with nodes or humps along them.

Nodipecten is a natural group with several species in the Recent and late Tertiary faunas.

***Lyropecten (Nodipecten) subnodosus* (Sowerby)**

Plate 20, figures 1-1b;
Plate 21, figures 5, 5a

Pecten subnodosus Sowerby, 1835, Proc. Zool. Soc. London, p. 109.—Sowerby, 1843, Thes. Conch., vol. 1, *Pecten*, p. 65, pl. 15, figs. 97, 112.—Reeve, 1852, Conch. Icon., vol. 8, *Pecten*, pl. 4, fig. 20.

Pecten nodosus subnodosus Sowerby, Maxwell Smith, 1944, Panamic Marine Shells, p. 52, fig. 692 D.

Pecten (Lyropecten) subnodosus Sowerby, Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 2, p. 58.

Lyropecten subnodosus (Sowerby), Durham, 1950, Mem. Geol. Soc. America, No. 43, pt. 2, p. 65, pl. 11, fig. 1.

Shell large, coarse, the adult often attains a height of 4 to 4½ inches. Both valves are similar, not strongly convex. Most specimens of the typical form have 10 ribs in the left valve and 11 ribs in the right, counting the deep furrows around the ventral margin. The ribs are as wide as their intervals, both covered with a series of close-set, coarse, slightly scabrous radial cords; there are usually a scattering of small or coarse, sometimes hollow nodes or humplike swellings along the summit of the ribs, best developed on the left valve. Color is usually a deep rose-purple or wine red, often lightly or heavily maculated, the variation in color being less than in the Caribbean forms of *L. nodosus*. Interior of the right valve is usually white with a colored marginal border, the left valve, the same color as the exterior but of a lighter shade, merging into white in the umbonal cavity. Ears unequal in size, the anterior larger and longer, that of the right valve with a deep notch.

Length 95.2 mm., height 93.7 mm., diameter 30.1 mm., length of hinge 48 mm. Manta, Ecuador.

The largest specimen of *L. subnodosus* seen from Ecuador has a height of about 110 mm. A large specimen of subspecies *L. intermedius*, recorded by Hertlein and Strong, has a height of 150 mm.

Northern forms from the Gulf of California have generally one less rib and have been separated as subspecies *L. intermedius* (Conrad) by some authors. This shell was noticed as variety 1 by Sowerby and shown by his figure 97 in the Thesaurus. It appears to be closely related to *nodosus* from the Caribbean. *Lyropecten nodosus* of the Caribbean and Western Atlantic can generally be separated from *L. subnodosus* by its broader, wider, and more rounded form, has one less rib, and the ribs are more coarsely sculptured with heavier, cordlike secondary radials and is more strongly nodose.

Range—Mexico to northern Peru. Costa Rica: Puntarenas. Panama and the Canal Zone: Bahia Honda and Hannibal Banks (Hertlein and Strong); Venado Beach in the Canal Zone. Ecuador: Santa Elena; Manglaralto; Punta Blanca; Isla la Plata; Manta. Peru: Mancora; Negritos.

***Lyropecten (Nodipecten) magnificus* (Sowerby)**

Plate 22, figure 1

Pecten magnificus Sowerby, 1835, Proc. Zool. Soc. London, p. 109, var. a Gallapagos; var. b Isla la Plata.—Sowerby, 1842, Thes. Conch., vol. 1, *Pecten*, p. 65, No. 60, pl. 15, fig. 114.—Reeve, 1852, Conch. Icon., vol. 8, *Pecten*, pl. 2, fig. 9.

Pecten (Lyropecten) magnificus Sowerby, Grant and Gale, 1931, Mem. San Diego Soc. Nat. Hist., vol. 1, pp. 182, 183, pl. 9, fig. 1; pl. 10, fig. 6.

Generally similar to *L. subnodosus* but with more numerous ribs (13 to 15), the nodes usually smaller or absent and with less heavily sculptured ears.

Range—Ecuador and the Galapagos Islands.

Genus **AEQUIPECTEN** Fischer, 1887

Type species by monotypy, *Chlamys opercularis* Linné. Recent, Europe.

Shell small or large, subequivalve, the left valve somewhat more inflated than the right. Sculpture formed by fairly numerous, rounded or flat-topped ribs between fairly wide, shallow or deep, narrow interspaces, the surface of both ribs and interspaces overrun by subsidiary longitudinals or concentrics. Ears subequal, the right anterior cut into by a byssal notch. Resilifer or chondrophore is fairly wide and deep, flanked on each side by a cardinal crura.

Subgenus **PLAGIOCTENIUM** Dall, 1898

Type species by original designation, *Pecten ventricosus* Sowerby (= *circularis* Sowerby).

Valves subequal, convex, with strong ribs without radial striation but with a minute sculpture of raised, concentric threads or lamellae looped across the ribs and interspaces, widely spaced on the umbones, more closely crowded ventrally. Submargins impressed, smoothish. Auricles subequal, the right anterior ear with a deep, byssal notch. A set of strong, crural teeth in the right valve fitting into sockets in the left, minutely, vertically striated.

Two species.

I. Shell large, often 100 mm. or more. Both valves with moderate convexity, Peruvian faunal area.

A. purpuratus

II. Shell of medium size, 60 mm. or less. Both valves are strongly convex. Entire Panamic-Pacific faunal area.

A. circularis

Aequipecten (Plagioctenium) purpuratus (Lamarck)

Plate 19, figures 1-1b

Pecten purpuratus Lamarck, 1819, Hist. Anim. s. Vert., vol. 6, pt. 1, p. 166.—Sowerby, 1843, Thes. Conch. vol. 1, p. 52, pl. 15, fig. 113; pl. 16, figs. 123-125.—Reeve, 1852, Conch. Icon., vol. 8, *Pecten*, pl. 5, fig. 25.—Dall, 1910, Proc. U. S. Nat. Museum, No. 37, pp. 149, 256, pl. 26, figs. 5, 6.

Shell of medium or large size (up to about 130 mm.), circular, subequivalve and moderately inflated, the right valve generally a little more convex and with a higher umbone. On typical specimens, ribs number from 21 to 23 merging into the smaller riblets on the sides. The ribs of the right valve have a flattened, rectangular section, much wider than their deeply grooved interspaces. Ventrally, the ribs appear to widen, their corner angles bevelled off and crossed by squamose, elevated threads. Ribs on the left valve are generally more triangular in section, their summits if flattened, narrower and their sides more deeply bevelled. Interspaces and sides of the ribs are covered by evenly spaced, squamose cross threads. Large specimens may have one or more interstitial riblets in the interspaces. The color is generally some shade of violet or purple, plain or mottled, the interior white or with brownish discoloration.

This is typically a cold-water scallop of the Humboldt Current and attains its best development along the coast of Peru southward from the Bay of Sechura. More northerly records are questionable. In Peru, it is a highly esteemed seafood, commonly appearing in the markets of Lima by the name of "senoritas". As fossil, it is plentiful in the Peruvian tablazos and in those of southern Ecuador. Grant and Gale considered certain fossil *Pectens* from the Pliocene of southern California as subspecies of *purpuratus*. *A. purpuratus* is strikingly similar to members of the *A. eboreus-solarioides* group from the Miocene and Pliocene of Florida and the south Atlantic states.

Range—Coastal waters of Chile and Peru northward to Paita and Sechura.

Aequipecten (*Plagioctenium*) *circularis* (Sowerby) Plate 19, figures 2-2b

Pecten tumidus Sowerby, 1835, Proc. Zool. Soc. London, p. 109. Not *P. tumidus* Turton 1822, nor Zeiten, 1830.

Pecten circularis Sowerby, 1835, Proc. Zool. Soc. London, p. 110 (Guaymas).—Sowerby, 1842, Thes. Icon., vol. 1, p. 51, pl. 12, fig. 23.—Reeve, 1852, Conch. Icon., vol. 8, *Pecten*, pl. 31, fig. 137.

Pecten (*Plagioctenium*) *circularis* Sowerby, Arnold, 1906, U. S. Geol. Survey, Prof. Paper 47, pp. 125, pl. 42, figs. 3, 4, 5, 6; pl. 44, figs. 6, 6a, 6b, 7.—Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 2, pp. 57, 58.—Hertlein and Strong, 1955, Bull. Amer. Mus. Nat. Hist., vol. 107, art. 2, pp. 179, 180.

Pecten (*Aequipecten*) *gibbus* (Linnaeus) variety *circularis* Sowerby, Grant and Gale, 1931, Mem. San Diego Soc. Nat. Hist., vol. 1, pp. 218, 219.

Pecten ventricosus Sowerby, 1842, Thes. Icon., vol. 1, p. 51, no. 19, pl. 12, figs. 18, 19, 26. (New name to replace *tumidus*).—Reeve, 1852, Conch. Icon., vol. 8, *Pecten*, pl. 7, figs. 31a, b.

Valves strongly and nearly equally convex, the average size from 45 to 60 mm. Ribs 20 to 22; in the left valve, the ribs are low, rounded, between narrowly grooved interspaces while in the right they are higher, rectangular to subtriangular, their sides somewhat bevelled, their interspaces deep; both ribs and interspaces crossed by looped concentric threads. Submargins somewhat flattened and plain. Color is variable, often brilliant, ranging from plain white, pink, orange, brown, but more often lilac or mahogany brown, generally more or less mottled. The right valve is usually white within, the left often stained with brown.

This is the common *Pecten* in Panama and along the northwest coast of South America. In some localities it is quite plentiful. Fossil forms found in the Pleistocene and Pliocene beds of Ecuador and northern Peru attain a much larger size than their Recent representatives.

Most recent authors consider *A. circularis* and *A. ventricosus* as one species, the distinctions between them, if any, too slight for consistent separation. Typical *A. ventricosus* from the Santa Elena Peninsula is a rather solid shell, the adductor scar somewhat impressed and the fluted ribs show only for a narrow zone around the inner margin. Specimens from Sechura in the Paita Buffer Zone have a much thinner shell with the ribs showing plainly inside well into the umbonal cavity. These shells are sometimes difficult to distinguish from half-grown *A. purpuratus* but have

higher, coarser ribs, and the umbones are much more inflated. Northern shells which we have seen, are thinner than from the south, with narrower ribs, and take on the general characteristics of *A. aequisulcatus*.

Range—Lower California southward to northern Peru. Panama: Pearl Islands; Garachine; San Carlos; Búcaro; Panama City. Canal Zone: Venado Beach; Palo Seco; Fort Amador. Colombia: Gorgona Island; Isla del Gallo. Ecuador: Esmeraldas; Charapota; Jaramijo; Manta; Puerto Callo; Santa Elena; Punta Mambri. Peru: Tumbes; Zorritos; Mancora; Negritos; Bayovar.

Subgenus **PACIPECTEN**, new subgenus

Type species *Aequipecten tumbezensis* (d'Orbigny).

Shell with broadly circular, slightly convex, subequal valves, with rounded, flat-topped or triangular ribs, their interspaces as wide or wider. Surface of the ribs and interspaces smooth except for growth-line concentrics (sometimes coarsely developed around the margins of old shells) and finer, indistinct radial threads or striations. Valves dissimilar in color, the left valve much darker, the right usually white. Ears large, the posterior one spreading, the right anterior long and narrow and cut into by a deep byssal notch bordered by a few pectinate teeth. Hinge line straight, the resilifer or chondrophore large and bordered by elongated crural ridges on each side, the space above the crurae furrowed and finely wrinkled. Internal margin of shell fluted by the external ribs.

The species of this subgenus have been referred to *Leptopecten* from which they differ by their more equilateral and heavier valves. As fossil, it is represented by *A. nelsoni* Olsson from the upper Miocene, Tumbes beds of Peru.

Aequipecten (Pacipecten) tumbezensis (d'Orbigny)

Plate 21, figures 2-2c

Pecten aspersus Sowerby, 1835, Proc. Zool. Soc. London, p. 110. Tumbes.—Sowerby, 1843, Thes. Conch., vol. 1, *Pecten*, p. 51, pl. 19, figs. 198, 199. (Not of Lamarck, 1819).

Pecten tumbezensis d'Orbigny, 1846, Vol. Amér. Mérid., vol. 5, p. 663. (New name for *P. aspersus* Sowerby, not Lamarck).—Maxwell Smith, 1944, Panamic Marine Shells, p. 52, fig. 692.

Pecten sowerbyi Reeve, 1852, Conch. Icon., vol. 8, *Pecten*, pl. 1, fig. 4. (New name for *P. aspersus* Sowerby).

Pecten (Leptopecten) tumbezensis d'Orbigny, Hertlein, 1935, Proc. California Acad. Sci., ser. 4, vol. 21, No. 25, p. 314, pl. 19, figs. 11, 12.—Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 2, p. 60.—Hertlein and Strong, 1955, Bull. Amer. Mus. Nat. Hist., vol. 107, art. 2, pp. 180, 181.

Pecten cf. *latiauritus fucicolus* Dall; *P. latiauritus splendens* Li; *P. latiauritus indentus* Li, Pilsbry, 1931, Proc. Acad. Nat. Sci. Philadelphia, vol. 83, p. 429.

Shell small or of medium size, seldom above 35 mm. in height, sub-equivalve. Ribs number from 13 to 15; those of the right valve are nearly square in section between deeply grooved interspaces; those of the left valve narrowly triangular between wider interspaces. Surface is nearly smooth except for minute concentrics and still finer radial striae. The right valve is usually light-colored, white, but many specimens show a blotch of brown along posterior submargins and occasionally even in the middle; the left valve is colored dark-brown, reddish-brown to slaty black,

sometimes mottled with white and under a lens seen to be sprinkled with small white dots or streaks. Interior generally white or slaty gray. Anterior right ear with a deep, byssal notch.

Common along the beaches of northwestern Peru.

Range—Gulf of California to northern Peru. For northern records, the writer is referred to Hertlein and Strong. Panama: Panama City; Guanico. Canal Zone: Venado Beach; Palo Seco. Ecuador: Santa Elena; Manta; Esmeraldas. Peru: Tumbes; Zorritos; Mancora; Lobitos; Negritos; Paita.

Subgenus **LEPTOPECTEN** Verrill, 1897

Type species by original designation, *Chlamys monotimeris* (Conrad), [*C. latiaurita* (Conrad)]. [As a subgenus of *Chlamys*.]

Shell small, thin or of medium weight, with nearly equal and similar sculptured valves of slight convexity, that of the right valve is a trifle less. Sculpture consists of narrow, rounded ribs, their interspaces flattened and as wide or wider, the whole crossed with fine or coarse, concentric threads, and below these fine radial threads. Ears subequal, except the right anterior which is cut into by a deep byssal notch, bordered on the disk side by several, sharp, pectinate teeth.

Aequipecten (Leptopecten) velero (Hertlein)

Plate 21, figures 1-1a

Pecten (Leptopecten) velero Hertlein, 1935, Proc. California Acad. Sci., ser. 4, vol. 21, No. 25, p. 316, pl. 19, figs. 13, 14 Bahia Honda, Veragua, Panama in 3 to 9 fathoms.—Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 2, p. 60.

The shell is small, thin, flattened, the left valve noticeably inequilateral, the right valve less so, and sculptured with low, rounded or flattened smooth or slightly scaly ribs, generally about 15 in the left valve, and about 13 in the right; in the left valve, usually every third rib is somewhat larger than the others, sometimes also in the right. Spaces between the ribs on the umbones are as wide as the ribs and usually strongly sculptured with coarse cross threads; this sculpture may extend over most of the surface but usually the interspaces ventrally are smooth or nearly so. Ears are large, the anterior, right ear elongated and provided with a deep, byssal notch bordered below by small pectinate teeth. Ears are usually well sculptured, the right anterior ear with strong ribs. Color is usually a purplish red, the left valve darker and often maculated, the right valve lighter, sometimes white or yellow. Hinge line long, minutely wrinkled or striated.

Length 11.4 mm., height 11.3 mm. left valve.

Length 11.2 mm., height 11.3 mm. right valve.

A relatively small species distinguished from the young of *A. tumbezensis* by its thinner shell and stronger sculpture, the umbonal ribbed interspaces are heavily cross-threaded. Widely distributed but easily overlooked because of its small size.

I am indebted to Dr. L. G. Hertlein of the California Academy of Sciences for the opportunity of examining typical specimens of this species.

Range—Mexico to northern Peru. Mexico, El Salvador, and Nicaragua, see Hertlein and Strong; Panama: Bahia Honda (Hertlein and Strong); Concepcion beach near Las Tablas. Peru: Mancora.

Aequipecten (Leptopecten) biolleyi (Hertlein and Strong) Plate 22, figures 3, 3a

Pecten (Leptopecten) velero biolleyi Hertlein and Strong, 1946, *Zoologica*, vol. 31, pt. 2, pp. 60, 61, pl. 1, fig. 6 Port Parker, Costa Rica.—Hertlein and Strong, 1955, *Bull. Amer. Mus. Nat. Hist.*, vol. 107, art. 2, p. 181.

Shell small and thin, sculptured with about 12 or 13, rather high, sharply triangular ribs which are separated by considerably wider interspaces. When fresh, both ribs and interspaces are covered with a dense fringe of imbricated lamellae but become smooth when worn. The lateral ribs are generally larger than the others although sometimes every third rib may be somewhat accentuated. Color white and brown arranged roughly in concentric bands. Length of the type specimen, 6.9 mm., height 6.6 mm.

This subspecies is said to differ from the typical form in having fewer ribs, 12 as compared to 14 to 16.

Range—Costa Rica to Panama. Costa Rica: Port Parker. Panama: Guayabo Chiquito, Panama (all Hertlein and Strong). Ecuador: Esmeraldas.

Genus **CHLAMYS** Roeding, 1798

Type species by subsequent designation, Herrmannsen, 1847, *C. cinabarina* Roeding (= *C. islandica* Müller).

Shell large or small, thin or of moderate weight, the left valve somewhat more inflated than the right, otherwise alike in shape and sculpture. Surface sculptured most often by primary and secondary radial ribs, often rendered coarsely scabrous by intersecting concentrics. The auricles or ears in the typical species are strongly unequal, the anterior ear much larger, that of the right valve cut into by a deep, byssal notch.

The typical species of *Chlamys* comprise high, rounded, and somewhat oblique, subequivalve shells, with unequal ears and a large, deep, byssal notch. Surface with strong primary ribs and smaller interpolated ribs which increase in number with growth. The genus has been subdivided into many subgenera and sections.

Chlamys (Chlamys) lowei Hertlein

Pecten (Chlamys) lowei Hertlein, 1935, *Proc. California Acad. Sci.*, ser. 4, vol. 21, No. 25, p. 308, pl. 19, figs. 1, 2, 7, 8 Carmen Island, Gulf of California, in 20 fathoms.—Hertlein and Strong, 1946, *Zoologica*, vol. 31, pt. 2, p. 57.

Shell small, the right valve with a deep byssal notch under the anterior ear. Surface sculptured with 20 to 22 rounded, triangular, and spinose ribs. A spinose secondary riblet is present in each interspace. Color is white or grey flecked with brown or some specimens may be partly orange or reddish brown. The largest specimens attain a height of about 18.5 mm.

Range—Gulf of California and Clarion Island to Panama and the Galapagos. For locality stations consult Hertlein and Strong.

Chlamys (Chlamys) zeteki Hertlein

Pecten digitatus Hinds, 1844, *Zool. Voy. Sulphur*, Moll., pt. 3, p. 61, pl. 17, fig. 2 "Bay of Guayaquil".—Reeve, 1853, *Conch. Icon.*, vol. 8, *Pecten*, pl. 35, fig. 172.—

Dall, 1909, Proc. U. S. Nat. Museum, vol. 37, No. 1704, p. 256.—Zetek, 1918, Los Moll. Republ. Panama. Revista Nueva. Probably Panama. Not *P. digitatus* Perry, 1811, Conch., No. 2, in expl. to pl. 55, fig. 2 (Amboyna and Eastern Seas).

Pecten (Chlamys) zeteki Hertlein, 1935, Proc. California Acad. Sci., ser. 4, vol. 21, No. 25, p. 306, pl. 19, fig. 9.

Shell somewhat triangular, rather flat, solid, equal-eared, pale, clouded transversely with blood-red; valves very like, with some rounded, grooved ribs; umbones rather flat, smooth; margins minutely denticulated; white within. Reeve after Hinds.

Additional specimens of this small *Pecten* have apparently not been found since its original discovery. Dall suggested that it could well be a young *P. subnodosus*. The species will remain questionable until new material becomes available or the type (if still extant) can be reexamined.*

Gulf of Guayaquil (Hinds).

Subgenus FLEXOPECTEN Sacco, 1897

Type species by original designation, *F. flexuosus* (Poli). Mediterranean.

Relatively small shells, the sculpture of the valves similar and formed by a few, wide ribs as if the surface had been sharply folded or creased along radial lines.

Chlamys (Flexopecten) fasciculata (Hinds)

Plate 20, figures 2-2b

Pecten fasciculatus Hinds, 1845, Zool. Voy. Sulphur, Moll. Pt. 3, p. 61, pl. 17, fig. 4 "West coast of Veragua. In seventeen fathoms, among sandy mud."

Pecten (Pallium) miser Dall, 1908, Bull. Mus. Comp. Zool., vol. 43, No. 6, p. 401, pl. 8, fig. 6 "Gulf of Panama in 182 fathoms."

Pecten (Decadopecten) fasciculatus Hinds, Hertlein, 1935, Proc. California Acad. Sci., ser. 4, vol. 21, No. 25, p. 318, pl. 18, figs. 1, 2.

Pecten (Mesopeplum) fasciculatus Hinds, Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 2, p. 59.

Shell small or of medium size, slightly inequilateral and equivalve, high and narrow above, the ears small, and the hinge line short, the general surface of each valve flattish but with the basal margin contracted sharply in the adult so that the edges meet each other nearly vertical. Shell texture is rather thin, its surface folded so as to form five or six heavy ribs (more or less similar in each valve) of which the middle three are the largest; in addition, the whole surface is covered with small radial threads or cords; in the left valve, the radial threads are wider than their interspaces, the latter crossed by upward looped concentric threads producing a network of rectangular or hexagonal cells; on the right valve, the secondary riblets are larger, rounder, and are separated merely by pitted grooved lines. The ribs are absent from the turned down marginal zone, the only sculpture there is the cordlike radials. In the interior, because of the thinness of the shell, the ribs and interspaces are shown in the reverse, the edges of the ribs by a thickened cord. Ears small, the anterior one a little longer. Hinge line without crura. Color in the specimens seen is a mauve or dull raspberry red, clouded with blotches of yellow or cream.

Length 29.1 mm., height 31 mm., semidiameter 9 mm. right valve.

*Gilbert Grau's long awaited work appeared while this paper was in press: *Pectinidae of the eastern Pacific* (Allan Hancock Pacific Expeditions, vol. 23). According to Grau, the *Pecten digitatus* of Hinds is probably a juvenile specimen of *Semipallium vexillum* (Reeve), an Indo-Pacific species. He concluded that it is almost certain that the original specimen of *P. digitatus* was collected in the western Pacific during the voyage of the *Samarang* and not as stated in the Gulf of Guayaquil.

Length 30.4 mm., height 31.7 mm., semidiameter 7.7 mm. left valve.

Gorda Bank, Gulf of California in 60 fathoms. Calif. Acad. Sci. 17769.

Range—Gulf of California to Panama. Mexico: Arena Bank, Gulf of California; Gorda Bank, Gulf of California (Hertlein and Strong); Veragua (Hinds); Gulf of Panama (Dall). Depth of 17 to 182 fathoms.

Family AMUSIIDAE

Genus AMUSIUM Roeding, 1798

Type species by subsequent designation, Herrmannsen, 1846, *Ostrea pleuronectes* Linné.

Shell large or small, generally thin, the inflation of the valves usually slight, subequal, the surface without pronounced radial sculpture, often completely smooth and polished.

Subgenus *Amusium*, s.s.

Shell often large, thin, with rounded disklike valves gaping at both ends. Both valves are smooth and polished, the umbones sometimes weakly ribbed or showing colored rays which may persist on the fossils. Interior of valves showing strong radial riblets or lirae which may be arranged in pairs or singly.

No known Panamic species. Numerous Miocene species.

Subgenus CYCLOPECTEN Verrill, 1897

Type species by subsequent designation, *Pecten pustulosus* Verrill.

Shell small, thin, rounded, scarcely oblique, with symmetrical ears and simple margins. Valves discrepant in sculpture and somewhat in shape, the right valve is a little flattened and upturned at the flexible margin, so as to fit tightly against the left valve; the thin, right valve has in the typical species, regular, thin, elevated, concentrics and its margin is usually flattened; the left valve is often marked with weak radials or it may be quite smooth, sometimes carrying radial rows of arched scales, pustules or concentric lines. No internal lirae.

This is a group of small, thin-shelled species, with smooth or discrepantly sculptured valves with simple margins and no internal lirae. Most of the species are deep-water or offshore forms.

Amusium (*Cyclopecten*) *pernomus* Hertlein

Plate 21, figure 6

Pecten (*Cyclopecten*) *rotundus* Dall, 1908, Bull. Mus. Comp. Zool., vol. 43, No. 6, p. 404. Panama Bay in 29½ fms.; also at station 2784, in 194 fms.

Pecten (*Cyclopecten*) *pernomus* Hertlein, 1935, Proc. California Acad. Sci., ser. 4, vol. 21, No. 25, p. 320, pl. 18, figs. 11, 12, 13. New name for *Pecten* (*Cyclopecten*) *rotundus* Dall, not *P. rotundus* von Hagenow; Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 2, pp. 61, 62.

Shell very small, thin, white, suborbicular, with subequal ears, both valves nearly equally convex; right valve polished, minutely regularly concentrically striated, which sculpture is barely visible under a hand lens; posterior ear smooth, anterior finely radially threaded, with a narrow but clean-cut byssal sulcus and fasciole; left valve finely sharply radially striated, the anterior ear finely reticulated, the posterior apparently nearly smooth; hinge line short, straight; interior smooth, a pair of small auricular crura present; the hinge line with a minute central pit and two relatively large transversely sharply striated, elongate areas representing a permanent provinculum. Height and length, 3; hinge line 2.5; diameter 1.0 mm.

The hinge line of this species is very much like that of *P. (Pseudamusium) thalassimus* Dall described in the "Blake" report. (Dall, 1908).

This species will be recognized by its small size, nearly circular form, except along the dorsal side which has a small triangular beak and large, subequal ears. Inner surface of valve plain, no lirae showing. The ears have a large, impressed, flattened inner surface which is finely vertically grooved or striated along the hinge, these groovings often interlock so well that the valves do not separate easily without breaking the shell.

Range—Cedros Island, Lower California to Panama. For numerous records along the coast of Mexico and Costa Rica, see Hertlein and Strong. Panama. Panama Bay (Dall). Drift shells on beach, Playa Marinero just west of Guanico.

Superfamily LIMACEA

Family LIMIDAE

Shell monomyarian or with a single adductor scar, obliquely subpectiniform with small, narrow ears and median beaks, equivalved, inequilateral, the shorter side being posterior, usually white, externally sculptured with fine or coarse, generally scabrous radial riblets. Lateral margins generally thickened, the anterior one with an open gap. Hinge line straight, edentulous, or with obscure denticulations on the side, the cardinal area high, subtriangular with a central resilial pit under the beak in each valve. A thin brown deciduous periostracum is often present.

But three shallow-water species of *Lima* appear to be regional in the southern part of the Panama-Pacific faunal province. Two deep-water species have been described: *L. agassizi* Dall from the Gulf of Panama and *L. diomedae* Dall from off the Galapagos. These belong to the subgenus *Acesta*, species of which may reach a large size.

Key to the species of *Lima* in the southern portion of the Panama-Pacific faunal province.

A. Valves rather thick and heavy, the anterior side straight and strongly flattened. Ribs strong, straight, coarsely scaly.

Lima (Lima) tetrica

B. Valves thin, the anterior side not flattened, Ribs fine.

1. Valves convex, inflated, the margins closed, the lateral gap if any very small.

Lima (Submantellum) orbigny

2. Valves flexed, widely gaping on both sides, in contact only at the hinge and along the ventral margin.

Lima (Promantellum) pacifica

Genus LIMA Bruguière, 1797

Type species by monotypy, *Ostrea lima* Linné.

Valves compressed to slightly convex, thick-shelled. Anterior side straight, strongly impressed or flattened, the anterior ear small. Ribs relatively few, large, straight and coarsely scaly.

Lima (Lima) tetrica Gould

Plate 17, figure 4

Lima tetrica Gould, 1851, Proc. Boston Soc. Nat. Hist., vol. 4, p. 93.—Gould, 1857, Jour. Boston Soc. Nat. Hist., vol. 6, p. 405, pl. 16, fig. 6.—Durham, 1950, Mem. Geol. Soc. America, No. 43, pt. 2, pp. 67, 68, pl. 11, figs. 2, 3.

Lima (Lima) tetrica Gould, Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 2, p. 65.

Differs from the Caribbean species commonly identified as *Lima lima* by its more convex shell, less flattened anterior side, and coarser ribs. Fairly rare.

Range—Lower California to Ecuador. Ecuador; Atacames. Colombia; Gorgona Island (Hertlein and Strong) For other records see Hertlein and Strong.

Subgenus **SUBMANTELLUM** Olsson and Harbison, 1953

Type species by original designation, *Lima orbigny* Lamy.

Shell obliquely subelliptical, thin, inflated with the valves closed or nearly so on all sides. Sculpture formed by fine, sharp, radial threads spaced irregularly between wider interspaces.

- Lima* (Submantellum) *orbigny* Lamy Plate 17, figure 3
Lima angulata Sowerby, 1843, Thes. Conch., vol. 1, p. 86, pl. 22, figs. 39, 40. (Not *Lima angulata* Münster, 1841.)
Lima (Mantellum) *orbigny* Lamy, 1930, Jour. de Conchyl., vol. 74, No. 3, p. 180. (New name for *L. angulata* Sowerby, not Münster).
Lima (*Limaria*) *orbigny* Lamy, Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 2, pp. 67, 68.

The largest specimen seen measures about 38 mm. high. The shell is thin and strongly convex. Most of our specimens have a flat margin and a gap, if present, must be small.

Range—Mexico south to northern Peru and the Galapagos. Panama Canal Zone: Palo Seco. Panama: Búcaro. Colombia: Isla del Gallo. Ecuador: Manta; Santa Elena. Peru: Zorritos; Paita.

Subgenus **PROMANTELLUM** Iredale, 1939

Type species by original designation, *Promantellum parafragilis* Iredale, Recent, Great Barrier Reef, Australia.

Shell thin, with flattened, somewhat flexed, oblique valves, widely gaping on both the anterior and posterior sides, in contact only at the hinge and ventral margin.

- Lima* (Promantellum) *pacifica* d'Orbigny Plate 17, figure 1-1b
Lima arcuata Sowerby, 1843, Thes. Conch., vol. 1, p. 86, pl. 22, figs. 41, 42. Not *Lima arcuata* Geintz, 1840. Sowerby in Reeve, 1872, Conch. Icon., vol. 18, pl. 4, figs. 6, 16.
Lima pacifica d'Orbigny, 1846, Vol. Amér. Mérid., vol. 5, p. 654. (New name for *Lima arcuata* Sowerby, not of Geintz).—Maxwell Smith, 1944, Panamic Marine Shells, p. 53, fig. 691.
Lima (Promantellum) *pacifica* d'Orbigny, Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 2, p. 66.

Shell about 35 mm. in height, white, narrowly elongate, vaulted, the umbones flattened. The hinge and umbonal area are comparatively narrow, the posterior side wider and expanded, the anterior and posterior sides widely gaping. Surface sculptured with 30 or more wavy, slightly scabrous, radial threadlets.

Range—Mexico to northern Peru and the Galapagos. Panama: Bay of Panama. Ecuador: Charapota; Manta. Peru: Zorritos; Mancora; Lobitos; Negritos.

Superfamily OSTRACEA

Family OSTREIDAE

Shell porcellaneous, monomyarian or with one adductor muscle scar in each valve, attached by cementation by its umbone or whole outer surface of the left valve to rocky ledges, sometimes to roots of trees, and the like. Valves generally much distorted through fixation, the lower or left valve generally larger and deeper, the upper valve often flat. Sculpture alike or markedly different on the two valves. Marine and brackish.

Genus OSTREA Linné, 1758

Type species by subsequent designation, Children, 1823, *Ostrea edulis* Linné; also Gray, 1847, same species. Recent, seas of Europe.

Ostrea is a composite genus of great antiquity; fossil species are recorded from rocks as old as the early Mesozoic. Recent species can be distributed amongst several well-marked groups on basis of shape, structure of shell, and surface sculpture but authorities differ widely as to the systematic importance which should be accorded these groups. For the sake of simplicity, the groups herein recognized, will be considered as subgenera of *Ostrea*.

Key to species of *Ostrea*

- A. Upper and lower valves unlike in sculpture and form.
 - I. Lateral margins near the beak without crenulations. Subgenus *Crassostrea*
 - II. Lateral margins near the beak crenulated.
 - 1. Attached valve subovate, deeply concave, with ribbed external sculpture, the upper or free valve flat, depressed, smooth, or with concentric sculpture only. Subgenus *Ostrea*, s.s.
 - B. Valves with similar sculpture but often differing greatly in size and shape.
 - III. Shell with strong ribs or plications in both valves. Subgenus *Alectryonia*
 - IV. No ribbed sculpture, the surface of the upper valve with concentric markings primarily. Group of *O. iridescens*

Subgenus OSTREA s.s.

This group is apparently not represented in Panama-Pacific waters. *Ostrea chilensis* Philippi, the common edible oyster of Chile belongs here.

Subgenus CRASSOSTREA Sacco, 1887

Type species by original designation, *Ostrea virginica* Gmelin. Recent, east American.

Shell irregular in form, generally more or less elongated. Attached valve is the larger and deeper, usually marked externally by a series of small riblets which may become raised or subspinose; the upper valve of the same general form but flatter and smoother. Adductor scars often colored purple. Lateral margins internally smooth.

Ostrea (*Crassostrea*) *cortezlensis* Hertlein Plate 23, figures 1, 1a
Ostrea cortezlensis Hertlein, 1951, Bull. South. California Acad. Sciences, vol. 50, pt. 2, pp. 68, 69, pl. 24, figs. 1, 2; pl. 26, fig. 7.

Shell elongate, commonly arcuate, the beak of the lower valve being usually curved strongly towards the posterior side. Lower valve is more convex and heavy, the outside smooth or marked with weak riblets most pronounced on the umbone, the general color white, tinged slightly with violet. Upper valve is flat to depressed, smooth or concentrically lamellated or wrinkled. Interior is white except for the adductor scars and sometimes the edges of the cardinal area which are stained deep purple. Margins of the shell white. Dorsal margins nondenticulate.

As noted by Hertlein, this oyster has sometimes been confused with *O. chilensis* Philippi but the Chilean species is a true *Ostrea* belonging to the group of *O. edulis* of Europe. *O. cortezensis* resembles some forms of *O. virginica* but is typically heavier and the riblets much weaker. *O. cortezensis* is common at Panama where it is gathered for food.

Range—Gulf of California to Panama. Panama; Cathedral Rocks, Panama City. For other records see Hertlein.

***Ostrea (Crassostrea) columbiensis* Hanley** Plate 23, figures 4, 4a

Ostrea columbiensis Hanley, 1846, Proc. Zool. Soc. London, p. 137.—Sowerby, 1871, Reeve, Conch. Icon., vol. 18, *Ostrea*, pl. 7, figs. 10a, b.—Dall, 1909, Proc. U. S. Nat. Museum, vol. 37, pp. 149, 255, pl. 26, fig. 2.—Maxwell Smith, 1944, Panamic Marine Shells, p. 51, fig. 677.—Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 2, p. 54.

Shell relatively small (length to about 90 mm.), very irregular, the attached valve deep, cup-shaped, the upper valve smaller and generally flattened. Sculpture smooth or with crudely formed ribs. External color usually a deep purple or a blue-black, the interior white except for a wide, purple-colored marginal band.

Generally attached to the roots of mangrove. Common along the shore of the Gulf of Guayaquil; quantities of this shellfish are sold in the markets of Guayaquil.

Range—Lower California to northern Peru. Peru: Lower Tumbes. Ecuador: Mangrove shores of Río de Oro.

Subgenus **ALECTRYONIA** Fischer de Waldhelm, 1810

Type species by subsequent designation, Stoliczka, 1871. *Ostrea cristagalli* Linné. Indo-Pacific. (Often known as *Lopha* Bolten, 1798); for a discussion of the rejection of the name "*Lopha*" see Stenzel, 1947, Jour. Pal., vol. 21, No. 2, pp. 169, 177.

Shell large or small, rounded, subovate to elongate, falcate or strongly sickle-shaped, the two valves of similar shape and sculpture. Sculpture consists of large, rounded ribs or sharp plications which deeply affect the margins. Margins of the valve near the beak and cardinal area are crenulated or finely pustulated.

***Ostrea (Alectryonia) megodon* Hanley** Plate 23, figures 3, 3a

Ostrea megodon Hanley, 1846, Proc. Zool. Soc. London, p. 106.—Sowerby in Reeve, 1871, Conch. Icon., vol. 18, *Ostrea*, pl. 12, figs. 24a, 24b.—Maxwell Smith, 1944, Panamic Marine Shells, p. 51, fig. 692K.—Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 2, p. 55.—Durham, 1950, Mem. Geol. Soc. America, No. 43, pt. 2, p. 59, pl. 5, fig. 3.

Shell elongate arcuate, (length up to 100 mm.), the two valves nearly alike, ventral margin folded into three or four large, sharp but short plications, attached generally by a small area on the extreme umbone of the left valve. The dorsal side is concave or excavated, often finely corrugated on the margin. Surface smoothish or roughened by concentric growth increments. Color white or green, tinged with violet or purple. Lateral margins finely crenulated.

Closely related forms occur in the Miocene of northern South America, Costa Rica, Santo Domingo, and Florida, but the group is extinct in the Caribbean area. It is a common fossil in the Peruvian tablazos.

Range—Gulf of California to northern Peru. Costa Rica: Opposite Judas Point (Hertlein and Strong). Ecuador: Atacames. Peru: Bay of Sechura.

Ostrea (*Alectryonia*) *palmula* Carpenter

Plate 17, figures 6, 6a;
Plate 23, figures 5, 5a, 7, 7a

Ostrea ?? *conchaphila* var. *palmula* Carpenter, 1857, Cat. Mazatlan Shells, Brit. Mus., pp. 163, 550.

Ostrea mexicana Sowerby, 1871, in Reeve, Conch. Icon., vol. 18, *Ostrea*, pl. 16, figs. 35a, b, c.

Ostrea palmula Carpenter, Hertlein and Strong, 1946, *Zoologica*, vol. 31, pt. 2, pp. 55, 56, pl. 1, fig. 14.

Shell comparatively small, heavy, irregular in form, the lower valve usually deep, strongly ribbed beyond the area of attachment and closely attached by a large part of its surface to rocks and the like. The upper valve is usually flat and depressed in the middle, becoming plicate around the margin. Color a dirty or greenish white veined with violet. Interior is mostly white, the marginal band brown or violet, the adductor scars white or with brown and violet staining. Inner margin of shell is denticulate all around in the upper valve, less so in the lower.

This species seems to be fairly abundant at many locations, usually firmly attached to rocks exposed to heavy surf. It is too small for any economic importance as a food.

Range—Gulf of California southward to Ecuador and the Galapagos. Panama: Panama City; Guanico. Ecuador: Camarones near Esmeraldas.

Ostrea (*Alectryonia*) *fischeri* Dall

Plate 23, figure 6

Ostrea jacobaea Rochebrune, 1895, Bull. Mus. Nat. Hist. Nat. Paris, vol. 1, p. 241. (Not *O. jacobaea* Linné.)

Ostrea fischeri Dall, 1914, *Nautilus*, vol. 28, No. 1, p. 1. (New name to replace *O. jacobaea* Rochebrune).—Hertlein and Strong, 1946, *Zoologica*, vol. 31, pt. 2, pp. 54, 55.—Durham, 1950, Mem. Geol. Soc. America, No. 43, pt. 2, p. 59, pl. 6, figs. 1, 4.

Shell large (length 120 mm.), subcircular to obliquely oblong, thick, generally strongly plicated with six or more heavy ribs and sharp folds, heaviest near the margin, similar in both valves. These ribs occasionally develop irregular hollow tubular extensions. Color violet red to dark purple, the interior white except for some brown staining. Adductor scars large, placed slightly posterior of the middle. Cardinal area wide and heavy. Substance of the shell is thick, made up of porcellaneous layers interfingering with porous and cellular seams.

This large oyster is closely related to several fossil species from the Caribbean and Floridan area such as *O. haitensis* Sowerby from the Miocene

of Santo Domingo and *O. tamiamiensis* Mansfield of the Florida Miocene which have a similar cellular formation to its shell. These oysters have been referred to a separate genus *Pycnodonte* Fischer, the type species of which is a Cretaceous species.

Typical specimens have a round, thick shell with strong ribs, the interior colored a porcelain-white with a wide purple border. Other specimens which have grown attached to smooth piling will have a flat or curved surface and a relatively thin shell without ribs. The outer layer is frequently thin and of a lilac-pink or purple color and marked with fine, flowlike lines. The colored marginal band will show on inspection the cellular structure of the inner layer. *O. solida* Sowerby, 1871 (in Reeve, Conch. Icon., pl. 14, fig. 28. Gulf of Panama) may be the same species.

Range—Lower California to Ecuador and the Galapagos Islands. Ecuador: Atacames; Esmeraldas.

SUBGENERIC POSITION UNCERTAIN

Ostrea (————) *iridescens* Gray

Plate 22, figure 7;
Plate 23, figures 2, 2a

Ostrea iridescens Gray, 1854, in Hanley, Conch. Miscell., *Ostrea*, pl. 2, figs. 6, 7.—Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 2, p. 55.

? *Ostrea prismatica* Gray, 1825, Ann. Phil., vol. 25.

Shell often large, irregularly ovate to subrectangular, attached by most of the surface of the lower valve, its outer edges only becoming free and raised. The upper valve is flat or slightly vaulted. Inner layer of shell is dense, porcellaneous and white, often showing an iridescent or strongly metallic luster, often thickened with closely packed layers interfingered between prismatic and more chalky seams. The outer layer is relatively thin, of a subhorny texture, concentrically fluted and radially wrinkled, and of a bronze or purple color. This outer layer is easily destroyed, but when perfect extends as a wide margin or as a denticulated fringe beyond the white, porcellaneous margin of the inner layer. Interior white with blotches of purple or metallic brown. Dorsal lateral margins denticulate.

This oyster grows to a large size and specimens 10 inches or more in length are fairly common. The outer, subhorny, laminated layer is easily lost by erosion, and is attacked by alkalis. Such worn valves are white, often profusely veined with purple and could easily be mistaken for *Ostrea virginica* as noted by Carpenter. This species grows attached to rocky ledges exposed to heavy surf waves and in northern Peru, as well as elsewhere, is much sought for as an article of seafood.

Range—Lower California to northern Peru. Panama: Panama City, Guanico. Ecuador: Esmeraldas; Manta. Peru: Caletto Mero; Caletto Sal; Mancora.

Ostrea (————) *tubulifera* Dall

Plate 17, figure 8

Ostrea tubulifera Dall, 1914, Nautilus, vol. 28, No. 1, p. 3.

Shell suborbicular, about 45 mm. in diameter, nearly flat, with a whitish nacre, brilliantly polished inside, purple clouds showing through, and with a translucent irregularly crenulated margin. The ligamentary area is nar-

row and very inconspicuous; on each side of it the margin is pustulate for a short distance; the outer surface is mostly dark purple, dull, minutely corrugated and densely covered with small erect tubules of a dark reddish-brown color, 2 to 4 mm., high and from $\frac{2}{3}$ to 1 mm. in diameter. Only those at the extreme margin communicate with the interior of the valve, and these are fissured on the distal side. Those of the surface behind the margin are completely tubular. The attached valve unknown. (Dall, 1914, in part).

Range—Gulf of California to Panama. Mexico: Gulf of California (type, USNM). Panama: Pedro Gonzalez Id. (Pearl Islands), J. P. E. Morrison, USNM. 588453.

Ostrea (————) *serra* Dall

Ostrea serra Dall, 1914, Nautilus, vol. 23, No. 1, p. 2.

Similar to *Ostrea frons* Linné of the West Indies growing attached to stems of Gorgonia, narrow, plicate, with flattish upper valve, deep lower valve, green or purple on the outside, inside white.

Rare and poorly known.

Range—Lower California to Panama (according to Dall). Panama: Búcaro.

Specific names referred to Panamic oysters of uncertain status.

Ostrea aequatorialis d'Orbigny, 1846, Voy. Amér. Mérid., p. 672. Unfigured.

The original description is too brief and generalized to identify the species. D'Orbigny's remark that it is found (parasitically) attached to trees suggests *O. columbiensis* Hanley, 1846, described the same year. Examination of the original specimens is needed.

Ostrea cumingiana Dunker, 1847

Recorded by Dall from the faunal province (range given as Lower California to Panama) but without mention of any specific locality. The origin of the shell described by Dunker and figured in the Beschreib. und Abbild. (vol. 2, p. 81, pl. 1, figs. 1-4) was unknown. It is a large, strongly plicate shell resembling *O. fischeri* but with more rounded ribs. Its occurrence in the Panamic Province is questionable.

Ostrea prismatica Gray, 1825

Often identified with *O. iridescens* and which it would predate in name. The figure presented by Reeve shows a shell with a high, massive cardinal area, and ligament quite unlike the usual development in *O. iridescens*. There are numerous fossil species which would fit this figure, but we have seen nothing like it in the Recent Panamic fauna.

Superfamily ANOMIACEA

Family ANOMIIDAE

Shell large or small, generally irregular and distorted, attached by close contact to various objects by means of a calcified byssal plug passing

through a round hole or foramen in the umbone of the right valve, remaining attached throughout life or only in the early stages. Valves rounded or subcircular, variously inflated, but generally more or less irregular because of fixation, nacreous, and often with a platy or micaceous texture, thin or heavy. Hinge edentulous but sometimes provided with large, divergent resilial processes or crura simulating hinge teeth. Ligament internal, attached to resilial processes along the hinge margin or to deep scars. Interior of the left valve has two or three rounded or elongated scars which represent the attachment impressions of the byssal and retractor muscles.

Because of their distorted shape, Anomias may resemble the shells of oysters. They differ in their mode of attachment which is by means of a byssal plug passing through an opening in the umbone of the right valve and in the texture of the shell which is subnacreous, resembling thin plates of mica. Surface of the valves may be smooth, folded, undulated or ribbed, but an irregular development of ribs on the surface of the upper valve may be merely the partial reproduction of the ribs of a *Pecten* or *Arca* on which the mollusk was once perched. In *Anomia*, the byssal foramen is a large, round, open hole; in *Pododesmus*, the foramen is closed by a calcified plug, and the surface of the lower valve is attached more closely to the substratum by direct cementation. *Placuanomia* is attached in the early stages, later sometimes becoming free; the byssal foramen is sealed off by a plug. The shell of *Placuanomia* is generally strongly plicated or folded and the hinge of the right valve has two large, crural lamellae-like teeth.

General key to genera of the Anomiidae

- I. Shell permanently fixed.
 1. Byssal foramen is a large open hole in the right or lower valve. Interior of the upper valve shows three muscle impressions. *Anomia*
 2. Byssal foramen closed off by a calcified plug within the shell margin. Interior of free valve with two muscle impressions. *Pododesmus*
- II. Shell at first fixed, later sometimes becomes free.
 3. Byssal foramen closed by a calcified plug lying well within the margin. Ligament attached to large, teethlike lamellae in the lower or fixed valve. Surface of valves generally plicate. *Placuanomia*

Genus ANOMIA Linné, 1753

Type species by subsequent designation, Schmidt, 1818, *Anomia ephippium* Linné.

Shell subcircular, always somewhat irregular and distorted, the right valve attached to the substratum by a calcified byssus which passes through a round hole in the umbone of the right or lower valve, its dorsal margin usually not fully closed. The lower valve is usually somewhat heavier and often more deeply colored, the upper or free valve thinner and more convex. The interior of both valves has a central thickened area; that of the right valve carries a single adductor scar; that of the left valve has three scars, the lower posterior scar representing the impression of the adductor muscle and the other two scars that of the byssal retractor muscles.

The ligament is internal; in the right valve the resilium is attached to a knob-like process along the dorsal margin and in the left valve to a semilunate scar under the beak. Surface smooth or radially wrinkled or striated.

Anomia peruviana d'Orbigny

Plate 24, figures 2-2f

Anomia peruviana d'Orbigny, 1846, Voy. Amér. Mérid., vol. 5, p. 673. (Payta, Peru).—Philippi, 1850, Abbild. und. Beschreib. Conchylien, bd. 3, heft 8, p. 131, *Anomia*, Tab. 1, figs. 2, 3.—Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 2, p. 68.

Anomia adamas Gray, 1849, Proc. Zool. Soc. London, p. 115.—Reeve, 1859, Conch. Icon., vol. 11, *Anomia*, pl. 3, fig. 15 Galapagos.

Anomia pacillus Gray, 1849, Proc. Zool. Soc. London, p. 117.—Reeve, 1859, Conch. Icon., vol. 11, *Anomia*, pl. 4, fig. 19 Tumbes.

?*Anomia laqueata* Reeve, 1859, *op. cit.*, pl. 4, figs. 18a, b. Hab.—?

Anomia alectus Gray, 1849, Proc. Zool. Soc. London, p. 115 Guayaquil.—Reeve, 1859, *op. cit.*, pl. 6, fig. 28.

Anomia hamillus Gray, 1849, Proc. Zool. Soc. London, p. 117.—Reeve, 1859, *op. cit.*, pl. 7, fig. 32 Bay of Cauas, West Colombia (Cuming).

Anomia larbas Gray, 1849, Proc. Zool. Soc. London, p. 117. Payta.—Reeve, 1859, Conch. Icon., vol. 11, *Anomia*, pl. 3, fig. 13.

Shell of medium size (about 50 mm.), subovate to subcircular, the length and height in a normal specimen about equal, but the valves are usually irregular due to fixation. Texture thin to moderately heavy, sub-translucent, the upper valve generally thinner and with a more micaceous or pearly luster, the lower valve heavier and flatter. Surface of upper valve smooth and concentrically wrinkled or marked with radial costae which in some specimens may be quite strong and riblike. Color of upper valve is white or in shades of light or dark coppery red or brown, the lower valve mostly greenish except for the central area which is porcelain white.

This *Anomia* is common at Paita and in the Bay of Sechura, its surface smooth, undulate or with irregular radial costae, the color a silvery, translucent white to deep copper brown. The relative position of the adductor scars in the upper valve have no specific value as assumed by Dall.

Range—Lower California to northern Peru and the Galapagos. Ecuador: Manta; Santa Elena. Peru: Zorritos; Negritos; Paita; Sechura.

Anomia fidenas Gray

Plate 24, figures 4, 4a

Anomia fidenas Gray, 1849, Proc. Zool. Soc. London, p. 116 Panama.—Reeve, 1859, Conch. Icon., vol. 11, *Anomia*, pl. 6, fig. 30 West Coast of Panama (Cuming).

Anomia tenuis C. B. Adams, 1852, Ann. Lyceum Nat. Hist. New York, vol. 5, pp. 469, 544, No. 378 Panama.—Turner, 1956, Occasional Papers on Mollusks, vol. 2, No. 20, p. 91, pl. 18, fig. 13.

Shell small or of medium size, suborbicular, flat, thin, smooth, or little wrinkled, white or glassy. On the under surface of rocks.

Range—Panama. Panama: Panama City. Canal Zone: Amador.

Genus *PODODESMUS* Philippi, 1837

Type species by monotypy, *Pododesmus decipiens* Philippi (= *P. rudis* Broderip).

Like *Anomia*, but with a heavier shell and the right valve is attached by its whole surface to the substratum as well as by the byssus. The byssal foramen is closed by a vertical layered plug which is situated well within the hinge margin; below it lies the single scar of the retractor muscle. The interior of the left valve has two muscle scars. Surface smooth or covered with fine, radial threadlets. Ligament attachment similar to that of *Anomia*.

Pododesmus follatus (Broderip)

Plate 24, figures 3-3d

Placuanomia foliata Broderip, 1834, Proc. Zool. Soc. London, p. 2.—Reeve, 1859, Conch. Icon., vol. 11, *Placuanomia*, pl. 1, fig. 5.

Only the upper or free valve is represented in my collection. These valves may be white or brown, smooth, undulate, or covered with fine radials. According to Broderip's original observation, the shell is attached by its whole lower surface.

Range—Gulf of California to Peru. Ecuador: Charapota; Isla la Plata; Puerto Callo; Santa Elena. Peru: Lobitos.

Genus **PLACUANOMIA** Broderip, 1832

(*Placuanomia* Swainson, 1840 abridged.)

Type species by monotypy, *Placuanomia cumingii* Broderip.

Shell of moderate size, (height 80 mm.), thick and often strongly plicate, attached by a byssus and by direct cementation of the umbone of the right valve to the substratum, sometimes, later becoming free. Byssal foramen becomes closed by a vertically layered plug which lies well within the margin of the shell; below it, is placed the single large adductor impression generally surrounded by a whitened area. In the right valve, the ligament is attached to two, large, diverging processes which resemble cardinal teeth and which fit into two deeply grooved sockets in the free valve. Both valves may be deeply plicated over their free zone or irregularly flattened, the surface almost smooth except for growth lines or covered by fine, radial threads.

Two species distinguished as follows.

I. Margin of valve with 4 or 5, large, sharp folds or plicae. Surface smooth except for growth incrementals.

P. cumingii

II. Margin of valves not sharply folded. Surface with small, threadlike radials.

P. panamensis

Placuanomia cumingii Broderip

Plate 24, figures 1, 1a

Placuanomia cumingii Broderip, 1832, Proc. Zool. Soc. London, p. 29 Gulf of Dulce, Costa Rica.—Reeve, 1859, Conch. Icon., vol. 11, *Placuanomia*, pl. 1, figs. 3a, 3b.—Olsson, 1924, Nautilus, vol. 37, p. 123 (as a Pleistocene fossil in Peru).—Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 2, p. 69.

Resembles a plicated oyster but fresh specimens have the micaceous-silvery sheen of an *Anomia*. Shells are quite large, frequently up to 80 mm. in height, subcircular and generally with four or five large, angular plications or ribs. The attachment area varies considerably in size; in some specimens, it may cover more than half of the surface of the lower half while in others, it is hardly noticeable. Except for the large plications and growth incrementals, the surface is smooth. *P. plicata* Tuomey and Holmes from the Miocene of the Carolinas is similar. The species occurs as a Pleistocene fossil in the Lobitos Tablazo at the mouth of Quebrada Pariñas, near Talara. It is a widely distributed species along the coast of Ecuador and in all probability extends southward into Peruvian waters.

Range—Gulf of California to Ecuador. For some records north of Panama see Hertlein and Strong. Ecuador: Palmar near Colonche; Manta; Jaramijo.

Placuanomia panamensis Olsson

Placuanomia panamensis Olsson, 1942, Bull. Amer. Paleont., vol. 27, No. 106, pp. 183, 184, pl. 1, figs. 1, 4, 5.

Shell of moderate or large size, rounded or subovate, with the white, silvery, micaceous texture of *Anomia*. The lower valve is attached directly by a broad area of the umbone, its counterpart indicated on the upper valve as a flattened area without sculpture. Sculpture of the free surface is formed by small, radial threadlets which may become partly obscured or obsolete along the margins by irregular concentrics. In general, the surface is flat with low, irregular undulations around the margins only.

Range—Panama. Canal Zone: Balboa; Amador Beach.

Order HETEREDONTIDA

Superfamily ASTARTACEA

Family CRASSATELLIDAE

Shell porcellaneous, solid, subtriangular to oblong, with convex or compressed umbones, the anterior side shorter, higher and rounded, the posterior contracted, flattened, pointed, or subtruncate. Hinge strong with large cardinal teeth and laterals. Ligament internal, attached to a resilifer groove between the cardinal teeth. Surface smooth or with growth line sculpture, sometimes concentrically undulate especially over the umbones. Pallial line simple, the adductor scars usually impressed. Ventral margin smooth or crenate.

Two genera.

I. Shell large, elongate, the posterior end recurved, pointed.

Genus *Eucrassatella*

II. Shell small to minute, subtrigonal.

Genus *Crassinella*

Genus **EUCRASSATELLA** Iredale, 1924

Type species by original designation, *E. kingicola* Lamarck. Recent. Australia.

Shell solid, elongate-subtrigonal, the posterior side contracted and pointed, the anterior end more rounded. Lunule and escutcheon distinct, deeply impressed. Hinge margins heavy, the ligament internal, lodged in a deep resilifer. Left valve with two, the right with three cardinal teeth, the marginal ones becoming effaced by the resilium or merging with the dorsal edge. Lateral margins above the muscle scars thickened or grooved to serve as pseudolaterals. Muscle scars deep, connected by a simple pallial line. Ventral margins smooth. Beaks more or less distinctly opisthogyrate. Umbones flattened or rounded, the external sculpture principally concentric, strongest near the beaks.—[Olsson and Harbison, 1953.]

Subgenus **HYBOLOPHUS** Stewart, 1930

Type species by original designation, *Crassatella gibbosa* Sowerby.

Two cardinal teeth in each valve. Umbones and beaks tilted or pointed backwards (opisthogyrate), the surface near the tip of the umbones strongly flattened and sculptured with wavelike, concentric undulations.

Eucrassatella (Hybolophus) gibbosa (Sowerby)

Plate 25, figures 1-1b

Crassatella gibbosa Sowerby, 1832, Proc. Zool. Soc. London, p. 56 (St. Elena and Xipixapi).—Reeve, 1843, Conch. Icon., vol. 1, *Crassatella*, pl. 1, figs. 1a, 1b.

Crassatellites rudis Li, 1930, Bull. Geol. Soc. China, vol. 9, No. 3, p. 257, pl. 3, fig. 16.—Pilsbry, 1931, Proc. Acad. Nat. Sci. Philadelphia, vol. 83, pp. 429, 430, pl. 41, figs. 9, 10 (figured *C. gibbosus*).

Crassatellites (Hybolophus) gibbosus (Sowerby), Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 3, No. 8, p. 103.—Hertlein and Strong, 1955, Bull. Amer. Mus. Nat. Hist., vol. 107, art. 2, pp. 181, 182.

Shell of medium or large size, solid, usually stubby, elongately sub-trigonal, the umbones convex and swollen, the anterior side convexly rounded, the posterior side a trifle shorter, contracted and pointed at the end. The flattened surface of the umbones is somewhat variable in size and in the strength of its sculpture; usually there are about six strong, concentric undulations present. Color of exterior is a deep brown or yellow, uniform or with brown radial lines. Interior white with brown blotches. Periostracum is a uniform ashy brown, usually worn off most specimens.

An average specimen measures: length 58 mm.; height 43.4 mm.; diameter 29.4 mm. Santa Elena, Ecuador.

This species is represented as fossil by several closely allied forms; some of which are a large size.

Range—Gulf of California to northern Peru. Panama: Búcaro; San Carlos; Panama City; Pearl Islands. Canal Zone: Venado Beach. Ecuador: Santa Elena; Punta Blanca; Manta; Galeras; Esmeraldas. Peru: Tumbes; Zorritos; Boca Pan; Mancora; Paita.

Eucrassatella (Hybolophus) diqueti (Lamy)

Plate 25, figure 2

Crassatella undulata Sowerby, 1832, Proc. Zool. Soc. London, p. 56 "Puerto Potrero, Americae Centralis."—Reeve, 1843, Conch. Icon., vol. 1, *Crassatella*, pl. 1, figs. 2a, 2b. Not *C. undulata* Lamarck, 1805, or *C. undulata* Say, 1824.

Crassatella diqueti Lamy, 1917, Jour. de Conchyl., vol. 62, No. 4, p. 2, 7 "Ile Ceralbo, Gulf of California. New name for *Crassatella undulata* Sowerby, not of Lamarck.

Crassatellites laronus E. K. Jordan, 1932, Nautilus, vol. 46, No. 1, p. 9. Near salt works at San Jose Island, Gulf of California.—E. K. Jordan, 1936, Contri. Dept. Geol. Stanford Univ., vol. 1, No. 4, p. 124, pl. 17, figs. 6, 7.

Crassatellites (Hybolophus) diqueti (Lamy), Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 3, pp. 102, 103.

This is a relatively rare species, and it differs from *E. gibbosa* by its longer form, less prominent, convex umbones and wider, less pointed, posterior end. It is closely related to *E. antillarum* of the Caribbean, having the same rich, deep chocolate-colored interior. According to Lamy, distinction between the two forms is largely based on their geographic separation.

Range—Gulf of California to Colombia (Hertlein). Mexico: Gulf of California. Costa Rica: Puerto Potrero; Port Parker. Colombia: Gorgona Island.

Genus *CRASSINELLA* Guppy, 1874

Type species by monotypy, *Crassinella martinicensis* d'Orbigny. Recent, West Indies.

As indicated by Grant and Gale, 1931, Guppy first used the name *Crassinella* in a list of species, in which only *C. martinicensis* was mentioned. A year later (1875), he indicated that the name was proposed as a substitute for *Gouldia* C. B. Adams, 1847 (substitute for *Thetis* C. B.

Adams, 1845) which was assumed to be preoccupied in birds (*Gouldia* Bonaparte, 1850). In his 1875 paper, Guppy mentioned two species as typical, *C. pacifica* and *C. martinicensis*. (For further discussion see *Gouldia*.)

Shell small, solid, subtrigonal with the lateral sides straight and generally subequal, the umbones flattened with the small beaks pointing backwards. Anterior side rounded, the posterior generally a little longer, indistinctly carinate, its end obtusely truncated or pointed. Ligament is largely internal, the pit for the resilium forming a deep socket in the hinge plate; it is bordered in each valve by two strong cardinal teeth on the anterior side. Left valve has a strong posterior lateral tooth bordered above by a linear socket. External surface smooth or with strong, concentric ribs or undulations, and sometimes a microsculpture of radial lines and striae best developed in the concentric troughs; this sculpture is generally not visible unless the shell is fresh and unweathered. Pallial line entire, the ventral margin plain.

This is a genus of small species, usually of trigonal, flattened form with small, pointed, opisthogyrate beaks, the surface smooth or with concentric sculpture like that of some species of *Astarte*. The genus "*Astarte*" is cold-water, its ligament external, and the ventral margin is usually strongly crenulated.

Key to Panamic *Crassinella*

- I. Shell strongly trigonal in shape with sharply pointed beaks. Surface smooth or with narrow, ridgelike concentric riblets between wide, troughlike interspaces. A microsculpture often present.
 - A. Concentric riblets strong and uniform over whole surface.
 1. Shell quite large for the genus (length 6 mm.), depressed, flattened. Posterior margin longer than the anterior and squarely truncated at the end.

C. pacifica
 2. Shell somewhat smaller, short and high, the sides more nearly alike, the posterior end not truncated.

C. mexicana
 3. Shell generally small, the posterior margin deeply concave, its end produced into a short snout.

C. ecuadoriana
 - B. Surface smooth or nearly so.
 4. Shell small, trigonal, almost equilateral.

C. varians
- II. Shell less trigonal in shape, the anterior side longer.
 5. Shell small, veneriform. Surface smooth or with strong, rounded riblets.

C. adamsi

Crassinella pacifica (C. B. Adams)

Plate 25, figures 5-5e

Gouldia pacifica C. B. Adams, 1852, Ann. Lyceum Nat. Hist. New York, vol. 5, pp. 499, 545, No. 450.—Turner, 1956, Occas. Papers on Mollusks, Mus. Comp. Zool., vol. 2, No. 20, p. 69, pl. 20, figs. 3, 4.

Crassinella pacifica (C. B. Adams), Pilsbry and Olsson, 1941, Proc. Acad. Nat. Sci. Philadelphia, vol. 93, p. 56. (fossil).—Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 3, pp. 103, 104.

Shell subtriangular, depressed or flattened, with the beaks nearly median, trigonal and pointed, usually inclined a little backwards, the ventral margin widely rounded. The two marginal sides are nearly alike, the posterior a little longer, straight or a little concave, becoming typically somewhat truncated at its end. Surface is covered uniformly with large, widely spaced, concentric ridges between wavelike troughs, usually between 8 to 12 in number. In addition, there is a fine, microscopic radial striation, heaviest in the concentric troughs, to be seen on fresh specimens. Color is variable, ranging from pure white to various shades of brown, purple and pink, often with narrow lines of brown radiating from the beaks.

Length 6.1 mm., height 5.7 mm., diameter 2.6 mm. Panama City.

This is the largest and commonest species of *Crassinella* in the Panamic fauna and is distinguished from the somewhat similar *C. mexicana* Pilsbry and Lowe (which is nearly equilateral) by its somewhat longer posterior side which at the end is wider as if sharply truncated. The concentric undulations are strong, rising as narrow ridges between wide, wavelike troughs. Fresh specimens show a fine pattern of submicroscopic, radial striations which may appear as divisions between rows of parallel oblong dots (Carpenter's strung-fig pattern) but this structure is quickly destroyed by beach wear. *C. pacifica* is closely related and perhaps conspecific with *C. mactracea* Linsley of the Atlantic and the Miocene *C. lunulata* Conrad.

Range—Gulf of Panama southward to Peru. Panama: Búcaro; Panama City; Las Tablas. Colombia: Isla del Gallo. Ecuador: Manta; Punta Blanca; Puerto Callo. Peru: Zorritos.

Crassinella mexicana Pilsbry and Lowe

Plate 25, figure 4

Crassinella mexicana Pilsbry and Lowe, 1932, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, pp. 103, 104, pl. 14, figs. 8, 9 Guaymas, Mexico.

Crassinella pacifica mexicana Pilsbry and Lowe, Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 3, p. 104.

The shell is similar to *C. pacifica* (C. B. Ad.), from which it differs chiefly by being relatively high and short, the posterior and anterior dorsal margins meeting in a smaller angle. The basal margin is strongly curved. Externally there are about 12 concentric ribs, each standing on a convex base, the rib and base in section being somewhat like a brace. The whole surface except the summits of the ribs, the lunule and escutcheon, is densely covered with fine radiating striae. The external color is whitish, with purplish brown stains behind and forward of the middle and a number of narrow light brown rays. The anterior dorsal area is somewhat concave and rather broad; escutcheon also sunken, narrower. Interior is white with some brown stains.

Length 3.4 mm., height 3.3 mm., diameter 1.8 mm. [Pilsbry and Brown, 1932.]

Range—Cedros Island to the Gulf of California. Mexico: Guaymas (Pilsbry and Lowe): East of Cedros Island; Lower California (Hertlein and Strong).

Crassinella ecuadoriana, new species

Plate 25, figures 6-6e

Shell small, heavy, oblique, subtrigonal, the posterior side is longer.

The beaks are small but prominent, pointed, and turned sharply backwards to face a long, excavated dorsal margin terminating in a pronouncedly pointed end. The anterior-dorsal margin mildly convex. Because of the obliquity of the axis of the shell, the ventral margin has a bulge in the posterior half while its anterior portion is slightly convex to insinuated with a depressed zone extending upwards across the disk to the beak. Surface slightly convex to depressed, sculptured by 10 or more, stout, concentric riblets between wide, wavelike depressions; in addition the whole surface is covered by fine, submicroscopic radial lineation. Color pure white to various shades of brown and lilac, often rayed with lines of purple-pink or brown. Interior glossy, white or stained. Hinge strong.

Length 2.9 mm., height 2.5 mm., diameter 1.4 mm. Puerto Callo. Holotype, ANSP 218934.

A small species, easily recognizable by its shape, its posterior side with its margin deeply concave or indented and ending in a short, snoutlike point.

Range—Coasts of Ecuador and western Colombia. Colombia: Isla del Gallo. Ecuador: Esmeraldas; Puerto Callo.

Crassinella varians (Carpenter)

Plate 25, figures 7-7b

Gouldia varians Carpenter, 1855, Cat. Mazatlan Shell, Brit. Mus., pp. 83, 84, No. 117.
Crassinella varians (Carpenter) Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 3, No. 8, p. 104.

The shell is generally small, subtrigonal, rather solid, moderately convex, subequilateral, the posterior side usually slightly longer, the dorsal margins quite straight, descending, the ventral margin widely rounded. Surface sculpture is often quite smooth except for growth incrementals or concentric riblets may be present, usually strongest on the umbones. Color plain white or blotched with brown, especially on the posterior side.

Length 3.5 mm., height 3 mm., diameter 1.7 mm. Punta Blanca, Ecuador.

This is a small, moderately convex, trigonal species, its shape that of a narrow, equilateral triangle with sharply pointed beak, the surface smooth or variably ribbed.

Range—Gulf of California to Ecuador. Mexico: Mazatlan (Carpenter). Nicaragua: Corinto (Hertlein and Strong). Ecuador: Punta Blanca.

Crassinella adamsi, new species

Plate 25, figures 3-3c

Shell small, moderately convex, solid, subtrigonal but with the anterior side longer, rounded at the end, the posterior side short, its margin rapidly descending, excavated by a narrow, linear, sunken escutcheon. Beaks small, pointed, opisthogyrate. Surface sculptured by small, strong, rounded concentric riblets which number from 10 to 14 depending upon the size of the shell; these riblets are close-set. Color commonly white or glassy, occasionally stained irregularly with brown. Length 22 mm., height 2 mm. Punta Blanca, Ecuador, Holotype, ANSP 218933.

In shape, this small shell recalls a venerid but its hinge and other characteristics show it to be a *Crassinella*. It differs from the other Pacific species of the genus by its longer anterior side. A closely similar species is found along the Caribbean coast of Panama which differs only in having the concentric riblets between deeper interspaces.

Range—Panama. Ecuador: Punta Blanca.

Superfamily CARDITACEA

Family Carditidae

Shell suborbicular to subquadrangular, often cordate, usually heavy, with large, prominent umbones, anteriorly directed and varying in position from submedian to nearly terminal, the anterior side commonly the shorter. Sculpture consists typically of strong, radial ribs, usually noded, the surface covered by a brown, hairy periostracum. Ligament external. Hinge plate curved, usually with 2 cardinal teeth in each valve, the posterior one elongate and with the lateral teeth absent or more or less degenerated. Pallial line simple, the ventral margin more or less fluted or crenated by the ends of the radial ribs. Byssus usually present.

Two genera, roughly distinguished as follows:

- I. Shell rounded, trigonal or cordate, the umbones submedian, a little nearer the anterior side. Lateral teeth absent or vestigial.
Genus *Cardita*
- II. Shell elongate to oblong, the umbones placed much nearer the anterior end, the posterior side often drawn out and more strongly sculptured. Lateral teeth more strongly developed.

Genus *Carditamera*

Genus *CARDITA* Bruguière, 1792

Type species by subsequent designation, Children, 1823. *C. sulcata* Bruguière (= *Chama antiquata* Linné). Recent. Mediterranean Sea.

Shell rounded, trigonal, cordate, solid, usually strongly ribbed, the ribs being generally noded. Umbone swollen, terminating in a coiled prosogyrate beak projecting over a small, deep lunule. Ligament external, the margin slightly overhanging the resilifer scar. Hinge plate heavy, the right valve with a large, massive, central tooth bordered by sockets on each side; the left valve has two cardinal teeth and a large, wide, central socket, the posterior tooth elongated, the anterior one small, and it is often bordered by a small, vestigial tooth at the base of the lunule. Lateral teeth are lacking or vestigial. The adductor scars are large, subequal, the pallial line entire. Margins of the valves are deeply fluted by the ends of the ribs.

The hinge pattern of *Cardita* is characteristic but has received different interpretation by authors. The large, massive, central cardinal tooth of the right valve is diagnostic; the base of this tooth is flattened or excavated and extended backwards along the inner edge of the hinge plate; it fits into a large, central socket in the opposite valve. *C. cuvieri* has a small, vestigial anterior tooth in the left valve which is received in a small, pit-like socket in the right. A similar tooth is also found in *C. tricolor*.

General key to Panamic-Pacific species

- I. Shell of average or large size. Lateral teeth absent or obsolete.
 - A. Sculpture formed by strong, coarsely noded, elevated ribs separated by deeply grooved interspaces.
 - a. Shell relatively coarse and heavy. Posterior-dorsal submargin deeply grooved or excavated.

1. Shell large, roundly cordate with high umbones and coiled beaks. Interspaces narrower than the ribs. Posterior margin widely truncated.
C. cuvieri
2. Shell smaller, broadly subquadrate, the ribbed interspaces wider. Posterior margin descending and narrowly rounded at the end.
C. tricolor
- b. Shell thinner, the posterior-dorsal margin not furrowed.
3. Shell small or of medium size, subovate, light-colored.
C. spurca beebei
- B. Ribs wide and low between shallow, lined interspaces. No vestigial tooth.
4. Shell large, solid, trigonally rounded with high beaks, pointed, and narrowly coiled. Color purple or brown under a coarse periostracum.
C. megastropa
- II. Shell small to minute (length 3 to 5 mm.), lateral teeth present.
5. Shell obliquely ovate with low ribs setoff by lined interspaces.
C. guanica

Cardita (Cardita) tricolor Sowerby

Plate 26, figures 4-4c

Cardita tricolor Sowerby, 1833, Proc. Zool. Soc. London for 1832, p. 194 Bay of Guayaquil.
—Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 3, No. 8, pp. 106, 107.

Cardita laticostata Sowerby, 1833, Proc. Zool. Soc. London for 1832, p. 195 Guacomayo.
—Reeve, 1843, Conch. Icon., vol. 1, *Cardita*, pl. 7, figs. 36a, 36b, 36c. var. B, fig. 36d (ref. to *C. tricolor* cited).—Maxwell Smith, 1944, Panamic Marine Shells, p. 56, fig. 709.

Shell of medium size (length usually 45 mm., or smaller, rarely to 60 mm.), subquadrate, heavy and solid, strongly ribbed. Umbones wide, the small beaks placed near the anterior fourth. Sculpture formed by about 15, strong, squarish, coarsely noded ribs, their interspaces deeply grooved and often cross-threaded, and nearly of the same width as the ribs themselves. Posterior-dorsal area excavated, more finely ribbed, vaulted in the middle. Color pattern rather variable, usually with a white base mottled by bands of brown of irregular shape and distribution, often only the top of the ribs colored. Interior white or with a slight pink flush. The posterior-dorsal margin descending, arched or slightly concave, its end narrowly rounded.

I have followed Lamy, and Hertlein and Strong in uniting *C. tricolor* and *C. laticostata* as one species, although extreme shells may appear quite different. Typical *C. laticostata*, so common at Panama, has a larger and higher shell and the color pattern is a simple brown and white. The brown spots frequently only paint the tops of the ribs, and do not penetrate into the interspaces. Shells from Peru are usually smaller and longer with a greater range of coloration, in which orange is frequently seen; these shells were named *tricolor* by Sowerby and perhaps could be separated as the typical subspecies but intermediate forms occur.

Range—Gulf of California southward to Peru and the Galapagos Islands. Panama: Burica Peninsula; Búcaro; San Carlos; Panama City. Panama, Canal Zone: Venado Beach. Ecuador: Punta Blanca; Manta. Peru: Tumbes; Zorritos; Punta Picos; Mancora.

Cardita (Cardita) cuvleri Broderip

Plate 26, figures 2-2b

Venericardia crassicosata Sowerby, 1825, Cat. Shells Tankerville, Appendix, p. IV. (Not *V. crassicosata* Lamarck, 1819.)

Cardita crassicosata Hanley, Cat. Recent Bivalve Shells, p. 129, Sup. pl. 17, fig. 56.

Cardita cuvleri Broderip, 1832, Proc. Zool. Soc. London, p. 55.—Reeve, 1843, Conch. Icon., vol. 1, *Cardita*, pl. 5, fig. 24.

Cardita crassicosata (Sowerby), Maxwell Smith, 1944, Panamic Marine Shells, p. 55, fig. 692 G. (in text as 629C).—Durham, 1950, Mem. Geol. Soc. America, No. 43, p. 71, pl. 16, figs. 1, 3, 4 (fossil).

Cardita cuvleri Broderip, Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 3, No. 8, p. 105.

Shell large (length to nearly 70 mm.), subquadrate, longer than high, solid and heavy, with large, full umbones at the anterior third, ending in prosogyrate beaks coiled strongly over a deeply sunken lunular area. Posterior-dorsal area deeply excavated on the outer side next to the umbonal angle, vaulted and ribbed on the hinge side. Sculpture coarsely ribbed, formed by large, strong, broad, square, flatly nodulous ribs (13 to 14) separated by narrower, deeply channelled interspaces. Color is a mottled orange-brown and white, sometimes reddish, the lunular area brown, in life with a dirty brown periostracum. Interior white to pinkish, the posterior margin truncate and excavated, the ventral margin fluted by the ends of the ribs. Hinge coarse and heavy.

This fine species together with *C. megastrophia* is fairly plentiful along certain parts of the Ecuadorian coast. In 1832, Broderip wrote the following: "This fine species, far exceeding in size and beauty any *Cardita* hitherto discovered, was dredged from sandy mud in eleven fathoms water, about seven miles from the shore. After its capture the dredge was kept at work for some hours, but no other specimen could be procured. — The shell is a very striking object and has almost the appearance of a carved work." [p. 56.]

Range—Lower California to northern Peru. Panama: Pearl Islands; Burica Peninsula. Colombia: Gorgona Island (Hertlein and Strong). Ecuador: Esmeraldas; Manta; Jaramijo; Isla la Plata; San Pedro near Manglaralto; Punta Mambri on the south side of Santa Elena peninsula. Peru: Zorritos.

Cardita (Cardita) spurca beebel Hertlein

Plate 39, figure 6

Cardita spurca Sowerby, Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 3, No. 8, p. 106. (Not *C. spurca* Sowerby, 1832, Iquiqui, in Peru).

Cardita spurca beebeli Hertlein, 1957, Bull. So. California Acad. Sciences, vol. 56, pt. 3, pp. 107, 108, pl. 21, figs. 3, 4, 12, 13, 14. Type, off Manzanillo, Colima, Mexico, in 35 fms.

Shell ovately oblong, moderately thick, sculptured with about 18 trigonal, finely nodulose, radial ribs, those on the anterior and posterior margins finer than the others. Shell differing from that of *Cardita spurca* Sowerby in that it is smaller, thinner, and has finer ribs. Dimensions: length, 18.2 mm., height, 15.5 mm., convexity, both valves together, 11 mm. (Hertlein, 1957.)

A single specimen with both valves from Panama Bay (perhaps a shrimper shell) was contributed by Mr. Stewart Jadis of Balboa, Canal Zone. This is a larger shell than described by Hertlein having the following

measurements. Length 30 mm., height 24.7 mm., diameter of closed valves 20 mm. Distinction between the Panama shell and typical *C. spurca* from Peru (Callao) appear slight, the more southern form is generally more rounded in shape and the ribs heavier.

Range—Panama to Mexico. Panama: Panama Bay (Mr. S. Jadis). Costa Rica: Punta Arenas (Hertlein). Mexico: Off Manzanillo, Colima. (Hertlein).

Subgenus **STROPHOCARDIA**, new subgenus

Type species, *Cardita megastropa* (Gray).

Shell rounded cordate, solid, with high umbones and strongly prosogyrate coiled beaks over a small, deeply sunken lunule. Dorsal-posterior margin flattened, escutcheon-like. Sculpture formed by relatively few, low, rounded ribs. Hinge plate massive, the right valve with a large, stout, more or less hooked cardinal tooth, the left valve with two cardinal teeth and a large central socket; no vestigial laterals.

This group is represented in the Recent fauna by *C. megastropa* (Gray) and by several fossil species in the Tertiary. The group differs so strikingly in shape and hinge characteristics from *C. cuvieri* (Broderip) and its allies that it deserves separate recognition.

Cardita (*Strophocardia*) *megastropa* (Gray) Plate 26, figures 5, 5a

Venericardia megastropa Gray 1825, Ann. Phil., new ser., vol. 25, p. 137, two figs. p. 138.—Lamy, 1922, Jour. de Conchyl., vol. 66, No. 4, p. 294, two text figs., p. 296.

Venericardia flammea Michelin, 1831, Mag. de Zool., vol. 1, Moll., pl. 6.

Cardita tumida Broderip, 1832, Proc. Zool. Soc. London, p. 56.—Reeve, 1843, Conch. Icon., vol. 1, *Cardita*, pl. 5, fig. 26.

Cardita varia Broderip, 1832, Proc. Zool. Soc. London, p. 56.—Reeve, 1843, Conch. Icon., vol. 1, *Cardita*, pl. 5, fig. 25a.

Cardita megastropa (Gray), Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 3, No. 8, p. 106. (Type locality selected La Plata Island, Ecuador).

Shell of medium or large size, solid, cordate, the ventral side rounded, the dorsal trigonal, with high umbones and strongly coiled beaks. The anterior-dorsal side is deeply impressed with a small, flattened lunule lying under and partially overhung by the beaks. Sculpture and appearance of specimens vary according to their freshness and degree of wear; perfectly fresh specimens have a dark-brown, coarsely, concentrically striated periostracum through which the ribs show rather obscurely; in beach specimens or those cleaned by acid or alkaline, the ribs assume greater prominence and are seen to be low, trigonal in section, their interspaces also trigonal and with a central line, their color is a reddish-brown often variegated by white and brown blotches. Interior white with the margins of the valves weakly furrowed by the ends of the ribs.

Length 57.8 mm.; height 58 mm.; diameter 44 mm. Manglaralto, Ecuador.

Range—Gulf of California southward to Ecuador and the Galapagos Islands. Panama: Pearl Islands: Búcaro. Colombia: Gorgona Island. Ecuador: Esmeraldas; Sua; Isla la Plata; San Pedro near Manglaralto.

Subgenus **PLEUROMERIS** Conrad, 1867

Type species by monotypy, *Pleuromeris decemcostata* Conrad (=

Cardita tridentata decemcostata Conrad). Miocene to Recent of the eastern Atlantic seaboard of the United States.

Shell small, stout, convex, broadly triangular and equivalve. Umbones submedian, prominent, ending in small, adjacent beaks. Sculpture formed by large, coarsely noded, radial ribs. Hinge of *Cardita* but with small lateral teeth consisting of a posterior socket and an anterior tooth in the left valve and their counterparts in the right. Lunule small, restricted to the left valve, the escutcheon minute and poorly defined.

Cardita (Pleuromeris) guanica, new species

Plate 25, figure 8

Shell small, white, obliquely ovate, the height and length are nearly equal, the anterior side a trifle longer, oblique, the umbone convex, ending in a small, slightly prosogyrate beak. The shell is moderately solid. There is a slightly flattened area along the posterior-dorsal margin and a small, flattened lunular surface in the right valve. Sculpture formed by about 17 low, axial ribs set-off by incised grooves, all finely granulated or noded. Hinge shows a large central cardinal tooth bordered by a small socket on each side and a faint anterior lateral socket in the right valve.

Length 3.2 mm., height 3.3 mm., diameter 1.1 mm. (right valve). Holotype, ANSP 218925.

The description of this species is based on a single right valve from Guanico, probably not fully mature but it is recorded here as representing the only *Pleuromeris* known from this part of the coast. In shape, it somewhat resembles *P. armilla* Dall from the Gulf of Mexico, but its anterior side is much longer and its size smaller.

Range—Panama. Panama: Guanico.

Genus *CARDITAMERA* Conrad, 1838

(*Lazaria* Gray, 1854, type species *L. radiata* Sowerby.)

Type species by monotypy, *Cypricardia arata* Conrad. Miocene and Pliocene of the eastern and southeastern United States.

Shell elongate, oblong, equivalve, the margins closed. Umbones and beaks placed much nearer the anterior end, the posterior side drawnout, often wider and more strongly sculptured. Hinge pattern that of *Cardita* but with lateral teeth and sockets weakly or strongly developed in both valves; the middle, right cardinal tooth smaller, its base drawnout into a long, slender, lamina-like arm extended posteriorly along the lower edge of the hinge plate. Sculpture formed by radial ribs, usually strong on the posterior side, often flattening and fading out anteriorly.

Two species occur in the Panama-Ecuadorian region belonging to two subgenera.

Key to subgenera of *Carditamera*

I. Lunule in both valves. Posterior-umbonal slope low. Lateral teeth quite strong.

Subgenus *Carditamera*, s.s.

II. Lunule small or absent. Posterior-umbonal slope elevated and angular. Lateral teeth small to vestigial.

Subgenus *Byssomeria*, new subgenus

Carditamera (Carditamera) radiata (Sowerby)

Plate 26, figures 1-1c

Cardita radiata Sowerby, 1833, Proc. Soc. London for 1832, p. 195.—Reeve, 1843, Conch. Icon., vol. 1, *Cardita*, pl. 1, fig. 5a.

Lazaria radiata Sowerby, H. and A. Adams, 1858, Gen. Rec. Shells, vol. 2, p. 489; vol. 3, pl. 116, figs. 4, 4a.

Lazaria observa Mörch, 1861, Malak. Blatter, bd. 7, p. 199. (Proposed for Reeve, pl. 1, fig. 5a).

Glans radiata (Sowerby), Maxwell Smith, 1944, Panamic Marine Shells, p. 56, fig. 692J (intext 692U).

Cardita (Carditamera) radiata Sowerby, Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 3, No. 8, p. 103.

Shell elongate, rectangular, widest or highest in the anterior region under the beak, the anterior side shorter with rounded margin, the posterior longer, its dorsal and ventral margins straight but approach each other slightly, the posterior end produced and pointed. Sculpture is formed by low, rounded ribs, almost equally strong over the whole surface, their interspaces flat and widely grooved; the ribs on the anterior slope finely noded, the others usually flat except the rib along the posterior-dorsal margin which may be coarsely scabrous. The posterior-umbonal slope is low, not angled or vaulted. Color generally with a white base with the ribs irregularly blotched with brown or black, except on the posterior slope which is unicolorous.

Length 46.2 mm., height 20 mm., diameter 12.8 mm. Rey Island, Pearl Islands, Panama.

According to Sowerby, the original specimens of this species were dredged by Cumings from a sandy mud bottom in 6 to 12 fathoms of water at Salango and at Panama; Salango was selected as the type locality for the species by Hertlein and Strong. My collections from the Ecuadorian coast contain no specimens of this shell, and it is possible that Sowerby's shells all came from Panama where the species is relatively common. *Carditamera radiata* is closely allied to several Miocene and Pliocene species from the southeastern United States; *Carditamera defuniak* Gardner, as figured by Mansfield from the Miocene of Florida being scarcely distinguishable.

Range—Panama southward to Ecuador? Panama: vicinity of Panama City; Pearl Islands; Garachine; Búcaro.

Subgenus **BYSSOMERA**, new subgenus

Type species, *Cardita affinis* Sowerby.

Shell elongated, the posterior side generally wider, with a high, arched or vaulted umbonal angle extending from the beak to the posterior ventral margin, the posterior set of ribs strongly developed, the more anterior one often flattened to nearly obsolete, the anterior-ventral side depressed. Hinge weak, the lateral teeth much reduced in size and more or less vestigial. Lunule small or absent.

Carditamera (Byssomera) affinis (Sowerby)

Plate 26, figures 3-3d

Cardita affinis Sowerby, 1833, Proc. Zool. Soc. London (for 1832), p. 195 Bay of Montejo and Gulf of Nocoíya.—Reeve, 1813, Conch. Icon., vol. 1, *Cardita*, pl. 1, fig. 6.

- Cardita (Carditamera) affinis* Sowerby, Hertlein and Strong, 1946, *Zoologica*, vol. 31, pt. 3, No. 8, pp. 107, 108.
Glans affinis californica Sowerby, Maxwell Smith, 1944, *Panamic Marine Shells*, p. 56, fig. 704.

Shell elongate, rectangular, often large (length to 70 mm.), with the umbones and beaks placed between the anterior one-fourth and one-fifth, the anterior side, therefore, much shorter and narrower than the posterior. Dorsal and ventral margins long and fairly straight, subparallel, the anterior margin rounded, the posterior wider and subtruncate. The posterior umbonal slope is high and angular and usually more heavily sculptured. Sculpture formed by ribs, usually numbering about 17; of these, the six posterior ones and along the umbonal slope are large and usually coarsely scabrous, the others placed more anteriorly small and sometimes so low or flattened as to form smooth, colored radial rays. Hinge variable, the teeth sometimes much distorted and partly obsolete but when fully developed in the following form; the left valve has a large, anterior cardinal tooth bordered on each side by deep sockets while the posterior cardinal tooth is a slender, narrow lamina separated from the nymph by a groove; the right valve has a large, slender cardinal tooth bordered in front by a deep socket; the left anterior tooth is small and placed close to the main cardinal. Outside color usually brown over the posterior side, lighter to almost white on the anterior side.

Length 68.4, height 26.5 mm., diameter 13.8 mm. Manta, Ecuador.

This is a common species varying much in size, shape and sculpture, due in part to its habit of living in close quarters as under stones and along narrow crevices.

Range—Gulf of California southward to northern Peru. Numerous stations cited by Hertlein and Strong in Costa Rica, Nicaragua, Guatemala, and Mexico. Panama: Búcaro. Ecuador: Puerto Callo; Manta; Santa Elena. Peru: Tumbes; Zorritos; Caleta Sal; Mancora.

Family CONDYLOCARDIIDAE

Shell small to minute, ovate, suborbicular, subtrigonal to cordate, often resembling an immature *Cardita* with plain umbones or the beaks may be capped with an exaggerated prodissoconchal cup edged by an upturned or raised rim. Surface smooth or sculptured with strong, radial riblets, and concentric lines. Ligament weak, mostly internal. Hinge of variable development, the cardinal and lateral teeth commonly merged.

This is a family of small to minute shells, some species of which (*Carditella*) resemble immature specimens of *Cardita* and, therefore, easily overlooked. In *Condylocardia*, the beaks are capped by an enlarged prodissoconch surrounded by a raised rim.

Genus *CONDYLOCARDIA* (Munier-Chalmas), Bernard, 1896

Type species by original designation, *C. pauliana* (Munier-Chalmas), Bernard.

Shell small, generally globose, glassy, equivalve, and strongly inequilateral, the anterior side longer. The umbones full and capped by a

prominent, cup-shaped, smooth embryonic shell or an enlarged prodissoconch surrounded by a raised ledge or rim. Hinge plate stout, with a submedian resilifer pit bordered by stubby or hook-shaped cardinal teeth and the anterior and posterior lateral margins with distant teeth and sockets. External sculpture formed by coarsely noded, curved, radial riblets.

Condylocardia panamensis Olsson

Plate 77, figure 4

Condylocardia panamensis Olsson, 1942, *Bulls. Amer. Paleont.*, vol. 27, No. 106, pp. 186, 187, pl. 3, figs. 9, 10.

Shell minute, generally glassy and solid, equivalve, but strongly inequilateral. Externally, the valves are broadly subtriangular, the posterior side produced and somewhat pointed with a large, excavated escutcheon-like area. Umbones prominent, surmounted by a platelike, smooth, prodissoconch encircled by a thickened raised margin. External sculpture consists of a few, strong, radial riblets, largest in the middle zone, smaller on the sides and nearly absent from the posterior extremity; on a normal shell, these ribs number about eight. Spaces between the ribs are wide, transversely grooved or striated by the lines of growth. Hinge: the right valve has a strong, knob or hook-shaped anterior cardinal tooth and a socket for the left posterior cardinal tooth and between these is the attachment pit for the resilium. There is also a large anterior lateral tooth and a smaller posterior lateral tooth. Shell cavity deep, the ventral margins deeply fluted by the ends of the ribs which show through the glassy or translucent texture of the shell. Average length about 1.75 mm.

Common as a Pleistocene fossil on the Burica Peninsula, Panama, but only a few Recent specimens have so far been collected. Recent specimens are white or rose-colored. The Pacific shell is closely related to *C. bernardi* Dall and *C. smithii* Dall from the Caribbean and West Indian waters.

Range—Panama. Panama: Búcaro.

Superfamily SPHAERICEA

Family CORBICULIDAE

Brackish or marine clams of medium or large size, ovate-triangular or rounded shape and of medium or solid texture. Fresh shells are covered with a coarse yellow, green or dark-brown periostracum as a protection against corrosion, often deeply worn off the umbones and beaks, the surface of the shell underneath white or flushed irregularly with purple and marked with fine growth line striae or stronger concentrics. The ligament is external, attached to a nymphal plate, the opposing surface of which may be smooth or rugose. Hinge with three cardinal teeth in each valve (some of which may be bifid) and both anterior and posterior lateral teeth, the lateral teeth being smooth or striate. No lunule or escutcheon. Pallial line entire or sinuate.

Although some species of Panamic-Pacific corbiculids are locally gathered as a seafood, their shells are but sparingly represented in museum collections and the range and variation of some species is not well understood. The Panamic species have been greatly overnamed but the status of many of these forms must await the availability of larger and more complete collections.

The Panamic-Pacific species appear to belong to two principal genera.

Key to genera of Corbiculidae

- I. Shell rounded or ovate, of thin or medium weight, generally inflated, covered with a concentrically striated, wrinkled or fuzzy periostracum, the surface beneath marked with growth line concentrics only. Hinge plate rather narrow.

Genus *Polymesoda*

 1. Rounded or ovate in shape, with a short, narrow pallial sinus not crowded against the posterior adductor scar.

Subgenus *Polymesoda*, s.s.
 2. Small, ovate-elongate shells, the pallial sinus ill-defined.

Subgenus *Pseudocyrena*
(not regional)
 3. Shell larger, rounded, strongly convex. Pallial line entire or with a short, ill-defined sinus pressed against the posterior adductor scar.

Subgenus *Egeta*
- II. Shell rounded or trigonal, usually solid, with a wide hinge plate and coarse lateral teeth. Periostracum closely adherent, usually smooth or polished. Sculpture smooth or coarsely concentric. Pallial sinus short but usually well developed.

Genus *Neocyrena*

Genus **POLYMESODA** Rafinesque, 1820

(*Leptosiphon* Fischer, 1872, same type species as *Polymesoda*.)

Type species by original designation, *Cyclas caroliniana* Bosc. Eastern United States northward to Virginia.

The shell is rounded trigonal, ovate or cordate, inflated, the beaks prosogyrate and often corroded, the texture of the valves of medium or heavy weight. Hinge with both cardinal and lateral teeth (the left anterior and middle teeth, and the right middle and posterior cardinal teeth often bifid), the laterals equidistant. Surface smoothish or marked simply with fine, concentric, growth line striae, and covered by a yellowish, greenish or brownish periostracum, closely adherent or with narrowly spaced, elevated or frilled lamellae. Surface color below the periostracum is white. Interior with a short, narrow pallial sinus.

Subgenus **POLYMESODA**, s.s.

With two, well-defined species in the Panamics-Pacific region.

Polymesoda (*Polymesoda*) *notabilis* (Deshayes)

Plate 27, figures 6, 6a:
Plate 28, figure 6

Cyrena notabilis Deshayes, 1854, Proc. Zool. Soc. London, p. 21 Peru (at the mouth of rivers).—Prime, 1865, Smith. Misc. Coll., No. 145, p. 28, No. 29.—Sowerby, 1876, Conch. Icon., vol. 20, *Cyrena*, pl. 29, fig. 110 Payta, Peru.

Polymesoda zeteki Pilsbry, 1931, Nautilus, vol. 44, No. 3, p. 85, pl. 7, figs. 2, 2a. Near Chame, Panama.

The shell is ovate, subrectangular, relatively thin, strongly inequilateral, the beaks placed at the anterior one-third, moderately convex, the posterior-umbonal slope rounded or obscurely angled. The anterior side

is short, its end rounded, the posterior side longer and higher, its margin more flatly rounded so as to appear obscurely truncated and sometimes lightly angulated. The beaks are small, prosogyrous, adjacent, touching the hinge line, the umbones wide and full. The periostracum is a dull, dingy, buffy-brown or olive-brown color, minutely, concentrically wrinkled or lamellose scaly, retained generally on the lower part of the disk only, elsewhere where worn-off, the exposed surface is corroded, chalky white, and in some instances the corrosion has been so deep that the outer layer has been removed and the shell substance reduced to a paper thinness. Hinge armature is rather weak, the anterior lateral tooth placed close to the cardinals, the posterior lateral tooth more distant, at the end of the hinge line above the adductor scar. Surface of the disk below the periostracum is sculptured with crowded, irregular, growth concentrics, the color white, more or less flushed with pink except for a broad ray or band of tyrian purple along the posterior-dorsal slope, this ray transmitted through the texture of the shell into the interior where its color is more intense; on the outside, this colored band is seen only after the periostracum and the outer chalky layer have been destroyed by corrosion. Interior of shell is white, except in the umbonal cavity which may be faintly flushed with pink or apricot and the tyrian purple ray previously mentioned along the posterior-dorsal area and across the upper half of the posterior adductor scar. The pallial line is entire except for a small sinus of variable size and shape near the posterior adductor scar. Size of shell varies within wide limits.

Length 55 mm., height 40.5 mm., diameter 31.8 mm. Sua, Ecuador.

Length 38.3 mm., height 29 mm., diameter 22.8 mm. Tumbes, Peru.

This is a common and widely distributed species, and at Guayaquil, is often served in hotels and restaurants as a seafood. The periostracum is generally retained only around the ventral margin of the disk, the greater part of the surface being corroded and revealing a chalky white shell underneath. In beach specimens, the periostracum and the outer layer is usually removed, the shell then appearing solid in texture. A distinctive character of the species is the wide, purple band over the posterior-dorsal slope developed in the inner porcellaneous layer and hence seen only on deeply corroded specimens; it always shows plainly in the interior.

Pilsbry's *P. zeteki* was named from relatively small specimens from Panama where it is locally common. Deshayes' name "*notabilis*" was apparently based on a beach worn specimen of fairly large size; this specimen was examined by Prime whose detailed description fits many of our shells.

Range—Costa Rica to northern Peru. Costa Rica: Puntarenas. Panama: Chame; Ecuador: Limones; Esmeraldas; Sua; Mompiche. Peru: Tumbes.

Polymesoda (Polymesoda) mexicana (Broderip and Sowerby)

Plate 27, figures 8, 8a, 8b

Cyrena mexicana Broderip and Sowerby, 1829, Zool. Journ., vol. 4, p. 364.—Carpenter, 1857, Cat. Mazatlan Shells, Brit. Mus., pp. 115, 116, No. 165 Mazatlan, Mexico.—Prime, 1865, Smith, Misc. Coll., No. 145, p. 22, No. 18.—Sowerby, 1867, Conch. Icon., vol. 20, *Cyrena*, pl. 29, fig. 110 Mazatlan, Mexico.

Neocyrena mexicana (Broderip and Sowerby), Fischer and Crosse, 1894, Miss. Scient. a Mexique et l'Amérique centrale, sept partie, tome II, pp. 637, 638, pl. 70, figs. 7, 7a, 7b.

This is a smaller, more ovate and generally a more solid species than *P. notabilis*. Color white, tinted irregularly with purple. The periostracum is dark brown or green, irregularly wrinkled and generally destroyed over the umbones.

A more northerly species than *P. notabilis* and apparently restricted to the coast of Mexico. A specimen in the U. S. National Museum Collection at Washington measures: length 31.8 mm.; height 25.6 mm.; diameter 20.2 mm.

Range—Pacific Coast of Mexico.

Subgenus **PSEUDOCYBENA** Bourguignat, 1854

Type species by monotypy, *Cyrena maritima* d'Orbigny, 1842. Recent, Cuba and Florida.

(*C. cubensis* Prime, 1865, a replacement name for *maritima* d'Orbigny but not necessary.)

The shell is generally small or medium size, ovate to elongate trigonal, usually thin, marked with concentric growth line striae, white or more or less tinted with purple, and covered with a thin, adherent, brown or olive-green periostracum. The ligament is external, the hinge provided with three cardinal teeth in each valve (the right middle and posterior and the left middle and anterior teeth bifid) and anterior and posterior lateral teeth equidistant from the beaks. Pallial sinus short and poorly defined, crowded against the posterior adductor scar.

A group of small species of the Caribbean and Floridian region.

Subgenus **EGETA** H. and A. Adams, 1858

(*Anomala* Deshayes, 1855, not of Hübner, 1816; Samouille, 1819; Stephens, 1829).

Type species by tautonymy, *Cyrena anomala* Deshayes. Panamic-Pacific.

Shell ovate to high, trigonal-cordate, inequilateral, the beaks placed nearer the anterior end, the posterior side rounded or pointed at the end. Valves are strongly inflated. Surface marked mainly with fine, concentric growth lines and covered by a dark brown or olive-green periostracum, finely wrinkled or fuzzy. Pallial line is nearly entire or with a small, narrow sinus crowded against the posterior adductor scar.

The name *Egeta* was proposed by the Adams brothers as a replacement of *Anomala* Deshayes, several times preoccupied. Deshayes did not give a description of *Anomala*, the name being shown in parenthesis as a subgenus of *Cyrena*. J. P. E. Morrison has suggested that *Egeta* should be considered a synonym of *Geloina* Gray, 1840 (type species, *Cyrena zeylanica* (Chem.), Lamarck), of the Indo-Pacific but since *Egeta* was proposed for American species, the name seems preferable in this instance.

Polymesoda (*Egeta*) *anomala* (Deshayes)

Plate 27, figure 7;
Plate 33, figures 7, 7a

Cyrena anomala Deshayes, 1855, Proc. Zool. Soc. London for 1854, p. 21 Bay of Caracas.

- Prime, 1865, Smith. Misc. Coll., No. 145, p. 30, No. 34, fig. 24.—Sowerby, 1876, Conch. Icon., vol. 20, *Cyrena*, pl. 19, fig. 109.
- Cyrena* (*Anomala*) *isocardioides* Deshayes, 1855, Proc. Zool. Soc. London for 1854, p. 22. Hab. Colombia.—Prime, 1865, *op. cit.*, p. 25, No. 23; Sowerby, 1876, *op. cit.*, pl. 18, fig. 103.
- Polymesoda isocardioides* (Deshayes), Maxwell Smith, 1944, Panamic Shells, p. 67.—Hertlein and Strong, 1955, Bull. Amer. Mus. Nat. History, vol. 107, art. 2, pp. 187, 188, pl. 2, figs. 25, 28.
- Cyrena cardiformis* Sowerby, 1876, *op. cit.*, pl. 8, figs. 27a, 27b Payta, Peru.

The shell is high, subtrigonal, cordate, inequilateral, the umbones swollen and high, narrowing into the small beaks which do not touch the hinge line and are not closely adjacent to each other. The substance of the shell is thin, the valves strongly inflated, especially along the anterior-umbonal slope; behind this zone, the surface of the disk is impressed with a weak bulge along the posterior-dorsal slope forming a narrow fold; the posterior-dorsal submargin itself is narrowly impressed, the posterior end slightly produced or beaked, especially in the young. The surface is covered with a thin, olive-brown periostracum, often worn off in spots exposing the disk beneath which is white, shaded irregularly with violet, most strongly so on the beak and along the posterior slope. The surface is nearly smooth across the middle zone with irregular concentric growth lines showing on the sides. Cavity of shell deep, the hinge weak, the lateral teeth elongated.

Length 49 mm., height 46.5 mm., diameter 40.4 mm. Tumaco, Colombia.

This species is recognized by its high, trigonal shape, markedly inflated, thin, cordate valves and its more or less pointed or beaked posterior end. Young shells are thin and the posterior beak is pronounced.

Range—Nicaragua to northern Peru. Nicaragua: Corinto. Colombia: Isla del Gallo; Tumaco. Ecuador: Santa Elena. Peru: Tumbes; Boca Pan.

***Polymesoda* (*Egeta*) *inflata* (Philippi)**

Plate 27, figures 3, 3a, 5

- Cyrena inflata* Philippi, 1851, Zeit. f. Malak., p. 71.—Prime, 1865, Smith. Misc. Coll. No. 145, p. 26, No. 26.
- Cyrena maritima* C. B. Adams, 1852, Ann. Lyceum Nat. Hist. New York, vol. 5, pp. 499, 545.—Sowerby, 1878, Conch. Icon., vol. 20, *Cyrena*, pl. 8, fig. 30.—Turner, 1956, Occas. Papers on Mollusks, Comp. Zool., vol. 2, No. 20, pp. 62, 63, pl. 20, figs. 5, 6.
- Cyrena inflata* Deshayes, 1854, Proc. Zool. Soc. London, p. 23 preoccupied by *C. inflata* Philippi, 1851 Panama.
- Cyrena panamensis* Prime, 1860, Proc. Acad. Nat. Sci. Philadelphia, vol. 12, p. 283 new name for *C. inflata* Deshayes preoccupied.—Prime, 1865, *op. cit.* No. 145, p. 24, No. 20.—Sowerby, 1878, Conch. Icon., vol. 20, *Cyrena*, pl. 8, fig. 29.
- Cyrena isocardioides* (Deshayes), Dall, 1909, Proc. U. S. Nat. Mus., vol. 37, No. 1704, p. 159, pl. 26, fig. 4. (Not *C. isocardioides* Deshayes, 1855.)
- Polymesoda joseana* Morrison, 1946, Smith. Misc. Coll., vol. 106, No. 6, p. 44, pl. 1, figs. 12-14.
- Cyrena cordiformis* Recluz, 1835, Jour. de Conchyl., vol. 4, p. 251, pl. 7, fig. 9 (no locality cited). Not *C. cordiformis* Deshayes, 1824.
- Cyrena reclusii* Prime, 1865, *op. cit.*, vol. 7, No. 145, p. 24, fig. 19. Hab. ?Central America.
- Polymesoda reclusii* (Prime), Hertlein and Strong, 1947, Zoologica, vol. 31, pt. 4, pp. 148, 149.
- Cyrena peruviana* Deshayes, 1854, Cat. Conch. Bivalve Shells, Brit. Mus., pt. 2, p. 259. Hab. Tumbes in littori Peruviana (coll. Cuming).

The shell is generally large, thin, strongly inflated, subrectangular in shape, the umbones swollen, wide, ending in small, prosogyrate beaks touch-

ing the hinge line and placed near the anterior one-third, surface covered with a dark brown to nearly black, closely concentrically wrinkled periostracum, generally worn off in spots exposing a chalky white surface underneath. The anterior side is shorter, with a rounded margin, the posterior side longer, with an obscure posterior angle, narrowed towards the margin which appears as if cut off or crudely truncated. Below the periostracum, the surface of the shell is white, and where extensively corroded, the outer, chalky layer may be completely destroyed revealing the more durable inner, porcellaneous layer. The shell with the periostracum removed is white with a shading of purple over the umbones and along the posterior-umbonal slope, the interior white, sometimes faintly pink or peach-colored in the umbonal cavity.

Length 61.6 mm., height 54.1 mm., diameter 48.2 mm. Tumbes, Peru.

This is a large, convex, rounded shell with a coarse, heavy, dark-colored periostracum, usually deeply corroded over the umbones, the exposed surface white and chalky. C. B. Adams noted that he found this species living at Panama in deep, impalpable mud, under bushes, at high water marl, and where a small stream emptied into the sea.

Range—Mexico to northern Peru. Costa Rica: Puntarenas (Hertlein and Strong). Panama: Panama City; Bahia Honda, El Lagartillo. Colombia: Isla del Gallo. Ecuador: Cojimenes; Santa Elena. Peru: Tumbes.

Genus **NEOCYRENA** Fischer and Crosse, 1893

Type species by subsequent designation, H. B. Baker, 1930, *Cyrena nicaraguana* Prime, 1869 (= *N. insignis* Deshayes, 1854). Central and South America.

Shell subtrigonal, with slightly anterior, prosogyrate beaks, porcellaneous and generally quite solid texture. Hinge wide with strong teeth, especially the lateral set and their sockets, the anterior lateral tooth placed a little closer to the cardinals than the posterior one. The surface of the valve is concentrically marked, either by fine or by coarse sulci, the whole covered by a shiny, olivaceous to nearly black periostracum, usually worn off the beaks. Color of shell below the periostracal cover is white, lightly or heavily flushed with purple often in rayed bands; also the interior. Pallial line with a small but distinct sinus just in front of the posterior adductor scar. Adductor impressions are distinct and of equal size. Ventral margin smooth.

Species of this genus are distinguished from those of *Polymesoda* by a more trigonal and usually a more solid shell. The periostracum is smooth and polished. The pallial sinus is short and well developed.

A large number of species of *Neocyrena* have been described from tropical America, mostly by Deshayes, often from unknown stations; the validity of many of these forms as distinct species cannot be properly assessed at this time or until much larger collections showing range of variation and distribution become available.

Neocyrena fontainei (d'Orbigny)

Plate 27, figure 4

Cyrena fontainei d'Orbigny, 1844, Voy. Amér. Mérid., vol. 5, 3d partie, Mollusques, p.

569, pl. 83, figs. 14, 15 Guayaquil.—Prime, 1865, Smith. Misc. Coll., No. 145, p. 21, No. 16, fig. 16.—Sowerby, 1876, Conch. Icon., vol. 20, *Cyrena*, pl. 9, fig. 34.

Shell of medium size, ovate-trigonal, slightly convex, the umbones full, erect, slightly anteriorly placed and narrow. The anterior side is short and rounded, the posterior somewhat longer, produced and bluntly pointed at the end. Surface covered with smoothish, raised concentrics and overlain by a brown or green periostracum, generally well preserved on specimens seen. Interior violet.

Length 51.4 mm., height 42.4 mm., diameter 26.1 mm. Guayaquil, Ecuador. ANSP 54635.

Similar in general shape to *E. triangula* but more regular and the sculpture smoother.

Range—Ecuador. Ecuador: vicinity of Guayaquil.

Neocyrena triangula (von du Busch), Philippi Plate 27, figures 2, 2a;
Plate 28, figure 3

Cyrena triangula von du Busch, Philippi, 1949, *Abbild. und Beschrieb. Conchylien*, bd. 3, p. 78, tab. 2, *Cyrena*, fig. 3.—Prime, 1865, Smith. Misc. Coll., No. 145, p. 14, No. 5 Mazatlan.

Cyrena altilis Gould, 1853, *Proc. Boston Soc. Nat. Hist.*, vol. 6, p. 400, pl. 16, fig. 5.

Cyrena olivacea Carpenter, 1857, *Cat. Mazatlan Shells*, *Brit. Mus.*, pp. 114, 115 Mazatlan.—Prime, 1865, *op. cit.*, pp. 17, 18, No. 10, fig. 12.—Sowerby, 1876, *Conch. Icon.*, vol. 20, *Cyrena*, pl. 9, fig. 12.

Neocyrena triangula (von du Busch), Fischer and Crosse, 1894, *Miss. Scient. a Mexique et l'Amérique centrale*, septième partie, tome II, p. 78.

Neocyrena olivacea (Carpenter), Fischer and Crosse, 1894, *op. cit.*, pp. 634, 635, pl. 70, figs. 5, 5a, 5b.

This species is similar to *N. fontainei* but has a more triangular shape and a more irregular and somewhat different surface sculpture. According to Carpenter, it is known outwardly by its flattened form, elevated, trigonal-cordate shell, its posterior end with a short but evident beak, and a surface covered by a rich olive or dark-brown, glossy periostracum. The sculpture is formed by small, rounded concentric costae which are even and strong on the anterior slope, smoother or subobsolete over the middle portion and more irregular on the posterior side. The interior is generally marked with deep purple. The adductor scars are placed close to the margin. There is a small but distinct pallial sinus pressed close to the adductor scar.

Length 58.2 mm., height 47.8 mm., diameter 28.5 mm. Mazatlan, Mexico. ANSP 54945.

Range—Mexico. Mexico: Mazatlan.

Neocyrena fortis (Prime) Plate 28, figures 2-2d

Cyrena fortis Prime, 1861, *Jour. de Conchyl.*, vol. 9, p. 355; vol. 10, p. 387, pl. 14, fig. 2 South America in Ecuador.—Prime, 1865, Smith. Misc. Coll. No. 145, p. 17, fig. 11.

Shell rounded, trigonal, solid, depressed or of medium convexity, inequilateral, the posterior side longer, weakly carinated along the umbonal slope and obliquely subtruncated at the end. Beaks large, prosogyrous but seldom perfect, the umbonal surface being nearly always deeply corroded. The sculpture is formed by small but strong concentric costae, even or regular over the disk proper, generally ending at the posterior-umbonal

angulation and overlain in fresh specimens by a heavy, greenish-brown periostracum which scales off easily from dead shells. Surface color of shell below the periostracum is white, irregular blotched or flushed with purple and pink, and often with scattered narrow or broad bands of deep purple radiating from the beaks. Interior white, deep purple or lighter shades of pink. The pallial sinus is small but distinct.

Length 41 mm., height 34.7 mm., diameter 21.2 mm. Cojimeses, Ecuador.

Length 52.1 mm., height 46 mm., diameter 31.6 mm. Ecuador. Paratype (Prime Coll.), MCZ 187454.

An ovate-subcircular, rather solid shell with a smooth periostracum and rather coarse, regular concentrics. The surface beneath the periostracum is dingy white, faintly tinted with violet or pink and often marked with rays of deeper purple. The posterior-umbonal slope is slightly angled.

Range—Ecuador to Peru. Ecuador: Cojimeses. Peru: Paita (MCZ 176877).

Neocyrena meridionalis (Prime)

Plate 28, figures 4, 4a, 4b

Cyrena meridionalis Prime, 1865, Smith. Misc. Coll., No. 145, p. 19, No. 12, fig. 14 South America, at Payta, in Peru (Cabinet of Prime).

A small, rounded, globose shell with a dark olivaceous green periostracum, the surface below white with purple rays. Interior white flushed with purple over the adductor scars and over the hinge.

Length 34.7 mm., height 34.5 mm., diameter 26 mm.

Tumbez, Peru. Lea Coll. USNM 122451.

Range—Peru. Peru: Tumbez.

Neocyrena tribunalis (Prime)

Plate 28, figure 1

Cyrena tribunalis Prime, 1869, Amer. Jour. Conch., vol. 5 (Appendix), p. 148, No. 78 (*nomen nudum*).—Prime, 1870, Ann. Lyceum Nat. Hist. New York, vol. 10, p. 300.

A coarse, heavy shelled species with a sharply folded posterior keel, coarse concentrics and a smooth, dark-green periostracum.

The holotype seen in Washington, D.C. (MCZ 17688, Prime Coll.), Tucumes River has the following measurements: length 55 mm., height 45.8 mm., diameter 34.5 mm.

The location of Tucumes River could not be determined; it is probably in Ecuador or Colombia.

Neocyrena radiata (Hanley)

Plate 28, figures 5-5c;

Plate 85, figures 2-2c

Cyrena radiata Hanley, 1844, Proc. Zool. Soc. London, p. 159 Realejo, Nicaragua.—Prime, 1865, Smith Misc. Coll. No. 145, p. 13, No. 14, fig. 7.—Sowerby, 1876, Conch. Icon., vol. 20, *Cyrena*, pl. 11, figs. 47a, b.

Shell of medium size, ovately rounded, with full, prominent umbones, slightly off the middle line, the small beaks directed anteriorly. Valves are strongly convex, solid. There is an indistinct posterior-umbonal angle which sets off a wide but poorly differentiated dorsal area. There is no lunule. Periostracum dark olivaceous, generally intact over the whole surface, often showing one or more radial rays faintly at the ventral margin. Beneath the periostracum, the surface is marked with somewhat irregular,

coarse concentrics. Interior white or variously shaded with violet, heaviest over the adductor scars and in a band outside the pallial line. Pallial sinus small but distinct, pressed close against the posterior adductor scar.

Length 39.5 mm., height 36 mm., diameter 28 mm. Holotype, British Museum (Natural History).

Recognized by its strongly convex and well-rounded valves, its poorly defined umbonal angle and rather coarse but even concentrics. Rayed markings often show near the ventral margin on removal of the periostracum. As yet a little understood species.

Range—Nicaragua to Ecuador. Panama: Búcaro; Guanico. Ecuador: Cojimeses.

Neocyrena sp.

Plate 28, figures 7, 7a

Shell of medium size, short, ovate, cordate, the umbones prominent and with the beaks placed near the anterior one-third. The posterior-dorsal area is not well defined, there is only a low angle and a small change in sculpture separating it from the main disk. Principal surface of the shell is sculptured with coarse, rounded, concentric sulci, narrower than their interspaces; these concentrics are regularly formed and distributed over the general surface but become simpler and reduced in number at the posterior-dorsal area, two sulci often joining to form a single one. Periostracum is colored a light, greenish yellow with some darker concentric bands, and below this faint purple rays are indicated. Hinge stained with purple and in the deep interior.

Length 34.6 mm., height 30.4 mm., diameter 21.3 mm.

The above description is based on a shell in the Academy of Natural Sciences Philadelphia, Collection (ANSP 155424) from the mouth of the Guarara River, Panama, collected by Dr. J. Zetek. This form seems nearest to *N. radiata* (Hanley) but differs by its more rounded form.

Superfamily LUCINACEA

Family DIPLODONTIDAE

Shells of this family are generally small (length up to about 40 mm.), suborbicular to subtrigonal, convex or depressed, thin, white. Surface smooth or sculptured with fine growth lines, often minutely punctate or coarsely granulose. Ligament external but sometimes becoming partly immersed below the margin and attached to a flattened nymphal plate. Hinge with two cardinal teeth in each valve, of which the left anterior and the right posterior tooth are typically double or bifid. Adductor scars subequal in size and connected by an entire pallial line which is often wide and ribbon-like.

From the Lucinidae, the members of this family differ by important anatomical characters. On shell features, the most distinguishable characters are the prominently double cardinal teeth (to which the group owes its name, *Diplodonta*) and in its subequal adductor scars. Certain species may be confused with the young of *Dosinia* and *Cyclinella* but the absence of a pallial sinus will distinguish them.

Two genera occur in the southern Panama-Pacific faunal area.

- I. Shell suborbicular to subtrigonal, convex or depressed. Surface smoothish, sometimes submicroscopically punctate but not nodose. Ligament external, the nymphal area not deeply immersed.

Genus *Diplodonta*

- II. Shell rounded, subcircular and convex or plump. Surface sculptured with coarse concentrics, often with coarse nodes or pustules most heavily developed on the anterior slope. Ligament deeply immersed, the margins of the valve typically rising well above the nymphal area.
Genus *Phlyctiderma*

Key to Panamic species of the Diplodontidae

- I. Surface covered with fine, growth-like concentrics, often irregular, smooth or minutely punctate (not coarsely nodose or granulose). Ligament external but not immersed into the hinge plate (*Diplodonta*.)
- A. Shell rounded, globose and plump.
- Aa. Without submicroscopic punctation.
1. Shell relatively large (length 37 mm.), nearly circular in shape, the umbones low.
D. suprema
2. Shell smaller (length about 18 mm.), venerid in shape and with the umbones and beaks rising well above the hinge line.
D. inezensis
- Ab. Minutely punctate, especially over the surface of the umbones.
3. Shell relatively small (length 17 mm. or less), rounded with the umbones and beaks decidedly anterior in position.
D. discrepans
- B. Shell with a round or subquadrate outline, its surface depressed or slightly convex.
4. Valves subquadrate in shape, the anterior side narrowed.
D. subquadrata
5. Valves subcircular, with low umbones and beaks, slightly anterior in position. *Cyclinella*-like. Length about 20 mm.
D. tellinoides
6. Less circular in shape, the umbones high and narrow, projecting above the hinge line. Length about 19 mm.
D. cornea
7. Shell quite small, length about 11 mm. Axis of shell obliquely inclined.
D. obliqua
- II. Shell rounded and convex, its surface plainly sculptured with concentrics or with a scattering of nodes and pustules. Ligament external but deeper, partly immersed in the hinge plate (*Phlyctiderma*).
- C. Sculpture plain, without nodes or pustules.
8. Subcircular, convex, length 18 mm. Umbones not prominently elevated.
P. orbella
- D. Sculpture formed by strong, cordlike concentrics dividing into rows of beadlike nodes or isolated pustules.
9. Shell relatively large (length about 20 mm.). The ligamental scar deeply impressed into the hinge plate.
P. semiaspera
10. Like *semiaspera* but smaller and with the nodes confined mainly to the anterior submargins.
P. insula
11. Shell small with wide umbones which rise high above the hinge line, the anterior side extended. Surface nodes small, strongest on the anterior submargin.
P. elenensis

Genus **DIPLODONTA** Bronn, 1831

Type species by subsequent designation, Gray, 1847, or Hermannsen, 1847, *Venus lupina* Brocchi. Miocene and Pliocene of northern Italy.

Shell generally small, rounded, suborbicular to subtrigonal, with median or slightly anterior umbones and prosogyrate beaks. Surface plain or marked with concentric incrementals, smooth or minutely punctate. Hinge as described for the family consists of two cardinal teeth in each valve and of which the left anterior and right posterior are bifid or sulcate, no laterals. Ligament external but sometimes becoming deeply immersed into the hinge plate, often encroaching against the posterior cardinal teeth, the nymphs raised into a platelike structure. No defined lunule or escutcheon. Margins entire, the pallial line simple. Adductor scars distinct and subequal in size. Shell white, overlain by a thin, usually brownish periostracum.

In recent years, the name "*Taras* Risso, 1826" has been used to replace that of *Diplodonta* but as Chavan, 1952 has indicated, Risso's name is extremely questionable and should be suppressed.

Two subgenera may be used for the Panamic species.

I. Shell rounded, subglose, plump, inequilateral.

Subgenus *Diplodonta*, s.s.

II. Shell with subtrigonal umbones, the valves often depressed or weakly convex, inequilateral.

Subgenus *Felaniella*

Diplodonta (Diplodonta) suprema, new species

Plate 32, figures 2-2b

Shell large (length 37 mm.), subcircular, convex, relatively thin, white or cream-colored. Surface nearly smooth, marked only with fine, concentric lines of growth and resting marks, and in some specimens very minute radial lines and wrinkles may be observed. The hinge line is straight, long, with the small beaks, subcentral, projecting slightly above it and placed a little in front of the middle. The anterior side is a little shorter than the posterior, narrower and broadly subtruncate at the end while the posterior and ventral sides form part of a wide circular curve. Externally the valves appear rounded and plump with the fullest inflation in a broad zone running from the beak to the posterior-ventral margin. Hinge normal with the left anterior and the right posterior cardinal teeth bifid. Cavity of shell deep, the adductor scars and pallial line plainly marked. Adductor scars are of nearly equal size, the anterior one somewhat more elongate, each placed just below the end of the hinge. Pallial line entire, attached to the lower end of each adductor. No lunule or escutcheon.

Length 37.3 mm., height 31.2 mm., diameter 28.2 mm.

Unusual amongst Recent species of the genus because of its large size recalling several fossil forms usually referred to the subgenus *Sphaerella*. It is most similar to *T. subvexa* (Conrad) from the Miocene of Maryland which attains nearly the same size but has larger umbones and a more circular form.

Range—Panama. Panama Canal Zone: Palo Seco.

Diplodonta (Diplodonta) discrepans Carpenter

Plate 32, figures 7, 7a

(b) *Diplodonta ?semiaspera*, var. *discrepans* Carpenter, 1857, Cat. Mazatlan Shells, Brit. Mus., p. 102 Mazatlan.

Shell small or of medium size, obliquely rounded, plump and relatively thin. The umbones are full with the small beak placed a little anterior of the middle, the anterior margin descending towards a widely rounded end. The posterior side is wide and evenly rounded into the curve of the central margin. External surface smooth or somewhat concentrically undulated by growth incrementals and when unworn punctated with fine dots over the whole disk including the dorsal submargins, where it is a trifle coarser. Anterior-dorsal margins grooved in each valve.

Length 16.6 mm.; height 14.7 mm.; diameter of a right valve 5 mm. Isla del Gallo, Colombia. Most valves are smaller.

This species has the microscopic punctation of *D. soror* C. B. Adams of the western Atlantic, but the shell is smaller, more circular and the anterior side is less expanded. Species with this type of surface punctation have often been referred to *Phlyctiderma*, but the weaker hinge and wholly external ligament are those of *Diplodonta*.

A series of small *Diplodonta* was extracted by Carpenter from a burrow in a *Chama* shell taken at Mazatlan, young and old specimens tightly wedged together. Carpenter noted that the shells varied much in shape, convexity, and in the position of the ligament; in some, the ligament was conspicuously external, in others entirely hidden or internal. Carpenter's specimens were not figured but manuscript drawings of the two forms are in the molluscan library of the U.S. National Museum; to the shell with the wholly internal ligament, Carpenter tentatively proposed the name *D. discrepans*. Carpenter's manuscript figure, herein reproduced, agrees well with specimens from Isla del Gallo, in southwestern Colombia.

Range—Mexico to southwestern Colombia. Colombia: Isla del Gallo.

Subgenus **FELANIELLA** Dall, 1899

Type species by original designation, *Felania usta* Gould.

Shell heavier, compressed, smooth externally or with relatively coarse, concentric sculpture. Surface usually covered with a dark periostracum. Valves are less equilateral.

Diplodonta (Felaniella) obliqua Philippi

Diplodonta obliqua Philippi, 1846, Zeitschr. f. Malakozool., p. 20 (Mazatlan).

Lucina calculus Reeve, 1850, Conch. Icon., vol. 6, *Lucina*, pl. 11, fig. 68 (Gulf of Nicoya).

Diplodonta (Felaniella) obliqua Philippi, Dall, 1901, Proc. U.S. Nat. Mus., vol. 23, No. 1237, p. 796.

Taras (Felaniella) obliquus (Philippi), Hertlein and Strong, 1947, Zoologica, vol. 31, pt. 4, No. 10, p. 131.

Generally small (max. about 11 mm.), white, obliquely subovate, inequilateral, the anterior side highest, rounded, the posterior shorter, obliquely subtruncate, the ventral margin well rounded. Valves depressed to moderately convex, mainly in the umbonal region, the dorsal slopes, somewhat depressed. Sculpture formed by irregular, fine and coarse concentrics over the entire disk.

Length 10.9 mm., height 10.8 mm., diameter 2.5 mm. (a right valve, El Lagartillo).

Small specimens may be subtrigonal in shape with narrow, convex umbones producing the effect of a hunch-backed shell. The largest shell seen, a specimen from the beach at El Lagartillo near Las Tablas, is slightly less than 11 millimeters long.

Range—Lower California to Ecuador. Panama: El Lagartillo, near Las Tablas; Búcaro. Ecuador: Puerto Callo.

Diplodonta (*Felaniella*) *tellinoides* (Reeve)

Plate 32, figures 4, 4a

Lucina tellinoides Reeve, 1850, Conch. Icon., vol. 6, *Lucina*, pl. 9, fig. 56 Isle of Muerte, Bay of Guayaquil (11 fathoms).

Diplodonta (*Felaniella*) *sericata* (Reeve), Pilsbry and Lowe, 1932, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, p. 137 listed.

Taras (*Felaniella*) *sericatus* (Reeve), Hertlein and Strong, 1947, Zoologica, vol. 31, pt. 4, pp. 131, 132, pl. 1, fig. 10.

Shell orbicular to subcircular, the beaks placed a little in front of the middle, thin, depressed to slightly convex, white, covered with a thin, light-brown or horn-colored periostracum. Surface marked with irregular, coarse concentrics showing a slight banded arrangement or undulations suggesting growth intervals. Radial striation if any, is weak. Ligament external but deeply inset and crowded against the thin, posterior cardinal tooth.

Length 20.7 mm., height 18.8 mm., semidiameter 4.7 mm. Tumaco, Colombia.

Length 23.9 mm., height 22 mm., semidiameter 6.4 mm. Santa Elena, Ecuador.

This is a common and widely distributed species found mostly on mud flats. The surface is white, covered by a thin, shiny periostracum of a light brown color.

This shell has usually been identified by authors with *D. sericata* Reeve (*D. cornea* Reeve) but a good series of specimens in my collection from Tumbez, agree best with Reeve's figure of *L. tellinoides* described from the nearby Isla la Muerte in the Bay of Guayaquil. Dall¹⁰, however, considered *L. tellinoides* a *Pseudomiltha* and compared it with Conrad's *Lucina floridana*, a relationship which is questionable.

Range—Lower California to northern Peru. San Salvador: Gulf of Fonseca (Pilsbry and Lowe, ANSP 178651). Costa Rica: Salinas Bay. ANSP 67147. Panama: Rey and Viveros Islands in the Pearl Island group; Búcaro. Colombia: Tumaco. Ecuador: Charapota; Santa Elena. Peru: Tumbez.

Diplodonta (*Felaniella*) *cornea* (Reeve)

Plate 32, figures 1-1b

Lucina cornea Reeve, 1850, Conch. Icon., vol. 6, *Lucina*, pl. 9, fig. 25 Nicoyia.

Lucina nitens Reeve, 1850, *op. cit.*, pl. 9 fig. 50 Isle of Muerte, Bay of Guayaquil.

Lucina sericata Reeve, 1850, *op. cit.*, pl. 9, fig. 55. Hab. unknown.

Diplodonta (*Felaniella*) *artemides* Dall, 1909, Proc. U.S. Nat. Museum, vol. 37, No. 1704, pp. 156, 263, pl. 28, fig. 8 Capon, Ecuador.

Diplodonta (*Felaniella*) *cornea* (Reeve), Hertlein and Strong, 1955, Bull. Am. Mus. Nat. Hist., vol. 107, art. 2, pp. 184, 185.

¹⁰ Dall, W. H., 1909, Proc. U.S. Nat. Museum, vol. 23, No. 1237, p. 812.

Shell small or of medium size, obliquely subcircular to orbicular, thin, depressed to slightly convex, white, the periostracum is thin and of a pale horn color to nearly white. The umbones are high, narrow, and project well above the hinge line, the beaks small and prosogyrous. The anterior slope is depressed, the margin itself straight or appears as if widely truncated, the posterior side longer, rounded at the end and a part of the circular curve which forms the ventral margin. Surface with an even sculpture of coarse, raised, concentric threads recalling that of *Dosinia dunkeri* spaced between slightly wider intervals. Ligament area excavated into the hinge plate, short.

Length 19 mm., height 18.2 mm., semidiameter 4.8 mm. Tumbes.

This species differs from *D. tellinoides*, with which it may occur, by its more oblique form and especially by its high, narrow, prominent umbones which project conspicuously above the dorsal margin. Its surface sculpture is neat and regular, formed by evenly distributed concentric threads which were likened to the surface pattern of *Dosinia dunkeri* by Dall.

Range—Gulf of California to northern Peru. Ecuador: Santa Elena. Peru: Tumbes.

Genus **PHLYCTIDERMA** Dall, 1889

Type species by original designation, *Diplodonta semiaspera* Philippi. Recent, West Indies, and the Caribbean.

Shell subcircular, convex or plump, semisolid. Hinge stout, the left valve with a large, hook-shaped or projecting, bifid, anterior cardinal tooth, the posterior cardinal simple, smaller, obliquely attached to the end of the nymph; the right valve has the posterior cardinal bifid, bordered in front by a deep socket. Ligament external but lies deeply immersed in an excavated furrow well below the valve margin, the nymph itself small, narrow, linear in shape. External surface coarsely sculptured with concentrics, often with large nodes or V-shaped pustules over most of the disk but lacking on the posterior-dorsal slope. Adductor scars large, connected at their base by a wide, entire pallial line.

Authors have generally considered *Phlyctiderma* as a subgenus of *Diplodonta* distinguished principally on the basis of its granulose or pustulate surface. However, in its peculiar hinge construction and deep immersion of its ligament, it differs sufficiently for separate generic recognition. *Phlyctiderma* has a stronger hinge, its bifid cardinal teeth larger, projecting or hook-shaped upward. The ligament is attached to a narrow, wedge-shaped nymph which lies deeply immersed below the posterior-dorsal margin of the valve. Typical specimens have a granulose or nodose surface sculpture, the nodes often V-shaped or elongated; some other species, such as *P. orbella* (Gould) have no granules, the surface marked with concentric riblets only.

Phlyctiderma semiaspera (Philippi)

Plate 32, figures 3-3c

Diplodonta semiaspera Philippi, 1836, Wieg. Arch., vol. 1, p. 225, pl. 7, figs. 2a-d.

Lucina caelata Reeve, 1850, Conch. Icon., vol. 6, *Lucina*, pl. 6, figs. 27a, 27b Island of Muerte, Bay of Guayaquil.

Diplodonta (Phlyctiderma) caelata (Reeve), Dall, 1901, Proc. U.S. Nat. Museum, vol. 23, No. 1237, p. 796.

Taras (Phlyctiderma) semirugosa (Dall), Hertlein and Strong, 1947, Zoologica, vol. 31, pt. 4, p. 132.

Diplodonta (Phlyctiderma) semirugosa Dall, Hertlein and Strong, 1955, Bull. Amer. Mus. Nat. Hist., vol. 107, art. 2, p. 185, pl. 2, figs. 12, 16, 17.

Shell of medium or large size (average length about 21 mm.), sub-circular, rounded and convex, thin or subsolid, white or light gray. Umbones full, the small beak placed at the anterior one-third. Surface with coarse concentric sculpture, generally breaking apart to form large nodes which cover the general disk except along the posterior dorsal slope.

Length 21.5 mm., height 19.7 mm., semidiameter 8.6 mm. Manta, Ecuador.

A comparison of specimens of *P. caelata* from Ecuador and Peru with *P. semiaspera* from Florida reveals no essential difference between them.

Range—Coast of Ecuador and northwestern Peru. Also West Atlantic. Ecuador: Manta; Puerto Callo. Peru: Boca Pan; Mancora; Sechura.

***Phlyctiderma insula*, new species**

Plate 32, figure 9

Shell relatively small (length about 8.5 mm.), white, rounded, globose, the umbones large and prominent with the beaks prosogyrate and placed almost median. Viewed internally, the two ends of the shell appear almost of the same size and well rounded, the anterior slightly shorter. Shell thin, glassy to subtranslucent, internally white with a subnacreous luster. Surface marked with fine, smoothish, growth lines and a scattering of small nodes or pustules, many of which are finely punctured or appear hollow. These pustules are thickly or thinly developed on the anterior half of the disk, lacking on the posterior side.

Length 8.5 mm., height 7.5 mm., semidiameter 3 mm. a left valve. Holotype, ANSP.

Resembles *P. caelata* but is much smaller, with a somewhat different form and the pustules are rounded, mostly concentric in their alignment.

Range—Panama and western Colombia. Panama: Búcaro. Colombia: Isla del Gallo.

***Phlyctiderma elenensis*, new species**

Plate 32, figures 6, 6a

Shell small (length about 9 mm.), rounded and plump, the umbones submedian, wide and full, projecting prominently above the hinge line. Beaks are small and prosogyrate. Anterior side longer, somewhat produced and narrowly rounded at the end while the posterior and ventral margins unite to form part of the same circular curve. The hinge line is straight and projects a little beyond each side of the beaks. In the type, the hinge teeth are poorly developed (perhaps the result of damage), the posterior cardinal tooth is simple and a little inclined; the anterior tooth appears to be missing. Ligamental scar is partially immersed, set apart by a groove to which the external ligament is attached, the margin of the valve not rising above it. Adductor scars large and subequal, connected by an entire pallial line which lies close to the ventral margin. Sculpture produced by

strong concentric riblets which over the anterior slope are partly divided so as to form elongated, concentric nodes.

Length 9.2 mm., height 8.3 mm., semidiameter 3.6 mm. a left valve. Holotype, ANSP 218936

Easily recognized by its shape. At present known only from the type specimen, a left valve.

Range—Ecuador. Ecuador: Santa Elena.

Family LUCINIDAE

Shells small or large, subcircular to suborbicular, generally equivalve but occasionally somewhat inequivalve (*Miltha*), thin or heavy, in the latter case, the interior may be coarsely pustulose. Hinge when typical has two strong cardinal teeth and an anterior and posterior lateral tooth or its socket in each valve, the posterior lateral element placed distantly at the end of the ligamental scar; in other forms, the hinge may be degenerate to a greater or lesser degree, the cardinal teeth and sometimes the laterals become obsolete and often wholly lacking in the adult. The ligament is external, attached to a deeply immersed scar lying below the margin of the valve. Adductor scars of unequal size, the anterior scar typically much larger, divided, the lower segment narrow and elongated and free from the pallial line. The pallial line itself entire and placed near the margin. Ventral margin smooth or crenulated. Surface sculpture formed by radial or concentric elements or a combination of both. Often with a scaly periostracum.

Although the family Lucinidae is well characterized, the definition of smaller taxon units such as genera is more difficult. The Lucinidae have a long geological history and a world-wide distribution especially in the warmer seas; they are, however, poorly represented in the Panamic-Pacific faunal area; some of its species are rare and known only from deep water.

Key to the genera of the Lucinidae

- I. Hinge teeth present (at least in the young), sometimes becoming obsolete in the adult.
 - A. Dorsal areas are well defined on both the anterior and posterior slopes, depressed, set off by a line or groove, or by a marked change of sculpture.
 1. Hinge provided with both cardinal and lateral teeth, one or the other sometimes becomes obsolete.

Genus *Lucina*
 2. Hinge with cardinal teeth only; no lateral teeth at any stage.

Genus *Miltha*
 - B. No dorsal areas; the surface marked with radial, cancellate, or a divaricate pattern of sculpture.
 3. Sculpture formed by a series of deeply incised lines in parallel curves and sharply divaricated along the anterior-umbonal slope.

Genus *Divaricella*
 4. Sculpture mostly radial, formed of simple, noded or cancellated ribs. Color white, often yellow in the interior, the marginal band sometimes coral red or purple.

Genus *Codakia*
- II. Hinge teeth absent (or nearly so) at all stages.
 5. Shell usually round and plump, concentrically sculptured.

Genus *Anodontia*

Genus *LUCINA* Bruguière 1797

(*Phacoïdes* Blainville, 1825 and *Phacoïdes* "Blainville" Gray, 1847.)

Type species by subsequent designation, Anton, 1838, *Lucina pensylvanica* Lamarck (*Venus pensylvanica* Linné). Recent, Florida, and the West Indies.

Shell rounded, thin or solid, more or less convex, the dorsal areas usually well defined, depressed or flattened, or set apart by a change of sculpture. Surface sculptured with strong concentric or radial riblets, sometimes with both. Lunule if present small, sunken; no escutcheon. Hinge teeth well developed or partly degenerate. Ventral margin plain or crenulated.

Typical *Lucina* is not known from the Panamic area. It has deeply excavated dorsal areas, strong hinge, and heavy concentric sculpture. Most of the minor groups, herein considered as subgenera of *Lucina*, were placed in *Phacoïdes* by Dall.

Key to the Subgenera of *Lucina*

- I. Surface of shell sculptured with concentrics only. In *Lucina*, s.s., the concentric edges of the periostracum is cut into by radial, riblike scales.
 - A. Hinge strong, the cardinal and lateral teeth both well developed.
 - a. Dorsal areas strong, set apart by deep grooves.
 1. Lunule small or wholly absent. *Lucina*, s.s.
 2. Lunule large and deep. *Here*
 - b. Dorsal areas poorly developed or absent.
 3. Shell small, the valve margins deeply crenulated. *Cavilinga*
 - B. Hinge structure weaker, either the cardinal or lateral teeth becoming obsolete.
 - c. Lateral teeth persisting, the cardinal teeth small or become obsolete as the shell attains maturity. *Phacoïdes*
 4. Shell of medium or large size, lentiform, the dorsal area deeply impressed. Sculpture concentrically lamellose. *Lucinoma*
 - d. Cardinal teeth persistent, the laterals become obsolete.
 5. Subequivalve, lentiform, the surface sculptured with widely spaced, concentric lamellae, their interspaces striated. Mainly in deep water. *Pleurolocina*
- II. Surface sculptured with both radial and concentric elements.
 - C. Dorsal areas well developed.
 6. Surface radial ribs large and few in number. *Lucinisca*
 - e. Radial and concentric elements in the sculpture of nearly equal size. *Bellucina*
 7. Like *Codakia* in shape and surface sculpturing but with well-defined dorsal areas. The cancellate sculpture often sharply nodose or beaded. *Bellucina*
 8. Shells usually small, with coarsely cancellated sculpture, the radials often large and riblike. *Bellucina*

D. Dorsal areas weakly developed or obsolete.

9. Surface almost smooth, the radial elements small. Size small.

Parvilucina

Subgenus **HERE** Gabb, 1866

Type species by monotypy or by subsequent designation, Stolizcka, 1871, *Lucina (Here) richthofeni* Gabb.

Shell similar to *Lucina*, *s.s.*, solid, globose with well-developed dorsal areas and conspicuous concentric sculpture. Lunule large, deeply excavated, penetrating into the hinge plate and partly effacing the anterior cardinal tooth.

Lucina (Here) excavata Carpenter

Plate 29, figures 7, 7a

Lucina excavata Carpenter, 1857, Cat. Mazatlan Shells, Brit. Mus., p. 98, No. 140 "Mazatlan"

Lucina (Here) richthofeni Gabb, Geol. Sur. California, Palaentology, vol. 2, p. 29.

Phacoides (Here) richthofeni (Gabb), Dall, 1901, Proc. U.S. Nat. Museum, vol. 23, No. 1237, p. 810, pl. 40, figs. 7, 9.

Lucina (Here) excavata Carpenter, Stewart, 1930, Acad. Nat. Sci. Philadelphia, Spec. Publ. No. 3, p. 181, pl. 15, fig. 3, pl. 17, fig. 5.—Grant and Gale, 1931, Mem. San Diego Soc. Nat. Hist., vol. 1, pp. 290, 291, pl. 14, figs. 2, 5, 10.—Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 3, p. 113.

Shell relatively small (length 25 mm. or less), rounded, globose, nut-shaped. Anterior dorsal area more strongly defined than the posterior, enclosing the deep, penetrating lunule. Surface marked with strong, concentric ridges, and smaller striae.

Relatively rare in the Recent. Also reported as fossil from the Oligocene, Miocene, Pliocene, and Pleistocene of California.

Range—San Pedro, California, to Mazatlan, Mexico.

Subgenus **PHACOIDES** Blainville, 1825

Type species by monotypy, *Lucina jamaicensis* Lamarck.

Shell subcircular to subovate, moderately convex and usually of coarse texture, the interior in old specimens become coarsely pustulose. Anterior and posterior dorsal submargins well defined by being more depressed, set off by a groove and a sharp emargination of the shell margins. Cardinal teeth weak or obsolete, the laterals remain strong and distant. External sculpture dominantly concentric, formed by raised lamellae between wider interspaces.

The name "*Phacoides*" is in doubtful standing; as pointed out by Iredale, Stewart, and others. It was used in a vernacular sense by Blainville for the true *Lucinas* and not as a newly proposed generic term. The group is well represented in the Caribbean but is not yet known from the Panamic-Pacific region.

Subgenus **LUCINOMA** Dall, 1901

Type species by original designation, *Lucina filosa* Stimpson.

Shell large or of medium size, subcircular to suborbicular, equivalve. Dorsal areas strongly depressed. Surface white, with a conspicuous periorstracum. Sculpture consists of raised, concentric lamellae, generally widely

spaced, and finer concentric striae. Hinge with two, strong, cardinal teeth in each valve, the left anterior and the right posterior are double or bifid; lateral teeth suppressed or with a tendency to become obsolete in the adult. Principally deep water.

Similar to *Phacoides* but has stronger, more widely spaced concentric sculpture. The lateral teeth tend to become obsolete as the shell attains maturity.

Lucina (Lucinoma) annulata Reeve

Plate 30, figures 3-3b

Lucina annulata Reeve, 1850, Conch. Icon., vol. 6, *Lucina*, pl. 4, fig. 17 "California".
Phacoides (Lucinoma) annulatus (Reeve), Dall, 1901, Proc. U.S. Nat. Museum, vol. 23, No. 1237, p. 824, pl. 40, fig. 10.

Lucinoma annulata (Reeve), Woodring, 1938, U.S. Geol. Survey, Prof. Paper, No. 190, p. 53.—Woodring, Bramlette, and Kew, 1946, *op. cit.*, No. 207, p. 83.—Woodring and Bramlette, 1951, *op. cit.*, No. 222, pp. 48, 65, pl. 19, fig. 8.

Lucinoma cf. L. acutilineata (Conrad), Woodring, Stewart, and Richards, *op. cit.*, No. 195, pl. 29, fig. 7.

Lucina (Lucinoma) annulata Reeve, Hertlein and Strong, 1949, Zoologica, vol. 31, pt. 3, p. 115.

Shell suborbicular, often large (height 55 mm.), the posterior-dorsal side fairly long, straight, its margin not deeply sunken, white or chalky, overlain by a brownish periostracum. Sculpture consists of fairly regular, sharp, concentric lamellae spaced about 2 mm. or more apart, the flat intervals between them with coarse, concentric threads.

This is a northern species ranging southward into the Gulf of California. *Lucina (Lucinoma) chiripanica* Olsson occurs plentifully in the Pliocene of Charco Azul, Panama (Olsson, 1942, plate 4, figs. 1, 4), and possibly may still be living in offshore waters. Another species of this group is *L. (Lucinoma) heroica* Dall described from the coast of Mexico.

Range—Alaska to the Gulf of California.

Subgenus **PLEUROLUCINA** Dall, 1901

Type species by original designation, *Lucina leucocyma* Dall.

Shell small with a few large radial ribs crossed by coarse concentrics. Hinge with cardinal and lateral teeth well developed. Lunule small, deeply impressed, and overhung by the coiled beaks.

Lucina (PleuroLucina) undatoides Hertlein and Strong

Plate 31, figure 13

Lucina undata Carpenter, 1865, Proc. Zool. Soc. London, p. 279 "Gulf of California".—Carpenter, 1872, reprinted in Smith. Misc. Coll., No. 252, p. 272. (Not *Lucina undata* Lamarck, 1819).

Phacoides (PleuroLucina) undatus (Carpenter), Dall, 1901, Proc. U. S. Nat. Museum, vol. 23, No. 1237, pp. 811, 826, pl. 39, fig. 14.

Lucina undatoides Hertlein and Strong, 1945, Nautilus, vol. 58, p. 105. (New name for *L. undata* Carpenter, not Lamarck, 1819).—Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 3, p. 117.

Shell small (length 11 to 12 mm.), rounded, moderately convex, white. Dorsal areas well defined, deeply impressed, the posterior one the larger. Sculpture produced by four, large, somewhat fan-shaped radial ribs between narrower interspaces, the entire surface crossed by coarse, even concentrics.

Range—Gulf of California.

Lucina (*PleuroLucina*) *leucocymoides* (Lowe)

Phacoides (*PleuroLucina*) *leucocymoides* Lowe, 1935, Trans. San Diego Soc. Nat. Hist., vol. 8, No. 6, p. 17, pl. 1, fig. 4.

Lucina (*PleuroLucina*) *leucocymoides* (Lowe), Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 3, pp. 116, 117.

Shell small, solid, its surface ornamented by a single, large radial rib which occupied the middle half of the disk and is bordered on each side by a deep groove or channel, the whole overrun by reflexed concentric lirae. Lunule large, cordate, and equally divided between the valves. Hinge strong with two cardinal teeth and divided laterals. Ventral margin strongly crenulated. Average height of a shell about 20 mm.

According to Hertlein and Strong, the species occurs as a Pleistocene fossil on Albemarle Island, Galapagos.

Range—Gulf of California south to Manzanillo and Tres Marias Islands, Mexico.

Subgenus *CAVILINGA* Chavan, 1937

Type species by original designation, Chavan, 1937, *Lucina trisulcata* Conrad. East coast of United States.

Shell small, trigonal, rounded, more or less inequilateral, the anterior side generally longer. Dorsal areas feeble to subobsolete. Hinge well developed, with two cardinal and lateral teeth in each valve. Surface marked principally with fine concentric threads, often interrupted by resting sulci which divide the disk in ledge or steplike sections. Lunule deeply excavated, placed below the small, pointed beaks. Ventral margins crenulated.

Key to Pacific *Cavilinga*

- I. Shell generally small (length 6 mm. or less). Valves strongly inequilateral, the anterior side much longer, obliquely produced. *L. prolongata*
- II. Shell larger (13 mm., or more) nearly equilateral.
 1. Shell dosinoid, rounded. *L. lampra*
 2. Shell tongue-shaped, generally higher than long. *L. linqualis*

Lucina (*Cavilinga*) *prolongata* Carpenter

Plate 31, figures 8, 8a, 10-10b

Lucina prolongata Carpenter, 1855, Cat. Mazatlan Shells, Brit. Mus., p. 100, No. 145 "Mazatlan".

Shell small, irregularly trigonal, strongly inequilateral, the anterior side is longer and obliquely produced, solid, depressed. Umbones wide and prominent, ending in small, prosogyrate beaks curved over the large, concave lunule. Surface sculptured by strong, rounded concentric threadlike riblets, the disk divided into unequal segments by deep, resting sulci. Hinge normal, the teeth well developed. Internal margins finely crenulated.

Length 5.2 mm., height 5.5 mm., diameter of a right valve 1.75 mm.

Length 7.7 mm., height 8 mm., diameter of a right valve 2.2 mm.

Differs from *L. linqualis* and *L. lampra* by much smaller size and strongly oblique form.

Range—Mazatlan, Mexico to Ecuador. Ecuador: Punta Blanca.

***Lucina (Cavilinga) linqualis* Carpenter**

Plate 31, figure 11

Lucina linqualis Carpenter, 1864, Ann. and Mag. Nat. History, ser. 3, vol. 13, p. 113 "Cape St. Lucas, Lower California". Carpenter, 1872, reprinted in Smith. Misc. Coll., No. 252, p. 211.

Phacoides (Cavilucina) linqualis (Carpenter), Dall, 1901, Proc. U. S. Nat. Museum, vol. 23, No. 1237, p. 827, pl. 39, fig. 7.

Lucina (Cavilinga) linqualis Carpenter, Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 3, p. 113.

Shell small (height about 13 mm.), tongue-shaped, higher than long, solid, white. Dorsal areas obscure, the posterior one somewhat stronger and flattened. The small beaks are subcentral, pointed forward. Surface sculptured with fine concentric threads, often irregularly interrupted by deep, resting sulci. Ventral margins crenulated.

Range—Lower California and the Mexican coast.

***Lucina (Cavilinga) lampra* (Dall)**

Plate 31, figure 12

Phacoides (Cavilucina) lamprus Dall, 1901, Proc. U. S. Nat. Museum, vol. 23, No. 1237, pp. 811, 827, pl. 39, fig. 9 "La Paz, Lower California".

Lucina (Cavilinga) lampra (Dall), Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 3, pp. 112, 113.

Shell small or of medium size (length about 24 mm.), rounded, dosinoid, solid, slightly convex, the dorsal areas inconspicuous, white or suffused with yellow or pink, strongest within. Beaks small, subcentral, placed above a small, excavated lunule, usually restricted to the right valve. Surface marked with fine, sharp, concentric threads and in the older specimens by an occasional deeper, resting sulci; radials consist of submicroscopic striations. Ventral margins minutely crenulated.

Length 23.5 mm., height 23.5 mm., diameter 10.5 mm.

Recognized by its rounded form and fairly large size for the subgenus.

Range—Gulf of California.

Subgenus **BELLUCINA** Dall, 1901

Type species by original designation, *Parvilucina eucosmia* Dall (= *Lucina pisum* Reeve).

Shell generally small, suborbicular. Dorsal areas well defined, the lunule small and deeply excavated. Sculpture coarsely cancellate, produced by intersecting radial riblets and concentric lamellae.

***Lucina (Bellucina) cancellaris* Philippi**

Plate 31, figures 4-4b

Lucina cancellaris Philippi, 1846, Zeit. f. Malakozool., p. 21 Mazatlan.

Phacoides (Bellucina) cancellaris (Philippi), Dall, 1901, Proc. U. S. Nat. Museum, vol. 23, pp. 814, 829, pl. 39, fig. 11.

Bellucina cancellaris (Philippi), Maxwell Smith, 1944, Panamic Marine Shells, p. 57, fig. 727.

Lucina (Bellucina) cancellaris Philippi, Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 3, No. 8, p. 112.

Shell small, obliquely rounded, solid, sculptured with 10 to 12, strong, radial ribs, the ribs and interspaces cancellated by evenly spaced, raised concentrics which show especially strong in the deeply grooved interspaces as coarse cross threads, enclosing squarish pits between them. The typical form has the radial interspaces simple but in some shells, the interspaces are wider and have two or more fine, interstitial threads. The posterior-dorsal area is well defined, wide, and sculptured with two strongly scabrous riblets. Internally, the ventral margin is strongly fluted by the ribs and in addition finely crenulated.

Length 5.5 mm.; height 5.4 mm.; diameter 1.7 mm. (left valve). Isla del Gallo, Colombia.

Range—Gulf of California to northern Peru. Panama: Búcaro. Colombia: Isla del Gallo. Ecuador: Punta Blanca; Santa Elena. Peru: Zorritos.

Subgenus *LUCINISCA* Dall, 1901

Type species by original designation, *Lucina nassula* Conrad. West Atlantic, Cape Hatteras to Florida and Cuba.

Shell small, medium or large, subcircular to subovate, depressed to convex. Surface with a sculpture like that of *Codakia*, cancellated by the intersection of radial and concentric riblets. Dorsal areas impressed or defined by a marked change of sculpture. The hinge with well-developed cardinal and lateral teeth.

Lucinisca may be confused with *Codakia* but will be distinguished by its well-developed, depressed dorsal areas. The cancellate sculpture is generally sharp or harsh to the touch.

Lucina (*Lucinisca*) *liana* Pilsbry

Plate 29, figures 9, 9a

Lucina muricata Chemnitz, Reeve, 1850, Conch. Icon., vol. 6, *Lucina*, pl. 8, fig. 46 Tumbes, Peru. Not *L. muricata* Chemnitz, 1795 = *muricata* Spengler, 1798, a West Atlantic species.

?? *Phacoides* (*Lucinisca*) *muricata* (Spengler), Dall, 1909, Proc. U. S. Nat. Museum, vol. 23, No. 1237, p. 812.

Phacoides (*Lucinisca*) *liana* Pilsbry, 1931, Proc. Acad. Nat. Sci. Philadelphia, vol. 83, p. 435, pl. 41, fig. 3. (*P. hispaniolana* Li, 1930, not of Maury, 1917).

Lucina (*Lucinisca*) *liana* (Pilsbry), Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 3, p. 114.—Hertlein and Strong, 1955, Bull. Am. Mus. Nat. Hist., vol. 107, art. 2, p. 183

Young shell less than 10 mm. in length, have a rounded depressed shell and a coarse, lattice-like sculpture of which the ribs are simple, sharply noded by intersecting concentric ridges, their dividing interspaces smooth. As the shell grows larger, it increases in solidity and convexity while small radial threads (one to three) appear in the primary interspaces.

Average specimens would measure about length 27 mm., height 25 mm., and the diameter of a single valve about 7 mm.

Common and widely distributed. In the identification of this and the following species, I have followed current practice. It is possible, however, that this *Lucinisca* is the true *fenestrata* of Hinds which the original figure of that species resembles. Only an examination of the type of *L. fenestrata*,

if still extant, could settle the question permanently. It is the Pacific analogue of *L. muricata* Spengler of the West Atlantic.

Range—Gulf of California to northern Peru. Panama: San Carlos; Búcaro. Colombia: Isla del Gallo. Ecuador: Santa Elena; Galeras; Mompiche. Peru: Tumbes; Zorritos; Boca Pan; Mancora.

Lucina (*Lucinsea*) *fenestrata* Hinds

Plate 29, figure 10

Lucina fenestrata Hinds, 1845, *Zool. Voy. Sulphur*, Moll. pt. 3, p. 66, pl. 19, fig. 2 Monte Christi; San Blas.

Lucina (*Lucinisa*) *fenestrata* Hinds, Dall, 1901, Proc. U. S. Nat. Museum, vol. 23, No. 1237, p. 811.—Hertlein and Strong, 1946, *Zoologica*, vol. 31, pt. 3, pp. 113, 114.—Hertlein and Strong, 1955, *Bull. Am. Mus. Nat. Hist.*, vol. 107, art. 2, p. 183, pl. 1, fig. 7.

Shell large (length 55 mm.), subcircular to suborbicular, equivalve and of slight or moderate convexity, white. Beaks small, pointed, placed a little in front of the middle. Dorsal areas impressed and sharply differentiated from the rest of the disk, the posterior area much larger, its margin wide and somewhat obliquely truncated. Surface sculpture is fine and uniform, produced by a series of small, slightly waved, radial riblets intersected by concentrics and producing a fine, sharp cancellation. The sculpture of the posterior-dorsal area is similar, except that the radials are more irregularly distributed. Anterior-dorsal area is much smaller and generally divided into two unequally sculptured portions. The basal margin is obliquely rounded, finely crenulate within. Lunule small.

Length 51 mm., height 44.8 mm., diameter 17.8 mm.

Length 55 mm., height 49.1 mm., diameter 17.7 mm.

This is the largest and finest species of the subgenus, and characterized by its fine, uniform sculpture. Formerly rare in most collections, the species appears to be fairly plentiful in offshore waters of from 10 to 30 fathoms depth and is now obtained by shrimp trawlers in fair numbers. *L. fausta* Pilsbry and Olsson from the Pliocene of Ecuador is closely related.

The identification of this large *Lucinisa* with *fenestrata* is not entirely certain; the figure of that species given by Hinds in the *Voyage of the Sulphur* shows a small, more circular shell with coarse, irregular sculpture, some of the radial costae split or divided as they approach the ventral margin. In the large number of specimens examined, none agree exactly with the original figure.

Range—Gulf of California to Panama and Ecuador. Panama: off Panama (shrimpers). Colombia: Ardita Bay (Hertlein and Strong).

Subgenus PARVILUCINA Dall, 1901

Type species by original designation, *Lucina tenuisculpta* Carpenter.

Shell small, rounded, plump, inequilateral. Surface smooth or sculptured with small radial and concentrics, generally forming a weakly or finely cancellate pattern. Dorsal areas not defined or obscure. Hinge teeth typically small but all present. Ventral margins crenulated.

Lucina (Parvilucina) approximata (Dall)

Plate 31, figure 7

Phacoides (Parvilucina) approximata Dall, 1901, Proc. U. S. Nat. Museum, vol. 23, No. 1237, pp. 813, 828, pl. 39, fig. 4.

Parvilucina tenuisculpta approximata (Dall), Maxwell Smith, 1944, Panamic Marine Shells, p. 57, fig. 722.

Lucina (Parvilucina) approximata (Dall), Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 3, No. 8, pp. 115, 116.

Shell small, rounded, nearly equilateral, the beaks high and full, curved over a deeply impressed, lanceolate lunule. The sculpture is produced by small, simple, rounded riblets between narrow interspaces, both neatly cancellated by concentric threads; the radials are strongest on the ventral side of the disk but in some southern shells, they are replaced almost completely by close-set, raised, concentric threads on the umbonal portion. The posterior-dorsal area is flattened to excavated, sculptured by concentrics only which may enlarge to form two rows of scabrous threads. Size 4 to 7 mm.

Length 6.3 mm., height 6.5 mm., diameter 4 mm. Gulf of California. USNM.

Range—Monterey California to Panama.

Lucina (Parvilucina) mazatlanica Carpenter

Plate 31, figures 3-3b, 9, 9a

Lucina mazatlanica Carpenter, 1855, Cat. Mazatlan Shells, Brit. Mus., p. 99, No. 144.

Phacoides (Here) mazatlanicus Carpenter, Dall, 1901, Proc. U. S. Nat. Museum, p. 811, vol. 23, No. 1237.

Lucina (Parvilucina) mazatlanica Carpenter, Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 3, p. 116.

Shell small, obliquely subcircular, and moderately convex. Anterior-dorsal area having the shape of a large, concave, lunular depression cutting deeply into the margin, the posterior-dorsal area longer, depressed, especially in the smaller shells. Surface principally sculptured with close-set concentric threads, the radials if present small and appear only near the ventral margin. Hinge teeth strong, the ventral margin crenulate.

Length 3.9 mm.; height 3.7 mm.; diameter 2 mm. Puerto Callo, Ecuador.

Identification of this small species is based on Carpenter's unpublished drawings in the U. S. National Museum. All the specimens seen are small, (less than 4 mm. in length).

Range—Gulf of California to Ecuador. Mexico: Mazatlan, Santa Inez Bay. Ecuador: Puerto Callo.

Genus **MILTHA** H. and A. Adams, 1857

Type species by monotypy, *Lucina childreni* Gray.

Shell subelliptical to subovate, higher than long, inequivalve, with one valve larger and more convex than the other. Posterior-dorsal area larger than the other and defined by a sharp line or groove. Lunule asymmetrical, larger in one valve, its margin overlapping the other and lying against the anterior cardinal tooth. Ligament scars deep, the left valve provided with a strong nymphal ridge. Cardinal teeth two in each valve, without laterals. Surface sculptured with fine, threadlike concentrics and weak, vermiculate radial striae.

Miltha differs from *Lucina* in the complete absence of lateral teeth. The type species (*Miltha childreni*) is a rare shell from the coast of Brazil.

***Miltha xanthusi* (Dall)**

Plate 30, figure 4

- Phacoides (Miltha) childreni* Gray, Dall, 1901, Proc. U. S. Nat. Museum, vol. 23, No. 1237, p. 812. (Not of Gray, 1825.)
Phacoides (Miltha) xanthusi Dall, 1905, Nautilus, vol. 18, No. 10, p. 111 "Cape St. Lucas"
Lucina (Miltha) xanthusi (Dall), Grant and Gale, 1931, Mem. San Diego Soc. Nat. Hist., vol. 1, pp. 291, 292, pl. 14, figs. 20a, 20b.—Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 3, p. 115 pl. 1, fig. 13.
Phacoides xanthusi (Dall), Pilsbry and Lowe, 1933, Proc. Acad. Nat. Sci. Philadelphia, vol. 54, p. 137.
Miltha xanthusi (Dall), 1950, Mem. Geol. Soc. America, No. 43, p. 77, pl. 19, figs. 3, 8.

Shell large, ovately rounded, produced ventrally, rather flat, right valve more convex than the left; ornamentation consists of concentric lines of growth and radial striae; posterior sulcus present, ornamented by one radial ridge; lunule chiefly in the right valve, depressed; two cardinal teeth, the right anterior and left posterior tooth bifid; ligamental groove long, posterior; muscle scars, especially the anterior one, large; inner surface of valve scatteringly pitted; margin smooth. (Hertlein and Strong, 1946.)

Dimensions. Height 71 mm., width 65 mm. (Dall, 1905)

Height 71.2 mm., width 68 mm. (Hertlein and Strong, 1946).

According to Dall, this Pacific *Miltha* is closely similar to *M. childreni* (Gray) from the Atlantic but appears to differ by its smaller adult size, more rounded and more equal valves as well as having a shorter ligament. Whether these characters will prove constant when a larger series of both forms become available for study remains to be seen. According to Hertlein and Strong, young specimens of *M. xanthusi* have a rounder form. *M. joannis* (Dall), 1905, incompletely described and unfigured from the Pliocene of Lower California, seems to be a doubtful species. It is said to be smaller, heavier, and more rounded. *M. caloosaiensis* (Dall), common in the Pliocene of Florida, is similar to *M. xanthusi* in general characters; it often reaches a much larger size; the interior becomes much thickened in the adult and the adductor scars deeply inset; its left valve is generally the more convex, the reverse of the condition found in *M. xanthusi*. *M. xanthusi* has been recorded as a Pleistocene fossil in Lower California.

Range—Lower California.

Genus **CODAKIA** Scopoli, 1777

Type species by tautonymy and monotypy, *Chama codak* Adanson (= *Codakia orbicularis* Linné). Recent, Florida, West Indies, and West Africa.

Shell large or small, suborbicular, equivalve, and moderately convex to depressed. Surface sculptured principally by radial riblets, noded or cancellated by the concentrics. Dorsal areas absent or weakly indicated by a change of sculpture. Lunule small and deeply sunken, confined to the right valve, its margin sharp and fitting into a narrow furrow in the

left valve. Ligament deeply immersed, overhung by the valve margin so that it is scarcely visible from above and attached to a broad, deeply excavated scar, its inner portion (resilifer), often abutting against the cardinal teeth. Hinge with a small and a large, cardinal tooth in each valve, also lateral teeth; the anterior lateral tooth or its socket is strong, the posterior lateral tooth absent in the restricted genus. The adductor scars are distinct, the anterior one is divided into two parts, the lower portion elongate and narrow, free from the pallial line. Surface white, the interior white or yellow, sometimes with a purplish red border. The genus may be divided into two groups as follows:

I. Shell large, depressed or slightly convex. Posterior lateral teeth obsolete. Interior of shell white, yellow or some shade of red, often with a wide marginal band of red or purple.

Codakia s.s.

II. Shell much smaller and generally convex. Posterior lateral teeth strong. Interior of shell usually white, no marginal band.

Subgenus *Ctena*

Subgenus **CODAKIA**, s.s.

Shell often large and heavy, subcircular, white, the interior often yellow with a coral-red or purple border. Hinge with a strong anterior lateral tooth in the right valve, its socket in the left; the posterior lateral tooth absent.

Three species in the Panamic area.

Key to species of *Codakia*

I. Surface sculptured with large, flat ribs separated by grooved interspaces, the spacing and size of the ribs irregular, sometimes obsolete across the middle.

C. punctata

II. Surface sculpture much finer, the riblets small and numerous, finely beaded by threadlike concentrics.

A. Shell coarse and heavy, often large, depressed to slightly convex.

C. distinguenda

B. Shell smaller, more convex and somewhat more coarsely sculptured.

C. pinchoti

Codakia (*Codakia*) *punctata* (Linné)

Plate 29, figure 1

Venus punctata Linné, 1758, Syst. Nat., 10th ed. p. 688, No. 116; 1767, 12th ed., p. 1134, No. 140. Habitat in O. Indico.

Lucina punctata (Linné), Reeve, 1850, Conch. Icon., vol. 6, *Lucina*, pl. 1, fig. 2 "Panama" in sand at low water, Cuming.

This species has been considered strictly an Indo-Pacific form. However, an excellent figure of this species is given by Reeve from a specimen taken by Cuming at Panama. The Academy of Natural Sciences has in its collection a double-valved shell also labeled Panama (Swift Coll. ANSP 54393) which in all probability came from the original lot collected by Cuming. Further substantiation of the occurrence of *C. punctata* in the eastern Pacific is furnished by another specimen in the Academy of Natural Sciences (ANSP 170324) from Wreck Bay, Chatham Island, Galapagos.

In the Panama specimen, the ribs are sharply defined over the whole surface while in most of the Indo-Pacific specimens I have examined, they are generally obsolete across the middle; in the Galapagos specimen (a left valve), the sculpture is intermediate, the ribs are partly obsolete in the middle.

Length 62.8 mm., height 57.8 mm., diameter 27.1 mm. Panama. Swift coll. ANSP 54393.

Range—Panama southward to the Galapagos Islands. Indo-Pacific. Panama: Panama (ANSP).

Codakia (Codakia) distinguenda (Tryon)

Plate 29, figure 3;

Plate 33, figures 4, 4a

Lucina (Codakia) distinguenda Tryon, 1872, Proc. Acad. Nat. Sci. Philadelphia, vol. 24, p. 130, pl. 6, fig. 3 Gulf of California.

Codakia colpoica Dall, 1901, Proc. U. S. Nat. Museum, vol. 23, No. 1237, pp. 801, 821, pl. 41, fig. 4 Gulf of California

Codakia distinguenda Tryon, Maxwell Smith, 1944, Panamic Marine Shells, p. 57, fig. 729.—Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 3, No. 8, pp. 117, 118.

Shell large, circular or orbicular, generally heavy and thick. Sculpture formed by small, finely beaded or cancellated, radial riblets, a few of the riblets are occasionally larger and separated by deeper radial grooves giving the effect of wide rays. Hinge plate much wider or higher than in the West Indian or Caribbean *C. orbicularis*; the hinge plate and internal margins of the valves are usually colored a deep, rose-purple.

Length 76 mm., height 68 mm., diameter 22 mm. (Dall)

Length 74.6 mm., height 68.7 mm., diameter 10 mm. (left valve, Isla la Plata.)

According to Hertlein and Strong, this species is fairly common in the Gulf of California. It is rare elsewhere. A large specimen from the Gulf of California recorded by Hertlein and Strong measures 140 mm. in length. It occurs rarely as a Pleistocene fossil in the Tablazos of Ecuador; a specimen from near the oil pits of Cautivo on the Santa Elena Peninsula has a length of about 115 mm; this specimen is heavy with wide radial riblets and resembles the figure of *Codakia recta* Dall and Ochsner, described as a Pliocene fossil from the Galapagos.

Range—Lower California to Ecuador. Ecuador: Isla la Plata.

Codakia (Codakia) pinchoti Pilsbry and Lowe

Codakia pinchoti Pilsbry and Lowe, 1932, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, p. 103, pl. 14, figs. 1, 2.—Maxwell Smith, 1946, Panamic Marine Shells, p. 57, fig. 723.

Like *C. orbicularis* of the West Indies but slightly more ventricose (the diameter about half the length), the lunule shorter and deeper. Exterior white, the concentric sculpture less sharp than in *C. orbicularis*; at irregular intervals growth rests are rather conspicuous. Interior not punctate though sometimes somewhat roughened, white, with a coral-pink submargin, broadening and becoming deep madder at the dorsal margin.

Length 58.5 mm., height 53 mm., diameter 31 mm. (type)

This shell from Panama is related to *C. distinguenda* (Tryon) but is much less compressed, and has stronger concentric sculpture. Panama. Panama City on the reef off "French Plaza".

Subgenus **CTENA** Mörch, 1860

Type species by subsequent designation, Dall, Bartsch, and Rehder, 1938, *Codakia pectinata* Carpenter (not Gmelin) = *C. mexicana* Dall. Recent, Pacific coast of Mexico.

Shell smaller than most species of *Codakia*, *s.s.*, obliquely rounded, the anterior side often the longer and generally convex. Lunule small, lenticular, impressed, and more or less equal in both valves. Hinge of *Codakia*, *s.s.* but with the posterior lateral tooth well developed. Surface sculptured by small riblets beaded or decussated by the concentrics.

Key to species of Panamic *Ctena*

- I. Sculpture elegant and neat, the radial riblets in the middle of the disk small and finely cancellated, large and strong on the sides.
 1. Radial riblets developed over the whole disk. *C. mexicana*
 2. Riblets lacking on the dorsal slope. *C. chiquita*
- II. Sculpture coarse and irregular, the riblets showing a tendency to divide ventrally. Distribution more common southward of Panama. *C. galapagana*

Codakia (Ctena) mexicana Dall

Plate 29, figure 5

Codakia (Jagonia) mexicana Dall, 1901, Proc. U. S. Nat. Museum, vol. 23, No. 1237, pp. 801, 822, pl. 40, fig. 6.

Codakia mexicana Dall, Maxwell Smith, 1944, Panamic Marine Shells, p. 57, fig. 720.
Ctena mexicana (Dall), Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 3, No. 8, p. 119.

Shell small or of medium size (length up to about 22 mm., but usually smaller), ovate-subcircular, the anterior side decidedly longer. Sculpture neat and regular, formed in the middle of the disk by small, finely beaded radials but considerably coarser on the anterior slope. Lunule large, lanceolate, moderately depressed.

Length 15.6 mm., height 14.8 mm., diameter 3.7 mm. right valve. Acapulco, Mexico.

Codakia (Ctena) galapagana Dall

Plate 29, figure 8

Codakia (Jagonia) galapagana Dall, 1901, Proc. U. S. Nat. Museum, vol. 23, No. 1237, pp. 801, 823, pl. 40, fig. 4 Galapagos Islands.

Shell small or medium sized (length 20 to 25 mm.), of medium convexity, rather solid, white, rounded. It is similar to *C. orbiculata* but has a somewhat looser and more irregular ribbed sculpture, in which the radial ribs have a stronger tendency to branch or divide as they approach the ventral margin. The lunule is small, elliptical, impressed and nearly equally divided between the two valves.

Length 25.2 mm.; height 22.7 mm.; diameter 6.8 mm. left valve, Santa Elena, Ecuador.

Length 20.2 mm.; height 20.6 mm.; diameter 6.4 mm. left valve, Manta, Ecuador.

First described from the Galapagos Island, this species is also common along the coast of Peru northward to Panama. Some specimens are similar to the Caribbean *C. orbiculata*, but in general, the Pacific shell has a coarser and cruder sculpture, with a greater tendency for the ribs to split ventrally.

Range—Peru northward to Panama and the Galapagos Islands. Panama: Búcaro. Ecuador: Manta; Puerto Callo; Santa Elena. Peru: Zorritos; Boca Pan; Mancora.

Genus **DIVARICELLA** von Martens, 1880

Type species by monotypy, *Lucina angulifera* von Martens (= *Lucina ornata* Reeve). Recent, Mauritius.

Shell subcircular or rounded, plump or convex, equivalve, and sub-equilateral, white or glassy. Umbones full, median but with the beaks prosogyrate and always placed a little closer to the anterior side. No dorsal areas but a small lunule, larger in the right valve is present. A minute or small nepionic shell, sculptured with fine, nondivaricating, concentric threads, caps the beak. Hinge lucinoid, with the teeth variably developed, often partly obsolete; when fully developed with a single strong cardinal tooth in the right valve bordered by a socket on each side; the left valve has two smaller cardinal teeth; laterals are variable, often strong, the anterior lateral placed close to the cardinals, the posterior one more distant. Surface sculpture is highly characteristic; it is formed by concentric incised lines at evenly spaced intervals, which begin at the lateral margins and swing obliquely upwards crossing the growth lines and heavier resting marks to meet along the anterior side of the umbonal slope where they form a line of divaricating angles pointing dorsally; these lines form between them flat, ribbon-like bands, their edges face dorsally as if made up of plates overlapping each other shingle-fashion. Shell cavity deep, the adductor scars lucinoid, subequal, and with the pallial line following quite close to the ventral margin which is finely crenulated.

Two or three species of *Divaricella* usually occur in each faunal area but because of their close resemblance, identification is at times difficult.

The following key may be helpful in the determination of the Panamic-Pacific species.

1. Nepionic shell relatively large and sculptured with fine, threadlike concentrics. Apex of the angles along the line of divarication rounded or obtuse, often partly obsolete or smooth. Hinge well developed, the lateral teeth persistent. Ventral margins generally crenulated.

P. parparvula

2. Nepionic shell small, hardly distinguishable. Apex of angles of divarication sharp and acute. Hinge weaker, the lateral teeth subobsolete. Ventral margins mostly plain.

D. eburnea

Divaricella eburnea (Reeve)

Plate 31, figure 2

Lucina eburnea Reeve, 1850, Conch. Icon., vol. 6, *Lucina*, pl. 8, fig. 49 Santa Elena.*Divaricella lucasana* Dall and Ochsner, 1928, Proc. California Acad. Sci., ser. 4, vol. 17, No. 4, p. 122, pl. 2, figs. 17, 21, 24. (New name for *D. eburnea* thought preoccupied by *D. eburnea* Deshayes, 1835 (*nomen nudum*).—Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 3, No. 3, pp. 119, 120.*Divaricella columbiensis* Lamy, 1934, Bull. Mus. Nat. Hist. Nat. Paris, ser. 2, vol. 6, No. 5, p. 433. (New name for *D. eburnea* Reeve, considered preoccupied).

Adult shell reaching a length of about 24 mm., relatively heavy, often becomes thickened, coarsely punctate, or chalky internally. Umbones and beaks more nearly medial than in the next species. Lunule small. Sculpture usually coarse, forming sharply acute angles in the bend of the lines of divarication; an underlying fine radial striation or internal radial structure usually visible, often strong.

Length 19.9 mm., height 18.3 mm., diameter 13 mm. fossil, Pliocene, Punta Blanca, Ecuador.

Length 24.2 mm., height 23.7 mm., diameter 14.8 mm. Santa Elena, Ecuador.

Both Dall and Lamy changed Reeve's name of *D. eburnea* on the assumption that it was preoccupied; however, Hertlein and Strong noted that the *Lucina eburnea* Andrzejowski, Deshayes, 1835 is a *nomen nudum* and hence has no nomenclatural standing.

Range—Gulf of California to northern Peru. Panama: Búcaro. Ecuador: Manta, Santa Elena. Peru: Mancora.

Divaricella perparvula Dall

Plate 31, figures 1-1b

Divaricella perparvula Dall, 1901, Proc. U. S. Nat. Museum, vol. 23, No. 1237, pp. 815, 816, 829, pl. 39, fig. 8 Acapulco.*Divaricella lucasana perparvula* Dall, Maxwell Smith, 1944, Panamic Marine Shells, p. 58, fig. 726.

Shell much like *D. eburnea* showing the same range in size but usually heavier and more convex. Angle of divarication in the incised lines is rounded, blunt, or obtuse. Lunule although quite small is distinct, deep, often with a widely flaring edge. Nepionic shell large, visible, and sculptured with fine, close-set concentric threads. Hinge strong, the cardinal and lateral teeth large and well developed at all stages.

Length 21 mm., height 21.7 mm., diameter 7 mm. right valve, Viveros Island, Pearl Island, Panama.

Dall's name of *D. perparvula* was proposed for a small shell from Acapulco, only briefly described. The figured specimen has a length of but 7 mm. It seems probable that this is but a young shell because other specimens of *Divaricella* from Acapulco, although agreeing with Dall's figure as to sculpture, are much larger. The description given above is based mostly on shells from Isla del Gallo, southwestern Colombia, where it is the dominant species. The line of divarication is sometimes partly smooth or obsolete, and the surface is strongly radially striated.

Range—Mexico southward to Ecuador. Panama: Viveros Island, Pearl Islands. Colombia: Isla del Gallo. Ecuador: Santa Elena.

Genus ANODONTIA Link, 1807

Type species by monotypy, *A. alba* Link (*Venus edentula* Linné, Gmelin, 1792, but not of Linné, 1758 (*chrystoma* Philippi)).

Shell rounded, globose, thin, concentrically striate; anterior and posterior dorsal areas present or obsolete. Lunule narrow and deep, confined largely to the right valve; no escutcheon. Ligamental scar deeply inset. Hinge edentulous or with subobsolete remnants of the teeth only. Lower, inner section of the anterior adductor scar long and narrow, lying above the pallial line. Ventral margin entire.

Identification of *Anodontia alba* is fixed by Link's reference to *Venus edentula* Linné in Gmelin (p. 3286) which is the West Indian shell commonly known as *A. chrystoma* (Philippi). This is not the *Venus edentula* Linné, 1758 which according to Hanley is a similar Oriental species. (See Dillwyn, p. 202, No. 100.)

Two subgenera.

I. Dorsal areas weak or obsolete.

Subgenus *Anodontia*, s.s.

II. Dorsal area sharply defined, depressed.

Subgenus *Lissosphaira*, new subgenus

Anodontia (*Anodontia*) *edentuloides* (Verrill) Plate 30, figures 1-1b

Loripes edentuloides Verrill, 1870, Amer. Jour. Sci., ser. 2, vol. 49, No. 146, p. 226 La Paz—J. Pedersen. One specimen.

Lucina edentuloides (Verrill), Dall, 1901, Proc. U. S. Nat. Museum, vol. 23, No. 1237, pp. 802, 803.

Anodontia edentuloides (Verrill), Grant and Gale, 1931, Mem. San Diego Soc. Nat. Hist., vol. 1, p. 292.—Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 3, p. 117.—Durham, 1950, Mem. Geol. Soc. America, No. 43, p. 75, pl. 13, figs. 11, 16.

Shell often large, relatively thin, subglobose, and convex with subcentral beaks. The surface is marked with irregular lines of growth and submicroscopic radial striae may also be seen. Verrill gave the following dimensions for the type specimen. Length 1.65, height 1.50, and breadth 1.10 inches.

Verrill described this shell as subglobose and more swollen than *L. edentula* (= *alba* Link), the Caribbean species, its apex more prominent and curved, and the lunular region more deeply excavated. The ligament is shorter and its supporting plate is not so stout, its inner edge but little elevated above the ligament groove.

Specimens in the U. S. National Museum have a white surface covered with thin patches of a dirty gray periostracum and a banded sculpture of wrinkled concentric growth lines set off by deep marks of resting stages. Interior white, the zone within the pallial line chalky or with a finely punctated calcareous coating. The largest specimen in the U. S. National collection measures about 65.6 mm. in length.

Range—Gulf of California.

Subgenus LISSOSPFAIRA, new subgenus

Type species *Anodontia spherica* (Dall and Ochsner).

Like *Anodontia*, *s.s.* in shape, rounded, and spherical, but with the dorsal areas well defined and deeply impressed.

Anodontia (*Lissosphaira*) *spherica* (Dall and Ochsner)

Plate 30, figure 2

Lucina spherica Dall and Ochsner, 1928, Proc. California Acad. Sci., ser. 4, vol. 17, Nos. 4, 5, pp. 121, 122, pl. 3, fig. 8; pl. 4, figs. 2, 7 "Pliocene. Indefatigable Island, Galapagos".

Loripinus (*Pegophysema*) *spherica* (Dall and Ochsner), Pilsbry and Olsson, 1941, Proc. Acad. Nat. Sci. Philadelphia, vol. 93, p. 57.

Shell of medium size (length 58 mm.), suborbicular, the height and length nearly equal, moderately convex and moderately heavy. Surface smoothish or roughened by irregular, concentric lines of growth. Lunule narrow and deep, confined mostly to the right valve. The beaks are placed a little nearer the anterior end and face forward over the anterior submargin which is somewhat depressed, arcuate, and semilunate in shape. Dorsal areas well defined, depressed, the posterior one longer and more strongly set off from the disk. Shell cavity deep, smooth or radially striated, or granulose within the pallial line.

Easily separated from *A. edentuloides* by its less inflated valves and deeply impressed posterior-dorsal area.

This species was first described as a Pliocene fossil from the Galapagos Islands. It is also a common shell of the Pliocene of Punta Blanca, Ecuador, where it is the dominant fossil in some beds. As a Recent species, it appears to be rare. I have a single, much decayed specimen from Isla del Gallo, Colombia, and there is a small shell in the U.S. National Museum collection, (USNM 96398) from Lower California.

Range—Lower California to Ecuador. Colombia: Isla del Gallo.

Superfamily CHAMACEA

Family CHAMIDAE

Shell irregularly suborbicular, attached (at least in the early stages) by the anterior side of one valve. In the temporarily fixed forms, such as *Echinochama*, the valves are similar in shape and sculpture, and the attachment scar (on the right valve) is comparatively small. Permanently fixed forms have strongly unequal valves; the lower or attached valve is then much larger and deeper while the upper or free valve is small, depressed, and caplike. Shells are normally heavy and thick walled, composed of two contrasting layers, the outer is prismatic in structure and often highly colored, and it generally shows as a band around the inner ventral margins of the valves; the inner layer is porcellaneous. In the dextral Chamae, the hinge has a large, massive, central cardinal tooth, often strongly rugose in the right valve which fits into a socket in the left; in the sinistral forms, the hinge arrangement is reversed. The external sculpture is often elaborate formed by both radial and concentric elements, often foliaceous or spiniferous. Adductor scars are large, elongate, connected by a simple, entire pallial line.

Carefully cleaned and in good condition, the shells of the Chamidae include some of the most colorful marine bivalves, often rivaling *Spondylus* in beauty, but old shells long exposed to erosive wave action and deeply

bored by marine organisms may prove difficult to determine. Recent members of the family belong to three groups, usually classed as genera. In the typical or dextral Chamias, the attachment is by the left valve (but not invariably so), hence, the upper or free valve seen from the inside, shows the beaks directed or coiled towards the right. In *Pseudochama*, attachment is by the right valve, and the beaks are sinistral or coiled towards the left. In *Echinochama*, the valves are attached only in the early stages by a small area along the anterior side of the right valve; its valves are, therefore, nearly alike in shape and sculpture and provided with a deep, cordate lunule defined by an incised line. As in other attached mollusks, the regularity of the sculptural pattern, even that seen on the upper or free valve, is determined to a large degree by the size and irregularity of the substratum to which the shell was attached, thus the normal sculptural pattern is generally not assumed until the growing edge of the lower valve has become free.

Key to genera and species of Chamidae

- I. Valves are nearly alike in shape and sculpture. Attachment is temporary, the shell becomes free and loose in the adult, the attachment scar hence small or obsolete. There is a large, cordate lunule outlined by an incised line.

Genus *Echinochama*

1. Sculpture ribbed and bearing large, sharp spines.

E. arcinella californica

- II. Shell permanently attached, the attachment area large. Strongly inequivalved.

- A. Shell attached normally by its left valve, the beaks directed or coiled towards the right. The dextral Chamias.

Genus *Chama*

- a. Outer shell layer showing as a wide band around the inner margin of the valve.

- aa. Interior of the valves white.

2. Shell of moderate size, usually rounded. The outer surface and its sculptural elements have a waxy or translucent luster.

C. pellucida

3. Shell small, rounded, and covered with short white spines.

C. squamuligera

4. Shell relatively small, the lower valve convex with strong, concentric sculpture; the upper valves with a scattering of small spines. Color red.

C. sordida

- ab. Interior of shell more or less colored.

5. Shell relatively large, its surface with an elaborate pattern of yellow or purple, foliated spines. Inner margin of shell with a purple border.

C. frondosa

6. Shell smaller, its surface bearing small, close-set spines. Color purple or coral-red, the cardinal tooth always colored deep red.

C. echinata

- b. Outer shell layer thin, the inner marginal band hence narrow.

7. Shell often large, its surface with a ground color of brownish violet, with radial rows of short, white spines.

C. buddiana

- B. Shell attached normally by its right valve, the beaks directed towards the left. Sinistral Chamas.

Genus *Pseudochama*

8. Color usually white or a light pink.

P. panamensis

9. Color of interior and of the hinge teeth a deep purple, sometimes flushed with white.

P. corrugata

10. Interior white, the outer surface white and pencilled with brown lines. Galapagos.

P. janus (Plate 86, figure 5)

Genus **CHAMA** Linné, 1758

Type by subsequent designation, Schumacher, 1817, *C. gryphoides* Linné. Recent, Mediterranean sea.

Dextral Chamas or in which the shell is attached by its left valve and the beaks are directed or coiled towards the right side. Other characters are those of the family.

Chama buddiana C. B. Adams

Plate 34, figures 2-2c

Chama buddiana C. B. Adams, 1852, Ann. Lyceum Nat. Hist. New York, vol. 5, pp. 477, 544, No. 405 Panama—Maxwell Smith, 1944, Panamic Marine Shells, p. 56, fig. 711.—Turner, 1956, Occas. Papers Mollusks, Mus. Comp. Zool., vol. 2, No. 20, p. 36, pl. 20, figs. 7, 8.

Shell often large (height 120 mm.), suborbicular to subcircular, the left valve attached to the substratum sometimes by more than half of its surface so that only the rim of the posterior portion is free or the attachment is by a smaller area along the anterior side of the umbone, the resulting form is then more rounded and regular. The upper valve is smaller and generally flatter than the lower, its height and length nearly equal but in other more broadly attached specimens, the outline of the shell is subovate, the height greater than the length. The external surface is often deeply eroded or encrusted with marine growth, but good specimens, when cleaned, may have an elaborate sculpture of rows of elevated, fluted white spines standing on a red or purple base. On the lower valve, the spines are crowded, coalescent, being the upturned edges of concentric lamellae while on the upper valve, the spines stand separately. The outer layer of the shell is relatively thin and forms a narrow, finely crenulated margin to the inner surface of the valve. Interior of the valves white or blotched with lilac or brown.

This is the largest and commonest *Chama* at Panama (rarer elsewhere) and is usually found attached to rocks at low or medium tide level.

Range—Panama. Panama: Pearl Islands; Panama City; El Lagartillo, near Las Tablas. Panama Canal Zone: Venado Beach.

Chama echinata Broderip

Plate 33, figure 3;

Plate 86, figures 3, 3a

Chama echinata Broderip, 1835, Proc. Zool. Soc. London for 1834, p. 150.—Broderip, 1835, Trans. Zool. Soc. London, vol. 1, p. 305, pl. 39, figs. 5-7.—Reeve, 1847, Conch. Icon., vol. 4, *Chama*, sp. 35, pl. 7, fig. 35 Puerto Portrero.—Maxwell Smith, 1944, Panamic Marine Shells, p. 56, fig. 715.—Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 3, No. 8, pp. 138, 109.

Shell small or of medium size, irregular, attached generally broadly by the anterior side of the left valve. Surface of right valve is covered with close-set, small spines. Usual color is a deep purple or coral-red, the large hinge teeth always colored red.

Range—Lower California to northern Peru and the Galapagos (in part from Dall). Panama; Burica Peninsula.

Chama frondosa Broderip

Plate 34, figures 1-1b;
Plate 86, figure 2

Chama frondosa Broderip, 1835, Proc. Zool. Soc. London for 1834, p. 148.—Broderip, 1835, Trans. Zool. Soc. London, vol. 1, p. 302, pl. 38, figs. 1, 2.—Reeve, 1846, Conch. Icon., vol. 4, *Chama*, sp. 1, pl. 1, figs. 1a Isla la Plata.—Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 3, No. 8, p. 109.

The shell is generally large, coarse, subovate. Outer layer heavy, with strong, concentric lamellae on the surface, generally extended into longitudinally plaited foliations. Ground color usually a light purple or pink, the finger-like foliations, a light yellow. Interior white, with a marginal band of purple.

Length 75 mm., height 91 mm., diameter (both valves) 76 mm. Manta, Ecuador.

This is the finest of the Pacific Coast Chamas but well-preserved specimens are rare.

Range—Gulf of California to Ecuador and the Galapagos (according to authors). Ecuador: Manta; Isla la Plata. Panama Canal Zone: Venado Beach.

Chama pellucida Sowerby

Plate 33, figures 2, 2a;
Plate 34, figure 5

Chama pellucida Sowerby, 1835, Proc. Zool. Soc. London for 1834, p. 149. (Iquiqui).—Broderip, 1835, Trans. Zool. Soc. London, vol. 1, p. 302, pl. 38, fig. 3.—Reeve, 1847, Conch. Icon., vol. 4, *Chama*, sp. 32, pl. 6, fig. 32.—Maxwell Smith, 1944, Panamic Marine Shells, p. 56, figs. 708, 714.—Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 3, No. 8, p. 109.

Shell generally rounded or subcircular, convex, waxy white, or coral-red. Outer layer is thick, forming in the interior a wide, subtranslucent marginal band which contrasts sharply with the porcellaneous white of the interior. Inner margin of shell minutely crenulated. Surface sculpture formed by strong fluted spines and wavy, concentric lamellae.

Range—Oregon to Chile. Peru: Bayovar, Yasila. Ecuador: Santa Elena.

Genus PSEUDOCHEMA Odhner, 1917

Type species by subsequent designation, Gardner, 1926, *Chama cristella* Lamarck. Recent, East Indies.

Sinistral Chamas, the shell usually fixed by the right valve, its beaks turned towards the right. Other characters as of the family.

Pseudochama panamensis (Reeve)

Plate 33, figures 1-1b

Chama panamensis Reeve, 1847, Conch. Icon., vol. 4, *Chama*, sp. 45, pl. 8, fig. 45 Panama.

Shell generally ovate, higher (dorso-ventrally) than long (anter-posteriorly), fairly large (68 to 70 mm.), solid, the right valve attached

by the right valve. When freed, the attachment area of the right valve is large and flat, with spirally wound beaks of $1\frac{1}{2}$ to 2 turns, its surface marked with widely spaced concentric lines which over the hollows become raised lamellae. The posterior or free side of the right valve is finely ribbed, occasionally rising into small nodes. The upper or left valve is much smaller; when well preserved its surface sculpture is formed mostly by small fimbriated scales rising from the edges of concentrics; on the posterior side of the left valve, the sculpture is formed by the edges of concentric growth layers (the two-fold sculpture of Reeve). Color white, usually with small lines of brown, the area of attachment white or pink.

Range—Lower California to Ecuador. Ecuador: Posorja; Santa Elena. Panama.

Pseuochema corrugata (Broderip)

Plate 34, figures 4-4b

Chama corrugata Broderip, 1835, Proc. Zool. Soc. London for 1834, p. 150.—Broderip, 1835, Trans. Zool. Soc. London, vol. 1, p. 305, pl. 38, fig. 7.—Reeve, 1846, Conch. Icon., vol. 4, *Chama*, sp. 9, pl. 2, fig. 9.

Pseudochema corrugata (Broderip) Maxwell Smith, 1944, Panamic Marine Shells p. 56.

Shell oblong-ovate to semicircular, the right valve attached as a rule firmly to the substratum by the greater part of its anterior side, its umbone large with prominently inrolled beak forming a deep, visceral cavity within. The upper valve is much smaller and flatter, its shape depending largely upon the size of the attachment area of the lower; in broadly attached specimens, the shape of the shell is elongate dorso-ventrally, more circular in those attached only by the anterior side of the umbone. Surface is often deeply weathered and sculptureless but in good specimens, the posterior side of the lower valve is finely ribbed and marked with brown lines together with one or more low radial ribs which may be crudely nodose. Well-preserved specimens of the upper valve are sculptured with close-set, short, fluted spines over the whole surface except along a narrow band on the anterior side which is smooth. Color of the external surface of the upper valve is generally purple. Shell cavity within may be stained a deep purple or white with blotches of purple, the hinge teeth and the anterior adductor scars usually purple. Inner margin of shell smooth or but obscurely denticulate.

This is the commonest of the Chamas along the north coast of Peru and fossil specimens in the tablazos of Peru and Ecuador sometimes reach a much larger size than any Recent examples seen. The species is easily recognized by its deep purple color of its interior, or the cavity of the shell within may be white or yellow but the anterior adductor scar and the hinge teeth remain stained with purple. It is usually attached by the entire anterior surface of its right valve, the resulting form is, therefore, an elongate ovate shell lengthened along the dorso-ventral axis.

Range—Panama southward to northern Peru. Peru: Sechura Bay; Paita, Negritos; Lobitos; Mancora, Caleta Sal; Zorritos. Ecuador: Santa Elena, Mancora, Mompiche. Panama: Puerto Mensabi; Búcaro; Montijo Bay.

Genus *ECHINOHAMA* Fischer, 1887

Type species by monotypy, *Chama arcinella* Linné, 1767 (*Arcinella* Schumacher, 1817, not of Oken, 1815). Recent, Florida, and the West Indies.

Shell equivalve, solid, usually attached in the early stages only, becomes free in the adult. Sculpture is formed by rows of radial ribs, sometimes developing strong spines and separated by interspaces which may be deeply pitted, reticulated, or netted. Umbones prominent, developing into strongly spirally coiled prosogyrate beaks. A large, deeply impressed lunule defined by an incised line is present. Hinge and ligament as in other members of the family.

Echinochama arcinella californica Dall

Plate 34, figure 3

Echinochama californica Dall, 1903, Proc. U. S. Nat. Museum, vol. 26, No. 1342, p. 950, pl. 62, fig. 5.—Maxwell Smith, 1944, Panamic Marine Shells, p. 56, fig. 716.—Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 3, No. 8, p. 111.

Echinochama arcinella californica Dall, Nicol, 1952, Jour. Paleont. vol. 26, No. 5, p. 806, pl. 119, fig. 8.

This is the Pacific subspecies of the Caribbean *E. arcinella arcinella* (Linné) from which it differs mainly in that the outline of the adult shell is angular or subtriangular, particularly in the right valve, while the anterior lobe is more sharply separated from the rest of the shell. It is a relatively rare shell. A larger subspecies occurs fossil on the Burica Peninsula in beds assigned to the Pleistocene.

Range—Gulf of California southward to Coiba Island, Panama.

Superfamily CYRENOIDACEA

Family CYRENOIDIDAE

A group of small, brackish-water clams, generally orbicular in shape with the small beaks nearer the anterior end, thin, the surface covered by a brown or olive-colored periostracum. The hinge is typical, provided with a thin, 7-shaped cardinal tooth in each valve and a smaller, lamellar, V-shaped cardinal below it in the right valve; there are no laterals. Ligament external. Pallial line generally indistinct, entire.

Genus *CYRENOIDA* Joannis, in Guérin, 1835

(*Cyrenella* Deshayes, 1836; *Cyrenodonta* H. and A. Adams, 1857.)

Type species by monotypy, *C. dupontia* Joannis. Senegal.

Shell subovate, rounded, convex, usually thin, with the beaks and umbones placed anterior of the middle line, prosogyrate. Hinge with two cardinal teeth, the right anterior one double, no laterals. Ligament external. A large, weakly defined lunular area is sometimes present. Adductor scars normal, connected by a simple pallial line. Sculpture formed by fine, hair-like, often wrinkled, concentric lines and covered by a brown or olivaceous periostracum. Brackish.

The type species, *C. dupontia* from Africa is large, attaining a length of 35 mm. or more but most South American species of the genus are small or medium-sized shells and are easily mistaken for *Diplodontia* if collected

amongst beach drift. The habitat station of *Cyrenoida* is in brackish water associated with mangrove swamps. Two species have been described from the Panamic region.

1. Shell of medium size (length up to 20 mm.), beaks anterior in position.
C. panamensis
2. Shell smaller (length to about 7 mm.), beaks more central.
C. insula

Cyrenoida insula Morrison

Cyrenoida insula Morrison, 1946, Smith, Misc. Coll., vol. 106, No. 6, p. 45, pl. 1, figs. 8-11.

Shell small, lenticular, suborbicular, vitreous, blue-white, under a pale corneous epidermis. Umbones smooth, little prominent, scarcely projecting above the general outline. Sculpture of minute, crowded concentric striae. Hinge well developed, lightly arcuate, wider anteriorly. Anterior and ventral margins evenly rounded as one curve. Posterior margin almost evenly rounded, a trifle more abruptly rounded into the dorsal and ventral margins.

Length 6.7 mm., height 6.2 mm., diameter 3.8 mm.

This species was collected from pools in the mud of a small mangrove swamp on the west side of San Jose Island. It was found only in small numbers and did not seem to be abundant in any of the mangrove swamps on the island. (Morrison, 1946.)

Range—Panama. Panama: San Jose Island of the Pearl Island group.

Cyrenoida panamensis Pilsbry and Zetek

Plate 84, figures 3, 3a

Cyrenoida panamensis Pilsbry and Zetek, 1931, Nautilus, vol. 45, No. 2, p. 69, pl. 3, fig. 4.

The shell is rounded, modified by the subtruncate posterior end, the weak dorsal curvature and the rather prominent beaks, which turn more to the anterior end than in *C. americana*; plump. Covered with a dull chamois periostracum with some isabella colored concentric streaks or suffusion; this periostracum is very minutely laminate along the lines of growth, and is persistent except at the beaks of old specimens. The interior is grayish white. Hinge rather narrow. Anterior limb or both limbs of the left cardinal teeth bifid at summit.

Length 18 mm., height 17.5 mm., diameter 10.3 mm. Panama City, Panama. (Pilsbry and Zetek, 1931.)

According to the authors, this species was once abundant in that part of Panama City now known as Hatillo, living along a narrow stretch of beach, brackish, and where mangrove then grew; the area is now well drained and built up; the species is probably living further east where similar conditions now prevail.

Range—Panama. Panama: Panama City.

Superfamily ERYCINACEA

The species of this superfamily form a composite group composed mostly of small (often minute) pelecypods known collectively as leptons. Many species are parasitic or commensal on other marine invertebrates, hence their shell and hinge often show characters suggestive of both immaturity

and degeneracy. The genera are classed together here largely for convenience of treatment rather than on a basis of common affinities with each other.

Some species of Panamic leptons are locally common and can be obtained in good series, such as *Aligena cokeri* and *Bornia zorritensis*, others are rare and known only from a few specimens, hence, this treatment of the group is admittedly incomplete and major additions can be expected in the future. Although work on the *Erycinacea* is specialized and difficult, they are nevertheless of great interest and well worth the attention of the qualified naturalist.

Family ERYCINIDAE

Genus ERYCINA Lamarck, 1805

Type species by subsequent designation, Stoliczka, 1871, *E. pellucida* Lamarck.

Shell small, white, ovate, oblong or subelliptical, subequivalve, thin, depressed or slightly convex. Ligament internal, lodged in a small, elongate resilifer behind the beak and under the shell margin. In front of the resilifer, there is a small, inclined tooth which in some instances may be obsolete; lateral teeth are variable in size and strength; in the right valve, the laterals are represented by sockets with elevated basal rims, placed equidistant from the beak; pallial line simple. Surface smooth or marked with fine, concentric growth lines and sometimes with fine radial striations.

Erycina colpoica Dall

Plate 36, figures 5, 5a

Erycina colpoica Dall, 1913, Proc. U. S. Nat. Museum, vol. 45, No. 2002, p. 596. Beach at the head of the Gulf of California.—Dall, 1925, Proc. U. S. Nat. Museum, vol. 66, art. 17, p. 16, pl. 27, fig. 2.—Hertlein and Strong, 1947, Zoologica, vol. 31, pt. 4, pp. 132, 133.

Shell small, white, equivalve, very inequilateral, the anterior end much the longer and somewhat expanded, posterior shorter and smaller, both rounded; dorsal and basal margins slightly arcuate, subparallel; surface sculptured only with concentric incremental lines, covered with a thin, pale, yellowish periostracum; beaks low, inconspicuous, valves rather compressed; interior polished, hinge formula $\overline{10.01.010}$; chondrophore very narrow, ob-

lique, and posteriorly directed. Length of shell, 10, of anterior part, 8, height 6, diameter, 3.5 mm. (Dall, 1913.)

Range—Gulf of California to Panama. Mexico: Gulf of California (Dall); Port Guatulco (Hertlein and Strong). Nicaragua: Corinto (in beach drift and at a depth of 12-13 fms.) abundant (Hertlein and Strong). Panama: off Taboga Island (dredgings) Mr. Lee Beil.

Family LEPTONIDAE

The shell is small, free, with equal valves, their margins smooth, closed tightly or with a small gap, the surface smooth or with radial sculpture. The ligament is mostly internal. Hinge variable, normally with one or two cardinal teeth and a pair of lateral teeth in each valve; the anterior lateral tooth is sometimes lacking, while the posterior lateral tooth is often so closely adjacent to the resilifer as to resemble a cardinal. The species are generally ovoviviparous.

Lepton lediformis, new species

Plate 36, figure 10

The shell is small, elongate, equivalve, with the beak near the anterior one-fourth, at which point also the valve is highest and most convex. Hinge: the left valve has a deep socket and a tooth on each side of a wide notch in the tip of the beak which also carries the resilifer; beyond these teeth, the margins of the valves are bevelled; in the right valve, the dorsal margin of the hinge line adjacent to the notch below the beak is sharp and fits into the lateral socket of the opposite valve. The shell wall is thin, sub-translucent and transmits into the interior the images of the fine, hairlike concentrics of the surface; adductor scars are indistinct. Area behind the beaks flat and impressed. Surface smooth and covered with fine, incremental growth lines.

Length 2.5 mm., height 1.6 mm., (a right valve). Length 2.6 mm., height 1.4 mm. (double valves).

A small shell with an elongate, *Nuculana*-like shape.

Range—Panama. Panama: El Lagartillo.

Genus LASAEA Brown, 1827

Type species by monotypy, *Cardium rubrum* Montagu. Recent, European seas.

Shell small, ovate, convex and generally solid, white, red, or brown, smooth except for the minute line of growth. The beaks and umbones are placed a little behind the middle, hence the posterior side is shorter as well as higher, its end well rounded; the anterior side is longer and narrower. The hinge plate is stout, deeply notched under the beak, the cardinal teeth small but with a long, narrow, lateral tooth on the posterior side; the anterior lateral tooth is shorter. The ligament is mostly internal, the resilium attached to an elongated groove below the posterior tooth.

This genus includes a number of small to minute species with convex, solid valves. Where found, they are generally abundant. The color of the shell is usually white, shaded with purple, lilac, or pink.

The figured example, *Lasaea rubra* (Montagu), Plate 36, figure 6. Specimen collected by T. L. McGinty, Boynton Beach, Florida.

Lasaea species

Shell small, obliquely rounded or subcircular, solid. The anterior side is somewhat narrowed and a trifle longer, both ends are well rounded. Hinge plate solid, with a deep, wide notch under the beak and bordered by strong teeth on each side. The resilifer occurs as an elongated groove which is placed obliquely under the posterior lateral tooth. The hinge plate and the umbone of the shell are often colored a lilac or coral red. Surface with fine, concentric threads.

A small *Lasaea* is known to occur at a few places along the coast of western Ecuador and northern Peru, but because only a few loose valves have been found, its identification with described species has not been attempted. As a rule, species of *Lasaea* occur in numbers under proper environmental conditions.

Range—Northwestern Peru and Ecuador. Peru: Negritos; Mancora. Ecuador: Punta Centinella, Santa Elena Peninsula.

Family KELLIIDAE

Shell small, ovate or orbicular, thin, convex, white or subtranslucent, the umbones and beaks submedian. Surface smooth and often glossy, occasionally punctate. External ligament small, the internal resilium attached to a posteriorly directed, oblique groove. Hinge with one or two cardinal teeth and one or two posterior lateral teeth in each valve; pallial line simple; surface sometimes covered by the mantle.

Genus **KELLIA** Turton, 1822

Type species by subsequent designation, Recluz, 1844, *Kellia suborbicularis* (Montagu).

Shell small or of medium size, thin, glassy, white, suborbicular and strongly convex, the surface usually smooth, polished or with fine or strong, concentric lines of growth. The umbones are prominent, submedian, the small beaks incurved and prosogyrous. Hinge plate narrow, with a wide notch in the middle bordered on each side by a small tooth, the anterior one shaped like a cardinal tooth, the posterior one placed more distantly; the left valve has two small divergent cardinal teeth with a socket or pit between them, the right valve has a single cardinal only; both valves have a flattened tooth at the posterior end of the median pit. Ligament is wholly internal, the tensilium small, narrow, lying below the margin and above a narrow nymphal lamina which distantly ends in a tooth, the resilium also elongated in form and attached to a linear groove in the roof of the subumbonal cavity. In some species, the surface is covered by a glossy, yellowish periostracum.

Kellia suborbicularis (Montagu)

Plate 33, figure 5;
Plate 35, figures 6, 14

Mya suborbicularis G. Montagu, 1803, Test. Brit., pt. 1, p. 39. In hard limestone at Plymouth, England, Suppl. 1808, pl. 26, fig. 6.

Kellia suborbicularis (Montagu), W. Turton, 1822, Conch. Insul. Brit., p. 57.—Jeffreys, 1863, Brit. Conchology, vol. 2, pp. 225-229, pl. 5, fig. 3.—Dall, 1909, Proc. U. S. Nat. Museum, vol. 37, No. 1704, p. 264.—Hertlein and Strong, 1947, Zoologica, vol. 31, pt. 4, p. 133.

Shell small (largest 5.5 mm.), suborbicular, with central umbones and beaks, strongly convex, thin, subtranslucent or white, the surface smooth or polished. As indicated by Hertlein and Strong, there seems to be no way at present for the consistent separation of the Pacific shells from typical examples of *K. suborbicularis* from Europe.

Range—British Columbia southward to Peru. Also in the west Atlantic, Caribbean, and European waters. Panama Canal Zone: Venado Beach. Colombia: Isla del Gallo. Ecuador: Esmeraldas; Puerto Callo; Punta Centinella. Peru: Zorritos; Sechurita near Zorritos.

Genus **BORNIA** Philippi, 1836

Type species by subsequent designation, Stoliczka, 1871, *Bornia corbuloides* Philippi. Recent, Mediterranean.

The shell is usually small, subtrigonal to subelliptical, subequilateral. The umbonal region is generally convex, the surface below often somewhat impressed or flattened. Color white; surface smooth or minutely striate, polished and sometimes faintly ribbed along the edge. The ligament has

an external, partly obsolete, amphidectic tensilium and a larger, subumbonal resilium. The scar of the resilium or resilifer is a narrow groove in the middle of the hinge plate and lies directly behind the beaks. The hinge plate is relatively narrow and carries strong, lateral teeth and sockets, the posterior set more distant, the anterior small and adjacent; in the left valve, the posterior lateral is an elongated lamina, the anterior lateral is a small, short tooth, and adjacent, and behind it is a small pseudocardinal tooth. In the right valve, the posterior lateral socket is large and conspicuous, its lower rim enlarged and toothlike. The adductor scars are subequal in size, placed rather high within, connected by an entire pallial line. The cavity of shell within is smooth or punctate.

Bornia is recognizable by its high, trigonal shape, its high, convex umbones, its polished surface and strong hinge in which the lateral teeth and sockets are most conspicuous. The species are probably parasitic or commensal in habit, and where found, generally abundant.

Bornia venada, new species

Plate 35, figure 12

Shell small, ovate or boat-shaped, convex, with nearly median umbone and beak, white. The two ends of the valve are much alike in shape and degree of roundness. The surface is smooth, polished, the lines of growth fine except for a narrow band near the ventral margin marked with several strong resting marks; in addition, the ventral margin is obscurely undulated. Shell cavity deep, the adductor scars small, equal and placed high within the valve.

Length 9.1 mm., height 6.6 mm., diameter 2.4 mm. a left valve, Venado Beach, Holotype, ANSP 218963.

Recognized by its shape and obscure radial undulations along the ventral margin.

Range—Panama. Canal Zone: Venado Beach.

Bornia egretta, new species

Plate 35, figure 11

The shell is relatively large, high-ovate, with narrow, pointed prosogyrate beaks placed slightly in front of the middle, the two ends of the shell nearly alike and widely rounded, the surface mildly convex to flattened. Surface smooth, polished, the lines of growth fine and hardly showing; along the anterior and posterior-ventral corners, there are a few, low, obscure, radial ripples or undulations and these show best on the inner side of the valve but the whole of the ventral margin is more or less weakly undulated. The adductor scars are placed high within the cavity and subequal in size, the pallial line entire but with wavy or irregular borders.

Length 10 mm., height 9.7 mm., diameter 2.1 mm. (a left valve). Sechurita near Zorritos, Peru. Holotype, ANSP 218885.

Only a single valve of this fine species is known to me.

Range—Peru. Peru: Sechurita, about 1 mile southwest of Zorritos.

Bornia zorritensis, new species

Plate 35, figures 9, 9a

Shell broadly trigonal or hatchet-shaped, subequilateral, with wide, submedian umbones, the two sides of the shell similar, their dorsal margins descending to a rounded end. Middle surface of disk wide, almost flattened,

sloping evenly to the ventral margin which is nearly straight. Anterior and posterior umbonal slope rounded and prominent, their sides turned down sharply and rather narrow. Hinge as illustrated, the laterals strong, the left valve with a small, double pseudocardinal under the beak. Surface smooth and polished, the growth lines fine, their distribution somewhat irregular.

Length 10.5 mm., height 8 mm., diameter 2.1 mm. (right valve).

Zorritos, Peru, Holotype, ANSP 218883.

This species is abundant in dredgings in Sechura Bay and at Zorritos. It resembles *B. mactroides* (Conrad) from the Chesapeake Miocene of Maryland and Virginia which is somewhat larger; *B. dodona* Dall from the Chipola of Florida is also similar but smaller.

Range—Peru. Peru: Sechura; Zorritos.

***Bornla chilclaya*, new species**

Plate 35, figure 13

The shell is small, thin, rounded, trigonal, or high and hatchet-shaped, subequilateral, the wide, flattened surface of the umbones submedian in position, below, the surface of the disk is nearly flat and slopes slightly towards the ventral margin which is wide and nearly straight. The beaks are small, pointed a little forward and placed slightly in front of the middle line. Color white or translucent, the surface smooth and glossy, usually the growth lines show faintly, and often banded concentrically with narrow, opaque and glassy ribbons. The right valve has a fairly strong hinge with the lateral teeth and their sockets placed close to the center and on each side of the excavated zone of the ligament. In the left valve, the hinge is weaker but has a large, thin, anterior lateral tooth and behind it a small, pseudocardinal. Pallial line is wide and entire.

Length 7.1 mm., height 5.9 mm., diameter 1.1 mm. (a right valve). Chimbote, Peru. Holotype, ANSP 218890.

In shape, similar to a triangle with rounded basal corners. It is a larger, higher, and more depressed species than *B. zorritensis*.

Range—Peru. Peru: Chimbote; Negritos.

Family MONTACUTIDAE

Shell generally small, ovate to oblong, thin or heavy, depressed or convex, the anterior side the longer. Ligament mostly internal, subumbonal or lodged in an elongated, oblique resilifer in the hinge margin behind the beaks. Surface smooth or with concentric growth lines and sometimes radial undulations. Habit of most species appears to be commensal.

Genus MYSELLA Angas, 1877

(*Rochefortia* Velain, 1877, type species, *R. australis* Velain.)

Type species by monotypy, *M. anomala* Angas. Australian waters.

Shell small, ovate, subquadrate to rounded-trigonal, the surface generally depressed, the anterior side longer. The hinge plate is stout and bears a short, central, subumbonal resilifer; in the right valve, the resilifer is bordered by two small teeth, one on each side, the anterior tooth is the larger, and above each of these there is a grooved socket in which the thickened margin of the left valve is inserted. The pallial line is a plain, wide band or ribbon connecting the adductor scars of which the anterior scar is the larger. Species live free or even up in the burrows of crustacea and other marine invertebrates.

***Mysella compressa* (Dall)**

Plate 35, figure 10

Rochefortia compressa Dall, 1913, Proc. U. S. Nat. Museum, vol. 45, No. 2002, p. 596.
Head of Concepcion Bay, Gulf of California as given on label of type USNM 214445.—Dall, 1921, Bull. U. S. Nat. Museum, No. 112, p. 37, pl. 3, fig. 1.

Shell small, compressed to slightly convex, rounded-quadrate to sub-ovate, the anterior side longer and widely rounded at the end, the shorter posterior side with its dorsal margin descending rather sharply to a rounded or subtruncated end. Hinge has a wide V-shaped notch in the middle with the beak at its tip, and directly under it in the cavity lies the scar of the resilium. In the right valve, the median notch is bordered by lamellar teeth on each side, and above each of these a grooved socket for the reception of the thickened, bevelled edge of the opposite valve. Surface white, more or less roughened by fine to coarse lines of growth. Adductor scars subequal, connected by an entire, ribbon-like pallial line.

Length 6 mm., height 4.6 mm. Zorritos, Peru.

Range—Alaska to northern Peru. Peru: Zorritos.

***Mysella negritensis*, new species**

Plate 35, figure 8

The shell is relatively large for the genus, white, high, ovate, depressed to slightly convex. The posterior side is short, its margin descending sharply to assume at its end, a slightly rounded or truncated shape. The hinge of the left valve has the usual deep umbonal notch carrying the resilifer in the cavity under the beak and it is bordered by the bevelled edges of the margin on each side which fit snugly into the grooved sockets of the opposite valve. The adductor scars are of nearly equal size, the connecting pallial line entire. Surface marked with rough, irregular lines of growth.

Length 10.3 mm., height 8.5 mm., diameter 2 mm. (a left valve). Negritos, Peru. Holotype, ANSP 218889.

The smaller shells are generally smoother than the large ones, the periostracum thin and of light brown color. This species is fossil in the Pliocene of Ecuador.

Range—Peru. Peru: Negritos.

Genus **ALIGENA** H. C. Lea, 1843

Type species by subsequent designation, Dall, 1900, *Aligena striata* H. C. Lea (= *A. aequata* Conrad).

Shell small, rounded-ovate to oblong trigonal, the anterior side generally longer, inflated, thin, white, with full umbones and small, prosogyrate beaks. Surface of the valves evenly inflated or with a more or less strong, constriction over the middle. Hinge weak, edentulous, or with a single, small, anterior tooth under the beak and behind it a wide, open gap or notch. Ligament internal, the resilifer elongated and placed in the margin of the hinge notch.

***Aligena cokeri* Dall**

Plate 33, figures 6, 6a, 6b

Aligena cokeri Dall, 1909, Proc. U. S. Nat. Museum, vol. 37, No. 1704, pp. 155, 264, pl. 28, figs. 5, 6. Attached to worm tubes thrown upon the beach of the lagoon at Capon, Peru.—T. Burch, 1941, Nautilus, vol. 55, No. 2, p. 48.—Hertlein and Strong, 1947, Zoologica, vol. 31, pt. 4, p. 134.

The shell is quite small, white, thin, tumid and more or less strongly constricted in the middle, the shape usually rounded ovate but varying

considerably between different specimens. The umbones high, full, with the beaks adjacent and slightly twisted in an anterior direction and somewhat in advance of the middle of the valve. Sculpture formed by concentric incremental lines and sparser, little elevated, concentric threads. In life, the shell appears to have been particularly liable to small accidents and injuries producing uneven depressions and other abnormal irregularities of growth. Interior of the valves white and smooth.

Length 7.5 mm., height 6.5 mm., diameter 6.5 mm. (Dall). Capon, Peru.

Length 9.2 mm., height 8 mm., diameter 2.7 mm. Venado Beach, Panama Canal Zone.

This is the commonest species of *Aligena* in the Panamic-Pacific region, variable in shape.

Range—Gulf of California to northern Peru. Panama Canal Zone: Venado Beach. Peru: Tumbes.

Aligena nucea Dall

Aligena nucea Dall, 1913, Proc. U. S. Nat. Museum, vol. 45, No. 2002, p. 597 Gulf of California.—Hertlein and Strong, 1947, Zoologica, vol. 31, pt. 4, p. 134.

Shell small, white, rather solid, ovate, slightly inequilateral, moderately inflated; surface rather rude, with irregular, rather coarse incremental lines; beaks full, somewhat posterior, the anterior end of the shell shorter; interior porcellaneous, the muscle scars unusually large, the pallial line irregular, entire; hinge with a long, strong, narrow chondrophore, a small pustular projection in front of it, as usual in the genus. Length of shell, 4.0, of anterior portion, 1.75, height, 3.0, diameter, 2.2 mm.

This species recalls *A. cokeri* Dall of Peru, but wants the median radial depression and has a proportionately stronger hinge. (Dall, 1913.)

Range—Gulf of California south to Nicaragua. Mexico, Gulf of California. Nicaragua, Corinto (Hertlein and Strong).

Genus **OROBITELLA** Dall, 1900

Type species by original designation, *Montacuta floridana* Dall. Recent, Florida.

Shell small to large, subovate, inequilateral, the posterior side short and rounded, the anterior side much longer. Hinge plate relatively narrow but stout, with a single, pluglike tooth directly under the beak in each valve, and behind it, an elongated, excavated or grooved, subumbonal resilifer which extends across the hingeplate obliquely. Adductor scars subequal, connected by an entire, ribbon-like pallial sinus. Surface smooth, more often concentrically marked, sometimes earthy or chalky, the periostracal coating thin, deciduous, plain or weakly rayed.

Key to species of *Orobitella*

- I. Surface marked with microscopic or minute, divaricating lines or striation (saggrination), best developed on the sides; destroyed on worn specimens.
 - A. Shell strongly convex.
 1. Shell large (length 13 mm.), the anterior side twice as long as the posterior, its end obliquely rounded.

O. stearnsi

2. Shell smaller (length 8.5 mm.), the anterior side not twice the length of the posterior, its end more evenly rounded; sagination fine.
O. zorrita
- B. Shell depressed or slightly convex.
3. Anterior-dorsal margin descending, hence not parallel with the ventral side.
O. peruviana
- II. Surface without evident sagination.
- C. Mid-zone of the valves impressed, the ventral margin, therefore, strongly inflected or sinuated.
4. Length of shell between 8 and 12 mm.
O. margarita
- D. Mid-zone of valves not flattened or impressed.
5. Valves with an oblique axis, the posterior-dorsal side descending sharply. Surface generally chalky and marked with coarse concentrics.
O. sechura
6. Valves, oblong, boat-shaped, convex. Sculpture formed by fine, irregular concentrics.
O. jipijapa

***Orobtella zorrita*, new species**

Plate 35, figure 3

The shell is of medium size (length 8.4 mm.), oblong, boat-shaped, convex, subequilateral, the anterior side a trifle longer, its dorsal margin at first straight and parallel with the basal or ventral side but shortly passing into the curve which forms the widely rounded, anterior end. The posterior side is shorter, its dorsal margin descending from the beginning, its end more narrowly rounded. The general surface is smooth except for fine, incremental growth lines, its color white or finely banded at the ends, the effect produced by alternating ribbons of opaque and glassy white; at the ends, there are traces of a thin, light brown periostracum which once covered the whole disk. The microscopic sagination is extremely fine and faint, visible only over the sides and under high magnification. The inflation of the valves is greatest over the anterior-umbonal slope, the surface of the disk being a little impressed across the mid-zone. The ventral margins straight and plain.

Length 8.4 mm., height 6 mm., diameter 1.8 mm. Zorritos, Peru. Holotype, ANSP 218886.

This species resembles *O. stearnsi* Dall but in the Peruvian shell, the posterior side is longer and the anterior end has a more even, semicircular curve.

Range—Peru. Peru: Zorritos.

***Orobtella stearnsi* (Dall)**

Plate 36, figure 2

Sportella stearnsi Dall, 1899, Proc. U. S. Nat. Museum, vol. 21, No. 1177, p. 885, pl. 87, figs. 9, 12.—Hertlein and Strong, 1947, Zoologica, vol. 31, pt. 4, pp. 137, 138.

Shell of moderate size for the genus, inequilateral, not very convex, white, with an almost imperceptible yellowish epidermis; anterior dorsal margin nearly straight, the base parallel with it, the ends bluntly rounded; surface nearly smooth, with faint incremental lines and microscopic sagination; teeth normal, strong, the posterior cardinal prominent, vertical; ligament strong, external, on a nymph; resilium well developed, its area of attachment thickened; posterior adductor scar rounded, unusually large. Lon. 13.5, alt. 10, diam. 5 mm.

One well-preserved specimen from the Gulf of California, exact locality unknown, is contained in the Stearns collection. (Dall, 1899.)

The type at the U. S. National Museum is a white, solid, somewhat worn shell; its surface is more or less chalky, marked with coarse, irregular concentrics with the sagrination showing but faintly.

Range—Lower California to Nicaragua and the Galapagos Islands. Mexico: Gulf of California (Dall); Santa Inez Bay (Hertlein and Strong). Nicaragua: Corinto (Hertlein and Strong). Galapagos Islands: Galapagos (Hertlein and Strong).

***Orobitella peruviana*, new species**

Plate 35, figure 7

Shell of moderate size (length between 13 and 14 mm.), slightly convex to depressed, subsolid, inequilateral, the anterior side the longer, its dorsal margin descending towards the end which is rounded with a half circular curve, the posterior side short, also rounded. Surface marked with concentric lines, sometimes irregular and banded, overrun with indistinct, microscopic sagrination. Hinge typical of genus.

Length 13.6 mm., height 10.8 mm., diameter 2.5 mm. (left valve). Holotype, ANSP 218882.

Resembles *O. stearnsi* (Dall) but differs by its shape, the anterior-dorsal margin sloping downward and not parallel to the ventral margin as described and figured for that species.

Range—Peru and probably Ecuador. Peru: Boca Pan. Ecuador: fossil in Pliocene of Punta Blanca.

***Orobitella margarita*, new species**

Plate 35, figure 2

Shell moderate in size for the genus (our largest about 11.4 mm.), oblong, boat-shaped, inequilateral, the posterior side a third shorter than the anterior, rather strongly convex, the fullest inflation lying along the posterior umbonal slope, the midzone of the valve in front of it lower, impressed, or flattened. Anterior dorsal and ventral margins are usually parallel or nearly so. Surface marked with irregular concentric growth lines. Interior smooth or sometimes with fine, indistinct radial lines. The ventral margin may be straight or deeply indented. No microscopic sagrination.

Length 8 mm., height 5.7 mm., diameter 2.2 mm.

Length 11.5 mm., height 7.1 mm., diameter 2.2 mm. Holotype, ANSP 218884.

Easily recognized by its peculiar shape, the mid-zone usually indented.

Range—Panama: Beach at San Miguel, Rey Island, Pearl Islands.

***Orobitella sechura*, new species**

Plate 35, figures 1-1b

Shell of medium size (length 9 to 10 mm.), broadly, obliquely subovate, depressed to weakly convex, the posterior side short, flatly rounded to subtruncate. The beaks are small, facing forward over the long, descending dorsal margin, the end rounded. Surface smooth with fine concentric lines but generally assuming an earthy or chalky texture through weathering. In some shells, the surface is covered by a thin, somewhat chalky textured,

pale-brown periostracum, sometimes this layer is faintly radially rayed. Hinge as described for the genus.

Length 10 mm., height 9.1 mm., diameter of a single valve 2.6 mm.

Paratype.

Length 9.7 mm., height 9.3 mm., diameter of a single valve 2.5 mm.

Holotype, ANSP 218886.

Range—Peru. Peru: Bayovar on Sechura Bay.

Oorbitella jipijapa, new species

Plate 35, figure 5

Shell relatively large, oblong-subovate, boat-shaped, inequilateral, the anterior side a little longer and narrower but otherwise the two ends similar, equally rounded, and quite convex. Left valve has a large tooth under the beak bordered behind by the oblique, subumbonal resilifer. Surface with relatively coarse, irregularly raised, threadlike concentrics, the texture somewhat chalky.

Length 12 mm., height 9 mm., diameter 3 mm. (left valve). Holotype, ANSP 218888.

Much like *O. floridana* Dall in shape and sculpture but less inequilateral, the umbone more median in position and the posterior side a trifle longer.

Range—Ecuador. Ecuador: Puerto Callo, Port of Jipijapa.

Genus PYTHINELLA Dall, 1899

Type species by monotypy, *Mysella* (*Pythinella*) *cuneata* (Verrill and Bush.) (*Montacuta cuneata* Verrill and Bush).

Shell small or minute, inequilateral, transversely trigonal with prominent beaks and umbones, the anterior side much the longer, produced, the ventral margin straight or flatly indented. Hinge of *Mysella*, the right valve having two, well-defined, thickened teeth bordered above by small sockets, and separated by a wide, deep notch under the beak; in the left valve, the hinge is simpler and consists mainly of the bevelled edges or the dorsal margins which fit into the small, grooved sockets of the opposite valve. Ligament principally internal. Surface marked with fine, concentric, growth threads and microscopic, radial striations. Animal probably commensal.

This group has generally been considered a subgenus of *Mysella*, but it is so well defined as to warrant generic status.

Pythinella sublaevis (Carpenter)

Plate 36, figure 11;

Plate 83, figure 12

Pythina sublaevis Carpenter, 1857, Cat. Mazatlan Shells, Brit. Mus., p. 112, No. 160 Mazatlan, Mexico.

Mysella (*Pythinella*) *sublaevis* (Carpenter), Dall, 1899, Proc. U. S. Nat. Museum, vol. 21, No. 1177, p. 881.

Shell small, with the characters as described for the genus. The shell is similar to *P. cuneata* Verrill and Bush taken off Cape Hatteras and may not be specifically distinct. I have a single specimen from shell drift collected at El Lagartillo near Las Tablas, Panama.

The figure is a reproduction of a camera lucida sketch prepared by Carpenter in the molluscan library at the U. S. National Museum.

Range—Mexico to Panama. Mexico: Mazatlan (Carpenter). Panama: El Lagartillo, near Las Tablas.

Family GALEOMMATIDAE

Shell small, oblong-ovate, often scalelike, usually with an open gap along the ventral margins and in the genus *Ephippodonta*, the valves are fully open and spread apart so that they lie flat in the same plane. Surface smooth, glossy or covered with small, fine, radial riblets and concentrics, sometimes minutely punctate, the periostracum if preserved, thin. Hinge edentulous or provided with small, weak cardinal teeth and sometimes laterals. The ligament is mostly internal, the resilium being attached to a small pit or groove. The ventral margin is entire or it may be deeply indented by a median sinus and a sulcus extending upwards towards the beak, the margin of the valve smooth or crenulate. The mantle extends over the external surface of the valves. Some species are said to be able to move freely about in the manner of snails.

Genus SOLECARDIA Conrad, 1849

(*Scintilla* Deshayes, 1855, type species *S. Cumingi* Desh., selected by Woodward, 1856).

Type species by monotypy, *S. eburnea* Conrad. Lower California.

Shell partly covered by the mantle, the valves subovate, boat-shaped, generally with wide, submedian umbones and rounded, subequal ends, moderately convex, white. The surface in fresh shells is covered with a granular, calcareous coating which may become polished and minutely punctate on wear. Hinge plate narrow, bearing two diverging lamellar teeth on each side of a large, socket-like pit occupied in part by the ligament, the margins of the plate beyond the cardinal lamellae grooved. Ligament divided, the tensilium external, small, amphidetic, its longer section posterior of the beak; the resilium internal, and attached to a narrow, linear scar in the roof of the central pit. The pallial line is placed close to the ventral margin, entire. Adductor scars, small, subequal, and lie within and separated from the pallial line.

Solecardia eburnea Conrad

Plate 36, figures 1, 1a

Solecardia eburnea Conrad, 1849, Proc. Acad. Nat. Sci. Philadelphia, vol. 4, p. 155.—Conrad, 1850, Jour. Acad. Nat. Sci. Philadelphia, 2d ser., vol. 1, p. 278, pl. 39, fig. 1.—Dall, 1899, Proc. U. S. Nat. Museum, vol. 21, No. 1177, pp. 875, 879, 884.—Pilsbry and Lowe, 1932, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, p. 136. Hertlein and Strong, 1947, Zoologica, vol. 31, pt. 4, pp. 136, 137. (Not *Scintilla eburnea* Mörch, 1876, renamed by Dall, 1899, as *S. mörchi*).

Scintilla cumingii Deshayes, 1855, Proc. Zool. Soc. London, p. 173. "Hab. ad littora Panamensis".—Sowerby, 1866, Thes. Conch., vol. 3, pt. 21, *Scintilla*, p. 177, No. 20, pl. 235, figs. 36, 38.—Sowerby, 1875, Conch. Icon., vol. 19, *Scintilla*, pl. 1, figs. 3a, 3b "Panama".

Shell relatively large (length nearly 30 mm.), oblong-elliptical or boat-shaped, white. Surface almost smooth except for minute punctations and large, subobsolete radial riblets near the basal margin which is weakly crenulated by them.

Length 29.2 mm., height 19.2 mm., semidiameter 6.7 mm. Holotype, ANSP 52615.

Range—Lower California to Panama. Mexico: La Paz. (Pilsbry and Lowe). Nicaragua: San Juan del Sur (Pilsbry and Lowe). Panama: Panama (Cuming and Deshayes).

Solecardia peruviana, new species

Plate 36, figures 3, 3a

The shell is small, elongate-oblong, the umbone placed a little anterior of the middle, the beak prosogyrate. Dorsal and ventral margins are nearly parallel and straight with the two ends equal and rounded. The embryonic shell is large and covers much of the beak. The hinge of the left valve has two anterior cardinal teeth; behind them is a linear pit for the ligament and on the margin behind it is a small posterior tooth. The sculpture consists of flattened, smooth concentrics and small fimbriated radials towards the basal margin and on the two ends, the riblets spreading out fan-shaped upward. Internal margin smooth but with the furrows of the external radials showing along both the anterior and posterior ends. There is no ventral gap.

Length 4.8 mm., height 2.7 mm. a left valve. Zorritos, Peru. Holotype, ANSP 218891.

The surface sculpture recalls that of some species of *Galeomma*, but the ventral margin is straight without any indication of an open gap.

Range—Peru. Peru: Zorritos.

Genus **TRYPHOMYAX**, new genus

Type species, *Tryphomyax lepidiformis*, new species. Panama.

The shell is small, thin, flat, scalelike, subovate, its posterior side somewhat longer. The prodissococonch is a small or minute, brown cap on the tip of the beak, and contrasts sharply with the pale white or translucent color of the adult shell. The middle of the disk of both valves is crossed by a narrow, vertical line or sulcus which at the ventral margin ends in a narrow, deep notch. The surface is sculptured with low, radial riblets which as they approach the dorsal margin fan out slightly at the ends; the riblets are finely cancellated or shagreened by minutely waved concentrics. The hinge of the right valve has a knoblike cardinal tooth in the middle; the left valve has two cardinal teeth, of which the anterior one is the larger. The ligament is internal, the resilifer small, placed behind the cardinal teeth. The hinge of the right valve has a small, narrow tooth along its posterior-lateral margin. The pallial line is entire, its course waved and situated well within the cavity of the valve.

Leiochasma Dall, Bartsch, and Rehder, 1938 (type species, *L. chascax* Pilsbry) from Hawaii is perhaps a related genus but has an edentulous hinge, smooth surface without a ventral notch. The presence or absence of the ventral notch is probably not an important character; it is extremely well developed in *T. lepidiformis*, the type species, but is lacking in its subspecies *laevis*. *Vasconiella* Dall, 1899, has its ventral notch restricted to the much smaller, right valve as recently demonstrated by Kisch.

Tryphomyax lepidiformis, new species

Plate 36, figures 4, 4a

The shell is small, flat, with the characters described for the genus. The holotype is a left valve; this specimen has the central sulcus placed a little in front of the middle, hence dividing the disk into two unequal parts, the anterior section is the widest and highest, the sulcus forms a deep cut or notch in the ventral margin. Sculpture formed by low, flat riblets, at first simple but towards the ventral margin become double; the riblets are minutely crenulated by fine concentric lines. The surface of the umbone smooth.

Length 4.1 mm., height 2.5 mm. Holotype, ANSP 218922.

So far, this interesting species is known only by eight free valves. A single specimen of another form has no median sulcus and the surface is nearly smooth. To this smooth form, the subspecific name "*laevis*" is proposed, however, additional specimens may show that it should be considered as a related but distinct species. *T. lepidiformis laevis*, new subspecies (Plate 36, figures 7-7b). Holotype, ANSP 218923.

Range—Panama. Panama: In beach drift, Lagartillo, near Las Tablas; also attached to worm tubes.

Family SPORTELLIDAE

Shells are generally small, ovate to narrowly elongate, thin and usually white in color. The umbones are usually prominent, sometimes near the middle, or much closer to the anterior end. Hinge generally with one or two large teeth in each valve. Ligament largely external, occasionally showing a small, internal resilium. Surface smooth or roughened with growth threads, sometimes heavily pustulated.

Genus **ENSITELLOPS** Olsson and Harbison, 1953

Type species by original designation, *Sportella protexta* Conrad. Miocene of Virginia.

Shell small, thin, solenoid, the anterior side much shorter than the posterior, the dorsal and ventral margins straight and nearly parallel. The prodissoconch is small but distinct, generally placed obliquely to the longer axis of the mature shell. General surface is white, often earthy and with a scattering of small spinelike pustules. In the left valve, the hinge has two small, divergent anterior cardinal teeth, the right valve with one only. The left valve has a long, slender, posterior tooth partly united with the nymph; it fits into a grooved socket in the dorsal margin of the opposite valve.

A genus of small, *Solen*-like shells common in the Miocene and Pliocene of the southeastern United States.

Ensitellops pacifica, new species

Plate 80, figures 9, 9a

Shell elongate, soleniform, the beak capped by the small, glossy prodissoconch placed near the anterior one-fourth or one-fifth. Valves unequal in the degree of inflation, either the right or left valve is cylindrically convex, the opposite valve is irregularly depressed, often strongly warped, the two ends flexed inward as if to effect the closure of an otherwise gaping shell. Color subtranslucent or milky white, marked with fine lines of growth, and smooth or with a sprinkling of small pustules on the flatter valve. Interior with the adductor scars indistinct, connected by an irregular pallial line placed rather high, the cavity of the beak showing in the inside surface of the prodissoconch in the semblance of a small pit. Hinge teeth small.

Length 5 mm., height 2.8 mm., more convex valve, right valve.

Length 5.4 mm., height 2.5 mm., a flatter valve with pustules, right valve.

Holotype, ANSP 218893; paratype, ANSP 218894.

This species is moderately common at El Lagartillo near Las Tablas, Panama. It is related to *E. protexta* (Conrad) first described from the Miocene of Virginia but now also known to occur in the Recent along the southeast coast of the United States.

Range—Panama southward to Ecuador. Panama: El Lagartillo, Las Tablas. Ecuador: Santa Elena.

Ensitellops hertleini Emerson and Puffer

Plate 36, figure 9

Ensitellops hertleini Emerson and Puffer, 1957, American Museum Novitates, No. 1825, pp. 21, 22, fig. 2.

Shell very transversely elongate; anterior margin oblique and ventrally rounded; exterior surface ornamented with numerous pustules. Shell small, thin, elongate, solenoid in outline, inequilateral, small beak in anterior quarter; posterior end rounded, anterior end obliquely truncated, with ventral portion attenuated and terminally rounded. Exterior surface sculptured with irregularly spaced concentric growth lines and scattered spinelike pustules, most commonly on the ventral-posterior portion. Prodissoconch small, unsculptured, prominent, raised, turned obliquely to the transverse axis of mature shell. Hinge typical for the genus. Color of shell: exterior dull chalky white; interior glossy white.

Length 9.5 mm., height 3.0 mm. (Emerson and Puffer, 1957.)

The measurements suggest that this is a much larger species than the preceding.

Range—West coast of Mexico. Mexico: Guaymas Harbor, four meters depth, Sonora.

Genus **BASTEROTIA** Hoernes, 1859

(*Eucharis* Recluz, 1850. Type species, *Corbula quadrata* Hinds) (Not *Eucharis* Latreille, 1804).

Type species by monotypy, *Basterotia corbuloides* Hoernes. Miocene of Europe.

Shell small, subquadrate corbuliform, with a sharp angle or carination running from the beak posteriorly. Valves convex and usually solid, white, the beaks prosogyrate. Surface marked with fine concentric lines of growth and a sprinkling of fine or coarse granules. Ligament external, attached to a short, stout, platelike nymph. Hinge with a large, hook-shaped cardinal tooth in each valve, bordered behind or in front by a deep socket; in the right valve, the socket lies in front of the tooth and in the left valve behind. There is no pallial sinus.

Basterotia (*Basterotia*) *quadrata* (Hinds)

Co-bula quadrata Hinds, 1843, Proc. Zool. Soc. London, p. 57.—Hanley, 1842-1856, Catalogue Recent Bivalve Shells, Appendix, p. 345, pl. 12, fig. 36 West Indies.—Reeve, 1844, Conch. Icon., vol. 2, *Corbula*, pl. 5, fig. 40. Hab. ---?

This species has been cited as a Pacific shell by Dall but without mention of locality station. Hanley recorded its locality as from the West Indies; Reeve—as unknown. The occurrence of this species in the eastern Pacific, therefore, remains unverified.

Subgenus **BASTEROTELLA** Olsson and Harbison, 1953

Type species by original designation, *Pleurodesma floridana* Dall. Pliocene of Florida.

Like *Basterotia* but with the nymphal ridge shorter and bearing a small resilial scar on its lower or inner side. The posterior-umbonal ridge is rounded or merely angled. No surface granulation.

Basterotia (Basterotella) ecuadoriana, new species Plate 36, figures 8, 8a

?*Basterotia peninsularis* (Jordan), Hertlein and Strong, 1947, Zoologica, vol. 31, pt. 4, p. 137. Probably not Jordan, as *Anisodonta*, 1936, Contr. Dept. Geol. Stanford Univ., vol. 1, No. 4, p. 147, pl. 18, figs. 11, 12 Magdalena Bay, Lower California "Pleistocene". See also Durham, 1950, Mem. Geol. Soc. America, No. 43, p. 95, pl. 25, figs. 3, 8.

Shell elongate-quadrate, inequilateral, the beaks placed at the anterior one-fourth, the anterior side short, contracted, the longer posterior side with closely parallel dorsal and ventral margins and rounded end, moderately convex, white. The posterior-umbonal slope is prominently vaulted but not angled or keeled. Sculpture produced by coarsely wrinkled concentrics and much finer lines of growth; no granules.

Length 12.3 mm., height 7.7 mm., diameter of a left valve 2.3 mm. Manta, Ecuador. Holotype, ANSP 218892.

Length 15.2 mm., height 9.6 mm., diameter of a left valve 3 mm. Santa Elena, Ecuador. Paratype.

This is probably the species referred to by Hertlein and Strong as *B. peninsulare* (Jordan), originally described as a Pleistocene fossil from Lower California; the figure of this species given by Durham is that of a more vaulted shell, with deeply impressed ventral side and a more strongly angled posterior-umbonal slope. My shell agrees better with the figure of *B. hertleini* Durham (*op. cit.*, pl. 25, figs. 4, 110) from the Pliocene of California, but has a longer form and less convexity.

Range—Gulf of California? southward to Ecuador and the Galapagos. Ecuador: Manta; Santa Elena.

STATUS UNCERTAIN

Solecardia ? obliqua (Sowerby)

Scintilla obliqua Sowerby, 1862, Thes. Conch., vol. 3, pt. 21, p. 179, No. 32, pl. 235, fig. 35.—Sowerby, 1875, Conch. Icon., vol. 19, *Scintilla*, pl. 4, fig. 34. Ecuador.

This species is unknown to me. Its short anterior side suggests an *Orobitella*.

Superfamily CARDIACEA

Family CARDIIDAE¹¹

Shell rounded or ovate, equivalve and generally inequilateral, the umbones prominent, the beaks approximate and prosocoelous, the posterior side of the valves often differing noticeably in sculpture from the rest of the surface. Hinge generally well developed, cyclodont, the cardinal teeth hook-shaped, curving outward and not seated on a flat plate, usually bordered by strong laterals. Ligament external, attached to a short, nymphal plate below and behind the beaks. Surface smooth or sculptured with strong, radial ribs, which may be smooth, noded, spiny or scaly; the ribs in some species produce deep furrows or serrations along the ventral and posterior inner margins of the valve.

The Cardiums may be divided into five groups or subfamilies of which four have member species in the Panamic-Pacific region, the true Cardiums

¹¹ Keen, A. Myra, 1951, Minutes 111, Conch. Club. S. California, pp. 6-9.

or *Cardiinae*, however, are absent: *Trachycardiinae*.—in this group, the shell is solid, strongly ribbed, the sides and crests of the ribs ornamented with spines, nodes and scales, the posterior and ventral margins of the valves serrated or fluted by the ends of the ribs; *Fraginae*.—solid or thick-walled shells, usually quadrate to rhombic in shape, the posterior slope strongly flattened or depressed, bordered by a sharp, umbonal angle, the surface of the ribs smooth or noded, their interspaces cross-threaded, the margins of the valves not serrated; *Protocardiinae*.—the shell usually thin, round, or quadrate in shape, the posterior surface set apart by an umbonal ridge (often fringed), and by a sharp change of sculpture, the radial interspaces often with scattered pustules; *Laevicardiinae*.—shell ovate to egg-shaped, often thin, smooth, glossy, or with small flat riblets, the posterior slope weakly defined, the valve margins smooth or crenulated.

Key to genera of Panamic *Cardiidae*

- I. Surface smooth, often highly polished and with fine or obscure, radial lines or riblets formed within the inner layer, and which produce fine crenulations along the inner ventral margins of the valve.

Genus *Laevicardium*

- II. Sculpture of the surface stronger, usually with strong, radial ribs or riblets.

- A. Sculpture similar over the whole surface, the lateral ribs gradational with those in the middle.

1. Length of shell greater than its height. Beaks anterior of the middle, the margins of the valve not closing tightly but with an open gap at both ends.

Genus *Papyridea*

2. Height of the shell is greater than its length. Valve margins closed, not gaping.

- 2a. Posterior side of the umbone with a strong, angled keel, its slope flattened, depressed, and truncated.

Genus *Trigoniocardia*

3. Posterior-umbonal slope merely rounded.

4. Ribs low, round or flat, smooth, or with weak nodes.

- 4a. Shell ovate and strongly convex. Surface color white, generally mottled with brown and covered by a heavy, dark-brown periostracum.

Genus *Mexicardia*

- 4b. Shell oblong-ovate, moderately convex, the ribs low, close, smooth, or weakly imbricated.

Genus *Acrosterigma*

5. Ribs higher, rectangular, between deeply grooved interspaces, ornate or adorned with sharp, imbricated scales tubercles, or spines.

Genus *Trachycardium*

- B. Sculpture differentiated into two, distinct areas, the smaller, posterior area set apart from that on the middle by a ridge or fringed keel as well as a marked change of detail. Substance of shell usually thin.

6. Shell longer than its height, the posterior side contracted, and slightly gaping at the end. Posterior area set off by a raised lamina. Hinge without lateral teeth.

Genus *Lophocardium*

7. Shell rounded, the length and height nearly the same, the posterior side not contracted. Hinge provided with lateral teeth.

Genus *Microcardium*

Subfamily TRACHYCARDIINAE

Genus TRACHYCARDIUM Mörch, 1853

Type species by subsequent designation, von Martens, 1870 *Cardium isocardia* Linné. West Atlantic.

Shell subovate, usually higher than long, convex, with large, full umbones (submedian) ending in small, adjacent, orthogyrate beaks. The sculpture is produced by large, elevated, radial ribs, covered in whole or in part, with imbricated scales, spines or noded, ribbon-like cords, usually best developed on the flanks. Hinge stout, usually with two cardinal teeth, of which one is large and prong-shaped, the other above it small, the socket between them large. The lateral teeth are large and spaced equidistant from the middle of the hinge. Margins deeply grooved by the ends of the ribs.

The genus *Trachycardium* is divisible into three subgenera on basis of the ornamentation of the ribs.

- I. Ribs covered completely with coarse, vaulted, imbricated scales producing a harsh, rasplike surface.

Subgenus *Trachycardium*, s.s.

- II. Posterior edge of each rib enlarged and elevated into a high, tuberculate cord or ribbon.

Subgenus *Phlogocardia*

- III. Ornamentation of the ribs weaker, reduced largely to small scales or nodes, strongest on the side ribs, the ribs in the mid-zone and on the umbones largely smooth.

Subgenus *Dallocardia*

Trachycardium (*Trachycardium*) *consors* (Sowerby)

Plate 37, figure 1

Cardium consors Sowerby, 1833, Proc. Zool. Soc. London, p. 85.—Sowerby, 1840, Conch. Illust. *Cardium*, p. 3, No. 40, fig. 8.—Reeve, 1845, Conch. Icon., vol. 2, *Cardium*, pl. 17, fig. 86.

Cardium (*Trachycardium*) *consors* Sowerby, Maxwell Smith, 1944, Panamic Marine Shells, p. 58, figs. 735, 745, 746.—Hertlein and Strong, 1947, Zoologica, vol. 31, pt. 4, p. 147.

Shell ovate, generally higher than long, with solid, highly convex valves and wide, full umbones, nearly median in position, the small beaks touching over the dorsal margin. Ribs high and strong, usually about 31 in number, rectangular in section and separated by deep, narrow interspaces, ornamented with elevated, inverted, U-shaped scales, coarsely imbricated on the anterior set of ribs, thinner and higher on the middle posterior set; on the latter, the posterior arm of each scale unites and joins the scale in front so as to form a high, curiously flattened, straight wall. Color a creamy white mottled with yellow and purple.

Length 56 mm., height 66.6 mm., diameter 57.5 mm. Pearl Islands, Panama.

This fine cockle is distinguished from all others of the region by the coarse, rasplike surface of its ribs. The species is related to *T. emmonsi* (Conrad), a fossil from the Pliocene of the Carolinas and Florida. *T. isocardia* (Linné), a Recent species from the West Indies, has weaker sculpture.

Range—Gulf of California to Ecuador and the Galapagos Islands. Panama: Pearl Islands. Ecuador: Manta, Santa Elena.

Subgenus **PHLOGOCARDIA** Stewart, 1930

Type species by original designation, *Cardium belcheri* Broderip and Sowerby.

Shell like *Trachycardium*, *s.s.*, in shape and sculptured with strong ribs, but the ribs without imbricating scales, instead they have a high, coarsely toothed or frilled cord along their posterior side which may partly overhang the adjacent interspace.

This is a well-marked group of cockles represented by several fine species in the Miocene of Florida and the Caribbean region. The curiously corded frill developed along the posterior side of each rib is often complex and elaborate, and Dall, commenting on this feature, compared it to a twisted ribbon of candy.

Trachycardium (Phlogocardia) belcheri (Broderip and Sowerby) Plate 37, figure 2

Cardium belcheri Broderip and Sowerby, 1829, Zool. Jour., vol. 4, p. 366, pl. 9, fig. 3 Gulf of California.—Sowerby, 1843, Conch. Illust., *Cardium*, p. 3, No. 41 Coast of California and Panama.—Reeve, 1844, Conch. Icon., vol. 2, *Cardium*, pl. 1, fig. 5.

Cardium (Phlogocardia) belcheri Broderip and Sowerby, Hertlein and Strong, 1947, Zoologica, vol. 31, pt. 4, p. 140.—Hertlein and Strong, 1955, Bull. Amer. Mus. Nat. Hist., vol. 107, art. 2, p. 186.

Shell ovate, higher than long, convex, with 24 or 25 strong, triangular ribs. A large specimen recorded by Hertlein and Strong measured approximately 53 mm. in height.

Length 38.1 mm., height 42.3 mm., diameter 36 mm. Panama Bay. (Shrimpers).

Apparently an offshore species and seldom found on the beach. Fossil in the Pliocene of Ecuador.

Range—Gulf of California to Ecuador Panama: Gulf of Chiriqui in 35-40 fathoms; Panama Bay (shrimpers).

Subgenus **DALLOCARDIA** Stewart, 1930

Type species by original designation, *Cardium quadrigenarium* Conrad (= *C. quadragenarium* Conrad).

Like *Trachycardium*, *s.s.*, but the shell usually more rounded, thinner, the ribs smaller, with small scales or nodes along their edge (posterior), nearly lacking from the ribs in the mid-zone and umbones.

Trachycardium (Dallocardia) senticosum (Sowerby) Plate 37, figure 3

Cardium senticosum Sowerby, 1833, Proc. Zool. Soc. London, p. 84.—Sowerby, 1840, Conch. Illust. *Cardium*, p. 3, No. 43, fig. 10.—Reeve, 1844, Conch. Icon., vol. 2, *Cardium*, pl. 16, fig. 82, (in text as *C. rastrum*).

Cardium (Trachycardium) senticosum Sowerby, Maxwell Smith, 1944, Panamic Marine Shells, p. 58, fig. 740.

Cardium (Dallocardia) senticosum Sowerby, Hertlein and Strong, 1947, Zoologica, vol. 31, pt. 4, pp. 147, 148.

Shell subcircular to subovate, with moderately convex valves. The ribs are small and usually number about 35. Imbrication of the ribs is formed by relatively small scales, sometimes partly spinous on the posterior slope and confined mostly to the marginal areas, the middle ribs smooth. Color creamy white, mottled with purple and yellow.

Length 48.2 mm., height 49.6 mm., diameter 36.8 mm. Manta, Ecuador.

A common and widely distributed species differing from *T. consors* by its more rounded, less convex valves, and weaker ribs; the umbonal ribs are usually smooth.

Range—Lower California to northern Peru. Panama: Panama City; Burica Peninsula; Pearl Islands. Colombia: Isla del Gallo. Ecuador: Manta; Santa Elena. Peru: Zorritos; Mancora; Lobitos; Negritos; Paita; Bay of Sechura.

Genus *MEXICARDIA* Stewart, 1930

Type species by original designation, *Cardium procerum* Sowerby.

Shell high or broadly ovate, convex, the dorsal slopes rounded, with high, prominent umbones and nearly central, orthogyrate beaks. Adult sculpture is formed by large, flattened, smooth ribs separated by grooved interspaces; young specimens have sharply triangular ribs bearing small scales. Hinge heavy, with two cardinal teeth in each valve of which the right posterior and the left anterior teeth are large and pointed, the other cardinal teeth small; the lateral teeth are strong and placed equally distant from the middle of the hinge. Posterior margins of the shell deeply serrated by the ends of the ribs. Color of shell beneath the brown periostracum is a dingy white variegated by brown.

*Mexicardla procer*a (Sowerby)

Plate 37, figure 4

Cardium procerum Sowerby, 1833, Proc. Zool. Soc. London, p. 83. Real Llejos.—Sowerby, 1840, Conch. Illust., *Cardium*, p. 5, No. 61, fig. 23.—Reeve, 1844, Conch. Icon., vol. 2, *Cardium*, pl. 10, fig. 51.

Cardium laticostatum Sowerby, 1833, Proc. Zool. Soc. London, p. 85. Xipixapi, Ecuador.—Sowerby, 1840, *op. cit.*, p. 1, fig. 30.

Cardium panamense Sowerby, 1833, Proc. Zool. Soc. London, p. 85. Panama.—Sowerby, 1840, *op. cit.*, p. 5, sp. 62, fig. 21.—Reeve, 1844, *op. cit.*, pl. 11, fig. 56.

Cardium rotundatum Carpenter, 1857, Cat. Mazatlan Shells, Brit Mus., p. 531, No. 687 (young shell).

Cardium dulcinea Dall, 1916, Proc. U. S. Nat. Mus., vol. 52, No. 2182, pp. 412, 413.

Trigonicardia eudoxia Dall, 1916, *op. cit.*, p. 412 (young shell).

Cardium (Mexicardia) procerum Sowerby, Hertlein and Strong, 1947, Zoologica, vol. 31, pt. 4, pp. 142, 143.

Shell often large (height 100 mm. or more), solid, with coarse, convex, ovate valves. Umbones full and prominent, the beaks located nearly midway. Ribs large, numbering from 22 to 25, low, rounded, or flattened between deeply grooved interspaces; ribs in the young shell have a triangular section and bear small scalelike spines. Periostracum coarse, brownish, the color of the shell underneath white mottled or variegated with brown. Posterior margins of the valves deeply serrated by the ends of the ribs.

Length 89 mm., height 99 mm., diameter 82 mm. Bayovar, Peru.

This is a common and widely distributed species ranging from the Gulf of California to northern Chile; the most southerly record is at Bahia de La Independencia (lat. 14° 15' S) in middle Peru. Peruvian specimens are as

a rule larger than those from more northerly stations. The shell varies considerably in shape and in numbers of its ribs and it is possible that several subspecies or geographic races should be recognized. This cockle is gathered by the Peruvian fisherman both for bait and food. As a fossil, it is found in the Pliocene of Ecuador and in the Pleistocene of Panama and Lower California.

Range—Gulf of California southward to Chile. Panama: Pearl Islands. Ecuador: Santa Elena; Manta; Esmeraldas. Peru: Tumbes; Zorritos; Mancora; Negritos; Paita; Sechura; Lobos de Tierra; Bahía de la Independencia.

Genus **ACROSTERIGMA** Dall, 1900

Type species by original designation, *Cardium dalli* Heilprin. Pliocene of Florida.

Shell of medium or large size, elongate ovate, slightly oblique, the height greater than the length. Umbones rather narrow, low, with small beaks. Ribs round or flat, close-set, their interspaces an incised line or groove only, except posteriorly where they are wider. The surface of the ribs are smooth except the anterior ones which are nodosely wrinkled or fringed with scales on the sides. Hinge with the anterior lateral tooth strong and distant, the posterior one small and sometimes obsolete. The type species has an internal rib in the middle of the umbonal cavity; it is lacking in *A. pristipleura* Dall.

Acrosterigma pristipleura (Dall)

Plate 37, figure 7

Cardium maculosum Sowerby, 1833, Proc. Zool. Soc. London, p. 85. (Not *Cardium maculosum* Wood, 1815).

Cardium maculatum Sowerby, 1840, Conch. Illust., *Cardium*, p. 4, No. 56, fig. 18. (Altered from *maculosum*, preoccupied).—Reeve, 1844, Conch. Icon., vol. 2, *Cardium*, pl. 11, fig. 58. (Not *C. maculatum* Gmelin).

Cardium (*Trachycardium*) *pristipleura* Dall, 1901, Proc. U. S. Nat. Museum, vol. 23, p. 389. (New name for *C. maculatum* Sowerby, not Gmelin).

Cardium (*Trachycardium*) *hornelli* Tomlin, 1928, Jour. Conch., vol. 18, No. 7, p. 194. (Name proposed to replace *C. maculatum* Sowerby, preoccupied).

Cardium (*Acrosterigma*) *pristipleura* Dall, Hertlein and Strong, 1947, Zoologica, vol. 31, pt. 4, p. 147.

Valves are gently convex with the umbones narrowing gradually towards the small beaks. Ribs number about 35; these are flattened and spaced so close together that their flattened summits seem to slightly overhang the deeply incised interspaces between them. Surface of ribs smooth, except the anterior set which are finely wrinkled and nodose. External color yellowish white, flushed with purple, red or brown.

Length 55.4 mm., height 71.5 mm., diameter 40.8 mm. Manta, Ecuador.

This species is related to *C. dalli* Heilprin from the Pliocene of Florida, but is smaller and lacks the internal subumbonal rib.

Range—Gulf of California to Ecuador. Panama: Burica Peninsula. Colombia: Gorgona Island (Tomlin). Ecuador: Manta; Isla la Plata.

Genus **PAPYRIDEA** Swainson, 1840

Type species by subsequent designation, Gray, 1847, *Cardium soleni-forme* Bruguière, (*Cardium hiatus* Meuschen, 1787).

Shell broadly subelliptical, the valves slightly flexed, gaping at both ends, with the umbones and beaks anterior of the middle, the posterior side hence longer than the anterior and with the dorsal and ventral margins nearly parallel. Hinge has a single large cardinal tooth in each valve, the second cardinal tooth small or subobsolete, the lateral teeth strong and equidistant. Ligament external, placed on the dorsal edge of a large, nymphal plate. Sculpture composed of numerous, flattened or triangular ribs which are larger and coarser on the posterior side. Posterior margin of valves deeply serrated by the ends of the ribs.

Papyridea crockeri (Strong and Hertlein)

Plate 38, figures 5-5b

Cardium (Papyridea) crockeri Strong and Hertlein, 1937, Proc. California Acad. Sci., ser. 4, vol. 22, No. 6, pp. 161, 162, pl. 34, figs. 1, 2, 7, 10.

Shell ovate, a little longer than high, beaks nearly central; posterior gap distinct; anterior-dorsal margin with a narrow depressed area; sculptured with 48 low, flattened, radiating ribs with much narrower interspaces, strongest at the posterior end, becoming narrower toward the anterior; of these ribs 12 on the posterior end and 18 on the anterior end are imbricated by small, pointed folds, more or less worn off towards the beaks, central ribs smooth; exterior yellowish white with short patches of red arranged in irregular concentric zones on the ribs; interior white stained with reddish toward the beak on the anterior side; margins crenulated; ligament external, strong; hinge with one cardinal and two laterals in each valve. The type measures: length, 46.8 mm., height, 41 mm., thickness of the two valves, 29 mm.

This species differs from *Cardium (Papyridea) aspersum* Sowerby in possessing a more convex shell, which has a more rounded outline and it is ornamented by brighter colors. The anterior plate on the hinge, which bears a groove and lateral tooth, is longer than the corresponding plate in *P. aspersum*.

Off Cabo Tosco, Santa Margarita Island, Lower California, Mexico. (Strong and Hertlein, 1937.)

Papyridea soleniformis aspersa (Sowerby)

Plate 37, figure 8;

Plate 38, figures 6-6b; Plate 86, figure 7

Cardium aspersum Sowerby, 1833, Proc. Zool. Soc. London, p. 85. Hab. ad Sanctam Elenam et ad Monten Christe.—Sowerby, 1834, Conch. Illust., *Cardium*, pl. 48, fig. 15.

Cardium (Papyridea) aspersum Sowerby, Hertlein and Strong, 1947, Zoologica, vol. 31, pt. 4, p. 139.

Cardium (Papyridea) spinosum var. *aspersum* Sowerby, Dall, 1900, Trans. Wagner Free Institute of Sciences, vol. 3, pt. 5, p. 1108.

Shell broadly subovate, the low umbones and beaks anterior of the middle, the posterior side somewhat longer and narrower, the two ends subequal, slightly but evenly convex, the umbonal slope not noticeably vaulted. Texture of shell relatively thin. Riblets numerous, smooth and low, rounded or flattened in the middle zone and on the umbones and separated by narrow, threaded interspaces; the anterior riblets heavier and slightly noded; the posterior ones wider and scaly. Surface mottled with violet red or reddish brown, heaviest on the umbones.

Length 44 mm., height 34 mm., diameter 21.7 mm. Venado Beach, Canal Zone.

The Pacific shell is closely related to *P. soleniformis* Bruguière (*P. hiatus* Meuschen, nonbinomial) from the Caribbean, the two forms at times indistinguishable.

Range—Lower California to Ecuador. Panama Canal Zone: Venado Beach. Ecuador: Manta; Santa Elena.

Papyridea mantaensis, new species

Plate 37, figures 5, 5a;
Plate 38, figure 7

Shell often large (length 64 mm.), elongate quadrate, subsolid and strongly vaulted along the posterior-umbonal slope, depressed across the anterior-middle zone. The beaks and umbones are decidedly anterior in position, the posterior side hence much the longer, higher and wider. The riblets are rather coarse (about 36 in number), unequal, trigonal in section, their anterior side wider, the spaces between them grooved or narrowly flattened. The riblets on the posterior-dorsal slope are largest, and often coarsely squamose, and their ends cut the margins in deep serrations. Color generally white mottled on the umbonal slope with pale red or violet spots. The periostracum is a thin, ash-colored skin. Tip of beaks white or stained with amber.

Length 40.5 mm., height 29.5 mm., diameter 8.7 mm. (a left valve). Manta, Ecuador. Holotype, ANSP 218895; paratype, ANSP 218896.

This form although quite variable in its shape appears to be fully distinct from *P. soleniformis aspersa* differing by its much heavier shell which is usually strongly vaulted along the umbonal slope as well as by its much stronger, elevated riblets. The surface color is generally a creamy white, faintly mottled with small spots except the tip of the beaks which may be more deeply colored.

Range—Panama to northern Peru. Panama: Búcaro. Ecuador: Manta; Santa Elena. Peru: Zorritos; Mancora.

Subfamily FRAGINAE

Genus TRIGONICARDIA Dall, 1900

Type species by original designation, *Cardium graniferum* Broderip and Sowerby.

Shell small or of medium size, heavy, obliquely trigonal or squarely cordate to rounded, with high umbones set off by a sharp, posterior angulation. Posterior side more or less smoothly flattened or mesially sulcated. Anterior side rounded. Sculpture formed by strong ribs, their tops smooth, beaded or covered by a deciduous layer formed of coarse, imbricated scales which is destroyed by slight wear. Spaces between the ribs often strongly cross-threaded or pitted. Hinge with the lateral teeth spaced equidistant from the cardinals or with the anterior lateral tooth closer.

The genus may be divided into three subgenera as follows.

- I. Shells with the beaks and umbones subcentral. Posterior slope subtruncated, depressed, sometimes with a strong medial sulcation which deeply emarginates the margin. Lateral teeth equidistant from the cardinals.

A. Shells small or of medium size. Without a deciduous outer layer covering the summit of the ribs which are, therefore, smooth, beaded or with scattered nodes. Intervals between the ribs coarsely pitted or cross-threaded. Contour of shell generally rounded.

Trigoniocardia, s.s.

B. Shells of medium-size, high, quadrate in form. Ribs strong, rectangular in section, their interspaces narrow. Summit of ribs covered by a deciduous layer of closely imbricated scales, easily destroyed by wear. Intervals between the ribs with fine cross threads.

Subgenus *Americardia*

II. Shells obliquely ovate, the umbones and beaks inclined towards the anterior side. Posterior side truncate, its surface flat or slightly convex, no medial sulcation. Anterior lateral teeth crowded against the cardinals.

Subgenus *Apiocardia*

Subgenus **TRIGONIOCARDIA** s.s.

Shell rounded or subovate in shape, the posterior side short and narrow, flat or deeply impressed, its margin as if sharply truncated. The ribs are low, round-topped or high and narrow, their intervals marked with coarse cross threads or deeply pitted. Surface of ribs may be smooth, beaded or noded. Periostracum lacking.

Two species are regional, *T. biangulata* has generally been referred to *Americardia* but its shape is like that of *T. granifera* and the ribs are not covered by a layer of imbricated scales.

A. Shell of medium size, height 30 mm. Ribs low, rounded, close-set, smooth or somewhat granose on the anterior side. Interior of shell generally colored a purple-red.

T. biangulata

B. Shell small, height about 15 mm. Ribs high, narrow, between widely grooved interspaces, smooth or finely beaded. Interior of shell white.

T. granifera

Trigoniocardia (Trigoniocardia) biangulata (Broderip and Sowerby)

Plate 37, figures 6, 6a

Cardium biangulatum Broderip and Sowerby, 1829, Zool. Jour., vol. 4, p. 367.—Sowerby, 1840, Conch. Illust. *Cardium*, p. 7, No. 82, fig. 2.—Reeve, 1844, Conch. Icon., vol. 2, *Cardium*, pl. 6, fig. 29.

Cardium (Fragum) biangulatum Broderip and Sowerby, Maxwell Smith, Panamic Marine Shells, p. 58, fig. 747.

Cardium (Americardia) biangulatum Broderip and Sowerby, Hertlein and Strong, 1947, Zoologica, vol. 31, pt. 4, p. 140.

Shell of medium size, with prominent, convex umbones and well rounded anterior side. Ribs low, rounded, close-set, the narrow interspaces closely and regularly cross-threaded. Interior colored with pink or mahogany red.

Length 31.6 mm., height 29.3 mm., diameter 23 mm. Pearl Islands, Panama.

Range—Gulf of California to Ecuador. Panama: Pearl Islands. Ecuador: Manta; Santa Elena.

Trigoniocardia (Trigoniocardia) granifera (Broderip and Sowerby)

Plate 38, figure 3

Cardium graniferum Broderip and Sowerby, 1829, Zool. Jour., vol. 4, p. 367.—Sowerby,

1834, Conch. Illust., *Cardium*, p. 3, No. 38, fig. 17.—Reeve, 1844, Conch. Icon., vol. 2, *Cardium*, pl. 8, fig. 43.

Cardium (Trigoniocardia) graniferum Broderip and Sowerby, Hertlein and Strong, 1947, *Zoologica*, vol. 31, pt. 4, p. 143.—Hertlein and Strong, 1955, *Bull. Amer. Mus. Nat. Hist.*, New York, vol. 107, art. 2, p. 186.

Shell relatively small, 15 mm. or less high. Ribs number about 20 of which those on the middle are high, narrow, triangular in section and separated by wide, deep, strongly cross-threaded intervals; the ribs on the posterior slope usually number about 11, are smaller and close-set. Summit of the ribs smooth or with scattered nodes.

Length 14.6 mm., height 15 mm., diameter 12 mm. Esmeraldas, Ecuador.

Range—Gulf of California to northern Peru. Panama: Panama City; San Carlos. Ecuador: Manta; Esmeraldas; Santa Elena. Peru: Zornitos.

Subgenus AMERICARDIA Stewart, 1930

Type species by original designation, *Cardium medium* Linné. Recent, West Atlantic.

Shell solid, quadrate in shape, with high, wide umbones, the posterior side flattened, the umbonal angle high and sharp, the posterior margin truncated. Ribs are flat-topped, rectangular in section, the interspaces between them narrow and deep. Ribs covered by a periostracal layer of coarse, imbricated scales, easily worn off. Interspaces are finely cross-threaded.

Trigoniocardia (Americardia) guanacastense (Hertlein and Strong)

Plate 37, figures 9, 9a

Cardium planicostatum Sowerby, 1833, *Proc. Zool. Soc. London*, p. 83. (Not *Cardium planicostatum* Sedgwick and Murchison, 1829).—Sowerby, 1840, *Conch. Illust. Cardium*, p. 7, No. 83, fig. 25.—Reeve, 1844, *Conch. Icon.*, vol. 2, *Cardium*, pl. 6, fig. 31.

Cardium (Americardia) guanacastense Hertlein and Strong, 1947, *Zoologica*, vol. 31, Pt. 4, pp. 140, 141.

The reason for the renaming of this species is discussed by Hertlein and Strong. Sowerby's type of *C. planicostatum* must remain the type of *T. guanacastense*.

The shell is often large (to about 50 mm.), solid. Ribs generally about 30 and when fresh, the surface is covered with close-set, concentric imbrication which scale off easily after a slight amount of beach wear. The interior of the shell is white.

Length 34.7 mm., height 43.2 mm., diameter 34.6 mm. San Pedro near Manglaralto, Ecuador.

Range—Gulf of California to northern Peru. Panama: Pearl Islands. Ecuador: Sua; Charapota; Manta; Isla la Plata; Manglaralto; Santa Elena; Punta Mambri. Peru: Mancora.

Subgenus APIOCARDIA, new subgenus

Type species *Cardium obovale* Sowerby.

Shell elongately subovate, the umbonal axis strongly inclined so that the umbones and beaks are distinctly anterior in position. Posterior side

truncate, flattened or slightly convex but the posterior margin is straight, nonemarginate. Ribs strong, usually smooth, flattened on top, sometimes with scattered nodes, the interspaces coarsely cross-threaded. Hinge with the anterior lateral teeth crowded against the cardinals.

Trigoniocardia (Aplocardia) obovale (Sowerby) Plate 38, figure 4

Cardium obovale Sowerby, 1833, Proc. Zool. Soc. London, p. 84.—Sowerby, (1840?) Conch. Illust. *Cardium*, p. 7, No. 90, fig. 4.—Reeve, 1845, Conch. Icon., vol. 2, *Cardium*, pl. 21, fig. 117.

Cardium ovuloides Reeve, 1845, Conch. Icon., vol. 2, *Cardium*, pl. 22, fig. 126.

Trigoniocardia obovale (Sowerby), Maxwell Smith, 1944, Panamic Marine Shells, p. 59, fig. 736.

Cardium (Trigoniocardia) obovale Sowerby, Hertlein and Strong, 1947, Zoologica, vol. 31, pt. 4, p. 144.—Hertlein and Strong, 1955, Bull. Amer. Mus. Nat. Hist., New York, vol. 107, art. 2, p. 187.

The shell is usually small, less than 23 mm. in height. Ribs number between 20 or 21, largest along the umbonal slope and just in front of it. The ribs are obliquely flattened, their detailed sculpture varying considerably. In beach specimens, the ribs are smooth because of wear, but in well-preserved shells, the surface is strongly sculptured, the corners of the ribs and the interspaces being etched with deep, incised lines and cross threads. To such a strongly sculptured specimen, Reeve gave the name *ovuloides*.

Length 15 mm., height 16 mm., diameter 15.6 mm. Zorritos, Peru.

This is a common and widely distributed species. Several related forms occur as fossil, the largest and finest being the *T. cabopasada* (Pilsbry and Olsson) from the Pliocene of Ecuador which attained a height of 38 mm., the summit of the ribs of which are coarsely noded.

Range—Gulf of California to northern Peru. Panama: Panama City; San Carlos; Búcaro; Guanico. Ecuador: Esmeraldas; Galeras; Manta; Puerto Gallo; Santa Elena. Peru: Tumbes; Zorritos; Mancora.

Subfamily **PROTOCARDIINAE**

Genus **MICROCARDIUM** Thiele, 1934

Type species by subsequent designation, Keen, 1937, *Cardium (Fulvia) peramabile* Dall. Recent, Florida and the Caribbean.

Shell generally small, thin and delicate, subcircular to subovate, with large, convex, subcentral umbones. Sculpture is formed by numerous, small riblets, their interspaces cross-threaded, enclosing deep pits between them, the posterior set of riblets set apart from the others by their smaller size and by their more finely cross-threaded intervals, some of which carry small granules or spinules, easily broken off. The hinge is normal to the family. Most plentiful in moderately deep waters.

There are two species regional.

- I. Shell rounded to subovate, the posterior side narrow and sharply truncated at the margin. Posterior set of granules are small.

M. panamensis

- II. Shell subelongate, the posterior side longer and narrower. Riblets numerous, the posterior set of granules fairly coarse.

M. pazianum

Microcardium panamensis (Dall)

Plate 39, figure 4

Protocardium panamensis Dall, 1908, Bull. Mus. Comp. Zoology, vol. 43, No. 6, p. 415, pl. 18, fig. 1.—Maxwell Smith, 1944, Panamic Marine Shells, p. 58, fig. 742.

Shell small, (the adult type 13.5 mm. long), thin and delicate, convex, subovate to subquadrate, the posterior side straighter, the prominent umbones subcentral. Umbonal slope rounded. Ribs numerous, on an average specimen numbering from 26 to 33 on the anterior and middle surfaces and 21 to 23 on the posterior; each set fading out laterally. The anterior and middle set have smooth-topped or slightly noded ribs, their interspaces coarsely cross-threaded so as to form deep pits; the posterior ribs are narrower than their interspaces which are more finely cross-threaded; each 4th or 5th and 9th or 10th ribs on the posterior slope bears small spinules, the others are generally without.

Length 13.5 mm., height 13.5 mm., diameter 9 mm. Gulf of Panama (Dall).

Range—Panama. Panama. Gulf of Panama in 182 fathoms (Albatross Exp.).

Microcardium pazianum (Dall)

Plate 39, figure 3

Protocardia paziana Dall, 1916, Proc. U. S. Nat. Museum, vol. 52, No. 2183, p. 412 off La Paz, Gulf of California, in 10 fm.

Cardium (*Microcardium*) *pazianum* (Dall), Hertlein and Strong, 1947, Zoologica, vol. 31, pt. 4, p. 142, pl. 1, figs. 9, 12, 15, and 16.

Shell small (length to about 15 mm., but usually much smaller), thin, rounded, the posterior side noticeably produced and narrower, the anterior side convex. The anterior and middle surface have numerous, (to about 40) minutely nodulous riblets, each giving the effect of a string of beads; on the posterior slope the riblets number about 22, are larger and when intact, each second or third interspace bears a row of large, coarse granules.

Length 10 mm., height 8.6 mm., diameter 6 mm. Off La Paz, Gulf of California. (Dall).

Resembles *M. panamensis* but is usually smaller, its riblets on the anterior side are more numerous and more coarsely concentrically nodulous while on the posterior slope, the sculpture is more strongly spinose or granulose. The species is likewise distinguished in that the posterior side is noticeably narrowed and produced, its characteristic sculpture covering a larger surface.

This appears to be a commoner, more widely distributed, and a shallower-water species than *M. panamensis*. Numerous records of its occurrence from the Gulf of California to Panama are given by Hertlein and Strong.

Range—Gulf of California southward to Ecuador. Northern records see Hertlein and Strong. Ecuador: Esmeraldas in about 10 to 30 fathoms.

Genus **LOPHOCARDIUM** Fischer, 1887

Type species by monotypy, *Cardium cumingü* Broderip.

Shell elongately ovate, longer than high, thin, convex, with full, submedian umbones. The posterior side is lower, slightly gaping at the end, the posterior area separated sharply from the rest of disk by a fringe or elevated

lamina extending from the beak to the ventral margin. The anterior side is strongly convex, its surface smooth or reticulated with small radial and concentric lines or riblets. The hinge formation is weak; the right valve has two, small, pointed cardinal teeth, the left valve one; there are no lateral teeth. External color white, pink or a rose-red.

There are two species in the Panamic-Pacific region. As fossil, *Lophocardium* is represented in the Caribbean Miocene with species known from Costa Rica, Colombia, and the Dominican Republic.

Lophocardium cumingii (Broderip)

Plate 39, figures 1, 1a

Cardium cumingii Broderip, 1833, Proc. Zool. Soc. London, p. 82.—Sowerby, 1840, Conch. Illust. *Cardium*, p. 1, No. 11, fig. 5.—Reeve, 1844, Conch. Icon., vol. 2, *Cardium*, pl. 12, fig. 59.

Cardium (Laevicardium) cumingii Sowerby, Strong, Hanna and Hertlein, 1933, Proc. California Acad. Sci., ser. 4, vol. 21, p. 113 Acapulco.

Protocardium (Lophocardium) cumingii Sowerby, Maxwell Smith, 1944, Panamic Marine Shells, p. 58, fig. 738.

Cardium (Lophocardium) cumingii Broderip, Hertlein and Strong, 1955, Bull. Amer. Mus. Nat. Hist., vol. 107, art. 2, pp. 185, 186, pl. 2, figs. 3, 4, 7, 8.

The shell is thin and fragile, broadly subovate and strongly convex or inflated across the anterior-middle zone with high, full umbones ending in small beaks inrolled against the hinge. The posterior side is shorter, strongly contracted and with an open gap at the end. The anterior and middle surface of the shell appears smoothish but on closer inspection, it is seen to be covered with numerous, close-set, radial riblets, uniformly spaced between wider interspaces and weakly reticulated by irregular, threadlike concentrics; the posterior surface is sculptured only with crowded growth threads. The posterior-umbonal lamina is formed of elongated, hollow cells of periostracum which stands erect in the living shell but when dead generally lies flattened appressed against its surface. The cardinal teeth are small but fully formed; there are no lateral teeth but a small lamina lies under the posterior margin of the right valve forming a groove which serves as a sort of a socket for the lodgement of the margin of the opposite valve. The color of the shell is usually pink or coral-red in various shades, the thin periostracum generally inconspicuous, but where massed together as on the posterior end, it is light straw-colored. A specimen measures as follows: Length 34.1 mm., height 26.6 mm., diameter 21.6 mm.

Formerly a rare species in most collections, but now often obtained by shrimpers fishing along the coast of Panama.

Range—Coast of Mexico to Panama and Colombia.

Lophocardium annettae (Dall)

Plate 39, figures 2-2b

Cardium (Lophocardium) annettae Dall, 1899, Nautilus, vol. 3, No. 2, p. 13 Lower California near Cerros Island.—Dall, 1890, Proc. U. S. Nat. Museum, vol. 12, p. 264, pl. 10, fig. 4.—Hertlein and Strong, 1947, Zoologica, vol. 13, pt. 4, p. 138, pl. 1, figs. 3, 8, 13.

Shell thin, fragile, inflated, subovate, longer than high, gaping prominently posteriorly. The color is usually a salmon or rose-red, sometimes quite pale, heaviest over the posterior area, the surface covered by a paper-thin periostracum. The surface sculpture is formed by numerous, small, flat

riblets between wider interspaces, the whole finely reticulated by concentrics, the radials generally weak on the anterior part of the shell and can be observed only by magnification. The posterior area is sculptured by well-developed radials crossed by a few, widely spaced concentric laminae. A large specimen measured by Hertlein and Strong measures: length 46.8 mm., height 38.7 mm.

L. annettae appears to be a more northerly species differing from *L. cumingii* by its paler color, higher, broader shell, and shorter posterior side which is also more strongly sculptured.

Range—Mexico to Costa Rica.

Subfamily LAEVICARDIINAE

Genus LAEVICARDIUM Swainson, 1840

Type species by subsequent designation, Stoliczka, 1871, *Cardium oblongum* Gmelin.

Shell ovate to obliquely subovate, convex, equivalve, with wide umbones and small, adjacent beaks, moderately thin. Surface often smooth and polished, sometimes with numerous, low, obvious to indistinct, radial riblets, due mainly to a radial structural characteristic of the inner layer and showing more plainly as sharp serrations or crenulations along the ventral margin. Dorsal areas well marked, differentiated principally by their plain surface, without radial riblets and simple, uncrenulated margins. Hinge with a single large cardinal tooth and socket in each valve, the right valve with a small anterior cardinal immediately above the deep cardinal socket; lateral teeth and sockets are equidistant and strong in each valve. Ligament external, seated above and behind a flat nymphal plate. Color white or yellow, often rayed and mottled. Periostracum thin, deciduous.

Laevicardium (Laevicardium) elenense (Sowerby) Plate 38, figures 2, 2a

Cardium elenense Sowerby 1840, Conch. Illust., *Cardium*, p. 6, No. 73, fig. 58.—Sowerby, 1841, Proc. Zool. Soc. London for 1840, p. 109.—Reeve, 1845, Conch. Icon., vol. 2, *Cardium*, pl. 20, fig. 104.

Cardium (Laevicardium) elenense Sowerby, Hertlein and Strong, 1947, Zoologica, vol. 31, No. 4, pp. 145, 146.—Hertlein and Strong, 1955, Bull. Amer. Mus. Nat. Hist., vol. 107, art. 2, p. 187.

The shell is generally small (less than 20 mm., high), obliquely subovate, the posterior-dorsal slope narrowly flattened, its margin straight. Surface smooth, polished, but weakly rayed. Color white but more often mottled with brown or purple, sometimes in irregular streaks or in wavy bands, the interior usually brown. Narrow concentric bands are often present on the umbones. Strength of the radial ribbing is variable.

Length 15 mm., height 15.3 mm., diameter 9.6 mm. Esmeraldas, Ecuador.

Range—Gulf of California to northern Peru. Panama: Pearl Islands. Ecuador: Santa Elena; Manta; Esmeraldas. Peru: Zorritos; Mancora.

Laevicardium (Laevicardium) elenense apicinum Carpenter

Laevicardium apicinum Carpenter, 1864, Annals Mag. Nat. Hist., ser. 3, vol. 13, p. 313. *Cardium (Laevicardium) elenense apicinum* (Carpenter), Hertlein and Strong, 1947, Zoologica, vol. 31, pt. 4, p. 146.

Distinguished from typical *L. elenense* by its wider shell and less flattened dorsal-posterior area. This form constitutes a doubtful subspecies. It occurs constantly with the typical form with which it appears to intergrade.

I have specimens from the Pearl Islands and from Manta.

Laevicardium clarionense (Hertlein and Strong)

Plate 39, figures 5, 5a

Cardium (*Laevicardium*) *clarionense* Hertlein and Strong, 1947, *Zoologica*, vol. 31, pt. 4, pp. 144, 145, pl. 1, figs. 5, 6, 7, 14.

Shell very obliquely ovate, rather compressed, pointed at the beaks, very slightly gaping at the sides; smooth over most of the surface but with fine radial sculpture along the basal margin and at the edges of the resting stages, internally with the basal and lower half of the anterior margin finely serrated; there is also a narrow posterior area defined by a slight angle exteriorly but scarcely visible internally; exterior light yellowish, variously maculated and spotted with brown, internally with a large yellow patch extending from the beaks to the middle of the shell, a broad white band along the margins; lateral teeth strong, cardinal teeth small, two in the left valve, one in the right. The type measures: maximum vertical diameter, 31.4 mm., maximum longitudinal diameter, 23.9 mm., convexity (both valves), 16.5 mm. (Hertlein and Strong, 1947.)

This species resembles *L. elenense* (Sowerby) by its external coloration but is larger, narrower, and higher. According to Hertlein and Strong, the largest specimen seen by them has a maximum height of 41 mm. A single specimen collected by Mr. Stewart Jadis of the Panama Canal Zone, was found at Palo Seco. This specimen measures: length 18 mm., height 20 mm., diameter of closed valves 13.2 mm.

Range—Gulf of California to Panama. Mexico: Santa Inez Bay; Gulf of California; Clarion Island; Revillagigedo group, (all Hertlein and Strong). Canal Zone: Palo Seco.

Laevicardium elatum (Sowerby)

Plate 38, figures 1-1b

Cardium elatum Sowerby, 1833, *Proc. Zool. Soc. London*, p. 84 Guaymas.—Sowerby, 1834, *Conch. Illust.*, pl. 46, fig. 3.—Reeve, 1844, *Conch. Icon.*, vol. 2, *Cardium*, pl. 8, fig. 41

Cardium (*Laevicardium*) *elatum* Sowerby, Hertlein and Strong, 1947, *Zoologica*, vol. 31, pt. 4, p. 145.

Shell often large, oval, somewhat oblique, and convex. Surface smooth and with numerous, shallow radial riblets, or grooves. Color white or yellow covered with a thin brownish periostracum. Margins serrated and interlocking.

This is the largest species of *Cardium* known, sometimes reaching a height of five inches or more. A species of the Gulf of California; records as far south as Panama are doubtful.

Range—Gulf of California.

Superfamily VENERACEA Menke, 1830

Family VENERIDAE Menke, 1830

Marine clamlike pelecypods, the shell usually ovate-cordate to sub-triangular in shape, the valves similar in form and sculpture, porcellaneous, the umbones generally prominent, ending in small, coiled or prosogyrate

beaks, anterior in position, the posterior side usually the longer. The hinge is always well developed with radial cardinal teeth under the beaks, usually three in each valve, simple or bifid; in *Mercenaria*, there is a coarsely rugose, supplementary, posterior cardinal tooth in each valve, the asperities of which form the interlocking surface; in *Tivela*, the cardinal teeth are multiple or divided into smaller units. A heart-shaped lunule and an escutcheon are generally present or one or both may be wanting. The ligament is always external, situated behind the beaks, the resilium portion attached to a large scar above or along the upper face of a nymphal ridge. The pallial sinus is always present, sometimes quite small as in *Chione*, s.s. Surface smooth and plain or marked with a strong sculpture of radial ribs and concentric folds or lamellae, often a combination of both. Color of surface varies from drab white to highly tinted, often with complicated markings. Periostracum thin or coarse.

The Veneridae is an important family of mollusks in the Panamic-Pacific region with many genera and species, some of great beauty both in coloration and sculpture. Dall characterized this family as being the most beautiful, genetically the most highly evolved, as well as most prolific in species of all bivalves in the Recent fauna. Several species are much sought for as important items of sea food. Several classifications of the Veneridae have been proposed; in this work, the family is divided into six groups or subfamilies as follows:

Panamic-Pacific subfamilies of the Veneridae

- I. Shell *subcircular* to *suborbicular*, slightly to strongly convex, the surface marked with *concentric sculpture only*, the color *white*. Hinge plate relatively long and high, bearing three cardinal teeth in each valve of which one or more may be double or bifid. The anterior lateral tooth if present (as in *Dosinia*) is small and is placed close to the cardinal tooth. Ligament scar large and occupies much of the hinge plate. Ventral margins smooth.

Subfamily Dosiniinae

- II. Shell *circular* to *orbicular*, *thin*, *convex* and sculptured with large, *deep*, *concentric undulations* which are so strongly impressed that they show well in the interior. Ventral margins are smooth.

Subfamily Clementiinae

- III. Shell with nearly *equal sides* and *submedian beaks*. Hinge with a *large*, *anterior lateral tooth* in the left valve and placed apart from the cardinals, its complementary socket in the right valve. The cardinal teeth are normally three in each valve, but in *Tivela* some of them are divided or supplemented by auxiliaries. Ventral margins smooth. Surface usually highly colored.

Subfamily Meretriciinae

- IV. *Beaks strongly anterior* in position. Hinge with three cardinal teeth in each valve, no auxiliaries, and a *large*, *anterior lateral tooth* in the left valve and its socket in the right. Surface *smooth* or *marked with concentrics*. *Ventral margins smooth*.

Subfamily Pitarinae

- V. Shell subcordate to subtrigonal, generally solid. Hinge plate stout, usually bearing *three cardinal teeth* in each valve, sometimes supplemented by a small or rudimentary, anterior lateral tooth. A lunule and

an escutcheon is usually well developed although wanting in some cases. The surface is seldom completely smooth, more often *heavily sculptured* with concentric lamellae, radial ribs or both. *Ventral margins crenulated.*

Subfamily Venerinae

- VI. Shell usually *small, smooth* or with *concentric sculpture, color often purple.* The species are ovoviviparous and carry the young within the perivisceral cavity for a considerable time. This subfamily includes several small venerids referred to the genera, *Gemma, Parastarte,* and *Psephidia.* Species locally common.

Subfamily Gemminae

Subfamily DOSINIINAE H. and A. Adams, 1858

Shell orbicular, equivalve, slightly or strongly convex, white and concentrically sculptured. Hinge plate wide, bearing three cardinal teeth in each valve, and in some groups, a small anterior lateral tooth is present in the left valve. Pallial sinus large, the ventral margins smooth.

Two genera are present in the Panamic-Pacific region.

- I. The left valve has a small anterior lateral tooth and a corresponding socket or pit in the right valve. Sculpture produced by rather strong, ribbon-like, concentric bands. Lunule deeply impressed.

Genus *Dosinia*

- II. No lateral teeth. The surface sculpture is finer, produced by closely spaced, threadlike, concentric growth lines. The lunule is weakly defined, not impressed.

Genus *Cyclinella*

Genus DOSINIA Scopoli, 1777

Type species by tautonymy and monotypy, *Chama dosina* Adanson (= *Dosinia africana* Hanley).

Shell subcircular to suborbicular, depressed or convex, white, the surface finely sculptured with incised concentric lines, evenly spaced and forming ribbon-like bands, narrow or quite wide. Lunule small and deeply depressed; the escutcheon absent in American species. The hinge plate high, mostly posterior of the cardinal teeth with a wide scar above for the ligament attachment, usually deeply inset and overhung by the margin of the shell. Hinge with three cardinal teeth in each valve, the left middle tooth and the right, posterior tooth large and bifid. There is a small, anterior lateral tooth in the left valve but merely a small socket or pit for its reception in the right valve. The adductor scars are large and subequal in size, connected across by the pallial line bearing a deep, V-shaped sinus. The ventral margins are smooth. Periostracum thin, gray, or straw-colored.

Subgenus DOSINIDIA Dall, 1902

Type species by original designation, *Dosinia concentrica* Born. Recent, West Indies, and the eastern seaboard of the United States northward to Hatteras.

No escutcheon. Members of this subgenus are confined to the warm temperate and tropical waters of America where it replaces all other sections of the genus.

Key to the species of *Dosinia* in the Panamic-Pacific region

- I. Shell of medium or large size (length 75 mm. or more), suborbicular, subsolid, the sculpture formed by rather large, wide, concentric ribbons, usually weaker or subobsolete across the middle of the disk.
D. ponderosa
- II. Shell smaller (generally less than 50 mm. in length).
1. Pallial sinus relatively short, hardly extending to the middle of the shell cavity. Sculpture usually smooth across the middle of the disk. Uncommon.
D. annae
2. Pallial sinus longer, extending past the middle of the shell cavity. Concentric sculpture fairly strong and uniform over the whole disk.
D. dunkeri

Dosinia (*Dosinidia*) *ponderosa* (Gray) Plate 40, figure 5;
Plate 42, figures 1-1c; Plate 43, figure 1

Artemis ponderosa Gray, 1838, *Analyst*, vol. 1, p. 309.

Cytherea (*Artemis*) *gigantaea* Sowerby, Philippi, 1847, *Abbild. und Beschreib. Conchylien*, bd. 2, *Cytherea*, p. 231, *Cytherea* taf. 7, figs. 1a, b, c.

Artemis ponderosa Gray, Reeve, 1850, *Conch. Icon.*, vol. 6, *Artemis*, pl. 1, fig. 4 "Gulf of California".—Sowerby, 1852, *Thes. Conch.*, vol. 2, *Artemis*, p. 656, No. 3, pl. 140, fig. 2.

Dosinia ponderosa (Gray), Römer, 1862, *Mon. Molluskengattung Dosinia*, Scopoli, p. 12, No. 6.—Dall, 1909, *Proc. U.S. Nat. Museum*, vol. 37, No. 1704, p. 265.

Dosinia (*Dosinidia*) *ponderosa* (Gray), Hertlein and Strong, 1948, *Zoologica*, vol. 33, pt. 4, p. 165.—Hertlein and Strong, 1955, *Bull. Amer. Mus. Nat. Hist.*, vol. 107, art. 2, pp. 188, 189.

SOME FOSSIL RECORDS

Artemis ponderosa Gray, Darwin, 1844, *Geol. Obser.* ed. 1; 1891, same, 3d ed., pp. 403, 405 Coquimbo, Chile.—Philippi, 1837, *Die Tert. u. Quart. Versteinerungen Chiles*, p. 113, pl. 14, fig. 5 (Coquimbo, the figure is taken from a Recent specimen).

Dosinia grandis Nelson, 1870, *Trans. Connecticut Acad. Sciences*, vol. 2, p. 201 Peru.

Dosinia (*Dosinidia*) *grandis* Nelson, Spieker, 1922, *Johns Hopkins Studies in Geology*, No. 3, pp. 138-140, pl. 8, fig. 4 Peru.—Palmer, 1927, *Paleont. Amer.*, vol. 1, p. 275, pl. 17, fig. 12; pl. 19, fig. 8; pl. 20, fig. 14; pl. 45, figs. 1-4.—Olsson, 1932, *Bull. Amer. Paleont.*, vol. 19, pp. 105, 106.

Dosinia (*Dosinidia*) *titan* Maury, 1925, *Bull. Amer. Paleont.*, vol. 10, No. 42, pp. 291, 292, pl. 24, figs. 1, 2; pl. 25, fig. 3 Miocene, Trinidad.

Dosinia ponderosa (Gray), Grant and Gale, 1931, *Mem. San Diego Soc. Nat. Hist.*, vol. 1, p. 351, pl. 15, figs. 1a, 1b, 1c; also variations, pl. 15, figs. 2a, 2b, 3 (*jacaltosana* Arnold); pl. 15, fig. 4 (*longidens* Grant and Gale).—Durham, 1950, *Geol. Soc. America, Mem.* 43, p. 84, pl. 22, figs. 3, 6 (Lower California).—Woodring, 1951, *U.S. Geol. Survey, Prof. Paper* 222, pp. 64, 89, 104, pl. 16, fig. 6; pl. 19, fig. 1; pl. 20, fig. 7 California.

Adult shell large (length to about 145 mm.), orbicular, the posterior side wide, convexly vaulted across the middle, solid in texture, white. Sculpture formed by rather wide, concentric ribbons, often divided on the sides, much wider on the middle zone or partly obsolete there. The lunule is small, its surface deeply impressed. Adductor scars are large, smooth, polished, connected by the pallial line with a deep sinus reaching to the middle of shell cavity.

This is the largest species of *Dosinia*, also recognized by its orbicular shape, and coarse, wide concentric ribbons which often fade out over the middle zone of the disk. As a late Miocene, Pliocene, and Pleistocene fossil,

this species and several closely allied forms have a wide geographic distribution extending from Chile northward to California and through the Caribbean region to Trinidad. It is a common fossil in the Pleistocene tablazos of Peru.

The typical form of *Dosinia ponderosa* as it occurs in the Gulf of California has been well figured by Grant and Gale (plate 15, figs. 1a, 1b, 1c). It is a medium to large, coarse, heavy shell with an excentric circular outline. Its lunule is so deeply impressed that its lower margin appears to have been turned sharply inward, almost at right angles, while the anterior margin below it is strongly produced, expanded and rounded. The hinge plate behind the cardinal teeth is high and flat, the ligamental scar so deeply inset that the shell margin above it overhangs widely. If the valves are not carefully separated the hinge plate is always broken or damaged. The surface of the disk is usually smooth and polished over the middle zone; the concentric sculpture of strong, ribbon-like concentrics shows best on the sides. Shells from the southern part of the Panamic region have a more perfect circular or quadrate outline, the lunule is less deeply sunken, the anterior margin below the lunule shorter, while the surface sculpture is stronger, the concentrics persisting across the middle of the disk. This latter form occurs frequently as fossil in the Pliocene and upper Miocene beds of northern Peru and in Ecuador, and was named *Dosinia grandis* by Nelson.

Range—Lower California to Peru and the Galapagos Islands. Panama: Panama City; Guanico; Pearl Islands. Ecuador: Santa Elena; Manta; Jaramijo; Esmeraldas. Peru: Zorritos.

Dosinia (Dosinidia) dunkeri (Philippi)

Plate 42, figures 3-3b

Cytherea dunkeri Philippi, 1844, *Abbild. und Beschreib. Conchylien*, bd. 1, *Cytherea*, p. 170, pl. 2, fig. 5 Mexico.

Artemis simplex Hanley, 1845, *Proc. Zool. Soc. London*, p. 11 Panama.

Artemis dunkeri (Philippi), Reeve, 1850, *Conch. Icon.*, vol. 6, *Artemis*, pl. 6, fig. 34.

Dosinia dunkeri (Philippi), Römer, 1862, *Mon. Molluskengattung Dosinia*, Scopoli, p. 17, taf. III, figs. 3, 3a, 3b.

Dosinia (Dosinidia) dunkeri (Philippi), Hertlein and Strong, 1948, *Zoologica*, vol. 3, pt. 4, p. 165.

Shell small or medium in size (length 40 to 55 mm.), subcircular to subovate, solid, moderately convex, white. The beaks project strongly over a deeply sunken lunule. Surface sculptured with regular, flattened, slightly shelving concentric ribbons which are of uniform strength over most of the disk. Adductor scars are relatively large, polished, the anterior one more deeply impressed. Pallial sinus is relatively large, straight and reaches a little beyond the middle of the shell cavity.

Length 55 mm., height 53.1 mm., diameter 28 mm. Santa Elena, Ecuador.

The commonest species of *Dosinia* in the Panamic zone, easily recognized by its circular form and regular sculpture.

Range—Costa Rica: Puntarenas. Panama: Panama City; Pearl Islands.

Colombia: Isla del Gallo; Gorgona Island. Ecuador: Esmeraldas; Manta; Santa Elena. Peru: Tumbes; Zorritos; Sechura.

Dosinia (*Dosinidia*) *annae* Carpenter

Plate 42, figures 2-2b

Dosinia annae Carpenter, 1855, Cat. Mazatlan Shells, Brit. Mus., p. 61.—Römer, 1862, Mon. Molluskengattung *Dosinia* Scopoli, p. 18, taf. 4, fig. 1.

The shell is generally a little larger than *D. dunkeri*, higher, less circular, the posterior side subtruncated and with weaker sculpture; the concentrics are best developed on the sides and smoother over the middle. Pallial sinus is smaller, not extending to the middle of the shell cavity.

Length 51.5 mm., height 50.5 mm., diameter 25.8 mm. Cojimenes, Ecuador.

A much rarer species than *D. dunkeri* but easily distinguished by the characters mentioned above.

Range—Mexico southward to Ecuador. Panama: Búcaro. Ecuador: Mompiche; Cojimenes.

Genus *CYCLINELLA* Dall, 1902

Type species by original designation, *Artemis tenuis* Recluz. Recent, West Indies.

Shell dosinoid, discoidal to suborbicular, depressed or convex, moderately thin, white, often chalky. Hinge as in *Dosinia* with three cardinal teeth in each valve, the right posterior tooth large and bifid, no laterals. Resilial scar as in *Dosinia*. Posterior adductor scar large, placed a distance below the end of the hinge line. Pallial sinus large, deep, pointed at the end. Sculpture formed by fine, crowded threadlike concentrics. Lunule large and defined by a weak line only, its surface not depressed. Valve margin smooth.

Cyclinella differs from *Dosinia* by its hinge which lacks the small, pimple-like anterior lateral tooth of the right valve; also by the texture of the shell which is usually thinner and by its surface markings formed by close, concentric growth threads which are irregular and do not form the flat, ribbon-like bands so commonly seen on *Dosinia*. The posterior adductor scar is placed low and separated from the end of the hinge plate by a wide space.

Key to Panamic-Pacific *Cyclinella*

- I. Shell quite large (60 to 100 mm. in length).
 - A. Shell with subrhomboidal to subquadrate form, the posterior side expanded. Greatest inflation of the valves lies obliquely along the umbonal slope.
 1. Shell often large. Posterior side with its ventral margin directed inward. Ecuador and Peru.

C. subquadrata
 2. Shell smaller. Posterior-dorsal margin shorter, the whole posterior margin more evenly rounded. Panama northward.

C. saccata
 - B. Shell with more circular outline. Inflation of the valves more centrally located.

3. Beaks nearly median, the height of the valve somewhat greater than its length. Posterior margin contracted. Gulf of California.

C. ulloana

4. Beaks placed in a more anterior position. Posterior side rounded, not contracted. Panama.

C. jadisii

II. Shell smaller (length less than 60 mm.).

5. Shell convex, its umbones hence large and full. Outline subcircular, the height usually a little more than the length. Pallial sinus deep and narrow, pointed towards the cardinal teeth.

C. singleyi

Cyclinella subquadrata (Hanley)

Plate 55, figure 2

Artemis subquadrata Hanley, 1845, Proc. Zool. Soc. London, p. 11 "Santa Elena" reference given to "Ind. Test., sup. t. 15, fig. 39".—Reeve, 1850, Conch. Icon., vol. 6, *Artemis*, pl. 3, fig. 15.—Sowerby, 1852, Thes. Conch., vol. 2, *Artemis*, pp. 661, 662, No. 24, pl. 141, fig. 27 "Santa Elena, Lobos Islands".

Shell often large (length 95 mm.), obliquely subrectangular, moderately convex or vaulted along a line running from the beak and along the umbonal slope to the posterior-ventral margin, the surface of the posterior submargins more or less depressed. Surface of disk chalky or sculptured with coarse, crowded, concentric threads. Lunule absent or indicated weakly. Hinge with three cardinal teeth in each valve and of which the right posterior and the left middle teeth are large and bifid, the others thin, lamellar. Pallial sinus large, placed rather low and extending to about the middle of the cavity.

Length 68 mm., height 66 mm., semidiameter 15.6 mm. (left valve).

Length 95 mm., height 85.6 mm., semidiameter 49.6 mm. (left valve), both Bayovar, Peru.

Range—Ecuador and northern Peru. Ecuador: Santa Elena. Peru: Bay of Sechura; Lobos Islands.

Cyclinella saccata (Gould)

Plate 40, figure 6;

Plate 42, figures 4, 4a; Plate 43, figures 4, 4a, 6, 6a

Artemis saccata Gould, 1851, Proc. Boston Soc. Nat. Hist., vol. 4, p. 91.—Gould, 1853, Boston Jour. Nat. Hist., vol. 6, p. 396, pl. 15, fig. 2 "Mazatlan".

Cyclinella subquadrata (Hanley), Hertlein and Strong, 1948, Zoologica, vol. 33, pt. 4, pp. 180, 181. (Not of Hanley, 1845).

Shell fairly large, rounded, dosinoid, white, with a thin, dirty, pale yellow or light brown periostracum, moderately convex, especially in the zone of the umbonal slope extending from the beak to the posterior-ventral margin. The exact outlines of the shell is best illustrated by the figures. Surface is closely striated by fine, concentric growth threads and deeper incised lines of the resting stages forming bands of unequal width, wider on the umbones and narrower below. The shell cavity is moderately deep, with the pallial sinus usually well marked, with a sharply angled point directed upwards towards the hinge and not reaching quite to the center of shell cavity. Adductor scars distinct, unequal, the anterior one narrower and placed just below the end of the hinge plate, the posterior larger and situated low down. Lunule narrowly cordate, defined by an impressed line. Measurements of a specimen: length 78.7 mm., height 72.6 mm., diameter 38.5 mm. Panama Bay, Shrimpers from the H. B. Johnson collection. Dimensions given by Gould, length 1 3/5 inches, height 1 1/2 inches, diameter 7/8 inches.

This species has generally been considered a synonym of the more southerly *C. subquadrata* Hanley to which it is obviously related, but it differs by its more circular form (see figures), the posterior-dorsal margin is shorter, less sharply descending at the end, and the anterior side is longer; internally, the posterior adductor scar is placed much lower, and the pallial sinus is directed upwards towards the hinge and not towards the anterior adductor scar.

Range—Gulf of California to Panama. Panama: Gulf of Panama (shrimpers); Búcaro. Mexico: Mazatlan.

Cyclinella ulloana Hertlein and Strong

Plate 43, figure 3

Cyclinella kroeyeri ulloana Hertlein and Strong, 1948, *Zoologica*, vol. 33, pt. 4, pp. 179, 180, pl. 2, figs. 5, 6, 7.

Shell orbicular, dosinoid, white, moderately inflated, moderately thick; sculptured by fine but well developed concentric lines of growth; pallial sinus fairly broad, short, rounded at the end, projecting about 33 mm. from the posterior margin toward the anterior muscle impression; margin smooth. Dimensions: length 75.5 mm., height 76.5 mm., convexity (one valve), 19 mm.—(Hertlein and Strong, 1948.)

Holotype, Santa Inez Bay, Gulf of California.

This species is similar to *C. galera* Pilsbry and Olsson (*Proc. Acad. Nat. Sci. Philadelphia*, vol. 93, p. 66, pl. 12, fig. 1; pl. 19, fig. 4), but an actual comparison of specimens have not been made. Both *C. galera* and *C. ulloana* differ from other Panamic species in that the height of the shell is a little greater than their length and also in having the posterior side narrower and somewhat contracted.

Range—Gulf of California.

Cyclinella jadis, new species

Plate 43, figures 2, 2a

Shell of medium size, subcircular, slightly convex, the zone of greatest inflation lying along the posterior-umbonal slope. External surface of valves covered with minute, concentric growth lines, and because of their fine, close spacing, often produce a sheen or luster like that of silk. Pallial sinus large and narrow, extending to about the middle of the shell cavity. Color white, often with the umbones stained red or amber-brown. The lunule is small, subelliptical, flat and not sharply outlined.

Length 61.5 mm., height 60.3 mm., diameter 26.4 mm. Holotype, ANSP 218900.

Length 67.7 mm., height 65.2 mm., diameter 27.8 mm.

I take much pleasure in dedicating this species to Mr. Stewart H. Jadis, a well-known collector of Panama shells for many years, and for his companionship on many a field trip in the Canal Zone as well as in Panama itself.

Range—Panama southward to Ecuador. Panama: Panama City; Pearl Islands. Panama Canal Zone: Palo Seco. Ecuador: Manglaralto; Santa Elena.

Cyclinella singleyi Dall

Plate 43, figures 5, 5a

Cyclinella singleyi Dall, 1902, Proc. U.S. Nat. Museum, vol. 26, No. 1312, p. 404, pl. 15, fig. 3.

Shell of small or medium size (length 42 mm.), suborbicular to sub-circular, strongly convex, the umbones wide and full with the small beaks placed near the anterior one-quarter, curved, and pointed over a small lanceolate lunule defined by a faintly incised line. Surface white or faintly ochraceous, covered by fine, sharp, concentric striation and sometimes an obscure, radial lineation. Interior white, sometimes with a faint flush of apricot pink in the middle and with a deep, angular pallial sinus reaching to about the middle of the cavity. Hinge plate stout, the right valve with three cardinal teeth of which the posterior one is bifid, the ligament long, straight, and deeply inset.

Length 41.8 mm., height 39.3 mm., diameter 28.4 mm. Tumbes, Peru.

Recognized by its relatively small size, rounded, convex valves. Most common on mud flats and similar situations.

Range—Gulf of California to northern Peru. El Salvador: La Union (ANSP Lowe). Panama: Panama City; Rey Island; Pearl Islands. Colombia: Isla del Gallo. Peru: Tumbes.

Subfamily CLEMENTIINAE Frizzell, 1936

(Clementiidae Frizzell).

Type genus, *Clementia* Gray, 1842.

Shell subovate, convex, generally thin, the surface marked with concentric, wavelike undulations, strongest on the umbones but usually fading out below, but more or less distinctly transmitted through the substance of the valve into the interior. Hinge carrying three cardinal teeth in each valve, the right, posterior cardinal tooth bifid and more or less joined above with the anterior tooth, the middle cardinal tooth below it standing free. There are no lateral teeth, but the lunular margin within the hinge plate is deeply grooved. Lunular area is impressed but not set apart by a line; there is no escutcheon. Pallial sinus deep, the ventral margins of the valves smooth.

Genus CLEMENTIA Gray, 1842

The genus at first proposed without species; the type species subsequently designated by Gray, 1847, *Venus papyracea* Gray. Australia.

Having the principal characters of the family.

Subgenus EGESTA Conrad, 1845

Type species by monotypy, *Venus inoceriformis* Wagner. Miocene of Maryland.

Similar to *Clementia*, *s.s.* but larger and heavier, the posterior side is longer and at its end assumes a crudely truncated form. The pallial sinus is long and narrow.

Clementia (*Egesta*) *solida* Dall

Plate 50, figures 5, 5a

Clementia solida Dall, 1902, Proc. U.S. Nat. Museum, vol. 16, No. 1312, p. 401, pl. 14, fig. 4 Topolobampo, Mexico.

Clementia (*Egesta*) *solida* Dall, Woodring, 1926, Prof. Paper, U.S. Geol. Survey, No. 147, p. 37, pl. 16, figs. 7, 8.

The shell is fairly large, oblong-ovate, thin or of a medium thickness. Surface marked with even, concentric undulations on the umbones (spaced about 3.5 mm. apart) but become irregular ventrally or replaced entirely by growth lines near the basal margin. The general color is a dirty white.

An average specimen measures: length 76.9 mm., height 59.8 mm., diameter 22.2 mm. (a right valve, Pedernales, Ecuador). Fragments show that the shell may grow considerably larger.

Range—Gulf of California to Ecuador. Panama: Búcaro; Guanico. Ecuador: Limones; Pedernales.

Subfamily MERETRICINAE Fischer, 1887

Type genus *Meretrix* Lamarck, 1799.

Shell trigonal, subequilateral, the left valve has an anterior lateral tooth which fits into a corresponding socket in the right. The cardinal teeth are arranged radially and are sometimes divided into smaller subsidiary teeth as in *Tivela*.

Genus TIVELA Link, 1807

Type species by subsequent designation, Dall, 1902, *Venus corbicula* Gmelin (= *Venus mactroides* Born).

Shell with a trigonal and often *Mactra*-like shape, the umbones being placed near the middle axis and with close, adjacent beaks. The valves are slightly to strongly convex, sometimes flattened, the surface smooth except for the usual lines of growth. Hinge plate massive, generally with three primary cardinal teeth in each valve, supplemented by several, smaller, auxiliary teeth, the posterior cardinal tooth usually large, rugose or divided into smaller segments. There is a large, anterior lateral tooth in the left valve and a socket for it in the right valve. The ligament is attached to a strong, nymphal plate. Adductor scars small and nearly equal in size. Lunule large, setoff by a faint line or by a change of color; there is no escutcheon. Color white or in varying shades of brown, often with a pattern of radial rays and zigzag lines. The ventral margins of the valve smooth, closing tightly or with a small, open, posterior gap in some species.

Subgenus TIVELA s.s.

Shell trigonal, mactroid, convex, with full, prominent umbones. Lunule cordate, impressed, generally circumscribed by an incised or colored line, its margin straight. Anterior lateral tooth large. Surface usually marked with brown rays, the periostracum brown, rather coarse and pilose when fresh.

Subgenus PLANITIVELA, new subgenus

Type species, *Tivela planulata* (Broderip and Sowerby).

Shell trigonal, depressed, or mildly convex, the umbones low, flattened. Lunule elliptical, flattened, not strongly impressed. Nymphal area forms a high plate separated by a slit or deep groove from an expanded or raised margin. Coloration in rays or zigzag bands, the periostracum thin, vernicous, and dehiscent.

Subgenus PACHYDESMA Conrad, 1854

Type species, *Donax stultorum* Mawe.

Shell of large or medium size, and often solid, elongate-trigonal. Hinge with four cardinal teeth in each valve in addition to a strong, anterior

lateral tooth. Ligament area large, wide, the nymphal plate not elevated and separated from the margin by a groove. Surface color white and covered by a vernicose, dehiscant periostracum.

Key to species of *Tivela* of the Panamic-Pacific region

- I. Shell trigonal with high beaks, the surface slightly convex or depressed. The nymphal area is a high plate separated from an expanded dorsal margin by a deep slit or groove.
- A. Valve margins closed, without a posterior gap. Beaks and umbones near the middle, the anterior and posterior sides of nearly the same form and size.
1. Shell large (length between 50 or 60 mm.), the anterior side slightly longer. Surface colored by broad rays and bands of dark brown.
Tivela planulata
2. Shell smaller, equilateral. Color in lighter shades, often a cream or light yellow, modified with lattice-like rays and brown zigzag markings, especially on the umbones.
Tivela planulata undulata
- B. Posterior ventral margins of valves not closed tightly but with a small, open gap. Beaks and umbones placed a little behind the middle. Shell texture moderately thin, the surface depressed as if flattened.
Tivela hians
- II. Shell mactroid in shape and moderately convex. The nymphal area is low, flattened, the bordering dorsal side not expanded.
3. Shell large with narrow umbones, the lunular margin concave. Color white and covered by a thin, dirty gray periostracum.
Tivela argentina
4. Shell smaller, color white or brown (if white, some brown markings are often present on the dorsal slopes.)
- 4a. Shell subelongated, *Iphigenia*-like in shape, the ends somewhat produced.
Tivela delessertii
5. Anterior and posterior ends of shell well rounded, not noticeably produced. Umbones full and prominent.
Tivela byronensis

Subgenus **TIVELA** s.s.

Tivela (Tivela) byronensis (Gray)

Plate 44, figures 3, 6, 6a, 7, 8, 8a

Cytherea radiata Sowerby, 1835, Proc. Zool. Soc. London, p. 23 (Salango and Xipixapi).—Sowerby, 1851, Thes. Conch., vol. 2, p. 615, pl. 128, figs. 20-31 (*Cythereaea*).—Reeve, 1864, Conch. Icon., vol. 14, *Cytherea*, pl. 7, fig. 27. Not *Trigona radiata* Megerle von Mühlfeld, 1811 (= *Tivela mactroides* Born, 1778).

Trigona byronensis Gray, 1838, Analyst, vol. 8, p. 304 Pacific Ocean.

Cytherea hindsi Hanley, 1844, Proc. Zool. Soc. London, p. 110 (Guayaquil).—Sowerby, 1851, Thes. Conch., vol. 2, p. 614, pl. 128, fig. 27.—Reeve, 1864, Conch. Icon., vol. 14, *Cytherea*, pl. 9, figs. 39a, b.

Venus solangensis d'Orbigny, 1846, Voy. Amér. Mérid., vol. 5, 3rd. pt., Mollusques, pp. 564, 565. (New name for *C. radiata* Sowerby, non *radiata* Chemn., 1795; Risso, 1826).

Tivela radiata (Sowerby), Römer, 1865, Monogr. Molluskengattung *Venus* Linné, vol. 1, *Cytherea*, 1. Sectio: *Tivela*, p. 13, pl. 6, figs. 1, 1a, 1b, 1c.

Tivela byronensis (Gray), Hertlein and Strong, 1948, Zoologica, vol. 33, pt. 4, No. 13, pp. 166, 167.

Shell of medium size, mactroid in shape but without a defined posterior-dorsal area, convex, the posterior side usually a little longer and somewhat

pointed at the end. Color white or in varying shades of brown or chestnut, sometimes quite dark, strongly rayed or with broken, lattice-like markings. Tip of beaks purple.

Length 36.7 mm., height 31.5 mm., diameter 23 mm. Mompiche, Ecuador.

This species is similar to *T. mactroides* Born of the Caribbean and some specimens cannot be effectively separated if their derivation or locality station is unknown. The types of *T. radiata* are preserved at the British Museum (Nat. Hist.); they are somewhat larger than the average, the largest specimen measures about 62.5 mm. in length. These specimens of *T. radiata* are similar to shells of *T. mactroides* from the Caribbean coasts of Colombia and Venezuela. Good figures of *T. radiata* are given by Römer. *T. bryonensis* sports several color variations, some of which have been named; the common form found along the coast of northern Peru and the Gulf of Guayaquil is usually a pale chestnut yellow with the umbones marked with lattice-like brown lines; this form was named "hindsii" by Hanley; similar pale-colored shells were designated *semifulva* by Menke, and as *gracilior* by Sowerby, figures of which are given in Römer. *T. pulla* is a small, rayed form of the above. In most specimens of *T. bryonensis*, the beaks and part of the umbones is stained with purple, a character also shared with *T. mactroides*.

Range—Lower California to northern Peru. Panama: Old Panama; Búcaro; Guanico; San Carlos; Pearl Islands. Ecuador: Mompiche; Sua; Manglaralto; Manta; Punta Blanca; Santa Elena. Peru: Tumbez; Boca Pan; Mancora; Organos.

Tivela (Tivela) delessertii (Deshayes in Sowerby) Plate 44, figures 9, 9a

Cytheraea nitidula Lamarck, Sowerby, 1851, *Thes. Conch.*, vol. 2, p. 616, No. 14, pl. 128, fig. 25. Not *C. nitidula* Lamarck.

Cytheraea delessertii Deshayes in Sowerby, 1854, *Thes. Conch.*, vol. 2, p. 785. Renaming of *C. nitidula*, p. 616, pl. 28, fig. 25.

Tivela arguta Römer, 1861, *Malak. Blatter.*, vol. 7, p. 148.—Römer, 1862, *Dunker Novit. Conch. Lief.*, vol. 4, No. 39, No. 37, t. 12, figs. 7, 8, 9.—Römer, 1865, *Mongr. Molluskengattung Venus*, Linné, bd. 1, *Cytherea*, 1. Sectio: *Tivela*, pp. 15, 16, pl. 4, figs. 5, 5a, 5b Panama.

Tivela delessertii (Deshayes in Sowerby), Hertlein and Strong, 1948, *Zoologica*, vol. 33, pt. 4, No. 13, p. 167, pl. 2, fig. 10.

Shell usually small (average length about 30 mm.), elongately trigonal or *Iphigena*-like in shape, noticeably longer than high, the posterior side longer and attenuated at the end, the anterior end more rounded. Coloration varied, sometimes pure white, more often the surface is clouded with brown, often with rays and zigzag lines. The umbonal cavity is usually a deep, violet-brown, the marginal area white.

Length 29.2 mm., height 23 mm., diameter 16.4 mm. Acapulco, Mexico.

Length 40.2 mm., height 31.3 mm., diameter 18.6 mm. Pearl Islands, Panama.

This species is common at Acapulco, rare at most other localities.

Range—Lower California to Panama. Mexico: Acapulco. Panama: Gibraleon and Bayoneta Islands, Pearl Islands.

***Tivela (Tivela) lineata* (Sowerby)**

Cytherea lineata Sowerby, 1851, Thes. Conch., vol. 2, *Cytherea*, p. 616, No. 15, pl. 128, fig. 26. Hab. unknown.

Tivela lineata (Sowerby), Römer, 1865, Monogr. Molluskengattung *Venus*, Linné bd. 1, *Tivela*, p. 16, No. 24.

Tivela subglobosa (Menke), Römer, 1865, *op. cit.*, p. 14, No. 21, pl. 7, fig. 5.

Shell ovate-trigonal, solid, subequilateral, the length of the shell a little more than their height, the umbones convex and prominent, nearly median. Surface smooth and polished, often pure white or marked with transverse, sharply waved, brown lines, sometimes interrupted with irregular radial rays of brown. The dorsal areas are impressed, plain or with feather-like markings of dark brown. Interior white or purple. Hinge heavy.

Length 31 mm., height 28 mm., diameter 10.6 mm. (right valve, an average specimen).

Tivela lineata was described by Sowerby from an unknown locality. Pure white shells from Panama with feather-like markings on the dorsal slopes agree quite well with Sowerby's figure of *T. lineata* in the Thesaurus. Completely white shells also resemble Römer's figure of *T. arguta* (Menke). *T. lineata* appears to be distinct from *T. byronensis*, differing by its larger and wider umbones.

Range—Panama. Panama: Pearl Islands; Las Tablas; Punta Pajaron (USNM 603409).

Subgenus **PLANITIVELA**, new subgenus***Tivela (Planitivela) planulata* (Broderip and Sowerby) Plate 44, figures 5, 6a**

Cytherea planulata Broderip and Sowerby, 1829, Zool. Jour., vol. 5, p. 48.—Sowerby, 1839, Zool. Beechey's Voyage, p. 151, pl. 43, fig. 6.—Sowerby, 1851, Thes. Conch., vol. 2, p. 618, No. 20, pl. 127, fig. 13.—Reeve, 1864, Conch. Icon., vol. 14, *Cytherea*, pl. 8, figs. 34 a, b.

Cytherea planulata, var. *suffusa* Sowerby, 1835, Proc. Zool. Soc. London, p. 46 Salango. *Cytherea undulata* Sowerby, 1851, Thes. Conch., vol. 2, p. 618, pl. 127, fig. 12.—Reeve, 1864, Conch. Icon., vol. 14, *Cytherea*, pl. 8, figs. 33 a, b.

Tivela planulata (Broderip and Sowerby), Römer, 1864, Monogr. Molluskengattung *Venus*, Linné, bd. 1, *Cytherea*, 1. Sectio: *Tivela*, pp. 8, 9, pl. 3, figs. 2, 2a, 2b.

Shell of medium or large size (length 60 mm.), subsolid, subtrigonal with fairly convex, submedian umbones, the anterior side a trifle longer. There is no evident posterior gap. Color usually a straw-yellow with large radial rays of brown. Lunule large, usually ill-defined but with its surface covering most of the flattened dorsal submargin. Pallial sinus short but distinct.

Length 61.4 mm., height 47.5 mm., diameter 27.2 mm. Boca Pan.

Length 58 mm., height 46.9 mm., diameter 24.8 mm. Manglaralto.

This species replaces *T. hians* north of Cabo Blanco in Peru and from which it is distinguished by its more solid, convex valves, stronger color and in the absence of a posterior gap. It may show considerable variation in shape and in surface markings which have resulted in some duplication of names. Small or medium-sized specimens from Panama with a rich color resemble the shell figured by Sowerby as *T. suffusa* based on a specimen

from Salango, Ecuador. A more distinctive form is *T. undulata* (Plate 44, figs. 2, 2a) which has a yellow or cream-colored shell overrun with broken, lattice-like rays of brown. D'Orbigny recorded *T. planulata* from Coquimbo, Chile, which probably refers to *T. hians*.

Range—Gulf of California to northern Peru.

Tivela (*Planitivela*) *hians* (Philippi)

Plate 44, figures 4-4b

Donax hians Philippi, 1851, Zeitschr. f. Mal., vol. 74 Mazatlan.

Tivela hians (Philippi), Römer, 1864, Monogr. Molluskengattung *Venus*, Linné, bd. 1, *Cytherea*, 1. Sectio: *Tivela*, p. 9, pl. 3, fig. 3, 3a, 3b.

? *Tivela planulata* Dall, 1909, Proc. U.S. Nat. Museum, vol. 37, No. 1704, p. 157, pl. 28, fig. 9 (= *hians*, not *planulata* Broderip and Sowerby).

Shell of medium size (length 55 mm.), relatively thin, subtrigonal or fan-shaped, nearly equilateral, the anterior side a little longer, depressed. Color usually a pale straw-yellow, marked with broken rays of purplish brown, the umbones light or violet-brown. Interior flushed with grayish violet, the margins white. Valves with a small gap near the posterior end. Pallial sinus short.

Length 59.7 mm., height 47.8 mm., diameter 20.8 mm. (Negritos).

This is a common species along sandy beaches in northwestern Peru south of Cabo Blanco and at many places it is gathered in large numbers both for food and for fish-bait. The Peruvian shells agrees well with the figures of *T. hians* given by Römer and were probably based on specimens received from Philippi if not on the actual types. Both Philippi and Römer cited Mazatlan as the type locality for this species, but I have seen no true specimens north of Cabo Blanco in Peru. It is significant that Carpenter did not mention the species in the Mazatlan Catalogue. Myra Keen gives the range of the species as extending from Magdalena Bay, Lower California to Chile. *T. hians* is easily distinguished from *T. planulata* by its thinner, more depressed shell, lighter coloration, and especially by its open gap near the posterior end. The anterior side is decidedly longer.

Range—Lower California to Chile. Peru: Negritos; Paita; Sechura Bay; Nonura Bay to the south of Bayovar.

Subgenus **PACHYDESMA** Conrad, 1845

Tivela (*Pachydesma*) *argentina* (Sowerby)

Plate 44, figure 1

Cytherea argentina Sowerby, 1835, Proc. Zool. Soc. London, p. 46 Nicoiyo.—Sowerby, 1851, Thes. Conch., vol. 2, p. 622, pl. 129, fig. 62. (as *Cytherea*).—Reeve, 1864, Conch. Icon., vol. 14, *Cytherea*, pl. 4, fig. 11.

Tivela argentina (Sowerby), Römer, 1861, Monogr. Molluskengattung *Venus* Linné, vol. 1, *Cytherea*, 1. Sectio: *Tivela*, pp. 17, 18, pl. 5, figs. 4, 4a, 4b.—Hertlein and Strong, 1948, Zoologica, vol. 33, pt. 4, No. 13, p. 166.

Shell large, high, trigonal, with median umbones, the anterior side concave or excavated by the large, elliptical, depressed lunule, the ventral margin rounded. The posterior end is often slightly flexed. Color entirely white, often polished with remnants of a thin, ash-gray periostracum.

Length 57 mm., height 49 mm., diameter 16.1 mm. (a left valve from Palmar, Santa Elena Peninsula).

Generally local. Easily distinguished by its shape and white color.

Range—Mexico to northern Peru. Panama: Puerto Mensabi; Búcaro. Panama Canal Zone: Balboa. Colombia; Buenaventura; Isla del Gallo. Ecuador: Limones; Mompiche; Palmar, near Santa Elena. Peru: Tumbes.

Genus **GOULDIA** C. B. Adams, 1847

(*Thetis* C. B. Adams, 1845, not of Sowerby, 1826).

Type species by subsequent designation, Dall, 1883, *Gouldia cerina* (C. B. Adams). Recent, Florida and the West Indies.

Shell small, subcircular to subtrigonal with a small, inconspicuous, often flattened umbone ending in a pointed or slightly prosogyrate beak. Hinge with three cardinal teeth in each valve of which the central tooth in the right valve is large, the central tooth in the left valve similar but bifid; an anterior lateral tooth is found in each valve. Adductor scars plain, nearly equal in size. Pallial sinus shallow. Lunule large and bounded by an incised line. The surface is sculptured by small radial and concentric riblets, the concentrics generally strongest in the middle and the radials on the sides, often together producing a cancellate pattern.

Gouldia C. B. Adams, 1847 is a substitute name for *Thetis* C. B. Adams, 1845 preoccupied by Sowerby, 1826. The original *Thetis* was proposed for two species, *cerina* and *parva*, the first a venerid, the other a crassitellid. In the subsequent works of the author, and of Carpenter, and H. and A. Adams, the genus *Gouldia* was used mainly for shells now referred to *Crassinella* of Guppy. Dall's selection of *G. cerina* as type species, fixed the genus *Gouldia* as a member of the Veneridae.

***Gouldia californica* Dall**

Plate 39, figure 9

Gouldia californica Dall, 1917, Proc. U.S. Nat. Museum, vol. 51, No. 2166, p. 579 Gulf of California near La Paz.—Hertlein and Strong, 1948, Zoologica, vol. 33, pt. 4, No. 13, p. 168.

Gafrarium (*Gouldia*) *stephensae* E. K. Jordan, 1936, Contr. Dept. Geol. Stanford University, vol. 1, No. 4, p. 136, pl. 19, figs. 10, 11.

Shell small, subcircular to ovate-triangular, thin, white, with touches of brown along the dorsal border. The anterior lateral tooth is large and prominent, the pallial sinus small. Sculpture reticulate, the concentric elements more prominent in the middle of the disk, the radial towards the end of the valves. Inner valve margins smooth.

Length 6 mm., height 5.5 mm., diameter 3 mm. (Dall).

Length 5.5 mm., height 4.75 mm., diameter 2.8 mm. Esmeraldas, Ecuador.

Similar to *G. cerina* of West Indian waters but smaller and with coarser sculpture, more strongly reticulated over the whole disk. Some specimens from Manta have a purplish color; others are white.

Range—Gulf of California south to Ecuador. Ecuador: Esmeraldas; Manta; Santa Elena.

Subfamily **Pitarinae** Stewart, 1930

The surface of the shell is smooth, plain or with strong, concentric sculpture, never radially ribbed, the inner side of the ventral margin smooth

or with incised lines. The hinge has three cardinal teeth in each valve which stand nearly free and are not joined to the margin above them; also a larger, anterior lateral tooth in the left valve and its deep, containing socket in the right. Lunule cordate, bordered by an incised line and also shown by a change of sculpture and of color; there is no escutcheon. Pallial sinus deep.

Key to genera of the Pitarinae

- I. Shell solid, the surface with a smooth, porcellaneous luster or weakly sculptured with low, rounded concentrics.
 - A. Shell generally large, smooth, and glossy. Scar of the *pedal retractor muscle* on the undersurface of the hinge plate and below the anterior cardinal tooth is distinct and deep.
 1. Shell ovate to elliptical in shape, the surface color plain and simple or with a strong, carpet-like pattern of radial rays and zigzag markings.
Genus *Macrocallista*
 - B. Shell smaller, the surface smooth, plain or with low concentrics. *Pedal retractor scar not deeply impressed.*
 2. Valve margins smooth.
Genus *Tinctora*
 3. Inner margin of valves cut by small, tangential lines.
Genus *Transennella*
 - II. Valves thin or of medium weight. Surface plain, marked only with growth lines or more heavily sculptured with concentric lamellae or ridges.
 - C. Surface sculptured principally with fine, growth lines.
 4. Shell cordate, convex, with large, full umbones.
Genus *Pitar*
 - D. Surface sculptured with coarse concentric riblets, rounded or lamellar.
 5. Posterior-dorsal area is poorly defined, the concentric riblets not interrupted by it.
Genus *Lamelliconcha*
 6. The posterior-dorsal area is set apart sharply by the umbonal angle armed with large spines or stumplike scales.
Genus *Hysteroconcha*

Genus **MACROCALLISTA** Meek, 1876

Type species by monotypy, *Venus gigantea* Gmelin. (= *V. nimbosea* Solander). Recent, Atlantic and the Gulf Coast of the United States.

Shell elongate-ovate, subsolid, flattened to convex, smooth and polished except for growth lines and in life covered by a thin, vernicose periostracum. Lunule is narrowly cordate, defined by an incised line. No differentiated escutcheon. Hinge of each valve has three cardinal teeth, the left posterior slender, adjacent to the nymph and partly fused to it, the anterior right cardinal tooth narrow and set vertical as if to close-off the lateral socket; there is an anterior, lateral tooth in the left valve and its fitting socket in the right. Anterior pedal scar seated on the hinge plate below the anterior lateral tooth. The pallial sinus is moderate. Ventral margins smooth.

Subgenus **MEGAPITARIA** Grant and Gale, 1931

Type species by original designation, *Cytherea aurantiaca* Sowerby.

Generally larger than *Macrocallista*, *s.s.* and with a more ovate or circular shape. Hinge heavy, the left anterior lateral tooth large. Surface smooth on the adult portion, the umbones with stronger, well-spaced concentrics (*Callista*-like).

Aside from shape and possibly a stronger hinge, the differences between *Macrocallista*, *s.s.* and *Megapitaria* are trivial and hardly above specific value.

Subgenus **MACROCALLISTA**, *s.s.*

Macrocallista (*Macrocallista*) **squalida** (Sowerby) Plate 46, figures 2-2c

Cytherea squalida Sowerby, 1835, Proc. Zool. Soc. London, p. 23.—Sowerby, 1851, Thes. Conch., vol. 2, *Cytherea*, p. 629, pl. 131, figs. 87, 88, 89.

Dione squalida (Sowerby) Reeve, 1863, Conch. Icon., vol. 14, *Dione*, pl. 3, fig. 10.

Macrocallista (*Chionella*) *squalida squalida* (Sowerby), Maxwell Smith, 1944, Panamic Marine Shells, p. 59, fig. 757.

Megapitaria squalida (Sowerby) Hertlein and Strong, 1948, Zoologica, vol. 33, pt. 4, p. 168.—Hertlein and Strong, 1955, Bull. Amer. Mus. Nat. Hist., vol. 107, No. 2, p. 189.

Shell medium to large sized (80 mm.), subelliptical, convex, smooth. Periostracum gray-brown, shiny, varnish-like; beneath this, the shell is gray-brown to purplish, usually with two brown rays running across the umbones to the ventral margin and a series of zigzag markings heaviest on the umbones. Interior of shell white or irregularly stained with purple or violet.

Length 79.5 mm., height 61.6 mm., diameter 39.2 mm. Pearl Islands, Panama.

This species is related to *M. maculata* (Linné) of the West Atlantic but is more convex and its color pattern is somewhat different.

Range—Lower California to northern Peru. Panama: Pearl Islands; San Carlos; Búcaro; Burica Peninsula. Ecuador: Ancon Point; Galeras; Manta; Isla la Plata; Santa Elena. Peru: Zorritos; Caletto Sal; Mancora.

Subgenus **MEGAPITARIA** Grant and Gale, 1931

Macrocallista (*Megapitaria*) **aurantiaca** (Sowerby) Plate 46, figures 1-1c

Cytherea aurantiaca Sowerby, 1831, Gen. Rec. and Foss. Shells, vol. 2, pt. 33, pl. 196, fig. 3.

Cytherea aurantia Hanley, Sowerby, 1851, Thes. Conch., vol. 2, *Cytherea*, p. 628, pl. 132, fig. 97 bis.

Dione aurantia Deshayes, Reeve, 1863, Conch. Icon., vol. 14, *Dione*, pl. 3, fig. 12.

Macrocallista aurantiaca (Sowerby) Maxwell Smith, 1944, Panamic Marine Shells, p. 59, fig. 762.

Full grown specimens are large (110 mm.), ovate, with solid porcellanous shell covered by a brown or mahogany colored periostracum under which the surface is smooth, polished and usually of a pink or salmon color. Internally, the ends of the hinge may be stained purple. Young shells have the beaks white or cream, marked off by a zigzag line, the color below usually brown but sometimes speckled with white or with zigzag markings.

Length 98.4 mm., height 82 mm., diameter 54 mm. San Pedro, near Manglaralto, Ecuador.

Length 110 mm., height 87.5 mm., diameter of a left valve 28.7 mm. Viveros, Pearl Islands, Panama.

Range—Lower California to northern Peru. Lobos Islands. Panama: Pearl Islands; Burica Peninsula. Ecuador: Manta; Isla la Plata; San Pedro, near Manglaralto; Santa Elena. Peru: Mancora; Lobos de Tierra.

Genus **PITAR** Römer, 1857

(*Caryatis* Römer, 1862; *Pitaria* Dall, 1902, emendation.)

Type species by monotypy, *Cytherea tumens* Gmelin.

Shell subtrigonal or subovate, inequilateral with convex umbones and small adjacent beaks. Lunule cordate or elliptical, defined by a faintly incised line, no escutcheon. Surface sculptured principally with fine hairlike concentric or growth incrementals, sometimes with superimposed zigzag grooves. Hinge with a strong, anterior lateral tooth in the left valve and its socket in the right. Cardinal teeth three in each valve; the left valve has the central and anterior cardinal teeth joined above forming an inverted V, the enclosed pit below forming the socket for the central cardinal tooth of the opposite valve; right valve has the anterior and posterior cardinal teeth joined forming a single lamellar structure which in a rooflike fashion overhangs the smaller, free-standing, central cardinal tooth below. Pallial sinus is large and extends nearly to the middle of the valve cavity. Inner ventral margins smooth.

May be divided into two subgenera as follows:

I. Surface plainly sculptured with growth incrementals only.

Subgenus *Pitar*, s.s.

II. Like *Pitar* but in addition has a superimposed system of zigzag grooves and punctae, usually best developed along the ventral slope (in some species of inconstant development).

Subgenus *Hyphantosoma*

Pitar (Pitar) consanguineus (C. B. Adams)

Plate 45, figures 3-3a

Cytherea consanguinea C. B. Adams, 1852, Ann. Lyceum Nat. Hist. New York, vol. 5, pp. 496, 545, No. 445 Panama.—Römer, 1867, Mongr. Molluskengattung *Venus* Linné, bd. 1, *Cytherea*, p. 108, pl. 28, figs. 5, 5a, 5b.—Sowerby, 1853, Thes. Conch., vol. 2, p. 743, pl. 163, fig. 203.—Turner, 1956, Occas. Papers on Mollusks, Mus. Comp. Zool., vol. 2, No. 20, pp. 42, 43. Types lost.

Pitar (Pitar) consanguineus (C. B. Adams), Hertlein and Strong, 1948, Zoologica, vol. 3, pt. 4, No. 13, pp. 170, 171.—Hertlein and Strong, 1955, Bull. Amer. Mus. Nat. Hist., vol. 107, No. 2, p. 189.

The shell is relatively small, (average length from 30 to 33 mm.), rounded trigonal to subovate, moderately convex, the umbones prominent and full, placed near the anterior one-third, the beaks curved over a relatively large, cordate lunule outlined by a faint line and deeply impressed in the middle. Viewed from the inside, the two ends of the valve appear almost equally rounded but the anterior one is more narrow and its dorsal-lunular margin is straight. The surface is covered with rather strong, concentrics, especially so on the anterior slope. The primary color of the shell is a cream-white, plain or with brownish, radial rays on the umbones and sometimes broken arrow-shaped or zigzagged lines. The inner portion of the lunular surface is usually colored a deep brown, also some part of the posterior-dorsal surface. The pallial sinus is well developed and extends nearly to the middle of the cavity of the valve.

Length 31.7 mm., height 26.5 mm., diameter 19.2 mm. Venado Beach, Panama Canal Zone.

This small species is known only with certainty from Panama; records from other places are questionable. It is generally a small, rounded or ovate form, the concentric line strong and regular on the anterior slope, much weaker elsewhere. The small lunule is deeply impressed, its inner part under the beaks stained generally a deep brown. Surface coloration is variable; sometimes a pure creamy white to other forms with radial rays and arrow-shaped brown lines.

Range—Panama: Panama City; Piñas Bay (Hertlein and Strong). Panama Canal Zone: Venado Beach.

Pitar (*Pitar*) *elenensis*, new species

Plate 45, figures 1-1b

Shell moderately large, thin to subsolid, trigonal, ventricose, the umbones wide and full with the small, adjacent beaks curved slightly forward and placed at the anterior one-third. The lunule is large, elliptical cordate, flat-surfaced, defined by a small line, its inner margin long and straight, extending three-fourths or more the length of the anterior side, the extreme anterior end being narrowly rounded. Posterior-dorsal margin is slightly arched and curves evenly into the broadly rounded curve of the posterior end. Outer surface convex, greatest in the middle of the disk, slightly roughened by irregular growth lines, cream-colored, the umbones sometimes marked with four or more brown lines, usually in pairs, but which do not extend beyond the middle of the disk. Cavity of the beaks white or faintly flushed with pink. Pallial sinus not extending to the middle of the shell cavity.

Length 45.5 mm., height 39 mm., diameter 14.9 mm. (right valve). Holotype, Santa Elena, Ecuador. ANSP 218901.

A much larger species than *P. consanguineus* and also distinguished by its more trigonal shape, longer and straighter anterior side, and by its larger lunule which is not impressed in the middle.

Range—Panama southward to northern Peru. Panama: Búcaro; Puerto Mensabi. Colombia: Isla del Gallo. Ecuador: Jaramijo; Santa Elena. Peru: Boca Pan; Zorritos.

Pitar (*Pitar*) *fluctuatus* (Sowerby)

Plate 43, figures 7, 7a;
Plate 45, figures 5, 7

Cytherea fluctuata Sowerby, 1851, *Thes. Conch.*, vol. 2, p. 634, No. 79, pl. 136, figs. 185, 186 Santa Elena.—Römer, 1867, *Mongr. Molluskengattung Venus*, Linné, bd. 1, p. 122.

Circe fluctuata (Sowerby), Reeve, 1863, *Conch. Icon.*, vol. 14, *Circe*, pl. 9, fig. 36.

Pitar (*Pitar*) *fluctuatus* (Sowerby), Hertlein and Strong, 1955, *Bull. Amer. Mus. Nat. Hist.*, vol. 107, art. 2, pp. 189, 190, pl. 2, figures 10, 15, 19.

Shell small or medium-sized (length about 33 mm.), rounded, ovate in form, cordate, with high, convex, full umbones ending in small, adjacent beaks placed near the anterior one-third. The lunule is large, more deeply impressed in the middle, and outlined by a faintly incised line. Anterior end is widely rounded, its outline accentuated by the deep lunule, the posterior end more narrowly rounded to crudely subquadrate in shape. Surface marked with fairly coarse, concentric threads; the color in our specimens

cream-white, uniform, or in concentric bands due to small difference in shade and intensity. Cavity of the shell white, the adductor scars subequal and distinct, the pallial sinus small, extending not quite to the middle.

Length 32 mm., height 26.4 mm., diameter 19.6 mm. Guanico, Panama.

Length 32.6 mm., height 26.4 mm., diameter 18.6 mm. Santa Elena, Ecuador.

There is some uncertainty as to the identification of this species. The specimen described and figured by Sowerby in the *Thesaurus* represents a small shell marked with arrow-shaped lines on the umbones and its outline is also more rounded. Hertlein and Strong's figure also shows a small shell with stronger markings.

Our specimens resemble *P. consanguineus* (C. B. Adams) but they differ by their larger, fuller umbones, and the anterior end appears more inflated and rounder. All our shells are white or plain, without zigzag markings.

Range—Panama to Ecuador. Panama: San Carlos, Guanico. Ecuador: Charapota; Manta; Santa Elena.

Pitar (Pitar) helenae, new species

Plate 45, figures 2, 2a

Shell small or medium in size, ovate, cordate, with full, convex umbones placed near the anterior one-third, the small beaks adjacent, the two ends similar, the anterior one being more narrowly rounded. Lunule large, cordate, impressed, defined by a weak line. Surface plain, smooth or irregularly wrinkled by concentric lines. Base color of the shell is a light cream, heavily rayed with brown rays and angular markings, the beaks stained with purple and a median lighter ray. Valve margins smooth. Interior white, or faintly blotched with purple in the umbonal cavity. Pallial sinus rather large but not long, broadly rounded at the end.

Length 23.8 mm., height 19.3 mm., diameter 14.2 mm. Vicinity of Pearl Islands, Panama. Holotype, ANSP 218899.

Named as a tribute to Mrs. Helen Lee Beil, an enthusiastic collector of Panamic shells.

Range—Panama. Panama: probably in the vicinity of Pedro Gonzalez Island, Pearl Islands, Panama.

Subgenus **HYPHANTOSOMA** Dall, 1903

Type species by original designation, *Cytherea carbasea* Guppy. Miocene of Jamaica.

Shell like *Pitar*, *s.s.* in shape and color but with a series of small arrow-shaped or zigzag punctations, irregularly distributed over the whole surface.

Pitar (Hyphantosoma) hertleini, new species

Plate 45, figures 6, 6a

Shell ovate, quite convex, relatively thin, umbones prominent, full, with the small beaks placed at the anterior one-third. The shell is broadly ovate in shape, the anterior-dorsal margin straight, descending, and when viewed from within, its end appears rounded, its posterior side longer, higher and expanded, its margin rounded. Lunule large, elliptical in shape, defined by a weak line. Surface smoothish, except for fine lines of growth

and more widely spaced deeper lines indicating rest periods. Under the lens, obscure zigzag grooves and pits are evident, best developed on the posterior slope. Base color of shell is a delicate cream, penciled with a pattern of fine, zigzag, brown lines and with two or more radial rays, the pattern not the same on both valves. Interior white, the pallial sinus extends nearly to the middle, rather broad, rounded at the end. Adductor scars subequal in size.

Length 35.9 mm., height 29.1 mm., diameter 19.5 mm. (double valves). Gorgona Island, off the coast of southwestern Colombia. Holotype, ANSP 218921.

This is probably the species recorded by Hertlein and Strong from Gorgona Island as *P. pollicaris*; also by Dall from Panama and Peru. It differs from true *P. pollicaris* by its smaller, thinner, and more convex valves as well as stronger coloration.

Range—Panama southward to northern Peru. Colombia: Gorgona Island. Ecuador: Manta. Peru: Paita.

Pitar (*Hyphantosoma*) *pollicaris* (Carpenter)

Plate 49, figures 7, 7a

Dione prora var. Reeve, 1863, Conch. Icon., vol. 14, *Dione*, pl. 10, fig. 45. (Not of Conrad, Hawaii). Cape St. Lucas, Xantus, Lower California.

Callista pollicaris Carpenter, 1864, Ann. and Mag. Nat. Hist., ser. 3, vol. 13, p. 312, reprinted in Smith. Misc. Coll., 1872, No. 252, p. 210. New name for *Dione Prora* var. of Reeve.—Verrill, 1870, Amer. Jour. Sci., vol. 49, p. 219.

Pitaria pollicaris (Carpenter), Dall, 1902, Proc. U.S. Nat. Museum, vol. 26, No. 1312, p. 387.

Pitar (Hyphantosoma) pollicaris (Carpenter), Hertlein and Strong, 1948, Zoologica, vol. 33, pt. 4, p. 173.

Adult shell large (67 mm.), rather solid, subporcellaneous, widely ovate-lenticular in shape, the anterior side narrowed and somewhat produced, rounded at the end, the posterior side longer, widely truncated at the end. The valves are only moderately inflated, externally marked with fine, concentric lines of growth and with an occasional deeper line marking a rest period, surface otherwise appearing smooth, but some perfect specimens may also show brown, zigzag markings, interspersed with radial rays.

Length 65.5 mm., height 57.15 mm., diameter 36.3 mm. Carpenter's type, USNM 12721.

This is a large, thick-shelled, subporcellaneous species, smoothish but with irregularly spaced, deep, concentric lines and sometimes faint divaricate grooves or pits, especially on the posterior-dorsal slope which is depressed or mildly excavated. The pallial sinus is deep, wide, and rounded. Lunule deep, narrowly lenticular, and outlined by an incised line.

This is a species of the Gulf of California. Records to the south, such as that of Dall from Callao, Peru, are questionable.

Pitar (*Hyphantosoma*) *aletes* Hertlein and Strong

Plate 49, figure 9

Pitar (Hyphantosoma) aletes Hertlein and Strong, 1948, Zoologica, vol. 33, pt. 4, pp. 172, 173, pl. 1, figs. 9, 11, 12, 13.

Shell solid, roundly trigonal, plump, uniformly white; beaks prominent, anteriorly directed over a large cordate lunule defined by a fine impressed line; anterior dorsal margin short, straight, posterior dorsal margin sloping, arched, with a shallow depression on each side of the hinge line and ex-

tending to the posterior end; ends and ventral margin rounded; exterior surface ornamented by fine lines of growth, strongest near the margin, very faint near the beaks, crossed by numerous, almost microscopic, radial grooves which divaricate along radial lines extending from the beaks to the posterior and anterior ends of the basal margin, obsolete near the beaks; hinge and ligament strong, normal for the genus and subgenus; pallial sinus short, fairly wide, rounded at the end, ascending, projecting forward to about one-third the length of the shell; interior white; margin smooth.

Length 53.8 mm., height 46 mm., convexity (double valves) 34.2 mm. (Hertlein and Strong, 1948.)

This species is somewhat similar to *P. pollicaris* but is higher in proportion to its length, more trigonal in shape, and more convex. It also resembles *P. carbaseus* Guppy from the Miocene of Jamaica. It is evidently a rare species.

Range—Gulf of California, south to Costa Rica.

Genus AGRIOPOMA Dall, 1902

Type species by original designation, *Cytherea texasiana* Dall. Plate 40, figure 1. Gulf of Mexico.

Shell cordate, convex, thin, inequilateral, with large, full umbones, the beaks placed anteriorly and noticeably recurved. The lunule is large, heart-shaped, defined by a faint line. Color is usually a gray white, smooth or chalky, and marked with fine, concentric growth threads. The hinge pattern is like that of *Pitar* and *Lamelliconcha* with three cardinal teeth in each valve and a small, pimple-like, anterior lateral tooth in the left valve, widely removed from the nearest cardinal tooth by an open or empty pit. In the right valve, the upper ends of the anterior and posterior cardinal teeth are joined together and form a single, large, hook-shaped lamina and which extends over the central cardinal tooth like a roof, the tooth standing wholly free below it. In the left valve, the anterior and central cardinal teeth are joined and form an unequal sided, inverted V, the central arm of which is the larger and heavier: above, the apex of this V-shaped tooth is separated from the hinge margin by a deep, narrow sulcus. The pallial sinus is deep, its end sharp.

This genus differs from *Pitar* in that the upper ends of the cardinal teeth do not touch the margin above but stand free and separated from the margin by a deep, narrow slit or sulcus; also by the much smaller, anterior lateral tooth bordered behind by a false socket.

Subgenus PITARELLA Palmer, 1927

Type species by original designation, *Pitaria gatunensis* (Dall). Miocene of Panama and Panama Canal Zone.

Like *Agriopoma*, *s.s.*, the shell is cordate in shape, convex, thin, its surface smooth or marked with crowded, concentric threads. Lunule is heart-shaped, bordered by a fine line. Hinge similar to that of *Agriopoma*, *s.s.*, but with the anterior side of the hinge plate shorter as if cut off or excavated by the deep, anterior adductor scar, hence, the anterior scar is crowded against the cardinal teeth, its dorsal side forming a curved transverse lamella joined at its end to the base of the cardinal tooth forming a deep, empty space or pit above it.

A good hinge of *A. gatunensis*, the type species of *Pitarella*, has not been available during this study, but the same features are shown equally as well by its Recent analogue, *A. catharia* (see Pl. 40, fig. 2). In the right valve, the upper rim of the anterior lateral socket forms a transverse lamina which connects directly with the base of the adjacent cardinal tooth, thus dividing the socket space into two sections, the upper one empty. *Pitarenus* Rehder and Abbott, 1951 is similar to *Pitarella*, but it lacks the transverse lamina between the lateral socket and the cardinal tooth. The ventral margins of valves of *Pitarenus* are obscurely crenulated.

Agriopoma (Pitarella) catharia (Dall)

Plate 40, figure 2;
Plate 49, figures 5, 5a

Callocardia (Agriopoma) catharia Dall, 1902, Proc. U.S. Nat. Museum, vol. 26, No. 1312, p. 402, pl. 14, fig. 3 "Bay of Panama, 30 fthms."—Hertlein and Strong, 1948, Zoologica, vol. 33, pt. 4, p. 177, pl. 2, figs. 14, 15.

Pitar (Pitarella) catharius (Dall), Hertlein and Strong, 1955, Bull. Amer. Mus. Nat. Hist., vol. 107, art. 2, pp. 190, 191, pl. 1, figs. 5, 6, 7, 8, 9, 10; pl. 2, fig. 24.

Shell large (length 50 to 60 mm.), white, strongly convex with large, full umbones and the beaks slightly coiled and directed anteriorly over a large, cordate lunule outlined faintly by a line. In shape, the shell is somewhat variable from nearly rounded forms to others with the posterior side somewhat produced and its margin weakly sinuated. The surface is colored white, often somewhat earthy or chalky, more or less shiny in the middle and marked with fine, close, concentric threads between narrowly grooved interspaces, these concentrics usually coarser on the two ends, often subobsolete in the middle so that the surface of the beaks and midzone of the shell appears smooth and polished. Interior mostly white but in some cases with a faint salmon flush in the cavity of the beaks. Adductor scars are fairly small, subequal, the posterior one a little more rounded and with the pallial line running near the margin, its sinus exceptionally wide and shallow, bluntly rounded at the end.

A typical specimen measures, length 53.8 mm., height 44 mm., diameter 33.3 mm. Bay of Panama.

This species is related to *A. gatunensis* (Dall) from the Gatun Miocene of Panama and the Canal Zone but the fossil shell is usually smaller, longer, and more inflated. *A. (Pitarella) tumbuzana* Olsson from the Miocene of northern Peru, is another closely related species.

Pitar tomeanus Dall, 1902, a Chilean species, has been recorded by Dall and others from the Panama region, but the occurrence seems doubtful; the small shells figured as such by Hertlein and Strong, 1955 (*op cit.*, p. 190, pl. 2, figs. 1, 2, 5, 6) seem to be young specimens of *A. catharia*; similar shells are in my collection from several places along the coast of Ecuador.

Range—Lower California south to Ecuador. Panama: Bay of Panama, (shrimpers); as fossil at Charco Azul. Colombia: Octavia Bay (Hertlein and Strong). Ecuador: Esmeraldas.

Agriopoma (Pitarrella) mexicana (Hertlein and Strong)

Pitar lenis Pilsbry and Lowe, 1932, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, p. 100, pl. 16, fig. 6 Acapulco, 20 fms., also Guaymas, 20 fms. (Not *Pitaria lenis* (Conrad) (as *Cytherea lenis* Conrad, 1848).)
Pitar (Pitarrella) mexicanus Hertlein and Strong, 1948, Zoologica, vol. 33, pt. 4, pp. 171, 172, pl. 1, figs. 3, 8.

Shell elongately oval, rather thin, white, exteriorly resembling *Compso-myax subdiaphana* (Carpenter); ornamented with close, fine, concentric riblets over the whole valve or subobsolete medially; lunule large, cordate, bordered by an incised line; hinge of left valve with 3 cardinals and an anterior lateral tooth, the anterior and middle cardinals are joined dorsally, the middle one is longer and thicker, a pit occurs at the base, the posterior cardinal is elongate and thin, the lamella forming the middle and anterior cardinals bears slight irregularities or cusps, the anterior lateral with 2; hinge of right valve with a high thin anterior cardinal connected with a bifid posterior cardinal, the middle cardinal is separated from the anterior cardinal by a narrow space but separated from the posterior cardinal by a much wider space, anteriorly there are two low laterals separated by a pit; pallial sinus short, wide, ascending, rounded at the end. Dimensions: length 42.3 mm.; height 33.3 mm.; convexity (both valves together), 25 mm.; pallial sinus projects forward approximately 20 mm. from the posterior margin. Holotype (Calif. Acad. Sc. Paleo.). 4 miles south-southwest of Maldonado Point, Mexico in 26 fthms. (Hertlein and Strong, 1948.)

This species differs from *A. catharia* by its longer posterior side. When small, the posterior-ventral margin is often slightly insinuated; such a small shell was figured by Pilsbry and Lowe under the name *Pitar lenis* (pre-occupied by Conrad); a small shell of this type is in my collection from the Pleistocene of Rabo de Puerco, Puerto Armuelles, Panama. Hertlein and Strong give many stations for this species north of Panama.

Range—Gulf of California to Ecuador. Ecuador: Esmeraldas.

Genus **TRANSENNELLA** Dall, 1883

Type species by monotypy, *Transennella conradina* Dall. Recent, Florida.

Shell usually small, subtrigonal to subovate, subsolid, smooth and polished or concentrically sculptured. Hinge with three cardinal teeth in each valve; an anterior lateral tooth is present in the left valve and received in a lateral socket in the right. Lunule subelliptical, defined by a small, incised line, no escutcheon. Nymph narrow and smooth. Pallial sinus angular, extending into the interior about a third. Inner margins of valves without crenulations but grooved tangentially with numerous incisions or sulci.

A genus composed mostly of small species, recognized readily by the small incised lines or grooves which cut across the ventral margins tangentially or in an oblique direction.

Transennella modesta (Sowerby)

Plate 46, figures 4-4b

Cytherea modesta Sowerby, 1835, Proc. Zool. Soc. London, p. 47 Xipixapi.—Sowerby, 1851, Thes. Conch., vol. 2, p. 627, pl. 136, fig. 184 (as *Cytheraea*).

- Venus cumingii* d'Orbigny, 1846, Voy. Amér. Mérid., vol. 5, 3d pt., Mollusques, p. 563. (New name for *C. modesta* Sowerby. Not *Venus modesta* Dubois, 1831).
Transennella sororcula Pilsbry and Lowe, 1932, Proc. Acad. Nat. Sci. Philadelphia, vol. 34, p. 102, pl. 9, figs. 12-16 San Juan del Sur, Nicaragua. (As *Macrocallista sororcula* on plate index).
Transennella sororcula Pilsbry and Lowe, Hertlein and Strong, 1948, Zoologica, vol. 33, pt. 4, No. 13, p. 170.

Shell ovate, convex, small or of medium size (usually between 15 to 25 mm. in length), solid, porcellaneous, the umbones prominent and placed at about the anterior one-third. The surface is rather deeply but unevenly grooved concentrically forming low, rounded riblets, strong near the ventral margin, subobsolete above, the general surface glossy. Color white or brown, more often variegated with zigzag lines and triangles of brown on a white base. Interior white irregularly stained with violet.

Length 22.5 mm., height 18.2 mm., diameter 12.8 mm. Búcaro, Panama.

Range—Gulf of California to Ecuador. Panama: Pearl Islands (several stations); Búcaro.

Transennella pannosa (Sowerby)

Plate 46, figure 3

- Cythera pannosa* Sowerby, 1835, Proc. Zool. Soc. London, p. 47.—Sowerby, 1851, Thes. Conch., vol. 2, *Cytherea*, p. 635, No. 82, pl. 133, figs. 140-142.
Macrocallista pannosa (Sowerby), Dall, 1909, Proc. U.S. Nat. Museum, vol. 37, No. 1704, p. 266.

Length of an average shell between 28 to 30 mm., ovate, resembling a small *Macrocallista*, the umbones and beaks near the middle and rounded, subequal ends, moderately convex, subsolid. The surface is smooth and polished but the umbones and beaks are frequently corroded and chalky. Color varies from a fine mahogany brown to a greenish yellow, often with superimposed radial rays and arrow-shaped markings. Pallial sinus short, extending to about the one-third, broadly or obliquely truncated at the end.

This is a species of the Peruvian faunal province; records further north in Panamic waters are questionable.

T. puella Carpenter from Lower California and *T. galapagana* Hertlein and Strong from the Galapagos, were compared with *T. pannosa* by Hertlein and Strong but appear to be smaller species.

Range—Callao, Peru south to Chile. Peru: Paracas.

Genus TINCTORA Jukes-Brown, 1914

(*Callizona* Jukes-Brown, 1913, preoccupied by *Callizona* Doubleday, 1848, Lepid., and Greeff, 1875.)

Type species by original designation, (*Callizona* Jukes-Brown, 1913), *Cythera vulnerata* Broderip.

Shell suborbicular, solid, the surface ridged concentrically and glossy. Hinge similar to that of *Pitar*, the anterior and posterior teeth joined above to form a single lamina, the middle cardinal tooth below it. Pallial sinus short, narrow, rounded at the end. Ventral margins crenulated.

Tinctora vulnerata (Broderip)

Plate 45, figures 4, 4a

- Cytherea vulnerata* Broderip, 1835, Proc. Zool. Soc. London, p. 46 Real Llejos.—Sowerby, 1851, Thes. Conch., vol. 2, p. 632, pl. 131, figs. 95, 96 (as *Cytherea*).
Dione vulnerata (Broderip), Reeve, 1863, Conch. Icon., vol. 14, *Dione*, pl. 5, figs. 16a, 16b.
Pitaria vulnerata (Broderip), Dall, 1902, Proc. U.S. Nat. Museum, vol. 26, p. 399.—Maxwell Smith, 1944, Panamic Marine Shells, p. 60, fig. 782.
Pitar (*Tinctora*) *vulneratus* (Broderip), Hertlein and Strong, 1948, Zoologica, vol. 33, pt. 4, No. 13, pp. 176, 177.

Shell suborbicular, solid, moderately convex, with fine concentric ridges, interspaced with deeper resting marks. The color of the surface is white or cream, often pencilled or mottled with brown lines, best seen on the umbones, and the resting lines show often as deeper colored rings of violet or purple. Interior white, porcellaneous, the ventral margins irregularly crenulated.

Length 47.6 mm., height 45 mm., diameter 29.9 mm. Holotype, British Museum (Nat. Hist.).

Range—Gulf of California southward to Panama. Panama: Pearl Islands.

Genus **HYSTEROCONCHA** Dall, 1902

(Dione Gray, 1847, not of Hübner, 1816, and others.)

Type species by original designation, *Venus dione* Linné. Recent, Caribbean.

The shell is ovate to trigonal, moderately convex to compressed, thin or solid. The lunule is small, cordate, impressed, bordered by an incised line, smooth, the escutcheon is less well defined and is represented merely by a narrow, flat area without sculpture along the dorsal margin. The hinge as in *Pitar*, the anterior lateral tooth placed near the cardinals. The right anterior, cardinal tooth is small, narrow, and vertical, joined above to the posterior, cardinal tooth to form a vault-like roof over the middle cardinal tooth beneath it. The surface is neatly sculptured with evenly spaced, concentric ridges of which the alternate ones become elevated or lamellose on the anterior slope; on the posterior-umbonal slope, the concentric ridges end sharply while each third or fourth one is prolonged or enlarged into a long, slender spine, or in some species ends in a short stump or scale. The color is usually some shade of purple or violet, sometimes a salmon-rose, more rarely completely white. Pallial sinus is large and ample, extending to or beyond the middle of the valve.

Key to species of Panamic-Pacific *Hysteroconcha*

- I. With lines of large spines on the posterior-dorsal slope, one row along the umbonal angle, the other in the middle.
 1. Shell large, subovate in shape, the concentric riblets usually weak or smoother across the middle of the disk. Color a violet-brown or purple.
H. lupanaria
 2. Shell smaller, elongate ovate in shape, the concentric riblets more elevated, lamellose, continuous across the disk, and rather harsh to the touch. Surface less strongly colored.
M. multispinosa

- II. Without large spines, the posterior-umbonal angle armed only with small, short spines or scaly nodes at the end of some concentrics. The posterior-dorsal area undivided.
3. Color white. Concentric riblets rather coarse, some divided at the umbonal angle.

H. brevispinosa

4. Surface of shell more strongly colored in shades of violet or chestnut red, the lunule and posterior-dorsal slope deeper colored. Concentric riblets fine and numerous.

*H. rosea***Hysteroconcha lupanaria** (Lesson)

Plate 47, figures 1-1c

Cytherea lupanaria Lesson, 1830, *Centurie Zool.*, p. 196, pl. 64 (four figures.) Between Colan and Payta, northern Peru.—Lesson, 1830, *Voy. Coquille, Zool.*, vol. 2, pt. 1, p. 430.

Cytherea Dione var. Broderip, 1835, *Proc. Zool. Soc. London*, pp. 45, 46 Salango and Tumbez.

Cytherea lupanaria Lesson, Sowerby, 1851, *Thes. Conch.*, vol. 2, p. 632, No. 69, pl. 132, fig. 11.

Dione lupanaria (Lesson), Römer, 1868, *Monogr. Molluskengattung Venus*, Linné, bd. 1, 5. Sectio: *Dione* Gray, pp. 130-132, pl. 34, figs. 2, 2a, 2b.

Pitar (Hysteroconcha) lupanaria lupanaria (Lesson), Maxwell Smith, 1944, *Panamic Marine Shells*, p. 60, fig. 784.

Pitar (Hysteroconcha) lupanarius (Lesson), Hertlein and Strong, 1948, *Zoologica*, vol. 33, pt. 4, No. 13, pp. 173, 174.

Dione semilamellosa Gaudichaud, Reeve, 1863, *Conch. Icon.*, *Dione*, vol. 14, pl. 6, figs. 20a, 20b, 20c.

Dione exspinata Reeve, 1863, *idem*, pl. 6, fig. 24.—Römer, 1868, *idem*, pl. 35, fig. 1 (as *lupanaria (exspinata)*).

Shell often large, ovate, triangular, the beaks nearer the anterior end, the posterior side, therefore, longer, its dorsal margin convex. The surface is sculptured with concentric riblets or lamellae, which may be strong and uniform over the whole disk, or they may become partly obsolete or lower across the middle. On the anterior slope, the alternate riblet is the larger and more lamellose. The posterior-umbonal angle bears a row of large, purple spines (often broken off) which appear to stand backwards and a second row of fewer and smaller spines runs through the middle of the posterior-dorsal area. Most specimens are colored a purple-red or a violet-brown, the space between the spines white, the lunule and posterior-dorsal slope colored a deep purple; rarely, the shell may be pure white or with only minor patches of pale purple.

Length 53 mm., height 42.5 mm., diameter 28 mm. Negritos, Peru.

Length 69 mm., height 55 mm., semidiameter 17.5 mm. A left valve, Santa Elena, Ecuador.

This is the common "*Dione*" along the coast of Peru and Ecuador and often attains a length of 70 mm. or more. It is a higher and more rounded form than *H. multispinosa*. In young shells, the concentric riblets are strong over the whole surface but with growth, they become lower and subobsolete over the middle of the disk. The color is usually a rich, mahogany-brown grading into violet red or purple on the sides.

Range—Lower California to northern Peru. Panama: Guanico, Colombia: Isla del Gallo. Ecuador: Mompiche; Manta; Manglaralto; Santa Elena. Peru: Tumbez; Zorritos; Boca Pan; Mancora; Lobitos; Negritos; Paita.

Hysteroconcha multispinosa (Sowerby)

Plate 47, figures 2-2d

- Cytheraea multispinosa* Sowerby, 1851, *Thes. Conch.*, vol. 2, p. 632, No. 70, pl. 132, fig. 112 Tumbes, Peru; in soft mud, at ten fathoms "Tumbes, Peru."
Dione multispinosa (Sowerby), Reeve, *Conch. Icon.*, vol. 14, *Dione*, pl. 6, fig. 22.—Römer, 1868, *Monogr. Molluskengattung Venus* Linné, vol. 1, 5 sectio: *Dione* Gray, pp. 132, 133, pl. 35, figs. 2, 2a, 2b, 2c.
Pitar (Hysteroconcha) lupanaria multispinosa (Sowerby), Maxwell Smith, 1944, *Panamic Marine Shells*, p. 60, fig. 774.

Like *H. lupanaria* but smaller (50 mm. or less), longer ovate, the concentric riblets more numerous, thinner and higher along their whole length, and generally sharp and harsh to the touch. Along the anterior submargin, the alternate riblets are elevated into high, thin lamellae. The valves are usually colored a grayish white, lightly stained with yellow, brown or violet, never as strongly colored as *H. lupanaria*. Spines are large and slender.

Length 40.1 mm., height 31.6 mm., diameter 24.5 mm. Búcaro, Panama.

This species resembles *H. dione* (Linné) from the Caribbean but is somewhat longer and has fewer, heavier, and more widely spaced concentric riblets while the spines along the posterior angle are fewer in number.

Range—Mexico to northern Peru. Panama: Búcaro; Guanico. Ecuador: Limones; San Francisco. Peru: Tumbes.

Hysteroconcha brevispinosa (Sowerby)

Plate 47, figures 4, 4a

- Cytheraea brevispinosa* Sowerby, 1851, *Thes. Conch.*, vol. 2, p. 632, No. 71, pl. 132, fig. 109 California?
Dione brevispinata Reeve, 1863, *Conch. Icon.*, vol. 14, pl. 6, fig. 21.
Dione brevispinosa (Sowerby), Römer, 1868, *Monogr. Molluskengattung Venus*, Linné, bd. 1, 5 Sectio: *Dione* Gray, pp. 133, 134, pl. 35, fig. 3.

Shell ovate, the beaks near the anterior one-third, subsolid, compressed or slightly convex, white. Sculpture is formed by relatively large, foldlike concentrics, even and uniform over most of the surface but near the posterior-umbonal angle occasionally divide or fork while on the anterior side, the alternate ones become narrowly lamellose. The concentrics end abruptly at the umbonal angle, their ends enlarged into short scales. Posterior-dorsal slope flattened or slightly rounded, smoothish.

Length 44.8 mm., height 37.7 mm., diameter 10 mm. (left valve, Esmeraldas).

Rare and local. I have seen specimens only from Ecuador and southern Colombia.

Range—Gulf of California to Ecuador. Colombia: Isla del Gallo. Ecuador: Port Limones; Esmeraldas; Sua; San Francisco.

Hysteroconcha rosea (Broderip and Sowerby)

Plate 47, figures 3-3d

- Cytherea rosea* Broderip and Sowerby, 1829, *Zool. Jour.*, vol. 4, No. 15, p. 364 St. Blas.—Sowerby, 1839, *Zool. Beechey's Voyage*, p. 151, pl. 43, fig. 7.—Philippi, 1847, *Abbild. und Beschreib. Conchylien*, bd. 2, *Cytherea*, pp. 181, 182, No. 6, pl. 5, fig. 6.
Cytherea rosea Broderip and Sowerby, Sowerby, 1851, *Thes. Conch.*, vol. 2, p. 132, No. 68, pl. 132, fig. 108.
Dione rosea (Broderip and Sowerby), Reeve, 1863, *Conch. Icon.*, vol. 14, *Dione*, pl. 7, fig. 29.—Römer, 1868, *Monogr. Molluskengattung Venus*, Linné, bd. 1, 5 Sectio: *Dione* Gray, pp. 134, 135, pl. 35, fig. 4.
Pitar (Hysteroconcha) rosea (Broderip and Sowerby), Maxwell Smith, 1944, *Panamic Marine Shells*, p. 60, fig. 755.
Pitar (Hysteroconcha) roseus (Broderip and Sowerby), Hertlein and Strong, 1948, *Zoologica*, vol. 33, pt. 4, No. 13, p. 174.

Shell ovate, the posterior side longer, the end bluntly rounded. The concentric lamellae are of medium-strength, flatly reflexed, wider than their interspaces, each eighth or tenth lamellae on the anterior slope, larger and more lamellose; they terminate sharply at the posterior-umbonal angle and there each third or fourth is raised to form a short spine. Color white, more often brown or chestnut-red, the lunule and the posterior-dorsal slope more deeply marked.

Length 47.9 mm., height 39.4 mm., diameter 10.5 mm. (right valve from Manglaralto, near Santa Elena.

Range—Gulf of California to northern Peru. Panama: Burica Peninsula; Gulf of Chiriqui; Guanico; Búcaro. Colombia: Isla del Gallo. Ecuador: Mompiche; San Francisco; Manglaralto; Santa Elena. Peru: Tumbes.

Genus *LAMELLICONCHA* Dall, 1902

Type species by original designation, *Cytherea concinna* Sowerby.

Shell trigonal or ovate, convex or subcompressed, thin or subsolid, sculptured concentrically with low, raised ridges or solid, rounded laminae which begin at the edge of the lunule and extend across the disk to the posterior-dorsal margin. Lunule cordate, deeply impressed, smooth; no escutcheon. The hinge is like that of *Pitar* or *Hysteroconcha* with a large, sharp, anterior lateral tooth in the left valve and its socket in the right. Pallial sinus large and deep. Color white or rose-brown, often with radial rays.

Key to species of *Lamelliconcha*

- I. Sculpture produced by low, rounded, rather solid and closely spaced concentric riblets.
 - A. Shell subovate to elongate in shape, the posterior side somewhat lower and produced, the posterior-ventral margin often indented or weakly sinuated. Umbones low and inconspicuous.
 - a. Posterior-dorsal submargin flattened and angled. Shell strongly colored.
 1. Subovate to trigonal in shape, convex, the concentrics numerous. *L. concinna*
 2. Usually longer and more compressed, the concentrics stronger. *L. paytensis*
 - b. Posterior-dorsal submargins rounded.
 3. Color usually white. *L. tortuosa*
 - B. Shell subovate, cordate, solid. Concentrics usually evanescent over the middle of the shell disk.
 4. Color a uniform white or brown. *L. unicolor*
- II. Surface sculpture more strongly lamellose, the concentrics forming thin, elevated, sharp-edged laminae. Shell generally rounded, cordate, with high, prominent umbones.
 - C. Concentrics numerous and closely spaced, uniform in strength or slightly alternate.
 5. Shell large (length 40 mm. or more), usually white or with the umbones rayed with violet. The lunule and escutcheon are colored chestnut-brown. *Group of L. circinata*
L. circinata alternata

6. Shell smaller (length 35 mm. or less), the surface uniformly colored white or violaceous-brown, the dorsal areas similar.

L. circinata vinaceous

- D. Concentrics higher and much more irregular, the individual lamella varying much in height and in spacing.

7. Shell subovate in shape, white in color.

L. callicomata

Lamelliconcha circinata alternata (Broderip)

Plate 48, figures 1-1b

Cytherea alternata Broderip, 1835, Proc. Zool. Soc. London, p. 45 Monte Christi.

Cytherea circinata var. *C. alternata* Broderip, Sowerby, 1851, Thes. Icon., vol. 2, *Cytherea*, p. 631, No. 65, pl. 132, fig. 104 West Colombia, Cuming.

Dione alternata (Broderip), Reeve, 1863, Conch Icon., vol. 14, *Dione*, pl. 7, figs. 28a, 28b. These figures are stated to be the types of Broderip's *alternata* and referred by Deshayes to *D. circinata*.—Römer, 1868, Monogr. Molluskengattung *Venus*, Linné, bd. 1, 5, Sectio: *Dione* Gray, pp. 136, 137, pl. 36, fig. 2.

Pitar (*Lamelliconcha*) *circinatus alternatus* (Broderip), Hertlein and Strong, 1948, Zoologica, vol. 33, pt. 4, No. 13, pp. 174, 175.

Shell trigonal-ovate, convex, the beaks placed at the anterior one-third, curved slightly forward, the posterior-dorsal margin arched, the anterior end well rounded. The lunule is small, cordate, deeply impressed and dark in color, even though the rest of the surface is white; there is no escutcheon, the dorsal margin bordered by a cord only. The surface is marked with strong, narrow concentric ridges of nearly uniform strength over most of the disk but they may show some alternation on the sides. The color of most specimens is white, except the lunule and the posterior-dorsal margins which are stained with chestnut red: some specimens (as many from Manta) have narrow, radial rays or lines across the umbones. The pallial sinus is large, rounded at the end and extends to about the middle of the shell cavity.

Length 44.7 mm., height 40.2 mm., diameter 27.4 mm. Santa Elena, Ecuador.

The Pacific shell described by Broderip as *Cytherea alternata* cannot consistently be separated from the common, Caribbean form of *L. circinata* (Pl. 48, fig. 3). In a large series of *L. alternata* from Manta and other nearby stations in Ecuador, the concentric lamellation of the surface sculpture is fairly uniform in size and spacing, only rarely do they show strong alternation. On the other hand, Caribbean shells, such as from the north coast of Panama and Costa Rica, may show the concentric lamellae alternating in strength to a marked degree; these Caribbean specimens then resemble fossil forms from the Miocene of the Dominican Republic.

L. circinata alternata is a common shell along parts of the Ecuadorian coast and occasional specimens may grow quite large (length 56 mm.), larger than any *L. circinata circinata* seen from the Caribbean. Most shells are white except for the lunule and posterior-dorsal submargins which are chestnut-brown. They may also show a series of small, red rays over the umbones as illustrated by Sowerby in the Thesaurus.

Range—Gulf of California to northern Peru. Panama: Burica Peninsula; Guanico. Colombia: Isla del Gallo. Ecuador: Manta; Sua; Santa Elena. Peru: Mancora.

Lamelliconcha circinata vinacea, new subspecies

Plate 48, figures 2-2b

Dione circinata Reeve, 1863, Conch. Icon., vol. 14, *Dione*, pl. 7, figs. 25a, b Mazatlan. Not of Born, 1780.

The shell is small or of medium size (35 mm. or less), ovately cordate, the umbones full and prominent, with the small beaks placed near the anterior one-fourth. The surface sculpture is formed by numerous, fairly strong, narrow and rather harsh concentric riblets, their tops thin and often slightly recurved; interspaces are wider than the riblets, both overrun by fine lines of growth. The anterior lateral tooth in the left valve large. The surface color is usually a violaceous brown or chestnut; more rarely white; the interior white or stained lightly with violet.

Length 35.6 mm., height 30.1 mm., diameter 10.1 mm. (a left valve). Charapota, Ecuador. Holotype, ANSP 218920.

Much smaller than *L. circinata alternata*, more ovate shape and usually of a different color.

Range—Mexico southward to Ecuador. Mexico: Mazatlan ANSP 175468. Panama: Panama City; Búcaro; Pearl Islands; Burica Peninsula. Colombia: Isla del Gallo. Ecuador: Mompiche; Sua; Charapota; Jaramijo; Manta; Puerto Callo; Santa Elena.

Lamelliconcha concinna (Sowerby)

Plate 48, figures 4-4c

Cytherea concinna Sowerby, 1835, Proc. Zool. Soc. London, p. 23 Panama.

Cytherea concinna Sowerby, 1851, Thes. Conch., vol. 2, p. 630, No. 64, pl. 132, figs. 99, 100.

Dione concinna (Sowerby), Reeve, 1863, Conch. Icon., vol. 14, *Dione*, pl. 8, figs. 31a, 31b. *Pitar* (*Lamelliconcha*) *concinna* (Sowerby), Hertlein and Strong, 1948, Zoologica, vol. 33, pt. 4, No. 13, pp. 175, 176.—Hertlein and Strong, 1955, Bull. Amer. Mus. Nat. Hist., vol. 107, art. 2, p. 192.

The typical form of *L. concinna* from Panama is a small shell although specimens may occasionally attain a length of about 40 mm. Shape is oblong ovate, moderately convex, the beaks placed near the anterior one-third, the posterior side narrowed and slightly produced, often with a weak depression extending along the front of the posterior-umbonal angle which thus slightly sinuates the ventral margin; the anterior side is well rounded. Color white or reddish chestnut, often radially rayed. Specimens from Santa Elena, Ecuador, are usually of heavier texture, white or violaceous brown, the lunule and posterior-dorsal area more deeply colored. The concentric riblets form low, rounded, solid ridges which generally extend uniformly over the whole surface except on the somewhat flattened posterior-dorsal submargin where they are reduced in number, the alternate riblet eliminated.

Length 40.3 mm., height 33.3 mm., diameter 22 mm. Santa Elena, Ecuador.

L. concinna, *L. paytensis*, and *L. tortuosa* have been regarded by some authors as subspecies of the same species. Extremes of the three are distinct and easily recognizable and hence they are dealt with here as separate but closely related species. Because of the confusion noted above, the range of *L. concinna* to the north of Panama is uncertain.

Range—Gulf of California ? south to northern Peru. Panama: Panama. Panama Canal Zone: Palo Seco. Ecuador: Santa Elena. Peru: Tumbes.

Lamelliconcha paytensis (d'Orbigny)

Plate 48, figures 6-6b

Cytherea affinis Broderip, 1835, Proc. Zool. Soc. London, p. 45 Xipixapi.
Cytherea affinis Broderip, Sowerby, 1851, Thes. Conch., vol. 2, p. 630, pl. 132, fig. 101.
Dione affinis (Broderip), Reeve, 1863, Conch. Icon., vol. 14, *Dione*, pl. 8, fig. 30.
Venus paytensis d'Orbigny, 1846, Voy. Amér. Mérid., vol. 5, 3d pt. Mollusques, p. 565.
 (New name for *affinis* Broderip, not *affinis* Gmelin, 1789, not *affinis* Matheron, 1842).

Shell elongate, the posterior side is much longer than the anterior, the posterior-dorsal and ventral margins approach each other so that the end is narrowly rounded or bluntly pointed, often slightly emarginate along its ventral margin. Surface compressed, sculptured with evenly spaced, narrow, solid concentrics, uniformly developed over the whole disk. The strength of these concentrics vary from relatively few and strong to more numerous and small. Color of shell is often a pure white or variously marked with wide or narrow rays of violet-red, the dorsal areas more deeply colored. The posterior-dorsal margins flattened.

Length 37.2 mm., height 25 mm., diameter 15.4 mm. Negritos, Peru.

Length 37.8 mm., height 26.1 mm., diameter 17 mm. Punta Ostiones, Esmeraldas.

Common and more widely distributed than *L. concinna* from which it is easily recognized by its longer shape; color usually white and is never as strongly rayed or marked with violaceous red as *L. concinna*. The sculpture is variable, the concentric riblets either strong and coarse or small and fine.

Range—Gulf of California ? southward to Peru. Panama: Puerto Armuelles; Búcaro. Ecuador: Punta Ostiones, Esmeraldas; Sua; Manta; Santa Elena. Peru: Tumbes; Punta Picos; Mancora; Negritos; Paita.

Lamelliconcha tortuosa (Broderip)

Plate 48, figures 5, 5a

Cytherea tortuosa Broderip, 1835, Proc. Zool. Soc. London, p. 45 Panama and Xipixapi.
Cytherea tortuosa Broderip, Sowerby, 1851, Thes. Conch., vol. 2, p. 630, pl. 132, fig. 103.
Dione tortuosa (Broderip), Reeve, 1863, Conch. Icon., vol. 14, *Dione*, pl. 12, fig. 61.
Pitar tortuosa (Broderip), Pilsbry and Lowe, 1932, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, p. 135.

This species resembles *L. concinna* in shape but is usually larger, heavier, and the posterior end is somewhat sinuated or twisted, and the normal color is white. The concentric lamellae are strong and may be developed uniformly over the whole surface, or they may show varying degrees of flexing below the posterior-umbonal angle as well as the introduction of short lamella between them. The posterior umbonal slope is well rounded.

Length 40 mm., height 32 mm., diameter 21.9 mm. Puerto Chame, Panama.

This is a distinctive species, usually found along mud flats so often present in front of a mangrove swamp where the waters may be partly brackish. The color is typically white, and the concentric riblets have a curious way of dividing as they cross the posterior half of the surface.

Range—Gulf of California to northern Peru. El Salvador: La Union, Gulf of Fonseca (ANSP). Costa Rica: Puntarenas (ANSP). Panama:

Garachine; Panama City; Rey Island, Pearl Islands; Puerto Chame. Panama Canal Zone; Amador Beach; Balboa; Palo Seco. Colombia: Buenaventura; Isla del Gallo. Ecuador: Puno Island. Peru: Tumbes.

Lamelliconcha unicolor (Sowerby)

Plate 40, figure 3;
Plate 49, figures 4, 4a

Cytherea unicolor Sowerby, 1835, Proc. Zool. Soc. London, p. 23 Real Llejos.—Sowerby, 1851, Thes. Conch., vol. 2, p. 629, pl. 131, figs. 90, 91 (as *Cytheraea*).

Cytherea ligula Anton, 1839, Verzeichniss der Conchyl., p. 7 no locality cited.—Philippi, 1844, Abbild. und Beschreib. Conchylien, bd. 1, heft. 6, *Cytherea*, p. 149, pl. 1, fig. 2.

Dione unicolor (Sowerby), Reeve, 1863, Conch. Icon., vol. 14, *Dione*, pl. 8, figs. 33a, 33b. *Pitar (Pitar) unicolor* (Sowerby), Hertlein and Strong, 1948, Zoologica, vol. 3, pt. 4, No. 13, p. 171.

Shell ovate, solid and heavy, slightly convex, the beaks placed near the anterior one-third, curved over a small, depressed, cordate lunule, the color a uniform white or vinaceous brown, the surface glossy. Sculpture is formed by low, rounded, concentric lamellae, uniform and strong on the umbones, the anterior submargins and along the posterior-umbonal angle, usually fading out across the middle of the disk. Faint radial striae are visible on some specimens. Posterior-umbonal slope is more or less angled, the surface above it slightly flattened or weakly rounded. Interior white, often clouded with vinaceous, the pallial sinus long and deep.

Length 54 mm., height 46.5 mm., diameter 26.8 mm. Guanico.

Range—Gulf of California to Ecuador. Panama: Búcaro; Guanico. Colombia: Buenaventura. Ecuador: Atacames; Sua; Jipijapi (Sowerby).

Lamelliconcha callicomata (Dall)

Plate 40, figure 4;
Plate 49, figure 6

Pitaria (Lamelliconcha) callicomata Dall, 1902, Proc. U. S. Nat. Museum, vol. 26, No. 1312, pp. 389, 402, pl. 16, fig. 8 (Bay of Panama).

Pitar callicomata Dall, Strong, Hanna and Hertlein, 1933, Proc. California Acad. Sci., ser. 4, vol. 21, No. 10, p. 118 Acapulco, Mexico.

Pitar (Lamelliconcha) callicomatus Dall, Hertlein and Strong, 1948, Zoologica, vol. 33, pt. 4, p. 175.—Hertlein and Strong, 1955, Bull. Amer. Mus. Nat. Hist., vol. 107, art. 2, pp. 191, 192.

Shell large or medium-sized, elongated ovate, moderately convex, white, rather earthy and covered with sharp, thin, concentric lamellar riblets, every third or fourth of which is larger and higher than the others; they are also somewhat higher along the anterior-umbonal slope. The primary riblets are widely spaced and generally show one or more, smaller, secondaries between them as well as still smaller tertiary threads between the latter. Lunule small, cordate, and nearly smooth. Interior pure white, the pallial sinus long, linguiform, its upper limb nearly horizontal. Internal margin of valves smooth.

Length 47.6 mm., height 36.7 mm., diameter 24.3 mm.

A distinctive species, often obtained by the shrimp fishermen.

Range—Coast of Mexico to Panama. Panama: Panama Bay in 14 fathoms of water (Dall, USNM); Bay of Panama (shrimpers, H. A. Johnson coll.); Gulf of Chiriqui (in 35-40 fathoms, Hertlein and Strong).

Subfamily VENERINAE Menke, 1830

Shell cordate, subtrigonal to well rounded, generally solid, often convex, and with prominent full umbones and prosogyrous beaks. Surface rarely smooth and glossy, more often marked with coarse, growth incrementals or large, concentric lamellae, radial riblets or both. Hinge plate heavy, usually with three cardinal teeth in each valve, sometimes supplemented by a small, rudimentary anterior lateral tooth. Lunule and escutcheon well defined, although wanting in some cases. Ventral margins crenulated.

Key to genera and subgenera of the *Venerinae*

- I. Hinge with three cardinal teeth in each valve but *without an anterior lateral tooth*. Pedal muscle scar below the anterior cardinal tooth is not deeply sunken.
 - A. An escutcheon is present in both valves.
 - Aa. Escutcheon is large, flattened or bevelled, equal in each valve. Pallial sinus small and short, hardly extending beyond the line of the posterior adductor scar. Anterior cardinal tooth in the right valve is small. Shell usually of trigonal shape and of solid texture.

Genus *Chione*

1. Shell trigonal in shape, the sculpture strongly cancellated by intersecting radial riblets and concentrics of nearly equal strength.

Subgenus *Chione*, s.s.

2. External sculpture formed by large concentric riblets, solid, and rounded over the middle of the disk, lamellose on the two ends.

Subgenus *Lirophora*

3. External sculpture formed by large, rounded, concentric undulations, pronounced on the umbones but become more or less obsolete ventrally. Radials sometimes present also. Color pattern variable.

Subgenus *Ilioichione*

- Ab. Escutcheon unequal, smaller in the right valve. The pallial sinus is large and deep. Anterior cardinal tooth in the right valve large. Shell cordate, thinner, the posterior end often produced and pointed.

4. Sculpture subreticulated, often with the concentric lamellae elevated and elaborately frilled or scalloped.

Genus *Chionopsis*

- B. An escutcheon is absent or restricted to the left valve.
 - Ba. The *escutcheon*, restricted to the left valve, is narrow, flattened. Posterior-dorsal margin of the right valve is often folded so that it overlaps the margin of the other at the distal end. Hinge like that of *Chione*, the *right anterior cardinal tooth* is small.

5. External sculpture formed by coarse, rounded, close-set, radial riblets crossed by widely spaced, concentric lamellations on the sides. Shells rounded and convex, the surface color pattern generally mottled.

Genus *Notochione*

6. External sculpture formed by much smaller radial riblets, noded, or cancellated by the concentrics.

Genus *Protothaca*

- 6a. Shell relatively large, white or drab in color, the external sculpture like that of a *Corbis* or *Fimbria*, the concentrics heavier on the anterior side. Cold-water.

Subgenus *Prothothaca*, s.s.

7. Shell smaller, the surface more highly colored, often with a varied and elaborate pattern. Warm waters.

Subgenus *Tropithaca*

Bb. The escutcheon is small, restricted to the left valve or wholly absent. Hinge has the *anterior cardinal tooth* in the *left valve*, high and *elongated* parallel to the lunular margin (resembles a lateral tooth) while the *basal arm* of the *central cardinal tooth* in the *right valve* is *narrowly prolonged* so as to connect with the lower rim of the anterior socket.

Bba. Shell a nestler or rock borer.

8. Valves irregular and distorted. External sculpture is formed by widely spaced concentric lamellae with smaller radials in the interspaces.

Genus *Paphonotia*

Bbb. Shell free, its valves not distorted.

Bbba. Lunule large and cordate in shape, defined by an incised line. Escutcheon small and restricted to the left valve.

Genus *Nioche*

9. External sculpture formed principally by scabrous or rasplike radial riblets.

Subgenus *Nioche*, *s.s.*

10. Shell rounded and convex, the external sculpture cancellated (*Antigona*-like).

Subgenus *Antinioche*

Bbbb. Lunule and escutcheon both absent.

11. Shell subquadrate, oblique. Color white and generally chalky.

Genus *Colonche*

II. Hinge with a *small*, sometimes *nearly obsolete anterior lateral tooth* in the left valve (placed close to the base of the cardinal socket) and with or without a lateral socket or pit in the right valve. *Pedal muscle scar*, below the anterior cardinal tooth, is *deeply sunken* into the hinge plate.

C. Shell oblong or rounded, convex, often solid. Surface strongly sculptured with coarse concentric ridges or lamellae.

c. Anterior-lateral tooth of the left valve strong, its socket or pit in the right valve usually visible.

Genus *Antigona*

12. Interspaces between the concentric lamellae marked with strong radial cords or lines.

Subgenus *Antigona*, *s.s.*

Not regional.

13. Interspaces between the concentric lamellae marked only with fine concentric threads.

Subgenus *Ventricolaria*

ca. Anterior-lateral tooth of left valve small or subobsolete.

14. Sculpture formed by strong, reflexed concentric lamellae, crenulated and with strong radial cords in their interspace.

Genus *Periglypta*

Genus *ANTIGONA* Schumacher, 1817

Type species by monotypy, *Antigona lamellaris* Schumacher (*Dosinia lamarckii* Gray, 1838). Indo-Pacific.

Shell of medium size, subtrigonal to elongate subovate in form, the posterior end truncate. Lunule large, deep, limited by an incised line. Escutcheon excavated, narrow, and long. Valves convex. Each valve has three cardinal teeth, the right posterior and the left middle teeth bifid and

with a small anterior lateral tooth in the left valve and its socket in the right. External sculpture formed by distant concentric lamellations frilled by radials. Pallial sinus small and of triangular shape.

Subgenus **VENTRICOLARIA** Keen, 1954
(*Ventricola* of most American authors.)

Type species by original designation, *Venus rigida* Dillwyn. Recent, Florida and the Caribbean.

Shell generally large, rotund, solid, the surface sculptured with coarse, concentric lamellar riblets, their crests sharp or reflexed and marked with fine, concentric threads in their interspaces; there are no radials. Lunule is deeply sunken, smooth, and flat. The ventral margins are finely crenulated.

This group of species has generally been referred to the subgenus *Ventricola*, after Dall's selection of *Venus rugosa* Gmelin, 1798 (= *V. rigida* Dillwyn, 1817, not *V. rugosa* Linné, 1767), as type species. As shown by Myra Keen, 1954 (Jour. Paleontology, vol. 28, p. 217), there is an earlier type designation for *Ventricola* Römer, 1867, namely that of Kobelt, 1881. Kobelt selected *Venus verrucosa* Linné, 1758 which makes *Ventricola* an absolute synonym of *Venus*.

Antigona (Ventricolaria) isocardia (Verrill)

Plate 50, figure 2

Venus isocardia Verrill, 1870, Amer. Jour. Sci., vol. 49, No. 146, p. 221 near La Paz. *Cytherea (Ventricola) rigida* Dillwyn, Dall, 1902, Proc. U.S. Nat. Museum, vol. 26, p. 390.

Antigona (Ventricola) isocardia (Verrill), Hertlein and Strong, 1948, Zoologica, vol. 33, pt. 4, No. 13, pp. 178, 179, pl. 2, figs. 2, 3.

Shell large, solid, cordate, convex, rotund, the surface sculptured with strong, coarse, elevated, concentric ridges or lamellae, their crests rounded, flattened, or reflexed. On fully grown specimens, the concentric riblets are spaced about two millimeters apart and separated from each other by a deep, flat interspace; the surface of the interspace is often marked with three to six, strong, concentric cords. Fresh specimens show no radial striation but such may appear on the surface of weathered shells. The lunule is small and deep, its surface marked with coarse, crowded concentrics. The left valve has a flat escutcheon; it is absent from the right valve. Color is usually a creamy white overrun with a faint pattern of zigzag lines and larger blotches of light brown, the beak and interior often flushed with pink.

Length 82.3 mm., height 78.5 mm., semidiameter 27.4 mm. a right valve. Burica Peninsula, Panama.

This species is questionably distinct from *A. rigida* (Dillwyn) from Florida and the West Indies.

Range—Gulf of California to Ecuador. Panama: Burica Peninsula; Coiba Island (USNM); Gulf of Chiriqui (USNM). Colombia: Gorgona Island (Hertlein and Strong). Ecuador: Manta; Isla la Plata.

Antigona (Ventricolaria) isocardia magdaleneae (Dall)

Cytherea (Ventricola) magdaleneae Dall, 1902, Proc. U. S. Nat. Museum, vol. 26, No. 1312, pp. 390, 403, pl. 15, fig. 6 off Magdalena Bay on west shore of Lower California.

Antigona (Ventricola) isocardia magdalenae (Dall), Hertlein and Strong, 1948, *Zoologica*, vol. 33, pt. 4, p. 179.

According to Dall, 1902, this is the Pacific analogue of *A. strigillina* of the Atlantic fauna, but thinner, less inflated, with more delicate sculpture, and pale yellowish coloration spattered with brown flecks. According to Hertlein and Strong, young shells differ from those of *A. isocardia* in having a more elongated form and a finer sculpture but in other respects, they considered the resemblance to *A. isocardia* so great as to justify only a sub-specific separation.

Range—Along the west coast of Lower California and into the Gulf of California. Dall also recorded this species from Panama Bay in 18 fathoms, but this occurrence has not been checked.

Genus PERIGLYPTA Jukes-Browne, 1914

Type species by original designation, *Venus puerpera* Linné.

Shell medium size to large, subovate, rotund, convex, and with a cancellate sculpture of large, narrow, rounded, concentric ridges, their sides and tops frilled or crenulated by simple radial riblets, also present in the interspaces. An escutcheon is present in both valves, that of the left valve is medially grooved. Lunule small, cordate, concentrically sculptured, circumscribed by an incised line. Ligament deeply inset, partly overlapped by the edge of the escutcheon of the right valve. Hinge plate solid, with an excavated margin, the middle and posterior cardinal teeth of the right valve and the middle cardinal tooth in the left valve are bifid. A small, often pimple-like lateral tooth at the base of the anterior cardinal tooth is present in the left valve; a lateral pit is sometimes indicated in the right valve. The impression of the pedal muscle scar under the hinge plate below the anterior cardinal tooth is large and deep. Ventral margins smooth or irregularly crenulate.

Periglypta multicostrata (Sowerby)

Plate 50, figures 3-3b

Venus multicostrata Sowerby, 1835, *Proc. Zool. Soc.*, p. 22.—Sowerby, 1853, *Thes. Conch.*, vol. 2, p. 706, pl. 152, fig. 10.—Reeve, 1863, *Conch. Icon.*, vol. 14, *Venus*, pl. 9, fig. 3.

Antigona multicostrata (Sowerby), Maxwell Smith, 1944, *Panamic Marine Shells*, p. 60, fig. 765.

Antigona (Dosina) multicostrata (Sowerby), Van Winkle Palmer, 1927, *Paleont. Amer.*, vol. 1, No. 5, pl. 30, fig. 11.

Antigona (Periglypta) multicostrata (Sowerby), Hertlein and Strong, 1948, *Zoologica*, vol. 33, pt. 4, p. 178.

This is a large, heavy-textured shell, often reaching a length of 115 mm., the surface sculptured with large, coarse, flat-topped or reflexed, concentric ridges coarsely crenulated by radials. Well-cleaned specimens are mostly white or cream-colored but with the umbones finely variegated with brown lines. This fine clam is locally plentiful in the Pearl Islands, Panama, where it is gathered as a highly esteemed sea food. A closely related form [*P. caribbeana* Anderson (*P. dominicana* Van Winkle Palmer)] occurs in the Miocene of the Dominican Republic, northern Colombia, and in Panama and is mainly distinguished from the Recent species by its more rounded form and less strongly crenulated concentrics.

Range—Lower California to Peru and the Galapagos Islands. Panama: Pearl Islands. Ecuador: Manta; Isla la Plata; Santa Elena. Peru: Cabo Verde.

Genus *CHIONE* Megerle von Mühlfeld, 1811

Type species by original designation, Gray, 1847, *Venus dysera* Chemnitz (= *Venus cancellata* Linné). Recent, along the the east coast of the United States, south of Cape Hatteras, and through the West Indies, Caribbean, to Panama and Brazil.

Shell ovate to trigonal, solid, convex, or somewhat compressed, typically with a strong, cancellate sculpture, particularly over the umbones, formed through the intersection of concentric raised lamellae and radial riblets. Lunule cordate or lanceolate, bordered by an incised line, its surface sculptured with radial riblets and crowded concentrics. The escutcheon is large and flat, narrowly lanceolate and nearly as strong in each valve, set apart sharply by an angled edge. The hinge is provided with three cardinal teeth in each valve of which the right, anterior and the central cardinal teeth are large. The right, anterior cardinal tooth is always small, and in some cases, it is represented only by the thickened edge of the adjacent cardinal socket. The pallial line is almost entire, the sinus is small. The lunular and ventral margins of the valves are finely crenulated.

Chione is easily distinguished by its solid, trigonal shell and also by its small, anterior cardinal tooth in the right valve and by its small, poorly formed pallial sinus. Most species have a cancellate sculpture, especially over the surface of the umbones.

Key to subgenera of *Chione*

- I. Surface sculpture cancellate, the radial and concentric elements of nearly equal strength and distribution.
 - Subgenus *Chione*, s.s.
- II. Surface sculpture formed by concentric folds, the radial elements much weaker.
 1. Concentric folds large, coarse, flattened or rounded in the midzone, often thinner and lamellar on the ends.
 - Subgenus *Lirophora*
 2. Concentrics formed by wavelike undulations, strong and even on the umbones, weaker and subobsolete ventrally, never foliaceous on the sides.
 - Subgenus *Ilioichione*

Chione (*Chione*) *compta* (Broderip)

Plate 41, figure 4;
Plate 51, figures 6, 6a; Plate 84, figure 1

Venus compta Broderip, 1835, Proc. Zool. Soc. London, p. 43, (Sechura).—Sowerby, 1853, Thes. Conch., vol. 2, p. 710, pl. 154, figs. 32, 33, 34.—Reeve, 1863, Conch. Icon., vol. 14, *Venus*, pl. 13, fig. 48.

Chione meridionalis I. S. Oldroyd, 1921, Nautilus, vol. 34, No. 3, p. 93, pl. 4, figs. 3, 4 Peru.

Chione compta (Broderip), Dall, 1909, Proc. U. S. Nat. Museum, vol. 37, No. 1704, pp. 158, 267.—Olsson, 1924, Nautilus, vol. 37, p. 129.

Chione (*Chione*) *compta* (Broderip), Dall, 1902, Proc. U. S. Nat. Museum, vol. 26, No. 1312, p. 393; Maxwell Smith, 1944, Panamic Marine Shells, p. 61, fig. 778.—Hertlein and Strong, 1948, Zoologica, vol. 33, pt. 4, p. 182.—Parker, 1949, Jour. Paleont., vol. 23, No. 6, p. 581, pl. 89, fig. 3; pl. 90, figs. 6, 8.—Hertlein and Strong, 1955, Bull. Amer. Mus. Nat. Hist., vol. 107, art. 2, pp. 192, 193.

Shell large (length up to about 60 mm.), solid and heavy, rounded, trigonal, compressed. Sculpture is composed of strong, evenly spaced (about

10), narrow, raised, concentric ridges, the spaces between them wide and flat, both the ridges and interspaces marked with strong, generally paired, cordlike, radial riblets. The escutcheon is large and elliptical in shape, nearly as long as the dorsal-posterior margin, flattened and set off by a sharp angle; the lunule is narrowly cordate, sculptured with fine radials and coarse, growth incrementals. Color white or cream and variegated with fine, brown lines.

Length 52.3 mm., height 49.4 mm., diameter 27.3 mm.; length 58.6 mm., height 54.7 mm., diameter of a left valve 15 mm. Both specimens from Bayovar, Sechura Bay, Peru.

In its typical form, *Chione compta* is a large, thick-shelled, compressed species, strongly sculptured with widely spaced, erect concentric ridges which are finely crenulated on their sides by the radials. It is a common species around the shores of Sechura Bay but rare elsewhere. The species resembles *Chione californiensis* (Broderip) (*succincta* Valenciennes) in its large size and shape but is typically more compressed and the concentrics are more widely spaced and not recurved on top as well as differing by its radial sculpture. It is possible that records of *C. californiensis* from the Panama region may represent *C. compta*. Hertlein and Strong recorded this species from Costa Rica. It is a common fossil in the Peruvian tablazos.

Range—Gulf of California? to northern Peru. Panama: Guanico; San Jose Id., Pearl Islands (USNM 603334). Ecuador: Jaramijo; Manta. Peru: Bayovar, and shores of Sechura Bay; Paita; Lobos de Tierra.

Chione (*Chione*) *subimbricata* (Sowerby)

Plate 55, figures 4-4b

Venus subimbricata Sowerby, 1835, Proc. Acad. Nat. Sci. Philadelphia, p. 21 Puerto Portrero.—Sowerby, 1853, Thes. Conch., vol. 2, p. 711, pl. 154, figs. 35-38.—Reeve, 1863, Conch. Icon., vol. 14, *Venus*, pl. 19, figs. 85a, b, c.

Venus neglecta Sowerby, 1839, Zool. Beechey's Voyage, p. 151, pl. 41, fig. 8.

Venus bilineata Reeve, 1863, Conch. Icon., vol. 14, *Venus*, pl. 22, figs. 105 a, b.

Anomalocardia subimbricata (Sowerby), Hertlein and Strong, 1948, Zoologica, vol. 33, pt. 4, No. 13, pp. 189, 190.

Chione (*Anomalocardia*) *subimbricata* (Sowerby), Parker, 1949, Jour. Paleont., vol. 23, No. 6, p. 587, pl. 92, fig. 5.

Shell unusually solid and heavy, subtrigonal, moderately convex, the beaks elevated, trigonal, flattened, pointed or coiled slightly forward. The sculpture is produced by a variable number of low, flattened, concentric riblets forming ledges or steps over much of the disk except on the umbones and beaks, where they rise in the shape of narrow, elevated ridges; in addition, the surface is overrun by strong, radial cords producing a cancellate sculpture. The color is variable, usually a white base mottled with rays, blotches and veinlets of brown, the lunule and escutcheon more deeply colored; in some cases, the rays are reduced to narrow, paired, brown lines (*bilineata* Reeve). Interior of the valves is usually white or flushed faintly with brown or violet.

Length 45.5 mm., height 40.3 mm., diameter 26.1 mm. Puerto Chame, Panama.

Authors have generally followed Dall (1909) in referring this species to *Anomalocardia* which its mature sculpture somewhat resembles; however, the pattern on the umbones is more regular and finely cancellate and its close relationship with *Chione* is apparent.

Range—Lower California to northern Peru. Panama: San Carlos; Pearl Islands; Burica Peninsula. Panama Canal Zone: Venado Beach; Balboa. Ecuador: Esmeraldas; Galeras; Jaramijo; Manta; Punta Blanca; Isla la Plata; Santa Elena. Peru: Boca Pan; Caletto Sal; Mancora.

Subgenus **LIROPHORA** Conrad, 1863

Type species by subsequent designation, Dall, 1892, *Venus athleta* Conrad (*Circumphalus (Lirophora) athleta* Conrad) (= *Venus latilirata* Conrad). Miocene of the middle Atlantic States.

Shell trigonal-ovate, usually solid and heavy, surface sculptured with thickened, flattened or rounded, concentric folds, continuous across the disk or lamellose at the ends. Hinge as in *Chione*, *s.s.*, the pallial sinus small. Ventral margin finely crenulate.

Chione (Lirophora) kelleltii (Hinds)

Plate 41, figure 5;
Plate 51, figures 4, 4a

Venus kelleltii Hinds, 1844, Zool. Voy. *Sulphur*, vol. 2, Moll., pt. 3, p. 65, pl. 19, fig. 5. Island of Quibo, West coast of Veragua, Panama.—Sowerby, 1853, Thes. Conch., vol. 2, p. 721, pl. 155, fig. 64.—Reeve, 1863, Conch. Icon., vol. 14, *Venus*, pl. 18, fig. 82.

Chione (Lirophora) kelleltii (Hinds), Pilsbry and Olsson, 1941, Proc. Acad. Nat. Sci. Philadelphia, p. 64, pl. 16, fig. 2.—Maxwell Smith, 1944, Panamic Marine Shells, p. 61, fig. 776.—Hertlein and Strong, 1948, Zoologica, vol. 33, pt. 4, No. 13, pp. 185, 186.—Hertlein and Strong, 1955, Bull. Amer. Mus. Nat. Hist., vol. 107, art. 2, p. 194.

Chione (Anomalocardia) kelleltii (Hinds), Parker, 1949, Jour. Paleont., vol. 23, No. 6, p. 586, pl. 92, fig. 8; pl. 93, fig. 1.

Shell often quite large (length 68 mm.), elongately ovate, the posterior side the longer. The sculpture consists of low, flat, more or less wrinkled or radially striated, concentric folds, best developed over the surface of the umbones but fade out or change into wide, smooth bands ventrally. On the dorsal slopes, the concentrics are elevated into thin, foliaceous lamellae. Color is usually a dull brown, the interior white. Pallial sinus small, the ventral margins finely crenulated.

Length 65.3 mm., height 53 mm., diameter 37 mm. Bay of Panama.

This is an off-shore species, now taken in some numbers by the shrimp fishermen in Panama. The species is known as fossil in the Pliocene of Ecuador.

Range—Gulf of California to Panama and probably still further south. Panama: Off Coiba Islands (Hinds); Off Punta Mala (shrimpers).

Chione (Lirophora) mariae (d'Orbigny)

Plate 49, figures 2, 8, 8a

Venus cypria Sowerby, 1835, Proc. Zool. Soc. London, p. 43. Isla la Plata.—Sowerby, 1853, Thes. Conch., vol. 2, p. 722, pl. 157, fig. 113.—Reeve, 1863, Conch. Icon., vol. 14, *Venus*, pl. 23, figs. 116a, 116b. (Not *Venus cypria* Brocchi, 1814 or Risso, 1826).

Venus mariae d'Orbigny, 1846, Voy. Amér. Mérid., vol. 5, p. 563. (New name for *Venus cypria* Sowerby, not of Brocchi, 1814, nor Risso, 1826).

Chione (Lirophora) mariae (d'Orbigny), Pilsbry and Olsson, 1941, Proc. Acad. Nat. Sci. Philadelphia, vol. 93, pp. 64, 65.—Hertlein and Strong, 1948, Zoologica, vol. 33, pt. 4, No. 13, p. 186.—Hertlein and Strong, 1955, Bull. Amer. Mus. Nat. Hist., vol. 107, art. 2, pp. 194, 195.

Chione (Anomalocardia) mariae (d'Orbigny), Parker, 1949, Jour. Paleont., vol. 23, No. 6, p. 586, pl. 92, figs. 7, 9, 10, 16.

Shell small (length seldom above 25 mm.), elongately ovate, rather solid, with a wide, elliptical escutcheon, flattened and nearly as long as the dorsal side; the lunule large, cordate, and flat. The sculpture is produced by high, strong, concentric riblets, solid in structure, between wide, flat interspaces, the crests of the riblets rounded or narrowly reflexed dorsally except at the posterior end where they are sharply narrowed and raised, sometimes with an obscure tooth at their ends. Both riblets and interspaces are smooth except for concentric growth lines, radial striae are faint or missing. General color is a cream white, often with three or more brown rays extending across from the beaks; the lunule and escutcheon is usually brown.

Length 22.8 mm., height 17.1 mm., diameter 12.4 mm. Punta Blanca, Ecuador.

This is a common and widespread species often appearing on some beaches in great numbers, usually as loose valves. The shell is somewhat variable in shape and in the size and spacing of the concentric riblets. Shells from Ecuador are usually larger than those from Panama and often show the strongly produced posterior end as illustrated by the original types from Isla la Plata.

Range—Lower California to northern Peru. Panama: Rey Island, Pearl Islands; Búcaro; Guanico; San Carlos. Panama Canal Zone: Amador Beach; Venado Beach. Colombia: Isla del Gallo. Ecuador: Mompiche; Charapota; Manta; Punta Blanca; Santa Elena. Peru: Zorritos; Mancora; Lobitos.

Subgenus **ILIOCHIONE**, new subgenus

Type species, *Venus subrugosa* Sowerby, 1853 (= *Venus subrugosa* Wood).

Shell ovate to elongate subtrigonal, solid. Sculpture produced by coarse, rounded concentric folds, strong and regular on the umbones, lower and irregular below the middle of the disk and often obsolete or nearly so near the ventral margin. The concentrics and their intervals are overrun by fine, regular, radial incised lines forming small flat riblets, but these also fade out ventrally. The posterior-umbonal angle is enlarged to form a strong, cordlike fold along the side of the umbone, weaker distally. Color varied and often with an elaborate pattern of rays and small spots of brown on a white base. Hinge and pallial sinus of *Chione*, s.s. Mostly on mud flats and similar habitat stations.

Species of this subgenus have usually been referred to *Anomalocardia* Schumacher (type species, *Venus rugosa* Schumacher=*V. flexuosa* Linné), but they are more closely allied to *Chione*. The genus *Anomalocardia* is a West Indian and Caribbean group, as yet unknown in the Pacific region.

Two Recent species distinguished as follows:

- I. The posterior-umbonal rib is strong. Concentric riblets numerous and cover a major part of the shell disk, absent only from close to the ventral margin. Peru northward.

C. subrugosa

II. Posterior-umbonal rib short and developed only along the upper side of the umbone. Concentric riblets fewer in number, the greater part of the surface of the disk smooth. Peru.

C. broggi

Chione (*Ilioehione*) *subrugosa* (Wood)

Plate 51, figures 5, 5a

Venus subrugosa W. Wood, 1828, Index, Test., Suppl., *Venus*, p. 5, pl. 2, fig. 6 Panama.—Sowerby, 1834, Gen. Recent and Fossil Shells, No. 41, pl. 250, fig. 2; pl. 251, fig. 5.—Sowerby, 1853, Thes. Conch., vol. 2, p. 721, pl. 155, fig. 63.—Reeve, 1863, Conch. Icon., vol. 14, *Venus*, pl. 19, fig. 86.

Anomalocardia subrugosa (Sowerby), Dall, 1909, Proc. U. S. Nat. Museum, vol. 37, No. 1704, pp. 158, 269, pl. 26, fig. 3.—Hertlein and Strong, 1948, Zoologica, vol. 33, pt. 4, No. 13, pp. 190, 191.

Chione (*Anomalocardia*) *subrugosa* (Sowerby), Parker, Journ. Paleont., vol. 23, No. 6, p. 587, pl. 89, fig. 10; pl. 92, fig. 20; pl. 93, fig. 4; pl. 94, fig. 15.

Shell rather coarse and heavy, ovate to elongate subtrigonal, the posterior side somewhat rostrate, narrowly or bluntly rounded at the end. Sculpture heaviest on the umbones and consists of low, rounded, concentric folds, finely radially striated but with a tendency to fade out across the middle of the disk. The posterior-dorsal fold is strong and quite persistent. Color variable, sometimes white, more often with three or more narrow or wide rays of dark brown on a lighter base, often with a fine mottling of broken lines or dots on a white or light-colored base. In life, the surface is covered by a thin, olive-yellow per.ostacum, which is quickly lost, the surface then becomes smooth and polished. The largest specimens seen have a length of nearly 50 mm.

An average specimen measures: length 45.5 mm., height 35.1 mm., diameter 24.4 mm. Tumaco, Colombia.

This species seems to prefer a lagoonal or mud flat habitat, and in many places it is harvested in large numbers for food. Many of the shell heaps or kitchen middens along the coasts of Ecuador are largely made up of the valves of this species.

Range—Gulf of California to Peru (also Chile according to Dall). Panama: Panama City; Pearl Islands; Garachine; Búcaro; Guanico. Panama Canal Zone: Palo Seco; Venado Beach. Colombia: Isla del Gallo; Tumaco; Gorgona Island. Ecuador: Port Limones; Esmeraldas; Cojimenes; Manta; Santa Elena; Puno Island. Peru: Tumbes; Zorritos; Mancora.

Chione (*Ilioehione*) *broggi* (Pilsbry and Olsson)

Anomalocardia broggi Pilsbry and Olsson, 1943, Nautilus, vol. 56, No. 3, pp. 78, 79, pl. 8, fig. 7.

Shell solid, oblong-subtrigonal, highest in the anterior portion or along a line extending from the beak to the anterior-ventral margin which is also the zone of greatest inflation. Sculpture consists of concentric, riblike folds present on the umbones and on the anterior submargins, generally obsolete or absent elsewhere, in addition to a series of fine, radial threads or striae; on some specimens nearly obsolete. The ground color is white or reddish brown with zigzag brown lines and generally three, brown bands radiate from the beak. Length 46 mm., height 37 mm., diameter of a single valve 17 mm. Holotype 178909 ANSP).

Differs from *C. subrugosa* by its somewhat thinner shell, its smoother,

subobsolete sculpture, the concentric foldlike ribs developed only over a small section of the beak and along the anterior submargins. The cord or rib along the posterior-dorsal submargin is developed along the margins of the beak only.

This species replaces *C. subrugosa* south of Cabo Blanco, Peru, especially plentiful on the beach at Bayovar. It is a common fossil in the Peruvian tablazos.

Genus **CHIONOPSIS** Olsson, 1932

(*Gnidiella* Parker, 1949, type species, *Venus gnidia* Broderip and Sowerby).

Type species by original designation, *Chione amathusia* Philippi.

Shell of medium or large size, thin or of medium thickness, with large, convex umbones ending in small adjacent beaks, generally placed at the anterior one-third. Sculpture strong, consisting usually of thin, elevated, distant, concentric lamellae between wider intervals, the edges of the lamellae frilled or scalloped by smaller, radial riblets usually in pairs, the radials showing best in the interspaces and on the ventral face of the concentric lamellae. The escutcheon is narrow, lanceolate in shape, nearly the same size in each valve, flat, smooth or sculptured with concentrics. The lunule is small, cordate in shape, smooth or coarsely lamellose. The hinge has three cardinal teeth in each valve, and of which, the left, middle cardinal and the right, posterior cardinal teeth are bifid, the left, posterior cardinal tooth is thin and long, the adjacent socket deep. Adductor scars are relatively small. The pallial sinus is small but larger than in *Chione*, *s.s.*

Chionopsis is here considered a full genus, differing from *Chione*, *s.s.* by its thinner, more convex valves, and by its larger and deeper pallial sinus. The genus appears to have originated in the Pacific region and spread into the Caribbean during the Miocene. It is represented in the Recent fauna by several fine species.

Chionopsis amathusia (Philippi)

Plate 41, figure 7;
Plate 51, figures 1, 1a; Plate 84, figure 2

Venus amathusia Philippi, 1844, *Abbild. und Beschreib. Conchylien*, bd. 1, heft 5, *Venus*, p. 129 (7), pl. 2, fig. 4. *Patria*?—Sowerby, 1853, *Thes. Conch.*, vol. 2, p. 709, pl. 154, figs. 26, 27. (These figures were referred to *V. darwini* Dunker by Römer and Lamy.)—Reeve, 1863, *Conch. Icon.*, vol. 14, *Venus*, pl. 11, fig. 36.

Chione amathusia (Philippi), Olsson, 1924, *Nautilus*, vol. 37, p. 129.

Chione (*Chione*) *amathusia* (Philippi), Maxwell Smith, 1944, *Panamic Marine Shells*, p. 61, figs. 900, 901.

Chione (*Chionopsis*) *amathusia* (Philippi), Hertlein and Strong, 1948, *Zoologica*, vol. 33, pt. 4, No. 13, pp. 183, 184.—Hertlein and Strong, 1955, *Bull. Amer. Mus. Nat. Hist.*, vol. 107, art. 2, p. 193.

Chione (*Gnidiella*) *amathusia* (Philippi), Parker, 1949, *Jour. Paleont.*, vol. 23, No. 6, p. 582, pl. 89, fig. 8; pl. 91, figs. 10, 12, 14.

Shell ovate-triangular, convex, the umbones full and prominent, the beaks small and curved slightly over a wide, cordate lunule, the posterior side somewhat longer, its dorsal margin straight, descending into a narrowly rounded end, the anterior margin deeply excavated in the lunular region, rounded below it. Size is variable but seldom exceeding 58 mm.

Sculpture formed by numerous, narrowly or widely spaced, raised concentric lamellae, tilted backwards, the ventral face and interspaces deeply engraved by fine radial cords. Color is usually a plain cream, sometimes a muddy brown, the lunule and escutcheon usually a deep brown.

Length 55 mm., height 45 mm., diameter 32 mm. Panama Bay, shrimpers.

This is a common and widely distributed species. Well-preserved specimens have an elaborate sculpture, the concentric riblets adorned with large, fluted, toothlike fringes, the space between the adjoining concentrics marked with fine, radial grooves.

Range—Gulf of California to northern Peru. Panama: San Carlos; Búcaro; Pearl Islands; Panama Bay, shrimpers. Ecuador: Sua; Mompiche; Galeras; Manta; Punta Blanca; Santa Elena. Peru: Tumbes; Zorritos; Boca Pan; Mancora.

Chionopsis gnidia (Broderip and Sowerby)

Plate 49, figures 1-1a

Venus gnidia Broderip and Sowerby, 1829, Zool. Jour., vol. 4, No. 15, p. 364.—Sowerby, 1853, Thes. Conch., vol. 2, p. 709, pl. 154, fig. 25 Pacific Ocean.—Reeve, 1863, Conch. Icon., vol. 14, *Venus*, pl. 11, fig. 37 San Blas, Mexico.

Venus (Chione) gnidia Broderip and Sowerby, Grant and Gale, 1931, Mem. San Diego Soc. Nat. Hist., vol. 1, p. 318, pl. 16, figs. 5a, 5b.

Chione (Chionopsis) gnidia (Broderip and Sowerby), Hertlein and Strong, 1948, Zoologica, vol. 33, pt. 4, p. 184.

Chione (Gnidiella) gnidia (Broderip and Sowerby), Parker, 1949, Jour. Paleont., vol. 23, No. 6, p. 583, pl. 89, fig. 12; pl. 91, figs. 1, 8, 11.

Similar to *C. amathusia* but larger and heavier, the concentric lamellae more widely spaced. The outline of the shell varies considerably, the posterior end usually subtruncated, less often pointed.

Range—Gulf of California.

Chionopsis jamaniana (Pilsbry and Olsson)

Chione jamaniana Pilsbry and Olsson, 1941, Proc. Acad. Nat. Sci. Philadelphia, vol. 93, pp. 63, 64, pl. 17, figs. 1, 2 (Pliocene, Jama, Punta Blanca, Ecuador.)

Chione (Chionopsis) gnidia jamaniana Pilsbry and Olsson, Hertlein and Strong, 1955, Bull. Amer. Mus. Nat. Hist., vol. 107, art. 2, p. 193, pl. 1, figs. 1, 3. Off Punta Pasado, Ecuador.

This shell may be the southern form of *Chione gnidia* as classified by Hertlein and Strong. The typical form is fossil in the Pliocene of Ecuador. Well-preserved examples of the fossil are more strongly sculptured than Recent *C. gnidia*, the concentric ridges are more solid, appressed, and their interspaces tend to become smooth in the older shells.

Range—Coast of Ecuador. Off Punta Pasado. (Hertlein and Strong).

Chionopsis ornatissima (Broderip)

Plate 51, figures 3, 3a

Venus ornatissima Broderip, 1835, Proc. Zool. Soc. London, p. 44 Panama.—Reeve, 1863, Conch. Icon., vol. 14, *Venus*, pl. 18, fig. 80.

Chione traftoni Pilsbry and Olsson, 1941, Proc. Acad. Nat. Sci. Philadelphia, vol. 93, pp. 61, 62, pl. 16, fig. 4; pl. 17, fig. 4 (fossil, Ecuador and Panama).

Chione (Chionopsis) traftoni Pilsbry and Olsson, Hertlein and Strong, 1900, Bull. Amer. Mus. Nat. Hist., vol. 107, art. 2, pp. 193, 194, pl. 1, figs. 2, 4.

Shell broadly subelliptical in shape, of medium thickness, convex. The ventral margin is semicircular, the posterior end blunt, the anterior side rounded and somewhat produced. The surface is beautifully adorned with a series of high, thin lamellae (radially grooved on both sides) which extend as continuous, elevated, lacelike frills from the edge of the lunule to the dorsal margin; and in addition, a set of strong, paired, radial riblets cover the wide, flat interspaces as well as on both sides of the concentric lamellae. On the umbones, the radials are simple but below they are mesially grooved so as to appear double.

Length 52.8 mm., height 44.6 mm., diameter 32.6 mm.

This is the finest and most ornate species of the genus but Reeve's figure in the *Conchologia Iconica* is poor and does not give full justice to its striking beauty. In this connection, the following quotation from Broderip's original description is of interest, "This unique and highly ornamented shell was dredged up from sandy mud at a depth of ten fathoms. The radiating ribs, each of which, as it advances from about the middle of the valve to the ventral border has a depression in the middle, and the crisply plaited well-developed concentric frill-like *lamellae*, render it the most curious in point of workmanship of any of the species."

Several fine specimens of this species were obtained by Mr. Harry B. Johnson, formerly of the Panama Canal Zone. The species is known as fossil in the Pliocene of Panama and was described from there by Pilsbry and Olsson as *Chione traftoni*.

Range—Panama southward to Ecuador. Panama: Off Cape Mala (shrimpers). Ecuador: Off Cabo Pasados, in 15 fathoms (Hertlein and Strong).

***Chionopsis purpurissata* (Dall)**

Plate 52, figure 3

Venus crenulata var. Reeve, 1863, *Conch. Icon.*, vol. 14, *Venus*, pl. 13, fig. 46. (Not *V. crenulata* Sowerby, 1853—*C. pubera* Valenciennes, 1827) Gulf of California.

Venus crenulata var. *lilacina* Carpenter, 1864, *Rept. Brit. Assoc. Adv. Sci. for 1863*, p. 570, No. 46. Reprinted 1872, *Smith. Misc. Coll.*, No. 252, p. 56. (Not *Chione lilacina* Gray, 1838.)

Chione (*Chione*) *purpurissata* Dall, 1902, *Proc. U. S. Nat. Museum*, vol. 26, No. 1312, p. 393. (New name for *C. lilacina* Carpenter, 1864.)

Chione (*Chionopsis*) *purpurissata* Dall, Hertlein and Strong, 1948, *Zoologica*, vol. 33, pt. 4, p. 185.

Chione (*Gnidiella*) *purpurissata* (Dall), Parker, 1949, *Jour. Paleont.*, p. 584, pl. 91, fig. 2, 15; pl. 93, fig. 13.

This beautiful species, with the interior of the disk rosepurple, was figured by Reeve as a variety of *Venus crenulata* of the West Indies (by which *Chione pubera* Valenciennes is meant), and was named variety *lilacina* by Carpenter, 1864; but it is not *Chione lilacina* Gray, 1838, and so a new name is proposed for it. It is a rounder shell than *C. pubera*, with less prominent lamellation, especially on the posterior slope, which, in this species, is often wholly destitute of lamellae. (Dall, 1902.)

Shell roundly trigonal, rather tumid, posterior end rounded; ornamented by rather fine radial and concentric sculpture; lunule large, ornamented only by lines of growth; a shallow and rather narrow radial depression occurs posteriorly just above the escutcheon which is large and

smooth; a strong raised ridge just above the ligament occurs on the left valve; mottled with brown externally, lunule brown; hinge normal for the subgenus; pallial sinus ascending and projecting to a point about level with the middle of the posterior adductor impression; margin crenulated except posteriorly; interior colored rose purple.

A large specimen in the collection of the California Academy of Sciences, collected by Fred Baker at Carmen Island in the Gulf of California, measures approximately: length, 64.5 mm.; height 57 mm.; convexity (both valves), 42.6 mm. (Hertlein and Strong, 1948.)

This species is related to *C. pulicaria* (Broderip) but tends to be larger, more rounded, and has much finer sculpture. It is also allied to *C. pubera* Val. of the Caribbean but is more finely sculptured and has a more rounded outline.

Range—Gulf of California to Ecuador. Ecuador: Punta Blanca.

Chionops's pulicaria (Broderip)

Plate 52, figures 4-4c, 5-5a

Venus pulicaria Broderip, 1835, Proc. Zool. Soc. London, p. 44 Chiripique and Tumaco.

Venus cingulata Lamarck, Sowerby, 1853, Thes. Conch., vol. 2, p. 729, pl. 161, fig. 191.—Reeve, 1863, Conch. Icon., vol. 14, *Venus*, pl. 8, fig. 26. (Not *V. cingulata* Lamarck, 1818.)

Chione (*Chione*) *pulicaria* (Broderip), Maxwell Smith, 1944, Panamic Marine Shells, p. 61, fig. 775.

Chione (*Chionopsis*) *pulicaria* (Broderip), Hertlein and Strong, 1948, Zoologica, vol. 33, pt. 4, pp. 184, 185.

Chione (*Gnidiella*) *pulicaria* (Broderip), Parker, 1949, Jour. Paleont., vol. 23, No. 6, p. 583, pl. 91, figs. 9, 13; pl. 93, fig. 7.

The shell is of medium size, ovate-trigonal in shape, solid, convex, the posterior side decidedly longer than the anterior, acuminate at the end. The lunule is of medium size, cordate, well defined by a deeply incised line, sculptured with coarse concentrics, and of a uniform dark brown color or it may be lightly mottled with white and brown. The escutcheon is small, narrow, and restricted largely to the left valve where it is bordered by a larger, outside area, depressed, and more strongly sculptured. On the main surface of the disk, the sculpture is formed by a series of rather fine, closely spaced, concentric lamellae, each inclined slightly backwards and with small, radial columns engraved on their ventral face, the radial marks less strongly shown in their interspaces. Most specimens are colored lightly, white or cream overlain by a set of brown zigzag lines. The pallial sinus is short but well formed. Ventral margins strongly crenulated.

Length 51.2 mm., height 44.3 mm., semidiameter 15 mm. (a right valve, Pearl Islands, Panama.

On large specimens, the concentric lamellae have a tendency to flatten or thin out over the posterior-dorsal slope.

Range—Gulf of California to southwestern Colombia. Panama: Pearl Islands. Colombia: Tumaco.

Chionopsis montezuma (Pilsbry and Lowe)

Plate 51, figures 2, 2a

Chione montezuma Pilsbry and Lowe, 1932, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, p. 101, pl. 15, figs. 12-14 Puntarenas, Costa Rica.

Chione (*Chionopsis*) *pulicaria* (Broderip), Hertlein and Strong, 1948, Zoologica, vol. 33, pt. 4, pp. 184, 185 (in part).

The shell is ovate-triangular, convex, the anterior and posterior dorsal margins nearly straight, the ventral margin convex. The posterior end is

more produced and pointed. Lunule cordate but little sunken, bounded by a sharp line. External sculpture is formed by even, close set, erect laminae with small but numerous radial threads in their intervals and on the ventral face of the laminae. The lunule and the posterior-dorsal submargin is laminate-striate but without radial sculpture. Surface usually marked with a beautiful pattern of zigzag brown lines, sparse or profusely developed, on a cream-colored base, the lunule generally a solid brown, the posterior dorsal submargin generally heavily maculated. Some shells may be pure cinnamon brown as in the type. Interior white or irregularly blotched with purple or violet. Inner margin of valve finely crenulated.

Length 44.7 mm., height 35.5 mm., diameter 25.5 mm. Type.

Length 37 mm., height 26.4 mm., diameter 22.3 mm. Venado Beach, Panama Canal Zone.

This lovely species is quite distinct from *C. pulicaria* with which it has sometimes been associated, differing by its thinner, much smaller size, more elongated posterior end and its pattern of zigzag brown lines is usually much stronger, although an occasional shell may be colored uniformly without any additional markings. The species appears to be local, most abundant in the Panama Canal Zone and vicinity.

Range—Costa Rica and Panama. Panama: Bahia Honda near Las Tablas. Panama Canal Zone: Palo Seco; Venado Beach. Costa Rica: Puntarenas (Pilsbry and Lowe).

Genus *NOTOCHIONE* Hertlein and Strong, 1948

Type species by original designation, *Venus columbiensis* Sowerby.

The shell is subovate to subcircular, solid, convex, the surface sculptured with large, coarse, rounded to flat-topped, radial ribs separated by grooved interspaces, the whole crossed by widely spaced, even concentric, raised cords, strong on the sides but more or less subobsolete along the posterior-umbonal slope. The lunule is small, cordate, marked with concentric lines and circumscribed by an incised line which cuts deeply into the anterior margin, thereby setting off the slightly vaulted surface of the lunule more sharply. The escutcheon is narrow and flat, bordered by a sharp angle in the left valve; in the right valve, the escutcheon is absent and the margin is merely rounded. The hinge plate is heavy, with three cardinal teeth in each valve of which the left, middle tooth is bifid; the right anterior cardinal tooth is small. The pallial sinus is short but distinct. The margins are crenulated except on the posterior side.

Notochione columbiensis (Sowerby)

Plate 41, figure 6;
Plate 52, figures 1-1b

Venus columbiensis Sowerby, 1835, Proc. Zool. Soc. London, p. 21 Santa Elena.—Sowerby, 1853, Thes. Conch. vol. 2, p. 713, pl. 155, figs. 53, 54.—Reeve, 1863, Conch. Icon., vol. 14, *Venus*, pl. 15, figs. 61a, 61b.

Chione (*Timoclea*) *columbiensis* (Sowerby), Dall, 1909, Proc. U. S. Nat. Museum, vol. 37, No. 1704, p. 268.—Maxwell Smith, 1944, Panamic Marine Shells, p. 61, fig. 786.

Chione (*Notochione*) *columbiensis* (Sowerby), Hertlein and Strong, 1948, Zoologica, vol. 33, pt. 4, No. 13, p. 188.

Shell coarse and heavy, often nearly round, the beaks placed near the anterior one-fourth, moderately convex. There are about 37, strong, flat to slightly rounded, radial ribs, close-set and uniform over most of the surface, except for about eight on the posterior slope which are smaller and the

concentric cords which pass over them higher or more lamellose. The shell is varied in its coloration, often a dull, violet brown, uniform or strongly mottled, sometimes with wide, broken rays of violet on a cream-yellow base. The interior is white.

A large, right valve in my collection from Santa Elena measures: Length 55.2 mm., height 46.7 mm., diameter 16.5 mm.

Range—Mexico to northern Peru. Panama: San Carlos; Búcaro; Burica Peninsula. Ecuador: Pedernales; Charapota; Manta; Punta Blanca; Santa Elena. Peru: Zorritos; Boca Pan; Mancora; Lobitos; Pacasmayo (Dall).

Genus **PROTOTHACA** Dall, 1902

Type species by original designation, *Venus dombeyi* Lamarck (= *V. thaca* (Molina) d'Orbigny).

Shell ovate and moderately convex, the surface marked with a cancellate sculpture, the radials usually the stronger. In the typical species, the coloration is dull and the sculptural pattern is more or less clearly divided into three areas; the anterior surface with both radial and scabrous elements, the middle zone chiefly radial, the posterior with the concentrics strongest. Lunule small, not impressed but sharply circumscribed; the escutcheon is restricted to the left valve and consists merely of a narrow, flat space, its margin rolled over so as to produce a slight overhang but not sufficient to hide the ligament. Hinge with three cardinal teeth in each valve, the middle left, and the middle and posterior right teeth being bifid; the anterior right tooth is strong and high. Pallial sinus of medium size, extending to about the middle. Valve margins crenulated except on the posterior side.

This group is mainly Pacific, the principal species living along the west coast of South America, Japan, and in New Zealand.

This genus may be divided into two subgenera as follows:

- I. Shell large, with a dull or drab-colored surface and sculptured with strong radial and concentric riblets, the concentric elements strongest over the anterior slope. Cold water.

Subgenus *Protothaca*, s.s.

- II. Shell smaller, with finer sculpture, the surface more highly colored, often with varied pattern. Warm or tropical waters.

Subgenus *Tropithaca*

Protothaca (*Protothaca*) *thaca* (Molina)

Plate 41, figure 1;
Plate 53, figures 1, 1a

Chama thaca Molina, 1782, Saggio Hist. de Chile, p. 178.

Venus dombeyi Lamarck, Philippi, 1844, Abbild. und Beschreib. Conchylien, bd. 1, Venus, p. 127, pl. 2, Venus, fig. 1.

Paphia (Protothaca) thaca (Molina), Dall, 1909, Proc. U. S. Nat. Museum, vol. 37, No. 1704, p. 269.

Although *Protothaca*, s.s. is not a member of the tropical Panamic-Pacific fauna, figures of its shell and hinge of *P. thaca*, its type species, are given here in order that its characters can be better understood. *P. thaca* is a species of the cooler waters of the Peruvian fauna and ranges from Lima southward to Chile.

P. staminea (Conrad), a common West Coast species ranging northward to Alaska, has been recorded from Cape San Lucas at the southern tip of Lower California. The species resembles *P. thaca* by its surface sculpture and chalky or drab color but differs in the absence of an escutcheon and in hinge details. The species should probably be transferred to *Callithaca* to which it appears more closely related.

Callithaca Dall, 1902 (type species *Tapes tenerrima* Carpenter) has been considered a section or subgenus of *Protothaca*, but a lunule and escutcheon are lacking in the type species.

Subgenus **TROPITHACA**, new subgenus

Type species *Protothaca grata* (Say).

Shell small or of medium size, elongately ovate, convex, the umbones and beaks at the anterior one-fourth. Hinge of *Protothaca*. Escutcheon much reduced in size. Color of surface extremely variable, sometimes quite plain or marked with radial rays and zigzagged lines, the interior white or irregularly stained with violet. Pallial sinus short.

A group of small tropical or warm-water species distinguished from typical *Protothaca* by their more colored surface, smaller size, and simpler sculpture which is not so sharply divided into zones. Shells are diversely patterned, hardly two specimens marked alike.

Protothaca (Tropithaca) grata (Say)

Plate 53, figures 2-2b, 7

Venus grata Say, 1830, Amer. Conch., No. 3, pl. 26, (three figures) West coast of Mexico.—Reeve, 1863, Conch. Icon., vol. 14, *Venus*, pl. 3, figs. 8a, 8b.

Venus fuscolineata Sowerby, 1835, Proc. Zool. Soc. London, p. 41 Guacamayo.—Reeve, 1863, *op. cit.*, pl. 16, fig. 69.

Venus tricolor Sowerby, 1835, *op. cit.*, p. 41 Puerto Portrero.—Reeve, 1863, *op. cit.*

Venus discors Sowerby, 1853, *op. cit.*, p. 42 Santa Elena and Guacamayo.—Reeve, 1863, *op. cit.*, pl. 7, figs. 22a, 22b.

Tapes fuscolineata (Sowerby), 1853, Thes. Conch., vol. 2, *Tapes*, p. 698, No. 69, pl. 151, figs. 145.

Tapes tricolor (Sowerby), 1853, *op. cit.*, p. 699, pl. 151, fig. 153.

Tapes discors (Sowerby), 1853, *op. cit.*, p. 698, figs. 148-150.

Protothaca (Callithaca) grata (Say), Hertlein and Strong, 1948, Zoologica, vol. 33, pt. 4, p. 193.

The above synonym could be greatly extended but the principal names given to this common species are noted.

The shell is of medium size, elongately ovate, the beaks nearer the anterior side, and the surface covered with small, closely spaced, radial cords, in places finely reticulated by concentrics. Coloration is varied, usually in tones of white, yellowish gray and purplish black, arranged in broad rays, blotches or lines, two specimens seldom the same. The interior may be white or with blotches of violet or purple. The sculpture is formed by numerous, low radial ribs, those on the anterior and posterior slope concentrically noded, the ribs on the middle plain. The lunule is small, cordate, and sculptured with radial lines. The escutcheon is absent or narrow, usually the posterior-dorsal margin is narrowly flattened distally, the end of the right valve noticeably overlapping the margin of the left valve. Hinge typical of the genus, the pallial sinus short but distinct.

Length 38 mm., height 31.2 mm., diameter 22 mm. Esmeraldas, Ecuador.

This is an abundant species throughout its range and in many places is gathered as a food in enormous quantities. It is most plentiful in bouldery or gravelly bars exposed at low tide. The shell is often marked with zig-zagged transverse lines on a brown or white-brown base, occasionally unicolor except for the beaks which may be white. These strongly patterned shells have been given several names as indicated in the above synonym. *P. grata* may be distinguished from the similarly marked shells of *Nioche asperrima histrionica* by its average smaller size, typically more oblong shape, much smaller lunule, and in the absence of a well-developed escutcheon.

Range—Gulf of California to Peru, Chile. Costa Rica: Puntarenas. Panama: Burica Peninsula; Puerto Armuelles; Ocones; Guanico; Búcaro; Puerto Chame; Panama City; Chepillo; Pearl Islands. Colombia: Isla Gorgona; Isla del Gallo. Ecuador: Limones; Camarones; Esmeraldas. Peru: Lobitos.

Genus **NIOCHE** Hertlein and Strong

Type species by original designation, *Venus asperrima* Sowerby.

Surface of shell with strong, radial costae, noded and rendered somewhat sharply scabrous by the intersecting concentrics, the costae often becoming medially divided below or near the ventral margin. The lunule is elliptical or cordate, not impressed and hence somewhat indistinct, usually with finer sculpture, a darker color, and set apart by a fine, incised line. A narrow, flat, smooth escutcheon is present in the left valve, absent or nearly so in the right valve. The hinge armature has three cardinal teeth in each valve; its most striking character is shown by the anterior cardinal tooth of the left valve which is large, sharp, narrow, and lies parallel to the lunular margin, and by its length and position resembles a lateral tooth, its socket in the left valve is deep and curved. The central and posterior cardinal teeth of the right valve and the central cardinal tooth of the left narrow and produced to form the sharp, toothlike edge of the anterior socket. The pallial sinus is short, the lunular and ventral margins finely crenulated.

Nioche was proposed by Hertlein and Strong as a subgenus of *Chione*, its characters considered as intermediate between that genus and *Protothaca*. In my opinion, its affinities seem much closer to *Protothaca* with which it agrees in its surface characters and hinge.

Nioche has recently been considered a synonym of *Leukoma* Römer, 1857 (type species by subsequent designation, Frizzell, 1936, *Venus marica* Linné) by Myra Keen and classed as a subgenus of *Protothaca*. Judged solely by the figures of *Venus marica* in Sowerby's Thesaurus, this treatment does not seem correct.

Nioche (Nioche) asperrima asperrima (Sowerby) Plate 53, figures 3, 3a;
Plate 54, figure 6

Venus asperrima Sowerby, 1835, Proc. Zool. Soc. London, p. 42 Lobos Islands.—
Sowerby, 1853, Thes. Conch., vol. 2, p. 714, pl. 155, figs. 57, 58.—Reeve, 1863,
Conch. Icon., vol. 14, *Venus*, pl. 6, figs. 19a, 19b.

Chione (Nioche) asperrima (Sowerby), Hertlein and Strong, 1948, Zoologica, vol. 33,
pt. 4, No. 13, p. 187.

Protothaca (Leukoma) asperrima (Sowerby), Keen, 1958, Sea Shells of Tropical West
America, p. 149, fig. 341.

Shell subcircular to subovate, generally coarse, moderately convex, sculptured by rather coarse, rasplike, radial costae, the surface in the type form, dull, chalky white, sometimes irregularly blotched with brown. The stronger radials are usually simple and uniform in size on the umbones but below, on the middle of the disk, they are generally dissected so that they become double, paired and sometimes triparted near the ventral margin. The costal intervals are deep, narrow grooves. Both the costals and their intervals are crossed by strong, corded concentrics producing a pattern like that of a coarse lattice.

An average specimen measures: Length 50.7 mm., height 45.7 mm., diameter 29 mm.

Nioche (Nioche) asperrima histrionica (Sowerby) Plate 53, figures 4, 4a, 6

Venus histrionica Sowerby, 1835, Proc. Zool. Soc. London, p. 41 Real Llejos and Santa Elena.—Sowerby, 1853, Thes. Conch., vol. 2, p. 714, pl. 155, fig. 52.—Reeve, 1863, Conch. Icon., vol. 14, *Venus*, pl. 16, fig. 70.

Tapes tumida Sowerby, 1853, Thes. Conch., vol. 2, p. 697, No. 64, pl. 146, figure 42 Columbia.

Shell usually smaller, ovate to oblong, plump and solid, the average length seldom over 45 mm. The sculpture is produced by small, cordlike costae crossed by evenly spaced, raised, corded concentrics producing a finely reticulated pattern; the costals on the middle and anterior surface of the disk are usually double or paired; simple on the posterior portion; between the primary concentrics there are usually five or six threads of growth. The lunule is cordate, generally large, not impressed, radially sculptured, brown in color, and circumscribed by a small line. There is a small, narrow, flat escutcheon in each valve; the escutcheon of the right valve overlaps the margin of the left valve slightly. The ground color is usually white, with three or more, discontinuous, radial rows of brown or finger-like markings, the posterior slope is usually more deeply colored. Interior white or purple. The pallial sinus is distinct and reaches about a quarter of the distance in.

Length 45.7 mm., height 37.3 mm., diameter 25.2 mm. Puerto Chame, Chorrera, Panama.

Typical *Nioche asperrima* is a Peruvian shell, first described from specimens obtained on the Lobos Islands. It is common along the shores of Sechura Bay, rare further north where it is replaced by the smaller and more colorful subspecies *N. histrionica*. Occasional forms of the two subspecies are so close that they can hardly be separated; hence they are treated here together. The typical subspecies is a large, coarse shell, subcircular in form, with a plain, dull surface of a white or chalky gray color, its radial riblets coarse and harsh to the touch. More common to the north,

especially along the coasts of Ecuador and Panama, is the smaller and longer shell, more highly colored, and to which Sowerby gave the name *histrionica*. The extremes of *histrionica* and *asperrima* are so different that they deserve recognition, although at times, the classification of some intergradational specimens is entirely arbitrary. *Nioche asperrima histrionica* is often found with *Protothaca (Tropithaca) grata* (Say) which it much resembles.

Range—Gulf of California southward to Peru. *Nioche asperrima asperrima* Panama: Panama City; Old Panama; Puerto Chame, near Chorrera; Guanico. Peru: Bayovar; Lobos Islands. *Nioche asperrima histrionica* Costa Rica: Puntarenas. Panama: Puerto Armuelles; Rey Island, Pearl Islands. Colombia: Isla del Gallo. Ecuador: Pedernales; Puno Island.

Nioche (Nioche) metodon (Pilsbry and Lowe)

Plate 55, figures 3, 3a

Chione metodon Pilsbry and Lowe, 1932, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, pp. 100, 101, pl. 15, figs. 7-11 Montijo Bay, Panama.

Chione (Nioche) metodon Pilsbry and Lowe, Hertlein and Strong, 1948, Zoologica, vol. 33, pt. 4, p. 187.

The shell is generally small (length 27 to 100 mm.), triangular-rotund, convex or plump, solid, light-buff in color with some dull violaceous angular markings and small spots, the lunule and escutcheon dark brown in solid color or in brown bars alternate with white on the escutcheon. The lunule is large, nearly flat, circumscribed by a small line, the escutcheon principally defined in the left valve, flattened, smooth, much smaller or absent in the right valve. On the umbones, the sculpture is formed by small, rounded riblets crossed by low concentric threads, larger and slightly lamellose at the ends. Below the middle of the disk, the riblets are a trifle wider and flatter, and towards the ends, they have a tendency to divide into three, small cords of about the same size as the individual crenulations along the ventral margin. On the anterior slope, the sculpture is a little coarser than elsewhere. The lunule is radially sculptured and because of its brown color stands out prominently. Pallial sinus small.

Length 40.7 mm., height 38 mm., diameter 32 mm. Montijo Bay, Panama. Type, ANSP 155571.

Length 26.4 mm., height 24 mm., diameter 18.5 mm. Bahia Honda, El Lagartillo, Panama.

Range—Panama. Panama Canal Zone; Venado Beach. Panama: Montijo Bay (Pilsbry and Lowe); El Lagartillo, near Las Tablas.

Nioche (Nioche) zorritensis, new species

Plate 53, figures 5, 5a;
Plate 55, figure 6

The shell is small or of medium size, triangular, rotund, convex, the posterior side a trifle longer, the two ends of nearly equal roundness. The lunule is elliptical, flat, sculptured with coarse, scabrous riblets, brown in color and bordered by an incised line. The escutcheon is developed best only in the left valve; it is narrow, flat, smooth or with concentric lines only. On the umbonal surface, the sculpture is finely cancellate, produced by small, simple, rounded riblets between narrow, flat intervals and more distantly spaced, low, concentric lamellae; below the middle of the disk, the riblets are wider and carry on the top of each, three to five threads which at the lower end match in size the individual crenulations along

the ventral margin. Foundation color of the shell is usually a creamy white overrun with a pattern of zigzag brown lines, or the entire surface may be colored a violaceous brown, the lunule and escutcheon a deeper brown. The interior is white with a flush of violet along the posterior end and over the adductor scars; also often under the posterior-dorsal surface. The pallial sinus is small but distinct. Ventral margins finely crenulated.

Length 19.3 mm., height 16.3 mm., diameter 10.6 mm. Zorritos, Peru. Holotype, ANSP 218962.

Length 25 mm., height 20.3 mm., semidiameter 12.2 mm. Zorritos, Peru. Paratype.

This species is common at Zorritos and will be recognized easily by its shape and color; there are generally two color forms, one plain, the other with zigzag markings. Specimens taken at Paita are usually larger and less strongly marked.

Range—Peru. Peru: Zorritos; Mancora; Paita.

Nioche (*Nioche*) *mcgintyi*, new species

Plate 52, figures 2, 2a

The shell is small or of medium size, rotund, cordate, convex, cancellately sculptured, marked with angular or zigzag brown lines over a cream-colored foundation. The lunule is large and broadly cordate, flat, neatly sculptured with radial riblets and outlined by an incised line. The escutcheon is a smooth, flat area, bordered by an angle, and confined largely to the left valve. Surface sculpture is produced by small, flat riblets and low, concentric lamellae; on the umbones, the riblets are simple; they are larger on the disk below and near the ventral margin they are grooved or divided into three or more sections, the dividing lines so deep that each primary riblet appears to be composed of parallel cords or broken up into three to five smaller riblets, all of uniform size. The ventral margin is finely crenulated. Interior white with a blotch of purple over the posterior section. Pallial sinus short but distinct.

Length 31.4 mm., height 27.1 mm., diameter 20.5 mm. Palo Seco, Panama Canal Zone. Holotype, ANSP 218897.

Differs from the somewhat similar *N. metodon* by its less rounded form, more pointed posterior end, less convexity, and in details of sculpture. The species is named for Mr. Thomas L. McGinty who accompanied the author to Ecuador and Panama in 1953.

Range—Panama. Panama Canal Zone: Palo Seco.

Nioche (*Nioche*) *squamosa* (Carpenter)

Plate 49, figure 10

Tapes squamosa Carpenter, 1857, Cat. Mazatlan Shells, Brit. Mus., p. 78, No. 111.

Chione picta Dall in Willett, 1944, Bull. South California Acad. Sci., vol. 43, pt. 1, p. 21, pl. 8, figs. A, B Magdalena Bay, Lower California.—Woodring, 1946, Prof. Paper, U. S. Geol. Survey, No. 207, pp. 84, 88, pl. 37, figs. 3, 4 Pleistocene, San Pedro, California.

Chione (*Nioche*) *picta* (Dall in Willett), Hertlein and Strong, 1948, Zoologica, vol. 33, pt. 4, No. 13, pp. 187, 188.

The shell is always small, usually between six and nine millimeters, ovately oblong, the posterior side much the longer and crudely rounded or squared-off at the end, the surface of the disk depressed to slightly convex. The umbones are wide and inconspicuous, ending in small, adjacent, prosogyrate beaks. The left valve has a small, narrow, flat escutcheon

marked with concentrics only and bordered on the disk side by a small, scabrous cord, usually white in color: the right valve has no escutcheon, the dorsal margin at this point is much enlarged, inrolled so as to resemble a large fold. The lunule is small, elliptical in shape, and brown in color. Surface of the disk is finely sculptured with small, flattened riblets, simple on the umbones, more or less divided ventrally. Color is mostly a dull white except for the lunule and the escutcheon which is brown. The posterior section of the ventral margin is crenulated.

Carpenter's types of this species have not been figured but there are manuscript drawings made by Carpenter in the library of Mollusca of the United States National Museum. *N. squamosa* is closely allied and possibly equivalent to *N. grus* (Holmes) of the southeastern United States which occurs both in the late Tertiary and Recent faunas. *N. squamosa* has been recorded as a Pleistocene fossil in California under the name of *N. picta*.

Range—Lower California to northern Peru. Panama: Puerto Armuelles. Ecuador: Puerto Callo; Santa Elena. Peru: Zorritos; Bayovar.

Subgenus **ANTINIOCHE**, new subgenus

Type species *Nioche (Antinioche) belli*, new species.

Shell subcircular and strongly convex, regularly cancellated by uniformly spaced, narrow concentric lamellae, finely crenulated on their ventral side and with stronger, rounded, radial riblets in their interspaces. Lunule cordate, not depressed, defined by an incised line and sculptured predominantly by radial ribs, wrinkled by the lines of growth. The escutcheon is a flattened, smooth band confined to the left valve. Hinge that of *Nioche*, the left anterior cardinal tooth being high, narrow, and elongated nearly parallel to the lunular margin; the anterior limb of the base of the right middle cardinal tooth is narrowly elongated so as to form the lower rim of the anterior cardinal socket. The adductor scars are relatively large, subequal and rounded, the pallial sinus short and narrow.

Antinioche resembles *Periglypta* by its cancellate sculpture but has the hinge pattern of *Nioche*.

Nioche (An'in'oeche) belli, new species

Plate 50, figures 1, 1a, 4

The shell is of medium size, subovate, rotund, with the beaks placed near the anterior one-fourth, convex, solid, the posterior-dorsal side nearly straight but distally passing smoothly into the circular curve of the posterior and ventral margins. The lunule is large, covering much of the anterior-dorsal side, elliptical, its margin somewhat flaring and circumscribed by an incised line, sculptured by strong ribs, waved or undulated by lamellae of growth; the escutcheon as described for the subgenus. The general surface of the convex disk is cancellated by the intersection of radial and concentric sculptural elements; the concentrics are widely and evenly spaced, raised lamellae spaced about 2 mm. apart, the radials are simple, cordlike costals between the concentric lamellae. The concentric lamellae are curiously ornamented on their ventral surface by short, double ribs which stand vertical like short columns in the small, narrow grooves between the radials. On the anterior and posterior slopes, the concentric lamellae are high and waved. General color of the surface is a creamy

white or a light brown, usually with three or more wide rays of a darker brown running across the umbones towards the ventral margin; the inner circle of the lunule is brown and the escutcheon is marked alternately with bars of brown and white. Interior white, the adductor scars large and round, the pallial sinus small but distinct. The ventral margin is neatly crenulated on the anterior side, much coarser on the posterior; the posterior margin itself is smooth.

Length 44.7 mm., height 38.7 mm., diameter 29.2 mm. Pedro Gonzales, Pearl Islands. Holotype, ANSP 218904.

This fine species appears to be widely distributed but scarce at all places. At Esmeraldas, Ecuador, this species lives deeply buried amongst large boulders and rocks in bars exposed at the time of lowest tides, and is sometimes obtained by the natives digging for other clams.

I take pleasure in naming this species for Mr. Lee Beil, formerly stationed in the Canal Zone, an enthusiastic and careful collector of Panama marine shells.

Range—Panama southward to Ecuador. Panama: Pearl Islands; San Carlos; Puerto Mensabi; Concepcion Beach near Poicri; Búcaro; Guanico. Colombia: Isla del Gallo. Ecuador: Esmeraldas; Sua; Pedernales; Charapota; Manta; Manglaralto; Santa Elena.

Genus **COLONCHE**, new genus

Type species, *Colonche ecuadoriana*, new species.

The shell is broadly orbicular, with large, convex umbones ending in small beaks placed nearer the anterior end. Surface color white, often chalky, sculptured with fine, scabrous, radial riblets, stronger and coarser on the anterior slope. The lunule and escutcheon are both absent, or the lunular area may be weakly indicated by a slight change of sculpture. Hinge as in *Nioche*, the right, anterior cardinal small and narrow, the right, middle, anterior tooth, stout, bifid, and produced downward so as to form the lower rim of the anterior socket. The pallial sinus is short but ample.

Colonche differs principally from *Nioche* in the complete absence of a lunule and an escutcheon.

Colonche ecuadoriana, new species

Plate 41, figure 2;
Plate 55, figure 5

Shell of medium size (length to about 50 mm.), ovate, subsolid, plump, chalky white, the beaks strongly anterior in position, the posterior side hence much longer, the greatest height of the valve is attained along a line extending from the middle of the dorsal margin on the posterior side across to the middle of the ventral. There is no lunule or escutcheon in either valve. The surface is usually chalky and somewhat weathered but when in more perfect condition shows a highly elaborate sculpture of many small radial riblets or costals, closely noded by evenly spaced concentrics, the resulting effect being sharp and harsh to the touch. On the earlier part of the umbone, the riblets are at first simple but soon, one and later many more interstitials appear in the interspaces and soon gaining in size so that the resulting sculpture near the ventral side is uniform and resembles that of a coarsely woven fabric but with the radial strands dominant; an-

teriorly the costals are coarser and more riblike. Color white, sometimes with faint brownish mottling along the posterior-dorsal margin.

Length 49 mm., height 41.2 mm., diameter 14 mm. a right valve
Holotype, ANSP 218898.

Length 52.7 mm., height 43.5 mm., diameter 16.4 mm. a left valve.
Paratype.

This interesting species is known to me only from some loose valves picked from shell heaps at Palmar, a fishing village and the port of the small, inland town of Colonche in Ecuador. At this place, this species was sufficiently plentiful that it was gathered along with other clams as a sea food. Its surface usually chalky and weathered suggests that it is a mud dweller, probably in somewhat brackish waters.

Genus PAPHONOTIA Hertlein and Strong, 1948

Type species by original designation, *Petricola elliptica* Sowerby.

Shell variable in shape, sometimes distorted, usually suborbicular to oblong, the beaks placed near the anterior one-third, strongly convex and sculptured with large, widely spaced, high concentric lamellae with radial riblets in their interspaces except on the posterior slope where they are lacking. Hinge with three cardinal teeth in each valve, the middle and posterior right cardinal teeth and the middle left cardinal tooth being bifid. Lunule defined by an incised line and sculptured with strong concentrics; the escutcheon narrow, flattened, restricted to the left valve. Area of the ligament small and immersed. Pallial sinus strong, rounded at the end, reaching to about the middle of the shell cavity.

These shells are rock borers or nestlers, their valves often distorted, sometimes nearly circular to narrowly produced. The color is usually a dirty white or cream, the interior colored brown at the ends and over the adductor scars. From *Petricola*, the genus is distinguished by its venerid hinge and well-defined lunule.

Paphonotia elliptica (Sowerby)

Plate 41, figure 3
Plate 55, figure 10

Petricola elliptica Sowerby, 1834, Proc. Zool. Soc. London, p. 46.—Sowerby, 1854, Thes. Conch., vol. 2, *Petricola* p. 774, No. 10, pl. 166, fig. 10 Païta.—Sowerby, 1874, Conch. Icon., vol. 19, *Petricola*, pl. 2, fig. 12.

Venerupsis elliptica (Sowerby), Lamy, 1922, Jour. de Conchy., vol. 67, pp. 306-308.
Petricola solida Sowerby, 1834, Proc. Zool. Soc. London, p. 46 Lambeyeque.—Sowerby, 1834, Thes. Conch., vol. 2, *Petricola*, p. 774, No. 11, pl. 166, fig. 9.—Sowerby, 1874, Conch. Icon., vol. 19, *Petricola*, pl. 2, fig. 15.

Petricola oblonga Sowerby, 1834, Proc. Zool. Soc. London, p. 46 Pacosmayo.—Sowerby, 1834, Thes. Conch., vol. 2, *Venerupsis*, p. 765, No. 10, pl. 165, fig. 21.

Irus (*Paphonotia*) *ellipticus* (Sowerby), Hertlein and Strong, 1948, Zoologica, vol. 33, pt. 4, p. 193.

Shell highly variable in shape from nearly circular to elliptical or oblong. Common along the southern coast of Ecuador and northern Peru, occasionally attains a length of about 40 mm.

Length 35.7 mm., height 32.9 mm., diameter 26.8 mm. Negritos, Peru.

Length 38.6 mm., height 28.5 mm., diameter 22.2 mm. Mancora, Peru.

Range—Mexico to northern Chile. Panama: Burica Peninsula; Búcaro. Ecuador: San Francisco; Puerto Callo; Santa Elena. Peru: Tumbes; Mancora; Negritos; Païta; Yasila; Lambayaque.

Subfamily GEMMINAE Dall, 1902

Small or minute venerids, usually with a plain or concentrically striated surface. Ovoviviparous, the embryos carried for a period within the perivisceral chamber.

Genus PSEPHIDIA Dall, 1902

Type species by original designation, *Psephis lordi* Baird. [Proposed as a genus to replace *Psephis* Carpenter, 1864 preoccupied by *Psephis* Guenée, 1854 (*Lepidoptera*).]

Shell small, veneriform, trigonal or ovate, inequilateral, with a narrow, feebly defined lunule and no escutcheon. Hinge with three small, simple cardinal teeth in each valve, no laterals. Surface smooth or with faint, concentric sculpture. Ventral margins smooth or weakly crenulated at the ends. Pallial sinus distinct, angular.

Psephidia cymata Dall

Psephidia cymata Dall, 1913, Proc. U. S. Nat. Museum, vol. 45, No. 2002, p. 593 Near Cerros Island, Lower California.—Dall, 1921, Bull. U. S. Nat. Museum, No. 112, p. 44, pl. 3, fig. 2 Santa Barbara Is., Calif. to the Gulf of California.—Hertlein and Strong, 1948, Zoologica, vol. 33, pt. 4, pp. 193, 194.

Shell small (length 5 to 6 mm.), white, solid, rounded triangular, with inconspicuous, somewhat anterior beaks, the lunule and escutcheon small and poorly developed. Surface marked with fine, threadlike concentrics, usually not perfectly regular. Periostracum rather coarse and of a yellow color. Pallial sinus small, pointed upward and bluntly rounded at the end, the adductor scars distinct.

Length 6 mm., height 5.5 mm., diameter 2.5 mm.

This species is probably not a true member of the Panamic fauna.

Range—California southward to the Gulf of California (Dall).

Extralimital species recorded or described as new species from the Panamic-Pacific Province.

Antigona fordii Yates. This is a Californian species.

Ventricola lepidoglypta Dall, 1902. Original described from a specimen in a lot of West Coast species purchased at Acapulco, Mexico, in 1868 by Dall. This is a Caribbean species, now known to be living at Martinique and some other West Atlantic localities.

Venus apodema Dall, 1902. Described from Humboldt Bay, Gulf of Panama. Arthur Schoot (more likely Humboldt Bay, California). The type specimen has the appearance of a ballast shell and is probably a worn *Ventricola lepidoglypta* from the Caribbean.

Chione obliterated Dall. Also described from Humboldt Bay. Like the preceding it is evidently a ballast shell and seems to be the same as *Chione clenchi* Pulley, 1952 from the Gulf of Mexico, a name which it would replace.

Chione schotti Dall, 1902. Also from Humboldt Bay. Another ballast shell, probably *Venus striatula* Da Costa of Europe.

Also from the same material collected by Arthur Schott at Humboldt Bay is a specimen of *Donacilla cornea* Poli, a Mediterranean species, USNM 6237.

Family **PETRICOLIDAE**

The mollusks of this family are borers in rock, clay, or shale, sometimes in thick-walled mollusks, corals, and barnacles. The valves are subovate to elongated in shape, sometimes pholadiform, regular in shape, or much distorted. Hinge venerid, bearing two or three cardinal teeth in each valve of which one or more may be bifid or they are hook-shaped and often enlarged; the posterior cardinal tooth is generally small and atrophied; there are no lateral teeth; the teeth often interlock so closely that the hinge cannot be separated without damage. Ligament external, attached to a coarse nymphal ridge. External sculpture formed by radial riblets and concentrics. Pallial sinus well developed, extending into the middle of the cavity of the valve.

This family is represented along the coast of Panama, Ecuador, and Peru, by several species belonging to three groups. Together with other rock borers they are an important factor in shore-line erosion.

Key to Panamic-Pacific genera

- I. Borers in comparatively hard rocks, hence, their shell usually much distorted or irregular in shape. Hinge teeth variable in development, the posterior left cardinal tooth missing or atrophied in the adult. Ligament deeply immersed.
 1. Surface sculptured by fairly simple, radial riblets; sometimes with concentrics; both elements uniformly developed over the whole disk.
Genus *Petricola*
 2. Sculptural pattern more or less divaricate, the radial elements forming disconnected hook-shaped bends or zigzag lines.
Genus *Naranio*
- II. Borers in softer rock formations or burrowing in sand, and clay, their shells more normal in shape, often elongated, pholadiform, and the surface sculpture is regular. Hinge teeth normal, the ligament not immersed.

Genus *Petricolaria*

Genus **PETRICOLA** Lamarck, 1801

Type species by subsequent designation, Gray, 1847, *Venus lithophagus* Retzius.

Valves of solid texture and generally more or less distorted. Surface sculptured with coarse radial riblets, generally heaviest on the posterior slope, often with concentrics forming together a decussate pattern. The hinge is generally normal in young shells but with growth, the posterior cardinal tooth becomes atrophied and sometimes completely eliminated.

Petricola (*Petricola*) *denticulata* Sowerby

Plate 54, figures 1-1d

Petricola denticulata Sowerby, 1834, Proc. Zool. Soc. London, p. 46. Hab. ad Paytam Peruviae.—Sowerby, 1854, Thes. Conch., vol. 2, p. 773, No. 6, pl. 146, figs. 6, 7.—Sowerby, 1874, Conch. Icon., vol. 19, *Petricola*, pl. 2, fig. 9.—Pilsbry and Lowe, 1932, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, pp. 97, 98, pl. 13, figs. 1, 2, 3, 3a.

Shell narrowly to broadly elongated, variable in shape and sometimes distorted, subsolid. The umbones are wide and prominent, the beaks small, prosogyrous, inrolled slightly over the margin and placed near the anterior

one-third. The anterior side is short, attenuated, the fullness of the valve is usually greatest along the umbonal slope to a point just behind the middle of the ventral margin. The sculpture is produced by narrow, raised concentric riblets, their sides and intervals decussated by radials. Color white or cream, the interior blotched with deep, mahogany-brown, deepest on the ends and along the margins. Posterior end gaping.

Length 33.8 mm., height 20.7 mm., diameter 20 mm.

Length 32 mm., height 14.2 mm., diameter 14.4 mm.

Santa Elena, Ecuador.

This is a common species along the coast of northern Peru and Ecuador; its shape variable depending upon the hardness or softness of the medium in which it bored. The typical form is elongated; the anterior end short, constricted, and attenuated.

Range—Gulf of California to Peru. Panama: Búcaro; Puerto Mensabi. Ecuador: Sua; Galeras; Crucitas; Manta; Santa Elena. Peru: Paita; Bayovar.

***Petricola (Petricola) peruviana*, new species**

Plate 55, figure 9

Shell irregularly subrectangular, with the umbone and beak placed near the anterior one-third, the anterior side hence short, rounded at the end, the posterior side much longer, its dorsal and ventral margins subparallel, the posterior end widely rounded and gaping. Surface sculpture is formed by rather fine radial riblets, more or less uniform over the whole disk. Concentrics are limited to lines of growth and irregular undulations. Pallial sinus large, rounded, and extending nearly to the middle of the shell cavity. Color white or cream, the posterior end stained with brown.

Length 30 mm., height 21 mm., semidiameter 7.3 mm. a left valve, Paratype, ANSP 218906.

Length 30 mm., height 19.1 mm., semidiameter 5.4 mm. a right valve, Holotype, ANSP 218905.

Range—Ecuador to northern Peru. Ecuador: Santa Elena. Peru: Tumbes; Mancora; Lobitos; Negritos; Paita; Bayovar.

***Petricola (Petricola) robusta* Sowerby**

Plate 54, figures 2, 2a

Petricola robusta Sowerby, 1834, Proc. Zool. Soc. London, p. 47.—Sowerby, 1854, Thes. Conch., vol. 2, *Petricola*, pl. 166, figs. 16, 17.—Sowerby, 1874, Conch. Icon., vol. 19, *Petricola*, pl. 3, fig. 20a, 20b Panama and Isla Muerte.

Petricola (Petricola) robusta Sowerby, Hertlein and Strong, 1948, Zoologica, vol. 33, pt. 4, No. 13, p. 194.

Shell ovate-trigonal, the anterior side convex with rounded margin, the posterior side narrowed and produced. Sculpture is formed by simple radial riblets, coarse on the posterior side much finer on the anterior, waved and slightly broken by concentric lines marking intervals of growth.

Length 24.3 mm., height 19.1 mm., diameter 16.1 mm. From the shell of a large *Spondylus*. Punta Montanita, Ecuador.

Range—Gulf of California to northern Peru. Ecuador: Santa Elena; Punta Montanita. Peru: Boca Pan; Caleta Sal.

Subgenus **PETRICOLARIA** Stoliczka, 1870

Type species by original designation, *P. pholidiformis* Lamarck. Recent, Maritime Provinces of Canada, southward to the West Indies.

Shell elongated, pholadiform, regular in shape, never distorted, usually thin. Surface is sculptured much like that of *Pholas*, the anterior set of ribs large and sharply squamose, the others across the middle and posterior slope simple, often reduced to small cords. Hinge with three, cardinal teeth in the left valve, the middle one large, bifid, the others small; the right valve has two cardinal teeth, both bifid, the posterior one more strongly so. The pallial sinus is large, rounded at the end.

The surface of the valves sculptured in a regular fashion with noded or scabrous ribs, as well as by their shape and thin texture, have shells which superficially resemble those of a pholad but can be distinguished at once by their hinge bearing interlocking teeth. Found boring in the softer types of rock such as shale and clay.

Petricola (*Petricolaria*) *parallela* Pilsbry and Lowe Plate 54, figures 3-3b

Petricola gracilis parallela Pilsbry and Lowe, 1932, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, p. 99, pl. 13, fig. 4.—Maxwell Smith, 1944, Panamic Marine Shells, p. 62, fig. 797.

Petricola (*Petricolaria*) *parallela* Pilsbry and Lowe, Hertlein and Strong, 1948, Zoologica, vol. 33, pt. 4, No. 13, p. 195.

The long or moderately slender shell is thin, white, or cream-colored with the posterior end brown, sculptured like *Pholas*, the ribs on the anterior side strong, coarsely noded or scabrous while posteriorly the ribs grade into fine threads. Lunular region excavated and smooth.

Length 41.2 mm., height 13.3 mm., diameter 33.2 mm. Búcaro, Panama.

This species resembles the East American *P. pholadiformis* but is somewhat heavier and more slender. The largest specimen seen has a length of about 44.3 mm.

Range—Gulf of California southward to Panama. Nicaragua: Corinto (Pilsbry and Lowe). Panama: Búcaro.

Petricola (*Petricolaria*) *cognata* C. B. Adams Plate 54, figures 5, 5a

Petricola cognata C. B. Adams, 1852, Ann. Lyceum Nat. Hist. New York, vol. 5, pp. 510, 546, 547, No. 477.—Pilsbry and Lowe, 1932, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, p. 99, pl. 13, figs. 10, 11 (figs. of type).—Turner, 1956, Occas. Papers on Mollusks, Mus. Comp. Zool., vol. 2, No. 20, p. 33, pl. 19, figs. 3, 4.

Shell pholadiform, dingy white. Sculpture on the posterior half of shell consists of fine radial threads which become much coarser anteriorly where they assume the character of riblets. Similar in general characters to the East American *P. pholadiformis* but differs by the much more massive teeth particularly in the right valve, the broader nymphs, and the wider lunule-like area free of radial sculpture. It is a thick shell for *Petricolaria* with strongly impressed adductor scars and pallial sinus.

This species known as yet only from the type, first figured by Pilsbry and Lowe, and recopied here. The above description is a partial revision from that of Adams and from Pilsbry and Lowe.

Range—Panama. Panama: Panama.

Subgenus *NARANIO* Gray, 1853

Type species by subsequent designation, Dall, 1900, *Naranio costata* (Lamarck) (= *Venus lapicida* Gmelin).

Shell generally ovate to oblong, plump. Sculpture of radial riblets often divaricated or with sharp, zigzag bends.

Petricola (*Naranio*) *botula*, new species

Plate 55, figures 7, 7a, 8

The shell is relatively small (length about 15 mm.), broadly to narrowly elongate, equivalve, convex, white or cream-colored. The umbone and beak is placed near the anterior one-fourth, the anterior end short and well-rounded. The shell is highest and most convex along a line running from the beak downward; behind this slope, the surface over the middle portion of the disk is slightly impressed. The posterior-umbonal slope is rounded to weakly angled, the dorsal surface above it somewhat flattened. Surface is finely marked with small radial threads, simple in the middle of the umbonal disk and on the anterior slope but towards the ventral margin and the ends, the markings are irregularly divaricate; there is also a line of marked divarication along the posterior-umbonal slope and at the anterior one-fourth. The hinge is typical, the area of the ligament short and excavated. The pallial sinus is large, rounded, and extends to about the middle of the shell cavity, the adductor scars distinct, the anterior one is much larger than the other.

Length 14.3 mm., height 7.9 mm., diameter 6.7 mm. Holotype, ANSP 218908.

Length 13.7 mm., height 8 mm., diameter 6.7 mm.

Length 15.5 mm., height 8.5 mm., diameter 8 mm.

A rock borer, the shell varying somewhat in shape, some specimens being short and stubby, others narrow and elongate. Found boring into Tertiary rocks at Guanico.

Range—Panama. Panama: Guanico.

Petricola (*Naranio*) *charapota*, new species

Plate 54, figure 7

Shell of medium size, subrectangular, subsolid, and of a brown-red color, the beak strongly anterior in position, the posterior side hence much longer, inflated, or strongly convex along the zone of the umbonal slope extending from the beak to the posterior-ventral corner. Dorsal and ventral sides are nearly parallel, the posterior end itself rounded, the anterior side short and subtruncate. Sculpture is formed by fine to medium size, radial riblets which are uniformly distributed over the whole surface except along two lines, the one extending along the middle of the posterior umbonal slope, the other at the anterior one-third at which place some of the riblets split, bend, or become hook-shaped. Color is a faded, reddish brown in the type specimen, similar over the whole valve. Pallial sinus is large, rounded, extending to about the middle of the shell cavity. Adductor scars large, the posterior one placed high. Ligament area deeply excavated and short.

Length 30 mm., height 20.2 mm., diameter 10 mm. a left valve.

Holotype, ANSP 218907.

Range—Coast of Ecuador. Ecuador: Charapota.

Family COOPERELLIDAE

A group of small shells, usually with thin, veneriform valves, the surface white and glossy, sometimes weakly undulate or marked with fine lines of growth only. Hinge as described for the genus.

Genus COOPERELLA Carpenter, 1864

(*Oedalia* Carpenter, 1864, not of Meigen, 1820 (Diptera). *Oedalina* Carpenter, new name for *Oedalia*).

Type species by monotypy, *Oedalia* (*Cooperella*) *scintillaeformis* Carpenter (= *Oedalia subdiaphana* Carpenter).

Shell small, thin and fragile, white, ovately subtriangular, equivalve, the umbones submedian, convex, the surface smooth or concentrically striated or undulated. Hinge plate narrow, bearing the cardinal teeth, in the forward section and a short, oblique, and partly immersed resilifer in the back, and separated from each other by a thin plate. The cardinal set has three teeth in the left valve and two teeth in the right valve, placed directly under the beaks; the central cardinal tooth is always bifid, the others sometimes so; there are no lateral teeth. Adductor scars are small, ovate, connected by the pallial sinus bearing an ample sinus. The inner margins of the valves are smooth.

Cooperella subdiaphana (Carpenter)

Plate 84, figure 4

Oedalia subdiaphana Carpenter, 1864, Rept. Brit. Assoc. Adv. Sci. for 1863, p. 639, n.g., n.s. Thin, swollen, shape of *Kellia*, ligament surrounding beaks; hinge with 5 bifid teeth (3-2); no laterals; large mantle bend. Reprinted in Smith. Misc. Coll. no. 25q, A, p. 125, No. 56.—Carpenter, 1865, Jour. de Conchy., vol. 13, p. 134, reprinted Smith. M. p. 302.

Cooperella scintillaeformis Carpenter, 1864, *op. cit.*, p. 639, No. 57. New subgenus of *Oedalia*. Cartilage semi-internal; only 1 tooth bifid. Reprinted, Smith, *op. cit.*, p. 125.

Oedalina subdiaphana (Carpenter), 1865, Proc. California Acad. Nat. Sci., vol. 3, p. 208.—Lamy, 1914, Jour. de Conchy., vol. 61, No. 3, p. 303, fig. of hinge on p. 302.

Cooperella subdiaphana (Carpenter), Dall, 1900, Trans. Wagner Free Institute Sciences, vol. 3, pt. 5, p. 1062.—Dall, 1921, Bull. 112, U. S. Nat. Museum, p. 145.—Hertlein and Strong, 1948, Zoologica, vol. 33, pt. 4, p. 196; Palmer, 1958, Mem. Geol. Soc. America, No. 76, p. 101, pl. 12, figs. 6-16.

Shell small to medium-sized (length to nearly 15 mm.), veneriform, convex, thin and fragile, the beaks nearly median, the anterior end rounded, the posterior somewhat narrower. Surface smooth or with fine, concentric lines and slightly undulated, white, shiny, with a play of iridescence. Periostracum thin, vernicose, and of a light straw-yellow color. The ligament is external and shows as a small knob behind the beak, the resilium seated in a deep, U-shaped pit floored by the nymph.

Range—Queen Charlotte Islands, British Columbia, south to San Felipe, east coast of Lower California and near the head of the Gulf of California.

Cooperella panamensis, new species

Plate 84, figure 5

Shell of medium size, subovate to subquadrate, the umbone prominent and nearly median, subequilateral, the anterior side a trifle higher and

flatly rounded at the end, the posterior side narrower. Texture of the shell is extremely thin and fragile. Surface smooth, polished, undulated on the anterior slope by fairly wide, concentric ribbons, less so on the posterior slope. Hinge as typical for the genus.

Length 10.4 mm., height 8.2 mm., diameter 2.4 mm., left valve. Holotype, ANSP 218964.

This form is similar to *C. subdiaphana* (Carpenter) and perhaps but a southern form of that species but its shell has a more rounded outline, the two ends are almost alike. It is also similar to *C. carpenteri* Dall, 1900, from the Miocene of Virginia, but differs somewhat in shape.

The species is evidently rare, and known to me by a few free valves only.

Range—Panama. Panama: Búcaro.

Family

Genus HALODAKRA, new genus

Type species, ?*Circe subtrigona* Carpenter. Recent, Panamic-Pacific province.

Shell small, ovate, veneriform, inequilateral, the posterior side longer than the anterior, rounded at the ends. There is no evident lunule or escutcheon. The ligament is internal or largely so, the resilifer represented by a small, narrow scar along the lower or inner side of a short, nymphal ridge; the tensilium, if present, is small and does not show above the valve margin. Cardinal teeth have a radial arrangement under the beaks as in the Veneridae, with two teeth in the right valve and three in the left; the middle left cardinal tooth and the right anterior tooth are bifid. The nymphal ridge in the right valve is a toothlike lamina. The pallial line is indistinct and is probably entire. Surface plain or sculptured only with fine, concentric threads. Color mostly white or cream but with a large, feather-like brown mark on the posterior slope, the color of which shows through into the interior, together with small zigzag lines elsewhere.

The familial affinities of this genus are unknown. Its internal ligament removes it from the Veneridae which it resembles by its shape. Carpenter, who described the type species, noted that the ligament was internal or deeply inset in the hinge plate; he tentatively referred the species to the Astartidae.

Halodakra subtrigona (Carpenter)

Plate 27, figures 1-1c

?*Circe subtrigona* Carpenter, 1857, Cat. Mazatlan Shells, Brit. Mus., p. 82, No. 115
Mazatlan, on *Spondylus lamarckii*.

Psephidia subtrigona (Carpenter), Myra Keen, 1958, Sea Shells of Tropical West America, p. 140, No. 317; also p. 622.

A small species with the characters as described for the genus. Always small, an average specimen measures: length 3.8 mm., height 3.2 mm., diameter 1.8 mm. The species is easily recognized from other small bivalve shells by the large, feather-like brown patch on its posterior slope, so dark in color that its image is clearly seen on the inside of the valve. This small species is often plentiful in fine, beach drift along with other small molluscan shells.

Range—Mexico to northern Peru. Mexico: Mazatlan. Panama: Panama City. Ecuador: Santa Elena, Punta Centinella. Peru: Mancora, Caleta Sal.

Superfamily MACTRACEA

Family MACTRIDAE

The shell is ovate, subtrigonal or hatchet-shaped, equivalve and generally inequilateral, usually convex, and of thin or coarse texture. The posterior-dorsal area is usually well defined, set apart by a line, angle or by a high fringe or keel. The ligament is almost completely internal, the major part or resilium lodged in a deep, cup-shaped pit or chondrophore in the hinge plate; the tensilium section of the ligament is always small and it may show externally behind the beaks as a small, brown knob, or it may lie concealed below the hinge margin as in *Mulinia*. The hinge plate is usually wide and carries the large, deep chondrophoral pit or resilifer in the middle bordered on the anterior side by an inverted V-shaped cardinal tooth and on the two sides by the lateral teeth or their sockets. The umbones are usually high, convex, and prominent and terminate in small, adjacent, prosogyrate beaks. In the interior, the adductor scars are subequal and generally show distinctly. Pallial sinus large, rounded or squared-off at the end. The inner ventral margins are smooth. Surface smooth or marked with concentric growth lines; sometimes the surface is waved or deeply undulated, and overrun with coarse, vermiculate striae, generally radial. Color white, the periostracum thin or vermice, yellow, gray, brown, or nearly black. The siphons are united to the tips.

The Mactridae are best divided into genera on the characters of the ligament, supplemented by the external features of the shell. The external section of the ligament or tensilium is always small and in the majority of forms, it is attached to a small scar set along the dorsal margin just behind the beaks and in living specimens, it is visible externally. In *Mactrellona* (*Mactrella*), the tensilium is attached to the dorsal surface of a small, nymphal plate which is connected anteriorly with the margin of the valve extended below the beak. In *Mactra*, *s.s.*, the tensilium lies deeper and only a small part may show above the margin, the scar of its attachment separated from the resilifer or chondrophoral pit by a small ridge, sometimes reduced to a mere ridge. In *Mulinia*, the entire ligament is internal, no part of which shows externally, but the tensilium is still functional and its scar of attachment is placed in the roof of the chondrophore but clearly separated from the main portion of the resilifer by an open or free space. In *Rangia*, the ligamental features are the same as in *Mulinia*.

As a family, the Mactridae are especially well defined and in general easily distinguished from most other marine clams by their characteristic hinge and by their large, internal ligament attached to a deep, spoon-shaped cup or chondrophore in the middle of the hinge plate. In key form, the Panamic genera have been arranged as follows:

Key to Panamic-Pacific genera

- I. Shell hatchet-shaped, ovate-trigonal, the umbones submedian in position, with small, prosogyrate beaks, the two ends of the valves more or less alike, the zone of greatest convexity lying along the umbonal slope. The posterior-dorsal area is usually well defined, often set off by an angle or keel.

Subfamily *Mactrinae*

- A. Ligament completely internal.
1. Shell trigonal-ovate in shape, with high, full, centrally placed umbones. Beaks not touching, removed from direct contact with the hinge margin by a narrow or wide space.

Genus *Mulinia*
 - B. Ligament is partly external, a small segment of it showing normally above the hinge margin behind the beaks. The beaks are adjacent and touch or nearly so at the hinge margin.
 - a. The external section of the ligament (tensilium) is small and is attached to a short shelly plate formed by an extension of the anterior margin backwards under the beak. The lateral teeth are of unequal size, the posterior lateral tooth small and placed close to the side of the chondrophore.
 2. Shell trigonal in shape, usually high, smooth, thin, the posterior-dorsal areas rather wide and defined by a sharp angle or a winged keel.

Genus *Mactrellona*
 3. Shell rounded, thin and fragile, its surface marked with deep, concentric undulations, transmitted equally strong into the interior. Posterior-dorsal areas distinct, narrow, set off by a ridge or keel.

Genus *Harvella*
 - b. The external section of the ligament (tensilium) large or small, attached directly to the margin of the shell behind the beaks and separated from the chondrophoral pit by a space or by a small line or ridge. Lateral teeth of nearly the same size and spaced about the same distance from the central chondrophore.
 - ba. Lateral teeth smooth.
 4. Shell wall thick or moderately so, the external surface smooth or simply covered with growth lines. Periostracum coarse, usually dark in color.

Genus *Mactra*
 - bb. Lateral teeth strongly or faintly striated.
 5. Shell ovate to elliptical, either side the longer. Pallial sinus short. Surface smooth or with growth line concentrics. Periostracum dark or light-colored.

Genus *Spisula*
 - II. Shell obliquely ovate in shape, the anterior-umbonal section strongly convex or inflated, the posterior side depressed. Shell wall usually thin and fragile. Posterior-dorsal slope poorly defined.

Subfamily *Pteropsidinae*

 - c. Surface marked with deep undulations.
 6. Surface undulations strictly concentric, generally strongest on the umbones, irregular and subobsolete elsewhere. A minute sculpture of fine, radial threads, or vermiculate striae cover the whole disk.

Genus *Raeta*
 7. Surface undulations in part strongly oblique to the valve margin and crossed by coarse growth lines and striations.

Genus *Tumbeziconcha*
 - d. Surface smooth, without deep undulations.
 8. Shell in shape like *Anatina*, the posterior side depressed and with a small weak ridge near the middle.

Genus *Labiosa*

Subfamily MACTRINAE

Shell usually hatchet-shaped, ovate-trigonal, subequilateral, the umbones submedian, and with small prosogyrate beaks. Hinge as described

for the family. Posterior-dorsal areas usually distinct. Siphons partly or wholly naked and retractible into the shell, the mantle lobes separated ventrally between the siphons and the anterior adductor.

Genus *MACTRA* Linné, 1767

Type species by subsequent designation, Gray, 1847, *Mactra stultorum* Linné.

The shell is usually elongately ovate, coarse in texture, the ends subequal or the posterior side may be a little longer. The posterior-dorsal area is low, flattened or rounded, and set apart weakly by a small line or ridge. The external portion of the ligament is small and attached to a scar along the dorsal margin just behind the beak. Surface smooth except for the usual lines of growth but often showing small waves or concentric undulations over the beaks.

Species belonging to the typical section of the genus *Mactra* are not represented in the Panamic region.

The genus has been divided into several smaller groups or subgenera but the lines between these groups are not often well defined. In this work, the Panamic species are referred to three subgenera defined as follows:

I. Valves subequilateral, the two ends appearing almost alike, the beaks and umbones near the middle. Surface of beaks and umbones generally rippled, the undulations strongest on the side slopes, fading away below.

1. Shell relatively small and of a medium weight.

Subgenus *Micromacra*

II. Valves strongly inequilateral, generally thick-walled. Surface of beaks and umbones not sulcated. Clams of moderate or large size.

2. Posterior side much longer than the anterior, the adductor scars unequal, the posterior one the larger. The anterior arm of the right cardinal tooth lies above or in the same general plane as the lateral lamina.

Subgenus *Macroderma*

3. Two ends of shell of nearly the same length, the anterior side narrow and cuneiform. Adductor scars subequal. Anterior arm of the right cardinal tooth lies below the plane of the lateral lamina.

Subgenus *Mactromeris*

Subgenus *MACTRODORMA* Dall, 1894

Type species by original designation, *Mactra velata* Philippi.

Shell inequilateral, the posterior side longer than the anterior, convex, and thick-walled. Posterior scar the larger. Posterior-dorsal slope rounded, set apart by a small line. Anterior arm of right cardinal tooth continuous with or in the same plane as the lateral tooth. Surface crude, marked with coarse, uneven growth lines, and covered by a coarse, brown to black periostracum.

Mactra (*Macroderma*) *velata* Philippi

Plate 58, figures 1-1c

Mactra velata Philippi, 1848, Zeitschr. für Mal., p. 153.—Philippi, 1850, Abbild. und Beschreib. Conchylien, vol. 3, p. 137, pl. 3, fig. 5.—Reeve, 1854, Conch. Icon., vol. 8, *Mactra*, pl. 5, fig. 20.

Mactra (*Macroderma*) *velata* Philippi, Dall, 1909, Proc. U.S. Nat. Museum, vol. 37, No. 1704, p. 274.

This is the common, coastal *Mactra* from Peru northward to Panama, recognized by its large, coarse shell. Philippi's original figure illustrates an

abnormal specimen with a high, rounded, posterior side. The species is common in Sechura Bay, Peru, where it grows larger than any specimens seen from further north. The shell is variable in shape, often high, and trigonal.

Length 115 mm., height 80 mm., diameter of a left valve 23.2 mm. Bayovar, Peru.

Range—Lower California (Dall) to northern Peru, and the Galapagos Islands. Panama: San Carlos; Panama City. Panama Canal Zone: Venado Beach. Ecuador: Sua; Padernales; Manta. Peru: Caletto Sal; Lobitos; Paita; Sechura Bay; Lobos de Tierra.

Subgenus **MACTROMERIS** Conrad, 1868

(*Simomactra* Dall, 1894, type species, *M. dolabriformis* Conrad.)

Type species by subsequent designation, Dall, 1898, *Spisula ovalis* Gould (= *Mactra polynyma* Stimpson).

Shell inequilateral, the two ends are of nearly the same length but differ greatly in shape, the posterior side is wide and round while the anterior side is narrow and cuneiform. The adductor scars are small and subequal. Hinge of medium size, the lateral teeth spaced about the same distance from the middle, the right, anterior lateral tooth not adjacent or in the same line as the anterior arm of the cardinal tooth.

Mactromeris has usually been considered a section or subgenus of *Spisula* or of *Hemimactra*, said to differ from those genera mainly in that the surface of the lateral teeth is smooth or without striations; in my opinion, the affinities of *Mactromeris* to *Mactra* seem equally as close. The typical species of the subgenus live in northern waters.

***Mactra* (*Mactromeris*) *dolabriformis* (Conrad)**

Plate 57, figures 1, 1a;
Plate 58, figures 4, 4a

Spisula dolabriformis Conrad, 1867, Amer. Jour. Conch., vol. 3, pt. 2, p. 193 Panama.—Conrad, 1869, Amer. Jour. Conch., vol. 5, p. 108, pl. 12, fig. 1 (only).—Burch, 1945, Min. Conch. Club. South. Calif., No. 44, pp. 17, 18.

Mactra dolabriformis (Conrad), Dall, 1894, Nautilus, vol. 7, p. 138, pl. 5, fig. no. 1.—Maxwell Smith, 1944, Panamic Marine Shells, p. 67, fig. 865.

Shell trigonal-ovate or flattened cuneiform, inequilateral, the anterior side is narrower and somewhat longer, the posterior side higher and well rounded, thin or of medium weight. Umbones submedian, flattened, ending in small adjacent beaks which touch the hinge margin. Surface smooth or marked with fine, hairlike growth lines and covered by a thin, straw-colored, deciduous periostracum. Pallial sinus well defined but short, the adductor scars subequal.

A right valve from Atacames, Ecuador, measures: length 93 mm., height 55 mm., diameter 13 mm.

A rare species but apparently of wide distribution through the Panamic faunal province. In shape similar to *Spisula falcata* (Gould) but generally smaller, thinner, and more depressed. A thin but distinct shelly ridge lies between the external ligament and the chondrophore.

Range—Southern California to Panama and Ecuador. Mexico: Nino Bay, Sonora Mexico (H. N. Lowe, ANSP). Panama: Panama (Conrad,

ANSP); Concepcion Beach near Las Tablas; Pedro Gonzalez Id. (Pearl Islands), J. P. E. Morrison, USNM. Ecuador: Atacames.

Subgenus **MICROMACTRA** Dall, 1894

Type species by original designation, *Mactra californica* Conrad *non* Deshayes.

Shell small (length less than 60 mm.), the beaks and umbones submedian, depressed to slightly convex, the umbones generally sulcated. Hinge that of *Mactrotoma*, the scar of the external ligament small, seated on the margin above the chondrophore, not separated by a nymphal ridge. Posterior-dorsal area narrow, generally flattened.

On hinge characters, *Micromactra* is similar to *Mactrotoma*, but it differs constantly by the smaller size of its typical species and generally in have the surface of the umbones neatly rippled with concentric undulations. The group is abundantly represented as fossil in the Tertiaries of the West Indian-Caribbean region.

Key to species of *Micromactra*

- I. Pallial sinus large, extending to or beyond the mid-center of the valves.
 1. Shell relatively high, the height about 68 to 70 per cent of its length. *M. isthmica*
 2. Shell longer, the height less than 65 per cent of its length, relatively thin. *M. fonsecana*
- II. Pallial sinus shorter, not reaching to the mid-center.
 3. Shell short, the anterior-dorsal margin straight, subsolid. *M. vanattae*
 4. Shell longer, the anterior-dorsal margin concave, relatively thin. *M. angusta*

Mactra (*Micromactra*) *isthmica* Pilsbry and Lowe Plate 57, figure 8d

Mactra (*Micromactra*) *isthmica* Pilsbry and Lowe, 1932, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, p. 89, pl. 15, figs. 1, 2; pl. 16, fig. 5.

The shell is broadly ovate-elliptical, depressed convex, widely gaping at the posterior end, slightly so anteriorly, white under a buff to olivaceous periostracum, minutely and delicately thread-striate. The small beaks have concentric waves in front and behind, sometimes continuous across the whole umbonal surface. Posterior-dorsal area as in *Mactroderma* is wide, with a downward slope and is defined on the lower side by a small thread. Pallial sinus ample, extending past the middle to 56 to 60 per cent of the length.

Length 55 mm., height 38.5 mm., diameter 20 mm.

A more solid and higher shell than *M. fonsecana*. In shape, this shell is much like species of *Mactrotoma*.

Range—El Salvador to Panama. El Salvador: Gulf of Fonseca (Pilsbry and Lowe). Panama: near Panama City (J. Zetek).

Mactra (*Micromactra*) *fonsecana* Hertlein and Strong Plate 57, figures 4, 4a, 8b

Mactra (*Micromactra*) *angusta* Deshayes, Pilsbry and Lowe, 1932, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, p. 89, pl. 15, figs. 3, 4; pl. 16, fig. 3. Not *M. angusta* Reeve, 1854.

Mactra (*Micromactra*) *fonsecana* Hertlein and Strong, 1950, Zoologica, vol. 35, pt. 4, p. 232, pl. 2, figs. 16, 19, 20.—Hertlein and Strong, 1955, Bull. Amer. Mus. Nat. Hist., vol. 107, art. 2, p. 204.

Shell elongate, ovate, white, covered with a thin, gray-brown periostracum, depressed to moderately convex. The posterior side is a trifle longer than the anterior, both ends evenly rounded. The posterior gap is large, the anterior one small. The surface of the extreme tip of the umbones are smooth or finely undulated with concentric waves, deepest on the sides; elsewhere, the surface is smooth or marked with fine, hairlike concentrics only. The posterior-dorsal slope as in some species of *Mactroderma* is sloping.

Length 50.5 mm., height 32 mm., diameter 17.2 mm. An average specimen.

Range—Nicaragua southward to Panama. Nicaragua: Type area from Potosi and Monypenny Point, Gulf of Fonseca (Hertlein and Strong). Panama: Montijo Bay. Panama Canal Zone: Palo Seco. Ecuador: Off Cabo Pasado (Hertlein and Strong).

Mactra (*Micromactra*) *vanattae* Pilsbry and Lowe Plate 57, figures 5, 8c

Mactra (*Micromactra*) *vanattae* Pilsbry and Lowe, 1932, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, p. 90, pl. 16, figs. 4-4b.—Maxwell Smith, 1944, Panamic Marine Shells, p. 66, figs. 853, 853a.—Hertlein and Strong, 1950, Zoologica, vol. 35, pt. 4, p. 232.

Shell usually small (length 48 mm., or less), compressed, gaping posteriorly and moderately solid, white, under a gray or drab periostracum. The beaks are smooth and plain or sculptured with short, concentric waves in front of the posterior-dorsal ridge. Beaks are nearly median in position, the two ends much alike. Posterior-dorsal slope narrow, defined by a small line or ridge, slightly vaulted in the right valve, more flattened in the left. Pallial sinus short, wide, rounded.

Length 31 mm., height 21 mm., diameter 11.2 mm.

In the variety or subspecies *M. acymata* Pilsbry and Lowe, the undulations on the beaks are obsolete. *M. vanattae* is the common *Micromactra* in Panama.

Range—Guatemala to northern Peru. Panama: Panama City; Burica; Búcaro; San Miquel, Rey Island, Pearl Islands. Ecuador: Galeras; Manta; Santa Elena; Ancon Point; Puno. Peru: Tumbes.

Mactra (*Micromactra*) *angusta* Reeve Plate 57, figures 2-2b; Plate 85, figure 9

Mactra angusta Reeve, 1854, Conch. Icon., vol. 8, *Mactra*, pl. 18, fig. 93; Deshayes, 1855, Proc. Zool. Soc. London for 1854, p. 67; Weinkauff, 1884, Conchyl.—Cab. von Martini-Chemnitz, bd. 11, abt. 2, Mactracea, p. 70, taf. 25, figs. 2, 2a.

Mactra (*Micromactra*) *angusta* Reeve, Hertlein and Strong, 1950, Zoologica, vol. 35, pt. 4, p. 231, pl. 2, figs. 14, 18.—Hertlein and Strong, 1955, Bull. Amer. Mus. Nat. Hist., vol. 107, art. 2, pp. 203, 204.

Mactra (*Micromactra*) *atacama* Pilsbry and Olsson, 1941, Proc. Acad. Nat. Sci. Philadelphia, vol. 93, p. 73, pl. 14, figs. 1, 3.

The shell is white, transversely elongate, compressed, gaping slightly at the posterior end. The beaks are nearly median in position, the shell hence nearly equilateral, the anterior side obliquely rounded at the end, and somewhat shorter than the posterior which is bluntly pointed. The anterior-dorsal margin is slightly concave, the posterior one a little arched. Valves are relatively thin, the surface white, often subtranslucent, covered by a

thin, gray periostracum. The umbones may be smooth or neatly sulcated over a small space. The posterior-dorsal slope narrow, flat, and subtruncated at the end. Pallial sinus small, wide and well rounded.

Length 53.4 mm., diameter 33.4 mm., semidiameter 7 mm.

Length 53.8 mm., diameter 32.7 mm., semidiameter 8.7 mm. a left valve. Mompiche, Ecuador.

A common and widely distributed species. Specimens from the Pliocene of Ecuador are larger than the Recent.

Range—Guatemala to northern Peru. Panama: Panama City; Guanico. Panama Canal Zone: Palo Seco. Ecuador: Esmeraldas; Mompiche; Charapota; Manta; Santa Elena. Peru: Tumbes; Zorritos; Mancora.

Genus *SPISULA* Gray, 1837

Type species by subsequent designation, Gray, 1847, *Mactra solida* Linné. European Seas.

Shell ovate, the two ends sometimes nearly alike or the posterior side is the longer. Tensilium visible externally and attached to a small scar along the shell margin behind the beak and separated from the deep, spoon-shaped chondrophore by a narrow space. Adductor scars subequal, the pallial sinus short, rectangular in shape. Lateral teeth and sockets strong, equidistant from the chondrophore, the sides of the teeth usually striated or transversely wrinkled. Surface with concentric growth line sculpture and covered by a thin or thick periostracum.

Spisula adamsi, new species

Plate 57, figures 7-7c

Shell small or of medium size, convex, trigonal-ovate, nearly equilateral, the anterior side slightly longer and wider, the posterior side shorter, its dorsal area flattened or weakly arched and setoff from the rest of the disk by a weak angle. The umbones are nearly median, convex, and prominent. Hinge typical for the genus, the lateral laminae and their sockets elongate, equidistant from the chondrophore, the face of the lateral teeth smooth or weakly striate. The small tensilium is external, visible from above, and separated from the large pit of the chondrophore by a small space. Surface colored a creamy white, polished, marked with indistinct lines of growth; on the posterior-dorsal area, the growth lines may join together in forming larger cross riblets. The periostracum is thin, varnish-like, and of a light, yellowish gray color, usually worn off beach specimens. Due to the relative thinness of the shell wall, the adductor scars and pallial sinus show indistinctly, the small pallial sinus extends only a short distance beyond the posterior adductor scar, quadrate at its end.

Length 36.2 mm., height 27.4 mm., diameter of shell with closed valves 17.6 mm. Palo Seco, Panama Canal Zone. Holotype, ANSP 218917.

This small clam is said to appear on the sand bar at Palo Seco, Panama Canal Zone, and was collected there in fair numbers by Messers. Stewart Jadis and Lee R. Beil. Specimens may attain a length of about 50 mm., but the majority are smaller.

Range—Panama southward to northern Peru. Panama Canal Zone: Palo Seco. Ecuador: San Francisco; Puerto Callo; Santa Elena. Peru: Zorritos.

Genus *MACTRELLONA* Marks, 1951(*Mactrella* of most authors but not strictly of Gray, 1853.)Type species by original designation, *Mactra alata* Spengler.

Shell trigonal or hatchet-shaped, thin, inflated, with full prominent and nearly median umbones and small, adjacent prosogyrate beaks. The surface is smooth or marked with fine growth lines only. The posterior-dorsal area is wide, flattened or slightly arched, marked off sharply by an angle or a keel which may be elevated and winged. Tensilium attached to a short, shelly plate forming a small roof over the chondrophore and formed as an extension of the anterior margin back under the beak. Hinge concentrated, the posterior lateral tooth small, and crowded close against the side of the chondrophore.

The species of this group have generally been referred to *Mactrella* Gray, 1853, for many years, including by Gray himself, in the general belief that *Mactra striatula*, its type species by monotypy, was identical or closely allied to *Mactra alata* Spengler. Gray's original description of *Mactrella* seems certainly to refer to a species of the *alata* group (a thin, cordate, triangular shell with a short, hinder, lateral tooth) but not to *M. striatula*, the species he designated as type; it is clearly a case of species misidentification. The *M. striatula* of Linnaeus, as this shell was figured by Hanley, evidently from the type specimen, has an elongated form and the umbones are waved, and it belongs to the group commonly known as *Mactrinula*. Marks has recently discussed this subject (1951, Bull. Amer. Paleont., vol. 33, No. 139, p. 355). If we must adhere strictly to the rule that a designated species must remain the type of a genus, irrespective of the author's description and real intentions, then *Mactrella* must fall and become a synonym of *Mactrinula*. As a replacement, Marks proposed the name "*Mactrellona*" which is used in this work under protest.

Key to Panamic-Pacific species of *Mactrellona*

- I. Posterior-dorsal area wide and flat, bordered by a high, winged keel.
 1. Shell elongate-ovate, the two ends nearly alike, the basal margin rounded without a marked bulge. No posterior gap. *M. alata*
 2. Shell higher, hatchet-shape, the ventral margin with a large bulge on the posterior side of the middle. Posterior margin with a small open gap. *M. clisea*
- II. Posterior-dorsal area flat or slightly arched, bordered externally by a small angle or ridge only, never alate. *M. exoleta*

Mactrellona alata (Spengler)

Plate 56, figure 4

Mactra alata Spengler, 1802, Skrivt. Nat. Selsk., vol. 5, pt. 2, p. 99.—Reeve, 1854, Conch. Icon., vol. 8, *Mactra*, pl. 8, fig. 29.—McLean, 1951, New York Acad. Sciences, vol. 17, pt. 1, p. 111, pl. 23, fig. 1.

Mactra (*Mactrella*) *alata* Spengler, Dall, 1894, Nautilus, vol. 8, No. 3, p. 26.

Mactra (*Mactrella*) *subulata* Mörch, 1861, Malak. Blätter, bd. 7, p. 180 Realejo, near Corinto, Nicaragua.

Mactra (*Mactrella*) *alata* Spengler, var. *subulata* Mörch, Olsson, 1935, Nautilus, vol. 48, No. 3, p. 105.

Shell elongated trigonal, the umbones median, moderately convex, thin. Posterior-dorsal area widely flattened but with a small mid-rib, the outer keel generally high and winged. Valves closed, no posterior gap.

Length 78.7 mm., height 56 mm., semidiameter 16 mm. a right valve, Búcaro, Panama.

M. alata has generally been considered a West Indian or Caribbean species strictly, but it is now known to be fairly common at several places along the Pacific Coast. A typical specimen was figured by Reeve from Santa Elena, Ecuador; Mörch in 1861, proposed the name "*subalata*" from a single right valve found at Realejo, near Corinto, Nicaragua, but the characters selected by Mörch as distinctive are of doubtful significance. As a fossil, *M. alata* has been recorded from the Miocene of the Dominican Republic and Costa Rica.

Range—Nicaragua to Ecuador. Panama: Burica Peninsula; Guanico; Búcaro. Ecuador: Sau; Santa Elena.

***Mactrellona clisea* (Dall)**

Plate 56, figure 1

Mactrella clisea Dall, 1915, Nautilus, vol. 29, No. 6, pp. 62, 63 "no mention of locality."—Dall, 1916, Proc. U.S. Nat. Museum, vol. 52, p. 415 type stated as from Manzanillo, Mexico.

Mactra (Mactrella) clisea (Dall), Olsson, 1935, Nautilus, vol. 48, No. 3, p. 105.—Maxwell Smith, 1944, Panamic Marine Shells, p. 66, fig. 860B.

Mactrella (Mactrella) clisea Dall, Hertlein and Strong, 1950, Zoologica, vol. 35, pt. 4, p. 233.

Mactrellona (Mactrellona) clisea (Dall), Hertlein and Strong, 1955, Bull. Amer. Mus. Nat. Hist., vol. 107, art. 2, pp. 204, 205.

Shell medium to large, thin, arcuate, hatchet-shaped, the zone of greatest inflation extending from the beak to the posterior-middle side of the ventral margin which is widely bulged as a result. The anterior side is somewhat produced, narrowed and depressed. The posterior-dorsal area is wide, flattened and carries a small mid-rib; externally, it is bordered by a raised, frilled or winged keel. There is a small gap near the forward end of the posterior area. Surface roughened by crowded growth lines and covered by a thin, yellowish periostracum.

The largest specimen measures: length 85 mm., height 70 mm., semidiameter 20 mm. a right valve.

Distinguished from *M. alata* by its higher, arcuate form, and the presence of a small, posterior gap.

Range—Gulf of California to Ecuador. Panama: Búcaro; Guanico; Burica. Ecuador: Sua; Galeras; Canaoa; Manglaralto; Santa Elena.

***Mactrellona exoleta* (Gray)**

Plate 58, figures 3-3b

Mactra exoleta Gray, 1837, Mag. Nat. Hist., vol. 1, p. 372 no locality cited.—Hanley, 1843, Cat. Recent Bivalve Shells, p. 33; 1856, p. 340, pl. 11, fig. 51.—Reeve, 1854, Conch. Icon., vol. 8, *Mactra*, pl. 4, fig. 16.—Grant and Gale, 1931, Mem. San Diego Soc. Nat. Hist., vol. 1, p. 402, pl. 22, figs. 10a, 10b.

Mactrella (Mactrella) exoleta (Gray), Hertlein and Strong, 1950, Zoologica, vol. 35, pt. 4, p. 234.

Shell of medium or large size, thin, with large, full umbones and evenly inflated valves. The posterior-dorsal area is wide, flattened or gently vaulted, externally limited by an angled line or low ridge which is not winged or frilled. The texture of the shell is thin and fragile, marked ex-

ternally by coarse lines of growth and covered by a thin, yellowish periostracum.

Length 130 mm., height 94 mm., semidiameter 30 mm. a left valve, Guanico, Panama.

Known also as fossil in the Miocene of Peru and Costa Rica.

Range—Gulf of California to northern Peru. Panama: Burica; Búcaro; Guanico; San Carlos. Colombia: Choco; Isla del Gallo. Ecuador: Santa Elena. Peru: Tumbez; Punta Picos; Caletto Sal.

Genus **HARVELLA** Gray, 1853

Type species by monotypy, *Harvella elegans* (Sowerby).

Shell rounded, convex, concentrically plicate, extremely thin. Posterior-dorsal area narrow but well defined by an outer ridge against which the concentric plicae end sharply. Lunule broadly cordate, deeply impressed, smooth. Hinge, with the general pattern of *Mactrellona*, has a large chondrophore in the middle bordered on the anterior side by an inverted, V-shaped, cardinal tooth. The sockets for the lateral teeth in the left valve are deep, the anterior one with a small accessory lamina on the dorsal wall. External ligament is small.

Key to Panamic-Pacific species

- I. Surface undulations are strong and deep, with nearly circular curve, concentric to the margin and spaced evenly over the whole disk.
 1. Concentric plications are widely spaced (about 4 mm. apart). Height of shell usually less than 60 mm.

H. elegans

2. Shell larger and heavier, the concentric undulations smaller and more numerous (spaced about 3 mm. apart).

H. elegans tucilla

- II. Concentric undulations have a sharp, V-shaped bend in the middle.

H. goniocyoma

Harvella elegans (Sowerby)

Plate 56, figures 5-5b

Mactra elegans Sowerby, 1825, Cat. Shells Tankerville, p. 11, pl. 1, fig. 3.—Reeve, 1854, Conch. Icon., vol. 8, *Mactra*, pl. 17, fig. 89.

Harvella elegans (Sowerby), H. and A. Adams, 1856, Genera Recent Shells, vol. 2, p. 378, pl. 99, figs. 4, 4a.

Harvella pacifica Conrad, 1867, Amer. Jour. Conch., vol. 3, pt. 2, p. 192.—Conrad, 1869, *op. cit.*, vol. 5, pt. 2, p. 108, pl. 12, fig. 2.

Mactrella (*Harvella*) *elegans* (Sowerby), Hertlein and Strong, 1950, Zoologica, vol. 35, pt. 4, p. 235.

Shell thin, white, roundly trigonal, the ventral margin forming the half circumference of a circle, the umbonal portion subtrigonal, convex. Sculpture is formed by strong, narrow, concentric ribs between deep, wide interspaces which run across the disk from a deeply sunken, smooth lunule to the edge of a posterior keel. Posterior-dorsal area smooth. Substance of shell thin, the concentric ribs showing through on the inside in the reverse or as concentric grooves.

Length 60.5 mm., height 51.3 mm., diameter 38.5 mm.

Although poorly represented in most museum collections, the loose valves of this fine mactrid is not uncommon along open beaches from Peru northward. It is now strictly a Pacific species but in Miocene times, there were several allied forms in the Caribbean region. *H. elegans tucilla* Olsson

is a large subspecies found in the upper Miocene beds of northern Peru and the Pliocene of Ecuador.

Range—Gulf of California to northern Peru. Panama: Old Panama; Búcaro. Panama Canal Zone: Venado Beach. Colombia: Isla del Gallo. Ecuador: Esmeraldas; Sua; Mompiche; Manta; Santa Elena. Peru: Tumbes, Zorritos; Boca Pan.

Harvella goniocyma Pilsbry and Lowe

Mactra (*Mactrinula*) *goniocyma* Pilsbry and Lowe, 1932, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, p. 90, pl. 15, figs. 5, 6.—Maxwell Smith, 1944, Panamic Marine Shells, p. 66, fig. 856.

Mactrella (*Mactrinula*) *goniocyma* (Pilsbry and Lowe), Hertlein and Strong, 1950, Zoologica, vol. 35, pt. 4, pp. 234, 235.

Mactrellona (*Mactrinula*) *goniocyma* (Pilsbry and Lowe), Hertlein and Strong, 1955, Bull. Amer. Mus. Nat. Hist., vol. 107, art. 2, p. 205.

The shell is thin and fragile, translucent whitish, ovate-triangular, the small beaks about median, the anterior end broadly rounded, posterior end triangular. Form rather compressed, a narrow, lanceolate, smoothish posterior area defined by a lamina radiating to the posterior-basal angle, a low convexity between lamina and post-dorsal edge. Sculpture of regular obliquely concentric corrugations which are angulated along a vertical line from the beaks, in form of very broad V's. The very fine, sharp concentric striation crosses the corrugations obliquely. The lunular region is smooth, lanceolate. Length 16 mm., height 12 mm., diameter 6 mm. (Pilsbry and Lowe, 1932.)

A rare, poorly understood species.

Range—Mexico to West Colombia. Mexico: Acapulco (Hertlein and Strong). El Salvador: La Libertad (Hertlein and Strong). Nicaragua: San Juan del Sur. Panama: Pinas Bay (Hertlein and Strong). Colombia: Ardita Bay (Hertlein and Strong).

Genus *MULINIA* Gray, 1837

Type species by subsequent designation, Hermannsen, 1847, *Mulinia lateralis* (Say).

Shell small or large, usually heavy. Left valve with strong lateral teeth, equidistant from the cardinals and fitting into deep sockets in the opposite valve. Ligament wholly internal, the resilium seated in a deep chondrophoral pit, the tensilium attached to a smaller scar in the roof of the chondrophore. The cardinal teeth are fused to form an inverted V, placed directly below the tip of the beak. Pallial sinus short but distinct. Posterior-dorsal areas are generally defined by an angled ridge. Surface smooth or roughened by the lines of growth, and in life covered with a thin, straw-colored periostracum.

Mulinia pallida (Broderip and Sowerby)

Plate 58, figures 2-2c

Mactra pallida Broderip and Sowerby, 1829, Zool. Journ., vol. 4, No. 15, p. 360 "From St. Blas".

Mulinia donaciformis Gray, 1837, Mag. Nat. Hist., n. ser., vol. 1, p. 376.—Sowerby, 1839, Zool. Beechey's Voyage, Moll., p. 154, pl. 44, fig. 13.

Mactra donaciformis (Gray), Reeve, 1854, Conch. Icon., vol. 8, *Mactra*, pl. 13, fig. 60.

Mactra angulata Reeve, 1854, *op. cit.*, pl. 9, fig. 34 "Gulf of California".

Mactra carinulata Reeve, 1854, *op. cit.*, pl. 10, fig. 38 "Gulf of California".

Mactra goniata Deshayes, 1855, Proc. Zool. Soc. London, p. 70 "Gulf of California".

- Mactra* (*Mulinia*) *bistrigata* Mörch, 1860, Malak. Blätter, bd. 7, p. 182 "Realejo, Nicaragua".
- Mactra bistrigata* Weinkauff, 1884, Conchy.-Cab. von Martini-Chemnitz, bd. 11, abt. 2, Mactracea, p. 102, taf. 34, figs. 5-7 "Busen von Panama (Oersted)".
- Mulinia pallida* (Broderip and Sowerby), Dall, 1909, Proc. U.S. Nat. Museum, vol. 37, No. 1704, p. 274.—Lamy, 1918, Jour. de Conchyl., vol. 63, No. 4, p. 335.—Hertlein and Strong, 1950, Zoologica, vol. 35, pt. 4, p. 233.
- Mulinia bradleyi* Dall, 1894, Nautilus, vol. 8, p. 6, pl. 1, right figure. Panama, Bradley. USNM.

Average size about 35 mm., but occasional specimens may attain a length of nearly 65 mm. The valves are trigonal in shape, with nearly median beaks and umbones, ventricose, the two ends subequal, the anterior margin rounded, the posterior descending to a pointed or truncated end. Posterior-dorsal area wide, flattened to depressed, limited externally by an angled line. Surface smooth, often polished or marked only by fine lines of growth, white or cream-colored, and covered by a thin, straw-colored periostracum, heaviest on the posterior-dorsal area. Hinge stout, with a deep chondrophore and strong, equidistant, lateral teeth. The ligament as typical of the genus is entirely internal, the scar of the silium showing as a scar in the roof of the chondrophore.

Length 63.7 mm., height 53.4 mm., diameter 33 mm. Sua, Ecuador.

Length 52.2 mm., height 40.3 mm., diameter 26.4 mm. Old Panama, Panama.

This is the common matrid in the southern portion of the Panamic-Pacific Province, somewhat variable in shape and in the thickness of its valves. Typically, it has high, prominent umbones, its posterior end somewhat narrowed and produced. The surface is usually polished over the umbones and midzone with scattered remnants of the thin, cream-gray periostracum remaining near the ventral margin. *M. bradleyi* Dall, 1894, described from Panama, is a questionable form with a more squared off outline and a fringed, persistent periostracum. Young specimens of *M. pallida*, especially if dredged, frequently show a strongly fringed periostracum which may occasionally persist until maturity. *M. modesta* Dall, 1894 (*M. coloradoensis* Dall, 1894) is a northern, estuarine form with a coarse heavy shell.

Range—Gulf of California to northern Peru. Panama: Burica Peninsula; Guanico; Búcaro; San Carlos; Garachine; Old Panama. Panama Canal Zone: Venado Beach. Colombia: Isla del Gallo. Ecuador: Esmeraldas; Sua; Cojimenes; San Francisco; Canoa; Manta; Santa Elena. Peru: Tumbes; Zorritos; Punta Picos; Mancora; Negritos; Paita.

Subfamily PTEROPSIDINAE

Shell ovate, the anterior-umbonal region inflated, the posterior side low and depressed. Posterior-dorsal area absent or but weakly defined. Substance of shell thin and delicate. Hinge with the lateral teeth reduced or partly obsolete. Siphons wholly retractible.

Genus RAETA Gray, 1853

Type species by monotypy, *R. campechensis* Gray [= *R. plicatella* (Lamarck), = *R. canaliculata* (Say)].

The shell is fairly large, thin, the anterior side high, rounded and

inflated, the posterior side much shorter and depressed. The posterior-dorsal area is small, narrow, a little stronger in the right valve. Surface of valves is concentrically undulated or plicated, the whole overrun by fine, submicroscopic threads, mostly radial and waved. The hinge plate is wide, with a large, downward sloping, and projecting chondrophore in the middle bordered on the anterior side by an inverted V-shaped, cardinal tooth, the inner arm of which projects slightly over the apex of the chondrophoral pit. The tensilium is small, deeply inset, and attached to a small nymphal plate which roofs over the posterior side of the chondrophore and is fused with the dorsal margin just below the beak. The lateral margins adjacent to the hinge plate are deeply grooved.

Raeta undulata (Gould)

Plate 56, figures 6-6b

Lutraria undulata Gould, 1851, Proc. Boston Soc. Nat. Hist., vol. 4, p. 89.—Gould, 1853, *po. cit.*, vol. 6, pp. 391, 392, pl. 15, fig. 7.

Labiola undulata (Gould), Stearns, 1894, Proc. U.S. Nat. Museum, vol. 17, p. 157.

Labiola (*Raëta*) *undulata* (Gould), Dall, 1894, Nautilus, vol. 8, p. 41.—Lamy, 1909, Jour. de Conchyl., ser. 4, vol. 11, p. 249.

Anatina (*Raëta*) *undulata* (Gould), Grant and Gale, 1931, Mem. San Diego Soc. Nat. Hist., vol. 1, p. 407, pl. 23, figs. 5a, 5b, 5c.—Hertlein and Strong, 1950, Zoologica, vol. 35, pt. 4, pp. 235, 236.—Hertlein and Strong, 1955, Bull. Amer. Mus. Nat. Hist., vol. 107, art. 2, p. 205.

The shell is broadly ovate, with full, median umbones, the small beaks prosogyrate and appressed to the dorsal margin, the anterior side broadly rounded, the posterior side depressed, narrowed and bluntly pointed at the end. Greatest convexity of the valves is over the anterior portion of the umbonal slope. The surface is deeply undulated with narrow concentric riblets, for the most part regular over the midzone, irregular and crowded ventrally. In young specimens with a thin shell, the external undulations are impressed on the inside surface of the valves, less so on older specimens with a heavier shell.

Length 80 mm., height 64.3 mm., diameter 21 mm. (right valve, Punta Picos, Peru).

This species seems to be more common along the Peruvian coast than further north, and at times its loose valves appear on the beaches of northern Peru in some numbers. The Peruvian examples also appear to attain a larger size than seen for instance along the coasts of Panama and Ecuador. The most southerly record is Bahia de la Independencia to the south of Paracas, the species hence entering the cold waters of the Peruvian faunal province.

The West Atlantic *R. plicatella* (Lamarck) (*canaliculata* Say) is somewhat similar to *R. undulata* but has the beaks placed nearer the posterior end.

Range—Southern California to the Bahia de la Independencia, Peru. Panama: Búcaro; Guanico. Ecuador: Galeras; Charapota; Santa Elena. Peru: Tumbes; Punta Picos; Boca Pan; Negritos; Bayovar; Bahia de la Independencia.

Genus **LABIOSA** Schmidt in Möller, 1832

(*Anatina* Schumacher, 1817 not Bosc, 1816; *Cypricia* Gray, 1840.)

Type species by monotypy, *Anatina pellucida* Schumacher [= *Mactra anatina* Spengler = *Mactra cyprinus* Gray]. Pacific Coast of Mexico and northwestern South America.

Shell small or of medium size, thin, white, subovate, moderately inflated over the wide, umbonal region, the posterior side shorter, depressed, flaring somewhat at the dorsal corner, the end widely gaping. The posterior-dorsal area is defined by an elevated ridge running downward from the beak. Hinge as in *Raëta*, the chondrophore large, the external section of the ligament small. Surface of valves smooth except for irregular lines of growth and sometimes small, obscure undulations on the umbones; there are no submicroscopic markings as in *Raëta*. The pallial sinus is short and high not confluent with the pallial line below.

An earlier paper by Schmidt (1829, Vers. Einth. Conch., reported in Sherborn), in which the name *Labiosa* may have been used, has not been seen. In Möller, 1832 (Isis, p. 130), *Anatina* Schumacher is noted in the synonym of *Labiosa*, hence, it may be considered a replacement name for *Anatina* and would have the same type species.

This is the *Anatina* Schumacher, 1817, unfortunately preoccupied by Bosc, 1816. The genus *Labiosa* has often been enlarged to include *Raëta* which is fully distinct, differing in shape, absence of strong undulations, and minute, submicroscopic, radial markings.

***Labiosa anatina* (Spengler)**

Plate 57, figures 3, 3a

Macra anatina Spengler, 1802, Skrivil. Naturh. Selsk., vol. 5, pt. 2, p. 120.

Anatina pellucida Schumacher, 1817, Nouv. Syst. Hab. Vers Test., p. 126, pl. 8, fig. 1.

Macra cyprinus Gray, 1828, in Wood Index Testae. Suppl., pl. 1, fig. 1.—Gray, 1854, Conch. Icon., vol. 8, *Macra*, pl. 10, fig. 37.

Cypricia anatina (Spengler), Gray, 1847, Proc. Zool. Soc. London, p. 185.

Labiosa anatina (Spengler), Dall, 1894, Nautilus, vol. 8, No. 4, p. 41. West Mexico.—Lamy, 1917, Jour. de Conchyl., vol. 63, pp. 349, 350.

This species is similar to the West Atlantic *L. lineata* (Say) but its outline is more ovate, the beaks are more centrally located, the anterior-dorsal margin less descending, and the posterior-dorsal area wider, its margin more rounded and flaring. A broken flat valve measures: length 41.8 mm., height 28.3 mm., diameter 8 mm. Santa Elena, Ecuador.

Range—Coast of Mexico southward to Ecuador. Ecuador: Santa Elena.

Genus **TUMBEZICONCHA** Pilsbry and Olsson, 1935

Type species by original designation, *Macra thracoides* Adams and Reeve.¹²

The shell is small, thin, white, ovate, the anterior side short and more convex, the posterior side longer and depressed. Whole surface of shell is covered with narrow, deep undulations, concentric to the valve margin on the anterior side, oblique to it on the posterior, thus producing the appearance of a broken or damaged valve. In addition the whole surface is covered with irregular lines of growth producing wrinkles as if painted with a coarse-haired brush. Posterior-dorsal area not defined. Hinge much like *Mactrel-lona*; the tensilium seated on a small, shelly plate behind the beak and above the deep chondrophore. Mostly on mud flats or similar locations.

***Tumbezioncha thracoides* (Adams and Reeve)**

Plate 56, figure 3

Macra thracoides Adams and Reeve, 1848, Zool. Voy. Samarang, Moll., p. 81, pl. 23, fig. 8 "Eastern Seas".—Reeve, 1854, Conch. Icon., vol. 8, *Macra*, pl. 20, fig. 116.

¹²Pilsbry, H. A., and Olsson, A.A., 1935, The Nautilus, vol. 48, No. 4, pl. 6, fig. 9.

Standella thracoides (Adams and Reeve), Lamy, 1917, Jour. de Conch., vol. 63, p. 336 reports a valve from Machala, Ecuador.

Tumbeziiconcha thracoides (Adams and Reeve), Pilsbry and Olsson, 1935, Nautilus, vol. 48, No. 4, pp. 119-121, pl. 6, fig. 9.

In outline, the shell is subelliptical, short, with the beaks placed in front of the middle so that the posterior side is somewhat longer, narrower than the anterior. The external sculpture is produced by deep waves or undulations which unlike those of *Harvella* and *Raëta* are not strictly concentric to the margin over the whole surface but are oblique on the middle and posterior sides. The posterior-dorsal area is set apart by the sudden ending of the concentric undulations and not by a ridge or keel. In addition to the surface undulations, the whole disk is thickly covered with incremental, concentric wrinkles giving the effect as if it had been painted with a coarse-haired brush. There is sometimes a faint line or small ridge extending along the anterior side of the umbone to the ventral margin. The shell is usually small, ranging in length from 30 to 43 mm. Some average measurements as follows:

Length 42.5 mm., height 31.7 mm., semidiameter 10 mm. right valve.
Length 34.0 mm., height 26.2 mm., semidiameter 8 mm. left valve.

This species was described erroneously as from the "Eastern Pacific" without indication of exact locality, but in all probability the original specimens were obtained from some station in the Panamic-Pacific region. It is most commonly found on or near mud flats fronting on mangrove swamps and in such situations, the species may be plentiful.

Range—Gulf of Fonseca, El Salvador to northern Peru. El Salvador; La Union (Lowe). Panama: San Miguel, Rey Island, Pearl Islands. Colombia: Isla del Gallo. Peru: Tumbes.

Family MESODESMATIDAE

Shell medium or large-sized, solid, donaciform, strongly inequilateral, the anterior side much longer than the posterior, its external surface smooth, usually polished and covered in life with a thick, often glossy periostracum; also including a group of small shells of trigonal form and nearly median beaks. The hinge is much like that of the Mactridae, the ligament largely internal, lodged in a large deep pit or chondrophore bordered by the cardinal and lateral teeth. The pallial sinus is small.

This family is mainly distinguished from the Mactridae on anatomical grounds and by its free, naked, retractible siphons.

I. Shell large, donaciform, the anterior side much longer than the posterior. Cold waters of the Peruvian province.

Genus *Mesodesma*

II. Shell small, subtrigonal, and subequilateral.

Genus *Erilia*

Genus *MESODESMA* Deshayes, 1830

(*Ceronia* Gray, 1853.)

Type species by subsequent designation, Anton, 1839, *Mactra donacia* Lamarck.

Shell solid, elongate subquadrate or donaciform, the posterior side shorter, its end as if obliquely truncated. Hinge strong, the ligament mostly internal, attached to a large, deep pit or chondrophore, the external section

of the ligament or tensilium small and narrow, lodged along the dorsal margin just behind the beaks. Hinge teeth strong, on each side of the resiliferal pit. Pallial sinus small but distinct and extends but a short distance beyond the edge of the posterior adductor scar. Surface smooth or marked with growth lines and covered by a skinlike periostracum, usually yellow and glossy. Ventral margins smooth.

Deshayes, who established the genus *Mesodesma*, cited *Maetra donacia* as the first species although he did not actually designate it as the type. Lamy divided the genus into several subgenera; most of its species live in the Southern Hemisphere.

Mesodesma donacium (Lamarck)

Maetra donacia Lamarck, 1818, Anim. s. Vert., vol. 5, p. 479.

Donacilla chilensis d'Orbigny, 1846, Voy. Amér. Mérid., Moll., p. 530.

Mesodesma donacia (Lamarck), Hupe, 1854, in Gay, Hist. Chile. Zool., vol. 8, p. 352, pl. 3, fig. 7.—Reeve, 1854, Conch. Icon., vol. 8, *Mesodesma*, pl. 2, fig. 11.—Dall, 1909, Proc. U.S. Nat. Museum, vol. 37, No. 1704, pp. 161, 275, pl. 27, fig. 1.—Lamy, 1914, Jour. de Conchyl., vol. 62, pp. 15, 16, text-fig. on page 5.

Shell solid, broadly elongate, wedge-shape, the anterior side long, depressed towards the end which is rounded, the posterior side short, its margin sloping downward sharply and forming with the dorsal margin at the beak a right angle bend. Surface smooth or with concentric markings, its color white, covered with a straw-yellow periostracum.

This species is not a member of the Panamic-Pacific fauna. It is common along the coast of Peru from Lima southward to Chile. Known as "Almejas", it is much used for both food and bait, often sold in the local markets.

Range—Peruvian cold-water province from near Trujillo southward to central Chile. Dall's record of this species from Sechura Bay is questionable.

Genus *ERVILIA* Turton, 1822

Type species by monotypy, *Mya nitens* Montagu. Recent, West Indies and Florida.

Shell small, ovate to subtrigonal, with the beaks and umbones placed near the middle line, but with the posterior side usually a little longer, its dorsal margin straight, sloping down towards a pointed or bluntly rounded end. The beaks are small, inconspicuous, and slightly opisthogyrate. External ligament small or obsolete, the internal ligament strong, attached to a deep, *Maetra*-like resilifer under the beak. The right valve has a strong, posterior cardinal tooth bordered by a narrow socket; the left valve has a posterior lamellar tooth along the hinge border with a deep cardinal socket below it; there are no laterals. Pallial sinus large, ample, rounded at the end, and reaching into the middle of the shell cavity, the inner margins of the valves smooth. Surface smooth or marked with strong, concentric threads.

Several species of *Ervilia* occur in the West Atlantic and Caribbean region and they are usually plentiful at all localities. As yet unknown in

the Panamic-Pacific zone but it is reasonable to expect that eventually one or more species will be discovered there. *E. californica* Dall, 1916 is said to range from San Pedro, California, to Magdalena Bay, Lower California.

Superfamily TELLINACEA

Family DONACIDAE

The shell is generally transversely trigonal to cuneiform, equivalve, solid in texture, with entire or crenulated and usually closed margins. The surface is smooth or with fine radial lineation or riblets. The ligament is external, short, usually opisthodontic, and attached to and along a nymphal plate. Pallial line distinct, placed a short space above the margin, its sinus short or of medium length, generally directed horizontally, its end well rounded. The adductor scars are subequal in size and often deeply impressed. Substance of the shell is usually coarse, porcellaneous, white externally or grading into violet or purple, the same coloration in the interior.

There are two genera in the Panamic-Pacific region.

- I. Shallow-water and beach shells, of small or medium-sized (seldom above 45 mm.), cuneate to trigonal in shape, the posterior side shorter, the posterior slope rounded, flattened, and sometimes sharply truncated. Surface smooth but nearly always showing fine radial lines, the ventral margins of the valves typically crenulated.

Genus *Donax*

- II. Lagoonal, the valves often quite large, the posterior side cuneate but not flattened or truncated. Surface smooth or roughened slightly by concentrics; radials are absent or merely in the shape of minute lines, the valve margins smooth. Surface covered by a thin or coarse, straw yellow periostracum.

Genus *Iphigenia*

Genus DONAX Linné, 1758

Type species by subsequent designation, Lamarck, 1799, Prodrôme, *D. trunculus* Linné; or by Gray, or Hermannsen 1847, as *D. rugosus* Linné.

Shell usually solid, porcellaneous, smooth and polished, elongately subtrigonal or wedge-shaped, the anterior side longer and rounded at the end, the posterior side shorter, with a straight or subtruncated margin. The ligament is external and shows as a short, rounded or convex, brown knob behind the beaks. The hinge has two cardinal teeth in each valve, the lateral teeth are more variable but usually there are two strong lateral teeth in the left valve and their corresponding sockets in the right. Surface smooth, glossy, often showing a fine sculpture of small radial lines or low ribs due mostly to a radial structure within the outer layer and which gives rise to strong crenulations along the ventral margin; divisions between the radials may be simple lines, or wider, deeply pitted grooves; fine concentrics may also be present, heavier over the posterior submargins. The periostracum is thin, inconspicuous or wholly wanting. Pallial sinus is wide and deep, horizontally directed, its end well rounded.

Donax trunculus has been accepted as the type species of the genus; a procedure which will be objected to by students who do not consider the names in Lamarck's Prodrôme as constituting type designations. Several names have been proposed as subgenera for *Donax* but with the

exception of *Machaerodonax* and *Amphichaena*, the others are not applicable to the species here under consideration.

Species of *Donax* are generally most plentiful on a sand-bottom environment, and many of them are typically shore shells, burrowing in the sand between tide levels along open beaches exposed to a heavy, pounding surf. Certain species are collected in large quantities and sold in the markets of Central America and South America under the name of "Almejas" and used in the preparation of an excellent light soup or "caldo".

Subgenus **DONAX**, s.l.

The shell is elongately trigonal to ovately trigonal in shape, porcellaneous, solid, with high umbones, usually smooth and glossy but often showing a fine radial lineation or ribbing which end in strong crenulations along the ventral margin. *The margins of the valves are closed tightly.*

Subgenus **MACHAERODONAX** Römer, 1870

The shell is elongate, razor-shaped, the anterior side long, the much shorter posterior side set apart by a sharp keel. *The margins of the valves are open or gaping at both ends.*

Key to Panamic-Pacific species of *Donax*

- I. Shell open or gaping at both ends. Subgenus *Machaerodonax*
 1. Shell elongated, razor-shaped, the anterior side much the longer, with the dorsal and ventral margins straight and parallel, the anterior end obliquely rounded. Posterior side short and with a sharply angled umbonal keel. Surface smooth, polished, and rayed. *D. transversus*
- II. Shell margins closed all around. Subgenus *Donax*, s.l.
 - A. Shape of shell much elongated, its length more than twice its height, the beak and umbone placed near the middle line.
 - a. Shape more or less tageloid, the substance of shell relatively thin.
 2. Posterior side high and flaring, its surface depressed or weakly vaulted, with evident radial sculpture and a rayed color pattern. *D. culter*
 - b. Shape not tageloid, the posterior side narrowed, produced into a rounded end. Shell rather solid, the radials small and indistinct.
 3. Ratio of height to length about 1 to 2.5. Surface plain. *D. gracilis*
 4. Shorter, ratio about 1 to 2.3. Color white with the dorsal margins marked with purple. *D. naviculus*
 - B. Shell subtrigonal to elongate, its length generally less than twice the height.
 - BA. Posterior side strongly flattened or truncated, setoff by a sharply angled umbonal keel.
 - c. Shell high, subtrigonal, the beaks and umbones subcentral.
 - ca. Posterior slope with coarse sculpture, divided near the middle by a deep, radial groove terminating at the margin in a sharp tooth.
 5. Shell high and broad, thinner than the next. Coloration varied. *D. dentiferus*
 - cb. Posterior sculpture strong, uniform, no tooth at the margin.
 6. Shell often large (30 to 42 mm.), solid. Generally white, the interior irregularly stained with purple. *D. asper*

7. Shell smaller and thinner (perhaps a form of *asper*). *D. rostratus*
- d. Shell broad, subquadrate, depressed, the beaks decidedly posterior in position.
8. Posterior, submedian groove weak, not forming a marginal tooth. Coloration varied. *D. panamensis*
- e. Shell elongated, subtrigonal, strongly convex, the posterior side short, the umbonal keel sharp.
9. Color usually a deep mahogany brown, the anterior surface smooth and polished, the deeply depressed or flattened posterior slope finely and uniformly sculptured. *D. carinatus*
- BB. Posterior side less sharply truncated, the umbonal keel obtuse or rounded.
- f. Shell small (15 mm. or less), obtusely subovate.
10. Color usually white or gray, with some purple staining. Umbonal keel rounded. *D. obesus*
- g. Shell generally larger, elongately subtrigonal.
- ga. Surface smooth except for indistinct fine radials, the interradial division merely lined, not pitted or punctated.
11. Color white, cream or light violet, plain or rayed, the interior generally with a purple stain. Peruvian. *D. peruvianus*
- gb. More heavily sculptured, the radial riblets or threads more distinct, their separating intervals finely pitted.
12. Shell small, the surface with strong cancellated and radially pitted sculpture. *D. ecuadorianus*
- gba. Shell larger, the sculpture consisting mainly of pitted radial interspaces. *Punctatostriatus* group
13. Radial riblets strong and distinct over whole surface, their intervals deeply punctated, especially anteriorly, cross-striated elsewhere. Mexican. *D. punctatostriatus*
14. Shell with less convexity, the radials finer, their intervals more closely punctated. *D. contusus*
15. Surface smooth, porcellaneous, white, the radials fine. Shell with strongly humped umbones and more inflated valves. *D. mancorensis*
- Donax rostratus** C. B. Adams Plate 61, figures 1-1b
- Donax rostratus* C. B. Adams, 1852, Ann. Lyceum Nat. Hist. New York, vol. 5, pp. 502, 545, No. 457. Panama.—Turner, 1956, Occas. Papers on Mollusks. Mus. Comp. Zool., vol. 2, No. 20, p. 82. Type lost.
- Donax granifera* Deshayes, Mörch, 1855, Proc. Zool. Soc. London, p. 353. Hab. - - -?—Reeve, October, 1854, Conch. Icon., vol. 8, *Donax*, pl. 7, fig. 43. Hab. - - -?
- Donax graniferus* Deshayes, Sowerby, 1866, Thes. Conch., vol. 3, *Donax*, p. 307, No. 12, pl. 280, fig. 18.
- Donax curtus* Sowerby, 1866, Thes. Conch., vol. 3, *Donax*, p. 308, No. 20, pl. 308, fig. 20 Caraccas Bay, West Colombia.

Donax obesula Reeve, 1854, Conch. Icon., vol. 8, *Donax*, pl. 5, fig. 30 Peru.—Deshayes, 1855, Proc. Zool. Soc. London, p. 352.

Donax obesulus Deshayes, Sowerby, 1866, Thes. Conch., vol. 3, *Donax*, p. 308, No. 23, pl. 280, fig. 15.

Shell small or medium-sized, convex, thin to moderately solid, trigonal-ovate, the umbones wide, prominent, submedian, the posterior side obliquely truncated, flattened, except for a small impressed or concave area under the beak, the somewhat longer but still short anterior side depressed and rounded at the end. The posterior keel is sharply angled. Sculpture is formed by fine, crowded, flattened, smooth, radial riblets on the anterior surface, somewhat larger and neatly cancellated by cross concentrics in a band just behind the posterior keel; and more finely cancellated on the flattened posterior surface. Interradial lines are not pitted. Color white, yellow, gray or salmon-brown, the umbones often darker and sometimes showing a short, purple ray on each side. Interior white or blotched with purple. Inner margin of valve coarsely crenulated along the whole ventral side; much finer along the posterior margin.

Length 34.2 mm., height 19 mm., diameter 13.2 mm. Puerto Mensabi.
Length 16.1 mm., height 13 mm., diameter 8.8 mm. Cojimenes.

D. rostratus was described from a single valve which measured, length 40.6 mm., height 29.2 mm., diameter 20 mm. The type is lost but its identification seems fairly certain. Adams compared it to *D. carinatus*, but it is more closely allied to *D. asper* and possibly is merely the young form of that species. At Cojimenes, this shell was found in considerable abundance, all specimens of the same size.

Range—Panama to Peru. Panama: Panama City (C. B. Adams); Puerto Mensabi. Ecuador: Cojimenes; Sua. Peru: Tumbes.

Donax panamensis Philippi

Plate 59, figures 3, 3a

Donax cayennensis Lamarck, Reeve, Conch. Icon., vol. 8, *Donax*, pl. 4, figs. 22a, 22b. Hab. Panama and Santa Elena, West Colombia; Cuming.—Sowerby, 1866, Thes. Conch., vol. 3, *Donax*, p. 308, No. 19, pl. 281, figs. 46, 47, 48, gives same habitat as Reeve. Not *D. caianensis* Lamarck, 1818, Anim. s. Vert., vol. 5, p. 550. Habite l'Océan de la Guyane (for a figure see Delessert, 1841, Rec. Coq. decrites par Lamarck et non encore figures, pl. 6, figs. 13a, 13b). See also Hanley, 1842, Recent Bivalve Shells, p. 82. Gave Guiana as habitat and remarked that it is less tumid but akin to the last (*D. striata* Linné).

Donax panamensis Philippi, 1848, Zeit. f. Malakozool., Jahrg. 5, No. 10, p. 145.—Reeve, 1854, *op. cit.*, pl. 9, fig. 63.

Donax assimilis Hanley, Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 4, p. 252. Not *D. assimilis* Hanley, 1845.

Shell trigonal, subquadrate, the anterior side much longer than the posterior, with the beaks placed at the posterior one-third. Posterior side flattened and truncated along the margin. The sculpture is formed by small, radial riblets, heaviest over the posterior section and along the umbonal angle, much finer and smoother elsewhere, the riblets and their interspaces beaded or cancellated. On the posterior slope, the ribbed sculpture is divided into a finer and a coarser section but the dividing line is not produced into a tooth at the margin (as in *D. dentiferus*). Color is usually a grayish white, shading to yellow, brown, or violet, the umbones usually darker and often marked with a white ray at the beaks. Interior generally purple around the margins, the cavity itself thickened and white.

Length 34 mm., height 22.4 mm., diameter of a left valve 7.7 mm. Panama City, Panama.

This species was figured by Reeve and Sowerby under the name "*cayennensis* Lamarck" from specimens taken at Panama or Santa Elena, but true *D. cayennensis* is generally believed to be a Caribbean species. According to Hanley, the figure of *D. cayennensis* given by Delessert and based on the original Lamarckian specimens, agrees so well with *D. striata* that he would hardly venture to consider the species distinct. Hertlein and Strong have identified this species with *D. assimilis* Hanley (described from Panama) which has much the same outline and color, but its description mentions a tooth along the posterior margin as in *D. dentiferus*, a species to which it was compared.

This species is common at Panama and is harvested in considerable quantity; often seen in the local markets.

Range—Mexico to Ecuador. Nicaragua: Isla Encantada, Corinto (Hertlein and Strong). Costa Rica: Culebra Bay, Cedro Island, Gulf of Nicoya (Hertlein and Strong). Panama: Burica Peninsula; Concepcion Beach at Poicri; El Lagartillo, Las Tables; Viveros and Gibrleon Islands, Pearl Islands; Old Panama; Bella Vista; Isla del Gallo. Ecuador: Limones; Indian kitchen middens on Rio Cayapas; Santa Elena.

Donax mancorensis, new species

Plate 61, figures 3-3b

This shell is medium-sized, solid, trigonal, subquadrate, the anterior side longer than the posterior, produced slightly at the end and rounded. The umbones are convex or slightly humped producing a vaulted umbonal slope which where it meets the ventral margin gives rise to a convex bulge. In the adult, the surface is usually smooth and plain but with low flattened radials showing under a glass except for a belt along the anterior umbonal slope where there is also a weak cancellation and the lines in the interradiar grooves may result in small pits. There is a depressed or flattened lenticular area in front of the beaks resembling a smooth lunule without radials. External color is mostly white or cream, the interior frequently stained with purple.

Length 25.4 mm., height 17.7 mm., diameter 13.3 mm. Zorritos, Peru. Holotype, ANSP 218910.

This species largely replaces *D. peruvianus* north of Cabo Blanco and is common at Mancora and Zorritos. It is a shorter and more strongly humped species than *D. peruvianus*. The sculpture is never as strongly cancelled as in *D. ecuadorianus*.

Range—Coast of northern Peru. Peru: Mancora; Zorritos.

Donax ecuadorianus, new species

Plate 61, figures 2-2b

The shell is relatively small, solid, humped, trigonal, wedge-shaped, and rather convex. The posterior side is short and sharply truncated, its surface depressed or flattened; the anterior side is much longer, narrowly rounded at the end with a low depressed zone just in front of the posterior-umbonal angle. The sculpture is finely and neatly cancelled over the whole surface formed by small, close-set, radial riblets, and a set of sharply incised concentric lines; these lines are not strictly concentric but over the middle of the disk, they appear to cross the riblets obliquely forming deep pits in their interspaces and where the interspaces are wider

as on the posterior surface, they form strong cross-threads. A lunular area in front of the beaks of a narrow lenticular form is depressed and smooth. Color of shell is white or pale straw-yellow, the beaks sometimes stained with purple. Interior white or blotched with purple.

Length 18.7 mm., height 13 mm., diameter 9 mm. Canoa, Ecuador. Holotype, ANSP 218909.

This appears to be a good species recognizable by its shape and sculpture. It is abundant along parts of the Ecuadorian coast, all specimens are strongly sculptured and of uniform size.

Range—Panama south to Ecuador. Panama: Búcaro. Ecuador: Canoa.

Donax navicululus Hanley

Plate 60, figures 3, 3a

Donax navicula Hanley, 1845, Proc. Zool. Soc. London, pt. 13, p. 15 Gulf of Nicoya.—Reeve, 1854, Conch. Icon., vol. 8, *Donax*, pl. 4, fig. 18.—Sowerby, 1866, Thes. Conch., vol. 3, *Donax*, p. 314, No. 60, pl. 282, fig. 80.—Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 4, p. 254, pl. 1, fig. 1.

Shell generally small (length to about 25 mm.), elongate, slightly convex and moderately solid. The beaks are placed at the posterior one-third, the posterior-dorsal margin descending to a narrowly rounded end, the posterior surface flattened to weakly depressed. The anterior side is nearly twice the length of the posterior, rounded at its end, its ventral margin showing a slight bulge. Surface smooth, porcellaneous, the fine radials hardly visible, and no stronger radials are present on the posterior surface. Color is mostly white, beneath a brown or straw-colored periostracum, the posterior side and dorsal margins stained purple. Inner margins are finely crenulated.

Range—Gulf of California to northern Peru. Mexican and Nicaraguan records see Hertlein and Strong. Panama: Búcaro; Guanico; San Carlos; El Lagartillo. Ecuador: Sua; San Francisco; Esmeraldas. Peru: Tumbes.

Donax gracilis Hanley

Plate 60, figure 5

Donax gracilis Hanley, 1845, Proc. Zool. Soc. London, pt. 13, p. 15 Gulf of Guayaquil.—Reeve, 1854, Conch. Icon., vol. 8, *Donax*, pl. 6, fig. 38.—Sowerby, 1866, Thes. Conch., *Donax*, p. 314, No. 59, pl. 282, figs. 76-79.—Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 4, pp. 253, 254, pl. 1, figs. 4, 6.

Shell small (length from 20 to 27 mm.), narrowly elongated, the beaks placed between the posterior one-third and one-fourth. Posterior end short, attenuated, the anterior side higher and more widely rounded at the end. Surface smooth, porcellaneous, the radials showing indistinctly. Color white to brown, sometimes rayed.

Related to *D. californicus* Conrad of California but longer and narrower, more compressed and the posterior end is more acutely pointed.

Range—Gulf of California to northern Peru. Nicaragua: Corinto (H. and S.) Panama: Búcaro; Puerto Mensabi; El Lagartillo. Columbia: Isla del Gallo. Ecuador: Santa Elena. Peru: Tumbes; Zorritos; Lobitos; Negritos.

Donax punctatostratus Hanley

Plate 61, figures 6-6b

Donax punctato-striatus Hanley, 1843, Proc. Zool. Soc. London, pt. 11, p. 5. Hab. - - ? —Hanley, 1843, Cat. Rec. Bivalve Shells, p. 84, pl. 14, fig. 24 (as *punctato-striatus* in plate explanation).—Reeve, 1854, Conch. Icon., vol. 8, *Donax*, pl. 3, figs. 16a, 16b.

Donax punctato-striatus Hanley, Sowerby, 1866, Thes. Conch., vol. 3, *Donax*, p. 310, pl. 281, figs. 49, 50.

Donax punctato-striatus Hanley, Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 4, p. 255, pl. 1, fig. 17.

Shell elongately subtrigonal, the beaks and umbones somewhat elevated and gibbous and placed a little behind the middle, the anterior side longer, its dorsal and ventral sides approaching each other to form a rounded or somewhat pouting end. The posterior umbonal slope is weakly angled but never sharply so. The surface is generally marked with small, narrow, radial riblets, their interspaces typically well pitted or coarsely cross-threaded but some shells which may appear superficially smooth will show on close examination fine punctation. The surface color is white, light brown, or violaceous, the interior white or irregularly blotched with purple. The margins are coarsely crenulated.

Length 28 mm., height 16.7 mm., diameter 11 mm.

Length 34 mm., height 21.8 mm., diameter 14.4 mm.

Hertlein and Strong mention specimens as large as 44.8 mm. in length and 30 mm. in height.

Carpenter's *Donax punctato-striatus caelatus* has not been figured but its description suggests a young *D. punctato-striatus* generally more elongated than the adult and with the radial interspaces strongly cross-threaded rather than punctate but the types should be reexamined.

Although *D. punctato-striatus* has often been cited as ranging southward to Peru, the typical form of the species seems to be restricted to the northern portion of the Panamic-Pacific province.

Range—Lower California to Panama. Especially common along the Mexican coast.

Donax carinatus Hanley

Plate 60, figures 4-4b

Donax carinata Hanley, 1843, Proc. Zool. Soc. London, pt. 11, p. 5. Hab.---?—Hanley, 1843, Cat. Rec. Bivalve Shells, p. 84; 1856, p. 349, pl. 14, fig. 28 (as *carinatus* on explanation of plate).—Reeve, 1854, Conch. Icon., vol. 8, *Donax*, pl. 2, fig. 11.

Donax carinatus Hanley, Sowerby, 1866, Thes. Conch., vol. 3, *Donax*, p. 305, No. 2, pl. 280, figs. 4, 5.—Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 4, p. 253, pl. 1, fig. 9.

Donax culminatus Carpenter, 1855, Cat. Mazatlan Shells, Brit. Mus., p. 43. (Young shell).

Shell much longer than high, convex, beaks posterior of the middle with a sharp posterior umbonal angle setting off a strongly flattened to excavated posterior area. There is often a shallow furrow or a depressed zone across the middle of the shell disk which slightly indents the ventral margin. The surface of the shell is smooth and polished, its sculpture formed by fine, flattened, radial riblets between narrowly grooved or lined interspaces, smooth over the greater portion of the surface but with the riblets finely beaded or cancellated on the posterior slope. Color of shell usually a rich mahogany brown blended with violet or purple, the interior violaceous white.

Length 35.5 mm., height 19 mm., diameter 13.75 mm. Camarones.

Length 42.9 mm., height 22.2 mm., diameter 15.25 mm. Tumbez.

The finest species of *Donax* in the Panamic region, distinguished by its relatively large size, elongated form, pointed posterior extremity, sharply

angled posterior keel, and rich coloration. *D. striatus* Linné of the Caribbean is a somewhat similar species but smaller, shorter, and more solid, color usually white.

Range—Mexico to northern Peru. Mexico: San Blas; Mazatlan. Nicaragua: Corinto (H. and S.). Panama: Panama City; Guanico. Colombia: Tumaco; Isla del Gallo. Ecuador: Ancon Point; Santa Elena; Charapota; Sua; Esmeraldas; Camarones. Peru: Tumbes; Zorritos; Mancora.

Donax peruvianus Deshayes

Plate 60, figures 2-2e

Donax radiatus Valenciennes, 1817, Humboldt et Bonpland, Recueil d'Observations de Zoologie, vol. 2, pp. 221, 222, pl. 50, figs. 3, a, b, c, et fig. 4. Not *D. radiatus* Gmelin, 1791.

Donax peruvianus Deshayes, 1854, Proc. Zool. Soc. London, pp. 350, 351.—Römer, 1870, Syst. Conch. Cabinet., vol. 29, p. 55, No. 32, pl. 9, figs. 18-20.

Donax aricana Dall, 1909, Proc. U.S. Nat. Museum, vol. 37, No. 1704, p. 273. New name for *D. radiatus* Val.

The valves are subelliptical, subtrigonal, convex, the beaks placed near the posterior one-third and with a low or moderate inflation continued along the umbonal slope downward to form a slight bulge in the ventral margin near the middle point. The anterior side is longer, narrower, rounded at the end, the posterior side with a gentle slope into the narrowly rounded or subtruncated end. The surface is nearly smooth except for narrow radial lines which show quite plainly except in shells which have a pure white color.

Length 33.7 mm., height 20 mm., diameter 16.4 mm. Negritos, Peru.

In shape, this species is similar to *D. punctatostriatus* except that it is usually a little longer and the surface is smooth without interradiation punctation. The surface color is usually an ivory white or a pale mauve, sometimes a pale yellow and often with unequal rays of violet across the middle. This is the common beach *Donax* of Peru ranging southward into Chile. It is often seen in the markets and it was consumed in large quantities by the Peruvian Indians in pre-Colonial times, judging by the abundance of its shells over their burial places. Santa Elena Peninsula of western Ecuador appears to be its northern limit of range; a few valves in my collection from there are unusually large (length 40 mm.).

Range—Santa Elena Peninsula, Ecuador to Chile. Ecuador: Santa Elena. Peru: Zorritos; Mancora; Lobitos; Negritos; Paita; Sechura; Chichayo; Chimbote; Mollendo (Weyrauch).

Donax asper Hanley

Plate 59, figures 1-1d

Donax asper Hanley, 1845, Proc. Zool. Soc. London, pt. 3, p. 14 Tumbes, Peru.—Reeve, 1854, Conch. Icon., vol. 8, *Donax*, pl. 2, fig. 12.—Sowerby, 1866, Thes. Conch., vol. 3, *Donax*, p. 307, No. 16, pl. 280, fig. 24.—Dall, 1909, Proc. U.S. Nat. Museum, vol. 37, No. 1704, p. 159, pl. 28, fig. 7.—Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 4, pp. 251-252.

Shell large, exceeding 30 mm. in height, trigonal, generally solid, the umbones gibbous and elevated above the hinge margin, the posterior side strongly flattened and truncated, the anterior side longer, somewhat narrowed, and rounded at the end. Radiating riblets are fine, closely spaced and trellized by crosstreads on the posterior slope but without a sub-

median deeper groove and tooth at the margin. Color usually white tinged with pink or purple.

Variable in size; large specimens from Tumbez have a length of 42 mm., and height of 34 mm. These specimens have a high, solid shell with gibbous umbones. Fresh shells have a thin epidermis.

Range—Gulf of California to Peru. For Mexican and Costa Rican localities see Hertlein and Strong. Panama: San Carlos; El Lagartillo; Guanico; Burica Peninsula; Pearl Islands. Colombia: Isla del Gallo. Ecuador: Sua; San Francisco. Peru: Tumbez.

Donax dentiferus Hanley

Plate 59, figures 2-2b;
Plate 85, figure 4

Donax dentifera Hanley, 1843, Proc. Zool. Soc. London, pt. 11, p. 6. Hab. - ?—Reeve, 1854, Conch. Icon., vol. 8, *Donax*, pl. 1, figs. 2a, 2b.

Donax dentiferus Hanley, Sowerby, 1866, Thes. Conch., vol. 3, *Donax*, p. 307, No. 17, pl. 280, fig. 23.

Donax paytensis d'Orbigny, 1846, Voy. Amér. Mérid., vol. 5, Mollusques, p. 541, unfigured.

Similar to *D. asper* in shape but smaller and less convex, the beaks placed a little more posteriorly, the umbones lower and flatter. The posterior side is truncated, flattened, its sculpture divided unequally into two sections by a submedian groove which ends in a double tooth at the margin. The principal surface of the valves is sculptured with low, flat, smooth, radial riblets separated by simple lines, coarse and somewhat cancellated near the posterior keel and on the posterior slope. Color varies from pure white through shades of pink, brown to dark purple, the interior often stained a deep purple. The margins of the valves are crenulated, more coarsely so at the posterior-ventral angle.

An average specimen measures: length 34 mm., height 26 mm., diameter 16.2 mm.

This species is easily recognized by its high, trigonal shape, and especially by the strong, toothlike projection along the posterior margin formed by a deep, medial, structural groove, often ending in a double tooth. *D. paytensis* d'Orbigny, from Paita, Peru, is equivalent to *D. dentiferus*, as shown by an examination of the type in the British Museum (Nat. Hist.) *D. assimilis* Hanley, described from Panama, from its figure in Reeve, appears similar to *D. dentiferus* but has a longer and thinner shell.

Range—Panama to Peru. Panama: Búcaro; Guanico; Puerto Mensabi. Ecuador: Montanita; Canoa; Charapota; Sua. Peru: Paita (d'Orbigny as *paytensis*).

Donax obesus d'Orbigny

Plate 61, figure 5;
Plate 85, figure 3

Donax obesa d'Orbigny, 1846, Voy. Amér. Mérid., vol. 5, Mollusques, p. 541, pl. 81, figs. 28-30 Paita.—Reeve, 1854, Conch. Icon., vol. 8, *Donax*, pl. 7, fig. 49.

Donax obesus d'Orbigny, Sowerby, 1866, Thes. Conch., vol. 3, *Donax*, p. 310, pl. 281, figs. 42, 43.

Shell small, short, ovately trigonal in shape, plump or convex, with wide umbones placed a little posterior of the middle line. The posterior side is high, subtruncated or widely rounded at the end, without an angled umbonal slope; the anterior side is a little longer, its dorsal margin sloping

down into a more narrowly rounded end. Surface smooth but with a neat sculpture of minute radial threads, their interspaces lined and finely pitted, especially over the umbones, merging into waved concentrics on the posterior slope. Length 11 mm., height 8.8 mm., diameter 7.7 mm. (Búcaro, Panama).

A small but easily recognizable species, apparently rare at all localities. Some records of *D. obesus* in the literature may be based on young specimens of some other species. The type of this interesting species is in the D'Orbigny collection at the British Museum (Natural History).

Range—Panama southward to Peru. Panama: Búcaro. Peru: Paita.

Subgenus **MACHAERODONAX** Römer, 1870

Type species by subsequent designation, Dall, 1900, *Donax scalpellum* Gray.

Shell elongated, razor-shaped, relatively thin, the posterior side short, its umbonal carination sharp and bordering a deeply impressed and more strongly sculptured posterior area, the rest of the surface smooth. Margins crenulated. Valves are open with a gap at both ends.

- Donax (Machaerodonax) transversus* Sowerby Plate 59, figures 4-4b
Donax transversa Sowerby, 1825, Cat. Shells Tankerville, Ap. p. IV.—Reeve, 1954, Conch. Icon., vol. 8, *Donax*, pl. 6, fig. 36.
Donax transversus Sowerby, Sowerby, 1866, Thes. Conch., vol. 3, *Donax*, p. 306, No. 6, pl. 280, fig. 11.—Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 4, p. 256, pl. 1, fig. 3.

Shell with elongate, soleniform, and moderately convex valves, the anterior side the longer, the dorsal and ventral margins more or less parallel except at the anterior end where the dorsal margin is slightly concave. The valves have an open gap at both ends. The posterior side is short, set off by a sharp, umbonal keel, the posterior slope depressed or flattened and with an angle or keel in the middle forming an open gap at the margin. Surface glossy, mainly smooth but with fine, radial lineation showing through; on the posterior slope, the sculpture is stronger, formed by finely beaded and cancellated riblets. The usual color of the surface is white rayed with broad belts of violet and purple, generally lightly tinted with yellow produced mainly by the thin layer of periostracum. Interior of valves purple. The largest shells may attain a length of about 40 mm.

Length 37.2 mm., height 14.7 mm., diameter 10.2 mm. Manglaralto, Ecuador.

Range—Mexico to northern Peru. Mexico: Mazatlan. Nicaragua: Corinto. Panama: Búcaro; Guanico; Burica Peninsula. Ecuador: Montanita, near Manglaralto; San Lorenzo; Punta Blanca; Santa Elena; Ancon Point. Peru: Punta Picos; Caletto Sal; Mancora; Paita.

Subgenus **AMPHICHAENA** Philippi, 1847

Type species by monotypy, *A. kindermanni* Philippi (= *D. culter* Hanley, 1845).

Shell elongated, often irregular tageloid, the beaks are placed a little behind the middle, the posterior side, therefore, the longer, expanded, the valves thin, the margins crenulated.

Philippi's specimens of *A. kindermanni* were probably beach-worn to an extent that their donacid characteristics were not immediately discernible. Young shells have extremely thin valves, and if worn slightly may have smooth margins and the shape and rayed markings of a young *Tagelus*. In Thiele's Handbuch, the group is placed in the Psammobiidae.

Donax (Amphichaena) culter Hanley Plate 59, figures 5-5b

Donax culter Hanley, 1845, Proc. Zool. Soc. London, No. 13, p. 14.—Reeve, 1854, Conch. Icon., vol. 8, *Donax*, pl. 4, fig. 21 Gulf of California.

Donax californicus Conrad, var. *D. culter* Reeve, Sowerby, 1866, Thes. Conch., vol. 3, *Donax*, p. 310, No. 36, pl. 281, figs. 56, 57, only (not *D. californicus* Conrad, 1837).

Amphichaena kindermanni Philippi, 1847, Archiv. f. Naturg. vol. 13, p. 63, tab. 3, fig. 7 Mazatlan.

Donax petallina Reeve, 1854, Conch. Icon., vol. 8, *Donax*, pl. 8, fig. 51.—Pilsbry and Lowe, 1932, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, p. 132. (listed only).

Donax petalina Deshayes, 1855, Proc. Zool. Soc. London, p. 350.—Sowerby, 1866, Thes. Conch., vol. 3, *Donax*, p. 315, No. 63, pl. 282, fig. 86.

Shell generally small (largest seen about 32 mm.), elongately subrhomboidal, tageloid, the ratio of height to length about 1 to 2, highest at the beak which is placed a short distance back of the middle. Surface is finely ribbed or radially striated, the finely grooved interspaces minutely punctate. Color is a pale yellow and mauve, divided into wide rays, the interior of the shell purple except under the yellow rays where it is white. Margins are finely crenulated.

Common as a beach shell at Acapulco, Mexico. *D. bella* Reeve, 1854 (*op. cit.* pl. 6, fig. 41, Acapulco) is probably this species also.

Range—Mexico. Mexico: San Ignacio; Sinaloa; Acapulco.

Genus **IPHIGENIA** Schumacher, 1817

Type species by monotypy, *Donax laevigata* Gmelin.

Shell large or medium-sized, subtrigonal to elliptical with submedian beaks, solid and porcellaneous, no lunule or escutcheon. The beaks are generally placed a little behind the middle, hence the anterior side is a little longer. Surface smooth or marked only with lines of growth and occasionally fine, obscure radial lineation may be present overlain by a thin, yellowish to olive-brown periostracum. The ventral margins are entire. Hinge has two cardinal teeth in each valve, the right posterior and the left anterior tooth being large and bifid, the others small and simple; lateral teeth are more or less obsolete. Ligament external, wholly posterior, seated on or behind a large, platelike nymph. Pallial sinus is ample, rounded at the end, and extending a little beyond the middle of the cavity of the shell. Color of shell under the periostracum is generally white, or suffused with violet or purple, heaviest on the umbones.

Iphigenia altior (Sowerby)

Plate 60, figures 1, 1a

Capa altior Sowerby, 1833, Proc. Zool. Soc. London for 1832, pt. 2, p. 196. "Hab. in Peruvia et America Centrali." Gulf of Nicoiyo; also a smaller variety at Tumbes.—Hanley, 1843, Cat. Rec. Bivalve Shells, p. 86, pl. 14, fig. 34; also p. 349.—Römer, 1869, Syst. Conchyl.-Cab., bd. 10, abt. 3, *Donacidae*, p. 114, tab. 21, figs. 1-4.

Iphigenia ambigua Bertin, 1881, Nouv. Arch. Mus. Hist. Nat. (Paris), ser. 2, vol. 4, p. 120, pl. 4, figs. 4a, 4b, 4c.

Iphigenia altior Sowerby, Dall, 1909, Proc. U.S. Nat. Museum, vol. 37, No. 1704, pp. 159, 274, pl. 25, fig. 8.—Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 4, p. 257.

Shell of medium or large size (length to about 70 mm.), subtrigonal, the umbones nearly central, solid and porcellaneous. Fresh shells have a straw-colored to dark-brown periostracum, beneath it the shell is porcellaneous white or tinted with reddish violet or deeper purple.

Length 70 mm., height 50 mm., diameter 35 mm.

This species is similar to *I. brasiliensis* Lamarck of the Caribbean and West Atlantic but in general *I. altior* has a higher shell with the beaks more nearly central, and the posterior-ventral indentation is generally not so marked as in the Caribbean shell.

Range—Gulf of California to northern Peru. Costa Rica: Gulf of Nicoya. Panama: Búcaro; San Carlos; Puerto Chama; Viveros Island (Pearl Islands). Colombia: Isla del Gallo; Tumaco. Ecuador: Santa Elena; Palmar; Manta; Charapota. Peru: Tumbes; Bayovar.

Family SANGUINOLARIIDAE

(*Psammobiidae* or *Gariidae*)

The shell is telliniform, donaciform, or soleniform, usually equivalve and if unequal, the right valve is the larger and more convex, usually with a gap at the posterior end. The surface is often highly colored in which shades of red, pink, and purple predominate, spread uniformly or in a streaked, maculated, or rayed pattern. The hinge has one or two, bifid or grooved cardinal teeth; there are no laterals. The ligament is external, large, lies entirely posterior of the beaks and is attached to a large, nymphal plate which rises prominently above the hinge margin. The adductor scars are distinct, placed rather high dorsally and connected by a pallial line bearing a deep sinus. The periostracum is usually coarse and dark in color in some groups, thin and inconspicuous in others.

This family differs from the Tellinidae mainly on anatomical grounds and in the more perfect adaptation of its species to a burrowing habit. In the typical species, the shell has a large, open, posterior gap; in the genus *Heterodonax*, there is no gap, the margins of the valves fitting closely. The species show much diversity in shell form and sculpture but the Panamic species are mostly smooth: in *Asaphis* of the Caribbean, the surface is finely ribbed. In key form, the Panamic genera are arranged as follows:

- I. No posterior gap, the margins of the valves closing tightly all around.
 1. Shape subcircular, solid, and with concentric sculpture.

Genus *Heterodonax*

- II. Valve margins not closing tightly but with an open space or gap at the posterior end.

- A. Shell razor-like in shape, elongated, the dorsal and ventral margins straight, and nearly parallel. The beaks and umbones are near the middle.

2. Surface of the valves plain, marked with concentric growth lines only. Color white or flushed irregularly with violet.

Genus *Tagelus*

- B. Shell subelliptical to subrectangular in shape, the basal margin usually more or less rounded. Surface color white, sometimes rayed, mottled or speckled with violet and brown; sometimes wholly white or pink.
3. Valves elliptical in shape, equilateral, or with the posterior side somewhat longer. Color uniformly white, pink or rose-red; sometimes white with the umbones deep rose-red. Periostracum thin and inconspicuous. Pallial sinus is high and with an angled outline under the beak.

Genus *Sanguinolaria*

4. Valves irregularly rectangular in shape, the two ends widely rounded or subtruncated. Surface plainly marked or with a rayed, mottled, or speckled pattern. Periostracum usually coarse, brown, or black in color.

Genus *Gari*

Genus **SANGUINOLARIA** Lamarck, 1799

Type species by monotypy, *S. sanguinolenta* (Gmelin) [= *S. cruenta* (Solander)].

Shell large, of medium convexity, thin, rose-red, or white. Hinge with two cardinal teeth in each valve; there are no laterals. Ligament external, posterior in position, the resilium attached to the upper surface of a long narrow nymph. The pallial sinus is deep and ample, angular above, and widely confluent with the pallial line below. The adductor scars are distinct, placed high in the valve.

Two subgenera.

- I. Valves of equal convexity and similar form, the posterior end not strongly flexed. Pallial sinus equal in the two valves.
- II. Valves of unequal convexity, the left valve flattened. Posterior end of right valve flexed. Pallial sinus more or less discrepant in the two valves.

Subgenus *Sanguinolaria*, s.s.

Subgenus *Psammotella*

Sanguinolaria (Sanguinolaria) tellinoides A. Adams

Plate 77, figures 10, 11

Sanguinolaria tellinoides A. Adams, 1850, Proc. Zool. Soc. London, p. 170, pl. 6, fig. 6.—Reeve, 1857, Conch. Icon., vol. 10, *Sanguinolaria*, pl. 1, fig. 3.—Hertlein and Strong, 1950, Zoologica, vol. 35, pt. 4, p. 219.

Tellina miniata Gould, 1851, Proc. Boston Soc. Nat. Hist., vol. 4, p. 90 San Juan, Lower California.—Gould, 1853, Boston Jour. Nat. Hist., vol. 6, p. 397, pl. 16, fig. 1.

Shell large (length to nearly 90 mm.), irregularly subelliptical, the anterior side shorter, higher, well rounded, the posterior side longer, narrowed, slightly impressed along a zone extending from the beak to the ventral margin. Surface smooth or marked with fine, concentric growth lines and colored a delicate rose-pink, generally in light and dark bands. Both valves are of equal convexity. Pallial sinus deep, angular above and fully confluent with the pallial line below.

Length 75 mm., height 44 mm., diameter 22 mm. Cojimenes, Ecuador.

Range—Gulf of California to Ecuador. Panama: Burica Peninsula. Colombia: Buenaventura; Isla del Gallo; Gorgona Island. Ecuador: Cojimenes.

Sanguinolaria (Sanguinolaria) vespertina Pilsbry and Lowe

Plate 85, figure 5

Sanguinolaria vespertina Pilsbry and Lowe, 1932, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, p. 90, pl. 12, figs. 3, 4 (on explanation of plate as *Semele vespertina*).—Hertlein and Strong, 1950, Zoologica, vol. 35, pt. 4, p. 220.

The shell is similar to *S. tellinoides* but much smaller (length up to about 35 mm.), more ovate, higher, the beak and umbone more median in position, the posterior end, therefore, only a trifle longer. Color white to pink, the umbone often a deep rose-red. Pallial sinus deep, with a high angle in the middle.

Length 31 mm., height 21 mm., diameter 11.2 mm. Pilsbry and Lowe.
Length 34.2 mm., height 22.7 mm., diameter 13.2 mm. Guanico, Panama.

A small lovely shell recalling the Caribbean *S. sanguinolenta* but of a more ovate form and with a higher, more steeply angled pallial sinus.

Range—Mexico south to Panama. Panama: Guanico.

Sanguinolaria (*Sanguinolaria*) *tenus*, new species Plate 85, figure 6

The shell is small, thin, translucent, subovate to subelliptical, the beaks submedian with low umbones. The two ends of the shell are subequal, the posterior side a trifle longer. Surface covered with fine lines of growth. Pallial sinus large, with a high angle in the middle and fully confluent with the pallial line below. Hinge delicate.

Length 32.9 mm., height 21 mm., diameter 11 mm. Canoa, Ecuador. Holotype, ANSP 218911.

From *S. vespertina*, this species differs by its more ovoid shell, the two ends are alike and nearly equally rounded. Color is white with a faint flush of pink. The type specimen was obtained at Canoa near Bahia, Ecuador. Another, but more fragmentary shell, was found at Punta Montanita to the north of Manglaralto, Ecuador.

Range—Ecuador. Ecuador: Canoa; Punta Montanita.

Subgenus **PSAMMOTELLA** Herrmannsen, 1852

Type species by monotypy, *Tellina rufescens* Chemnitz (= *T. operculata* Gmelin).

Generally similar to *Sanguinolaria*, *sensu stricto* but longer, with unequal valves, the right valve is strongly convex, the left flattened. The posterior side is narrowed and weakly flexed at the end.

Sanguinolaria (*Psammotella*) *bertini* Pilsbry and Lowe Plate 77, figure 8

Tellina rufescens Chemnitz, Hanley, 1846, Thes. Conch., vol. 1, p. 307, pl. 63, fig. 213. (Not *Tellina rufescens* Chemnitz, 1792, Syst. Conchyl.-Cab., bd. 6, p. 105, taf. 11, fig. 97 or *Tellina rufescens* Gmelin, 1791.)

Tellina hanleyi Bertin, 1878, Nouv. Arch. Mus. Hist. Nat., ser. 2, vol. 1, p. 268. (Not *Tellina hanleyi* Dunker, 1853.)

Sanguinolaria bertini Pilsbry and Lowe, 1932, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, p. 91, pl. 10, figs. 7, 8.—Maxwell Smith, 1944, Panamic Marine Shells, p. 63, fig. 811.—Hertlein and Strong, 1950, Zoologica, vol. 35, pt. 4, p. 220.

Shell large with a length up to 92 mm., elongate, subelliptical, the right valve is strongly convex, the left flattened. Color is usually a rose-pink to nearly white on beach specimens. *S. operculata* (Gmelin) from the Caribbean is similar and in a large series may not be distinguishable.

Length 71 mm., height 36.4 mm., diameter 15 mm. Guanico, Panama.

Range—Gulf of California to northern Peru. Panama: Guanico. Colombia: Isla del Gallo. Ecuador: Esmeraldas; San Francisco. Peru: Tumbes; Punta Picos; Mancora; Lobitos.

Genus TAGELUS Gray, 1847

Type species by original designation, *Solen guineensis* Chemnitz (= *Solen gibbus* Spengler). Recent along the east Atlantic Coast.

Shell with elongated, solen-like valves but with the beaks near the middle, the length between three and four times the height. The anterior side is generally a little fuller, the posterior side often slightly depressed, especially near its dorsal margin. Both ends of the valves are rounded and generally with a wide open gap. Hinge weak with two small cardinal teeth in the right valve and only one in the left; there are no laterals. The ligament is external and attached to a high nymphal plate. Adductor scars large, placed close to the dorsal margin, and connected across by the pallial line bearing a large open sinus. There is sometimes a slight flexure across the middle of the valves, the surface marked with lines of growth only, white or colored faintly with violet or brown, sometimes rayed. The periostracum is dark brown or straw-colored, generally coarsely wrinkled.

This genus is generally divided into two subgenera on the presence or absence of an internal rib in the umbonal cavity. This character has little systematic value but is helpful in identification and segregation of the species.

- I. Shell without an internal rib in the umbonal cavity.
Subgenus *Tagelus*, s.s.
- II. Shell with a small thickened rib in the umbonal cavity, usually showing as a small purple or violet streak on the surface of the umbone.
Subgenus *Mesopleura*

General key to species of *Tagelus*

- I. Shell without a thickened rib or ray in the umbonal cavity.
Subgenus *Tagelus*, s.s.
 - A. Pallial sinus not reaching quite to the middle. Shell elongated, its height about a fourth of its length. Ends of the valves white or shaded with violet or brown, the umbones rayed.
T. dombeii
 - B. Pallial sinus extending to the middle of the shell cavity or to a point directly under the beak. Color of exterior white under an olive or straw-yellow periostracum.
 - a. Ratio of height to length 1 to 3. Periostracum straw-colored.
T. affinis
 - b. Ratio of 1 to 2.25. Periostracum olivaceous.
T. peruanus
- II. Shell with a thickened rib in the umbonal cavity, generally colored violet or brown and showing through the wall onto the surface of the umbone as a colored ray. This internal rib is always well developed in the young but may not persist throughout life.
Subgenus *Mesopleura* Conrad
 - C. Shell large (60 mm. or longer), thick, with a wide, flangelike wing along the posterior-dorsal margin.
T. peruvianus
 - D. Shell smaller and usually of thin texture.
 - c. The internal ray is directed backward.
T. politus
 - d. Internal ray vertical or directed forward.
T. bourgeoisae

Tagelus (Tagelus) dombeii (Lamarck)

Plate 62, figures 1, 1a, 5

- Solen dombeii* Lamarck, 1818, An. s. Vert., vol. 5, p. 454.—Lamarck, Encyl. Meth., pl. 224, fig. 1.—Hupé, 1854, Hist. de Chile, vol. 8, Moll., p. 366. pl. 7, fig. 5.
Siliquaria dombei (Lamarck), Martínez y Saez, 1879, Hidalgo, Molluscos del Viaje al Pacífico. Parte Segundo, Bivalvos Marino, p. 7, pl. 1, fig. 4.
Tagelus (Mesopleura) dombeyi (Lamarck), Dall, 1910, Proc. U.S. Nat. Museum, vol. 37, pp. 160, 273, pl. 27, fig. 3.

Shell narrowly elongated, the dorsal and ventral sides parallel, the ratio of height to length nearly 1 to 4. The valves are moderately convex and slightly flattened across the middle zone, the ventral margin straight or weakly inflected. Color over most of the surface is a rusty brown, deepest on the umbones and with two, narrow white rays extending obliquely backwards from the beak, the posterior and anterior ends often shaded lightly with violet; also in the interior. The pallial sinus is deep but does not reach the middle of the shell cavity. Periostracum coarse and heavy, coarsely wrinkled and dark brown in color. Valves are widely open at both ends.

Length 90 mm., height 25.3 mm., diameter 16 mm. Tumbes, Peru.

This is the common *Tagelus* in Peru recognized by its relatively long shell, rayed umbones and purple coloration of its two ends. It has no internal ray or rib radiating from the beak even in young specimens.

Range—Panama southward to Chile. Panama: El Lagartillo. Colombia: Isla del Gallo. Ecuador: Canoa; Santa Elena. Peru: Tumbes; Negritos; Bayovar.

Tagelus (Tagelus) affinis (C. B. Adams)

Plate 62, figures 4, 4a

- Solecurtus affinis* C. B. Adams, 1952, Ann. Lyceum Nat. Hist. New York, vol. 5, pp. 524, 548, No. 510 Panama.—Turner, 1956, Occas. Papers on Mollusks, Mus. Comp. Zool. vol. 2, No. 20, p. 29, pl. 19, figs. 17, 18.
Tagelus (Tagelus) affinis (C. B. Adams), Hertlein and Strong, 1950, Zoologica, vol. 35, pt. 4, No. 19, p. 222, pl. 1, figs. 9, 11.

Shell elongate, the dorsal and ventral sides subparallel, the small, inconspicuous beak placed a trifle closer to the anterior side, the ratio of height to length nearly 1 to 3. Both ends are well rounded, gaping, the posterior-dorsal slope appearing a little depressed, the mid zone of the disk flattened to slightly depressed. External surface beneath the periostracum white, marked with growth incrementals generally coarser on the sides. Teeth and nymphal plate small. Periostracum is usually worn off the umbones, elsewhere it is a thin, light brown to straw-colored, smoothly wrinkled, generally with coarse, open reticulated meshlike wrinkles on the ends. Interior white, often porcellaneous, with the pallial sinus large and extending to about the middle. Measurements of average specimen: length 58.7 mm., height 21.4 mm., diameter of a single valve 6.8 mm. Another double-valved specimen: length 55 mm., height 18.5 mm., diameter 11.5 mm.

Range—Mexico to Ecuador. Panama: Panama City. Colombia: Isla del Gallo. Ecuador: Esmeraldas; Sua.

Tagelus affinis longisinuatus Pilsbry and Lowe

- Tagelus affinis longisinuatus* Pilsbry and Lowe, 1932, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, p. 91, pl. 11, figs. 4, 5 Mazatlan.

Specimens from Negritos, Peru, seem referable to this subspecies. They are longer and narrower than the typical form of *T. affinis*. A speci-

men has the following dimensions: length 61 mm., height 18.8 mm., length of pallial sinus from the posterior end 32.2 mm.

Tagelus (Tagelus) irregularis, new subspecies

Plate 62, figure 6

The shell is larger than that of typical *T. affinis*, relatively thin, strongly convex, often much distorted, the anterior and posterior umbonal slopes more pronounced, the midzone of the disk often deeply impressed. The surface is white or stained rusty brown, the lines of growth coarse and undulate, the periostracum thin, often worn off or left adhering only in spots. The impression of the pallial sinus and the adductor scar is usually deep.

Length 80 mm., height 26.8 mm., diameter 20 mm., length of pallial sinus from the posterior end about 42 mm.

This is a larger, thinner, and more inflated shell than typical *T. affinis*. It should perhaps be considered a distinct species but its somewhat irregular shape may also be due to distortion and accidents of growth through living amongst coarse cobbles.

Range—Ecuador. Ecuador: Punta Montanita near Manglaralto.

Tagelus (Tagelus) peruanus (Dunker)

Plate 62, figures 2-2b

Siliquaria peruana Dunker, 1861, Proc. Zool. Soc., p. 426, No. 35. Hab. In littore Peruano (H. Cuming).

Solecortus peruanus (Dunker), Reeve, 1874, Conch. Icon., vol. 19, *Solecortus*, pl. 8, fig. 38. Hab. Tumbes, Peru.

Shell medium-sized, broadly rectangular, the ratio of the height to length about 1 to 2.25, the beak and umbone nearly median, thin, moderately convex, the surface of the disk somewhat depressed across the middle. Posterior side rounded, the anterior somewhat obliquely subtruncate. General color white, the surface marked with coarse lines of growth, under a thin, dull olive-brown periostracum. Substance of the shell is thin but the adductor scars and pallial line show distinctly, the pallial sinus itself rather large, wide, and reaching to the middle of the shell cavity.

Length 41.5 mm., height 18.1 mm., diameter 12 mm. Old Panama.

The shortest and highest species. Some loose valves from Búcaro have a length of nearly 48 mm.

Range—Panama southward to Peru. Panama: Old Panama; Búcaro. Peru: Tumbes.

Subgenus *Mesopleura* Conrad, 1867

Type species by subsequent designation, Gardner, 1928, *Mesopleura (Solen) bidentata* Spengler (= *Tagelus divisus* Spengler). Recent, east coast of the United States.

Umbonal cavity with a short, thickened ray, generally colored violet and showing through onto the surface of the umbone as a colored streak.

Tagelus (Mesopleura) politus (Carpenter)

Plate 62, figures 7, 7a

Solecortus politus Carpenter, 1855, Cat. Mazatlan Shells, British Museum, p. 27, No. 38.

Tagelus (Mesopleura) politus (Carpenter) Hertlein and Strong, 1950, *Zoologica*, vol. 35, pt. 4, p. 224, pl. 1, figs. 8, 10.

Shell small, elongate, thin, and subtranslucent, its general color white flushed with violet and with two small, oblique, white rays extending across the umbones backwards. Dorsal and ventral margins subparallel, straight, except for a slight inbend of the ventral margin due to a flattening of the surface of the valve across the middle. The internal thickened ray is usually strong, dark-purple in color and extends a little below the middle either vertical or inclined slightly posteriorly; it shows through the substance of the shell as a dark streak on the umbone; behind it there are two white rays which extend obliquely downward to the posterior portion of the ventral margin. The largest specimens attain a length of about 40 mm.

Range—West Mexico to northern Peru. Panama: Búcaro. Colombia: Isla del Gallo. Ecuador: Santa Elena. Peru: Tumbes.

Tagelus (Mesopleura) peruvianus Pilsbry and Olsson Plate 62, figures 3-3d

Tagelus (Mesopleura) peruvianus Pilsbry and Olsson, 1941, Proc. Acad. Nat. Sci. Philadelphia, vol. 93, pp. 70, 71, pl. 18, fig. 5.—Hertlein and Strong, 1950, Zoologica, vol. 35, pt. 4, p. 224.—Hertlein and Strong, 1955, Bull. Amer. Mus. Nat. Hist., vol. 107, art. 2, pp. 202, 203.

Shell elongate, its height about a third of its length, of moderate convexity, the small beak not central, the posterior end is a trifle longer. Ventral margin straight, the dorsal a little arched on the anterior side, noticeably winged on the posterior. The shells are usually a little warped in the middle which accentuates the gap at the ends. Young shells are thin and translucent on removal of epidermis and show the thickened ray of *Mesopleura* directed slightly backwards, but in the adult this ray may disappear entirely or show only as a slight thickening of this part of the shell. Pallial sinus ample, rounded, higher within the shell than at its opening, and extends not quite to the middle. Color in most specimens is white shaded with brown or violet and with a colored streak over the internal ray or its location, and there are two narrow, white rays over the umbones. The periostracum is coarsely wrinkled and dark-brown in color.

Length 82.6 mm., height 79.6 mm., diameter 15.8 mm. Puerto Callo, Ecuador.

This is a common Pliocene fossil in Ecuador. It is easily distinguished from all other Pacific Coast tagelids by the flangelike wing on the posterior-dorsal margin. Like *T. dombeii* in surface coloration but with more elongated valves.

Range—Gulf of California to northern Peru. Panama: Guanico. Ecuador: Galeras; Manta; Puerto Callo; Santa Elena. Peru: Tumbes; Mancora; Zorritos.

Tagelus (Mesopleura) bourgeoisae Hertlein

Tagelus (Mesopleura) bourgeoisae Hertlein, 1951, Bull. South. California Acad. Sci., vol. 50, pt. 2, pp. 73, 74, pl. 26, figs. 5, 6.

This species was described by Hertlein from specimens collected at Santa Cruz, Mexico. It is distinguished from other allied species (such as *T. politus* Carpenter) in that the internal rib slopes anteriorly rather than posteriorly. The species was also recorded by Hertlein from Santa Elena, Ecuador, but I have not seen specimens.

Range—Mexico to Ecuador. Ecuador: Santa Elena (Hertlein).

Genus **SOLECURTUS** Blainville, 1824

(Solenocurtus Blainville emend., Psammosolen Risso, 1826)

Type species by subsequent designation, Anton, 1839, *S. strigilatus* Blainville (= *Solen strigilatus* Linné).

Shell with broad, razor-shaped, rectangular valves, with the umbones placed a little nearer the anterior end but never terminal, the ends rounded, the posterior gap large. The surface is coarsely marked with growth lines and generally with a series of transverse and oblique lines across the middle and posterior parts of the disk. The pallial sinus is large and deep.

Solecortus broggii Pilsbry and Olsson

Plate 63, figure 2

Solecortus broggii Pilsbry and Olsson, 1944, Proc. Acad. Nat. Sci. Philadelphia, vol. 93, p. 71, pl. 18, fig. 4 Puerto Callo, Jipijapa, Ecuador, also in the Pliocene of Ecuador.—Hertlein and Strong, 1950, Zoologica, vol. 35, pt. 4, pp. 227, 228.—Keen, 1958, Sea Shells of Tropical West America, p. 191, fig. 468.

The shell is large, coarse, moderately convex, its dorsal and ventral margins nearly straight and parallel, the posterior gap large. The small beak is placed a short distance behind the front third of the length. Surface marked with coarse, irregular lines of growth except on the posterior area where, in addition, there is a series of spaced lines which cross the shell vertically and bend obliquely forward near their lower ends. There is also one or more faint rays radiating from the umbones towards the ventral margin. Coloration white and in life covered with a coarse, black periostracum.

Length 84 mm., height 33 mm., diameter of a valve 10.3 mm.

Sparingly distributed along the coast of Ecuador and northern Peru. It is locally common as a Pliocene fossil at Punta Blanca in Ecuador.

Range—Panama southward to northern Peru. Panama: Gulf of Chiriqui (Hertlein and Strong). Ecuador: Jaramijo; Puerto Callo. Peru: Zorritos, Boca Pan; Punta Picos.

Solecortus guaymasensis (Lowe)

Plate 63, figure 8

Psammosolen guaymasensis Lowe, 1935, Trans. San Diego Soc. Nat. Hist., vol. 8, No. 6, p. 18, pl. 1, fig. 7 Guaymas.—Strong and Hertlein, 1950, Zoologica, vol. 35, pt. 4, pp. 228, 229.—Keen, 1958, Sea Shells of Tropical West America, p. 192, fig. 469.

This is a smaller, shorter species with the umbones in a more central position. The oblique lines are developed over a larger part of the surface and have been likened to that produced by a series of overlapping clapboards.

Range—Lower California to Panama. Panama: Gulf of Chiriqui (Hertlein and Strong).

Genus **HETERODONAX** Mörch, 1853Type species by monotypy, *Tellina bimaculata* Linné.

Shell ovate, inequilateral, the beaks and umbones a little posterior of the middle, hence the anterior side is longer, rounded at the end, the shorter posterior side often appearing somewhat truncated. Ligament external, seated on or behind a high nymphal plate. Hinge: left valve has a large,

grooved or bifid central cardinal tooth with a socket on each side, also a small thin posterior cardinal tooth; right valve has two strong cardinal teeth and a central socket; lateral teeth are partly obsolete, the right valve has a small anterior and posterior tooth. Surface marked with concentric growth lines. Pallial sinus is large, rounded, and extends to about the middle of the shell cavity. Valve margins plain.

Heterodonax bimaculatus (Linné)

Plate 85, figure 10

- Tellina bimaculata* Linné, 1758, Syst. Nat., ed. 10, p. 677.—Hanley, 1846, Thes. Conch., vol. 1, *Tellina*, p. 250, No. 52, pl. 56, figs. 16, 19, 20, 21, 22.—Sowerby, 1866, Conch. Icon., vol. 17, *Tellina*, pl. 18, figs. 94a, b, c.
Psammobia pacifica Conrad, 1837, Jour. Acad. Nat. Sci. Philadelphia, vol. 7, p. 241, pl. 18, fig. 13.
Tellina vicina C. B. Adams, 1852, Ann. Lyceum Nat. Hist. New York, vol. 5, pp. 509, 546, No. 473.—Turner, 1956, Occas. Papers on Mollusks, Mus. Comp. Zool., vol. 2, No. 20, p. 98, pl. 18, figs. 11, 12.
Donax ovalina Deshayes, 1855, Proc. Zool. Soc. London for 1854, p. 352.
Donax ovalinus Deshayes, Sowerby, 1866, Thes. Conch., vol. 3, *Donax*, p. 312, No. 47, pl. 283, fig. 104.
Heterodonax bimaculata (Linné), Hertlein and Strong, 1950, Zoologica, vol. 35, pt. 4, p. 221.

Shell triangularly rounded to ovate, with the beaks nearer the posterior end which generally appears somewhat truncated. Surface sculptured with coarse irregular concentrics and often showing short irregular radial lines or streaks. Color variable from white, salmon, brown, violet to purple, often rayed or maculated. Average size about 22 mm.

This species is also found in the Western Atlantic. Generally variable in surface color and markings.

Range—Southern California to northern Peru. Panama: Pedro Gonzalez, Pearl Islands. Panama Canal Zone: Venado beach; Farfan. Peru: Tumbes (Weyrauch).

Genus GARI Schumacher, 1817

(*Psammobia* Lamarck, 1818.)

Type species by tautonomy, *G. vulgaris* Schumacher (= *Tellina gari* Linné).

Shell slantingly elongate-ovate or subrectangular, with the beaks and umbones placed submedian or slightly nearer the posterior side. The two ends more or less rounded, equivalve, depressed or slightly convex, thin or of medium weight. Nymphal plate prominent. Hinge with one or two cardinal teeth in each valve, one or both of which may become partly obsolete. Pallial sinus large, its upper margin straight, end widely rounded, its lower margin confluent with the pallial line. Adductor scars placed high within the valve or just below the dorsal margin. Periostracum usually coarse and heavy; beneath it the surface is usually mottled or rayed with purple, smooth, or with growth line striation only.

Two subgenera.

I. Posterior end of the valves somewhat pointed; closed or with a small gap only.

Subgenus *Gari*, s.s.

II. Posterior margin of valves evenly rounded or truncated, the end widely open.

Subgenus *Gobraeus*

Subgenus **GOBRAEUS** Leach in Gray, 1852

Type species by monotypy, *G. variabilis* Leach (= *Solen vespertina* Gmelin, 1791).

Shell usually somewhat inequilateral, the posterior side is a little longer and narrower, with widely rounded or obliquely truncated ends. Surface smooth, plain or with a rayed pattern, lilac and purple tints predominating. Posterior end with an open gap.

The species of this subgenus have been referred by most authors to *Psammocola* Blainville, 1824. As shown recently by Palmer (1958, Mem. 76, Geol. Soc. America, pp. 111, 112), the name "*Psammocola*," first introduced by Blainville in 1824 must be based on its original description with its reference to a species illustrated in the Encyl. Méthodique (pl. 231, figs. 3 a, b, c), and not on the figure given by Blainville the following year (1825, Manuel de Malacologie, pl. 77, fig. 4). The figure in the Encyclopédie represents a different species from that illustrated on Blainville's plate, which was, therefore, subsequently added. Blainville's illustration seems to represent a species near or closely similar to the Caribbean *Asaphis deflorata*.

Gari (Gobraeus) maxima (Deshayes)

Plate 63, figures 7-7b

Psammobia maxima Deshayes, 1855, Proc. Zool. Soc. London for 1854, p. 3.7. Hab. ---?

—Reeve, 1857, Conch. Icon., vol. 10, *Psammobia*, pl. 1, fig. 4. Hab. Panama.

Gari (Psammocola) maxima (Deshayes), Hertlein and Strong, 1950, Zoologica, vol. 35, pt. 4, p. 218.—Keen, 1958, Sea Shells of Tropical America, p. 190, fig. 464.

Shell high, ovate-rectangular, inequilateral, the posterior side longer, slightly convex or depressed, the anterior side obliquely rounded, the posterior more or less truncated. The surface in life or in fresh specimens covered by a straw-brown to nearly black periostracum, the shell underneath pale lilac or purplish-brown with narrow white rays, best shown on the posterior area. The pallial sinus is large, rounded at the end, and extends to a vertical under the beak. The shell internally is white or faintly flushed with purple.

Length 52 mm., height 31.3 mm., diameter 15.8 mm.

Range—Gulf of California to Ecuador. Colombia: Gorgona Island (Hertlein and Strong). Panama: Pearl Islands. Ecuador: Manta; Santa Elena; San Lorenzo.

Gari (Gobraeus) lata (Deshayes)

Plate 63, figure 9

Psammobia lata Deshayes, 1855, Proc. Zool. Soc. for 1854, p. 318. Hab. Central America.

—Reeve, 1857, Conch. Icon., vol. 7, *Psammobia*, pl. 1, fig. 7.—Hertlein and Strong, 1950, Zoologica, vol. 35, pt. 4, p. 218, (foot-note).

Gari (Psammocola) lata (Deshayes), Keen, 1958, Sea Shells of Tropical West America, p. 190, fig. 464.

Short, obliquely rectangular, with the dorsal and ventral sides straight and parallel, the anterior end, obliquely rounded. Surface plain and covered with a dark, scaly periostracum. Length about 60 mm., height 40 mm.

Apparently rare and not recorded since its first discovery.

Range—Central America.

Gari (Gobraeus) sp.

Plate 63, figure 10

Psammobia (?Amphichaena) regularis Carpenter, 1864, Ann. and Mag. Nat. History, No. 3, vol. 13, p. 312 Cape San Lucas.

?*Gari* (*Psammocola*) *regularis* (Carpenter), Hertlein and Strong, 1950, *Zoologica*, vol. 35, pt. 4, p. 218, pl. 2, fig. 10.—Keen, 1958, *Sea Shells of Tropical West America*, p. 190, fig. 466.

Shell broadly elongate, nearly equilateral, the anterior end narrowly rounded, the posterior end obliquely truncate. The posterior dorsal area is depressed and marked with fine radially incised lines. Surface speckled and mottled with white and purple spots, the whole covered in life with a golden-brown periostracum.

Length 46.8 mm., height 25 mm., diameter 15 mm. (Hertlein and Strong).

This species seems to be limited to the northern part of the Panamic-Pacific province.

This species was figured by Hertlein and Strong as *G. regularis* Carpenter but is probably distinct. The type of *G. regularis* is in the U.S. National Museum and was recently figured by Palmer, 1958 (Mem. 76, Geol. Soc. America, p. 113, pl. 15, figs. 1-6), and shows a small, thin, plainly marked shell, the posterior area bearing a series of widely spaced, transverse lines. *G. regularis* should probably be considered a synonym of *G. fucata* Hinds, 1843, described from Magdalena Bay on the west coast of Lower California.

Range—Coast of Mexico.

Gari (*Gobraeus*) *panamensis*, new species

Plate 63, figure 11

Similar to *G. maxima* but longer and lower, the beaks placed less centrally and the posterior-dorsal margin is longer and more descending. The posterior side is longer and more attenuated at the end. Texture of the shell thin, internally white with the rays of pattern showing through near the margin. Shell slightly convex, the ground color white rayed with irregular bands of a delicate violet-brown. Pallial line indistinct because of the thinness of the shell, the sinus large, complete, and high, reaching to about the middle of the valve. Nymphal plate large and flat. Periostracum light-brown, thin, and varnish-like.

Length 54.5 mm., height 31.6 mm., diameter 16.4 mm. Holotype, ANSP.

The commonest *Gari* at Panama, easily recognized by its thin shell and coloration.

Range—Panama. Panama Canal Zone. Palo Seco.

Gari (*Gobraeus*) *helenae*, new species

Plate 63, figures 12, 12a

Shell rather elongate, the length nearly twice its height, moderately convex, the beaks placed nearly central, the valves almost equilateral but are slightly unequal in shape and convexity, the left valve being more convex, while the right is depressed across the middle and more strongly flexed along the posterior-ventral margin. The height is greatest on the anterior side of the middle, its end narrowly rounded while the posterior side is narrower and obliquely truncated at its end. The posterior gap between the valves is quite wide. Color under the periostracum is purple with a mottling of rays and patches of dull white, internally the color is purplish with a shading of white. The general texture of the shell is of moderate weight, the external rays showing through indistinctly, the pallial sinus

rather short, extending to the middle, complete and rounded at the end. The nymphal plate is distinct but not as high or prominent as in *panamensis*. Length 52 mm., height 27.3 mm., diameter 14.3 mm. Holotype, ANSP.

In shape, this species resembles *G. regularis* but is more slender, the posterior side narrower and more flexed, and the coloration is different. Faint, radial, divaricating lines may be seen on the posterior-dorsal area under a lens.

This species is named for Mrs. Helen L. Beil, a capable and enthusiastic collector of Panama shells.

Range—Panama. Panama: Pearl Islands, (Coll. Lee Beil).

Family SEMELIDAE

Shell small or large, heavy or thin, orbicular to elliptical in shape, the valves convex or depressed. The ligament is mostly internal, the resilium attached to an oblique groove in the hinge plate or to a bulging spoonlike chondrophore, the tensilium small, narrow and placed above a wide, flattened nymph. Hinge teeth variable in strength, the cardinals usually small or obsolete, the lateral teeth absent or strong. The pallial sinus is large, rounded at the end. Ventral margins smooth.

Members of this family resemble the Tellinidae but are distinguished by the large internal ligament attached to an obliquely grooved resilifer. Five genera of the family occur in the Panamic-Pacific region. In key form, these genera may be distinguished as follows:

I. Pallial sinus large, entire, rounded at the end, free, its lower limb not united with the pallial line below.

1. Shell large or of medium size, usually rounded or elliptical in shape. Sculpture varied, smooth, or with radial and concentric elements or a combination of both.

Genus *Semele*

2. Shell small, subovate, nuculiform, the anterior side longer than the posterior, rounded at the end. Cardinal teeth stout. Surface marked with concentric riblets only.

Genus *Semelina*

II. Pallial sinus with its lower limb widely confluent with the pallial line.

A. Hinge with strong lateral teeth.

3. Shell free, or more often a nestler, hence distorted in shape. Sculpture concentric, often lamellose. Hinge strong.

Genus *Cumingia*

4. Shell small, regular in shape, trigonal or quadrangle. Hinge weak. Surface smooth or with fine concentrics.

Genus *Abra*

B. Hinge without lateral teeth. Resilifer grooved, not projecting into the hinge cavity.

5. Shell elongately trigonal in shape, usually thin.

Genus *Leptomya*

Genus *SEMELE* Schumacher, 1817

(*Amphidesma* Lamarck, 1818)

Type species by monotypy, *Tellina reticulata* Spengler (= *Tellina proflucua* Pulteney). Recent, Florida, West Indies, and the Caribbean.

Valves elliptical, orbicular to nearly circular, generally subequal, or if unequal, as in some species, the right valve is a little larger and more convex than the left. Beaks prosogyrate, nearly median or placed a little behind the middle. Ligament mainly internal, the resilium seated in a deep, elongated chondrophore, similar in each valve, and separated from the much smaller tensilium or external part of the ligament by a wide, nymphal plate. Hinge with the cardinal teeth small, sometimes partly obsolete, the lateral teeth much stronger, equidistant. The pallial sinus is large and deep, rounded at the end, free from the pallial line below it. Surface sculpture varies from nearly smooth shells or with concentric growth lines only, to highly sculptured forms with strong ribs and concentric lamellae, sometimes a combination of both.

Key to Panamic-Pacific species of *Semele*

- I. Valves are of unequal size, the left valve decidedly larger and more convex.
 1. Shell large (90 mm., or more), the sculpture formed by growth lines and weak radial striae. External color white, the interior apricot. Peruvian. *S. corrugata*
- II. Valves are nearly equal in size, the external surface plain, smooth or strongly sculptured.
 - A. Surface smooth or marked with growth line concentrics only.
 - Aa. General size large (40 mm. or more).
 - a. An escutcheon or flattened area along the posterior dorsal margin is absent.
 - aa. Shell broadly subovate to elliptical in shape.
 2. Anterior side much longer than the posterior, the surface smooth and polished. *S. laevis*
 3. Shell higher, subovate, the posterior weakly flexed. Surface marked with fine, incised, concentric lines (dosinoid) and weak, radial striae. *S. elliptica*
 - b. An escutcheon is present, the posterior-dorsal slope strongly flattened and bordered by an angle.
 4. The shell is subcircular in shape, its surface white and covered by a thin, gray or yellow periostracum. The concentric sculpture is irregularly developed, overrun by fine, radial lines, often granulose on the sides. *S. flavescens*
 - Ab. Shell smaller (40 mm. or less).
 5. Shell elliptical in shape, the anterior side much longer than the posterior. Sculpture consists of fine, concentric lines intersected by oblique lines on the anterior side. Color white, mottled with yellow, violet or brown. *S. sparsilineata*
 6. Shape subcircular to subelliptical, nearly equilateral. Surface marked with fine concentrics, regularly distributed and minute or submicroscopic striae fanning out on the lateral slopes. Color usually white, the umbones and interior stained with yellow, purple or brown. *S. lenticulare*
 - B. Sculpture stronger.
 - Ba. Sculptural elements predominantly concentric, if any radials are present, they consist of fine striae only.

- c. Concentrics small, threadlike.
7. Shell small (length 25 mm.), subelliptical, convex and thin. Color a dingy white, the interior yellow or purple.
S. pallida
- d. Concentric elements stronger.
- da. Concentric riblets coarse and regular, not divided or waved.
8. Obliquely subovate, coarse textured, the posterior side weakly flexed. Color white, narrowly banded and rayed with purple, the umbones yellow.
S. formosa
9. Subrectangular, the beaks nearly median, concentric rugae strong and coarse. Posterior zone well marked, subtruncate at the end.
S. craneana
10. Shell smaller, obliquely elliptical, the posterior side much shorter. Generally rayed with white, violet or purple, the interior white or variously stained.
S. venusta
- db. Concentric elements entire but irregular and strongly waved.
11. Subovate, heavy, the sculpture formed by irregular, broken, ropelike concentrics. Galapagos.
S. punctata
12. Trigonal-subovate in shape, thinner, depressed. Sculpture of wavy concentrics overrun by vermiculate striae. Posterior side strongly flexed.
S. tortuosum
- dc. Concentric elements not entire but splitting into scalelike segments on the ends.
13. Medium size (length 35 mm.), subelliptical, heavy, depressed. Color white mottled with purple.
S. verrucosa
- dd. Concentric sculpture sharp or rasplike, formed by thin, raised lamellae, their interspaces flat, narrow or wide, smooth or cut by fine, radial striae.
14. Shell rounded to orbicular in shape. Surface cream-colored, often deeply suffused with red or pink.
S. rosea-S. tabogensis
15. Shell longer, elliptical, the beaks submedian and pointed. Color usually a purple or dull lilac, sometimes white, the umbones yellow.
S. sowerbyi-S. jovis
- Bb. Sculpture including strong, radial elements over the whole disk or confined to one or both ends.
- e. Concentric sculpture reduced to lines of growth only.
16. Shape obliquely subovate with high, trigonal beaks. There is an excavated lunule and a flattened escutcheon in the left valve. Sculpture formed by low, irregular, radial riblets, the whole surface coarsely granulose. Interior apricot-colored.
S. pilsbryi
- f. Sculpture with strong concentrics and radials.
- fa. Sculpture strongly cancellated over the whole surface.
17. Shape obliquely elliptical, the anterior side longer. Color a creamy white and with violet zigzag markings.
S. pacifica
18. Shell smaller, ovate, the ends nearly equal. Sculpture rather coarse.
S. margarita

fb. Concentric elements of the sculpture dominant, the radials restricted to groovings on one or both ends.

fb. Concentrics small and fine.

19. With radial groovings on the anterior slope only.

S. pulchra and *S. quentinensis*

20. With radial groovings on both ends.

S. jaramija

fb. Concentric elements coarse.

21. Radial groovings mostly on the anterior slope, sometimes also on the posterior but much weaker.

S. guaymasensis

Semele corrugata (Sowerby)

Plate 64, figures 1, 1a, 1b

Amphidesma corrugata Sowerby, 1833, Proc. Zool. Soc. London for 1832, p. 200 (in Peruvia et ad Iquiqui).—Sowerby, 1833, Conch. Illust., p. 7, No. 8.—Reeve, 1853, Conch. Icon., vol. 8, *Amphidesma*, pl. 1, fig. 4.

Semele corrugata (Sowerby), Dall, 1910, Proc. U.S. Nat. Museum, vol. 37, No. 1704, p. 271.

Shell large, subcircular to suborbicular, thick, the right valve larger and more convex, the left valve flattened to slightly convex. Surface marked with small, wrinkled, concentric corrugations and weak to subobsolete radial lines and striations, often so arranged as to form radial rays. External color white, the interior white or a deep apricot, the teeth generally stained with violet or purple. Adductor scars large and subequal, the pallial sinus deep, well rounded at the end.

Length 96 mm., height 85.5 mm., diameter 40 mm. Specimen from Bahia de la Independencia, Peru.

This is a large, white shell often with an apricot-colored interior, the teeth stained deep red or violet. It is quite common at many places along the middle and south Peruvian coast where it is used both for food and bait by the natives. It has been reported as ranging as far northward as the Gulf of California but I have seen no authentic specimens north of the Santa Elena peninsula.

Range—Southern Ecuador to Chile. Ecuador: Santa Elena. Peru: Negritos; Bay of Sechura; Paracas; Bahia de la Independencia.

Semele laevis (Sowerby)

Plate 64, figure 6

Amphidesma laeve Sowerby, 1833, Proc. Zool. Soc. London for 1832, p. 199. Xipixapi.—Sowerby, 1833, Conch. Illust., No. 22, pl. 18, fig. 6.

Amphidesma laevis Sowerby, Reeve, 1853, Conch. Icon., vol. 8, *Amphidesma*, pl. 7, fig. 50.

Semele laevis (Sowerby), Hertlein and Strong, 1948, Zoologica, vol. 34, pt. 4, No. 19, p. 245.

Shell medium or large (to about 90 mm.), subsolid, ovately elliptical in shape, equivalve, and with slight or moderate convexity. The beaks are placed a little behind the middle, the posterior side being shorter and higher, its dorsal margin weakly arched. The posterior dorsal area is barely defined, not flexed. Anterior dorsal margin descends with a slight curve towards the end, the whole anterior side appears as if drawn out slightly. The beaks are small and overhang a small, elongate lunule found only in the left valve; there is also a narrow escutcheon in the same valve. Surface smooth, polished, especially over the umbones, the growth lines showing best but somewhat irregular towards the ventral side. A large pallial sinus extends to about the middle of the shell cavity.

Length 91.8 mm., height 84.2 mm., diameter 17.7 mm. (a left valve, Mompiche, Ecuador).

As fossil, this species is represented by closely related forms in the Zorritos Miocene of Peru and in the Miocene of northwestern Costa Rica (subsp. *costaricensis* Olsson). It occurs as a Pliocene fossil in Ecuador and in the Pleistocene of Panama.

Range—Guatemala to northern Peru. Guatemala: El Salvador and Costa Rica, recorded by Hertlein and Strong. Panama: Búcaro; Guanico; Bahia Honda near Las Tablas; San Carlos. Panama Canal Zone: Fort Amador beach. Colombia: Choco (O. L. Haught, USNM). Ecuador: Sua; Mompiche; Charapota; Jamaico. Peru: Tumbes; Zorritos.

Semele elliptica (Sowerby)

Plate 64, figure 5

Amphidesma ellipticum Sowerby, 1833, Proc. Zool. Soc. London for 1832, p. 200 Monte Christe.—Sowerby, 1833, Conch. Illust., No. 6, fig. 17 (no figure given).—Reeve, 1853, Conch. Icon., vol. 8, *Amphidesma*, pl. 5, fig. 31.

Semele elliptica (Sowerby), Maxwell Smith, 1944, Panamic Marine Shells, p. 62, fig. 808.

This species much like *S. laevis* but consistently smaller, higher, the anterior side shorter, more widely rounded at the end. The posterior side is quite short, with a well-marked, depressed, posterior-dorsal area, more or less flexed, and widely truncated at the end. Surface white under a gray periostracum, the surface smooth but frequently ringed or banded, the umbones smooth and with fine, low, concentrics below. Inside white, often with slight yellow or pink staining in the middle.

An average shell measures: length 47.3 mm., height 42.7 mm., diameter 21 mm.

A common species in Panama at several places.

Range—Panama. Panama: Cathedral Rocks; Panama City; Concepcion beach near Poicri; Las Tablas; Puerto Chame. Panama Canala Zone: Venado Beach.

Semele flavescens (Gould)

Plate 64, figures 4-4b

Amphidesma flavescens Gould, 1851, Proc. Boston Soc. Nat. Hist., vol. 4, p. 89.—Gould, 1853, Boston Jour. Nat. Hist., vol. 6, p. 392 San Diego.

Amphidesma proximum C. B. Adams, 1852, Ann. Lyceum Nat. Hist. New York, vol. 5, pp. 513, 547, No. 487.—Turner, 1956, Occas. Paper on Mollusks, Mus. Comp. Zool., vol. 2, No. 20, pp. 76, 77, pl. 18, figs. 14, 15.

Amphidesma proxima C. B. Adams, Reeve, 1853, Conch. Icon., vol. 8, *Amphidesma*, pl. 3, fig. 20.

Semele proxima (C. B. Adams) Maxwell Smith, 1944, Panamic Marine Shells, p. 62, fig. 805.

Semele californica A. Adams, 1853, Proc. Zool. Soc. p. 96.—Lamy, 1914, Jour. de Conchyl., vol. 61, No. 3, pp. 359, 360.

Amphidesma californica (A. Adams), Reeve, 1853, Conch. Icon., vol. 8, *Amphidesma*, pl. 3, fig. 19.

Semele flavescens (Gould), Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 4, No. 19, pp. 242, 243.

Shell of medium size to large, (length 62.4 mm.), orbicular to nearly circular, slightly longer than high, thick, the beaks median. Surface with irregularly spaced, concentric groovings, marking stages of growth and fine radial striae. On close examination under a lens, the texture of the surface is seen to be finely granulose as if built up of small, closely packed grains. External color a dull white, overlain by a thin, gray periostracum retaining the fine, granulose textured surface of the shell beneath. Interior of shell

cavity white, often tinted with light yellow. Both valves have an elongate, flattened escutcheon set off sharply from the shell disk by angled borders. Lunule small, deeply sunken.

Length 52.8 mm., height 47 mm., diameter 25.3 mm. Santa Elena.

Gould's original specimens of *S. flavescens* have never been figured, and hence, some doubt may exist as to its real identity but an escutcheon was mentioned in the original description which appears to indicate the shell here under consideration. The name "*proximum*" was given to the same shell by C. B. Adams the following year.

Semele flavescens is similar to *S. corrugata* in shape but is smaller, its dorsal side is higher and more trigonal in shape. It is best distinguished by the presence of a small escutcheon in both valves and by its submicroscopic granulose surface. The species is common over a wide range.

Range—California to northern Peru. Panama: Panama City; Búcaro. Panama Canal Zone: Venado Beach. Ecuador: Sua; Punta Blanca; Palmar; Manglaralto; Santa Elena. Peru: Zorritos; Boca Pan.

Semele sparsilincata Dall

Plate 66, figure 7

Semele sparsilincata Dall, 1915, Proc. Acad. Nat. Sci. Philadelphia, vol. 67, p. 26 "Panama".—Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 4, pp. 247, 248, pl. 1, fig. 8.

Shell ovately elliptical, of moderate convexity, the beaks placed a little behind the middle, the anterior side hence longer, somewhat narrower and well rounded, the posterior side higher. Surface marked with small, even and widely spaced threadlike, concentric ridges which begin on the posterior slope and pass obliquely across the midzone onto the anterior slope. Surface usually white or light-colored, blotched with brown or purple, heaviest on the umbones and as finer zigzag markings elsewhere.

Length of a specimen 33.2 mm., height 27.6 mm., diameter of a left valve 7.2 mm. Santa Elena.

Closely resembles the Atlantic *S. purpurascens* (Gmelin) but usually smaller, heavier, and less convex.

Range—Nicaragua to Ecuador. Nicaragua: Corinto (Hertlein and Strong); San Juan del Sur (Lowe). Panama: Taboga Island (Lowe); Ecuador: Santa Elena; Punta Blanca; Esmeraldas.

Semele lenticulare (Sowerby)

Plate 65, figures 8-85;
Plate 66, figures 9-9a

Amphidesma lenticulare Sowerby, 1832, Proc. Zool. Soc. London, p. 200 "Sanctam Elenam".—Sowerby, 1833, Conch. Illust. fig. 9.

Amphidesma lenticularis Sowerby, Reeve, 1853, Conch. Icon., vol. 8, *Amphidesma*, pl. 6, fig. 39.

Amphidesma bicolor C. B. Adams, 1852, Ann. Lyceum Nat. Hist. New York, vol. 5, pp. 512, 547, No. 485.—Turner, 1956, Occas. Papers on Mollusks, Mus. Comp. Zool., vol. 2, No. 20, p. 35, pl. 18, figs. 7, 8.

Amphidesma ventricosum C. B. Adams, 1852, *op. cit.*, pp. 516, 547, No. 491.—Turner, 1956, *op. cit.*, p. 97, pl. 19, figs. 9, 10.

Amphidesma striosum C. B. Adams, 1852, *op. cit.*, pp. 515, 547, No. 489. Not *A. striosum* Turner, 1956, *op. cit.*, p. 90 (*pulchra* Sowerby).

The shell is small or of medium size (average length 23 to 25 mm.), subcircular, thin or heavy, white, but often with the beaks and the interior

of the valves stained with brown, yellow or purple. The valves are nearly equal in size, equilateral, the small beaks placed near the middle. Surface smooth but on close inspection seen to be covered with fine, widely spaced, concentric threads, best developed on the sides and near the ventral margin, often worn off the umbones: there is also a submicroscopic sculpture of radial striae which on the anterior and posterior slopes assume a fan-shaped pattern.

Length 24.7 mm., height 21.1 mm., diameter 11.6 mm. Santa Elena, Ecuador.

Shells from Panama are more circular than the typical form from Ecuador but are otherwise quite similar. The type of C. B. Adams, *A. striosum* seems to be lost; the specimen figured by Turner as the type is evidently a misplaced shell: this specimen was seen by the author some years ago and identified then as *S. pulchra*.

This small *Semele* is especially common along the Ecuadorian coast, and except for its much smaller size, it shares many characters in common with *S. proficua* (Pulteney) of the Western Atlantic.

Range—Panama southward to Peru. Panama: Panama City; Búcaro. Panama Canal Zone: Venado Beach. Ecuador: Esmeraldas; Manta; Puerto Callo; Santa Elena. Peru: Zorritos; Boca Pan; Negritos.

Semele pallida (Sowerby)

Plate 66, figure 8

Amphidesma pallidum Sowerby, 1833, Proc. Zool. Soc. London for 1832, p. 199 Salango.

—Sowerby, 1833, Conch. Illust., No. 3, pl. 17, fig. 3.

Amphidesma pallida Sowerby, Reeve, 1853, Conch. Icon., vol. 8, *Amphidesma* pl. 4, fig. 22.

Semele regularis Dall, 1915, Proc. Acad. Nat. Sci. Philadelphia, vol. 67, p. 25 off La Paz, Lower California.

Semele simplicissima Pilsbry and Lowe, 1932, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, p. 93, pl. 12, figs. 6, 6a Acapulco.—Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 4, p. 247.

Semele paziana Hertlein and Strong, 1949, *op. cit.*, p. 274. (New name for *S. regularis* Dall, 1915, not *S. regularis* E. A. Smith, 1885).

Shell ovate, thin, delicate, moderately convex, slightly inequilateral, the beaks being placed not quite median, the anterior side being a little longer and narrower, its dorsal margin sloping and nearly straight, rounded at the end. Posterior side is a little higher, depressed or flattened, set off by a weak angle from the rest of the surface, its end appearing truncated and straight. Sculpture consists of fine, narrowly shelving concentrics, their interspaces narrow and flat, smooth or without concentric lineation. Color usually a dingy white, the interior of fresh specimens tinted with salmon pink, orange or purple. Average length about 25 mm.

There seems to be little doubt that *Semele pallida*, *regularis*, and *simplicissima* represent a single species characterized by its ovate form, thin shell, and fine concentric sculpture. The fine, concentric lines between the riblets (as described for *S. regularis*), are not well developed on all specimens but can generally be seen on close inspection.

Range—Lower California to Ecuador. Mexico: Off La Paz (Dall for *regularis*); Acapulco (Pilsbry and Lowe for *S. simplicissima*). Ecuador: Esmeraldas; Salango (*pallida*).

Semele formosa (Sowerby)

Plate 85, figure 8

Amphidesma formosum Sowerby, 1833, Proc. Zool. Soc. London for 1832, p. 199 "Santa Elena".—Sowerby, 1833, Conch. Illust. fig. 8.

Amphidesma formosa Sowerby, Reeve, 1853, Conch. Icon., vol. 8, *Amphidesma*, pl. 4, fig. 27.

Semele formosa (Sowerby), Maxwell Smith, 1944, Panamic Marine Shells, p. 62, fig. 801.

Shell broadly subovate, thick, the posterior side a little shorter than the anterior, strongly flexed. Surface marked with rather coarse, regular concentrics. Basal color white interrupted by narrow purple bands following the resting marks and faintly variegated over the umbones and broadly rayed on the middle and ventral surface of the disk.

Length 64.4 mm., height 52 mm., diameter 27 mm.

Range—Gulf of California ? south to Ecuador. Ecuador: Santa Elena (Brit. Museum Nat. History.)

Semele punctata (Sowerby)

Plate 64, figure 2

Amphidesma punctatum Sowerby, 1833, Proc. Zool. Soc. London for 1832, p. 200 Galapagos.—Sowerby, 1833, Conch. Illust., No. 18, pl. 18, fig. 7.—Reeve, 1853, Conch. Icon., vol. 8, *Amphidesma*, pl. 26. (as *A. punctata*.)

Semele punctata (Sowerby), Maxwell Smith, 1944, Panamic Marine Shells, p. 62, fig. 809.

The shell is ovate, sculptured with coarse, concentric folds on the ventral portion, finely radially striate. The umbonal surface is flat and coarsely punctate as if due to weathering. Color is white, lightly maculated with rose or purple. The figure is a photograph of the right valve of a specimen from the Hanley collection in the British Museum (Natural History), marked co-type. The specimen measures length 49.7 mm., height 39.1 mm.

Range—Galapagos Islands.

Semele tortuosa (C. B. Adams)

Plate 64, figures 3-3b

Amphidesma tortuosum C. B. Adams, 1852, Ann. Lyceum Nat. Hist. New York, vol. 5, pp. 515, 547, No. 490.

Shell irregularly trigonal-ovate, compressed, the beaks high, submedian, subequilateral, triangular above, rounded, subcircular below. The posterior side is widely folded and twisted in each valve resulting in a median fold bordered by two lateral depressed rays in the right valve and a corresponding depressed, central furrow in the left valve. Surface sculptured principally by waved, strong, concentric riblets thickly overrun by submicroscopic radial threads. External color yellowish white, the interior also white or stained with light yellow. The dorsal margin and hinge teeth may be white or lilac-colored.

Length 45.1 mm., height 40.9 mm., semidiameter 7.3 mm. right valve, Puerto Callo, Ecuador.

Length 62 mm., height 56.2 mm., semidiameter 12.4 mm. right valve, Palo Seco, Panama Canal Zone.

This is a rare species, as yet known only from a few loose valves. In shape and sculpture, this species resembles *S. decisa* (Conrad) of California but differs in detail.

Range—Panama to Ecuador. Panama Canal Zone: Palo Seco. Ecuador: Palmar; Puerto Callo; Manta; Sua.

Semele verrucosa Mörch

Plate 65, figures 1-1b

Semele (Amphidesma) verrucosa Mörch, 1860, Malak. Blätter, bd. 7, p. 190 Los Bocorones Islands, Costa Rica.

Semele verrucosa Mörch, Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 4, p. 249, pl. 1, figs. 21, 24.

Shell of medium size (average length 35 to 45 mm.), broadly ovate, the two ends almost equally rounded, inequilateral, the beaks flattened, high, and placed on the posterior side of the middle, the general base color white radially blotched with purple, most heavily near the ventral margin. Sculpture is formed by coarse, concentric riblets which on the anterior and posterior ends become irregularly wrinkled, often splitting up into small segments which resemble a series of small, scalelike nodes, all finely wrinkled on their ventral sides. Interior glossy, white, mottled with purple, the cavity itself often stained yellow.

Length 54.8 mm., height 42.7 mm., diameter 20.6 mm. Pearl Islands (Mr. Lee R. Beil collection).

A rare species. Similar in shape and color to *S. formosa* but the valves are less convex, the concentric riblets coarser and at the ends curiously scalloped or frilled.

Range—Gulf of California to Panama. Mexico: Gulf of California. Costa Rica; Bocorones Islands (Mörch). Panama: Hannibal Banks (Hertlein and Strong); Pearl Islands (Lee R. Beil coll.).

Semele rosea (Sowerby)

Plate 64, figure 8

Amphidesma roseum Sowerby, 1833, Proc. Zool. Soc. London for 1832, p. 199 Tumbes. —Sowerby, 1833, Conch. Illust., pl. 17, fig. 1.—Reeve, 1853, Conch. Icon, vol. 8, *Amphidesma*, pl. 3, fig. 17.

Semele junonia Verrill, 1870, Amer. Jour. Sci., ser. 2, vol. 69, No. 146, p. 217 near La Paz.—Lamy, 1914, Jour. de Conchy., vol. 61, No. 3, pp. 356, 357 as a var. of *rosea*.—Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 4, p. 245.

Semele tabogensis Pilsbry and Lowe, 1832, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, pp. 91, 92, pl. 12, figs. 5, 5a, 5b (Taboga Island, amongst rocks).—Maxwell Smith, 1944, Panamic Marine Shells, p. 63, fig. 800.

The shell is relatively large, thin, broadly ovate in shape, compressed to moderately convex, slightly inequilateral, the beaks nearly central, the posterior submargin weakly flexed forming an impressed area with more subdued sculpture. The anterior side is somewhat longer, broadly rounded, the posterior shorter, straight, subtruncated at the end. The sculpture is formed by regular, concentric, thin-edged, recurved, lamellar riblets, separated by wider interspaces with fine, weak, radial striations. Color is a light, rose-pink shading into apricot or yellow, the beaks always much darker, the interior with the same shade of color. In life, the surface is covered with a thin, light-brown periostracum.

Length 60.2 mm., height 51.5 mm., semidiameter 10 mm. (Búcaro, Panama).

Length 63.7 mm., height 54.2 mm., diameter (both valves) 24 mm. Venado Beach, Panama Canal Zone.

Semele rosea tabogensis Pilsbry and Lowe

Plate 64, figure 7

The shell is somewhat more obliquely subovate in shape than the typical form, its posterior side longer, the posterior-dorsal margin straighter, more descending and the surface coloration more uniform.

S. rosea and its subspecies *tabogensis* are lovely shells distinguished

by their rose-red color and sharp, rasplike sculpture. The right valve is slightly more convex, the anterior and posterior margins more expanded and overlapped by the margins of the left valve. The species is closely allied to *S. leana* Dall from the Pliocene of southern Florida.

Range—Peru to Mexico. Panama: Búcaro. Panama Canal Zone: Venado Beach. Ecuador: Manta. Peru: Tumbes.

Semele sowerbyi Lamy

Plate 65, figures 7, 7a

Amphidesma purpurascens Sowerby, 1833, Proc. Zool. Soc. London for 1832, p. 199 "St. Elena, W. Col."—Sowerby, 1833, Conch. Illust., pl. 18, fig. 5.—Reeve, 1853, Conch. Icon., vol. 8, *Amphidesma*, vol. 8, pl. 6, fig. 37. (Not *Venus purpurascens* Gmelin, 1792. (*Semele*).

Semele sowerbyi Lamy, 1912, Bull. Mus. Nat. Hist. Paris, vol. 18, No. 3, p. 165 footnote.—Lamy, 1914, Jour. de Conchyl., 4th ser., vol. 61, pp. 328, 352 footnote. (New name to replace *S. purpurascens* (Sowerby), 1833, not *S. purpurascens* (Gmelin), 1792, an Atlantic species).—Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 4, p. 248 (footnote).

Shell subovate to subelliptical, the dorsal side low trigonal with nearly median beaks, the ventral side broadly rounded. Valves are nearly similar and subequilateral, the posterior side slightly narrower with an impressed, slightly flexuous dorsal area, the end subtruncate. Sculpture formed by numerous, small, thin concentric lamellae or ridges evenly spaced between flattened interspaces, the edges of the lamellae and their interspaces are minutely, radially striate. Color generally in shades of violet or purple, lighter ventrally and deeper on the umbones, the tip of the beak usually marked with a white streak. Interior white flushed with purple.

Length 47 mm., height 36.3 mm., diameter 13 mm. San Jose Islands, Pearl Island, Panama. USNM 588133

Length 44.3 mm., height 36.5 mm., semidiameter 4.5 mm. a right valve, Manta, Ecuador.

This is a rare and imperfectly known species. Specimens from Panama have a higher and more ovate shape than those from Ecuador. The species is closely related to *S. perlamellosa* Heilprin from the Pliocene of southern Florida.

Range—Panama to Ecuador. Panama: San Jose Island (Pearl Islands), Coll. J. P. E. Morrison, USNM 588133. Ecuador: Suya; Manta; Santa Elena.

Semele jovis (Reeve)

Plate 66, figure 12;
Plate 85, figure 7, 7a

Amphidesma jovis Reeve, 1853, Conch. Icon., vol. 8, *Amphidesma*, pl. 5, fig. 34. Hab. ---? *Tellina barbara* Boone, 1928, Bull. Bingham Oceanogr. Coll. Peabody Museum, Yale University, vol. 2, art. 5, p. 9, pl. 1, upper figure Pearl Islands.

Semele jovis (Reeve), Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 4, No. 19, pp. 244, 245.—Hertlein and Strong, 1955, Bull. Amer. Mus. Nat. Hist., vol. 107, art. 2, pp. 201, 202.

Shell subovate to subelliptical, weakly convex. Valves subequal and subequilateral, with nearly median flattened umbones and small beaks, the posterior side differing from the anterior by its slightly narrower form and weaker flexure. Surface sculptured over the whole disk with small, closely spaced, raised lamellae with minute, radial lineation present in their interspaces on the anterior slope. Color white to a pinkish brown, the umbones orange to red, usually with a small, white streak across them. Interior white, with a well-rounded pallial sinus, often brown in the middle.

Length 58.1 mm., height 49.4 mm., diameter 23.2 mm. Holotype, British Museum (Natural History).

Length 66.7 mm., height 56 mm., diameter of a single valve 11.5 mm.

This may be a race or subspecies of *S. sowerbyi*, most common to the north of Panama, and distinguished by its somewhat rounder form, finer sculpture, and lighter color, often white.

Range—Gulf of California to Panama. Mexico: Kino Bay. Costa Rica: Port Parker (Hertlein and Strong). Panama: Isla del Rey, Pearl Islands. (Hertlein and Strong).

Semele pilsbryi, new species

Plate 65, figures 6, 6a

Shell of medium size, obliquely subovate, the beaks high and trigonal in shape, the lunular area deeply excavated, depressed or of medium convexity. Sculpture formed by flattened radial riblets of variable width, separated by lined interspaces, the whole surface in addition coarsely granulose (fig. 6a). A flattened escutcheon is present in the left valve. Surface color a dirty, cream white, the interior apricot except for the hinge teeth which are dark coral red.

Length 45.5 mm., height 42.4 mm., diameter 10 mm of a left valve. Búcaro, Panama. Holotype, ANSP 218959.

Known only from a left valve but easily distinguished from all other Panamic *Semele* by its sculpture and coarsely granulose surface. Named in tribute to the late Dr. H. A. Pilsbry of the Academy of Natural Sciences of Philadelphia.

Range—Panama. Panama: Búcaro.

Semele pacifica Dall

Plate 65, figure 3

Semele pacifica Dall, 1915, Proc. Acad. Nat. Sci. Philadelphia, vol. 61, p. 27.—Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 4, No. 19, pp. 245, 246, pl. 1, fig. 11 type. Off La Paz, Lower California.

Shell of medium size (length about 26 mm.), relatively thin, obliquely subovate, depressed, strongly inequilateral, the anterior side longer, obliquely rounded at the end, the shorter, narrower posterior side having a weakly depressed, flexuous dorsal area, subtruncated at the end. Sculpture consists of numerous, rather strong, radial riblets with narrower interspaces developed over the whole disk, finely and sharply noded by the intersection of concentric ridges. The radial riblets are coarser on the ends, scabrously noded on the posterior slope. General color of the surface is a buff or cream, lightly variegated with zigzag lines of purple.

This is a beautiful species, closely similar to *S. bellastrata* of eastern United States. In its typical form, the sculpture is finely cancellate over the whole disk. On the umbones, the radials are mainly developed in the concentric interspaces but ventrally cut deeply into the concentrics, their intersections finely beaded.

Range—Gulf of California to Panama.

Semele pulchra (Sowerby)

Plate 65, figure 5

Amphidesma pulchrum Sowerby, 1832, Proc. Zool. Soc. London, p. 57. (Sinu Caraccensi, Americae Meridionalis. = Bahía de Caráques).—Sowerby, 1833, Conch. Illust., sp. No. 2, pl. 17, fig. 2.

- Amphidesma pulchra* Sowerby, Reeve, 1853, Conch. Icon., vol. 8, *Amphidesma*, pl. 1, fig. 2.
- Amphidesma striosum* Turner, 1956, Occas. Papers on Mollusks, Mus. Comp. Zool., vol. 2, No. 20, p. 90, pl. 18, figs. 1, 2. (not *A. striosum* C. B. Adams).
- Semele pulchra* (Sowerby), Maxwell Smith, 1944, Panamic Marine Shells, p. 62, fig. 810.—Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 4, No. 19, p. 246, pl. 1, fig. 15.

Shell small or medium-sized, solid, ovate-elliptical, the beaks small, trigonal and placed a little behind the middle, the anterior side hence longer and narrower, its dorsal margin descending with both ends evenly and broadly rounded. The posterior end is weakly flexed. The surface is sculptured with fine, close, concentric riblets, sometimes a little oblique in the middle zone; these concentrics are uniformly developed over the whole disk except on the posterior slope where they are lacking while on the anterior slope, the concentrics are cut through by a set of fine radial grooves. Escutcheon long, narrow, and flattened, the lunule smaller and deeply impressed, both are generally colored a deep purple. Color white, cream or yellowish gray, the interior white except the hinge and inner cavity which may be blotched with purple.

A specimen measures: Length 27.6 mm., height 23.1 mm., diameter 5.5 mm.

Range—Nicaragua to northern Peru. Costa Rica: Puntarenas. Panama: Búcaro. Panama Canal Zone: Palo Seco. Ecuador: Bahia de Caraquez (Cuming). Peru: Zorritos.

Semele guaymasensis Pilsbry and Lowe

Plate 65, figure 4;
Plate 66, Figure 6

Semele guaymasensis Pilsbry and Lowe, 1932, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, p. 92, pl. 12, figs. 8, 9 "Guaymas".—Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 4, No. 19, pp. 243, 244.

Shell irregularly ovate, nearly equilateral, compressed to slightly convex; dorsal margin slightly convex behind, straight, and somewhat lower in front of the beaks. Posterior-dorsal slope slightly depressed and flexuose, its end somewhat squarely truncated, the posterior end well rounded. Sculpture consists of strong, concentric, rounded ridges between slightly wider interspaces, the concentrics often irregular and waved, especially over the anterior slope where they are intersected by radial grooves, usually seven in number, and in addition finely wrinkled by growth threads. The escutcheon is narrow and flat, marked with growth lines only, and often colored a fine purple. The lunule is much smaller, depressed, an outside bordering area wider. The pallial sinus is large and deep. The interior is white or cream-colored, often with a staining of purple in the umbonal cavity. Surface is usually colored with cream or buff, faintly mottled or rayed with purple, the dorsal border and hinge teeth a deeper purple.

A specimen measured, length 27.3 mm., height 22.7 mm., diameter 12.4 mm. Palo Seco, Panama Canal Zone.

Another specimen, length 24.5 mm., height 18.7 mm. USNM 557879.

Similar to *S. venusta* but shorter and with strong, radial grooves on the anterior-dorsal margin, lacking or less strongly developed on the posterior dorsal margin. The lunule and escutcheon are generally stained deep purple.

Range—Gulf of California to Panama. Mexico: Guaymas; Punta Penasco. Panama Canal Zone: Palo Seco.

Semele venusta (Reeve)

Plate 66, figures 1, 1a

Amphidesma venusta Reeve, 1853, Conch. Icon., vol. 8, *Amphidesma*, pl. 1, fig. 3 West
Columbia.—A. Adams, 1854, Proc. Zool. Soc. London for 1853, p. 96.

Semele venusta (Reeve), Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 4, No. 19, pp.
248, 249, pl. 1, fig. 13.

Shell of medium size (31 mm., or less), obliquely oblong-elliptical, moderately convex, the beaks high, placed a little behind the middle, the anterior side hence much longer, its dorsal margin straight. Posterior side wide, its surface impressed. Sculpture is produced by small, rounded, close-set, concentric riblets between grooved spaces; on the right valve, the riblets may divide as they pass over the posterior slope, while on the left valve, the riblets in the same position are weak or obsolete. The pallial sinus is large, and reaches almost to the anterior adductor scar. The surface color is usually white or pale violet rayed with yellow; interior white or stained lightly with purple.

Length 30.8 mm., height 24 mm., diameter 12.3 mm. Palo Seco, Panama Canal Zone.

Much like *S. guaymasensis*, with which it often occurs, but is longer and lacks the radial grooves on the dorsal submargins.

Range—Coast of Mexico to northern Peru. Mexico: Santa Cruz and Tangola-Tangola Bays (Hertlein and Strong). Panama: Pearl Islands. Panama Canal Zone: Palo Seco: Ecuador: Manta; Puerto Callo. Peru: Punta Picos.

Semele margarita, new species

Plate 66, figure 3

Shell relatively small, oblong, the beaks placed a trifle anterior of the middle, the two ends evenly rounded, depressed, rather solid. Dorsal areas not defined. Sculpture is coarsely cancellate, consisting of strong, evenly spaced concentrics, crenulated by irregular radial lines. Color white or weakly tinted with red along the dorsal margin.

Length 14.1 mm., diameter 11.5 mm., diameter of a right valve 2.4 mm. Holotype, PRI 25935.

Somewhat similar to *S. pacifica* but with coarser cancellation and higher, more ovate shape.

Range—Panama: West side of Rey Island, Pearl Islands.

EXTRALIMITAL SPECIES

Semele mediamericana Pilsbry and Lowe=***S. proficua*** (Pulteney) (***reticulata*** Reeve)

Semele mediamericana Pilsbry and Lowe, 1932, Proc. Acad. Nat. Sci. Philadelphia, p. 92, pl. 12, figs. 1, 1a, 2.

Described as a Pacific species from Nicaragua (collected by MacNeil), the specimen evidently came from the Caribbean coast. Holotype, ANSP 53295.

Genus **CUMINGIA** Sowerby, 1833

Type species by subsequent designation, Gray, 1847, *C. lamellosa* Sowerby. Panama-Pacific faunal province.

Shell free or as a nestler in crevices or abandoned burrows, sometimes

under rocks, hence variable in shape and often much distorted. Sculpture is produced principally by concentric growth lines, often lamellose, their interspaces flat and wide, and finely striated with submicroscopic radial lines. Ligament with both external and internal elements, the resilium attached to a large, prominent, cup-shaped chondrophore developed equally in both valves. Hinge plate wide and stout, bearing the median chondrophore and bordered by strong, lateral teeth developed principally in the right valve. The cardinal teeth are small and weak (there is a small lamellar tooth (or its socket) on the anterior side of the chondrophore). There is a small, smooth lunule and an escutcheon (largest in the left valve). Pallial sinus large, confluent with the pallial line below.

Some species of *Cumingia* are nestlers and live in confined or crowded quarters, hence, their shells are commonly distorted and irregular in shape; other species with more normal shells, lived in open situations as buried in mud or attached by their byssus to worm tubes and the like. Three species of the genus are noted in this work, but the status of some named forms is not well understood.

Key to Panamic-Pacific species of *Cumingia*

I. Valves coarse, generally distorted and with strong, concentric surface sculpture.

C. lamellosa

II. Valves thinner, normal in shape. Surface lamellae rather fine, their interspaces with minute, radial striae.

a. Shell large (20 mm., or more), depressed, or convex. Peruvian.

C. mutica

b. Valves smaller and generally convex. Panamic.

C. adamsi

Cumingia lamellosa Sowerby

Plate 66, figures 10, 10a;
Plate 67, figures 3, 3a

Cumingia lamellosa Sowerby, 1833, Proc. Zool. Soc. London, p. 34. Found at Payta in hard clay at low water; and at Panama in deep water.—Sowerby, 1873, Conch. Icon., vol. 19, *Cumingia*, pl. 1, fig. 5.—Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 4, No. 19, pp. 250, 251.

Cumingia coarctata Sowerby, 1833, Proc. Zool. Soc. London, p. 34. Hab. ad Sinum Caraccensem.

Cumingia trigonularis Sowerby, 1833, Proc. Zool. Soc. London, p. 35. Hab. ad Sanctam Elenam.—Sowerby, 1873, Conch. Icon., vol. 19, *Cumingia*, pl. 1, fig. 4.

Shell white, moderately coarse and heavy, oblong but often distorted, length to about 22 mm., but generally smaller. The umbones and beaks are nearly median, the anterior side rounded and expanded; on the posterior side, the dorsal margin descends forming an obliquely angled or obtuse end at the ventral corner. Sculpture is produced by raised, concentric lamellae or lines which when well formed are regular and widely spaced. Hinge coarse, the lateral teeth prominent.

Similar to *C. californica* Conrad (Plate 40, figs. 3, 3a) but has a smaller and thinner shell. *C. lamellosa* is found living buried in sand, clay or along fissures in rock; hence the shape of the shell may be irregular and the strength of the concentric lamellae variable.

Range—Gulf of California to northern Peru. For some northern records see Hertlein and Strong. Panama: Panama City; Pedro Gonzales Is. (Pearl

Islands), USNM 588410. Colombia: Isla del Gallo. Ecuador: Santa Elena. Peru: Paita.

Cumingia mutica Sowerby

Plate 66, figure 4

Cumingia mutica Sowerby, 1833, Proc. Zool. Soc. London, p. 34.—Sowerby, 1873, Conch. Icon., vol. 19, *Cumingia*, pl. 1, fig. 3 Chile, Peru.

Subtrigonal, white, nearly equilateral, if normal, the umbones high, median, with pointed, slightly prosogyrate beaks. Anterior side widely rounded, fairly convex along the umbonal slope, the posterior end obtusely rounded. Sculpture formed by fine, threadlike concentrics between wider interspaces, the surface of which is minutely radially striate. A large specimen measures: Length 19.8 mm., height 16 mm., semidiameter 5.1 mm.

A thinner, usually less distorted and more finely sculptured species than *C. lamellosa*. Specimens from northern Peru are much smaller than from further south.

Range—Ecuador to Chile. Peru: Paita; Callao.

Cumingia adamsi Carpenter

Plate 67, figures 6, 6a

Cumingia—sp. indet. c. C. B. Adams, 1852, Ann. Lyceum Nat. Hist. New York, vol. 5, p. 512, No. 483. 1 valve, Panama.

Cumingia adamsi Carpenter, 1863, Proc. Zool. Soc. London, p. 367.—Carpenter, 1872, reprint, Smith. Misc. Coll., No. 252, B. p. 203, No. 483.

483. *Cumingia* sp. ind. c. M. 45. This appears a distinct species and may be quoted as *C. adamsi*, in remembrance of the labours of Messers. H. A. and C. B. Adams. (Carpenter, 1863.)

The original specimen has never been figured or adequately described but through the kindness of William J. Clench of the Museum of Comparative Zoology, Harvard, I have been able to examine and photograph the type, a picture of which is given here.

Shell small or of medium size, thin, white, obliquely trigonal-ovate, convex, with small, nearly median, erect beaks. Anterior side impressed below the beaks and with a nearly circular marginal outline; the posterior-dorsal margin descending to form a narrowly rounded or blunt posterior end. Surface marked with fine, rather widely and evenly spaced, concentric lamellar lines, the space between each pair ornamented with fine radial striae which on the anterior-umbonal slope divaricate or fan out rather sharply towards the margin; on weathering, the surface appears almost smooth. Pallial sinus large and deep, its upper limb not reaching to the anterior adductor scar, coalescent with the pallial line below. Hinge normal, the lateral teeth small.

Length 9.6 mm., height 8.1 mm., thickness of one valve, 2.2 mm. Holotype, a left valve MCZ 203763. Panama.

Length 16.6 mm., height 12.7 mm., thickness of one valve 4.2 mm. Jaramijo, Ecuador, mud flats.

The type is slightly worn so that its surface appears nearly smooth, but the fine radial striae are visible along the anterior-umbonal slope. The species is distinguished by its regular, undeformed shell, and characteristic sculpture.

Range—Panama to Ecuador. Panama: Panama (C. B. Adams). Colombia: Isla del Gallo. Ecuador: Jaramijo.

Genus *ABRA* Lamarck, 1818

Type species by monotypy, *Mactra tenuis* Montagu. Recent, European Seas.

Shell small or of medium size, generally subtriangular to subquadrate, the posterior end narrower and shorter, often weakly flexed at the end, the valves moderately convex. Surface sculptured principally with growth lines. External ligament narrow, attached along the upper surface of a small, nymphal ridge which separates it from the larger, elongated internal chondrophore lying along the posterior side of the hinge plate. Hinge armature weak; the right valve has two cardinal teeth and generally two, lateral laminae; the left valve has a single, strong, cardinal tooth and traces of a second, the lateral teeth weak or absent. The pallial sinus is large, widely confluent with the pallial line below.

In this genus, the hinge is like that of *Semele* but with smaller cardinal teeth, sometimes much reduced or vestigial. Valves are generally inequilateral, the anterior side generally well rounded. Surface smooth or with fine, concentric growth lines and covered with a thin periostracum, silky or faintly iridescent.

Abra tepocana Dall

Abra tepocana Dall, 1915, Proc. Acad. Nat. Sci. Philadelphia, vol. 67, p. 28.

Abra palmeri Dall, 1915, *op. cit.*, vol. 67, p. 28. Ballenas Lagoon on the west coast of Lower California; Panama Bay, the type locality.—Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 4, No. 19, p. 250, pl. 1, figs. 16, 18, 20, 23.

Shell small or of medium size, short, high, moderately convex. Anterior side longer, rounded at the end, the posterior side shorter, its dorsal margin descending more rapidly into a rounded end. The valves are thin, delicate, subequal, white, the surface marked with fine growth lines. Pallial sinus large, deep, reaching beyond the middle of the cavity, rounded, widely confluent with the pallial line below. My largest specimen about 12 mm.

This species is the Pacific analogue of the West Atlantic *A. lioica* Dall. The name "*A. palmeri* Dall" was apparently given to the mature form.

Range—Gulf of California to northern Peru. Panama: Búcaro. Panama Canal Zone: Venado Beach. Ecuador: Santa Elena; Ancon. Peru: Tumbes; Zorritos.

Abra pacifica Dall

Abra pacifica Dall, 1915, Proc. Acad. Nat. Sci. Philadelphia, vol. 67, p. 28 "Guaymas, Mexico."

Shell small, thin, white, finely concentrically sculptured, giving to the surface a silky look; the concentric lines slightly prominent on the dorsal side of the posterior side. Beaks not prominent, slightly anterior; outline elongate, attenuated and pointed behind, rounded in front; with only faint traces of radial striae or none. Hinge normal, right cardinal tooth bifid, anterior right laterals stout, very short, posterior feeble, longer; left valve with a bifid cardinal and no laterals. Pallial sinus obscure.

Length 9 mm., height 5.5 mm., diameter 3.0 mm. (Dall, 1915.)

This is a small, elongate-ovate shell, thin, with nearly median beaks, and a pointed posterior end, a trifle longer than the anterior which is widely rounded. In shape, this small shell is strikingly like *Leptomya americana*, and possibly may be merely the young of that species, but the right valve is provided with a set of weak lateral teeth and the resilifer is larger, *Cumingia*-like in shape. The species is known only by the type.

Range—Mexico. Mexico: Guaymas.

Genus *LEPTOMYA* A. Adams, 1864

Type species by subsequent designation, Stoliczka, 1871, *Neaera cochlearis* Hinds. Recent, Japan, Philippines.

The shell is generally elongately triangular with elevated pointed beaks, the anterior end rounded, the posterior side pointed at the end. Ligament largely internal, the resilifer in the shape of posteriorly directed groove or pit in the hinge plate, not projecting below it. Hinge with cardinal teeth only; one in the left valve, two small ones in the right. Pallial sinus large, its lower limb confluent with the pallial line. Surface plain or with growth-line striation.

Leptomya differs from *Abra* by the generally larger size of its representative species, its more triangular shape, the absence of lateral teeth and by its simple, grooved resilifer which does not project below the hinge plate. Its species are mainly distributed in the western Pacific. (Japan, Philippines, Australia.) A single species is now known from the eastern Pacific.

Leptomya ecuadoriana Soot-Ryen

Plate 66, figure 5;
Plate 67, figure 5

Leptomya ecuadoriana Tron Soot-Ryen, 1957, Lunds Universitets Årsskrift. N. F. Avd. 2, Bd. 53, nr. 10, pp. 10, 11, fig. 2 Puna, outside Guayaquil, Ecuador, 8 fms., clay.

Leptomya americana A. Keen, 1958, Bull. Amer. Paleont., vol. 38, No. 172, p.246, pl. 30, figs. 9, 10; pl. 31, figs. 3, 5, 6.

The shell is of medium size (average about 30 mm.), obliquely ovate-triangular in shape, *Macoma*-like, thin, white, subequivalve, the posterior end somewhat pointed, the beaks nearly median. The anterior side is higher, inflated or convex across its umbonal slope, its dorsal or lunular submargin somewhat impressed, its end broadly rounded. The posterior side is much narrowed, appearing slightly attenuated, weakly twisted and bluntly pointed at the end, but not longer than the anterior side. Surface of shell is white, usually showing a dull luster which under the lens is found to be due to a thin, chalky, outer layer covered in exceptionally well-preserved specimens with fine granules; under this outer layer (usually destroyed by wear in beach specimens), the surface is smooth, with the growth lines showing indistinctly. Pallial and muscle impressions show indistinctly, but the pallial sinus is large, highest under the beak, rounded in front, not reaching to the anterior adductor scar and united below with the pallial line for three-fourths of its length. The right valve has two small cardinal teeth directly under the beak, the left valve with one; no lateral teeth.

Length 29.3 mm., height 20.1 mm., diameter 10.6 mm. Puerto Pizarro, Peru.

This recently described species is widely distributed and fairly common in its proper environment, mostly on mud flats near mangrove swamps. Fresh shells have a slightly frosted surface due to minute granules, most heavily developed over the posterior slope but beach specimens are generally smooth due to wear.

Range—Panama to northwestern Peru. Panama: Garachine on San Miguel Bay. Colombia: Isla del Gallo. Ecuador: Esmeraldas. Peru: Puerto Pizarro at the mouth of the Tumbes River.

Genus *SEMELINA* Dall, 1900

Type species by original designation, *Semelina nuculoides* (Conrad). Miocene and Recent. Southeastern coast of the United States.

The shell is small, nuculiform, elliptical, with the posterior side much shorter than the anterior. The hinge is characterized by the strong, lateral sockets in the right valve, the left valve without distinct, lateral teeth, the dorsal margins fitting into the opposite sockets; each valve has a central, bifid cardinal tooth, the resilifer or attachment scar of the internal ligament behind them. Surface sculptured with close, concentric threads.

This is a genus of small shells belonging to several species, common and widely distributed in the western Atlantic. A single species known from the Pacific zone.

Semelina subquadrata (Carpenter)

Plate 66, figure 11

?*Montacuta subquadrata* Carpenter, 1857, Cat. Mazatlan Shells, Brit. Mus., p. 113, sp. 162.

Shell small, seldom above 5 mm., ovate-elliptical, relatively solid, and of low but uniform inflation. Umbones low, ending in small, acutely pointed, opisthogyrate beaks accentuated by a pronounced flattening or excavation of the posterior dorsal margin below them. Hinge as normal for the genus, the lateral sockets of the right valve being strong. Pallial sinus large, rounded, almost reaching to the anterior adductor, below the lower limb of the sinus is about half confluent with the pallial line which as a simple line extends well beyond its junction. Color generally white, more rarely flushed with apricot-pink. Sculpture over most of the anterior and middle surface of the valves is formed by even, close-set, threadlike concentrics but on the posterior umbonal slope, the alternate threads end sharply, the others increasing in strength, the resulting sculpture, thereby, becoming finely lamellose.

Length 5.3 mm., height 3.8 mm., diameter 1 mm. (a left valve).

This species is closely similar to the West Atlantic, *S. nuculoides* Conrad.

Range—Mexico to Colombia. Mexico: Mazatlan (Carpenter). Panama: El Lagartillo; Puerto Mensabi; Pearl Islands. Colombia: Isla del Gallo.

Family TELLINIDAE

The shell varies much in shape and size with narrowly elongated to broadly orbicular valves, generally inequilateral, the anterior side being the longer. Valves are usually unequal, the left valve typically the larger, more strongly convex, the posterior side often narrow and produced, and

frequently strongly flexed towards the right. The umbones are usually wide and flat, the beaks small, inconspicuous, adjacent, and prosogyrous. The ligament is external, usually attached to a narrow nymph, or, in groups with a concentrated hinge, the resilifer may lie somewhat deeper in the hinge plate. Hinge with one or more cardinal teeth, simple or bifid, the lateral teeth may be large and strong or wholly absent. The pallial sinus is usually large and ample, its upper limb sometimes extending across the interior of the valve to contact with the anterior adductor scar, or it may be shorter with a well-rounded end. External surface is smooth with growth-line sculpture only, or it may be more strongly marked with concentric ribs, obliquely incised lines, more rarely with radials. Inner margins of the valves usually smooth.

Most Tellinas are marine although some species can tolerate fairly brackish water conditions. The largest and finest species of the family are tropical and many species are showy with fine color, usually in tones of red, pink, yellow or violet; northern species have usually more somber tints, often with a chalky surface protected by a coarse periostracum. The shape is variable, some species have strongly flexed valves.

A satisfactory classification of the Tellinidae remains to be worked out as it should be based on a world-wide study of the shells, both Recent and fossil, as well as on the soft anatomy. In this review of the Panamic-Pacific species, I have followed Dall in placing the genera in two subfamilies based on the presence or absence of lateral teeth. This arrangement is unnatural as it brings together genera which in other respects do not appear closely related.

Key to the genera of Panamic Tellinidae

- I. *Hinge bearing both cardinal and lateral teeth* Tellininae
- A. Anterior and posterior lateral teeth are strong, equidistant, and placed some distance from the cardinals.
- AA. Valves narrowly to broadly elongated, sublanceolate, inequilateral, the *posterior side shorter, narrower, often rostrated and strongly flexed* towards the right.
1. Surface with strong concentric sculpture. Genus *Tellina*
- AB. Valves elongately subovate to subquadrate, the *posterior side generally but little flexed*.
2. Valves subovate in shape, both ends rounded, the posterior-dorsal area not defined. Sculpture showing radial riblets on the posterior slope. Genus *Elliptotellina*
3. Valves subquadrate in shape, the posterior-dorsal area well defined. Sculpture formed by strong, often lamellose concentrics, generally enlarged and foliated along the posterior-dorsal margin. Genus *Phyllodina*
- AC. Valves higher, subovate to subtrigonal in shape.
- a. *Posterior-dorsal area well defined*, set apart by a ridge or by a marked change of sculpture.
4. Valves elliptical in shape and marked with strong, concentric sculpture. Posterior side rounded, not extended into a beak. Genus *Lyratellina*

5. Valves smaller, unequal, usually with strong sculpture. Posterior end pointed, or produced into a short beak.

Genus *Merisca*

- b. *No differentiated posterior-dorsal area.*

6. Valves trigonal, unequal, the dorsal margin serrated or toothed. Surface marked with wavelike, concentric undulations.

Genus *Tellidora*

- AD. Valves rounded, subequal, convex or depressed.

7. Sculpture formed by *oblique* and *generally divaricated* or *sharply flexed lines*.

Genus *Strigilla*

- B. Right valve with the *anterior lateral tooth placed near or against the cardinal tooth*.

- BA. The ligament is wholly external, attached to a narrow, cross-striated scar.

- c. A posterior-dorsal area present, defined by its impressed surface, stronger sculpture and bordered by an angle or line.

- ca. Shell elongately subquadrate or subelliptical in shape, compressed or slightly convex, the anterior side longer and more rounded, the posterior side sloping and somewhat flexed.

8. Shell usually large, (generally over 25 mm. in length), surface smooth or marked with evenly spaced incised lines or concentric sulci.

Genus *Eurytellina*

9. Similar but with a fine, reticulate sculpture.

Genus *Tellinidella*

- cb. Shell small, usually less than 25 mm. in length.

10. Surface smooth or with fine, concentric lines, or, as in the subgenus, *Scissula*, with fine, incised lines cutting across the concentrics obliquely.

Genus *Moerella*

11. Shell subtrigonal to subovate, thin, subequivalve, the anterior side expanded and convex, the posterior side shorter, sloping and pointed. Surface smooth.

Genus *Elpidollina*

- d. Posterior-dorsal area not well defined. Shell subquadrate in shape, *Sanguinolaria*-like.

12. Surface relatively smooth but generally with faint, oblique, incised lines across the middle.

Genus *Hertellina*

- BB. Ligament partly internal, the resilifer section short and partly immersed in the hinge plate.

13. Large or medium-sized, relatively thin. Color white with a yellowish or ochraceous tinge.

Genus *Scrobiculina*

- II. *Hinge with cardinal teeth only.* Macominae

- C. Color a dull white, the surface often earthy or chalky, and covered in life by a coarse, dark-colored periostracum.

14. Shell subovate in shape, the posterior side shorter, pointed, and generally flexed. Northern.

Genus *Macoma*

- D. Color a more brilliant white, the surface smooth and polished. Periostracum thin and light in color.

- Da. Adductor scars of unequal size and shape, the anterior scar is longer and narrower than the other.

- e. Valves with a deep, folded, posterior flexure forming a large, widely expanded or winged posterior area.

15. Shell broadly subovate in shape, growth-line sculpture coarsely wrinkled.

Genus *Florimetus*

- f. Posterior flexure smaller, the posterior area itself narrow, not expanded or winged.

- fa. Ligament entirely external, slender, attached to a narrow scar; no nymphal ridge.

16. Like *Macoma*, s.s. in shape, subovate, the posterior side short. Caribbean.

Genus *Austromacoma*

- fb. Ligament partly internal, the resilifer scar short, triangular in shape, immersed in the hinge plate and pressed against the cardinal tooth.

17. Shell elongate, tellinoid or tagelloid, the posterior side much shorter than the anterior, usually weakly flexed.

Genus *Psammacoma*

18. Shell elongate, tellinoid or subtriangular, generally flexed, the posterior side narrowly rounded or truncated at the end.

Genus *Psammotreta*

19. Shell in shape like *Sanguinolaria*, depressed, the flexure weak or absent, the posterior-dorsal area small, the end pointed.

Genus *Ardeamya*

- Db. The adductor scars nearly equal in size.

- g. Surface marked with strong, wavelike undulations.

20. Shell small, lediform, its posterior end strongly flexed.

Genus *Cymatoica*

- h. Surface smooth or with the usual concentric lines.

21. Shell in shape like *Psammobia* (*Gobraeus*), oblong, subquadrate, equi-valve, the posterior side wide, and not flexed. Surface smooth and usually marked with obliquely trending, incised lines across the middle and anterior portions of the disk.

Genus *Psammothalia*

Subfamily TELLININAE

Shell narrowly or broadly lanceolate to ovate in shape, the posterior side generally shorter and often strongly flexed towards the right, hence, the valves are usually unequal, the left one larger and more convex, the right often depressed across the middle. Hinge provided with both cardinal and lateral teeth. Surface sculptured with concentrics, generally heavier on the rostral areas.

Genus **TELLINA** Linné, 1758

Type species by subsequent selection, Lamarck, 1799, *Tellina virgata* Linné. Indo-Pacific.

Lamarck's citation of only one species as illustrating the characteristics of each genus discussed in the Prodom is considered a valid type designation.¹³

Shell more or less elongate, the posterior side narrowed and produced, flexed strongly to the right, and carrying a differentiated rostral area. Surface sculptured with raised or rounded concentrics usually becoming coarser and scabrous on the rostral area. Hinge fully formed; there are two cardinal teeth in each valve, one of which is bifid with bordering sockets;

¹³Olsson, A.A., Harbison, A., and others, 1953, Mon. Acad. Nat. Sci. Philadelphia, No. 8, p. 121.

the left valve has two small, distinct lateral teeth (mainly enlargements of the valve margins) which fit into two, strong, lateral sockets in the right valve; the lower edge of each lateral socket in the right valve is enlarged and toothlike but these are merely subsidiary thickenings, since there are no sockets opposite them in the left valve for their insertion. The pallial sinus is large and deep but does not reach across to the anterior adductor scar; its lower limb is partially confluent with the pallial line below.

Tellina (*Tellina*) *cumingii* Hanley

Plate 68, figure 13;
Plate 69, figure 3

Tellina cumingii Hanley, 1844, Proc. Zool. Soc. London, p. 59 Guacomayo, Central America.—Hanley, 1847, Thes. Conch. vol. 1, *Tellina*, p. 223, sp. 3, pl. 58, fig. 72.
Tellina (*Tellinella*) *cumingii* Hanley, Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 2, p. 65.

Shell of medium or large size (length up to about 72 mm.), elongate, solid, the beaks nearly median, the anterior side subelliptical, straight along the dorsal side, strongly obliquely rounded at the end, the posterior side narrowed and sloping, strongly flexed. The left valve is more convex, the right is flattened or depressed across the posterior side of the middle. The posterior side has a strong rostral zone which in the right valve has two, coarsely scabrous ridges, while in the left valve, this area is lower, only the dorsal ridge is strongly scabrous. General sculpture is formed by narrow, concentric ribbons, between incised lines, rounded or shelving on the anterior portion of the disk, sharper and more elevated on the posterior; where these lamellae cross the rostral area, in the right valve, they become stronger and squamose. Color a cream-white, often in banded zones of shade with scattered narrow rays of brown.

Length 72.5 mm., height 30.4 mm., diameter 15 mm. Pearl Islands, Panama.

A beautiful and generally rare species.

Range—Gulf of California to Ecuador. Panama: Pearl Islands (Lee Beil).

Tellina (*Tellina*) *zacae* Hertlein and Strong

Plate 69, figures 4, 4a

Tellina (*Tellinella*) *zacae* Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 2, pp. 65, 66, pl. 1, figs. 12, 13, 17.

Shell of medium size (length about 34 mm.), elongately ovate, the umbones placed a little behind the middle, white, with golden-orange rays of varying size. Anterior end elliptically rounded, the posterior side shorter, the surface sculptured with strong concentrics which become squamose as they cross the rostral ribs.

Length 33.4 mm., height 15.2 mm., diameter, both valves 7.8 mm. (Hertlein and Strong)

Similar to *Tellina cumingi* but differs in being smaller, higher, its posterior side shorter and in some other details.

Range—Gulf of California.

Genus *PHYLLODINA* Dall, 1900

Type species by original designation, *Tellina squamifera* Deshayes. Recent, western Atlantic.

Shell broadly elongate, subequilateral, the two ends nearly alike. The posterior side has a wide rostral area, weakly flexed. Concentric sculpture

strong, rising into short leaflike lamellae along the posterior-dorsal margin. Pallial sinus deep, almost free from the pallial line below.

There are two Recent species in the Panamic-Pacific region.

I. Surface sculpture regular and uniformly developed.

P. fluctigera

II. Surface sculpture developed unequally over different parts of the disk.

P. pristiphora

Phyllodina fluctigera (Dall)

Plate 68, figure 9;
Plate 69, figure 5

Tellina (*Phyllodina*) *fluctigera* Dall, 1908, Bull. Mus. Comp. Zool., vol. 43, No. 6, pp. 419, 420.

Shell solid, elongate-ovate, nearly equilateral, of a dull yellowish-white color. Umbones low, flat, the beaks small and inconspicuous. The left valve has a long, subtriangular, flattened lunule over the anterior lateral tooth. Surface sculpture is formed by rather strong, concentric riblets, flattened and shelving over the middle of the disk, more erect and crowded on the sides. The posterior-dorsal or rostral area is defined by an umbonal angle in the left valve across which the sculptural lamellae bend sharply at right angles; at the dorsal margin, the ends of these lamellae become erect to form short, stout, leaflike scales.

Length 32 mm., height 20 mm., diameter of left valve 4.5 mm. Holotype Panama Bay (Dall).

Length 29.2 mm., height 17.1 mm., diameter of left valve 4.4 mm. Zorritos, Peru (G. Petersen dredging).

A rare species, as yet, known only from a few specimens. The holotype in the United States National Museum was dredged in the Gulf of Panama in 182 fathoms. A left valve was dredged by Dr. G. Petersen off Zorritos, Peru, in about 24 brazas depth.

A closely similar or identical species occurs as fossil in the Esmeraldas beds of northwestern Ecuador.

Range—Panama to Peru. Panama: Gulf of Panama (USNM). Peru: Zorritos.

Phyllodina pristiphora (Dall)

Plate 69, figure 11

Tellina (*Phyllodina*) *pristiphora* Dall, 1900, Proc. U.S. Nat. Museum, vol. 23, No. 1210, p. 316, pl. 4, fig. 14.—Pilsbry and Lowe, 1932, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, p. 132.—Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 2, pp. 86, 87.

Shell small or of medium size (length up to 35 mm.), subovate, compressed, nearly equilateral, the anterior side rounded, the posterior narrower and squarely truncated at the end. The rostral area is well defined, strongly sculptured, with small but prominent, elevated squarish foliations along its dorsal margin. Surface greenish-white, chalky, sculptured with evenly spaced concentric lamellae which are separated by wider and finely concentrically striated intervals; on the right valve, the lamellae tend to become obsolete on the anterior two-thirds of the disk.

Length 16.5 mm., height 9.5 mm., diameter 3 mm. (Dall).

Length 35.8 mm., height 23 mm., diameter both valves 10.2 mm. (an unusually large specimen, Hertlein and Strong).

This is a shorter and higher species than *T. fluctigera* Dall and with less regular sculpture.

Range—Lower California to Costa Rica.

Genus **TELLIDORA** H. and A. Adams, 1858

Type species by original designation, Dall, 1900. *Tellina burneti* Broderip and Sowerby. Panamic-Pacific region.

Shell of medium size, triangular, with high, central beaks and nearly equal sides, the dorsal margins commonly crested or serrated. The valves have unequal inflation, one or the other, according to species, being depressed or flattened, the other mildly convex. Ligament partly immersed, the tensilium attached to a long, deep groove, the resilium to a smaller scar below it. The hinge has two, small cardinal teeth in each valve, the anterior left and the posterior right cardinal teeth are bifid, the other much smaller, narrow and sometimes partly obsolete. The pallial sinus is deep and half confluent below. Surface smooth or with concentric undulations on the umbones.

There are two Recent species, *T. cristata* Recluz, found in Atlantic-Caribbean waters, and *T. burneti* Broderip and Sowerby in the Pacific zone. They differ from each other in the reversed convexity of their valves.

Tellidora burneti (Broderip and Sowerby)

Plate 69, figures 1-1b

Tellina burneti Broderip and Sowerby, 1829, Zool. Jour., vol. 4, No. 15, p. 362, pl. 9, fig. 2. Found in the estuary of Mazatlan, among the shoals of large Pinnæ which are left dry at low water.—Hanley, 1846, Thes. Conch., vol. 1, *Tellina*, p. 271, pl. 58, fig. 99 Salango.—Sowerby, 1867, Conch. Icon., vol. 17, *Tellina*, species 199, pl. 35, figs. 199a, 199b.

Tellidora burneti (Broderip and Sowerby), Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 2, No. 9, p. 88.—Hertlein and Strong, 1955, Bull. Amer. Mus. Nat. Hist., vol. 107, art. 2, p. 199.

Adult specimens may reach a length of nearly 50 mm., white, the valves unequal, the left valve is somewhat larger, convex, the right flattened to depressed, the posterior side flexed and turned towards the right, ending in a short, stout, truncated nose. Surface smooth or marked with fine lines of growth and with irregular undulations on the beaks. Pallial line and muscle scars deeply impressed.

Range—Lower California southward to Ecuador. Panama: San Carlos; Bucaró. Panama Canal Zone: Amador Beach, Balboa. Colombia: Isla del Gallo. Ecuador: Santa Elena; Charapota; Portete; Sua; Galeras.

Genus **MERISCA** Dall, 1900

Type species by original designation, *Tellina crystallina* Wood. West Atlantic.

The shell is trigonal-ovate in shape, inequilateral and inequivalve, the posterior end with a strong, ridged flexure, the left valve convex, the right valve more or less depressed. The beaks are submedian, the anterior side wide and rounded, the posterior side with a narrow but well-defined rostral area which is terminated in a beaked end and in the right valve bordered by an impressed ray and a change in sculpture. The surface is sculptured with raised, concentric ridges or lamellae, closely or widely spaced. The hinge is normal, the right valve with a strong, lateral socket buttressed with a tooth on each side, the anterior set a little closer to the cardinal teeth; the left valve has no lateral teeth, the hinge margins are

merely bevelled or bladeliike at these points so as to fit into the lateral sockets in the opposite valve. The pallial sinus is large, high, and irregularly rounded under the beaks, almost reaching to the anterior adductor scar, and wholly confluent with the pallial line below.

***Merisca crystallina* (Spengler)**

Plate 70, figures 2, 2a

Tellina crystallina Spengler, 1798, Skr. Nat. Selsk. (Copenhagen), vol. 4, No. 2, p. 113 refers to Ch'rnitz, 1795, Neues Syst. Conchyl.-Cab. Martini-Chemnitz, bd. 11, p. 210, pl. 199, figs. 1947, 1948.—Hanley, 1846, Thes. Conch., vol. 1, *Tellina*, p. 270, No. 89, pl. 57, fig. 43.

Tellina (*Merisca*) *crystallina* Wood, Dall, 1900, Proc. U.S. Nat. Museum, vol. 23, No. 1210, pp. 293, 302, 311, pl. 2, fig. 10.—Maxwell Smith, 1944, Panamic Marine Shells, p. 64, fig. 834.

Tellina (*Merisca*) *crystallina* Spengler, Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 2, No. 9, pp. 82, 83.—Hertlein and Strong, 1955, Amer. Mus. Nat. Hist., vol. 107, art. 2, pp. 198, 199. in part.

Shell roundly trigonal, relatively thin, white, or translucent, inequivalve, the left valve is larger, more convex than the left which is strongly flattened or depressed; the posterior side in both valves is strongly and narrowly flexed ending at its tip in a pronounced snoutlike end. The valves are inequilateral, the ventral margin is widely rounded, forming almost a half circle, the small, sharply angled beaks placed near the middle, dorsal margins on both sides long and perfectly straight. Surface sculpture is formed by thin, lamellar, concentric riblets, spaced about a millimeter apart, their wide interspaces marked with minute growth lines.

Length 25.7 mm., height 18.8 mm., diameter of both valves 6.7 mm. Monte Cristi, Dominican Republic.

Merisca crystallina, typically a Caribbean and West Atlantic species, has been reported frequently from the Panamic-Pacific region. Hertlein and Strong discussed this species at some length and reached the conclusion that the specimen figured by Chemnitz represented the Caribbean shell and that it likely came from the Danish West Indies, then a Danish possession. Dall, followed later by Hertlein and Strong, considered the species as also Pacific. As here understood, typical *M. crystallina* is a thin, trigonal shell, with nearly median beaks, and the dorsal margin on both sides of the beak is long and straight, its sculpture uniform and coarse. Figures of a specimen from the Dominican Republic for more ready comparison with the Pacific forms are shown on the plate.

Range—South Carolina southward to the Caribbean. Also fossil in Miocene and Pliocene rocks.

***Merisca rhynchoscuta*, new species**

Plate 70, figures 3-3b

Shell with the upper half of each valve trigonal, the beaks elevated and sharp, pointed forward, the lower or ventral half widely rounded and forming a half circle. The left valve is moderately convex, the right flattened or depressed, each with its posterior side produced at the end into a short but conspicuous snout flexed towards the right. Color white or glassy, sculptured with strong, concentric ridges or lamellae usually spaced 1 to 1½ mm. apart, the interspaces between them flattened and marked with small lines of growth.

Length 24.6 mm., height 17.8 mm., diameter 3 mm. (right valve), Manglaralto, Ecuador. Holotype, ANSP 218942.

Length 22.8 mm., height 15.9 mm., diameter 4 mm. (left valve), Guanico, Panama. Paratypes, ANSP 218943, 218944.

Differs from *M. crystallina* by its heavier, more stubby valves, stronger and coarser sculpture, its curved dorsal margins (the posterior one is deeply concave) and also by the deeper ray or sulcus which extends in front of the rostral ridge.

Range—Panama to Ecuador. Panama: Bucaró; Guanico. Ecuador: Santa Elena; Manglaralto; San Francisco (Galeras Peninsula).

Merisca margarita, new species

Plate 70, figures 5, 5a

Shell elongate to ovate-trigonal, small or of medium size, relatively thin, white. The valves are slightly unequal in shape, both are moderately convex, the left uniformly so over the whole disk, the right valve, convex along the umbonal slope and slightly flattened or impressed in the posterior-middle zone. The posterior flexure is of moderate size, ending in a short snout turned towards the right. Surface is covered with fine, close-set, concentric lamellae developed evenly over the whole disk (these usually run about $3\frac{1}{2}$ to 4 in the space of a millimeter). Hinge normal, the posterior lateral tooth well removed from the cardinals, the anterior one spaced a little closer. Pallial sinus is large, its upper limb, high and angular in the middle and reaching to the anterior adductor scar which it barely touches at its lower edge, the lower limb confluent with the pallial line for its whole length.

Length 19.8 mm., height 15 mm., diameter of a right valve 3 mm.

A distinctive species, recognized by its finer sculpture, more elongated shape, and nearly equal convexity of both valves. Its Atlantic analogue is *M. aequistriata* (Say). Holotype, ANSP 218945.

Range—Panama. Panama: Puerto Chame. San Miquel, Rey Island, Pearl Islands.

Genus *LYRATELLINA*, new genus

Type species, *Tellina lyra* Hanley.

Valves elliptical in shape, white or glassy, equal, depressed, or slightly convex; the beaks median, prosogyrate, the posterior side rounded, unflexed, but with a narrow, strongly sculptured rostral area. The surface is sculptured with strong, concentric ridges between wide, flat interspaces. The ligament is external but lies partly immersed in the hinge plate, the margin of the shell rising above the ligament scar. The hinge is normal and strong; in the right valve, there is a single, bifid, cardinal tooth, its posterior arm large, inclined, bordered on the sides by sockets; there is a lateral socket on each side, the anterior one placed a little closer to the cardinal teeth, the lower rim of each socket is enlarged to form a tooth; the left valve has a single, small, narrow, bifid, cardinal tooth bordered on the sides by sockets, the lateral teeth are merely slight enlargements of the hinge margin. There is a small, sunken lunule, larger in the left valve and not set apart by a line. The escutcheon is narrow and deep, the margin of the valve arising above it as a narrow wing.

The type species (*Tellina lyra*) was referred by Dall and some later authors to *Macaliopsis* Cossmann, 1886 (type species, *Tellina barrandei* Deshayes, an Eocene shell from the Paris Basin) but the resemblance of the

American species to the Eocene shell is merely superficial. Two fossil forms of *Lyratellina* are now known, *L. protolyra* (Anderson) from Miocene of Colombia, and *L. aequizonata* (Pilsbry and Olsson) from the Pliocene of Ecuador.

There are two species in the Panamic-Pacific region.

I. Beaks high and sharp, the valve margin in front deeply excavated. Concentric lamellae of the surface sculpture of medium size, spaced about a millimeter apart.

L. lyra

II. The beaks are lower, the margin in front not deeply excavated. Concentric lamellae much finer and spaced three to a millimeter.

L. lyrica

***Lyratellina lyra* (Hanley)**

Plate 70, figures 1-1c

Tellina lyra Hanley, 1844, Proc. Zool. Soc. London, p. 68 Tumbes.—Hanley, 1846, Thes. Conch., vol. 1, *Tellina*, p. 271, pl. 62, fig. 187.—Sowerby, Conch. Icon., vol. 17, *Tellina*, pl. 36, fig. 203.

Tellina (Macaliopsis) lyra Hanley, Maxwell Smith, 1944, Panamic Marine Shells, p. 64, fig. 842.—Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 2, No. 9, p. 81.

Shell elliptical, compressed, thin, the anterior side higher, more rounded, the posterior side with its dorsal margin descending. Rostral area as long as the posterior side, narrow, excavated and well sculptured. Sculpture consists of small, regular, thin, sharp concentrics separated by flattened interspaces about a millimeter wide. The pallial sinus is large, its highest point forming an acute angle a short ways in front of and on level with the middle of the posterior adductor scar, its end rounded, its lower limb confluent with the pallial line.

A rare species. The largest specimen seen, a right valve from the beach at Fort Amador, Balboa, measures: length 56.2 mm., height 39.6 mm., diameter 6 mm.

Range—Lower California to northern Peru. Off San Salvador and Guatemala (H. and S.). Panama: Búcaro. Panama Canal Zone: Fort Amador beach. Ecuador: Sua; Mompiche. Peru: Tumbes (type locality).

***Lyratellina lyrica* (Pilsbry and Lowe)**

Plate 70, figures 6, 6a

Tellina (Macaliopsis) lyrica Pilsbry and Lowe, 1932, Proc. Acad. Nat. Sci., Philadelphia, vol. 84, p. 94, pl. 10, figs. 4, 4a.—Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 2, No. 9, pp. 81, 82.

The shell is generally smaller, more elliptical than *L. lyra* with much finer sculpture formed by evenly spaced, concentric threads spaced about three to a millimeter. The escutcheon is deep and narrow. According to Hertlein and Strong, the exterior of perfectly fresh specimens show a brilliant iridescence of spectral colors caused by the fine growth lines between the larger concentrics acting as a diffraction grating. The species occurs fossil in the Pliocene of Ecuador. A perfect specimen (bored) obtained by shrimp trawlers off Punta Malo, Panama, measures:

Length 45.8 mm., height 32.8 mm., diameter 14.3 mm (closed valves; from Mr. and Mrs. H. B. Johnson, Rodman, Canal Zone).

Range—Lower California to Panama and probably Ecuador.
Panama: Off Punta Malo; Gulf of Chiriqui (Hertlein and Strong). Mexico:

Guaymas (Pilsbry and Lowe, type locality); Santa Inez, Gulf of California (Hertlein and Strong).

Genus **STRIGILLA** Turton, 1822

Type species by subsequent designation, Gray, 1847, *Tellina carnaria* Linné.

Shell subovate to suborbicular, depressed or convex, usually equivalve, the ends well rounded. Sculptural pattern is characteristic, consisting of evenly spaced, steeply inclined or oblique lines or sulci over the middle of the disk, usually sharply flexed or divaricated along the posterior-umbonal slope (principal line of flexure) forming a line of narrow, sharply acute angles pointing ventrally and often a second line of weaker flexure on the anterior-umbonal slope, sometimes partly effaced by a smooth tract. Sculpture over the posterior-umbonal area is simple, formed by unbroken tangential sulci or it may also show one or more lines of flexing and sharp zigzag bends. Ligament external, partly immersed in the hinge plate. Hinge with both cardinal and lateral teeth, the cardinal teeth usually small, the laterals stronger; the right valve has strong lateral sockets, the left valve with lateral teeth only. The pallial sinus is deep, its lower limb formed by the pallial line. The prodissoconch of *Strigilla* is small, smooth, perched on the extreme tip of the beak and followed by the first nepionic stage with fine concentric lines, the sulci beginning later along a weakly defined posterior keel. Color white, pink or rose-red, uniform or in bands.

Several names have been given to various Panamic *Strigillas* by Mörch and Philippi but since none of these were figured, their status is somewhat uncertain. *Strigilla* is said to begin in the Eocene, but the earliest known species which show the characteristic divaricate sculpture are of late Oligocene or early Miocene age. Recent species live mostly in shallow water on a sandy bottom. The genus is here divided into the following subgenera:

- I. Surface of the shell ornamented with relatively simple, unflexed, incised lines or sulci which cross the disk obliquely but do not show any line of divarication at any point.

Subgenus *Simplistrigilla*, new subgenus

- II. Surface ornamentation more elaborate, formed by oblique incised lines or sulci flexed or sharply divaricated by one or more lines of zigzag bends. The principal line of divarication lies along the posterior-umbonal slope and along it, the points of the acute angles are directed ventrally. The space between this line and the dorsal margin constitutes the posterior-dorsal slope or area.

- A. A secondary line of sharp, angular bends extends across the anterior-middle zone; sulci in front of this line are horizontally directed and nearly straight. Distribution: in African and Mediterranean waters.

Subgenus *Aeretica* Dall

- B. A secondary line of divarication lies along the anterior-umbonal slope; it is sometimes poorly developed or it may be partly effaced by a smooth tract.

- Ba. Ornamentation of the posterior-dorsal area simple, the sulci fairly straight, tangential to the margin, and if more irregular without a definite pattern.

Subgenus *Strigilla*, s.s.

- Bb. Ornamentation of the posterior-dorsal area more complex, the sulci showing one or more lines of zigzag bends.

Subgenus *Pisostrigilla*, new subgenus

General key to Panamic-Pacific species of *Strigilla*

- I. Surface ornamentation fairly simple, the incised lines strongly oblique to the margin but not flexed or divaricated at any point.

Subgenus *Simplistrigilla*

1. Sulci rather coarse, run obliquely across the disk from the ventral to the dorsal margin. Color white.

S. strata

- II. Surface ornamentation more complex, the sulci flexed or divaricated along one or more lines of sharp, angular bends.

- A. Ornamentation of the posterior-dorsal area simple, its sculpture produced by straight, tangential sulci, often fine and crowded, or if more irregular, do not develop a fixed pattern.

Subgenus *Strigilla*, s.s.

- Aa. With two lines of sharp divarication, the principal one along the posterior-umbonal slope, a smaller one along the anterior-umbonal slope.

- a. Shell large, its length between 25 and 45 mm.

2. Valves subcircular, depressed, white (rarely shaded with pink), the lines of sulci fine.

S. disjuncta

- b. Of average smaller size, the sulci coarser. Color white or rose-red.

- ba. Shell of medium size, length between 15 and 25 mm.

3. Ornamentation along the posterior-dorsal area produced by crowded tangential lines only. Color white or red.

S. carnaria

4. Ornamentation of the posterior-dorsal area more irregular, the sulci sometimes irregularly flexed at the margin.

S. chroma

- bb. Shell much smaller, its length usually less than 10 mm.

5. Valves pea-shaped, white, often with pink umbones. Sulci along the middle zone stand almost vertical to the ventral margin. The anterior-umbonal flexure often partly effaced by a smooth tract.

S. cicerula

6. Similar to last, generally plain white, the middle sulci more inclined, the anterior line of divarication weaker but without a smooth tract, the anterior sulci often irregular or branching.

S. dichotoma

- Ab. With only a single line of sharp flexure (posterior or main line of divarication).

7. Shell small, convex, subequilateral, the beaks nearly median. The sulci are fine and regular.

S. ervilia

- B. The posterior-dorsal area has a middle line of strong flexing of the sulci, the lines along it showing sharp, zigzag bends.

Subgenus *Pisostrigilla*

8. Shell relatively small (6 to 7 mm., in length), convex, subcircular, white in color.

S. panamensis

Subgenus **STRIGILLA**, s.s.

(*Rombergia* Dall, 1900.)

Shell of medium or large size, suborbicular and slightly inequilateral,

depressed to weakly convex, white, or in shades of pink. Posterior or principal line of flexure is always present and sharply defined, the sulci over the posterior-dorsal area generally finer, more closely crowded, and not flexed except in some cases adjacent to the dorsal margin. On the anterior one-third of the disk, there is often a second line of flexure, the sulci there are bowed convexly to a varying degree, sometimes partly obsolete or replaced along the umbonal slope by a smooth tract. Pallial sinus deep, free or with its upper limb reaching across to the anterior adductor scar.

In *Rombergia* Dall (type species, *S. rombergi* Mörch of Caribbean waters) the upper limb of the pallial sinus is attached to the pallial line a short distance behind the anterior adductor scar; this is a character of minor importance.

Strigilla (Strigilla) disjuncta Carpenter

Plate 73, figures 1-1c

Strigilla disjuncta Carpenter, 1856, Proc. Zool. Soc. London, p. 160.—Strong and Hertlein, 1949, Zoologica, vol. 34, pt. 2, No. 9, pl. 1, fig. 20.

Strigilla sincera Hanley, Maxwell Smith, 1944, Panamic Marine Shells, p. 65, fig. 845.
S. ? sincera Hanley, 1844.

Shell large, (length 30 mm. or more), suborbicular, slightly inequivalve, the left valve is smaller, depressed to slightly convex, relatively thin, white. The anterior side is about half the length of the posterior, evenly rounded at the end and often slightly flexuous. The posterior-dorsal submargin is narrowly flattened. Sculpture is fine and uniform over most of the surface. On the umbones, the concentric lines are fine and threadlike and become almost invisible close to the beaks where they are nearly concentric with the shell margin. Ventrally, the sulci are coarser and more strongly oblique and over the anterior-umbonal slope bunched together into a small infold. The posterior-umbonal line of divarication is sharp and straight, the sulci above it fine and crowded together. Pallial sinus large, not extending to the anterior adductor scar.

Length 45 mm., height 40.5 mm., semidiameter 9.3 mm. (a large right valve from Mompiche, Ecuador).

Easily known by its large size, depressed surface, and ovate-elliptical shape. The sculpture is extremely fine. The color is white, very rarely flushed with pink. Young shells are thin and glassy. Best known in the literature as *S. sincera*. Hedley has shown that the name "*sincera*" should be applied to an Australian species.

Range—Nicaragua to northern Peru. Panama: Panama City; Las Tablas; Búcaro; Coiba Island (USNM). Colombia: Isla del Gallo. Ecuador: Santa Elena; Charapota; Sua; Mompiche. Peru: Tumbuz.

Strigilla (Strigilla) carnaria (Linné)

Plate 73, figures 4, 4a

Tellina carnaria Linné, 1758, Syst. Nat. ed. 10, p. 676.—Hanley, 1846, Thes. Conch., vol. 1, p. 260, pl. 56, fig. 38.

Shell of medium size (average length about 22 mm.), suborbicular, the anterior side about half the length of the posterior, its margin broadly rounded or subtruncate. Surface with the characteristic sculpture of the genus and as noted in the key having two lines of divarication, a posterior and anterior; that along the anterior slope is rather broad or obtuse, often partly obliterated or smooth. Posterior-dorsal area with a smooth, even slope, the incised lines become crowded and hairlike. Pallial sinus large and

deep, highest at the posterior one-third and connected directly with the anterior adductor scar. Color white or in varying shades of rose-pink.

Strigilla carnaria is a common and widely distributed species through the Caribbean region but its occurrence in the Pacific zone, in spite of Hanley's early records, has generally been denied. I have numerous specimens of a *Strigilla* from the coasts of northern Peru and Ecuador which appear identical with typical Caribbean examples of *S. carnaria*, or they differ merely in size and minor details of sculpture.

Range—Panama to northern Peru. Panama: Bucaró. Colombia: Isla del Gallo. Ecuador: Galeras; Mompiche; Santa Elena; Camerones. Peru: Zorritos.

Strigilla (*Strigilla*) *chroma* (Salisbury)

Plate 73, figure 5

Tellina (*Strigilla*) *fucata* Gould, 1851, Proc. Boston Soc. Nat. Hist., vol. 4, p. 91.—Gould, 1853, Boston Jour. Nat. Hist., vol. 6, p. 399, pl. 16, fig. 4. (Not *Tellina fucata* Hinds, 1844). Mazatlan.

Strigilla costulifera Mörch, Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 2, No. 9, pp. 95, 96, pl. 1, fig. 15.—Hertlein and Strong, 1955, Bull. Amer. Mus. Nat. Hist., vol. 107, art. 2, p. 201. Probably not of Mörch, 1860.

Tellina chroma Salisbury, 1934, Proc. Malacol. Soc. London, vol. 21, pt. 2, p. 84. New name for *T. (Strigilla) fucata* Gould.

Like *S. carnaria* but usually smaller and less inequivalve (the left valve is a little larger). The posterior-dorsal surface has a small escutcheon-like area bounded by a rounded ridge and sculptured with irregular and somewhat zigzagged lines. The commonest and most widely distributed *Strigilla* in the Panamic area.

Range—Lower California to northern Peru. Mexico: Acapulco. Panama: Búcaro. Ecuador: Puerto Callo; San Francisco; Punta Montanita near Manglaralto. Peru: Punta Picos.

Strigilla (*Strigilla*) *cicerula* (Philippi)

Plate 73, figure 3

Tellina cicerula Philippi, 1846, Zeit. f. Malakozool., Jahrg. 3, p. 19, No. 2 Mazatlan.

Strigilla costulifera Mörch, 1860, Malak. Blätter, bl. 7, p. 189, No. 270 Sonsonate.

Strigilla interrupta Mörch, 1860, *op. cit.*, p. 190, No. 271 Sonsonate.

Strigilla cicerula (Philippi), Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 2, No. 9, p. 95, pl. 1, fig. 19.

Shell small, usually less than 10 mm. in length, ovate to subcircular, the beaks placed slightly anterior of the middle, moderately convex. Surface generally highly polished, white, with pink-colored umbones, which color is usually transmitted through the texture of the shell into the interior. Sculpture as usual for the genus consisting of oblique, divaricating incised lines which appear to intersect the ventral margin in the middle zone almost at right angles, the lines on the anterior slope more widely spaced and often interrupted by a smooth tract.

Length 9.6 mm., height 8.7 mm., diameter of a right valve 2.6 mm.

Generally rare. In size and shape, this species bears some resemblance to *S. pisiformis* of the Caribbean, but is larger, less convex and with non-zigzagged sculpture on the posterior-dorsal area.

Range—Gulf of California to Ecuador. Panama: Búcaro. Colombia: Isla del Gallo.

Strigilla (Strigilla) ervilla (Philippi)

Plate 73, figures 6, 6a

Tellina ervilla Philippi, 1846, Zeit. f. Malakozool., Jahrg. 3, p. 20, No. 5 Mazatlan. Probably *Strigilla lenticula* (Philippi), Dall, 1900, Proc. U.S. Nat. Museum, vol. 23, No. 1210, p. 305.—Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 2, No. 9, p. 96, pl. 1, fig. 21.

Shell of medium size (length to about 11 mm.), subcircular to subovate, plump with a high, submedian umbone and beak, white or faintly suffused with pink. The posterior flexure is sharp, the incised lines meeting along it at angles of 70 to 80 degrees, the anterior flexure is absent, the incised lines across the anterior-umbonal slope showing no change of direction except close to the margin where they are slightly undulated by a weak fold in the substance of the shell itself. The sculpture is regular and neat over the whole disk, the incised lines are close-set and forming elevated threadlets, smooth on top, but finely etched by concentric striations in their intervals. Interior deep and smooth, the lateral teeth strong.

Length 11.1 mm., height 10.8 mm., diameter 3.3 mm. (a right valve, Santa Elena, Ecuador).

This is perhaps the species determined by Hertlein and Strong as *S. lenticula* (Philippi) from Corinto, Nicaragua, but their figure shows a more circular shell with coarser sculpture. The species is easily recognized by its ovate, nearly equilateral form, and characteristic sculpture.

Range—Lower California to Ecuador. Panama: Búcaro; El Lagartillo near Las Tablas. Colombia: Isla del Gallo. Ecuador: Punta Blanca; Santa Elena.

Strigilla (Strigilla) dichotoma (Philippi)

Plate 73, figure 2

Tellina dichotoma Philippi, 1846, Zeit. f. Malakozool., Jahrg. 3, p. 20, No. 4 Mazatlan.

The shell is small, subovate, slightly inequilateral, the posterior side a little longer and narrower, its dorsal margin descends into a widely rounded end, the surface of the valves depressed to slightly convex, white in color. The posterior or principal line of divarication is sharp, the sulci meeting at acute angles along it and continue across the posterior-dorsal area in straight lines, rather coarsely spaced. The sulci are strong over the main portion of the disk and stand at angles of 60 to 70 degrees to the margin; they are more irregular over the anterior slope, with shorter threads, to the number of two or three, intercalated between some of them; nearer the anterior margin they tend to become concentric.

An average specimen measures: length 8.5 mm., height 6.4 mm., semi-diameter 2.2 mm. a left valve.

This species has the shape and size of *S. cicerula* but the surface of the valves is more depressed and the sulci are less steeply inclined and more closely spaced over the middle zone of the disk. A peculiar feature of the species is the splitting of the sulci by twos or threes across the anterior-umbonal area, a character which evidently suggested its name to Philippi.

Range—Gulf of California to Ecuador. Mexico: Mazatlan (Philippi). Panama: Guanico. Ecuador: Punta Blanca.

Subgenus **PISOSTRIGILLA**, new subgenusType species *Strigilla pisiformis* (Linné). Caribbean.

Shell generally small, convex, solid, with a coarse hinge. Sculpture of oblique lines or sulci as in *Strigilla*, *s.s.* but with a line of sharp flexure or zigzag bends along the middle of the posterior-dorsal area.

Strigilla (Pisostrigilla) panamensis, new species

Plate 39, figures 8-8b

Shell small (length 6 to 8 mm.), solid, strongly convex, subcircular, the posterior side nearly as rounded as the anterior and only slightly longer. Umbones wide, the small beaks inconspicuous and closely appressed to the hinge margin. Sculpture uniformly strong over the whole surface with the principal line of divarication along the posterior slope straight and sharp, the anterior one much weaker, showing as a wide, shallow bend, convex upward, with or without a smooth tract along it; on the middle zone of the disk, the sulci are inclined obliquely to the ventral margin forming angles between 60 and 70 degrees. On the posterior-dorsal area a line of zigzag flexure lies along the middle. Color white in all the specimens examined.

Length 6.6 mm., height 6.1 mm., diameter 2 mm. (a left valve), Guanico, Panama. Holotype, ANSP 218938. Paratype, length 7.7 mm., height 7.5 mm., diameter 2.8 mm. (a right valve) Guanico.

This is a small, plump species similar to *S. pisiformis* of the Caribbean but has a more rounded form and a pure white color.

Range—Panama to Ecuador. Panama: Guanico. Colombia: Isla del Gallo. Ecuador: Punta Blanca; Santa Elena.

Subgenus **SIMPLISTRIGILLA**, new subgenusType species *Strigilla strata*, new species.

Shell small, subovate, convex, the surface marked with strongly oblique incised lines or sulci crossing the shell from one margin to the other but without any line of flexure or a change in direction.

Strigilla (Simplistrigilla) strata, new species

Plate 39, figure 7

The shell is small, rounded, subovate, white, relatively solid in texture and moderately convex. The umbones are submedian, the beaks at the end bluntly trigonal. The nepionic surface of the umbone is relatively large and sculptured with hairlike concentrics; this type of sculpture ends sharply and on the succeeding adult portion, the sculpture is produced by rather wide, inclined bands set apart between sharply incised lines which run obliquely across the face of the disk from the posterior or ventral margins to the anterior-dorsal side, the result a rather coarse pattern; these bands are continuous and show little or no flexing or any change of direction along the posterior and anterior submargins.

Length 7.2 mm., height 6.8 mm., semidiameter 3.1 mm. (a left valve). Punta Blanca, Ecuador. Holotype, ANSP 218950.

A rare and unusual species easily known by its sculpture.

Range—Panama southward to Ecuador. Panama: El Lagartillo. Ecuador: Punta Blanca.

Genus **EURYTELLINA** Fischer, 1837Type species by original designation, *Tellina punicea* Born.

The shell is large or small, elongate-ovate, compressed to slightly convex, the posterior side equal or but a little shorter than the anterior, weakly flexed or not at all, sloping and generally obliquely subtruncated or pointed at the end, the beaks usually submedian. The posterior-dorsal slope has usually a narrow rostral area, more strongly sculptured than the surface below it and set off by a low angle. Surface smooth and glossy in some species but more often with fine, evenly spaced, incised concentric lines forming narrow ribbons. Hinge with both cardinal and lateral teeth, the anterior lateral placed close to the cardinal; right posterior cardinal and left anterior posterior teeth bifid. Pallial sinus is deep, rounded at the end, or extended across to touch or connect with the anterior adductor scar, its lower limb coalescent with the pallial line below. Ventral margin smooth, rarely with irregular crenulations.

In most works, *Eurytellina* is classed as a subgenus of *Tellina*, but the group is entitled to a higher rank. It includes our most common tellinids.

Two subgenera.

- I. Posterior area above the umbonal angle sculptured similar to that of the main disk.

Subgenus *Eurytellina*, s.s.

- II. Posterior area sculptured with squamose foliations or with fine, plate-like scales.

Subgenus *Phyllodella*

General key to Panamic species of *Eurytellina*, s.s.

- I. Shell generally solid in texture and of a white color only.
- A. The *pallial sinus* is large and deep, so that it covers most of the interior of valve; Its upper limb attached lightly to the anterior adductor scar with a small area between the adductor scar and the pallial line open.
1. Rather solid, elongated valves with nearly median beaks and a smooth, glossy surface. The posterior flexure is weak. *E. laceridens*
2. Shell higher with the beak placed a little behind the middle line, the posterior end more strongly flexed. Surface covered with narrow, concentric ribbons. *E. hertleini*
- B. The *pallial sinus* is shorter, its end partly rounded, and set well apart or not in contact with the anterior adductor scar; the lower limb of the sinus confluent with the pallial line for about four-fifths of its length.
3. Dorsal margin of the left valve widely expanded and sculptured with coarse, widely spaced, transverse wrinkles. Concentric ribbons of the surface sculpture rather large and coarse (about .75 mm. wide each). *E. laplata*
4. Dorsal margin of the left valve not so widely expanded, sculptured with finer longitudinal threads. *E. eburnea*
- II. Texture of shell more varied, thin or thick, the color white, red or pink in the same species.
- C. *Pallial sinus* large and deep, its upper limb extending across to connect directly with the anterior adductor scar, no triangular space below, the lower limb of sinus and the pallial line continuous.
5. Shell small or of medium size, usually colored red or pink. *E. rubescens*

- D. *Pallial sinus shorter*, not reaching to the anterior adductor scar or merely touching it, its end rounded and leaving a small, triangular space between the sinus and the adductor scar.
- Da. Shell elongated, its length nearly twice its height.
6. Average length about 40 mm., usually deep rose-red, rarely white, its surface depressed. Sculpture strong, formed by regular, narrow, concentric ribbons between incised lines.

E. ecuadoriana

7. Shell smaller (usually 35 mm., or less), solid, white or rose-red. Sculpture usually stronger in the middle. The anterior-ventral margin is weakly crenulated and the anterior adductor scar is bordered by a thickened ray.

E. inaequistriata

- Db. Shell relatively solid. Surface sculptured with strong, uniform, concentric ribbons.
8. Shell oblong-elliptical, generally less than 45 mm. in length, color white or pink.

E. simulans

- Dc. Texture thinner, surface sculpture weak, the umbones often plain, glossy.
9. Shell small, length 35 mm., or less.

E. mantaensis

10. Shell larger, the anterior side much the longer.

*E. prora***Eurytellina (Eurytellina) laceridens** (Hanley)

Plate 68, figure 1:
Plate 71, figures 8, 8a

Tellina laceridens Hanley, 1844, Proc. Zool. Soc. London, p. 61 Tumblez.—Hanley, 1846, Thes. Conch., vol. 1, *Tellina*, p. 243, No. 40, pl. 61, fig. 168.—Sowerby, 1867, Conch. Icon., vol. 17, *Tellina*, pl. 20, fig. 104.

Tellina (Angulus) eburnea Hanley, Dall, 1910, Proc. U.S. Nat. Museum, vol. 37, No. 1704, pp. 160, 270, pl. 28, fig. 3. (Not *eburnea* Hanley, 1844).

Tellina (Eurytellina) laceridens Hanley, Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 2, No. 9, p. 75.

Shell elongate, nearly equilateral, the posterior side narrower, its end concavely or obliquely subtruncate. The shell grows to a fair size (length up to about 85 mm.), solid, porcellaneous white, often with small remnants of a thin, deciduous, buff-colored periostracum. Valves are subequal, of low convexity, often appearing as if flattened across the middle of the disk, the posterior end only mildly flexed. Surface is nearly smooth except for wide, flattened concentric ribbons which show indistinctly on the anterior end and along the ventral side, subobsolete elsewhere. The rostral area is narrow, flat or excavated, wrinkled and often radially striate, the defining umbonal angle low. Interior of the valves usually thickened so that the subequal adductor scars and the pallial lines are plainly visible and deeply impressed. The upper limb of the pallial sinus is sinuous, highest just behind the line of the beak, sometimes nearly straight, extending from the posterior adductor to the lower edge of the anterior adductor but enclosing below it a small, triangular area, largely confluent with the pallial line below.

Length 55.5 mm., height 31 mm., diameter 12.6 mm. Búcaro, Panama.

Length 75 mm., height 36.7 mm., diameter 13.7 mm. San Francisco, Ecuador.

Length 83.3 mm., height 40.6 mm., semidiameter 7.8 mm. San Francisco, Ecuador.

This is the largest of the Panamic Eurytellinas, recognized by its elongated valves, solid texture, and nearly smooth surface. Often common.

Range—Nicaragua southward to northern Peru. Panama: Búcaro. Panama Canal Zone: Balboa. Colombia: Isla del Gallo; Choco (Oscar Haught). Ecuador: Sua; San Francisco (Galeras Peninsula); Limones. Peru: Tumbes; Mancora.

Eurytellina (Eurytellina) hertleini, new species

Plate 68, figure 6;
Plate 71, figures 2, 2a

Tellina laceridens Hanley, 1846, *Thes. Conch.*, vol. 1, *Tellina*, pl. 61, fig. 176. (Not fig. 168). Not *laceridens* Hanley, 1844.

Tellina (Eurytellina) planulata Sowerby, Hertlein and Strong, 1949, *Zoologica*, vol. 34, pt. 2, pp. 76, 77, pl. 1, fig. 22. Not *T. planulata* Sowerby, 1867.

Shell ovate-trigonal, white, moderately solid, beaks submedian, the posterior side narrowed, its dorsal margin straight, sloping downward to a narrowly truncated end. The valves are slightly flexed towards the right, hence, the left valve is a little convex while the right is broadly depressed across the posterior-middle zone. The sculpture is formed by narrow, relatively strong, flat, concentric ribbons which cover the surface uniformly except on the posterior-dorsal or rostral area where they assume the characteristics of irregular growth lines. Interior of a porcellaneous white color, the muscle scars rather deeply impressed. There is no lunule but a slight flattening of the middle zone of the rostral area may correspond to a poorly defined escutcheon.

Length 54.8 mm., height 33.3 mm., diameter 12.7 mm. Isla del Gallo, Colombia. Holotype, ANSP 218941.

This appears to be the shell illustrated by Hanley (as fig. 176) and noted in the description of *laceridens* as a variety of that species. It is also the shell identified as *E. planulata* Sowerby by Hertlein and Strong. Sowerby's *planulata* was described without knowledge of locality and is probably not a Panamic species.

Range—El Salvador to northern Peru. El Salvador and Costa Rica: see Hertlein and Strong for records. Panama: Burica Peninsula; Búcaro. Colombia: Tumaco; Isla del Gallo. Ecuador: Manta; Jaramijo; Palmar; Santa Elena. Peru: Tumbes; Zorritos.

Eurytellina (Eurytellina) laplata (Pilsbry and Olsson)

Plate 71, figures 4, 4a

Tellina (Eurytellina) laplata Pilsbry and Olsson, 1941, *Proc. Acad. Nat. Sci. Philadelphia*, vol. 93, pp. 67, 68, pl. 15, figs. 1-5.

Shell of medium or large size, white, subsolid, coarsely sculptured. The anterior side is decidedly longer, wide, well rounded at the end, the posterior side with its dorsal margin descending sharply, straight, to a narrowly truncate end. The right valve is more convex than the left, their ventral margins pressed lightly together due to a slight flexing which makes the posterior end turn slightly towards the right. Sculpture consists of strong, flat concentric ridges or narrow ribbons (.75 to 1 mm. wide), fairly uniformly developed over the whole disk. The left valve has a large, wide lunule, and escutcheon which project outwards as if to clasp the opposite valve while in the right valve the corresponding marginal zone is widely excavated or concave. Both the lunule and escutcheon are strongly and characteristic-

ally sculptured by transverse ridges which as on the posterior-dorsal area represent the continuation of alternate ridges of the surface sculpture. Pallial sinus large and ample but not reaching to the anterior adductor scar.

Length 50.7 mm., height 31.5 mm., diameter 15 mm. Bayovar.

Length 60 mm., height 37 mm., diameter 12.4 mm. (Left valve, Bayovar).

Common as a Pliocene fossil in Ecuador. Recent records are entirely Peruvian.

Range—Northwestern Peru. Peru: Paíta; Bayovar.

Eurytellina (*Eurytellina*) *eburnea* (Hanley)

Plate 68, figure 2;
Plate 71, figure 3

Tellina eburnea Hanley, 1844, Proc. Zool. Soc. London, p. 61 "Tumbez".—Hanley, 1846, Thes. Conch., vol. 1, *Tellina*, p. 241, No. 36, pl. 58, fig. 91.—Sowerby, 1867, Conch. Icon., vol. 17, *Tellina*, pl. 13, fig. 60.

Tellina (*Eurytellina*) *eburnea* Hanley, Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 2, pp. 73, 74; 1950, *idem*, vol. 35, pt. 4, pl. 2, fig. 7.

Tellina panamanensis Li, 1930, Bull. Geol. Soc. China, vol. 9, No. 3, p. 262, pl. 5, fig. 32.

Tellina (*Eurytellina*) *panamanensis* Li, Pilsbry, 1931, Proc. Acad. Nat. Sci. Philadelphia, vol. 83, p. 436, pl. 41, figs. 4, 5, 6 (good figures).—Hertlein and Strong, 1949, *op. cit.*, vol. 34, pt. 2, p. 76.—Hertlein and Strong, 1955, Bull. Amer. Mus. Nat. Hist., vol. 107, art. 2, p. 198.

Tellina liana Hertlein and Strong, 1945, Nautilus, vol. 58, p. 105.

Shell of medium size, coarse, ovate-elliptical, the anterior side about three-fifths the total length, the surface white, overlain by a thin, buff or ochraceous, deciduous periostracum. The posterior side is short, its dorsal margin descending into an obliquely rounded end. Sculpture formed by coarse, narrow, flat, concentric ribbons (two in a millimeter), nearly uniformly distributed over the disk but crowded together on the rostral slope and lunular area. The valves are hardly flexed, the right valve is a little more convex than the left only. A characteristic feature is the large, expanded lunular area in the left valve; there is no corresponding lunule in the right valve, instead the margin of the valve at this point is concave and excavated. Interior white, porcellaneous, the end of the pallial sinus not reaching to the anterior adductor.

Length 49.4 mm., height 32.3 mm., diameter 14.6 mm. Venado Beach, Panama Canal Zone.

This species may be known by its heavy, white-colored shell, coarse, even surface sculpture and in having the dorsal areas in the left valve widely expanded and marked with coarse ridges and wrinkles running parallel to the margin. As a subfossil, the shells of this species are common in dredgings from the Panama Canal at Thatcher's Ferry and elsewhere near the Pacific entrance of the canal and specimens from this source were described by Li, under the name "*panamensis*" and considered as a Miocene species.¹⁴

Range—Gulf of California to northern Peru. Panama: Búcaro. Panama Canal Zone: Fort Amador; Thatcher's Ferry. Colombia: Isla del Gallo. Ecuador: Charapota; Jaramijo; Manglaralto; Santa Elena. Peru: Tumbez; Boca Pan.

¹⁴Typical Miocene fossils have been found at Thatcher's Ferry in the canal dredgings, probably derived from barge dumps brought here from the Gatun area in the early days of canal construction.

Eurytellina (Eurytellina) rubescens (Hanley)Plate 68, figure 8;
Plate 71, figures 7, 7a

Tellina rubescens Hanley, 1844, Proc. Zool. Soc. London, p. 60. Panama and Tumbes.—Hanley, 1846, Thes. Conch., vol. 1, *Tellina*, p. 242, No. 38, pl. 60, fig. 153.—Sowerby, 1866, Conch. Icon., vol. 17, *Tellina*, pl. 18, fig. 93.

Tellina (Eurytellina) rubescens Hanley, Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 2, No. 9, pp. 78, 79.

The shell is broadly ovate, its height nearly five-eighths of its length, the beaks nearly median, the side subequal, the surface color white or light pink. The posterior-dorsal area is of medium width, slightly furrowed in the middle and marked off by a low, umbonal angle and a slightly coarser sculpture. The valves are thin in texture and of low convexity, nearly equal, the posterior end not flexed or only weakly so. Surface nearly smooth and glossy but on closer examination, an obscure sculpture of rather wide, concentric ribbons is seen, most heavy on the rounded anterior end, and in addition much finer growth lines which often are wrinkled; also faint radial striations may be present. The most characteristic feature of the species is the shape of the pallial sinus whose upper limb is attached directly to the anterior adductor scar. There is no lunule or escutcheon.

Length 34.5 mm., height 22 mm., diameter 7.8 mm. Venado Beach, Panama Canal Zone.

Length 45.7 mm., height 29.6 mm., semidiameter 3 mm. Rio Chepo mouth, Panama.

This is a small or medium-sized species as indicated by the dimensions above. The surface of the valves is slightly convex, nearly smooth, the principal concentric sulci fading out before they reach the umbonal angle. The species is easily known by the contour of the pallial sinus as shown in illustration.

Range—Mexico southward to northern Peru. Panama: Pearl Islands (Rey Island); mouth of the Rio Chepo. Panama Canal Zone: Amador Beach; Venado Beach. Colombia: Isla del Gallo. Ecuador: Cojimenes. Peru: Zorritos; Tumbes.

Eurytellina (Eurytellina) ecuadoriana (Pilsbry and Olsson) Plate 71, figures 5-5b

Tellina (Eurytellina) ecuadoriana Pilsbry and Olsson, 1941, Proc. Acad. Nat. Sci. Philadelphia, vol. 93, p. 67, pl. 15, figs. 6-8.—Hertlein and Strong, 1955, Bull. Amer. Mus. Nat. Hist., vol. 107, No. 2, pp. 197, 198.

Shell elongate-ovate, rich rose-pink, glossy, the beaks nearly median, the posterior side is a little longer, narrower, its dorsal margin descending, straight to a narrowly subtruncated end. Ventral margin is straight in the mid-zone, curved or rounded towards the ends. Valves are of slight but nearly equal convexity, the right valve is a little depressed across the middle due to a weak flexing of the ventral margin. Posterior-dorsal area similar in both valves, narrow, flattened or depressed, smooth ventrally but with weak radial lines showing. Sculpture consists of flat, concentric ridges or narrow ribbons which are uniformly developed over most of the disk except on the posterior slope, ending rather sharply at the umbonal ridge especially so on the right valve. No definable lunule or escutcheon except for a narrow flattening of the margin along this zone. The pallial sinus is long, its upper limb somewhat sinuous, almost reaching to the anterior adductor scar, and enclosing a small, triangular area between the scar and its rounded off end.

Length 50.4 mm., height 28.4 mm., diameter 9.4 mm. An average specimen.

This is a lovely rose-red species, its range confined to the Ecuadorian coast as far as known.

Range—Coast of Ecuador. San Francisco; Mompiche; Charapota; Jaramijo; Manta; Punta Blanca; Manglaralto.

Eurytellina (*Eurytellina*) *inaequistriata* (Donovan) Plate 71, figures 9, 9a

Tellina inaequistriata Donovan, 1802, Nat. Hist. British Shells, vol. 4, pl. 123 (two figures).—Hanley, 1846, Thes. Conch., vol. 1, *Tellina*, p. 238, No. 31, pl. 58, fig. 80. (Not fig. 58, pl. 57). Bay of Guayaquil.—Sowerby, 1867, Conch. Icon., vol. 17, *Tellina*, pl. 36, figs. 202a, b. Bay of Guayaquil.

Tellina (Eurytellina) inaequistriata Donovan, Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 2, pp. 74, 75, pl. 1, fig. 18.—Hertlein and Strong, 1955, Bull. Amer. Mus. Nat. Hist., vol. 107, art. 2, 198.

Tellina (Eurytellina) leucogonia Dall, 1900, Proc. U.S. Nat. Museum, vol. 23, No. 1210, p. 317, pl. 4, fig. 5.

Shell relatively small (length 25 to 35 mm.), trigonal-elongated, moderately heavy, slightly convex to compressed, subequilateral, the anterior side is a trifle longer and wider than the posterior. Color light rose-pink, often arranged in lighter and darker concentric bands, suffused with yellowish brown, the dorsal margins and umbones usually white. Surface plain, often nearly smooth and polished (especially on the left valve) but with an underlying sculpture of evenly spaced, incised lines forming narrow, concentric bands which may be weakly or well developed; this type of sculpturing may be developed over the whole surface or it may be much coarser on the posterior-middle section of the disk. The texture of the shell is usually heavy, the adductor scars are deeply impressed, the anterior one bordered posteriorly by a thickened ray. Upper limb of the pallial sinus does not touch the lower, inner side of the spatula-shaped, anterior adductor scar. Extremely fine radial striae are visible under the lens and the anterior margin of the valve is often strongly crenulated.

The fine crenulation of the ventral margin along its anterior side is the most striking feature of this shell, a character unique amongst other species of the genus. The shell is heavy, the adductor scars sunk deeply, the anterior scar bordered behind by a thickened ray. The species occurs as a Pleistocene fossil on the Burica Peninsula, Panama.

Range—Gulf of California to Ecuador. Panama: Several stations cited by Hertlein and Strong, 1955. Ecuador: Gulf of Guayaquil.

***Eurytellina (Eurytellina) simulans* (C. B. Adams)** Plate 71, figures 1, 1a

Tellina punicea Born, Hanley, 1846, Thes. Conch., vol. 1, *Tellina*, p. 240, No. 33, pl. 60, fig. 154. Xipixapi. (Not *T. punicea* Born, 1780).

Tellina simulans C. B. Adams, 1852, Ann. Lyceum Nat. Hist. New York, vol. 5, pp. 509, 546, No. 471.—Maxwell Smith, 1944, Panamic Marine Shells, p. 65, fig. 840.—Turner, 1956, Occas. Papers on Mollusks, Mus. Comp. Zool., vol. 2, No. 20, pp. 86, 87, pl. 18, figs. 5, 6.

Tellina (Eurytellina) simulans C. B. Adams, Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 2, No. 9, p. 79.

Shell as a rule of small or medium size, seldom exceeding 45 mm. in length, oblong-elliptical, the beaks nearly median, the posterior side being narrower, its dorsal margin straight, descending to an obliquely sub-truncated end. Valves are but weakly convex, almost flat, subsolid, generally showing an internal thickened ray along the inner side of the anterior ad-

ductor extending to the beaks and the adductor scars are often deeply impressed. Color white or rose, generally more or less banded, the beaks colored more deeply. The surface sculpture is formed by neat, even, concentric ribs (about 5 to each 2 mm.), which begin at the rostral angle and cover the whole disk rather uniformly. The rostral area is narrow, flattened or excavated, and with simpler sculpture. There is usually a small sulcus along the anterior-dorsal margin.

Length 44 mm., height 26.6 mm., diameter 11.2 mm. Guanico, Panama.

This is a small or medium-sized species characterized by its rather heavy shell, white or pink color, the shades of color often arranged in wide, concentric bands, the umbones shaded generally a deep rose-red. The surface is neatly marked with strong, uniform, concentric ribbons. The species appears to be common and widely distributed.

There is some doubt whether *E. simulans* should be considered as fully distinct from the Caribbean eurytellinid, commonly identified as *E. punicea*, especially as the locality for Born's specimens was not stated in its description. In general, *E. simulans* is smaller and somewhat longer, and also usually of a lighter color, than the Caribbean form.

Range—Gulf of California to northern Peru. Panama: Panama City; Guanico. Panama Canal Zone: Venado Beach. Ecuador: Point Ancon; Mompiche; Galeras Peninsula; Santa Elena. Peru: Tumbes.

Eurytellina (Eurytellina) mantaensis (Pilsbry and Olsson)

Tellina (Eurytellina) mantaensis Pilsbry and Olsson, 1943, *Nautilus*, vol. 56, No. 3, p. 80, pl. 8, figs. 1-4.—Hertlein and Strong, 1949, *Zoologica*, vol. 34, pt. 2, No. 9, pp. 75, 76.

The shell is small (length generally less than 34 mm.), rose-colored, stained more deeply so on the umbones and often somewhat brownish ventrally; the different shades of color sometimes arranged in concentric bands. General sculpture consists of flat, concentric ridges which are well developed below the middle of the disk and around the anterior end but the umbones and the middle zone of the disk is smooth. The right valve has the posterior-dorsal area marked off well and more heavily sculptured with regular, waved, raised threads; in the left valve, the posterior-dorsal area is nearly smooth. A thickened ray borders the inner side of the anterior adductor scar. Pallial sinus deep, confluent below, its rounded end nearly reaching to the anterior adductor scar.

Length 31 mm., height 17 mm., diameter 6.75 mm.

The smallest of the Panamic-Pacific *Eurytellinas*.

Range—Panama to Ecuador. Panama: Gulf of Chiriqui (Hertlein and Strong); Pedro Gonzales Island (Pearl Islands), USNM 589750. Ecuador: Manta.

Eurytellina (Eurytellina) prora (Hanley)

Plate 71, figures 6, 6a

Tellina prora Hanley, 1844, *Proc. Zool. Soc. London*, p. 61 Santa Elena.—Hanley, 1846, *Thes. Conch.*, vol. 1, *Tellina*, p. 243, No. 39, pl. 60, fig. 152.—Sowerby, 1866, *Conch. Icon.*, vol. 17, *Tellina*, pl. 18, fig. 90.—Maxwell Smith, 1944, *Panamic Marine Shells*, p. 65, figs. 827, 840.

Tellina (Eurytellina) prora Hanley, Hertlein and Strong, 1949, *Zoologica*, vol. 34, pt. 2, No. 9, pp. 77, 78.

Shell elliptical-trigonal, nearly equilateral, the beaks submedian, sub-solid and of low convexity. Shell white or pale rose-pink, the white and pink

color often arranged in broad, concentric bands or in lighter shades of the same. Surface smooth and polished but with a neat sculpture of fine, closely spaced concentric lines forming narrow ribbons spaced about six to eight to a millimeter. The lunule is narrow and excavated, larger in the right valve, the escutcheon similar. The tip of the pallial sinus does not reach the anterior adductor by a short space, its lower limb largely confluent with the pallial line.

Length 51.7 mm., height 30 mm., diameter 11.7 mm. (Off Punta Malo, shrimpers. From Harry B. Johnson).

Somewhat like *E. rubescens* but longer, easily separated by the features of their respective pallial sinus. *T. simulans* has much heavier sculpture.

Range—Mexico to northern Peru. Panama: Off Punta Mala (shrimpers). Panama Canal Zone: Fort Amador. Ecuador: Mompiche; Santa Elena. Peru: Zorritos.

Subgenus **PHYLLODELLA** Hertlein and Strong, 1949

Type species by monotypy, *Tellina (Phyllorella) insculpta* Hanley.

Like *Eurytellina*, *s.s.* but with the posterior-dorsal area squamosely sculptured or roughened by small platelike scales. Pallial sinus deep, almost reaching to the anterior adductor scar, its lower limb united with the pallial line.

Eurytellina (Phyllorella) insculpta (Hanley)

Tellina insculpta Hanley, 1844, Proc. Zool. Soc. London, p. 70. Hab. Chiriqui, West Colombia (Panama).—Hanley, 1846, Thes. Conch., vol. 1, *Tellina*, p. 289, No. 123, pl. 60, fig. 136.—Sowerby, 1867, Conch. Icon., vol. 17, *Tellina*, pl. 37, fig. 208.

Tellina (Phyllorella) insculpta Hanley, Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 2, p. 87.—Hertlein and Strong, 1950, *idem.*, vol. 35, pt. 4, pl. 1, fig. 15.

Shell elongately oblong, compressed, thin or relatively solid, equilateral, the dorsal margins sloping, anterior end rounded the posterior end angulated. Internally and externally white, the surface sculptured with crowded, equidistant, concentric sulci (about four per mm.), and most minute posterior radiating striate. Posterior area setoff by a weak angulation, its surface roughened by small scales or interrupted delicate lamellae. Hinge as typical of *Eurytellina*, the cardinal teeth being grooved. Pallial sinus deep, rather high behind, and then descending, its end blunt and almost, but not quite, touching the lower edge of the anterior adductor scar, its lower limb completely confluent with the pallial line.

Length 33.6 mm., height 18.3 mm., convexity (both valves together), 5.8 mm. (Hertlein and Strong).

Range—Guatemala to Ecuador. Guatemala: Champerico. El Salvador: Santa Elena. Guatemala and El Salvador records by Hertlein and Strong; Panama by Hanley.

Genus **TELLINIDELLA** Hertlein and Strong, 1949

Type species by original designation, *Tellinides purpureus* Broderip and Sowerby. Recent, eastern Pacific.

Shell elongately elliptical, white or rose-pink, nearly equilateral, thin, the beaks small and nearly median, the right valve a little more convex than the left, usually flexed by a depressed zone across the middle, the left valve

flattened or depressed. The posterior side is pointed at the end and with a narrow, excavated rostral area along its dorsal border. Hinge that of *Eurytellina* but more delicate; the right valve has two, small cardinal teeth, the posterior one bifid, a small anterior lateral tooth is placed close to the cardinals and a small, posterior lateral tooth is situated along the margin just in front of the adductor scar; the left valve is provided with a small, bifid, cardinal tooth with a socket on each side and also a small, partly obsolete posterior cardinal lamina. The lateral teeth of the left valve are formed by small, ridgelike laminae along the lower edge of the hinge plate, the anterior one is much the longer. The pallial sinus is large and deep, its end separated from the adductor scar by an open space, its lower limb continuous with that of the pallial line. Surface sculpture produced by narrow concentrics, neatly and finely crenulated by radial lines.

This group of species is so well marked that *Tellinidella* deserves generic status. Three species occur in the Panamic-Pacific region.

1. Shell large (length 67 mm.), subsolid, the adductor scars impressed, the hinge plate and teeth strong. Ventral margin straight in the midzone.
T. princeps
2. Shell smaller (length 62 mm.), thin, elliptical, the basal margin widely rounded, the length less than twice the height, hinge weak.
T. purpurea
3. Shell thin, narrowly elliptical, its length more than twice the height, hinge delicate, radial crenulations fine.

T. mompichensis

***Tellinidella purpurea* (Broderip and Sowerby)**

Plate 72, figure 2

Tellinides purpureus Broderip and Sowerby, 1829, Zool. Jour., vol. 4, No. 15, p. 363.—Sowerby, 1839, Zool. Beechey's Voyage, p. 153, pl. 42, fig. 2.

Tellina (*Tellinides*) *purpurascens* (Broderip and Sowerby), Hanley, 1846, Thes. Conch., vol. 1, *Tellina*, p. 295, No. 141, pl. 62, fig. 194. Real Leijos, Central America.

Tellina broderipii "Deshayes", Carpenter, 1855, Cat. Mazatlan Shells, Brit. Museum, p. 32.

Tellina (*Tellinides*) *broderipii* Deshayes, Maxwell Smith, 1944, Panamic Marine Shells, p. 64, fig. 851.

Tellina (*Tellinidella*) *purpureus* (Broderip and Sowerby), Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 2, No. 9, pp. 80, 81.

The shell is ovately elliptical, flattened to slightly convex, the umbones near the middle. Color of surface is a rose-purple, usually darker on the umbones and in the interior which is bright and glossy. The texture of the valves is fairly thin. Surface sculpture formed by closely arranged, small concentrics, much finer on the umbones, finely crenulated by radial lines. The species is separated from the rarer *T. princeps* by its thinner and more elliptical shell and much weaker hinge.

Range—Gulf of California to northern Peru. Panama: Guanico; Burica Peninsula. Ecuador: San Francisco; Sua; Punta Blanca; Point Ancon. Peru: Tumbes; Punta Picos.

***Tellinidella princeps* (Hanley)**

Plate 68, figure 3;
Plate 72, figure 1

Tellina princeps Hanley, 1844, Proc. Zool. Soc. London, p. 62. Tumbes.—Hanley, 1846, Thes. Conch., vol. 1, *Tellina*, pp. 238, 239, pl. 63, fig. 206.—Sowerby, 1867, Conch. Icon., vol. 17, *Tellina*, pl. 25, fig. 135.—Salisbury, 1934, Proc. Malacol. Soc. London, vol. 21, pt. 2, p. 91, pl. 9, fig. 4 (figure of type).

Larger and heavier than *T. purpurea*, the ventral margin nearly straight in the mid-zone. Surface sculptured like that of *T. purpurea*. Color dark rose-pink.

Range—Panama to northern Peru. Panama: Bahia Honda, El Largarillo near Las Tablas; Isla del Rey, Pearl Islands (Tomlin). Peru: Tumbes.

Tellinidella mompichensis, new species

Plate 72, figure 3

Shell thin, narrowly elliptical, the length more than twice the height, the beaks median, the two sides nearly alike. Color rose or white, often more or less banded. Rostral area narrow but well marked, deeply excavated, sculptured with cross threads, without radial striations. Like *T. purpureus* in general form but longer and with finer surface reticulation.

Length 57 mm., height 27.3 mm., diameter 5 mm. (right valve). Mompiche, Ecuador. Holotype, ANSP 218947.

My three right valves from Mompiche are of a light pink color, perhaps in part due to beach exposure. An entirely white shell was obtained in dredgings at Zorritos.

Range—Ecuador and Peru. Ecuador: Mompiche. Peru: Zorritos.

Genus *MOERELLA* Fischer, 1877

Type species by monotypy, *Tellina donacina* Linné. Recent, European seas.

Shell generally small, subquadrate to subelliptical, depressed or slightly convex, the posterior side much shorter, its dorsal margin descending rather sharply, sometimes a little flexed, and often subtruncated at the end. Surface smooth or marked with concentric growth lines and in the subgenus *Scissula* by incised lines cutting across the concentrics diagonally. Hinge as in *Eurytellina*, the right, anterior lateral tooth being placed close to the cardinal; the lateral teeth in the left valve are small and hardly represent more than a thickening of the valve margin so as to fit between the grooved sockets of the opposite valve.

Three subgenera may be recognized in the Panamic area.

- I. Shell usually small (seldom above 25 mm.), subquadrate to subelliptical in shape.
 1. Surface plain or marked only with growth line concentrics.

Subgenus *Moerella*, s.s.
 2. With incised lines cutting diagonally across the concentrics.

Subgenus *Scissula*
- II. Shell large (40 mm. or more), subovate to subelliptical, the anterior side expanded, convex; the posterior side shorter, pointed at end and somewhat twisted.
 3. Shell white, often with the umbones colored rose-pink.

Subgenus *Elpidollina*

Key to species of Panamic-Pacific *Moerella*, s.s.

Surface marked with concentric sculpture only, sometimes reduced to fine or hairlike growth lines or with stronger, incised lines. Posterior flexure weak.

- A. Shell subtrigonal in shape, the beaks subcentral.
 1. Moderately convex and of medium weight, the posterior side short, flexure weak. Surface marked with fine, raised, hairlike concentrics. Color white.

M. meropsis

2. Shell thinner, the anterior side high, rounded, the posterior side longer than in *M. meropsis*, bluntly pointed at the end, the flexure obsolete. Color white, yellow or pink, often with a red streak on the sides of the umbone.

M. suffusa

- B. Shell subelliptical to subquadrate in shape, the beaks nearer the posterior end, the anterior side hence always the longer.
 a. The posterior side narrows steadily towards the end, not indented by the ligament.
 3. Shell relatively large (20 to 25 mm.), solid and porcellaneous, white in color or suffused with red.

M. erythronotus

- b. Posterior margin arched or curved, indented by the ligament, generally expanded and wider distally, its end appearing obliquely truncated.
 ba. Shell relatively large (15 mm. or more), white or red.
 4. Subquadrate, the length about half the height, the posterior end expanded, widely truncated.

M. arenica

5. Broadly lenticular in shape, the anterior side much longer than the posterior which is not expanded but simply rounded at the end.

M. tumbezensis

bb. Shell smaller.

bba. Color usually a deep rose-red.

6. Umbones impressed, the posterior side wide, depressed, its end truncated obliquely.

M. felix

bbb. Color white, rarely pink.

x. Shell small, length less than 7 mm.

7. Posterior side cuneate.

M. cerrosiana

y. Shell larger, length from 7 to 15 mm.

8. Posterior side wide and squarely truncated at the end.

M. recurvata

9. Posterior-dorsal margin sinuated, terminating in a blunt, attenuated point.

M. hiberna

10. Posterior-dorsal margin straight.

M. amianta

Moerella (Moerella) meropsis (Dall)

Plate 69, figures 9, 9a

Tellina (Moerella) meropsis Dall, 1900, Proc. U. S. Nat. Museum, vol. 23, No. 1210, pp. 303, 317 "San Diego, Calif."

Tellina meropsis Dall, Grant and Gale, 1931, Mem. San Diego Soc. Nat. Hist., vol. 1, p. 359, pl. 14, figs. 9a, 9b; pl. 20, figs. 9a, 9b.

Tellina (Moerella) paziana Dall, 1900, Proc. U. S. Nat. Museum, vol. 23, No. 1210, p. 318, pl. 3, fig. 8 "La Paz, L. Cal."—Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 2, p. 71.

Shell small, thin or of medium texture, obliquely subovate, the anterior side wide and a third longer than the posterior, full and convex along the anterior umbonal slope; and in the left valve impressed behind. Posterior side with its dorsal margin descending rather rapidly to form a narrowly rounded or blunt point. Umbones prominent, the small beaks pointed anteriorly and projecting a little above the general profile. Surface usually appearing smooth because of some wear but well-preserved specimens will show a sculpture of fine, widely spaced concentric threads, best developed around the anterior and ventral margins, elsewhere more or less obsolete,

the growth lines fine and indistinct. There is a small lunule and a narrow escutcheon. Hinge weak; there is a strong anterior lateral in the right valve adjacent to the cardinal. Pallial sinus large and deep, highest and rounded under the beak and almost reaching to the anterior adductor scar, its lower limb united with the pallial line below for about half its length.

Length 20 mm., height 14.6 mm., semidiameter 4.3 mm., a left valve, Manta, Ecuador.

Length 17.4 mm., height 12.5 mm., semidiameter 3.2 mm., a right valve, Galeras Peninsula, Ecuador.

Specimens from Ecuador seem identical in size and shape to typical *M. meropsis* from California. *M. paziana* is probably a small form of the same species.

Range—Southern California to Ecuador. Panama: Búcaro. Ecuador: Esmeraldas; Galeras; Manta; Santa Elena.

Moerella (Moerella) suffusa (Dall)

Plate 69, figures 10, 10a

Tellina (Angulus) suffusa Dall, 1900, Proc. U. S. Nat. Museum, vol. 23, No. 1210, pp. 303, 319, pl. 3, fig. 10 "San Ignacio Lagoon, Lower Cal."

Tellina (Moerella) suffusa Dall, Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 2, p. 72.

Shell cuneate, very thin, convex, blunt in front, pointed behind, the posterior end slightly longer, pinkish, yellowish, or translucent white in color; surface rather strongly, closely, and irregularly concentrically striate, with an unusually large and wide, lunular impression, but no escutcheon to speak of; hinge normal, delicate; interior polished; the pallial sinus high, well separated from the anterior adductor, though there seems to be no trace of a ray in the specimens examined. (Dall, 1900.)

Length 13.5 mm., height 9.2 mm., diameter 4.7 mm.

This species is characterized by its broadly trigonal form, by its nearly medium beaks, large lunule and short, bluntly pointed anterior end. Color white, yellow or pink, often with a red streak on each side of the umbone. Some specimens show a strong play of rainbow colors over the surface.

Range—Lower California to southwestern Colombia. Mexico: Lower California. Nicaragua: Corinto (Hertlein and Strong). Colombia: Isla del Gallo.

Moerella (Moerella) erythronotus (Pilsbry and Lowe)

Plate 68, figure 4;
Plate 69, figures 2, 2a

Tellina puella C. B. Adams, 1852, Ann. Lyceum Nat. Hist. New York, vol. 5, pp. 507, 546, No. 468. (Not *puella* Hanley, 1846). Panama.

Tellina puellula Salisbury, 1934, Proc. Malacol. Soc. London, vol. 21, pt. 2, p. 86. (New name for *T. puella* C. B. Adams).

Tellina (Angulus) erythronotus Pilsbry and Lowe, 1932, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, p. 94, pl. 12, fig. 7.

Tellina (Moerella) erythronotus Pilsbry and Lowe, Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 2, pp. 69, 70.

Shell small or of medium size (length to about 25 mm.), elongate, solid, the anterior side a trifle longer, full and of medium convexity along the umbonal slope, the posterior side a little shorter, its dorsal margin straight, sloping into a narrowly produced, obtuse point, slightly contracted in front and narrowly depressed along its dorsal margin. Color white but more often flushed with pink, generally heaviest around the borders

and on the sides of the beak. Surface of disk smooth and often polished with fine growth line markings. Hinge teeth strong. The pallial sinus is large and deep, and fills most of the interior cavity, highest under the beak and from thence descending along an irregular line almost to the anterior adductor scar, its lower limb fully confluent with the pallial line. Adductor scars large, irregular in shape, and deeply impressed. An average shell measures: Length 24.3 mm., height 14.1 mm., semidiameter 3.6 mm., a right valve.

An elegant species recognized by its relatively large size, solid, porcelainous white shell generally suffused with rose-red on the umbones, along the dorsal margins and in the interior. The posterior side is straight, narrowed, and pointed at the end and slightly flexed. The species is abundant at many localities, particularly at Old Panama and Balboa.

Range—Lower California to Panama. Panama: Numerous localities.

Moerella (Moerella) tumbezensis, new species

Plate 68, figure 5;
Plate 69, figure 8

Shell ovate-quadrate, its height nearly three-fifths of its length, of medium convexity, thin and delicate, and of a white or pale pink color. The beaks are small, placed near the anterior two-thirds, the posterior side short, its margins descending, arcuate, the posterior slope itself flattened, setoff from the shell disk by a rounded umbonal angle and a slight change in sculpture. The ventral margin is slightly rounded passing into the more rounded outline of the anterior margin. There is no lunule and escutcheon. The ventral margins are weakly impressed in the posterior half with the result that the anterior margin appears to have a slight gap. Surface is nearly smooth, marked only with weak growth incrementals which are uniformly developed over the whole surface except on the posterior slope where only the heavier incrementals generally persist. The surface of the posterior area is also marked with small, divaricate, radial striae which begin at the umbonal angle and radiate downward. Pallial sinus ample, highest under the beak and then descending, its end not reaching the anterior adductor but is placed low so that the lower limb of the sinus is confluent with the pallial line for its whole length. Hinge normal, the right valve with a large, bifid posterior cardinal tooth.

Length 28.2 mm., height 18 mm., semidiameter 4.3., a right valve, Tumbes, Peru. Holotype, ANSP 218940.

On the mud flats at the mouth of the Tumbes River, Peru.

Range—Shores of the Gulf of Guayaquil, Ecuador and Peru. Ecuador: Posorja. Peru: Tumbes.

Moerella (Moerella) felix (Hanley)

Plate 69, figures 6, 6a

Tellina felix Hanley, 1844, Proc. Zool. Soc. London, p. 71 "Panama."—Hanley, 1846, Thes. Conch., vol. 1, *Tellina*, p. 281, pl. 57, fig. 52.—Maxwell Smith, 1944, Panamic Marine Shells, p. 64, fig. 839.

Tellina (Moerella) felix Hanley, Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 2, No. 9, p. 70, pl. 1, fig. 1.

Tellina (Angulus) macneilii Dall, 1900, Proc. U. S. Nat. Museum, vol. 23, No. 1210, pp. 303, 318, pl. 3, fig. 7 (Guaymas).

Tellina (Moerella) macneilii Dall, Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 2, pp. 70, 71.

Shell small (average length about 15 mm.), broadly elongate, rose-red, more or less concentrically banded, equivalve, depressed or slightly convex.

Anterior side nearly twice the length of the posterior, high, its dorsal and ventral margins subparallel, end widely rounded. The posterior area is short, uniformly flat, or slightly convex, sloping from the umbonal angle downward to its margin which is broadly arcuate, its end blunt. Shell is thin or subsolid, the adductor scars frequently showing as sunken areas. Surface smoothish but under a lens the sculpture is seen to be formed by even, narrow, concentric bands between sharply incised lines which apparently overrun the much finer, indistinct growth incrementals. Pallial sinus is deep, extending nearly to the anterior adductor, confluent with the pallial line for most of its length.

Length 10 mm., height 8.6 mm., diameter 3.3 mm.

This small species is easily recognized by its bright, rose-red color. It is fairly common at Panama.

Range—Mexico to northern Peru. Mexico: Guaymas. Costa Rica: Gulf of Nicoya. Panama: Panama City; Bella Vista. Panama Canal Zone: Fort Amador; Venado Beach. Colombia: Isla del Gallo. Peru: Zorritos.

Moerella (Moerella) cerrosiana (Dall)

Tellina (Angulus) cerrosiana Dall, 1900, Proc. U. S. Nat. Museum, vol. 23, No. 1210, pp. 303, pl. 3, fig. 11. "Off Cerros Island, Lower California in 9-10 fathoms."—Keen, 1958, Sea Shells of Tropical West America, p. 170, fig. 394.

The shell is small (length about 6.5 mm.), broadly elongate, slightly flexed, thin, glassy, the anterior side nearly twice the length of the posterior and widely rounded at its end. The left valve is slightly convex for the most part; the right valve is of similar inflation except that it is slightly impressed across the middle due to a weak flexing of the end towards the right. The surface color is white, often glassy, and marked with fine, concentric lines forming narrow ribbons; in addition there is often visible fine radial streaks or even a pattern of divaricating branches. The hinge is normal for the genus; the left valve has a single, bifid, cardinal tooth, and the laterals are weak or absent; the right, anterior lateral tooth is long and strong. Because of the thin texture of the shell, the pallial sinus is usually indistinct but when visible, it is seen to be large with a high angle under the beak and almost reaching to the anterior adductor scar, its lower line joined with the pallial line.

This is a small species. Specimens were dredged in some numbers at Manta and at Esmeraldas; these Ecuadorian specimens seem to have the posterior end a little longer than shown for the typical form but otherwise are identical.

Range—Lower California to Ecuador. Ecuador: Manta; Esmeraldas.

Moerella (Moerella) hiberna (Hanley)

Plate 84, figure 6

Tellina hiberna Hanley, 1844, Proc. Zool. Soc. London, p. 149.—Hanley, 1846, Thes. Conch., vol. 1, *Tellina*, p. 282, No. 112, pl. 57, fig. 53 Panama, Gulf of Guayaquil.—Salisbury, 1934, Proc. Malacol. Soc. London, vol. 21, pt. 2, p. 91, pl. 13, figs. 7, 8, 9.

Tellina (Angulus) panamensis Dall, 1900, Proc. U. S. Nat. Museum, vol. 23, No. 1210, p. 319, pl. 3, fig. 3 Panama. (Not *T. panamensis* Philippi, 1848.)

Tellina (Angulus) panamensis Dall, 1900, Proc. U. S. Nat. Museum, vol. 23, No. 1210, p. 319, pl. 3, fig. 3 Panama. (Not *T. panamensis* Philippi, 1848.)

Tellina tabogensis Salisbury, 1934, Proc. Malacol. Soc. London, vol. 21, pt. 2, p. 86. (New name for *T. panamensis* Dall.)

Tellina (Moerella) tabogensis Salisbury, Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 2, pp. 72, 73.

Shell small (length 19 mm. or less), oblong, white, thin or of medium weight, the posterior end slightly flexed. Anterior side is half again as long as the posterior, slightly convex along the umbonal slope, impressed along the ventral side, its end evenly rounded; the posterior side is wedge-shaped, its dorsal margin somewhat flaring above, then incurved near the end which is narrowly pouting or subtruncate. Surface relatively smooth but with small lines of growth spaced so as to form narrow concentric ribbons, wider spaced ventrally. The posterior area of the right valve is marked with heavier concentric lines which are especially coarse on the zone bordering the umbonal slope; small radial streaks may also be present. Pallial sinus large, having its highest point in an angle just in front of the posterior adductor scar, then sloping down into a rounded end, not quite extending to the anterior adductor scar. Below, the sinus is confluent with the pallial line.

Length 18.7 mm., height 11 mm., semidiameter of a left valve 2.5 mm.

This is a common and widely distributed species. It is easily recognized by its shape and the heavier sculpture along its posterior surface. Fresh specimens often show an iridescent luster.

This species was cited by Hanley from Panama and from the Gulf of Guayaquil, the latter place may be accepted as the general type locality. It is common at Zorritos, both in beach drift and in dredgings. Hertlein and Strong cite several localities north of Panama.

Range—Gulf of California to northern Peru. Panama: San Carlos. Ecuador: Santa Elena. Peru: Zorritos; Boca Pan; Talara.

Moerella (Moerella) amianta (Dall)

Tellina (Moerella) amianta Dall, 1900, Proc. U. S. Nat. Museum, vol. 23, No. 1210, pp. 303, 317, pl. 3, fig. 12. "Off Cape Tepoca near the head of the Gulf of California."—Hertlein and Strong, 1949, Zoologica, vol. 43, pt. 2, No. 9, p. 67.—Keen, 1959, Sea Shells of Tropical West America, p. 170, fig. 392.

The shell is small, elongate, its length about twice the height, sub-solid, white or glassy, the posterior side hardly flexed. The anterior side is longer than the posterior, its lower and upper margins subparallel, the end rounded. The posterior side is wedge-shaped, its dorsal side a little flattened, smooth, its end bluntly rounded. The umbones are low, flattened, the small beak projecting slightly and pointed forward. The surface is sculptured with close, concentric ridges forming narrow ribbons over most of the disk, but behind and on the posterior-umbonal slope they are more or less fused with each other or end completely; on the posterior-dorsal area, the sculpture is sharp and lamellose. There are small radial streaks as in *M. cerrosiana*, best seen on glassy specimens. The pallial sinus is deep, almost extending across to the anterior adductor scar and widely confluent with the pallial line below.

Length 12.5 mm., height 6.2 mm., diameter 3.5 mm.

This species resembles *M. cerrosiana* but is larger, heavier, and longer, its posterior side not so strongly flexed.

Range—Gulf of California to Colombia. Panama: Búcaro. Colombia: Isla del Gallo.

Subgenus *SCISSULA* Dall, 1900

Type species by original designation, *Tellina decora* Say (= *T. similis* Sowerby). Recent, West Atlantic.

The shell is usually small, elongate, and subelliptical, the posterior side shorter than the anterior, the surface depressed or mildly inflated, the texture thin, white or colored, sometimes glassy. Hinge as in *Moerella*, s.s. Surface with the usual growth line sculpture but in addition has a pattern of oblique or diagonal lines which cross the concentrics usually at high angles; these diagonal lines are most strongly developed over the middle and anterior sections of the disk.

Three species are regional.

Key to Panamic-Pacific *Scissula*

- I. Oblique lines are relatively coarse, widely spaced and intersect the basal margin at angles of about 40 degrees. There is a narrow, well-marked, smooth ray in front of posterior-umbonal angle. Posterior area well sculptured.

M. (S.) virgo
- II. Oblique lines much finer, more closely spaced and intersect the basal margin at angles of 15 to 20 degrees.
 1. Entire surface of disk in front of the posterior angle covered more or less uniformly by the oblique lines.

M. (S.) varilineata
 2. Oblique lines on anterior and middle portions of shell disk terminating sharply along a line running downward from the beak, the surface between it and the posterior angle wide, smooth and sculptureless.

M. (S.) esmeralda, new species

Moerella (Scissula) virgo (Hanley)

Plate 72, figure 4

Tellina virgo Hanley, 1844, Proc. Zool. Soc. London, p. 143.—Hanley, 1846, Thes. Conch., vol. 1, *Tellina*, p. 284, pl. 57, fig. 42.—Pilsbry and Olsson, 1943, Nautilus, vol. 56, No. 3, p. 79, pl. 8, fig. 5.

Tellina (Scissula) virgo Hanley, Salisbury, 1934, Proc. Malacol. Soc. London, vol. 21, pt. 2, p. 91, pl. 13, figs. 5, 6.—Maxwell Smith, 1944, Panamic Marine Shells, p. 65, fig. 850C.—Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 2, No. 9, p. 86.

With characters indicated in the key. This is a small delicate shell, often found plentifully in beach drift but the valves seldom perfect.

Range—Gulf of California to northern Peru. Panama: Búcaro; El Lagartillo. Panama Canal Zone: Venado Beach. Colombia: Isla del Gallo. Ecuador: Galeras. Peru: Tumbes.

Moerella (Scissula) varilineata (Pilsbry and Olsson)

Tellina (Scissula) varilineata Pilsbry and Olsson, 1943, Nautilus, vol. 56, No. 3, p. 79, pl. 8, fig. 6.

This species differs from *M. virgo* by its longer, heavier shell, and more especially by its much finer sculpture, the diagonal lines intersecting the basal margin at a much lower angle.

Length 17 mm., height 9.75 mm., semidiameter 2.1 mm. Búcaro, Panama.

Often found in association with *M. virgo*, and as indicated above, easily recognized by its much finer sculpture.

Range—Mexico to northern Peru. Panama: Búcaro. Peru: Tumbes; Boca Pan.

Moerella (Scissula) esmeralda, new species

Plate 68, figure 11;
Plate 72, figure 5

Shell nearly 20 mm. in length, ovately elongate, inequilateral, nearly equivalve, the ventral side longer, straight and nearly parallel to the much shorter, central-dorsal margin, flatly compressed, thin, white to subtranslucent. The beak is placed near the posterior one-third, hence, the posterior side is shorter, its marginal end straight to slightly subtruncated, the longer anterior side widely rounded at the end. The surface is sculptured on the anterior two-thirds of the disk by finely incised, oblique lines which end sharply in front of the posterior umbonal slope; behind this zone, the surface is mainly smooth. Posterior-umbonal angle is low, almost flat. Substance of shell thin and glassy, the surface sculpture showing as plainly on the inside as on the outside. Submicroscopic streaks and larger rays may show on some specimens.

Length 19.7 mm., height 10.3 mm., diameter 3.1 mm. (type)

Length 23.2 mm., height 12.2 mm., diameter 2.2 mm. (a right valve).

Camarones, Ecuador. Holotype, ANSP 218946.

Range—Ecuador. Ecuador: Camarones (beach).

Genus **ELPIDOLLINA**, new genus

Type species, *Tellina decumbens* Carpenter. Recent, Panama.

Shell with thin, subtrigonal valves, thin and rather inflated, subequal, the posterior side shorter and pointed, and hardly flexed. The hinge provided with both cardinal and lateral teeth, the cardinals usually small and of which the left anterior and the right posterior teeth are bifid, the others much smaller and simple. The lateral teeth are fairly large in the right valve, much smaller in the left; the anterior lateral tooth is placed near but not actually in contact with the cardinal tooth, the posterior lateral tooth more distant and beyond the end of the ligament scar. The ligament is external, its scar long and narrow. The pallial sinus is large and deep, highest under the beak and extending across to connect with the anterior adductor scar; its lower limb is fully confluent with the pallial line. Surface smooth except for minute lines of growth.

Elpidollina decumbens (Carpenter)

Plate 68, figures 14, 15

Angulus amplexans Carpenter, 1863, Rept. British Assoc. Adv. Sci., p. 669 nude name. (*Tellina*) *Angulus decumbens* Carpenter, 1865, Proc. Zool. Soc. London, pp. 278, 279.

Reprinted 1872, Smith. Misc. Coll., No. 252, pp. 271, 272 Panama.

Tellina peasii Sowerby, 1868, Conch. Icon., vol. 17, *Tellina*, pl. 49, fig. 288.

Tellina (Moerella) decumbens (Carpenter), Myra Keen, 1958, Sea Shells of Tropical West America, p. 170, fig. 395.

Shell of medium size (to about 47 mm.), obliquely subovate to sub-trigonal, the anterior side longer, higher, its dorsal margin somewhat expanded, the posterior side shorter, pointed, pinched but with hardly any flexing. The valves are nearly equal, moderately convex, especially along the anterior umbonal slope, slightly depressed on the posterior-ventral slope. Valves are relatively thin, smooth except for fine, growth concentrics, the color for the most part white, but some shells have the umbones and the shell cavity within flushed with pink; periostracum is thin, light-cream color.

Length 40.8 mm., height 38.2 mm., diameter 15.5 mm.

Young shells may resemble *T. lineata* Turton of the Caribbean but are more elliptical, thinner, and more convex. Most specimens are white, but occasional specimens have the umbones stained with rose or pink. This appears to be a localized species; it is common at Old Panama.

Range—Panama. Panama: Old Panama.

Genus SCROBICULINA Dall, 1900

Type species by original designation, *Scrobicularia viridotincta* Carpenter. Gulf of California.

(*Schumacheria* Cossmann, 1902, was proposed to replace *Scrobiculina* Dall, 1900, because of *Scrobiculinus* Monterosato, 1884, but now thought unnecessary.)

The shell is large or medium-sized, relatively thin, subovate, the umbones and beaks near the middle line, the posterior side narrower and flexed at the end. The hinge has two cardinal teeth in each valve but the posterior one often becomes partly effaced or wholly eliminated by the encroachment of the ligament scar in large specimens; the right or anterior lateral tooth is placed close to the cardinals. Ligament external but becomes deeply immersed into the hinge plate, its scar short and high. Surface approaching smoothness except for fine concentric threads, the left valve somewhat more plain but often showing faint radial lines. The pallial sinus is of moderate size, discrepant in the two valves, lower and narrower in the left.

This genus resembles *Macoma* in the shape of its valves and by its deeply immersed ligament, but the hinge is provided with an anterior lateral tooth.

Scrobicularia viridotincta (Carpenter)

- ? *Scrobicularia virido-tincta* Carpenter, 1856, Proc. Zool. Soc. London, p. 160 Panama.
Macoma viriditincta (Carpenter), Stearns, 1894, Proc. U. S. Nat. Museum, vol. 17, p. 156 La Paz and several other localities in the Gulf of California.
Tellina (*Scrobicularia*) *viridotincta* (Carpenter), Dall, 1900, Proc. U. S. Nat. Museum, vol. 23, p. 302.—Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 2, pp. 66, 67.—Hertlein and Strong, 1950, *op. cit.*, vol. 35, pt. 4, pl. 1, fig. 14.—Myra Keen, 1958, Seashells of Tropical West America, p. 176, fig. 415.
Tellina viridotincta (Carpenter), Pilsbry and Lowe, 1932, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, p. 133.

The shell is relatively large, subovate in shape, depressed to slightly convex, the posterior side short and narrow, slightly flexed towards the right at the end. Color white but usually more or less deeply flushed with yellow or orange.

This is a species of the Gulf of California; more southerly records as from Panama are questionable. *S. ochracea* Carpenter is an allied form, said to differ from *S. viridotincta* by its deeper orange or brown color.

Range—Gulf of California to Panama? Panama: Panama (Jewett). USNM 22823.

Genus **HERTELLINA**, new genus

Type species *Tellina* (*Scissula*) *nicoyana* Hertlein and Strong. Costa Rica.

Shell subelliptical, thin, nearly equilateral (*Sanguinolaria*-like in shape), the anterior side a little longer than the posterior. Surface smooth with indistinct growth lines and a heavier sculpture of concentric ribbons between incised lines which are a little oblique to the growth lines and margin of the valve. Hinge plate narrow and delicate, the teeth small; right valve has two, small, grooved cardinal teeth and a long, narrow, anterior lateral placed fairly close to the cardinals and a distant posterior lateral tooth; left valve has two cardinal teeth of which the anterior one is bifid, the other simple. Pallial line is large and deep but not reaching to the anterior adductor scar but separated from it by considerable space, the lower limb confluent with the pallial line below.

Externally shaped like *Sanguinolaria*, but with hinge characters of *Eurytellina*.

Named to honor Dr. Leo George Hertlein of the California Academy of Sciences in recognition of his many major contributions to the paleontology and malacology of the Pacific region.

Hertellina nicoyana (Hertlein and Strong)

Tellina (*Scissula*) *nicoyana* Hertlein and Strong, 1949, *Zoologica*, vol. 34, pt. 2, pp. 85, 86, pl. 1, figs. 23-26.

The shell is relatively small, elongately ovate to elliptical, thin, mildly convex, and of a pale rose or pink color. The surface is smooth, the lines of growth weak but with a stronger sculpture of concentric ribbons between evenly spaced incised lines which begin on the posterior-middle side of the disk and run diagonally to the margin in the middle zone and concentric or parallel to the margin on the anterior side.

Length 34.4 mm., height 19 mm., diameter 7.8 mm. Ballena Bay, Gulf of Nicoya, Costa Rica. Holotype, Calif. Acad. Sci.

This is evidently a rare species known only from a few specimens. The shape is like that of a small *Sanguinolaria* but the hinge is that of a *Tellina*. A specimen labelled *Sanguinolaria panamensis* Dall (evidently an unpublished name) is in the collection at the U. S. National Museum from Bay of Panama (USNM 96361). I have a single valve which was dredged off Zorritos, Peru.

Range—Costa Rica to northern Peru. Panama: Panama Bay (USNM). Peru: Zorritos.

Subfamily **MACOMINAE**

The valves are tellinoid in shape, the anterior side usually longer, the posterior side shorter, with or without a pronounced flexure. The hinge is provided with small cardinal teeth but the lateral margins are plain and

without any teeth or interlocking sockets. The pallial sinus is usually large, entire, its end rounded, and its lower limb partly joined with the pallial line. Margins of the valves smooth and without crenulations.

The typical species of the genus *Macoma* are cold-water forms. In that group, the surface of the valves is usually chalky and covered with a coarse dark-colored periostracum. Species from warmer waters have a thinner and lighter-colored periostracum, the surface beneath smooth, polished, and often a brilliant white. The ligament, as in the *Tellinas* proper, is external but in some genera as *Florimetus*, *Psammotreta* and the like, it is partly immersed or lies more deeply inset in the hinge plate; in such cases, the ligamental scar is often much reduced in size and has a triangular shape, closely appressed against the posterior cardinal tooth. The extent of the posterior flexure varies between different groups; it is wanting completely in some or so slight as to be hardly noticeable; in others, it is sharp and angular, and the posterior-dorsal slope may be expanded into a large winglike area as in *Florimetus*.

Genus FLORIMETIS Olsson and Harbison, 1953

Type species by original designation, *Tellina intastriata* Say. Florida.

Shell broadly subovate, inequivalve with a wide, depressed or winglike posterior area, which in the right valve is set off by a fold or angled keel extending from the beak to the posterior extremity. Both valves are strongly convex along the anterior umbonal slope, the right valve being impressed just behind it or across the middle. In the adult, the adductor scars are plainly marked, the anterior one being narrowly elongate or lucinoid with the pallial line attached to its lower end; the posterior scar rounded and placed quite low. Pallial sinus large and deep, reaching into the middle of the shell cavity and confluent below with the pallial line by more than half of its length. Hinge bearing small cardinal teeth, the left anterior and the right posterior tooth are bifid; there are no lateral teeth. Ligament external with a large, nymphal ridge. Outer surface white, the sculpture produced by growth incrementals, usually coarse over the posterior areas.

This group of American species has generally been known by the generic names of *Metis* or *Apolymetis*, the type of which is a little known East Indian species not closely related to our American shells. (See Olsson and Harbison, 1953, Mon. 8, Acad. Nat. Sci. Philadelphia, p. 129).

Florimetus cognata (Pilsbry and Vanatta)

Plate 67, figures 2-21;
Plate 68, figure 10

Lutricola cognata Pilsbry and Vanatta, 1902, Proc. Washington Acad. Sci., vol. 4, p. 556, pl. 35, fig. 5 "Tagus Cove, Albatraz." Galapagos Islands.

Apolymetis cognata (Pilsbry and Vanatta), Pilsbry and Lowe, 1932, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, pp. 96 (in text), 133.—Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 2, pp. 93, 94.

Apolymetis excavata (Sowerby), Pilsbry and Olsson, 1941, Proc. Acad. Nat. Sci. Philadelphia, vol. 93, p. 70. Not *Tellina excavata* Sowerby, 1867 (= *P. dombei* (Hanley).)

Shell large, with a length to about 84 mm., subsolid. Umbones and beaks are nearly median, the anterior side a little longer, the posterior side deeply flexed, producing a large, winglike posterior area. Valves roundly

subrhomboidal, the left valve a little larger than the right, more convex over the umbonal slope, depressed behind the posterior keel. Surface white and irregularly marked with coarse lines of growth.

A left valve from Paita measures: length 84 mm., height 73 mm., diameter 20 mm.

This species, although plentiful along parts of the coasts of Peru and Ecuador, has remained little known and poorly represented in most collections. It is similar to the northern *F. biangulata* (Carpenter) in its flaring and less steeply sloping posterior area and much narrower, weaker hinge. It is also closely related to *F. magnoliana* (Dall), a Miocene and Pliocene species from Florida and the Carolinas, as well as to *F. biplicata* (Conrad) from the Miocene of Maryland.

Range—Panama to northern Peru; also the Galápagos Islands. Panama: Guanico; El Lagartillo; Las Tablas. Panama Canal Zone: Venado Beach; Palo Seco. Ecuador: Sua; Charapota; Santa Elena. Peru: Boca Pan; Mancora; Paita; Bayovar.

Genus PSAMMOTRETA Dall, 1900

Type species by original designation, *Tellina aurora* Hanley.

The valves are elongately ovate to trigonal, the posterior side shorter than the anterior, its dorsal margin descending to form a narrower and sometimes slightly expanded or winged posterior area. The posterior flexure may be weak or strong. Except for the flexure, the valves are generally similar in shape and degree of inflation, the greatest zone of convexity lying diagonally along the anterior-umbonal slope. The adductor scars are unequal in size, the posterior one long and narrow. The pallial sinus is deep and rounded at the end, its lower limb coalescent in part with the pallial line. The surface is smooth except for lines of growth and occasionally with still finer, radial striae. The ligament is external, its scar relatively short and formed by an excavated or inset pit in the hinge plate, crowded against the cardinal tooth which may be partly obliterated by it.

Psammotreta Dall was based on *Macoma aurora* Hanley, a species with elongate-quadrate valves, the posterior side with a weak flexure; its ligamental scar is short and subtriangular in shape and so deeply immersed in the hinge plate that the adjacent cardinal tooth is partly obliterated by it. The larger and more trigonal species such as *P. dombei* have similar hinge and ligament features but the valves are more strongly flexed, so that the posterior-dorsal area may be slightly winged; such species have often been referred to *Apolymetis* (*Florimetis*) but the posterior area is never so broadly winged or the posterior flexure so sharply folded as in the typical species of that genus. *Psammotreta* is allied to *Florimetis* as shown by its unequal adductor scars and immersed ligament.

Psammotreta aurora (Hanley)

Plate 74, figures 6, 6a

Tellina aurora Hanley, 1844, Proc. Zool. Soc. London, p. 147 Panama.—Hanley, 1846, Thes. Conch., vol. 1, *Tellina*, p. 301. No. 153, pl. 58, fig. 76.

Macoma (*Psammacoma*) *aurora* (Hanley), Salisbury, 1934, Proc. Malacol. Soc. London, vol. 21, pt. 2, p. 91, pl. 11, fig. 4 (figure of lectotype).

Macoma (*Psammotreta*) *aurora* (Hanley), Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 2, No. 9, p. 92.

Shell broadly elongate-ovate, the right valve slightly flexed, the beaks placed a little behind the middle, subsolid. Color white or gray with the umbones tinted with yellow or ochraceous salmon extending into the interior. Surface smooth or irregularly banded with the lines of growth; there is usually some fine, radial striation showing under a lens. Pallial sinus deep, highest under the beak and then descending to form a bluntly rounded end and confluent with the pallial line below for about half its length.

Length 48.5 mm., height 34 mm., diameter 15.8 mm.

Range—Lower California to Ecuador. Panama: Búcaro. Panama Canal Zone: Palo Seco; Venado Beach. Ecuador: Punta Blanca.

Psammotreta dombel (Hanley)

Plate 74, figure 2;
Plate 85, figures 1-18

Tellina dombei Hanley, 1844, Proc. Zool. Soc. London, p. 144 Panama.—Hanley, 1846, Thes. Conch., vol. 1, p. 323, pl. 62, fig. 182 Panama.

Tellina dombeyi Hanley, 1844, Proc. Zool. Soc. London, index p. 195.—Sowerby, 1867, Conch. Icon., vol. 17, *Tellina*, pl. 30, fig. 169.

Apolymetis dombei (Hanley), Maxwell Smith, 1944, Panamic Marine Shells, p. 65, figs. 850, 850A.—Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 2, No. 9, p. 94.

Tellina excavata Sowerby, 1867, Conch. Icon., vol. 17, *Tellina*, pl. 26, fig. 138. Hab. - - ?

The shell is ovate-oblong, the posterior side shorter, its dorsal margin descending into a rounded and slightly flexed end; generally with a small open gap along the anterior margin. The valves are nearly alike in shape and inflation, the left valve is a trifle smaller only. Both valves are convex along the anterior-umbonal slope, impressed behind. Surface smooth except for the lines of growth which are irregularly distributed and sometimes set off in bands by the deeper resting marks. The periostracum is thin, straw-colored, and flakes off easily. Color of surface white, sometimes with the umbones flushed faintly with red. The pallial sinus is large, highest in the middle, united below with the pallial line. The ligament scar immersed.

Length 60.6 mm., height 46.1 mm., diameter 24.3 mm.

Length 77.6 mm., height 58 mm., semidiameter 14.8 mm., a right valve.

As suspected by several workers, Sowerby's *Tellina excavata* described from an unknown locality, has proved on examination of the type at the British Museum (Natural History) to be the same species as Hanley's *P. dombei*. *P. dombei* is a common shell in northern Peru, generally found on mud flats.

Range—Gulf of Fonseca to northern Peru. Panama: Panama City; Puerto Chame; Chorrera; El Lagartillo near Las Tablas; Garachine; Río Chepo. Peru: Puerto Pizarro near Tumbes.

Psammotreta grandis (Hanley)

Plate 67, figure 4;
Plate 68, figure 7

Tellina grandis Hanley, 1844, Proc. Zool. Soc. London, p. 141 Tumbes.—Hanley, 1846, Thes. Conch., vol. 1, *Tellina*, p. 327, No. 206, pl. 65, fig. 247.—Sowerby, 1867, Conch. Icon., vol. 17, *Tellina*, pl. 40, fig. 231.

Shell large (length up to about 85 mm.), broadly elliptical, solid, depressed to slightly convex, subequivalve. A posterior flexure is almost lacking. Valves with the beaks placed a little behind the middle, the anterior side being somewhat longer, the two ends of the shell having much the same rounded outline. Surface smooth or marked with fine growth lines,

often appearing banded, the deeper lines of the resting stages being spaced some distance apart. Under a lens, the surface shows faint radial striae. Patches of a thin, straw-colored periostracum may persist near the ventral margin. Interior of the shell is a porcelain white and often so heavily thickened that the pallial sinus and the adductor scars appear as if deeply engraved. Adductor scars large, subequal, shiny. The pallial sinus is a large bay, extending almost to the middle, its end obtusely rounded or angled, its lower limb coalescent with the pallial line for about quarter of its length. Cardinal teeth small, the anterior left and posterior right are double.

Length 85.2 mm., height 65 mm., diameter of a right valve 15 mm. Mompiche, Ecuador.

This is the largest and heaviest of the Panamic Macomas.

Range—Panama to northern Peru, also Galapagos. Panama: Guanico. Panama Canal Zone: Palo Seco. Colombia: Choco (Oscar Haught), USNM 488850. Ecuador: Limones; Mompiche; Sua; Pedernales; Charapota; Jaramijo. Peru: Tumbes. Galapagos: Tagus Cove and Charles Island (Tomlin).

Psammotreta gubernacula (Hanley)

Plate 74, figures 4, 4a

Tellina gubernaculum Hanley, 1844, Proc. Zool. Soc. London, p. 142.—Hanley, 1846, Thes. Icon., vol. 1, p. 325, No. 201, pl. 62, fig. 186 Real Lejos, Central America.

Macoma pacis Pilsbry and Lowe, 1932, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, p. 95, pl. 10, figs. 1, 1a, 2, 3 La Paz, Lower California.

Macoma (Psammotreta) pacis Pilsbry and Lowe, Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 2, pp. 92, 93.—Hertlein and Strong, 1955, Bull. Amer. Mus. Nat. Hist., vol. 107, art. 2, p. 201.

Shell subovate, inequilateral, the anterior side longer, broadly rounded at the end, the posterior side short, depressed to mildly convex, the maximum inflation across the anterior-umbonal slope, flattened or weakly depressed behind it. The valves are slightly unequal, the right a trifle larger, the posterior flexure hardly noticeable except in the left valve. The dorsal margin is slightly curved in front of the beaks, straight and more steeply sloping behind them, the ventral margin moderately arcuate. The surface is dull or polished, covered with fine, hardly visible growth lines and sometimes extremely minute radial striae. Color plain white or shading into light, ochraceous salmon towards the beaks, the same color within. The pallial sinus is large, high, and angled in the middle, rounded at the end. Ligament scar short, deeply inset into the hinge plate.

Length 52.5 mm., height 41 mm., diameter 18 mm. Bella Vista, Panama City, Panama.

As noted by Pilsbry and Lowe (as *pacis*), this species shows much variation in shape, some shells are decidedly more quadrate or oblong. It is also similar to *P. dombei*, but it may be distinguished by its flatter and less flexuous valves.

Range—Lower California to Ecuador. Panama: Bella Vista beach, Panama City; Puerto Chame; Búcaro. Ecuador: Santa Elena; Puerto Limones.

Psammotreta asthenodon (Pilsbry and Lowe)

Plate 74, figures 1, 1a

Apolymetis asthenodon Pilsbry and Lowe, 1932, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, p. 96, pl. 11, figs. 1-3.

The shell small or of medium size, relatively thin, white, under a thin, deciduous buff periostracum, inflated in the anterior half, which has a broadly rounded outline, tapering to the truncated posterior end which is bent a little towards the right. The small beaks are behind the middle. The right valve has an obtuse, post-basal ridge, and is broadly flattened or weakly concave in front of it. Pallial sinus large, high, extending deep into the valve cavity but confluent with the pallial line below only for a short distance near its opening. Surface plainly sculptured with growth lines only.

Length 58.5 mm., height 40.5 mm., diameter 25 mm. (Type ANSP 116052 La Union, Gulf of Fonseca, San Salvador.

A right valve from Puerto Chame, Panama, has a length of nearly 77 mm.

Apparently a rare but distinctive species.

Range—San Salvador to northern Peru. Panama: Panama City (Zetek); Puerto Chame; Guanico. Peru: Tumbes.

Genus *PSAMMACOMA* Dall, 1900

Type species by original designation, *Tellina candida* Lamarck (= *galathea* Hanley).

Shell elongate, tagelloid, valves subequal, the posterior side much shorter, weakly flexed, and bluntly truncated at the end. Ligament and resilium attached to a long, narrow scar which is wholly external, no nymphal ridge. Adductor scars subequal. Pallial sinus not extending to the anterior adductor, rounded at the end, free or partly coalescent with the pallial line. Surface smooth except for fine lines of growth and covered by a thin and often radially hirsute periostracum.

Two subgenera

I. Entire surface smooth except for the lines of growth.

Subgenus *Psammacoma*, s.s.

II. Similar but with the posterior slope granulose.

Subgenus *Macoploma*

Psammacoma lamproleuca (Pilsbry and Lowe)

Plate 68, figure 12;
Plate 74, figures 3-3b

Tellina lamproleuca Pilsbry and Lowe, 1932, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, p. 93, pl. 11, figs. 6, 7 (as *Macoma parthenopa* Pilsbry and Lowe, p. 144, explanation of plate).

Macoma (Psammacoma) lamproleuca (Pilsbry and Lowe), Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 2, No. 9, p. 90.

Shell generally large (length 75 mm., or more), *Tellina*-like, solid, white under a thin, deciduous, buff-colored periostracum, the anterior side a third longer than the posterior. The right valve is moderately flexed, the zone behind the posterior-umbonal slope is depressed, the posterior area itself flattened and fairly wide; the left valve is more evenly convex, the posterior area narrow, the end turned inward but slightly. Surface smooth with the growth lines fine and indistinct. Interior porcellaneous white, the adductor scars subequal, shiny, the pallial sinus as figured, extends a little beyond the middle and confluent with the pallial line for about a quarter of its length.

This is a common species in the Panama Canal Zone, especially at Palo Seco and Thatcher's Ferry. It is often large, a specimen from Punta Ostiones in Ecuador measures as follows: length 96.2 mm., height 54.4 mm., semi-

diameter 17.6 mm. (a left valve). The species occurs as fossil in the Pliocene of Ecuador.

Range—Gulf of California to northern Peru. Panama: Búcaro; San Carlos; Panama City. Colombia: Isla del Gallo. Ecuador: Punta Ostiones (Esmeraldas); Mompiche; Puerto Callo. Peru: Mancora; Boca Pan; Tumbes.

Psammacoma elytrum (Keen)

Plate 74, figure 7

Tellina elongata Hanley, 1844, Proc. Zool. Soc. London, p. 144.—Not *T. elongata* Dillwyn, 1823.—Hanley, 1846, Thes. Conch., vol. 1, p. 302, No. 156, pl. 62, fig. 199 Chiriqui, West Columbia.—Sowerby, 1867, Conch. Icon., vol. 17, *Tellina*, pl. 25, fig. 137.

Macoma (Psammacoma) elongata (Hanley), Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 2, pp. 89, 90.—Hertlein and Strong, vol. 1955, Bull. Amer. Mus. Nat. Hist., vol. 107, art. 2, p. 200.

Macoma (Psammacoma) elytrum Keen, 1958, Bull. Amer. Paleont., vol. 38, No. 172, p. 244, pl. 30, fig. 14. New name to replace *T. elongata* Hanley, preoccupied by *T. elongata* Dillwyn, 1823.

Shell elongate-quadrate, the anterior side about a third longer than the posterior, somewhat expanded, highest and most inflated along the umbonal slope, slightly impressed across the anterior-ventral side; the shorter posterior side is narrowed, slightly flexed, rounded, or weakly pointed at the end and slightly gaping. The valves are thin, white, sub-translucent, smooth and often polished, covered with minute lines of growth which sometimes may show a play of weak, iridescent colors; the covering periostracum is thin and of an ashy gray or dirty straw color. The pallial sinus is of moderate size, extends well beyond the middle of the valves, highest under the beak, and partly confluent with the pallial line below. The hinge is weak, the scar of the ligament long.

Length 46.4 mm., height 25.9 mm., diameter of a right valve 6.6 mm.

Length 51.8 mm., height 28.7 mm., diameter 15.1 mm. Panama Bay

Distinguished by its elongated thin white shell. Although rare as a beach shell, it is obtained by shrimp trawlers in fair numbers along the Panama coast.

Range—Lower California to Ecuador. Panama: Bella Vista; Panama City. Panama Canal Zone: Thatcher's Ferry. Colombia: Cojimenes.

Psammacoma siliqua (C. B. Adams)

Plate 74, figures 9, 9a

Tellina siliqua C. B. Adams, Ann. Lyceum Nat. Hist., New York, vol. 5, pp. 508, 546, No. 470.—Turner, 1956, Occas. Papers on Mollusks, Mus. Comp. Zool., vol. 2, No. 20, p. 85, pl. 19, figs. 15, 16. Panama.

The shell is small, elongate, thin, convex, and strongly inequilateral, the umbones and beaks placed near the posterior third, the anterior side hence much longer, higher, inflated, widely rounded at the end, the posterior side shorter, narrower, strongly flexed, and subtruncated at the end. The left valve is a little larger than the right, rather strongly convex over all, its dorsal and ventral margins straight and parallel, the left a little less convex, flattened or impressed across the posterior-middle zone due to the twist or bend of the valve towards the right. The outer surface is smooth and shiny, marked only by the extremely minute lines of growth. Hinge weak, the pallial sinus deep and reaching almost to the anterior adductor scar, its lower limb about half confluent with the pallial line below.

Length 19.1 mm., height 9.7 mm., diameter of a left valve 4 mm.

Because of its thin and easily broken shell, this species is seldom seen in collections. My specimens were obtained from beach drift taken at Venado Beach in the Panama Canal Zone.

Range—Panama. Panama: Panama City, (C. B. Adams). Panama Canal Zone: Venado Beach.

Subgenus **MACOPLOMA** Pilsbry and Olsson, 1941

Type species *Macoma ecuadoriana* Pilsbry and Olsson. Pliocene of Ecuador.

Shell elongate, nearly equivalve, the left valve a little larger and more convex than the right; its surface covered with earthy granules, heaviest on the posterior area, absent or weaker on the rest of the disk.

Distinguished from other macomid genera by the heavy granulation of the posterior submargins, suggestive of that of *Periploma*.

Psammacoma (Macoploma) medioamericana (Olsson)

Macoma (Macoploma) medioamericana Olsson, 1942, Bull. Amer. Paleont., vol. 27, No. 106, p. 196, pl. 17, fig. 8 Pliocene, Quebrada Penitas, Burica Penn., Costa Rica.—Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 2, p. 93.

Shell elongated, resembling *P. lamproleuca* in size and shape but proportionately longer and the surface is covered irregularly with earthy granules, heaviest on the posterior area. A specimen from the Gulf of Nicoya, Costa Rica, recorded by Hertlein and Strong has the following measurements: length 101 mm., height 54 mm., diameter of both valves together 24 mm.

First found as fossil in the Pliocene of the Burica Peninsula in Costa Rica but since recorded as still living by Hertlein and Strong at several places from Mexico southward to Panama. *P. ecuadoriana* Pilsbry and Olsson is another fossil species from the Pliocene of Ecuador.

Range—Gulf of California to Panama.

Genus **PSAMMOTHALIA**, new genus

Type species, *Tellina cognata* C. B. Adams.

The shell is subrhomboidal or *Psammobia*-like in shape, with flattened umbones and the beaks placed a little behind the middle, the two ends of the valves almost alike, except that the shorter posterior side is more depressed and its margin more widely truncated. The hinge is provided with small cardinal teeth, but there are no laterals; the left valve has a single, narrowly bifid, cardinal tooth with a socket on each side: the right valve has two, small, bifid, cardinal teeth. The ligament is external, attached to a long, narrow, grooved scar along the upper side of a nymphal ridge. The adductor scars are large and nearly equal, placed high in the interior of the valve. The pallial sinus is deep, its upper limb almost reaching across to the anterior adductor scar, rounded at its end and joined with the pallial line below for about half its length. The external surface is usually smooth and polished, marked lightly with concentric lines of growth and diagonally across these a set of incised lines (*Scissula*-like)

which cover most of the disk in front of a smooth band along the posterior-umbonal slope.

The generic relations of *Tellina cognata*, the type species, has long been controversial; it was referred to *Psammobia* by Reeve; to *Quadrans* by Dall; and to *Scissula* by Hertlein and Strong. The squat rhombic shape of its valves and oblique surface sculpture is strongly suggestive of the Psammobiidae but the nymph is tellinoid, small, and narrow. The cardinal teeth are all bifid and there are no laterals.

Psammothalia cognata (C. B. Adams)

Plate 67, figures 1-1b;
Plate 68, figure 16

Tellina cognata C. B. Adams, 1852, Ann. Lyceum Nat. Hist. New York, vol. 5, pp. 503, 545, No. 459.—Turner, 1956, Occas. Papers on Mollusks, Mus. Comp. Zool., vol. 2, No. 20, p. 38, pl. 18, figs. 9, 10.

Tellina concinna C. B. Adams, 1852, *op. cit.*, pp. 504, 546, No. 461.—Turner, 1956, *op. cit.*, p. 41, pl. 18, figs. 16, 17.

Psammobia casta Reeve, 1857, Conch. Icon., vol. 10, *Psammobia*, pl. 8, fig. 55. Not *Tellina casta* Hanley, 1844. (Guatemala).

Macoma (Psammacoma) cognata (C. B. Adams), Maxwell Smith, 1944, Panamic Marine Shells, p. 65, fig. 849.

Tellina (Scissula) cognata C. B. Adams, Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 2, No. 9, p. 85.

Shell with oblong, rectangular valves, slightly convex to depressed, the anterior end obliquely rounded, the posterior side shorter, depressed, its margin straight as if crudely truncated. Surface color is principally white except for the umbones which may be shaded lightly with salmon-pink or brown; the interior often pink. The surface is generally smooth and polished, the growth lines showing indistinctly and sometimes under a lens, fine radial striations may often be seen, but the principal sculpture is formed by a series of evenly spaced, diagonal, incised lines which begin in front of a smooth ray bounding the posterior-umbonal angle. The periostracum is straw-gray in color, thin and preserved only on live shells.

Length 53.7 mm., height 35.8 mm., diameter 15.1 mm. Tumbes, Peru.

Length 65.5 mm., height 41 mm., semidiameter 9 mm., a right valve, Zorritos, Peru.

This species, long misunderstood and poorly represented in most museum collections, is now known to be common and widely distributed. A smooth form or one without the obliquely incised lines was named *concinna* by C. B. Adams. It is a common fossil in the Pliocene of Ecuador. The same species or a similar one has recently been discovered in the Gulf of Mexico and seen by the author (Steger collection, Tampa, Florida).

Range—Mexico to northern Peru. For northern records, see Hertlein and Strong. Panama: Búcaro; San Carlos. Panama Canal Zone: Venado Beach. Ecuador: Sua, Charapota, Playas. Peru: Tumbes; Zorritos; Boca Pan.

Genus **ARDEAMYA**, new genus

Type species, *Tellina columbiensis* Hanley. Panama-Pacific.

Shell elongate-elliptical, subequivalve, inequilateral, compressed or slightly convex, thin, smooth, white. Posterior side somewhat shorter, pointed or wedge-shaped at the end, straight or with the right valve weakly flexed. Hinge plate small forming a narrow roof or shelf above the umbonal

cavity and bearing two small, weak cardinal teeth in each valve, the left posterior and the right anterior cardinal teeth bifid, the others small and simple; no laterals but the valve margins may be grooved and overlapping. Ligament external, posterior of the beak, the resilifer small, obliquely wedge-shaped and showing a chalky surface texture. Pallial sinus ample, angled, highest in front of the posterior adductor, joining and becoming confluent with the pallial line near the anterior one-third. Adductor scars subequal, shiny. Surface smooth, often polished, the growth lines small and close, covered by a thin, drab-colored periostracum.

Ardeamya columbiensis (Hanley)

Plate 74, figures 5, 5a

Tellina columbiensis Hanley, 1844, Proc. Zool. Soc. London, p. 71.—Hanley in Sowerby, 1846, Thes. Conch., vol. 1, p. 307, No. 166 (as 165), pl. 65, fig. 246. Monte Christi.

Shell elongate-elliptical, compressed or slightly convex, thin or fragile, white, smooth, with a length up to about 80 mm., but usually smaller. Anterior side is the longer, high, the small beaks somewhat pointed and projecting, the ventral margin widely rounded, the posterior side shorter, pointed or wedge-shaped at the end, straight or in the right valve sometimes slightly flexed. Surface smooth and marked with minute lines of growth, the whole covered with patches of a thin, cream or drab-gray periostracum.

Length 60 mm., height 34.9 mm., diameter of a right valve 5 mm. Tumbez, Peru.

Length 68.2 mm., height 39.7 mm., diameter of a right valve, 5 mm. Punta Picos, Peru.

This is a lovely species, distinguished by its depressed, subelliptical shape and white, shiny valves. Although the beaks are small, they rise sharply above the general outline of the valves.

Range—Panama to northern Peru. Panama: Lagartillo near Las Tablas; San Carlos. Ecuador: Manta; Mompiche. Peru: Tumbez; Zorritos; Punta Picos.

Genus *CYMATOICA* Dall, 1889

Type species, *Tellina undulata* Hanley. Santa Elena, Ecuador.

Shell small, elongated, *Nuculana*-like, the valves thin, white, with a narrowly produced, flexed posterior side and a longer, rounded anterior side. Hinge delicate bearing small cardinal teeth but no laterals. Pallial sinus deep but not extending to the middle and becoming partly confluent with the pallial line below. Surface sculptured with low, wavelike undulations, transmitted through the shell, parallel to the concentric growth lines over most of the disk but cutting across them on the anterior slope.

Cymatoica undulata (Hanley)

Plate 69, figure 7

Tellina undulata Hanley, 1844, Proc. Zool. Soc. London, p. 72.—Hanley, 1846, Thes. Conch., vol. 1, *Tellina*, p. 310, pl. 59, figs. 107, 107a Santa Elena.

Cymatoica occidentalis Dall, 1900, Proc. U. S. Nat. Museum, vol. 12, No. 773, p. 272, pl. 10, fig. 11.

Macoma (Cymatoica) undulata (Hanley), Maxwell Smith, 1944, Panamic Marine Shells, p. 66, fig. 850F.—Hertlein and Strong, 1949, Zoologica, vol. 34, pt. 2, No. 9, p. 89.—Hertlein and Strong, 1955, Bull. Amer. Mus. Nat. Hist., vol. 107, art. 2, p. 200.

Shell small, thin, with strongly flexed valves, white or glassy. Beaks small and erect, placed at the posterior third, the posterior side behind

them produced to a narrowly truncate end. Surface sculpture consists of 12 or more, deep, parallel undulations which terminate sharply at the anterior and anterior-ventral margins as if cut off, the undulations because of the thinness of the valves show clearly in the interior and generally undulate the anterior margins.

A rare species, easily recognized by its sculpture. Usually less than 16 mm. in length. Fossil in the Pliocene of Ecuador.

Range—Gulf of California to Ecuador. Panama: Lagartillo, near Las Tablas; South Passage, Pearl Islands (Hertlein and Strong). Ecuador: Esmeraldas; Manta; Santa Elena.

Genus *AUSTROMACOMA*, new genus

Type species, *Macoma constricta* (Brugière). Caribbean and south Florida.

Shell subovate, fairly convex, generally thin, the posterior side weakly or strongly flexed towards the right, the left valve as a result somewhat larger and more inflated than the right. Two cardinal teeth in each valve, the posterior right and the anterior left teeth bifid; lateral teeth absent. Ligament entirely external, attached to a long, slender scar behind the cardinal teeth; no nymphal ridge. The anterior adductor scar is long and narrow, lucinoid, with the pallial line attached to its lower end and follows close to the ventral margin. Pallial sinus large, somewhat discrepant in the two valves, widely coalescent with the pallial line below. Surface white, marked with fine, hairlike concentric threads and covered with a thin light-colored periostracum.

Typical *Austromacoma* has a large pallial sinus, high and pointed under the beak, and connected with the anterior adductor scar at its lower end. The genus appears to be restricted to the Caribbean.

Order ADAPEDONTIDA

Superfamily SOLENACEA

Family SOLENIDAE

Shells usually elongate, sword or razor-shaped, equivalve, usually open and truncated at both ends. Beaks low, terminal or somewhat distant from the anterior end, the posterior side always longer. Pallial sinus small in species with anterior umbones, larger in those species having the umbones more distant from the end, the adductor scars large and well marked. Hinge relatively weak with one or two small cardinal teeth, more or less projecting, the ligament external and attached to a short nymph. Surface smooth or sculptured with concentric lines of growth, sometimes with oblique striae or groovings, covered by a coarse brown or straw-colored periostracum. Hinge plate often strengthened or buttressed by a thickened ray. Burrowers in sand.

Key to genera of the Solenidae

- I. Shell straight or almost so. A single cardinal tooth in each valve.
 1. Beaks terminal, placed at the extreme anterior end. Genus *Solen*
 2. Beaks not fully terminal. Subgenus *Solena*
- II. Shell with a decided curve. Hinge provided with two cardinal teeth in the left valve. Genus *Ensis*

Genus **SOLEN** Linné, 1758

Type species by subsequent designation, Lamarck, 1799 or by Schumacher, 1817, *Solen vagina* Linné.

Shell long, subcylindrical, approximately straight, with the dorsal and ventral margins parallel. Beaks near the anterior end. Valves subequal, subtruncated and gaping at both ends, the surface smooth or roughened by lines of growth, covered by a smooth or rough periostracum. Ligament external, attached to an elongated nymph. Hinge with a single, large, projecting cardinal tooth in each valve. Adductor scars subequal, distinct, the posterior one placed a short way within the margin, the two scars connected across by a straight, narrow, ribbon-like pallial line, its sinus small and irregular in shape.

Solen (Solen) pfeifferi Dunker

Plate 63, figure 6

Solen pfeifferi Dunker, 1861, Proc. Zool. Soc. London, p. 420. "Hab. Caracas, West Colombia (H. Cuming).—Sowerby, 1874, Conch. Icon., vol. 19, *Solen*, pl. 6, fig. 26.—Hertlein and Strong, 1950, Zoologica, vol. 35, pt. 4, p. 226, pl. 1, fig. 2.

Shell small, length usually less than 50 mm., the ratio of height in the order of 1 to 5, nearly straight, thin and fragile, convex, the two ends are slightly, obliquely truncated. Color white or irregularly flushed with violet. Surface smooth and covered by a thin, olive-brown periostracum.

Length 45 mm., height 8.5 mm., diameter 6.6 mm. Santa Elena, Ecuador.

Range—Mexico southward to Ecuador. Panama: Guanico. Panama Canal Zone: Palo Seco. Ecuador: Jaramijo; Santa Elena.

Subgenus **SOLENA** Mörch, 1853

(Hypogella Gray, 1854.)

Type species by subsequent designation, Stoliczka, 1871, *Solen obliquus* Spengler. (*S. ambiguus* Lamarck). Caribbean and West Indies.

Beaks not strictly terminal but placed a short space in from the anterior end. Surface covered with a coarse rude periostracum.

Solen (Solena) rudis C. B. Adams

Plate 63, figures 1, 1a

Solen rudis C. B. Adams, 1852, Ann. Lyceum Nat. Hist. New York, vol. 5, pp. 524, 525, 548, No. 510 "Panama".—Turner, 1956, Occas. Papers on Mollusks, Mus. Comp. Zool., vol. 2, No. 20, p. 83, pl. 19, figs. 1-2.

Shell often large (length 140 mm.), the ratio of height to length about 1 to 4½, solid, straight or slightly curved, the posterior end sharply truncated, the anterior end more obliquely so, its margins heavily thickened. Surface of shell white beneath an olive-brown to light, straw-yellow periostracum which may be extended beyond the margins of the valves. Growth lines are coarse, especially so along the posterior-umbonal slope.

Doubtfully distinct from the Caribbean *S. obliquus* Spengler from which it differs only by its somewhat more slender form.

Range—Costa Rica to Peru. Costa Rica: Burica Peninsula, west shore. Panama: Panama City; Guanico; El Lagartillo. Colombia: Isla del Gallo. Ecuador: Sua; Manta; Santa Elena.

Genus **ENSIS** Schumacher, 1817

Type species by monotypy, *Ensis magnus* Schumacher. European waters.

Shell elongate, razor or scabbard-shape, concave on the dorsal side. The valves are generally thin, equal in size, each end obliquely truncated and slightly open or gaping. Beaks small, inconspicuous, and placed at the extreme anterior end of the dorsal margin. The ligament is external, attached to a long narrow nymph. The hinge of the right valve has a single vertical directed cardinal tooth and a single lamelliform tooth; the left valve has two cardinal teeth and one horizontal tooth. The anterior adductor scar is elongated and lies in the general direction of the major axis of the shell and about one-fourth its length; the posterior, adductor scar is smaller, and it is placed a distance within the margin. Pallial line is nearly as long as the shell itself, with a wide and shallow sinus at its posterior end. Surface white and smooth except for the usual lines of growth, covered by a verrucous periostracum, light brown or straw-yellow in color, often with a dark ray along the length of the umbones.

This group of razor shells is poorly represented in the Panamic-Pacific fauna.

***Ensis californicus* Dall**

Ensis californicus Dall, 1899, Proc. U. S. Nat. Mus., vol. 22, No. 1185, p. 110 off Island of San Pedro Martir, Gulf of California.—Hertlein and Strong, 1950, Zoologica, vol. 35, pt. 4, p. 227.

Shell small, slender, arcuate, the sides nearly parallel, the valves being slightly attenuated towards the ends, beaks anterior, the anterior truncation bluntly rounded, the posterior similar; color white with livid pink streaks concentrically disposed; epidermis olivaceous brilliantly polished; hinge with small and very delicate cardinals (usually broken off), one in the right and two in the left valve, the dorsal ridge comparatively strong and elevated, shorter than the ligament. Length of shell, 60 mm.; of dorsal tooth or ridge, 5.2 mm.; of ligament, 9 mm.; width of shell, 7 mm.; perpendicular to the chord of the arc formed by the dorsal margin of the valves, 2 mm. (Dall, 1899.)

According to Dall, this small species is similar to the east American *E. minor*, which, however, differs by being wider distally than in front, larger when adult, with proportionately wider and more arcuate valves. Specimens may reach a length of 85 mm. The Californian species previously identified as *californicus* is now known as *E. myrae* S. S. Berry.

Range—Gulf of California to Ecuador. Ecuador: Camarones near Esmeraldas.

***Ensis tropicalis* Hertlein and Strong**

Plate 63, figure 3

Ensis tropicalis Hertlein and Strong, 1955, Bull. Amer. Mus. Nat. Hist., vol. 107, art. 2, p. 203, pl. 3, figs. 34, 35 South Passage, Pearl Islands, Panama.

Shell small, slender, very slightly arcuate, sides nearly parallel, slightly attenuated towards the ends, the anterior end slightly upturned, beaks anteriorly situated, anterior and posterior ends bluntly rounded; color olive-gray, polished; a diagonal line from the beaks to the posterior ventral margin separating a uniformly colored elongated triangular area below from the dorsal area above, the larger portion of it ornamented with brownish, convex markings, the area bordering the dorsal margins nearly uniform in color; hinge with delicate teeth, one in the right, two in the left; dorsal ridge well developed and a little more than half as long as the ligament.

Length 50 mm.; of dorsal ridge, 4.5 mm.; of ligament 6.9 mm.; height of shell, 6.0 mm.; convexity, 1.6 mm.; chord of arcuation of dorsal margin, approximately 0.5 mm. South Passage, Pearl Islands. AMNH. 73421. (Hertlein and Strong, 1955.)

According to Hertlein and Strong, this species is characterized by the slight arcuation of its valves, a feature that is constant in all the specimens examined and which serves to distinguish it easily from *E. californicus* and other similar forms.

Range—Panama. Panama: Pearl Islands.

Superfamily MYACACEA

Family MYACIDAE

Burrowers in sand or mud, sometimes nestlers, usually with elongated or ovate, subequal valves but often irregular or distorted in nestling forms, the surface white, earthy or chalky, often with coarse concentric growth sculpture and a covering periostracum. Ligament mostly internal; in the left valve, the resilium is attached to a large projecting arm or chondrophoral plate, the resilifer being a rounded or sagittate scar bordered above and behind by a small ridge (nymph); this chondrophoral arm fits into a deep pit in the beak of the right valve, the scar of the resilifer is placed in the roof of the umbone within, while above it on the posterior margin of the valve, there is a smaller scar to which the external portion of the ligament (tensilium) is attached. Hinge margin with or without teeth. Internal margins of valve smooth. Pallial sinus present or wanting.

Mya arenaria Linné

Plate 77, figure 1

Mya arenaria is not a member of the Panamic-Pacific fauna but an enlarged figure of its hinge armature is introduced here to illustrate the general pattern of ligament attachment characteristic of the Myacacea. In the Myacidae and the Corbulidae, the ligament, combining both the tensilium and the resilium, is attached to a plate or armlike process found only in the left valve. This large plate carries on its upper surface two deep scars, separated by a ridge, for the attachment of the two parts of the ligament; the larger anterior scar represents the true chondrophore and to which the resilium was attached; the smaller narrower scar on the posterior side that of the tensilium. This plate extends like a large tooth under the beak of the opposite or right valve where a similar divided scar is found in the roof of the umbonal cavity directly under the beak, and to which the two bands of the ligament, side by side, were attached. The ligament of the Corbulidae follows the same general pattern but with variation in detail as to genus and species.

General key to the genera of Myacidae in this region

- I. Shell of medium size (length about 30 mm.), subovate, subequivalve. No definite sinus. Burrowers in sand and mud. Genus *Cryptomya*
- II. Shell smaller, usually less than 10 mm., nestlers in crevices and abandoned burrows. Valves usually distorted. The pallial sinus is well developed.
 1. Valves lediform, the anterior side longer, convex, the surface marked with uniform, concentric sculpture. The chondrophoral plate is relatively small, usually pointed behind.

Austroplatyodon as a subgenus of *Platyodon*

2. Valves more variable in shape, the anterior side usually shorter and expanded, the surface sculptured by irregular growth lines. The chondrophoral plate large.

Genus *Sphenia*

Genus **CRYPTOMYA** Conrad, 1848

Type species by monotypy, *Sphenia californica* Conrad. California.

Shell small or of medium size (25-30 mm.), ovate, subequivalve, the umbones somewhat flattened and ending in small, inconspicuous, median beaks, the valves depressed to moderately convex, white. Hinge edentulous, the ligament as in *Mya*, the left valve bearing a large, projecting chondrophore to which the resilium and tensilium are each attached to a separate scar; in the right valve, the attachment scars of the resilium and tensilium lie in the roof of the umbonal cavity under the beak. The adductor scars are of subequal size, connected across by a simple pallial line. Surface marked with concentric growth lines only.

Cryptomya has the generic characters of *Mya* but is smaller and has no pallial sinus.

Cryptomya californica (Conrad)

Plate 77, figures 2, 2a

Sphaenia californica Conrad, 1837, Jour. Acad. Nat. Sci. Philadelphia, vol. 7, p. 234, pl. 17, fig. 11.

Cryptomya californica Conrad, 1848, Proc. Acad. Nat. Sci. Philadelphia, vol. 4, p. 121.—Grant and Gale, 1931, Mem. San Diego Soc. Nat. Hist., vol. 1, pp. 417-419, pl. 21, figs. 7, 8a, 8b, 11, 14a, 14b.

Mya californica (Conrad), Sowerby in Reeve, 1875, Conch. Icon., vol. 20, *Mya*, pl. 1, sp. 3.

Several other names have been given to this species. For complete synonym see Grant and Gale.

Shell small or of medium size, the length seldom over 30 mm., ovate, depressed to slightly convex, the umbones flattened, median in position, the beaks small and adjacent. There is a low, obscure posterior-umbonal angle which defines a narrow, depressed posterior-dorsal slope, the anterior end of the shell widely rounded, the posterior crudely, obliquely subtruncate. Surface white to chalky, irregularly marked with concentric growth lines. There is no true pallial sinus, the pallial line assuming a more vertical direction at the posterior end. Adductor scars subequal and generally prominent.

Length 28.2 mm., height 20 mm., diameter 11.4 mm. Negritos, Peru.

This is a widely ranging species, especially common in northwestern Peru.

Range—Alaska to northern Peru. Also in Japan. Ecuador: Santa Elena. Peru: Tumbes; Zorritos; Boca Pan; Mancora; Lobitos; Negritos; Paíta; Bayovar.

Genus **PLATYODON** Conrad, 1837

Type species by monotypy, *Mya (Platyodon) cancellata* Conrad. Recent, California to Washington.

Relatively large, lediform, solid, the anterior side longer, convex and expanded, the posterior side shorter and narrowly produced, gaping. Ligament like that of *Mya*, the chondrophore somewhat smaller. Surface white, often earthy, sculptured with close-set concentrics or emphasized growth

lines. Pallial sinus large, open, rounded, extending nearly to the middle of the shell's interior. In the living animal, the siphons are protected by armor as in *Mya*.

In typical *Platyodon*, the shell is relatively large, and attains a length of 60 mm. or more.

Subgenus **AUSTROPLATYODON**, new subgenus

Type species *P. (Austroplatyodon) australis*, new species. Esmeraldas, Ecuador.

Like *Platyodon* in general shape and surface sculpture but the shell small, generally less than 6 mm. in length. The anterior side is longer, strongly convex, and expanded, the posterior side much shorter, narrowed.

Platyodon (Austroplatyodon) australis, new species Plate 76, figures 6, 6a

Similar in shape, sculpture, and hinge to *Platyodon cancellata* Conrad, from California and Washington but much smaller, the largest specimen before me about 5.7 mm. in length. Valves inequilateral, subequivalve except for some distortion, convex, and relatively thin. Umbones are wide, ending in small, adjacent and usually eroded beaks which are placed near the posterior one-third, the anterior side hence larger, strongly inflated, and widely rounded at the end, the posterior side shorter, much narrowed and terminating in a bluntly rounded, gaping end. The left valve has a wide resilifer or chondrophoral plate, its margin oblique as if cut at an angle. In the right valve, the resilifer is developed as a wide pitlike scar in the roof of the umbonal cavity. There are no hinge teeth. External sculpture of fine, close-set, and quite uniform concentrics. The posterior surface set off sharply from that of the disk by a keeled umbonal ridge, in front of which the surface is somewhat depressed. The texture of the shell is generally so thin as to appear subtranslucent with the external markings showing plainly in the interior. The pallial sinus is usually indistinct but much as in *Platyodon*, *s.s.*, the impression of the posterior adductor scar large and deep.

Length 4.7 mm., height 3.1 mm. Esmeraldas, Ecuador. Holotype ANSP 218912.

Probably a nestler in small crevices.

Range—Ecuador. Ecuador: Esmeraldas.

Genus **SPHENIA** Turton, 1822

Type species by original designation, Gray, 1847. *Sphenia binghami* Turton. European Seas.

The shell is small, inequivalve, elongate, usually irregular because of a nestling habit in crevices or in abandoned burrows. Hinge without teeth. Ligament as in *Mya*, the left valve bearing a large chondrophoral plate. Pallial sinus large, widely rounded at the end. Surface with irregular growth line sculpture.

Sphenia fragilis Carpenter

Plate 77, figures 9-9b

Sphaenia fragilis Carpenter, 1857, Cat. Mazatlan Shells, Brit. Mus., pp. 24, 25, No. 35. Mazatlan, in the burrows of worms and mollusks in *Chama* and *Spondylus*; also in dead Balani on *Strombus galea*.

Shell small, white, relatively thin, length seldom over 8.5 mm., irregularly inequivalve, the umbones and beaks placed near the anterior one-third which is also the zone of maximum inflation. Behind the beaks, the posterior side is often narrowed, produced, and of irregular form, its end truncate and gaping; in others, the posterior side is as high as the anterior

so as to resemble a small *Hiatella arctica*, its end in consequence more broadly truncate. The posterior-dorsal slope is set apart by a small umbonal angle. Surface marked with coarse, often wrinkled growth lines, heaviest on the posterior slope, and covered by a thin, skinlike, light-colored epidermis. Interior with the adductor scars quite large, subequal, and showing prominently. Pallial sinus large, rounded but relatively shallow.

This is a small nestler inhabiting abandoned worm burrows, hence extremely variable in shape. Specimens in the U. S. National Museum labeled *S. fragilis* from California and Oregon are much larger than any seen from the Panamic province and should probably be referred to another species. *S. trunculus* Dall, described originally from San Diego, California, has been recorded from Panama (specimens, USNM), but they are probably only a form of *S. fragilis*.

Range—Oregon? to northern Peru. Mexico: Mazatlan (Carpenter). Panama: Panama City and numerous other localities. Panama Canal Zone: Venado Beach. Ecuador: Esmeraldas. Peru: Zorritos.

Family HIATELLIDAE

Shell usually ovate or oblong, generally irregular due to distortion, widely gaping behind, byssiferous. Surface smooth but more often with irregular concentric riblets or undulations. Hinge weak, the teeth often obsolete, no laterals, the ligament external, attached to a strong nymphal ridge. Pallial sinus of irregular size, the animal provided with large siphons. Burrowing in deep sand, gravel, or as nestlers or borers in rock.

Genus HIATELLA Daud'n, 1801

(*Saxicava* Bellevue, 1802 is a synonym.)

Type species by subsequent designation, Hertlein and Strong, 1850, *Hiatella biaperta* Bosc (= *Mya artica* Linné). North Atlantic.

With the characters of the family.

Hiatella solida (Sowerby)

Plate 77, figures 6, 6a

Saxicava solida Sowerby, 1834, Proc. Zool. Soc. London, pp. 88, 89 (ad Sanctam Elenam).—Reeve, 1875, Conch. Icon., vol. 20, *Saxicava*, pl. 1, fig. 6.—Sowerby, 1884, Thes. Conch., vol. 5, p. 133, No. 7, pl. 471, fig. 12.

Saxicava tenuis Sowerby, 1834 *op. cit.*, p. 88 Pacosmayo et ad Lambeyeque.—Reeve, 1875, *op. cit.*, pl. 2, fig. 9.—Sowerby, 1885, *op. cit.*, pl. 471, fig. 11.

Saxicava purpurascens Sowerby, 1834, *op. cit.*, p. 88 ad Insulam Muerte.—Reeve, 1875, *op. cit.*, pl. 2, fig. 14.—Sowerby, 1884, *op. cit.*, pl. 471, fig. 7.

Hiatella arctica (Linné), Hertlein and Strong, 1950, Zoologica, vol. 35, pt. 4, pp. 244, 245.

Generally subrectangular, longer than high, inequivalve, the right valve deep and higher than the left at the umbones, the anterior side short and sloping, but the shell variable in shape and thickness. The posterior side is generally drawnout, often with a strong, umbonal ridge running to the posterior-ventral margin and another smaller one along the dorsal margin. Color yellow, brown, or more or less purplish.

Because of wide differences in size and shape, due mostly to distortion or other accidents of growth, several names have been given to this shell. Some authors consider this species the same as the widespread, boreal *H. arctica* (Linné) but for the present, it seems best to regard the South American form as distinct.

Range—Coast of Peru northward to Panama. Panama: Pearl Islands. Ecuador: Charapota; Santa Elena; Isla del Muerte. Peru: Zorritos; Lobitos; Paíta.

Family CORBULIDAE

The shell is small or medium size, rarely large, elongately ovate, usually solid, the beaks generally submedian, the anterior side rounded, the posterior side rostrated and pointed at the end. The right valve is usually larger and with stronger sculpture, the left valve may be similar, or much smaller, with a more rounded outline, its surface flat or depressed, and with finer or smoother sculpture. The ligament is entirely internal, attached to an armlike resilifer in the left valve, simulating a large tooth and which fits into a deep socket-like resilifer in the right valve. Hinge armature is variable but most Corbulas have a single, large, hooked cardinal tooth in the right valve placed in front of the resilial pit; there is a single cardinal socket in the left valve; lateral teeth are absent in most groups. The pallial line is entire or it may carry a small obscure posterior sinus. Surface covered with a periostracum, sometimes heavy.

Although the ligament of the Corbulidae, as in the Myacidae, is completely internal, the two bands of which it is composed, are attached to separate scars. The armlike resilifer of the left valve carries two scars along its upper surface; the larger scar on the inner or anterior side serves for the attachment of the resilium; the other smaller one on the posterior side for the tensilium. Both the resilium and tensilium have separate attachment scars in the roof of the umbonal cavity of the right valve.

The Corbulids are widely distributed and include marine, brackish, and some fresh-water species, the latter mostly fossil. The family may be divided into several subfamilies, based on characters of the hinge and ligament, and on general habit. Most marine species belong to the Caryocorbulinae.

Because of inadequate descriptions and small-sized figures, the identification of a few Panamic species is somewhat uncertain and will remain so until the types, if they are still extant, have been restudied and refigured.

The Corbulidae may be divided into several subfamilies but only the Caryocorbulinae is represented in the marine waters of the Panamic-Pacific region.

Subfamily CARYOCORBULINAE

The chondrophore or resilifer is generally a large, projecting plate or arm which simulated a cardinal tooth and is set obliquely to the hinge margin of the left valve; it bears on its dorsal surface the attachment scars of the tensilium and resilium. To this subfamily, belong the larger number of marine Corbulas.

Key to the genera of Caryocorbulinae in Panamic waters

- I. Valves more less similar in size, shape, and sculpture.
- A. Shell subovate, subrectangular to elongate in shape, the anterior end rounded. The rostrum is relatively narrow and sometimes not sharply defined. The posterior side is usually the longer, pointed or even twisted at the end, often with a snoutlike extension formed by small, accessory, shelly plates.

- a. Ventral margin of the valves smooth.
1. Surface sculptured with small, cord, or threadlike concentrics, their interspaces with or without radial striae or pustules.
Genus *Caryocorbula*
 2. Surface more strongly sculptured with coarse concentric waves or riblets.
Subgenus *Hexacorbula*
- b. Ventral margin of valves serrated or radially striated.
3. Shell generally coarse and heavy, its shape like that of *Caryocorbula*. Brackish.
Genus *Serracorbula*
- B. Shell oblong, rectangular or squarish, the posterior side short, flattened as if truncated.
- c. Rostrum is well defined, bordered by a sharp angle or keel. Marine.
 4. Shell extremely thin and fragile. The rostral angle is a high sharp keel.
Genus *Tenuicorbula*
 5. Shell solid, the rostral keel a sharp angle.
Genus *Juliacorbula*
 - d. Rostrum is poorly defined or absent. Brackish.
 6. Shell often large, ovate, or cylindrical in shape, the two valves nearly equal and similarly sculptured with growth lines only. Traces of lateral teeth.
Genus *Panamicorbula*
- II. Valves unlike in size, shape, and sculpture.
7. Valves rounded and unequal, the right valve is much larger, convex, and with strong, concentric sculpture, the left smaller, flattened or depressed, smooth or with some radial markings.
Genus *Varicorbula*

Genus **CARYOCORBULA** Gardner, 1926

Type species by original designation, *Corbula alabamiensis* Lea. Eocene of Claiborne, Alabama.

Marine *Corbulas* with nearly equal, elongate-ovate to subelliptical valves and small, adjacent, submedian, prosogyrate beaks, the posterior side of the valves somewhat narrowed, rostrated, and often ending in a twisted snout which may be formed by accessory shelly growth. The valves are usually, slightly unequal in size, the right valve is a little larger, overlapping or clasping the left valve by its ventral margin, otherwise, the two valves are much alike in shape and sculpture. The ligament is completely internal; in the left valve, the ligament is attached to a projecting arm or chondrophore set obliquely to the hinge margin and bearing two scars divided by a central ridge or line. In the right valve, the ligament is attached to scars on the inner wall and margin of the resilifer pit. Hinge teeth are reduced to a single large cardinal tooth in the right valve fitting into a socket along the resilifer pit in the left valve; there are no lateral teeth. Pallial line mostly entire or its posterior section may show an obscure sinus.

To this genus belong most marine *Corbulas*, recognized by their nearly similar valves as to sculpture and convexity, and their pointed or rostrated posterior end. The species are usually small and somewhat variable in shape, hence often difficult to identify, and there is still much uncertainty as to the status of many named forms. Fresh specimens often have a strongly twisted siphonal end or snout which is formed by the growing edge of the periostracal layer, usually lost on a beachworn specimen.

Key to species of *Caryocorbula*

- I. Surface of valve sculptured principally with fine or coarse, growth-like concentrics; with or without radial lineation.
- Subgenus *Caryocorbula*, s.s.
- A. Shell fairly large (length 22 mm. or more, solid). No radial lineation.
1. Shell elongately ovate, the posterior end produced and rostrated, generally twisted and snoutlike. Color white, tinged with brown; the umbones sometimes rose-red.
- C. ovulata*
2. Shell higher, ovate-trigonal, the posterior end obliquely truncated and pointed, not twisted. Color usually white tinted with rose-pink or red.
- C. amethystina*
- B. Shell smaller (length 16 mm. or less). Sculpture formed by growth line concentrics, usually with fine radial threads or pustules showing on some part of the surface.
- a. Posterior end extended into a twisted or upturned siphonal snout, usually with accessory, shelly plates.
3. Shell elongated to elliptical, thin, or thick. Average length about 15 mm.
- C. nasuta*
4. Shell smaller, shorter, and more convex, ovate-trigonal in shape. Average length about 12 mm.
- C. nuciformis*
- C. Without radial striation or lines of minute pustules, or if present, they are largely confined to the rostral area.
5. Shell small, flattened, solid, with a marble-like surface mottled faintly with white.
- C. marmorata*
6. Shell small (length 7.5 mm.), with short convex valves and strong concentric sculpture. Microscopic granulation is present on the surface of the rostrum.
- C. porcella*
7. Shell larger (length 13 mm.), with high, median umbones, and strong sculpture. Rostral area plain.
- C. ventricosa*
- II. Surface with strong sculpture consisting of large, deep, wavelike, concentric ribs.
- Subgenus *Hexacorbula*
8. Shell large (length about 22 mm.), coarse, solid, elongated ovate in shape, the posterior end pointed.
- C. esmeralda*

***Caryocorbula* (*Caryocorbula*) *ovulata* (Sowerby)**

Plate 75, figures 2-2c

- Corbula ovulata* Sowerby, 1833, Proc. Zool. Soc. London, p. 35.—Reeve, 1843, Conch. Icon., vol. 2, *Corbula*, pl. 1, fig. 7.—Hanley, 1843, Cat. Rec. Bivalve Shells, p. 47, suppl. pl. 10, fig. 52.—Maxwell Smith, 1944, Panamic Marine Shells, p. 68, fig. 866.
- Aloidis* (*Caryocorbula*) *ovulata* (Sowerby), Hertlein and Strong, 1950, Zoologica, vol. 35, pt. 4, p. 241.—Hertlein and Strong, 1955, Bull. Amer. Mus. Nat. Hist., vol. 107, art. 2, p. 206.

Shell large for the genus, solid, elongate-elliptical, generally white, and in life covered with a thin, light brown to rusty colored periostracum. Sculpture of coarse concentrics, similar in both valves. Adult shells become thickened, porcellaneous, the visceral cavity rounded and deeply excavated, surrounded by wide thickened margin. Adductor scars distinct, the pos-

terior one large and seated on the thickened margin above a small bend or sinuosity in the pallial line. Posterior end of the shell twisted or bent to the left. Generally pure white but occasionally brown in the visceral cavity and along the margins, sometimes rose-pink with the tip of the beak remaining white.

Average shell: length 27 mm., height 15 mm., diameter 12.2 mm. Zorritos, Peru.

This is a common and widely distributed species. The shell is usually white or gray with the rostral area, posterior end and the ventral margin colored brown. Occasional specimen may have the middle of the disk and the umbone painted with deep, purplish red but with the beaks remaining white; such shells resemble *C. amethystina* but will be separated easily by their longer *Leda*-like form. This *Corbula* occurs as fossil in the Pliocene of Ecuador.

Range—Gulf of California to northern Peru. Panama: several places, Búcaro. Panama Canal Zone: Venado Beach. Ecuador: Mompiche; Manta; Santa Elena; Ancon. Peru: Zorritos; Tumbes; Mancora.

***Caryocorbula (Caryocorbula) amethystina*, new species** Plate 75, figures 1-1c

The shell is large or of medium size, solid, obliquely elongate-ovate, with nearly median beaks and low, flattened, inconspicuous umbones. The anterior side is somewhat impressed in front of the beaks but shows no true lunule, its end widely rounded and passing evenly into the curve of the ventral margin so that the contour of the shell as a whole is strongly oblique. The posterior side is strongly contracted and narrowed, its upper and lower margins approaching to form a bluntly pointed end. Valves are nearly equal in size, the right is a trifle larger and more convex so that its posterior-ventral margin overlaps or clasps that of the left slightly. Rostral area is narrow, flattened, and defined by an angle. Surface covered with coarse, wrinkled, concentrics, and much finer, growth incrementals. Color white, more or less deeply suffused with violet or rose-purple, heaviest on the umbones. Interior white, often bordered by pink or brown. The substance of the shell is usually solid, the visceral cavity deep, the adductor scars distinct.

Length 27.4 mm., height 18.2 mm., diameter 14 mm. Tortutilla, Panama. Coll. H. B. Johnson. Holotype, ANSP 218902.

This is a large, solid shell, often confused with *C. ovulata* but from which it differs by its more rectangular form, pink, violet or rose-purple color, and by its shorter posterior side, the end of which is not twisted.

Range—Panama south to Ecuador. Panama: Pearl Islands at numerous places; Puerto Mensabi; San Carlos; El Lagartillo. Panama Canal Zone: Venado Beach; Taboquilla. Ecuador: Puerto Callo; Santa Elena.

***Caryocorbula (Caryocorbula) nasuta* (Sowerby)** Plate 75, figures 3-3e

Corbula nasuta Sowerby, 1833, Proc. Zool. Soc. London, p. 35.—Reeve, 1843, Conch. Icon., vol. 2, *Corbula*, pl. 1, fig. 1.—Maxwell Smith, 1944, Panamic Marine Shells, p. 68, fig. 868.

Corbula pustulosa Carpenter, 1855, Cat. Mazatlan Shells, Brit. Mus., p. 22.

Corbula fragilis Hinds, 1843, Proc. Zool. Soc. London, p. 56.—Hinds, 1844, Zool. Voy. Sulphur, Moll., pt. 3, pl. 68, pl. 20, fig. 11.—Reeve, 1843, Conch. Icon., vol. 2, *Corbula*, pl. 3, fig. 19.

Aloidis (*Caryocorbula*) *nasuta* (Sowerby), Hertlein and Strong, 1950, *Zoologica*, vol. 35, pt. 4, p. 240.—Hertlein and Strong, 1955, *Bull. Amer. Mus. Nat. Hist.*, vol. 107, art. 2, pp. 205, 206.

Shell elongate-elliptical, *Nuculana*-like, the average length about 15 mm., subequivalve, the right valve somewhat larger, its posterior-ventral margin overlapping and clasping the left. Valves relatively thin or of moderate weight only. Posterior-dorsal area distinct, of equal size in both valves, generally somewhat excavated, and defined externally by a low angle. Valves similarly sculptured with concentrics fairly regular on the umbones, coarser and crowded on the ventral side, their interspaces usually marked with minute radial threadlets, often producing a fine reticulated pattern. Posterior end bluntly pointed, often produced into a snout by secondary growth. Color white, with periostracum yellow, or rusty brown.

Length 15 mm., height 9.1 mm., diameter 7.1 mm. Zorritos, Peru.

C. fragilis appears to be merely a thin-shelled form but has been considered a separate species by some authors. Specimens in good condition show fine radial striae between the concentrics, which according to Hertlein and Strong are formed by lines of minute pustules and it was to such a specimen that Carpenter gave the name *C. pustulosa*. Such lines of pustules are to be seen on many different species of *Corbula*.

Range—Lower California to northern Peru. Panama: Búcaro. Panama Canal Zone: Amador; Venado Beach. Colombia: Isla del Gallo. Ecuador: Manta; Santa Elena. Peru: Tumbes; Zorritos.

Caryocorbula (*Caryocorbula*) *nuciformis* (Sowerby)

Plate 75, figures 7-8;
Plate 76, figure 7

Corbula nuciformis Sowerby, 1833, *Proc. Zool. Soc. London*, p. 35. Real Llejos.—Reeve, 1843, *Conch. Icon.*, vol. 2, *Corbula*, pl. 2, fig. 9.—Maxwell Smith, 1944, *Panamic Marine Shells*, p. 68, fig. 869.

Aloidis (*Caryocorbula*) *nuciformis* (Sowerby), Hertlein and Strong, 1950, *Zoologica*, vol. 35, pt. 4, p. 241, pl. 2, fig. 1.

Corbula obesa Hinds, 1843, *Proc. Zool. Soc. London*, p. 57.—Hinds, 1844, *Vol. Sulphur*, *Moll.*, pt. 3, p. 68, pl. 20, fig. 12.—Reeve, 1844, *Conch. Icon.*, vol. 2, *Corbula*, pl. 5, fig. 38.

Shell generally small (length 12 to 14 mm., or less), elongate, trigonal-ovate, both valves strongly convex and solid, the right valve somewhat larger and clasping the left valve along the posterior-ventral margin. The umbones are wide, with the beaks close, touching, the anterior side depressed below the beaks and prolonged a little into a well-rounded end, the posterior side generally a little shorter, contracted, with a wide rostrum in each valve, flattened or depressed, setoff by an angle along the side of the umbone and often terminating in a long, narrow, upturned snout, that of the left valve formed of shelly, accessory growth. Sculpture over the disk is formed by medium to coarse, concentric riblets, usually overrun by lines of fine, pustulated, radial riblets, pronounced on the umbones and disk, absent nearer the ventral margin; near the ventral margin the shell is often sharply inflected, forming a flattened surface sculptured with large and coarse concentrics. Color white except along the ventral side and the posterior snout which is brown.

Length 11.3 mm., height 5.6 mm., diameter 6.3 mm. Zorritos, Peru.

Often found with *C. nasuta* and at times may appear to grade into it but typically smaller, of more solid build, the ventral side is more strongly

contracted and flattened thus adding to the convexity of the shell. Adults have a strongly produced, snoutlike, posterior end, that of the left valve formed by discrete, accessory lamellae. The sculpture is formed by concentric riblets, strongest near the ventral margin, and in addition, the surface is covered with fine or coarse, radial lines which sometimes form deep grooves, the space between them forming flattened rays of irregular width and on higher magnification reveal a series of minute pimples or granules, usually set in pairs. This radial sculpture is best brought out if the specimens are slightly weathered.

As noted by Hertlein and Strong, the identification of *Corbula obesa* of Hinds is uncertain, its small-sized figure and incomplete description is not sufficient for an exact identification. (See also under *C. porcella*).

Range—Lower California to northern Peru. Mexico: Concepcion Bay and Tangola-Tangola Bay (both Hertlein and Strong). Nicaragua: Real Llejos (Cuming). Costa Rica: Gulf of Nicoya (Hertlein and Strong). Panama: Búcaro. Ecuador: Guayaquil (Cuming); Puerto Limones. Peru: Zorritos.

***Caryocorbula* (*Caryocorbula*) *porcella* (Dall)**

Plate 76, figure 8

Corbula porcella Dall, 1916, Proc. U.S. Nat. Museum, vol. 52, No. 2183, pp. 415, 416 off Lower California in 44 fathoms, mud.—Dall, 1921, Bull. 112, U. S. Nat. Museum, p. 54. Range Santa Rosa, Calif., to Panama.

Aloidis (*Caryocorbula*) *porcella* (Dall), Hertlein and Strong, 1950, Zoologica, vol. 35, pt. 4, p. 242, pl. 2, figs. 13, 15.

Shell small, whitish, short-rhombic, the umbones wide, low, submedian, the anterior side rounded, the posterior side a little longer, obliquely truncated at the end, slightly curved or pouting at the lower extremity. The valves are nearly alike in convexity and shape, left being a trifle smaller and overlapped widely by the right valve along the posterior-ventral margin. Surface with the umbones usually smooth but with heavier or coarser, rounded, concentric riblets showing near the ventral margin. The rostrum is short but defined by an angled edge, its surface often with strong cross sculpture or if smoother, its surface is often minutely granulose, especially so in the case of the right valve. Color usually a dirty white, with clay particles adherent, and covered by a thin olive periostracum, the interior white. The species varies somewhat in size and general dimensions. Dall's type measures: length 8.5 mm., height 4 mm., diameter 4.5 mm.

The above description is based on typical specimens of *S. porcella* in the U. S. National Museum. As pointed out by Hertlein and Strong, this species is perhaps *C. obesa* Hinds (see under *C. nuciformis*). Hinds made no mention of radial striations but this minute sculpture could easily have been overlooked. On most specimens of *C. porcella* examined, the concentric riblets are smooth over the surface of the disk, the minute granules or shagreenation developed only on the rostral surface. The range of *C. porcella* as given by Dall, is from Lower California to Panama, but records south of Mexico require confirmation.

***Caryocorbula* (*Caryocorbula*) *marmorata* (Hinds)**

Plate 75, figure 5

Corbula marmorata Hinds, 1843, Proc. Zool. Soc. London, p. 58 west coast of Veragua from 26 fathoms, mud.—Hinds, 1845, Zool. Voy. Sulphur, Moll. pt. 3, p. 69, pl. 20, fig. 13.—Reeve, 1844, Conch. Icon., vol. 2, *Corbula*, pl. 5, fig. 39.

Aloidis (*Caryocorbula*) *marmorata* (Hinds), Hertlein and Strong, 1950, *Zoologica*, vol. 35, pt. 4, pp. 239, 240, pl. 2, fig. 17.

Shell small, ovately trigonal, nearly equivalve, whitish, mottled, a purplish-red spot present under the beaks; rounded in front, slightly projecting posteriorly and obliquely truncated at the end, often with a short lamellated projection; a strong posterior angulation marks off a flattish sloping posterior area; an excavated area is present beneath the beaks but only a minute sloping escutcheon is present back of the beaks; sculpture consists of strong, often somewhat angular or carinate concentric ribs which continue with equal strength over the posterior area but become finer toward the posterior and anterior dorsal margins; the interspaces and especially the posterior dorsal area is ornamented with fine radial striae; interior often pinkish with well-defined whitish adductor impressions. Length 7 mm., height 4.8 mm., convexity (both valves together) 3.4 mm. Description after Hertlein and Strong, 1950.

The above description is copied from Hertlein and Strong. *C. marmorata* is perhaps a small form of *C. biradiata*. Specimens referred to this species before me, are similar in shape to that species, but much smaller, the surface nearly smooth except for a few concentric riblets; these specimens have no radial striae as described by Hertlein and Strong, but radial striae are sometimes to be seen on specimens of *C. biradiata*. Surface is mottled with blotches of white on a gray-white base, the edge of the beaks and the ventral margins often stained pink.

Range—Mexico to Ecuador. Mexico: Punta Penasco; Port Guatulco. Nicaragua: Corinto. Costa Rica: Port Parker (these records all from Hertlein and Strong). Panama: Veraguas (Hinds). Ecuador: Santa Elena.

Subgenus **HEXACORBULA** Olsson, 1932

Type species by original designation, *Corbula hexacyma* Pilsbry and Brown. Miocene of Panama.

Shell moderately large and heavy, the anterior end rounded, the posterior rostrated and pointed. Surface sculpture with deep, wavelike, concentric ribs, usually sulcated in the middle, and finer lines of growth. No lunule or escutcheon.

Caryocorbula (**Hexacorbula**) **esmeralda**, new species Plate 76, figures 3-3c

The shell is relatively large (length 22 mm.), heavy, transversely oblong, with nearly median beaks, the anterior end well rounded, the posterior side narrower or contracted, with a sloping, flattened or depressed rostral area, its end oblique and pointed. Surface sculpture of each valve is similar, produced by a few, large, wavelike, concentric riblets, their intervals deep, the whole overrun by the much finer growth lines; the concentric riblets are strongest over the anterior middle of the disk, and from there curve smoothly over the umbonal slope to the margin; posteriorly they fade out near the rostral angle. On the rostrum, the sculpture is produced by even, close-set, medium-size, cross-concentrics. On some specimens, small radial threadlets may be seen but they are usually inconspicuous. Old shells may be much thickened, with the ventral margin sharply inflected and flattened; this thickening is largely concentrated along the ventral margin below the pallial line, thereby emphasizing the depth

of the visceral cavity. Adductor scars are of nearly equal size, placed on the thickened marginal zone; the pallial sinus is small.

Length 21.4 mm., height 12.3 mm., diameter 9.6 mm. Esmeraldas, Ecuador. Holotype, ANSP 218903.

A depressed ray extends from the beak across the middle of the disk to the ventral margin. This Recent species is related to the Miocene *C. hexacyma* Brown and Pilsbry from the Gatun Miocene as well as to *C. cruziana* Olsson from the Miocene of Peru, but is proportionately longer and the depressed ray is deeper.

Range—Coast of Ecuador. Ecuador: off Esmeraldas in about 20 feet of water.

Genus **SERRACORBULA**, new genus

Type species, *Serracorbula tumaca*, new species. Southwestern Colombia.

Shell solid and heavy, subequivalve, convex, the anterior end well rounded, the posterior with a rostrum in each valve, its end produced into a short, narrow beak. The surface sculpture is similar in each valve. Ventral margin is evenly serrated or striated all around. Visceral cavity, deep and round, its depth emphasized by thickening of the marginal zone below the pallial line. The adductor scars are large and distinct.

Serracorbula tumaca, new species

Plate 76, figures 4-4d

Shell of medium size (length about 12 mm.), ovate, strongly convex, with high, central umbones and beaks, the valves subequilateral except for the short, twisted, posterior snout or beak. Surface sculpture consists of fine or medium, close-set, concentric riblets. In the adult, the shell becomes much thickened, its ventral side turned sharply inward to form a flattened area, the growing edge formed by a dark, brown layer; in the right valve, this layer is striated transversely on the inner side, and on the outer side in the left valve; along the margin itself, these striations form fine, even crenulations except at the hinge.

Length 12.3 mm., height 7.3 mm., semidiameter 4.8 mm. A right valve. Tumaco, Colombia. Holotype, ANSP 218948.

A species of tidal mud flats, and easily recognized by its serrated margins, usually brown.

Range—Panama southward to Peru. Panama: Rey Island, Pearl Islands. Colombia: Tumaco. Ecuador: Limones. Peru: Tumbes.

Genus **TENUICORBULA** Olsson, 1932

Type species by original designation, *Corbula tenuis* Sowerby. Pacific coast of Central America.

Shell elongated, subrectangular, inequilateral, the anterior side usually a little longer, higher and wider, the posterior side contracted and bearing a strong keel which encloses a large rostral area, the texture of the shell usually thin. Valves are subequal in size, shape, and sculpture. No lunule, but there is a large, sunken escutcheon in each valve. Hinge as in *Caryocorbula*, the cardinal tooth of the right valve large, curved upward, or hook-

shaped. The chondrophore is a grooved, narrow plate in the left valve, and projects more than in the other *Caryocorbulinae*.

This group of *Corbula* is distinguished from other members of the family by its unusually thin and delicate shell; by its high angled posterior keel and its elegant sculpture. Fossil species are known from the Miocene of Peru.

Tenuicorbula tennis (Sowerby)

Plate 77, figures 3, 3a

Corbula tenuis Sowerby, 1833, Proc. Zool. Soc. London, p. 36. "Hab. in America Centrali".—Reeve, 1843, Conch. Icon., vol. 2, *Corbula*, pl. 2, fig. 13.—C. B. Adams, 1852, Ann. Lyceum Nat. Hist., New York, p. 523.—Maxwell Smith, 1944, Panamic Marine Shells, p. 68, fig. 869B.

Corbula glypta Li, 1930, Bull. Geol. Survey of China, vol. 9, p. 264, pl. 5, figs. 38, 38a. (See Pilsbry, 1931, Proc. Acad. Nat. Sci. Philadelphia, vol. 83, p. 431).

The shell is thin, white, elongate, subrectangular in shape, and strongly inequilateral, the umbones high and full and placed nearly in the middle. The posterior side is strongly contracted and bears a sharp, elevated, umbonal keel. The rostral area is flattened or deeply impressed; in the middle of which there is an elongated escutcheon also defined by an angled keel. Surface ornamented with coarse, concentric riblets over the whole disk and also on the rostral area. There is usually a mild sulcation across the disk from the beak to the middle of the ventral margin.

Length 21.2 mm., height 13.2 mm., diameter 15.4 mm. Palo Seco, Panama Canal Zone.

A rare but widely distributed species.

Range—Panama to northern Peru. Panama: Montijo Bay (Cuming); San Carlos; Búcaro. Panama Canal Zone: Palo Seco; Venado Beach. Colombia: Isla del Gallo. Ecuador: Puerto Callo; Santa Elena. Peru: Zorritos.

Genus PANAMICORBULA Pilsbry, 1932

Type species by original designation, *Corbula (Panamicorbula) inflata* (C. B. Adams) (*Potamomya inflata* C. B. Adams). Panama.

Shell moderately large, of medium weight, subovate, convex, subequivalve, the beaks submedian, the anterior side a little longer, rounded, the posterior side shorter, its dorsal margin sloping to a bluntly truncated end. Posterior-dorsal area wide but defined externally by a weak angle. Surface smoothish or sculptured only by irregular growth incrementals. Hinge: the right valve has the usual large or small, hook-shaped cardinal tooth in front of the deep pit, but on the margins on each side, equidistant from the beak, there are deep, lateral sockets, their inner edge thickened to resemble a lateral tooth; the left valve has no lateral teeth, the margins merely beveled so as to fit into the sockets of the opposite valve. Chondrophoral plate in the left valve is similar to that of *Caryocorbula* but wider. Adductor scars large, subequal, the pallial sinus absent or weak. Color white, the periostracum thin, yellow or light brown. Habitat: "In soft impalpable mud, under a mangrove thicket, near high water margin, and near the outlet of a small stream, with *Arca tuberculosa*" C. B. Adams. Two species seem recognizable.

I. Shell large, (length 27 mm.), moderately heavy. Beaks submedian, the anterior side somewhat longer.

P. inflata

II. Shell generally smaller (length 22 mm. or less), roundly convex, sub-cylindrical, thinner, the beaks a trifle more anterior in position, the posterior end hence longer.

P. cylindrica

Panamicorbula inflata (C. B. Adams)

Plate 76, figures 1-1c

Potamomya inflata C. B. Adams, 1852, Ann. Lyceum Nat. Hist. New York, pp. 520, No. 500, p. 548.

Potamomya aequalis C. B. Adams, 1852, *idem.*, pp. 519, 520, No. 499; pp. 547, 548.

Potamomya trigonalis C. B. Adams, 1852, *idem.*, p. 520, No. 501; p. 548.

Corbula macdonaldi Dall, 1912, Smith. Misc. Coll., vol. 59, No. 2, p. 3.—Dall, 1925, Proc. U. S. Nat. Museum, vol. 66, art. 17, No. 2554, p. 15, pl. 17, fig. 1, 3.

Shell large, moderately heavy, with subequal ovate valves and high prominent umbones. The anterior side is a little longer than the posterior. An adult right valve measures: length 26.9 mm., height 21.7 mm., diameter 9.6 mm. Dall's *Corbula macdonaldi* said to have been collected from the Pleistocene muck beds at Colon (loc. 5848), probably came from the Pacific side of the isthmus.

Range—Mazatlan to northern Peru. Panama Canal Zone: Farfan Beach; Palo Seco. Colombia: Isla del Gallo. Ecuador: Limones; Puerto Palmar (Colonche). Peru: Tumbes.

Panamicorbula cylindrica Morrison

Plate 76, figures 2, 2a

Panamicorbula cylindrica Morrison, 1946, Smith. Misc. Coll., vol. 106, No. 6, pp. 47, 48, pl. 1, figs. 15, 17.

Panamicorbula inflata (C. B. Adams), Vokes, 1945, Bull. Amer. Museum Nat. Hist., vol. 86, No. 1, pp. 11, 12, pl. 2, figs. 1-4. (Not *inflata* C. B. Adams.)

This is a smaller and thinner species than *P. inflata*, with more anterior beaks, the posterior side hence longer. Although the valves are strongly convex, the umbones seem relatively low, the shell, therefore, assuming an apparent ovate-cylindrical form. The species is generally found associated with *C. inflata* and in the same environment.

Length 22 mm., height 16.3 mm., diameter 16 mm. Río Marina mangrove swamp, San José Island, Pearl Islands (Morrison, USNM).

Range—Panama to northern Peru. Panama: San José Island, Pearl Islands; Búcaro. Panama Canal Zone: Palo Seco. Ecuador: Limones. Peru: Tumbes.

Genus **JULIACORBULA** Olsson and Harbison, 1953

Type species by original designation: *Corbula cubaniana* d'Orbigny (= *C. knoxiana* C. B. Adams). Recent, Florida southward through the West Indies and the Caribbean to Panama.

Shell small or medium-sized, thin or heavy, rhombic to subrectangular, the anterior side rounded, the posterior side sharply truncate. Posterior-dorsal area is well defined, generally wide and strongly sculptured, enclosing a small, lanceolate escutcheon along the dorsal margin, externally limited by a sharp angle, ridge or keel. No lunule, but the area below the beaks is often deeply impressed. Hinge as in *Caryocorbula*. Surface sculptured with medium or coarse, regular concentrics, similar in each valve.

Key to Panamic-Pacific species

- I. Shell of square-ovate or rectangular form, subequilateral, the beaks placed near the middle.
- A. The rostral angle is high and sharp, the rostrum itself wide.
1. Shell small, solid, convex, with a squarish ovate form. Surface strongly sculptured. *J. bicarinata*
2. Shell larger, longer, and thinner. Sculpture finer. *J. elenensis*
- B. Rostral angle lower, the rostrum narrower.
3. Shell elongated ovate, solid, white with colored rays along the umbones and in the interior. *J. biradiata*
- II. Shell obliquely oblong in shape, strongly inequilateral, the beaks placed nearer the posterior end.
4. Shell of moderate weight, the rostral area low. *J. ecuabula*

***Juliacorbula bicarinata* (Sowerby)**

Plate 75, figures 6-6b

Corbula bicarinata Sowerby, 1833, Proc. Zool. Soc. London, p. 35. "Hab. ad littora Columbiae Occidentalis." "Found in sandy mud at from seven to seventeen fathoms at Panama, Real Llejos, Caraccas and St. Elena." Panama was designated as type locality by Hertlein and Strong.—Hanley, 1843, Cat. Rec. Bivalve Shells, p. 46, appendix pl. 12, fig. 31. West Colombia.—Reeve, 1844, Conch. Icon., vol. 2, *Corbula*, pl. 3, fig. 23.

Aloidis (Caryocorbula) bicarinata (Sowerby), Hertlein and Strong, 1950, Zoologica, vol. 35, pt. 4, p. 238.

Shell small, solid, squarely ovate, nearly equilateral, the anterior side somewhat longer, rounded at the end, the posterior side shorter, abruptly truncated, and flattened. The posterior-dorsal area or rostrum is wide, depressed and outwardly set apart by a sharp angle or keel, and usually carrying a radial mid-rib enclosing a deep, smooth, escutcheon-like depression. There is also a sunken, plain area on the anterior side of the beak suggestive of a lunule. The valves are of nearly equal size and sculptured with coarse, concentric cords; on the rostrum the cords are finer and more close-set. Color white, the growing edge of the valves generally brown.

Length 11.2 mm., height 8 mm., diameter 2.7 mm. (left valve). Venado Beach, Panama Canal Zone.

This is a characteristic species, easily recognized by its rectangular form, sharply truncated posterior margin and neat sculpture. It is similar to *J. scutata* Gardner¹⁵ from the Pliocene of Florida and North Carolina, but is generally somewhat larger. *Corbula (Cuneocorbula) ira* Dall, 1908, "Albatross Report" (Bull. Mus. Comp. Zool., vol. 43, No. 6, p. 423), hitherto unfigured (see Plate 76, figure 5), was described from specimens dredged in the Gulf of Panama from a depth of 182 fathoms. This shell resembles *J. bicarinata* and perhaps should be united with it.

Range—Gulf of California to northern Peru. Panama: Panama City; Búcaro. Panama Canal Zone: Venado Beach. Colombia: Isla del Gallo. Ecuador: Isla la Plata. Peru: Zorritos.

¹⁵Gardner, 1943, Prof. Paper 199-A, U.S. Geol. Survey, pp. 140, 141, pl. 23, figs. 26, 30 - 32.—Olsson and Harbison, 1953, Mon. Acad. Nat. Sci. Philadelphia, No. 8, p. 149, pl. 7, fig. 6.

Julliacorbula biradiata (Sowerby)

Plate 75, figures 4-4b

Corbula biradiata Sowerby, 1833, Proc. Zool. Soc. London, p. 33. "Hab. ad Chiriqui et ad sinum caraccensium".—Reeve, 1843, Conch. Icon., vol. 2, *Corbula*, pl. 1, fig. 3.—Hanley, 1843, Cat. Rec. Bivalve Shells, p. 47, suppl. pl. 10, fig. 51.

Corbula rubra C. B. Adams, 1852, Ann. Lyceum Nat. Hist. New York, pp. 523, 548.—Turner, 1956, Occas. Papers on Mollusks, Mus. Comp. Zool., vol. 2, No. 20, pp. 82, 83, pl. 17, figs. 8, 9.

Corbula polychroma Carpenter, 1856, Proc. Zool. Soc. London, p. 198 issued Jan. 7th, 1957. "Hab. in Sinu Californiensi".

Aloidis (Caryocorbula) biradiata (Sowerby), Hertlein and Strong, 1950, Zoologica, vol. 31, pt. 4, pp. 238, 239.

The shell is small or of medium size, solid, irregularly oblong in shape, somewhat depressed, the wide, flattened umbones and beaks placed a little behind the mid-zone. The anterior side is longer, rounded at the end, the posterior side shorter and subtruncated. The rostrum or posterior-dorsal area is wide, externally limited by a sharp angle. The escutcheon, along the dorsal margin, is narrow and elongated and sculptured only by growth lines; there is no lunule. Surface sculptured with strong, irregular, cordlike concentrics, continued also on the rostrum. Color white, gray or purple, generally with a white ray along each side of the umbone below which the sides of the beak may be purple or red. The interior is often colored with purple on the lateral and ventral margins. Average size about 15 mm., but occasional specimens may be larger (length 20.5 mm.).

Length 15 mm., height 10.6 mm., diameter of a right valve 3.7 mm. Búcaro, Panama.

Easily recognized by its flattened, subrectangular shape, and by its colored umbones and beaks.

Range—Gulf of California to northern Peru. Panama: Pearl Islands; Búcaro; San Carlos; Panama City. Colombia: Isla del Gallo. Ecuador: Manta; Santa Elena. Peru: Tumbes; Mancora; Paita.

Julliacorbula ecuabula (Pilsbry and Olsson)

Corbula ecuabula Pilsbry and Olsson, 1941, Proc. Acad. Nat. Sci. Philadelphia, vol. 93, p. 75, pl. 12, figs. 3, 4, 5.

Shell of medium size, moderately thin, strongly inequilateral, and subequivalve. The umbones and beaks are placed at the posterior third, the anterior side, therefore, much longer, its dorsal margin descending slightly so that the outline of the valve is oblique. The margin of the short posterior side slopes down sharply, its rostrum narrow, bounded outwardly by a weak keel or angle only. The left valve is a little smaller than the right with a depressed ray in the ventral region. Surface smooth or marked with coarse concentrics, stronger on the anterior side and over the rostrum.

Length 16.25 mm., height 12 mm., diameter of a right valve 3.7 mm. Fossil, Punta Blanca, Ecuador.

Length 18.1 mm., height 11.3 mm., diameter of a left valve 3.6 mm. Zorritos, Peru.

This species was first described as fossil from the Pliocene of Ecuador but a few Recent specimens have also been collected. It is distinguished from its allies by its oblique shape and extreme posterior position of its beaks.

Range—Coast of Peru and Ecuador. Ecuador: Punta Blanca. Peru: Zorritos.

Juliacorbula elenensis, new species

Plate 77, figure 5

Shell of medium size and of moderate weight, oblong-ovate, sub-equilateral and equivalve. The beaks are nearly central, the anterior side is equal or only slightly longer than the posterior, well rounded at the end. The dorsal margin along the posterior side descends at an angle of about 45 degrees terminating in an obtuse end. The rostrum is of moderate width, bounded externally by a strong angle, along which, the concentric cords are bent sharply; the rostral surface is flattened or a little arched, and borders the margin; there is a narrow, smooth, depressed escutcheon. There is no lunule. The surface is sculptured by a series of rather coarse, even, slightly inclined concentrics set apart from each other by deeply grooved interspaces. Color white or cream, the umbones often bordered by a white ray on each side.

Length 17 mm., height 12 mm., diameter of a right valve 4.2 mm. Santa Elena, Ecuador. Holotype, ANSP 218913.

This species resembles *J. biradiata* but is more convex, its sculpture more regular, and it lacks the colored rays along the sides of the beak and umbone. It differs from *J. ecuabula* by its more equilateral valves. It is also similar to *C. knoxiana* (C. B. Adams) of the Caribbean, but is larger than most specimens of that species, and its outline is longer and less squared off at the ends.

Range—Ecuador and Peru. Ecuador: Puerto Callo; Santa Elena, Peru: Tumbez; Zorritos.

Genus **VARICORBULA** Grant and Gale, 1931

Type species by original designation, *Corbula gibba* (Oliv). Mediterranean Sea and west coast of Europe. Recent and fossil.

Shell generally small, subtrigonal, the valves unequal in size and sculpture, the right valve larger, convex, obtusely rostrated, the umbone high, ending in an erect or prosogyrate beak curved over the hinge line, its surface ornamented with strong, concentric sculpture; the left valve is much smaller, depressed or flattened, smooth or with faint, widely spaced, radial lines.

Varicorbula speciosa (Reeve)

Plate 77, figures 7-7c

Corbula radiata Sowerby, 1833, Proc. Zool. Soc. London, p. 36. Not of Deshayes, 1824. "Hab. ad Acapulcam".

Corbula speciosa Reeve, 1843, Conch. Icon., vol. 2, *Corbula*, pl. 1, fig. 6. (new name for *C. radiata* Sowerby) "Gulf of Nicoya".—Hinds, 1843, Proc. Zool. Soc. London, p. 57.—Hinds, 1844, Zool. Voy. *Sulphur*, Moll., pt. 3, p. 68, pl. 20, figs. 7, 8.

Shell rounded or trigonal ovate, inequivalve, the right valve much larger than the left, convex, with coarse, undulate, concentric sculpture, whitish, rayed with salmon pink or purple; the left valve smaller, longer, more depressed and with finer sculpture, its color darker, rayed with reddish-brown. Both valves have the umbones capped by a large, conspicuous, nepionic shell, finely mottled or marbled with white and violet-brown markings. Interior white with a narrow brown margin.

Length 18.2 mm., height 12.3 mm. Gulf of Nicoya. British Museum (Natural History).

Length 19.2 mm., height 15 mm., diameter of both valves 12.5 mm. Off Clarion Island (Hertlein and Strong).

When fully grown, this fine species is easily recognized by its unusual shape and by its large, conspicuous, nepionic shell capping the umbones of both valves. Fresh specimens are generally brightly colored, rayed with red but plainly marked shells may also occur. Hertlein and Strong recorded this species from several localities in the Gulf of California and southward to Costa Rica.

Range—Gulf of California south to Costa Rica. Gulf of California. Costa Rica: Gulf of Nicoya.

Family GASTROCHAENIDAE

Borers in limestone, coral, and the thick wall of shells, forming flask-shaped excavations or if found in softer material such as sand, they develop a calcareous tube which covers the small valves and siphons. The shell, itself, is small to medium-sized, thin, equivalved and inequilateral, elongate-mytiliform, the ventral-posterior side so widely open that the valves are in contact only along the dorsal side and at the ends. The hinge is edentulous, the ligament external, attached to a linear groove above a weak, nymphal ridge. In some forms, there is a shelflike lamina under the beaks extending into the umbonal cavity; its function is believed to be that of a myophore.

The Gastrochaenidae are mainly borers in limestone rock, coral, shell, lining their excavation with a tube which at the exit may project above the surface in the shape of a narrow neck or it may lay prone on the surface in the shape of an irregular, gourdlike tube. Gould considered this gourdlike growth as characteristic of some species and proposed the name *Cucurbitula* (type species *C. cymbium* Spengler = *lacinula* Lamarck), but later workers have shown that this sort of tube is accidental and is formed only in such *Gastrochaena* which have become affixed to a thin-walled shell into which they could not bore.

With two genera characterized as follows:

- I. Surface of valves with a plain sculpture of concentric growth lines only.
 - Genus *Gastrochaena*
 - A. Cardinal margin thickened and carrying an internal lamina or myophore extending towards the umbonal cavity.
 - Subgenus *Gastrochaena*
 - B. No myophore, the dorsal margin plain and unthickened.
 - Subgenus *Rocellaria*
 - II. Surface marked by a deep ray or sulcus running from the beak to the posterior-ventral margin, the posterior surface above sculptured with deep, transverse ridges, the posterior margin more or less sharply tuncated.

Genus *Spengleria*

Genus GASTROCHAENA Spengler, 1783

Type species by subsequent designation, Bucquoy, Dautzenberg, and Dollfus, 1896, *Gastrochaena cuneiformis* Spengler. Recent, West Indies.

Shell small or of medium size, with two, thin, elongate, wedge-shaped valves, the ventral gap large. Beaks nearly terminal, the anterior side short

and projects beyond the tip of the beaks but slightly. Myophoral plate relatively large, forming a shelflike lamina attached below and within the hinge margin and extending into the umbonal cavity, its inner edge open and free. Surface with concentric sculpture. Adductor scars of unequal size, the pallial sinus narrow and deep, extending into the inner sections of the shell cavity.

***Gastrochaena (Gastrochaena) truncata* Sowerby**

Gastrochaena truncata Sowerby, 1834, Proc. Zool. Soc. London, p. 21, Hab. Found in *Spondyli*, in Sinu Panamensi (Isle of Perico).—Sowerby, 1878, Conch. Icon., vol. 20, *Gastrochaena*, pl. 3, fig. 19.—Sowerby, 1884, Thes. Conch., vol. 5, p. 130, No. 23, pl. 470, fig. 13.

Shell large (length 36 mm.), elongate, and narrowly modioliform, convex, the valves in contact only along the dorsal and posterior margin, the posterior end somewhat truncate or widely rounded. Ventral gap large, elliptical, and extending across nearly the whole length of the ventral margin. Shell texture relatively solid and sculptured with coarse, wrinkled growth incrementals, the surface covered by a brown epidermis, which is heaviest on the posterior portion. An internal myophore present.

This is a large species, broad, square or widely subtruncate at the posterior end, and much narrower and pointed at the anterior end.

Range—Mazatlan to Panama. Panama: Panama.

***Gastrochaena (Gastrochaena) ecuadoriensis*, new species** Plate 80, figures 8, 8a

Valves relatively large, reaching a length of about 25 mm., thin, obliquely modioliform, the ventral gap large, extending the whole length of the ventral margin from the anterior extremity to the posterior-ventral corner. The small beaks are nearly terminal, the anterior margin, projecting beyond them, short. Dorsal margin straight, the external ligament extending about halfway along it, the posterior end of the valves wide, the margin itself widely rounded to subtruncate. There is a weak umbonal ridge running obliquely across the disk of the valve from the beak to the posterior-ventral edge along which the concentric ridges and emphasized growth wrinkles are bent backwards almost at right angles. The myophoral shelf within the umbonal cavity large. Pallial sinus long and narrow, extending deep into the cavity of the shell. Adductor scars of unequal size.

Length 25 mm., height 12 mm., diameter of both valves 11 mm.

Taken from a thick shell *Spondylus*. Punta Montanita above Manglar-also, Ecuador. Holotype, ANSP 218914.

Subgenus **ROCELLARIA** Blainville, 1828

Type species by monotypy, *Gastrochaena modiolina* Lamarck = *Mya dubia* Pennant. Europe.

Shell small or of medium size, thin, moderately convex, the valves obliquely modioliform, with the umbones and beaks strongly anterior, the anterior end pointed. Ventral margin is widely open or gaping, the valves in contact only along the dorsal margin and at the ends. No internal myophoral plate. Surface sculptured by strong, concentric wrinkles, and accentuated growth lines, sometimes becoming lamellar. Pallial sinus moderately deep and sharply angular.

Gastrochaena (Rocellaria) ovata Sowerby

Plate 80, figures 7, 7a, 7b

Gastrochaena ovata Sowerby, 1834, Proc. Zool. Soc. London, p. 21. Found in *Spondyli* at the Isle of Perico (Panama), and in coral rock at a depth of 17 fathoms at the island of Plata.—Sowerby, 1878, Conch. Icon., vol. 20, *Gastrochaena*, pl. 3, fig. 18 (not 16).—Sowerby, 1884, Thes. Conch., vol. 5, p. 128, No. 12, pl. 470, fig. 9.—Lamy, 1925, Jour. de Conchyl., vol. 68, No. 4, pp. 304, 305.

Rocellaria ovata (Sowerby), Hertlein and Strong, 1950, Zoologica, vol. 35, pt. 4, No. 19, pp. 246, 247, pl. 2, fig. 2.

Shell relatively short and high, the length usually between 20 and 30 mm. Highest and widest about the middle, the posterior end long and narrowly rounded at the end, the anterior side in front of the beaks much constricted and somewhat produced. The ventral gap is large and broadly elliptical. Surface sculptured with rather coarse to fine raised concentrics, spaced evenly and widely over the posterior surface, much crowded on the posterior-ventral and anterior side where the lamellae are also obscurely denticulated. Interior of the shell shows vascular markings over much of its surface, the posterior adductor scar large and distinct, weakly joined above with that of the retractor; the anterior adductor scar is also well marked and lies largely in the attenuated portion; the pallial line connecting the adductors is wide, pustulated, or veined, the pallial sinus is deep, reaching into the middle of the shell cavity. Hinge line plain, the ligament external.

A specimen from Manta measures: length 19.2 mm., height 10.6 mm., diameter 9.7 mm. ANSP.

Range—Lower California south to Ecuador. Also in the Atlantic and West Indies. Mexico: at various localities in the Gulf of California; Mazatlan (Carpenter). Costa Rica: Uvita Bay (Hertlein and Strong). Panama: Pearl Islands (Cuming). Ecuador: Isla la Plata (Cuming); Manta.

Gastrochaena denticulata Deshayes

Gastrochaena denticulata Deshayes, 1857, Proc. Zool. Soc. London, p. West Colombia. Sowerby, 1878, Conch. Icon., vol. 20, *Gastrochaena*, pl. II, fig. 8.—Sowerby, 1884, Thes. Conch., vol. 5, *Gastrochaena*, p. 129, pl. 470, fig. 7.

This species is known only by its figure which shows a shell with a short hinge margin, with an 120 degree angle at the end and strong, denticulated concentric lamellae on the anterior-ventral surface setoff from the posterior surface by a sharp, middle line; this figure is strongly suggestive of a young pedolad with a large pedal gap.

Range—West Colombia (Ecuador).

Superfamily PHOLADACEA**Family PHOLADIDAE**

Complex and highly specialized Pelecypoda adapted for boring or burrowing in sand, clay, rock or wood, sometimes in coral and the walls of thick-shelled mollusks, the valves usually thin, fragile, and white. In addition to the paired valves on the sides of the animal, smaller accessory plates to the number of four or less may be present in some species, while they are partly or wholly lacking in others; these accessory plates may be paired

or fused together, and are so placed as to cover open spaces along the margins of the primary valves, and over the anterior, the anterior ventral or pedal gap thus protecting the soft tissues within. Both the ligament and the hinge teeth are absent or much modified. The umbonal margins are inrolled over the beaks forming a rounded umbonal reflection which may be appressed closely to the surface underneath or it may be widely separated from it leaving an open or a multiseptate space. The walls of the shell are usually thin and fragile; they may form a single uninterrupted surface or the disk may be divided into smaller areas by one or two deep sulci which radiate from the beak, the areas so set apart differing greatly in size, shape and sculpture; typically, the anterior area has a sculpture of coarse, sharp, radial costae, while the posterior area is usually smooth or marked with concentrics only. There is a slender apophysis in the umbonal cavity of each valve in some species; it is lacking in others.

The pholads are typically marine species, although some forms have become adapted to moderately brackish waters. In many species, the soft parts cannot be retracted fully within the shell, the long, leathery siphons remaining extended (see Plate 78, figure 2c). In the subfamily, Pholadinae, the shell is similar at all stages of growth and the anterior gap, if one is present, remains open. In the idealized sketch, (Plate 78, figure 1), copied after Turner, 1954, the external surface of the right valve of a typical pholad is shown, its sculpture, and the position of the accessory plates.

In the most recent review of the family Pholadidae, that of Turner,¹⁶ four subfamilies are recognized as follows:

- I. A slender, armlike process or apophysis is present in the umbonal cavity.
- A. The anterior-ventral or pedal gap is open, not closed or covered by an accessory plate or callum at any stage. External surface not divided into separate sections, its sculpture fairly uniform or gradational over the whole disk and usually consists of sharply scabrous radial riblets. Animal not capable of complete retraction within its shell.

Subfamily *Pholadinae*

- B. The pedal or anterior-ventral gap is covered by an accessory plate (callum) in the adult stage. External surface divided into distinct areas by one or two deep radial sulci. Sculpture dissimilar in the separate areas. Animal contained within its shell.

Subfamily *Martesiinae*

- II. No internal apophyses.

- C. Anterior gap covered completely by the callum in the adult, open in the juvenile stages; other accessory plates may also be present. Surface divided by an umbonal ventral sulcus into two distinct areas. Animal contained within its shell.

Subfamily *Jouannetiinae*

- D. Anterior gap is open at all stages of growth. Valves teredo-like. Animal capable of complete retraction within its shell.

Subfamily *Xylophaginae*

¹⁶Ruth Turner, 1954. *Johnsonia*, vol. 3, part 1, No. 33; part 2, No. 34.

Subfamily PHOLADINAE

With the characters as described in the key. With three genera and three species regional.

I. Umbonal reflection septate beneath.

Genus *Pholas*

II. Umbonal reflection separated from the surface of the umbones beneath by an open or empty space.

A. With a single accessory plate. A protoplax present only.

Genus *Barnea*

B. With two accessory plates, a protoplax and mesoplax.

Genus *Cyrtopleura*

Genus PHOLAS Linné

Type species by subsequent designation, Childrens, 1822, *Pholas dactylus* Linné. Recent, east Atlantic, and the Mediterranean.

Shell elongate, white, thin, sculptured by concentric ridges, and sharply noded radial riblets, more or less uniform over the whole surface. Umbonal reflection septate. Accessory plates three in number; a simple or paired protoplax, a transverse mesoplax and a long, narrow metaplax. Anterior end of shell beaked or rounded.

The genus is divided into three subgenera as follows:

I. Protoplax fused into a single plate.

Subgenus *Monothyra* (not regional)

II. Protoplax paired.

A. Anterior side beaked.

Subgenus *Pholas*, s.s. (not regional)

B. Anterior side rounded.

Subgenus *Thovana* (American)

Subgenus THOVANA Gray, 1847

Type species by monotypy, *Pholas oblongata* Say (= *P. campechiensis* Gmelin). West Atlantic.

Shell with the anterior side rounded, the beak and umbones covered by a rounded marginal reflection, deeply septate beneath. There are three accessory plates, usually lost when the valves are separated. The protoplax is longitudinally divided into two parts. Mesoplax small, transverse. The metaplax is long, narrow, and thin.

With two Recent species, both American, *P. campechiensis* Gmelin in Atlantic waters, and *P. chiloensis* Molina in the Pacific.

Pholas (*Thovana*) *chiloensis* Molina

Plate 78, figures 4, 4a

Pholas chiloensis Molina, 1782, Saggio Sulla Storia Naturale de Chili, p. 204 Archipelago de Chiloe.

Pholas chiloensis var. *parva* Sowerby, 1834, Proc. Zool. Soc. London, p. 69 Island of Plata.

Pholas laqueata Sowerby, 1849, Thes. Conch., vol. 2, *Pholas*, p. 486, pl. 103, figs. 19, 20 Isle of Plata.

Pholas (*Dactylina*) *retifer* Mörch, 1860, Malak. Blätter, vol. 7, p. 177 Realejo, Nicaragua.

Pholas dilecta Pilsbry and Lowe, 1932, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, p. 88, pl. 11, figs. 8, 9.—Maxwell Smith, 1944, Panamic Marine Shells, p. 68, fig. 381.

Pholas (*Thovana*) *chiloensis* Molina, Turner, 1954, Johnsonia, vol. 3, No. 33*, pp. 51-54, pls. 25, 26, 27.

Shell elongate, reaching a length of nearly 5 inches but usually smaller, white, thin to moderately solid, gaping slightly at both ends. Beaks and umbones placed near the anterior one-fourth or one-fifth, the dorsal margins at this point rolled over the beaks to form a wide, umbonal reflection which is coarsely septate underneath, and anteriorly, under the whole, there is a deep, umbilical perforation. The sculpture is produced by concentrically frilled ridges, the frills, spaced evenly, forming a series of coarse, fluted, or scabrously serrated, radial riblets.

Closely related to the East American *P. campechiensis*, it is separated by its average shorter, stouter shell, much coarser sculpture and by the smaller perforation under the rolled-over, anterior-dorsal margin.

Range—Mexico southward to Chile. Panama: Burica Peninsula; Búcaro. Ecuador: Bahía de Canoa; Manta; Punta Blanca; Manglaralto; Santa Elena. Peru: Tumbes; Boca Pan; Lobitos.

Genus **BARNEA** Risso, 1826

Type species by monotypy, *Barnea spinosa* Risso (= *Pholas candida* Linné). Recent, European seas.

Like *Pholas*, the shell is elongate, subcylindrical in shape, thin, white, but with a single accessory plate (protoplax), lanceolate in shape, and the space below the umbonal reflection is open (not septate). The sculpture is formed by imbricated, sharp, rasplike radial ribs which because of the light weight of the shell show internally as pitted furrows. Pallial sinus is usually well marked and of medium size and depth.

Two subgenera are distinguishable.

I. Anterior side rounded.

Barnea, s.s.

II. Anterior side narrowed into a beak.

Anchomasa Leach

Barnea (*Anchomasa*) **subtruncata** (Sowerby)

Plate 78, figures 2-2c

Pholas subtruncata Sowerby, 1834, Proc. Zool. Soc. London, p. 69 "Isla la Plata."

Barnea pacifica Stearns, 1871, Conch. Memoranda, No. 7, p. 1.—Stearns, 1873, Proc. California Acad. Sci., vol. 5, p. 81, pl. 1, figs. 6, 6a-c.—Hertlein and Strong, 1950, Zoologica, vol. 35, pt. 4, No. 19, p. 248.

Barnea (*Anchomasa*) *subtruncata* (Sowerby), Turner, 1954, *Johnsonia*, vol. 3, No. 33*, pp. 31-34, pls. 8 and 14 to 16.

Shell subcylindrical, the dorsal and ventral sides parallel, convex and thin, widely gaping at both ends, the anterior side shortened and produced into a beak, the posterior side sharply truncated as if cut off. Length of full grown shell is nearly 70 mm., but the average size is between 40 and 50 mm. Sculpture is formed by small, finely scabrous ribs which slowly diminish in size posteriorly and in the Peruvian specimens do not fade out completely except on the posterior dorsal slope. Apophyses long and narrow.

This is a widely distributed species. It was found in large numbers on the mudflat at the mouth of the Tumbes River in Peru.

Range—Oregon to Chile (according to authors). Ecuador: Isla la Plata (type locality). Peru: Tumbes; Paita.

Genus **CYRTOPLEURA** Tryon, 1862

Type species by subsequent designation, Stoliczka, 1870, *Pholas crucifera* Sowerby (= *Pholas cruciger* Sowerby). Ecuador.

Shell elongate, white, relatively thin, the anterior margin rounded or beaked, the anterior ventral or pedal gap varying in size from a narrow slit to broadly ovate. Accessory plates two, consisting of a protoplax and mesoplax, the protoplax chitinous or only slightly calcified. Umbonal reflection well separated from the surface of the umbones, the space between empty, not septate.

Divided into two subgenera as follows:

- I. Valves beaked anteriorly. Pedal gap ovate and large.
Subgenus *Cyrtopleura*, s.s.
- II. Valves rounded anteriorly, the pedal gap small, slitlike.
Subgenus *Scobinopholas*

Subgenus **CYRTOPLEURA** Tryon, s.s.

Cyrtopleura (Cyrtopleura) cruciger (Sowerby) Plate 78, figure 3-3b

Pholas cruciger Sowerby, 1834, Proc. Zool. Soc. London, p. 69. "In soft sandstone, Island of Puna in the Gulf of Guayaquil; in soft stone at low water in the Bay of Caraccas; and in hard clay in the Gulf of Nocoioy [Nicoya]."

Pholas crucifera Sowerby, 1849, Thes. Conch., vol. 2, p. 489.

Pholas crucifera Sowerby, 1849, *idem.*, pl. 104, figs. 24-26.

Cyrtopleura (Cyrtopleura) cruciger (Sowerby), Turner, 1954, Johnsonia, vol. 3, No. 33*, pp. 41-43, pls. 17, 20, 21.

This pholad is a borer in soft rock. The shell is generally small, seldom exceeding two inches in length, white, its surface usually with a chalky appearance. Valves are elongate, uniformly convex throughout, highest just behind the beaks, the dorsal and ventral margins are straight and nearly parallel, the anterior-ventral margin with an expanded, ovate-lanceolate gap. The sculpture is formed by fairly strong, radial riblets, coarser towards the anterior end, fading out and becoming replaced entirely on the extreme posterior end by concentrics. The concentrics as they pass over the radial riblets form vaulted, imbricated scales, the posterior arm of the V more or less in line.

Range—Mexico south to northern Peru. Colombia: Isla del Gallo. Ecuador: Galeras; Sua; Manta; Puna. Peru: Tumbes.

Subfamily **MARTESIINAE**

Borers in soft rock, shell or wood. Characters of the shell as given in the key.

- I. Valve with a single sulcus extending from the beak across the umbone to the ventral margin dividing the surface of the disk into two sections.
- A. Callum with an extension between the beaks and along the ventral margins, the metaplax small and placed entirely behind the beaks. Rock borers.

Genus *Hastasia*

- B. Callum without dorsal and ventral extensions. Metaplax large, covering the beaks and umbones. Wood borers.

Genus *Martesia*

- II. Surface of valves with two sulci extending across the disk and dividing it into three sections.

Genus *Parapholas*

Genus **MARTESIA** Sowerby, 1824

(*Hiata* Zetek and McLean, 1936)

Type species by monotypy, *Pholas clavata* Lamarck (= *P. striata* Linné). Western Europe, cosmopolitan.

Borers in wood. Shell pholadiform, wedge-shaped, thin, white, inequilateral, the surface of the valves divided into two sections by an umbonal-ventral sulcus, the anterior portion sculptured with fine, toothed, concentric ridges which are deeply inflexed near the middle, the posterior portion with larger, smoother concentrics which are wholly absent from the more extreme end. Anterior side of shell is widely open in the juvenile stage (*Hiata* stage), later closed off by a large, paired callum. There is no protoplax, its place taken by the much enlarged, shieldlike metaplax, at first relatively soft and wrinkled, later becoming more indurated. Metaplax and hypoplax are both present, long and narrow in shape. The internal apophyses are slender and hook-shaped.

Following Turner, the genus is divided into two subgenera as follows:

I. Mesoplax ovate to subcircular. Metaplax and hypoplax pointed or truncated behind, not divided.

Subgenus *Martesia*, s.s.

II. Mesoplax wedge-shaped or cuneiform, metaplax and hypoplax divided posteriorly.

Subgenus *Praticoma*

Martesia (*Martesia*) *striata* (Linné)

Plate 79, figures 6, 7, 7a

Pholas striata Linné, 1758, Systema Naturae, ed. 10, p. 669 western Europe.

Hiata infelix Zetck and McLean, 1936, Nautilus, vol. 49, No. 4, pp. 110, 111, pl. 8, figs. 1-4.

Martesia intercalata 'Carpenter' Hertlein and Strong, 1950, Zoologica, vol. 35, pt. 4, No. 19, p. 250. (Not *M. intercalata* Carpenter=*Penitella conradi* [Val.]).

Martesia (*Martesia*) *striata* (Linné), Turner, 1955, Johnsonia, vol. 3, No. 34, pp. 103-111, pl. 35, figs. 61-64.

For full synonym and discussion of this species, the reader is referred to Turner.

Shell white, thin, variable in shape and often deformed, generally under two inches in length. Undeformed specimens are elongate, the posterior end of the shell produced and flattened, closed. Anterior section of the valves in front of the umbonal-ventral sulcus is neatly sculptured with close-set, denticulated concentrics, smooth and large just behind the sulcus and absent entirely on the extreme posterior end. Young specimens (*Hiata*) have no callum, the anterior side is widely open but this becomes closed or roofed over by a large, paired callum in the adult. The mesoplax is large, cuneiform, constricted in the middle, narrower in front, and with four large, rounded corners.

A common borer in wood. Specimens collected in Panama from stranded piling at Venado Beach showed both the young *Hiata* stage without callum and the adult form with the callum.

Martesia fragilis Verrill and Bush, a pelagic species, taken mostly from floating wood, is recorded from the Gulf of Panama by Tucker; closely related to *M. striata*, it is distinguished by its depressed keeled-edged metaplax sculptured with concentric lines.

Range—Atlantic from North Carolina to Brazil, the Gulf of Mexico and the Caribbean. Pacific Coast of Mexico south to northern Peru. Also Japan, the Hawaiian Islands. Panama: Guanico. Panama Canal Zone: Venado Beach. Colombia: Isla del Gallo; Tumaco. Ecuador: Sua. Peru: Tumbuz.

Genus **PARAPHOLAS** Conrad, 1848

Type species by monotypy, *Pholas californica* Conrad. California.

The shell is pholadiform, anteriorly convex, the posterior side tubular and moderately produced. Valves have an anterior beak, below which in the young, there is a large, open gap, closed in the adult by a globose, double, calcareous plate or callum, the umbones and the beaks covered by another large plate (the mesoplax); two other accessory plates (the metaplastax and hypoplastax) cover the posterior-dorsal and the ventral margins respectively. The surface of each valve is crossed by two, radial sulci, the anterior one across the umbone to the ventral margin and it shows plainly in the interior as a rib, its end projecting like a tooth at the margin; a second, smaller sulcus extends across the more posterior portion of disk. In front of the first or principal sulcus, the sculpture is produced by scabrous, radial riblets; in the middle zone between the sulci, the sculpture is mainly concentric; in the posterior portion or behind the second sulcus, the periostracum is raised into small laminae. The anterior-dorsal margin is doubled over in front of the beak and extends back a short distance as a small spur. The internal apophyses, one in each valve, are relatively small and slender. The mollusk lies in a secondary tube or chimney, but not attached to it, composed of agglutinated rock grains, produced during the excavation of the bore in hard shale or limestone.

Parapholas acuminata (Sowerby)

Plate 78, figure 5;
Plate 79, figure 3

Pholas acuminata Sowerby, 1834, Proc. Zool. Soc. London, p. 70 "Panama, in limestone rocks at low water".—Sowerby, 1849, Thes. Conch., vol. 2, p. 492, pl. 105, figs. 48, 49.

Parapholas acuminata (Sowerby), Carpenter, 1857, Cat. Mazatlan Shells, Brit. Mus., pp. 12, 13, No. 18.—Maxwell Smith, 1944, Panamic Marine Shells, p. 68, fig. 872 (as *calva* Gray in Sowerby).—Turner, 1955, Johnsonia, vol. 3, pp. 128-131, pl. 78-80.

Specimens from Ecuador have a length of nearly 60 mm. The posterior extremity is pointed or acuminate, brownish to nearly black in color, ornamented by the edges of the concentric lamellae of the periostracum. The internal rib (condyle) formed by the external, umbonal sulcus does not extend beyond the ventral margin in the form of a short spur. The large, shieldlike mesoplax, its edges turned in to fit under the umbonal reflection is well developed. The chimney is generally a well-formed, smooth, fine-grained cement-like tube and attains a length of three inches or more.

This species is fairly common along the coast of Ecuador boring in Tertiary shale at Manta, Esmeraldas, and other localities.

Range—Gulf of California to northern Peru. Panama: Guanico. Ecuador: Santa Elena; Manta; Crucitas; Esmeraldas. Peru: Boca Pan.

Parapholas calva (Sowerby)

Plate 79, figure 2;
Plate 80, figures 5, 5a, 6, 6a

Pholas calva 'Gray', Sowerby, 1834, Proc. Zool. Soc. London, p. 69 "Perico Island, Panama Bay".—Sowerby, 1849, Thes. Conch., vol. 2, p. 493, pl. 105, figs. 51-53.

Pholas calva var. *nana* Sowerby, 1834, Proc. Zool. Soc. London, p. 70 Panama.

Parapholas bisulcata Conrad, 1850, Proc. Acad. Nat. Sci. Philadelphia, vol. 4, p. 156 Lower California and Peru.—Conrad, 1850, Jour. Acad. Nat. Sci. Philadelphia, vol. 1, pt. 4, p. 279, pl. 39, fig. 5.

Parapholas calva (Sowerby), Turner, 1955, Johnsonia, vol. 3, No. 34, pp. 131-133, pl. 81.

Apparently rare, and distinguished from *P. acuminata* by its larger

and deeply lobate mesoplax. The figured specimen was obtained at Jaramijo along with more abundant *P. acuminata*. Its measurements are: length 32 mm., height 17.8 mm., greater diameter 17.5 mm.

Range—Mexico to Ecuador. Mexico: Guaymas; Mazatlan (Turner). Panama: Perico Island (Cuming and Sowerby). Ecuador: Manta (Turner); Jaramijo.

Genus **HASTASIA** Gray, 1851

Type species by subsequent designation, Stoliczka, 1870, *Pholas melanura* Sowerby.

The shell is broadly pholadiform, each valve with a single median sulcus dividing the surface into two unequal parts; the anterior section with scabrous sculpture and beaked at the end; the posterior section with smooth concentrics. The anterior side is widely open in the young, later closed by the large, paired callum, extensions of which are prolonged upward along the beaks, and downward along the ventral side and partly around the posterior end. There is no protoplax as the function of this plate is performed by the extension of the paired callum. The mesoplax in the juvenile stage is a small, flat, semicircular plate, and in one piece. The siphonoplax is chitinous. An incipient metaplax and hypoplax is present or absent. The internal apophyses are long and slender.

This group has generally been considered as a subgenus of *Pholadidea*, but its characters are sufficiently distinct to warrant full generic status.

Hastasia melanura (Sowerby)

Plate 78, figure 6;
Plate 79, figure 1

Pholas melanura Sowerby, 1834, Proc. Zool. Soc. London, pp. 70, 71.—Sowerby, 1849, Thes. Conch., vol. 2, p. 499, pl. 107, figs. 78, 79.

Pholadidea melanura (Sowerby) Carpenter, 1857, Cat. Mazatlan Shell, Brit. Mus., p. 8, No. 15.—Maxwell Smith, 1944, Panamic Marine Shells, p. 69, fig. 874.

Some free valves from Guanico are large and measure over 2½ inches in length; still other larger valves in the collection are from San Pedro, a place to the south of Manglaralto in Ecuador. The shell is heavy. The median sulcus is deep, cross-threaded, and shows well in the interior as a coarse rib. In the adult, the anterior gap is closed by a large, convex paired callum extensions of which are carried upward to the point just behind the beaks, and also along the ventral margins, and in these places, it replaces the protoplax and the hypoplax.

Range—Lower California to Ecuador. Mexico: Mazatlan. Panama: Guanico; Burica Peninsula. Ecuador: Manta; San Pedro.

Hastasia tubifera (Sowerby)

Plate 79, figures 4-4d

Pholas tubifera Sowerby, 1834, Proc. Zool. Soc. London, p. 71. (Sinum Caraccensem Bahía de Caráques).—Sowerby, 1849, Thes. Conch., vol. 2, *Pholas*, p. 499, pl. 106, figs. 64, 65.

Pholadidea tubifera (Sowerby), Gall, 1909, Proc. U.S. Nat. Museum, vol. 37, No. 1704, p. 277.—Maxwell Smith, 1944, Panamic Marine Shells, p. 69, fig. 877.

This is a relatively small species probably never exceeding 40 mm. in length. In this species, the protoplax remains in connection with the callum but joined with it only by a narrow constriction or neck. Specimens which have lost the protoplax show the area beneath it to be covered by the wide, flattened, appressed surface of the reflected margin of the valves thus

forming a seat on which the protoplax once rested. The posterior ends of the valves have a short, brown-colored, tongue-shaped siphonoplax to which is joined a longer calcareous tube of irregular form, notched at the end. The anterior side of the valves is sculptured with scabrous riblets, the posterior side with concentrics. Our largest specimen measures 39 mm. in length.

Range—Panama to Ecuador. Panama: Búcaro. Ecuador: Crucitas.

Hastasia esmeraldensis, new species

Plate 79, figures 5, 5a

Like *H. tubifera* but more slender, the posterior half of the valves longer and narrower, the calcareous tube in all of my specimens quite short. The protoplax is long, narrow, paired, joined to the callum by a narrow neck. Mesoplax short, subquadrate with an outer thin flange, and separated from the protoplax by a transverse slit. No metaplax, the margins of the valves closed by an inner chitinous membrane.

Length 30.1 mm., height 9.4 mm., diameter 8.8 mm.

This species is abundant at Esmeraldas, its burrows excavated in a medium-hard Tertiary shale.

Range—Ecuador. Ecuador: Esmeraldas.

Hastasia quadra (Sowerby)

Plate 80, figures 2, 2a

Pholas quadra Sowerby, 1834, Proc. Zool. Soc. London, p. 71 Montem Christi, Columbiae Occidentalis.—Sowerby, 1849, Thes. Conch., vol. 2, pt. 10, p. 499, pl. 106, figs. 62, 63.

Pholadidea (Hastasia) quadra Sowerby, Turner, 1955, Johnsonia, vol. 3, No. 34, pp. 95, 96, pl. 58.

Shell small (length of valves and siphonal tube about 25 mm.), thin, fragile, white, subquadrate, the anterior side higher. Valves divided into two sectors by a narrow, slightly indented, umbonal sulcus, the anterior side beaked and sculptured with scabrous concentrics, the posterior side narrower and with smoother concentrics. Callum large, semicircular, connected with the anterior-umbonal reflection which forms a deeply concave or excavated, platelike area along the anterior-dorsal margins. Siphonoplax chitinous, brown in color, with swellings near the base and connected with a longish, calcareous tube.

A rare and imperfectly understood species. It is recognized by its shape and the concave, platelike area covering the anterior-dorsal margins.

Range—Panama to Ecuador. Panama: Guanico. Ecuador: Manta; Crucitas.

Subfamily JOUANNETIINAE

Valves pholadiform, short, globose and inequivalve. Internal apophyses short or lacking. Anterior gap open in the juvenile stage, closed by a large, coarse callum extended along or over the beaks in the adult.

Genus JOUANNETIA de Moulins, 1828

Type species by monotypy, *J. semicaudata* des Moulins. Miocene of Europe.

Shell large or small, short, globose, with a large, open gap in the juvenile stage, closed by a heavy callum in the adult which overlaps the right valve from the left and may be extended narrowly or widely and lobe-like between or over the beaks. The surface of the disk is divided by a nar-

row, impressed line or sulcus into two unequal areas, expressed internally as a weak or stout rib ending at the margin as a short spur or tooth. The anterior area of the disk, generally larger, is sculptured with crenulated concentrics ending as radial ribs at the anterior end; the more posterior part with concentrics only, the posterior end of the right valve produced in the shape of a short tongue with smooth or pectinate margins. Apophyses short, styloid, or shaped like a small chondrophore and is developed principally in the left valve. In *Jouannetia*, *s.s.*, there is a large, platelike lamina or septum which stands vertical in the cavity of each valve and served for the attachment of the posterior adductor muscle; this septum is absent in *Pholadopsis*. Borers in rock or coral.

Divided into two subgenera as follows:

- I. Umbonal cavity in each valve bearing a large, platelike lamina or septum (myophore) for the attachment of the posterior adductor muscle. Margin of the siphonoplax developed at the posterior end of the right valve, smooth or entire.

Subgenus *Jouannetia*, *s.s.*

- II. No platelike myophore. Siphonoplax with dentate or serrate margins.

Subgenus *Pholadopsis*

Jouannetia (*Jouannetia*) *duchassaingi* Fischer

Plate 80, figures 1-1c

Jouannetia duchassaingi Fischer, 1862, Jour. de Conchyl., vol. 10, pp. 375-376, pl. 15, fig. 3.

Jouannetia (*Jouannetia*) *duchassaingi* Fischer, Turner, 1955, Johnsonia, vol. 3, No. 34, pp. 135, 136, pl. 82.

The adult shell is large, two inches or more in length, ovate, globose when complete but at present, the species is known from a few, isolated valves only. The anterior gap is closed by a large, convex callum which is continued above to form a separate lobe which covers the sides of the umbone. Valves unequal, each one divided mesially by a narrow, sharp sulcus into two segments; the anterior segment has a nearly straight edge and is neatly marked with fine, crenulated concentrics and on its most anterior portion by radial riblets, heavier forward; the posterior segment is sculptured more plainly with concentrics and resemble coarse, growth incrementals. The right valve is larger than the left, its posterior end extended into a short, tongue-like, thickened lobe which projects a little beyond the margin of the left valve; this lobe has plain margins. The myophore in the interior of the umbonal cavity is a flat plate, standing vertical and it is attached to the shell wall just behind the rib formed by the external sulcus.

Fischer's type specimen was collected in Panama, its exact station not known. The Manta record is based on three, incomplete, beach valves. *J. cumingii* of the Indo-Pacific is related but a larger species. The other known species are fossil in Europe; all are smaller.

Range—Ecuador to Panama. Panama: Panama (Fischer). Ecuador: Manta.

Subgenus **PHOLADOPSIS** Conrad, 1849

(*Triumphalia* Sowerby, 1849).

Type species by monotypy, *P. pectinata* Conrad. Eastern Pacific.

Without an internal platelike myophore. Posterior margins of the right valve serrated.

Jouannetia (Pholadopsis) pectinata (Conrad) Plate 80, figures 3, 3a

Pholadopsis pectinata Conrad, 1849, Proc. Acad. Nat. Sci. Philadelphia, vol. 4, p. 156
Baja California and Peru.—Conrad, 1850, Jour. Acad. Nat. Sci. Philadelphia,
vol. 1, p. 279, pl. 39, fig. 3.

Triumphalia pulcherrima Sowerby, 1849, Thes. Conch., vol. 2, pt. 10, p. 501, pl. 106, figs.
58, 59 in soft rock at low water, West Colombia.—Sowerby, 1850, Proc. Zool.
Soc. London for 1849, p. 161, pl. 5, figs. 2a-d.

Jouannetia (Triumphalia) pectinata (Conrad), Hertlein and Strong, 1950, Zoologica,
vol. 35, No. 19, p. 248.

Jouannetia (Pholadopsis) pectinata (Conrad), Turner, 1955, Johnsonia, vol. 3, No.
34, pp. 137, 138, pl. 83.

Adult shell large (length about 50 mm.), bullet or pearshaped, inequivalve, white, thin. Young shells are nearly equivalve, beaked posteriorly and have the anterior gap uncovered. In the adult, the valves become strongly unequal and the anterior gap is covered by a large paired callum. Posterior end of each valve is wedge or tongue-shaped, that of the right valve longer and sharply serrated on the sides.

A small, bullet-shaped *Pholadopsis* is common along the coast west of Manta, Ecuador, boring into shale rocks. These forms are probably small specimens of *J. pectinata* but good examples are difficult to extract. None have been available for close examination and figuring in the present study.

Range—Lower California to northern Peru. Ecuador: Manta.

Subfamily XYLOPHAGINAE

Valves like those of *Teredo* with the anterior gap open at all stages of growth. Borers in wood but not forming a calcareous tube.

Genus XYLOPHAGA Turton, 1822

(*Xylotomea* Dall, 1898).

Type species by monotypy, *X. dorsalis* Turton. Norway.

Shell like that of *Teredo* but with a double protoplax and without internal apophyses. The united valves form a globular shell, each with a median furrow, the anterior side widely gaping, not covered by a callum, the valves closed behind. No siphonoplax or calcareous tube, the animal contained within its shell, except for the slender, contractile siphons. Borers in wood.

Xylophaga mexicana Dall

Plate 80, figure 4

Xylophaga mexicana Dall, 1908, Bull. Mus. Comp. Zool., vol. 43, No. 63, p. 425. "Off Acapulco, Mexico in 141 fathoms".—Turner, 1955, Johnsonia, vol. 3, No. 34, pp. 150-152, pl. 90, fig. 1, 2.

Shell small (length 5 mm.), beaked and widely gaping in front, rounded and closed behind. Beak large, sculptured with numerous, finely denticulated, concentric ridges. The umbonal-ventral sulcus is narrow and deep, bordered by a small ridge on the posterior side.

This species is known only from a dead specimen dredged off Acapulco. Lacking the dorsal plate, its affinities with other forms cannot be determined. It appears to be related to *X. globosa* Sowerby, 1834, described from Chile.

Range—Mexico. Mexico: Acapulco.

Family TEREDINIDAE

Wood borers. The two piece or bivalved shell is much reduced in size,

equivalved and auriculate, and covers only a small portion of the anterior end of the mollusk, the larger part of which is wormlike, often reaching a length of several feet and it lies along a burrow, straight or tortuous, its walls lined with a calcareous secretion forming a long, stout, winding tube. The small valves, when separated from the animal, are in contact only along the dorsal side and ventrally at the points of the parietal tubercle, elsewhere the margins are apart or gaping; there are no accessory plates. Shell cavity within the umbones has two slender apothyses, one in each valve. External surface of the valves is divided into two sections by a median sulcus or narrow furrow; the anterior section has strong sculpture formed by crenulated or frilled concentrics, sometimes also with radials; the posterior section with plain concentrics only. The distal ends of the siphons have their openings guarded by two slender, feather-like structures known as pallets.

The family is divided into two genera on characters of the pallets.

1. Pallets of simple construction formed in one piece, the distal end flattened, cup-shaped or paddle-like.
Genus *Teredo*
2. Pallets more complicated, segmented or plumose at the distal end forming cup or cone-shaped vanes nestling one within the other.
Genus *Bankia*

The Tereidos, or, as more commonly known as shipworms, are among the most destructive of all marine, invertebrate animals causing heavy toll of all kinds of wooden structures immersed in seawater such as wharfs, piling, and in former days, of wooden-bottom ships. The many species are widely distributed, occurring in all seas with the exception of the partially brackish Baltic, but their identification belongs to the specialist, and requires collections containing the animal and shell, and especially the pallets; the latter, club or feather-like structures composed of lime and chitin, and placed near the siphons, and used to close-off the end of the tube. Several species have been described from the Panamic region, some taken from the locks of the Panama Canal; others from mangrove trees. *Bankia dryas* Dall was described from specimens collected by R. E. Coker from living mangrove trees at Tumbes, Peru. The majority of the species live in dead wood.

Order ANOMALODESMACEA

Superfamily ANATINACEA

Family PANDORIDAE

Shell with a crescentic or bladelike form, the valves unequal, the anterior side short, the posterior longer, often much elongated, its dorsal margin straight or deeply concave, often terminating posteriorly in a sharp point. The left valve is usually larger, strongly convex, the right valve smaller, flattened, or deeply impressed. Inner surface of shell nacreous and of a pearly white color, the outer layer thin and nondurable. The beaks are erect but in the adult stage, generally corroded. The hinge is formed by dentiform crural ridges or laminae, one or several in number, which radiate from under the beak. Ligament internal, the tensilium being obsolete or small, the resilium lodged in a deep groove below the posterior crural lamina or between it and the more central crural lamina if one is developed. Surface smooth or with radial markings. Ligament sometimes strengthened by a calcareous plate known as the lithodesma.

Genus **PANDORA** Chemnitz, 1795

Opinion 184, acceptance of Chemnitz's generic names, type species by subsequent designation, Children, 1825, *Tellina inaequalis* Linné. Recent. European seas.

Shell transversely elongated, inequivalve, the right valve depressed, flat or concave, the left valve convex, larger, overlapping the other along the ventral margin. Inner layer of shell pearly, covered by a thin, prismatic outer layer.

The genus is divided into subgenera on basis of the hinge.

- I. Right valve with two crural teeth; an obscure tooth may be present in the left valve.
 - I. Lithodesma absent. Surface smooth or with growth lines only.
Subgenus *Pandora*
 2. Lithodesma present. Right valve with radial markings.
Subgenus *Pandorella*
- II. Right valve with three teeth or crural laminae.
 3. Left valve with a posterior and anterior inverted V-shaped crural lamina. Cavity within the pallial line usually with radial markings.
Subgenus *Frenamya*
 4. Left valve with three crura, two in front, the other behind, slender, elongated and parallel to the dorsal margin; below, it is bordered by the resilifer groove.
 - a. Posterior lamina separated from the margin by a deep groove.
Subgenus *Clidiophora*
 - b. Anterior lamina short, hooked at the end, the posterior lamina slender, its anterior section united with the dorsal margin by a sheet or platform which roofs over an empty space below.
Subgenus *Foveadens*

General key to species of *Pandora* in the southern Panamic province.

- I. Right valve having two crural laminae.
 1. Shell wide and high, subovate. Surface with radial markings.
P. (Pandorella) rhypis
 2. Valves elongated and narrow; surface smooth.
 - a. Anterior side with a deep, hook-shaped cut.
P. (Pandora) uncifera
 - b. Anterior side entire.
P. (Pandora) brevifrons
- II. Right valve with two crural laminae.
 3. Left valve with two crural laminae. Cavity of shell within the pallial line with radial markings.
P. (Frenamya) radiata
 4. Left valve with three crural elements.
 - c. Anterior lamina long and slender, touching the anterior adductor scar. Anterior-dorsal margin serrated.
P. (Clidiophora) arcuata
 - d. Similar to the above but with the dorsal margin simple.
P. (Clidiophora) cornuta
 - e. Anterior lamina short, hooked.
P. (Foveadens) panamensis

Subgenus **PANDORA** s.s.

The right valve has one or two crural laminae; an erect, buttress-like plug under the beak, and a posterior one set at an angle to the margin. An anterior lamina may be present in the left valve. Surface smooth or showing growth lines only.

Pandora (Pandora) uncifera Pilsbry and Lowe

Plate 81, figure 4

Pandora uncifera Pilsbry and Lowe, 1932, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, pp. 104, 105, pl. 17, figs. 17, 18, 19.

Pandora (Pandora) uncifera Pilsbry and Lowe, Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 3, No. 8, p. 97.

Shell small, elongate, strongly compressed, inequilateral, and inequivalve, the left valve larger, its ventral margin folded over that of the right. Right valve has two obliquely set crural teeth; the first, just below the beak, is relatively short and stout, the other on the posterior side, is long and narrow; the ligament lies between them. The posterior-dorsal margin is straight in the forward section, then somewhat concave, its end truncated. The anterior-dorsal margin has a deep, hook-shaped cut. Surface smooth.

Length 12.4 mm., height 5.5 mm., diameter 1.3 mm. Type ANSP.

The hook-shaped cut along the anterior-dorsal margin is characteristic. The species is related to *P. brevifrons* Sowerby but differs by its broader outlines.

Range—Mexico southward to Ecuador. Mexico: Acapulco (Pilsbry and Lowe); Gorda Banks, Port Guatulco, Tangola Bay (Hertlein and Strong). Costa Rica: Port Parker (Hertlein and Strong). Ecuador: Manta.

Pandora (Pandora) brevifrons Sowerby

Plate 81, figure 5

Pandora brevifrons Sowerby, 1835, Proc. Zool. Soc. London, p. 93 Panama.—Sowerby, 1855, Spec. Conch., vol. 1, pt. 2, *Pandora* pl. not numbered, figs. 25, 26.—Sowerby, 1874, Conch. Icon., vol. 19, *Pandora*, pl. 2, fig. 12.

Shell thin, elongate, the length nearly three times the height, inequivalve, the left valve larger, convex, overlapping the smaller, depressed or flattened right valve along the ventral margin. Beaks are strongly anterior. Surface smooth, the growth lines hardly visible. Posterior-dorsal submargin with two, rounded or obscure keels.

Length 24.8 mm., height 9.6 mm. Panama. ANSP 55372.

Range—Panama. Panama: Panama.

Subgenus **PANDORELLA** Conrad, 1863

(*Kennerlia* Carpenter, 1864, emendations: *Kennerleya* Fischer, 1887 and *Kennerlyia* Dall, 1903).

Type species by monotypy, *P. (Pandora) arenosa* Conrad. Miocene of Virginia.

Shell like *Pandora*, s.s. the hinge having two crural elements in the right valve but with the resilium heavily reinforced by a lithodesma. Surface of the right valve marked with radial grooves.

Conrad's name has priority over that of Carpenter by about one year but until the hinge of the type species, *P. arenosa* is better known, the equivalence of *Pandorella* with *Kennerlia* remains doubtful.

Pandora (Pandorella) cornuta C. B. Adams

Plate 81, figures 7, 7a

Pandora cornuta C. B. Adams, 1852, Ann. Lyceum Nat. Hist. New York, vol. 5, pp. 519, 547, No. 498 Panama.

Clidiophora acutedentata (vice C. B. Adams), Carpenter, 1864, Proc. Zool. Soc. London, p. 598, No. 5. Replacement name. Reprinted as Smith. Misc. Coll., No. 252, p. 227.

Kennerlyia convexa Dall, 1915, Proc. U.S. Nat. Museum, vol. 49, p. 449 Ballenas Lagoon, Lower California.

Pandora (Kennerlia) convexa (Dall), Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 3, p. 97, pl. 1, fig. 5.

Shell subovate, inequilateral, more or less depressed, the anterior side shorter, rounded, the posterior side wider, obtusely angled at the end. Surface smooth, not divided by a transverse line but with an angle or double carina which overlies the internal posterior lamina and runs from the beak to the posterior end a short distance below the hinge margin.

Length to about 21 mm.

This species was described as *P. cornuta*, based on a somewhat damaged specimen having a subcircular break at the posterior end forming two horns, suggesting the name. The holotype is herewith figured. As the name "*cornuta*" seemed inappropriate to Carpenter, he suggested "*acutedentata*" as a replacement. *Pandora convexa* Dall, from its figure as given by Hertlein and Strong, is thought to represent the same species.

Range—Lower California to Panama. Panama: Panama.

Pandora (Pandorella) rhytis Pilsbry and Lowe

Plate 81, figure 6

Pandora (Kennerlia) rhytis Pilsbry and Lowe, 1932, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, p. 105, pl. 16, figs. 8-11.

The shell is thin, short and high, with a weakly convex left and flat right valve; white. Upper margin is concave behind the beaks; basal margin strongly convex in the middle and posteriorly; anterior third contracted, rounded in front. Sculpture of many narrow radiating riblets on the posterior two-thirds, much weaker in the right valve. Anterior third with lines of growth only. There is also some very weak, coarse, concentric corrugation of both valves. Teeth rather well developed but thin.

Length 24.5 mm., height 20.7 mm., diameter 4.0 mm.

Length 24.5 mm., height 19.3 mm., diameter 3.7 mm. (Pilsbry and Lowe, 1932.)

This species was described from La Union, Gulf of Fonseca, El Salvador. As the species may eventually be found to occur further south the original description and figures have been included here.

Range—El Salvador. El Salvador: La Union.

Subgenus **CLIDIOPHORA** Carpenter, 1864

Type species by original designation, *Clidiophora claviculata* Carpenter (= *Pandora arcuata* Sowerby). West Mexico.

Shell usually sickle-shaped, its dorsal side deeply impressed or concave, its posterior end pointed and with a small, open gap. The right valve has three crural laminae, the anterior one elongated, narrow, extending to the front side of the adductor scar; the posterior lamina is also long and narrow, distinct from the elevated edge of the dorsal margin; in the left valve, the anterior lamina is similar to that of the right valve and like it extends

nearly or quite to the front side of the adductor scar; there is no posterior lamina in the right valve, the dorsal margin itself is narrow so that it resembles and may function as a crural lamina and carries along its inner side a grooved depression for the contact of the posterior lamina of the right valve; and below this, another deeper groove which is the resilifer. The resilium is reinforced by accessory plates of the lithodesma. The cavity within the valves is often marked with deep radial rays.

Pandora (Clidiophora) arcuata Sowerby Plate 81, figures 1-1g

Pandora arcuata Sowerby, 1835, Proc. Zool. Soc. London, p. 93 Santa Elena.—Sowerby, 1855, Spec. Conch., vol. 1, pt. 2, figs. 27, 28.—Sowerby, 1874, Conch. Icon., vol. 19, *Pandora*, pl. 1, fig. 8.

Clidiophora cristata Carpenter, 1864, Zool. Soc. London, p. 597.

Pandora cristata (Carpenter), Sowerby, 1874, Conch. Icon., vol. 19, *Pandora*, pl. 1, fig. 1.

Pandora claviculata Carpenter, 1855, Proc. Zool. Soc., p. 228.—Sowerby, 1874, Conch. Icon., vol. 19, *Pandora*, pl. 3, figs. 20a, 20b.

Clidiophora claviculata (Carpenter), 1864, Proc. Zool. Soc., p. 596.

Shell small to medium-sized (length up to about 30 mm.), irregularly elongate, the left valve moderately convex, the right concavely depressed. The right valve is divided into two unequal parts (the left valve less clearly so) by an obscure, radial line extending across the umbone to the ventral margin; posterior of this line, the ventral margin shows a slight bulge, anteriorly it is slightly contracted; fresh shells retain the brownish epidermis and the thin outer layer shows this by a change in color. Anterior-dorsal margin with three or more sharp, triangular serrations; in others, the anterior margin is turned over towards the right.

This is the common *Pandora* along the coast of Ecuador and northern Peru. According to Carpenter, the original specimens of *P. arcuata* in the Cumings collection at the British Museum (Nat. Hist.) are too badly worn for a definite determination; however, the obsolete impressed groove mentioned in the original description and also by Hanley identifies the species easily. Fresh specimens of *P. arcuata* have three sharp teeth or serrations along the anterior-dorsal margin and it is believed that *P. cristata* of Carpenter represents the same species.

Range—Lower California to northern Peru. Panama: Old Panama; Búcaro. Ecuador: Charapota; Manta; Santa Elena. Peru: Tumbes; Zorritos; Mancora.

Subgenus **FRENAMYA** Iredale, 1930

(*Coelodon* Carpenter, 1864, not Andinet-Serville, 1832, or Lund, 1838, insects).

Type species by original designation, *F. patula* Tate.

The right valve has three, the left valve two crural elements, the anterior left lamina is shaped like a tent. Internally, the cavity of the shell within the pallial line is generally marked with radial lines. A lithodesma is absent.

The typical species of this subgenus are Indo-Pacific and Australian but the following American species may perhaps belong here also.

Pandora (Frenamya) radiata Sowerby Plate 81, figure 3

Pandora radiata Sowerby, 1835, Proc. Zool. Soc. London, p. 94 Insulam Muerte.—Sowerby, 1874, Conch. Icon., vol. 19, *Pandora*, pl. 2, fig. 9.

?*Coelodon radians* Dall, 1915, Proc. U.S. Nat. Museum, vol. 49, No. 2116, pp. 450, 451
Ballenas Lagoon, Lower California, in 5½ fathoms.

Shell relatively small, delicate, half-round, arcuate behind the beaks, compressed with the anterior area defined by an impressed line but not interrupting the basal margin. Posterior side a little attenuated with a rib near the dorsal margin. Valves unequal, the left one convex, the right valve flat, and marked with radiating linear grooves.

Length 15 mm., height 8.75 mm., diameter 3.75 mm. (Sowerby's measurements of *radiata*).

Length 15 mm., height 8 mm., diameter 1.3 mm., beaks behind the anterior end, 3.5 mm. (Dall's measurements for *radians*).

The type specimen of this species was described from Isla del Muerto in the Gulf of Guayaquil. The shell described by Dall as *Coelodon radians* from the Gulf of California may be the same species.

Range—Gulf of California southward to Ecuador. Mexico: Ballenas lagoon. Ecuador: Isla del Muerto.

Subgenus FOVEADENS Dall, 1915

Type species by original designation, *Foveadens panamensis* Dall.
Panama.

Shell pandoriform, the valves almost alike, flattened or depressed, the left one slightly the larger. The hinge of the right valve has two, large, divergent, crural laminae under the beak, the arms of which form a V, the first lamina under the beak is short, narrow and vertical, the other is much longer, narrow, bent towards the end; there is only a faint indication of an anterior ridge extending to the adductor scar. The left valve has two, short, anterior teeth or laminae placed close together, their ends turned sharply forward; there is a third, much longer, posterior, crural lamina bordered on its inner side, first by the insertion groove for the lamina of the opposite valve, and below this by the larger scar of the resilum. Behind the left, posterior lamina, there is a deep groove or furrow which is extended forward and passes under a decklike sheet fused with the dorsal margin.

Pandora (*Foveadens*) *panamensis* Dall

Plate 81, figures 2-2b

Foveadens panamensis Dall, 1915, Proc. U.S. Nat. Museum, vol. 49, No. 2116, p. 451
"Old Panama."

Pandora (*Foveadens*) *panamensis* Dall, Hertlein and Strong, 1946, Zoologica, vol. 31,
pt. 3, No. 8, p. 98.

Full-grown specimens attain a length of 25 to 26 mm., but are usually smaller; both valves are nearly flat, the right valve a trifle larger, overlapping the other by a flattened edge along the posterior-dorsal margin. Near the anterior one-third, the disk is divided into two unequal areas by a line running from the beak to the ventral margin. Surface smooth or with coarse, concentric growth lines and sometimes faintly undulate. Outer layer thin, white, chalky, often worn-off revealing the heavier, pearly layer beneath.

Old Panama, abundant.

Range—El Salvador to Panama. Panama: Old Panama; Pearl Islands.

Family THRACIDAE

Shell non-nacreous, thin or of medium weight, oblong, sometimes

trapezoidal, inequivalve and inequilateral, slightly gaping behind, the right valve larger than the left, the surface earthy, chalky or granulose, and covered by a thin periostracum. Hinge edentulous, the hinge plate often fissured. Ligament mostly internal, the tensilium small, placed above and behind the resilium which is attached to a large, spoon-shaped chondrophore in the hinge plate of both valves. Pallial sinus of moderate size. Surface marked with growth lines only, or with concentric and sometimes oblique undulations.

Two genera are regional.

I. Surface with growth lines only, often earthy.

Genus *Thracia*

II. Surface sculptured with concentric, sometimes more or less oblique, wavelike plications, granulose.

Genus *Cyathodonta*

Genus **THRACIA** Blainville, 1824

Type species by subsequent designation, Blainville, 1827. *Thracia corbuloidea* Blainville. Mediterranean.

In a final note, Blainville, 1827 (Man. Mal., vol. 2, p. 600) restricted the name of *Thracia* to Division A, and thereby selecting *T. corbuloidea* as the type species for the genus. Gray selected the same species as type in 1847.

Shell oblong-ovate to trapezoidal in shape, inequivalve, the right valve larger and more convex, the beaks often placed so close that they touch and puncture each other. Texture of shell usually thin, concentrically striate, and usually earthy, or with fine superficial granulations beneath a thin periostracum. Valves with a small gap behind. Hinge edentulous. The external portion of the ligament small, the resilium larger and deeply immersed into the hinge plate. A small lithodesma (often lost) may be present.

Thracia colpoica Dall

Plate 83, figures 7, 7a

Thracia colpoica Dall, 1915, Proc. U.S. Nat. Museum, vol. 49, No. 2116, pp. 443, 444
Gulf of California.

Shell small (length about 17 mm.), subovate, thin and papery, inequilateral and strongly inequivalve, the right valve larger and more convex, with high, full umbone and an oblique umbonal axis, the posterior side shorter, depressed, bounded externally by an angle and carrying a submedian angle or rib within it. The left valve has a more ovate shape, depressed to slightly convex. Surface somewhat earthy, the periostracum mostly thin, heavier, and darker in color; on the posterior surface, markings mostly concentric growth incrementals.

A specimen from Tumbes, measures: length 17 mm., height 16 mm., diameter 8.7 mm.

This species is common on the mud flat at the mouth of the Tumbes River in Peru but the shell is so fragile that specimens are difficult to collect or to preserve intact afterwards.

Range—Gulf of California to northern Peru. Peru: Tumbes.

Thracia anconensis, new species

Plate 83, figures 4, 4a

Left valve of medium size (length 34 mm.), slightly convex, sub-

elliptical, the beaks apparently opisthogyrate, placed at the anterior one-third, the anterior side with rather full umbone, its margin well rounded. The posterior side is much longer, somewhat depressed with an obscure carina running from the beak to the posterior-ventral corner. Surface irregularly undulated by concentrics which are heaviest on the anterior-umbonal slope. Entire surface coarsely granulose. Pallial sinus short, extending about a third of the distance into the shell cavity.

Length 34 mm., height 22 mm., semidiameter 6.7 mm. a left valve. Point Ancon, Ecuador. Holotype, ANSP 218955.

Known only by a single left valve.

Range—Ecuador. Ecuador: Point Ancon, Santa Elena Peninsula.

Genus *CYATHODONTA* Conrad, 1849

Type species by monotypy, *Cyathodonta undulata* Conrad. Gulf of California.

Shell broadly ovate to subrectangular, the anterior side longer, rounded, the posterior side shorter, depressed and subtruncate. Surface sculptured with concentric and sometimes somewhat oblique, wavelike plications or undulations. Surface granulose.

Cyathodonta undulata peruviana, new subspecies

Plate 83, figures 2-2b

Cf. *Cyathodonta undulata* Conrad, 1849, Proc. Acad. Nat. Sci. Philadelphia, vol. 4, p. 156.—Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 3, No. 8, p. 96.

Cf. *Thracia plicata* Deshayes, Reeve, 1859, Conch. Icon., vol. 12, *Thracia*, pl. 2, figs. 7b, 7c.

Cf. *Thracia (Cyathodonta) undulata* Conrad, Grant and Gale, 1931, Mem. San Diego, Soc. of Nat. Hist., vol. 1, p. 259, pl. 13, figs. 6a, 6b.

Cyathodonta dubiosa Dall, Durham, 1950, Mem. Geol. Soc. America, No. 43, p. 70, pl. 16, figs. 2, 7. Fossil, Lower California. Not *C. dubiosa* Dall, 1915.

Shell is subrectangular in shape, rather high, with the height and length in the ratio of four to five, moderately thin and fragile, the umbones and beaks placed slightly behind the middle. Valves are much alike, the anterior side convex and widely rounded at the margin, the posterior side shorter, depressed and more plainly marked. Sculpture is produced by rather coarse, even undulations which on the anterior half of the disk are strongly oblique, crossing the lines of growth; posterior of the middle line, the undulations are concentric to the valve margin, and are lacking completely on the posterior slope. The posterior-umbonal slope and for a space in front of it, there is a relatively wide smooth band extending down from the beak. Entire surface is covered with minute granules arranged in close lines radiating from the beak.

Length 49.7 mm., height 39.5 mm., semidiameter 9.7 mm. a right valve. Tumbes, Peru. Holotype, ANSP 218953.

This subspecies differs from typical *C. undulata* from the Gulf of California by its higher, less elongated form, and especially in having the surface undulations strongly oblique to the lines of growth. It occurs rarely as a Pleistocene fossil in the Peruvian tablazos, I have specimens from the Lobitos tablazo at Malacas, Parinas near Talara, Peru. It appears to be the same form as the shell figured by Durham as *P. dubiosa* Dall, fossil in Lower California.

Range—Panama southward to Peru. Panama Canal Zone: Amador; Palo Seco. Colombia: Isla del Gallo. Ecuador: Galeras; Manta; Santa Elena. Peru: Tumbes.

Cyathodonta tumbeziana, new species

Plate 83, figures 1, 1a

Shell ovate, the umbones high and prominent, subcentral, with the beaks placed a trifle closer to the posterior side, the middle of the ventral margin of the right valve with a pronounced bulge, the ventral margin of the left valve more evenly curved. Posterior side short, depressed, bordered by a low umbonal angle. Sculpture consists of small wavelike undulations, concentric to the lines of growth except on the anterior-umbonal slope where they are slightly oblique; they are best developed on the umbones of the right valve but fade-out rapidly towards the ventral margin. The left valve is less convex than the right, its sculpture weaker. The granulation is principally developed on the posterior slope where it may be quite coarse and without a fixed pattern of distribution; on the posterior umbonal angle the granules often show a linear arrangement; elsewhere the submicroscopic sculpture is reduced to minute, concentric threads. Pallial sinus short, not quite extending to the line of the beak.

Length 37.8 mm., height 32.3 mm., semidiameter 8 mm. a right valve, Tumbez, Peru. Holotype, ANSP 218952.

This species differs from *C. undulata peruviana* by its shape, unequal valves, and in sculpture.

Range—Peru. Peru: Tumbez; Punta Picos; Mancora.

Family PERIPLOMATIDAE

This family includes subnacreous shells, often thin and fragile, white and pearly within, rounded or oblong-ovate in shape, inequivalve, the right valve more strongly convex, the other often flattened and depressed. The posterior side is usually short, lower, often flexuous, but not open or gaping at the end. Hinge edentulous, the ligament wholly internal, attached to a forward projecting spur or chondrophore in each valve, strengthened below and behind by a rib or clavicle; closely connected with the chondrophore is a small accessory plate or lithodesma, well developed in *Periploma*, much smaller or obsolete in others; in *Periploma*, the lithodesma is a calcified, lunate plate lying transversely, in front and above the chondrophore, its function to strengthen or aid in the operation of the resilium; after death, the lithodesma is often detached and lost as the valves open. Interior pearly, the adductor scars and pallial line well marked. The pallial sinus is wide and short. Beaks usually with a seam or crack, fractured by the shrinkage and separation of the resilium and lithodesma. Surface white or cream-colored, and usually minutely granulose.

Genus PERIPLOMA Schumacher, 1817

Type species by monotypy, *Periploma inaequivalvis* Schumacher. Recent, West Indies, and the Caribbean.

Shell suborbicular to elongate-ovate, the beaks opisthogyrate, the posterior side typically narrower and shorter. Distinguishing character of the genus is the large chondrophore found in each valve, strengthened below and behind by a rib or clavicle soldered to the wall of the shell. Lithodesma, as described above, is seen only in specimens with tightly closed valves. Surface minutely granulose, most heavily so on the posterior slope, often

faint or absent elsewhere. Surface with plain sculpture of growth lines, or with concentric undulations as in *Cyathodonta*, or strongly radially ribbed.

The genus *Periploma* is divided into three subgenera as follows:

I. Surface plain, unsculptured.

Subgenus *Periploma*, *s.s.*

II. Surface with concentric or radial ribbed sculpture.

1. Surface with concentric riblets.

Subgenus *Halistrepta* (not regional)

2. Sculpture of a few, large, strong ribs ending in clawlike spurs at the ventral margin.

Subgenus *Albimanus*

Eight species of *Periploma* have been described from the Panamic-Pacific region of which five only have been recorded from Panama southward. *P. planiuscula* is the most common form and ranges from southern California to northwestern Peru. The species may be arranged in key form as follows:

I. Surface of the left valve bearing five, large, radial ribs, the ends of which project like fingers or claws at the ventral margin.

P. (Albimanus) pentadactylus

II. Surface of both valves smooth except for concentric lines of growth and minute, submicroscopic granulation.

A. Valves inequilateral, the beaks being decidedly posterior in position.

1. Valves subovate to broadly elliptical in shape, the right valve more convex. Open sandy beaches.

P. (Periploma) planiuscula

B. Valves subcircular, more nearly equilateral, with the beak and umbone submedian.

Ba. Granulation in radial lines.

P. (Periploma) stearnsii

Bb. Granulation along concentric lines.

2. Valve rather large (50 mm.), the posterior side expanded, and well rounded.

P. (Periploma) alta

3. Similar but smaller, the posterior side less expanded.

P. (Periploma) carpenteri

4. Valves nearly circular, the dorsal margin straight, the posterior end slightly beaked.

P. (Periploma) discus (Pl. 82, fig. 4)

Bbb. Dorsal margin straight, the posterior end more or less beaked.

5. Valves nearly circular.

P. (Periploma) discus (Pl. 82, fig. 4)

6. Shell smaller, thin, the granulations minute.

P. (Periploma) lagartilla

Periploma (Periploma) alta (C. B. Adams)

Plate 82, figures 1-1b

Anatina alta C. B. Adams, 1852, Ann. Lyceum Nat. Hist. New York, vol. 5, pp. 518, 547, No. 497.—Turner, 1956, Occas. Papers on Mollusks, Mus. Comp. Zool., vol. 2, No. 20, pp. 30, 31, pl. 19, figs. 19, 20.

Shell suborbicular, anteriorly subangular and flexuous, otherwise with

the margins well rounded, thin, pearl-white, with a thin, brownish epidermis. Beaks submedian, the umbones moderately convex. Surface smoothish, with lines of growth and fine, submicroscopic, threadlike granules arranged in concentric rows.

Length 1.98 inches (50.3 mm.), height 1.35 inches (34.3 mm.), diameter 17.8 mm. (Holotype, MCZ).

This species was described from a single left valve now at the Museum of Comparative Zoology at Harvard University. It is a relatively large species with a nearly circular outline and submedian umbone and beak. As suggested by Hertlein and Strong, it seems probable that *P. carpenteri* Dall, based on a right valve dredged in the Gulf of Panama at 210 fathoms, may represent the same species.

Range—Panama. Panama: Vicinity of Panama City (C. B. Adams).

Periploma (Periploma) carpenteri Dall

Plate 82, figures 7, 7a

Periploma carpenteri Dall, 1896, Proc. U. S. Nat. Museum, vol. 18, No. 1034, p. 20
Gulf of Panama, 210 fathoms.—Dall, 1908, Bull. Mus. Comp. Zool., vol. 43, No. 6, p. 426, pl. 16, fig. 8.—Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 3, pp. 94, 95.

This species is similar to *P. stearnsii* but is more inflated, more orbicular, and with the beaks having a more central position; the granules are said to be coarser and not arranged in separate rows.

The figure shows the interior and exterior of the type. The original was taken in 210 fathoms of water in the Gulf of Panama. The species has also been recorded by Hertlein and Strong from specimens dredged in three fathoms of water at La Union, San Salvador. *P. lucina* Olsson from the Pliocene of Panama is an allied species.

Range—Panama and El Salvador.

Periploma (Periploma) stearnsii Dall

Plate 82, figure 6

Periploma stearnsii Dall, 1896, Proc. U. S. Nat. Museum, vol. 19, No. 1034, p. 19 off
Point Fermin, Gulf of California.—Dall, 1908, Bull. Mus. Comp. Zool., vol. 43, No. 6, p. 426, pl. 16, fig. 5.—Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 3, p. 95.

Shell suborbicular, thin, whitish, with pale straw-colored epidermis, sculptured with faint concentric irregularities harmonizing with the lines of growth and by very fine pustules arranged in radiating lines, stronger and more adjacent near and upon the rostrum; beaks not prominent, fissured; left valve slightly less convex than the right; rostrum about two-thirds as wide as the shell, not strongly differentiated, but with the epidermis coarser, and, especially on the left valve, more raised and wrinkled, and the basal margin slightly excavated; interior faintly pearly; pallial sinus large, rounded, shallow; chondrophore strong, spoon-shaped, inclined obliquely forwards. Length of shell, 46; height 35.5; diameter of the right valve, 9 mm.; the rostrum 20 mm. wide, rounded, and moderately gaping; total diameter, 18 mm.

This differs from *P. discus*, Stearns, in the radial arrangement and larger size of its surface granules, its wider rostrum and more compressed form. (Dall, 1896.)

Figure 6, Plate 82 shows the exterior of the holotype, 110548 U. S. Nat.

Museum. *P. stearnsii* has been recorded from the Pliocene of Burica Peninsula of Panama.

Range—Gulf of California questionably southward to Panama.

Periploma (Periploma) planiuscula Sowerby

Plate 82, figures 2-2e

Periploma planiuscula Sowerby, 1834, Proc. Zool. Soc. London, p. 87 Sanctam Elenam.

—Hanley, 1842, Rec. Bivalve Shells, p. 21, Appendix, p. 339, pl. 10, fig. 33.—
Maxwell Smith, 1944, Panamic Marine Shells, p. 54, fig. 702.

Periploma lenticularis Sowerby, 1834, *op. cit.*, p. 87 Isla Muerto.

Periploma argentaria Conrad, 1837, Jour. Acad. Nat. Sci. Philadelphia, vol. 7, p. 238,
pl. 18, fig. 8 California.

Periploma obtusa Hanley, 1842, List of Illustrations to Lamarck Shells, t. 2, fig. 50.—
Hanley, 1842, Rec. Bivalve Shells, Appendix, p. 339, pl. 13, fig. 50 West
Colombia.

Periploma excurva Carpenter, 1855, Proc. Zool. Soc. London, p. 229.

Periploma excurvata Carpenter, 1857, Brit. Assoc. Adv. Sci., Rept. p. 287, (error for
excurva).

Shell of medium size (length up to about 57 mm.), elongately ovate, thin, fragile, pearly, the right valve convex, the left with slight convexity to flattened, depressed. The posterior side is much shorter, somewhat flexuous, and generally truncated at the end. Surface usually cream-colored with a dull luster and minutely pustulate or wrinkled over the whole disk, more coarsely so on the posterior slope so that this area may appear somewhat chalky. Interior shiny, pearly, the pallial sinus distinct but short.

This is a common and widely distributed species, along sandy beaches, from southern California to northern Peru. The shell shows considerable variation in relative height to length. Californian specimens are heavier than those from localities further south.

Well-preserved shells have a slightly wrinkled surface, like that of leather, the extremely small pustules arranged so as to form slightly irregular, concentric lines.

P. lenticularis, an unfigured form, described from the Isla del Muerto in the Gulf of Guayaquil is believed to represent the same species. Its type has not been seen.

Range—Southern California to northern Peru. Panama: Búcaro; Guanico. Colombia: Isla del Gallo. Ecuador: Mompiche; Sua; Santa Elena. Peru: Tumbes; Boca Pan; Negritos.

Periploma (Periploma) teevani Hertlein and Strong

Plate 83, figure 9

Periploma teevani Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 3, p. 95, pl. 1, figs.
2, 6 Tangola-Tangola Bay, Oaxaca, Mexico, 30 fathoms.

According to its author, this species resembles *P. planiuscula* but differs by its higher valves, shorter and wider rostrum and in having the pustules arranged along radial lines.

Range—Coast of Mexico.

Periploma (Periploma) lagartilla, new species

Plate 82, figures 5-5b

Shell small or of medium size, thin, white to subtranslucent, obliquely subcircular, with the beaks placed a trifle closer to the posterior side, in-

equivalve, the right valve being larger and more convex, the left valve smaller, flatter or only slightly convex. The anterior side is higher, wider and its margin evenly rounded, the posterior side shorter, its margin oblique, straight below but becoming produced and somewhat flexed above. Dorsal margin nearly straight, the tip of the beaks rising in a short point above it. Pallial sinus short, not reaching to a line drawn under the beak. The texture of the shell is thin enough so that the pallial sinus and other internal markings show through plainly along with those of the surface such as growth lines, faint undulations arranged roughly in concentric bands, and still smaller radial striations. Granulation is minute and visible only under microscopic power, and arranged concentrically. The periostracum is thin, light in color.

Length 23 mm., height 18 mm., diameter 7.9 mm. El Lagartillo, Panama. Holotype, ANSP 218951.

In shape, this species resembles *P. stearnsi* (as figured by Dall) but is higher and has a more produced posterior end. It is a smaller and thinner species than *P. alta*. The granulations of the surface are minute and for the most part difficult to see; they are arranged along concentric lines. Two specimens were collected on the beach at El Lagartillo, Panama.

Range—Panama. Panama: El Lagartillo.

Subgenus **ALBIMANUS** Pilsbry and Olsson, 1935

Type species by original designation, *Periploma (Albimanus) pentadactylus* Pilsbry and Olsson. Panama.

Shell small, strongly inequilateral and inequivalve, white, pearly and rather stout, longer than high, with five strong radial ribs which project like claws at the margin. Beaks not slit.

Periploma (Albimanus) pentadactylus Pilsbry and Olsson Plate 82, figures 3, 3a

Periploma (Albimanus) pentadactylus Pilsbry and Olsson, 1935, Nautilus, vol. 48, No. 4, pp. 118, 119, pl. 6, figs. 5, 6, 7.

The shell is white, oblong, much longer than high, plump, conspicuously inequivalve, the right valve strongly convex, the left valve weakly convex to depressed and much smaller. In the right valve, the beak is placed close to the posterior end which hence is short; below and behind the beak there is a small, deeply sunken escutcheon bordered by a rib. The anterior-dorsal margin is long and strongly arched, terminating in a point, the basal margin trilobed. Sculpture is formed by strong, radial ribs, the second and fourth bifid or seamed along the top, the third less distinctly so, the first rib is simple, while the fifth and smallest rib bounds the escutcheon; these ribs show in the interior and at the margin project as short, stout, clawlike spurs. Delicate lines of growth are festooned between the ribs. The left valve is much smaller than the right and with much weaker sculpture.

Length 21.3 mm., height 15.3 mm., diameter 7 mm. (Type).

The ribs begin when the shell is about 3 to 4 mm. long. It was found in some abundance along the beach at Guanico.

Range—Panama. Panama: Guanico.

Superfamily **POROMYACEA**

Family **CUSPIDARIIDAE**

Shell generally small, thin, corbuliform, mostly white or gray, rostrate or pointed behind, the anterior side rounded and convex, with the umbones

near the middle or slightly anterior. Surface smooth or with strong, concentric or radial sculpture, sometimes granulose and covered by a thin, light brown periostracum. Ligament internal, situated in a groove or fossette which sometimes projects from the hinge line; a lithodesma present. Hinge teeth absent or present. An internal, posterior rib or buttress is sometimes present. Interior white but not pearly. Pallial sinus absent.

Genus **CUSPIDARIA** Nardo, 1840

Type species by original designation, *Cuspidaria typus* Nardo (= *Tellina cuspidata* Olivi).

Shell small or of medium size, with a well-rounded, convex, anterior side and a narrowly produced posterior end. Hinge without cardinal teeth, the right valve having a strong, posterior, lateral tooth bordered above by a linear socket into which the margin of the left valve fits. Chondrophore is a narrow, spoon-shaped plate placed directly under the beak, directed slightly backward, and similar in both valves. Surface with concentric ribbing.

Subgenus **CARDIOMYA** A. Adams, 1864

Type species by monotypy, *Neaera gouldiana* Hinds.

Shell with strong, radial ribs, and large vertically directed chondrophore.

Cuspidaria (Cardiomya) ecuadoriana, new species

Plate 83, figure 3

The shell is small, plump and relatively thin, with a short, narrower and rostrated, posterior end. Anterior and middle surface of the disk is strongly inflated, its anterior-dorsal margin somewhat expanded and flaring. The sculpture is produced by two, primary, radial costae which are widely spaced, and which begin along the posterior side of the umbone and extend across to the ventral margin which is deeply fluted by them; in front of the two, primary costae, there are 20 or more, smaller radial riblets which are most pronounced along the ventral side, fade away over the middle towards the umbonal surface which is largely smooth. The anterior-dorsal slope is strongly contracted, flaring slightly at the margin.

Length 8.5 mm., height 5.5 mm., semidiameter 2.3 mm. a left valve. Galeras, Ecuador. Holotype, ANSP 218954.

In its sculpture, this shell is similar to some forms of *C. ornatio*r Pilsbry and Johnson¹⁷ from the Miocene of Santo Domingo, but it differs from them by its more widely expanded, anterior-dorsal margin.

Range—Ecuador. Ecuador: Galeras.

Cuspidaria (Cardiomya) costata (Sowerby)

Plate 83, figures 6, 6a

Anatina costata Sowerby, 1834, Zool. Soc. London, p. 87 Santa Elena.

Cuspidaria (Cardiomya) dulcis Pilsbry and Lowe, 1932, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, p. 104, pl. 17, figs. 20-22.

Cuspidaria (Cardiomya) dulcis Pilsbry and Lowe, Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 3, No. 8, pp. 100, 101.

Shell small, white under a thin buff periostracum, plump, the left valve slightly larger, the beaks placed a little in front of the middle. The

¹⁷Pilsbry, 1922, Proc. Acad. Nat. Sci. Philadelphia, vol. 73, p. 414, pl. 28, especially fig. 12.

right valve has seven or eight, high and narrow, radial ribs, the posterior ones strongest, widely separated from the next, the size and spacing of the others diminishing forwards; in the left valve the posterior set of larger ribs are double or twinned.

The doubling of the posterior set of ribs on the left valve is not mentioned by Sowerby in his description of *C. costata*. Specimens from Santa Elena, Ecuador, the type locality for this species, show simple ribs on the right valve while they are more or less paired in the left valve.

Range—Mexico to Ecuador. Panama: Taboga Island. Ecuador: Santa Elena.

Family POROMYIDAE

Generally deep-water species of small size and thin, fragile texture, their shape rounded, cordate, with angular posterior side, pearly within. Ligament with both external and internal elements, the resilium attached to a small chondrophore in the hinge plate. Hinge of the right valve has a short, stout cardinal tooth in front of the chondrophore, the left valve with a smaller tooth behind and above the chondrophore. Surface smooth or granulose.

Genus POROMYA Forbes, 1844

Type species by monotypy, *P. anatinoides* Forbes (= *Corbula granulata* Nyst and Westendorp). European Seas.

Shell with the characters as described above for the family. The species herein considered belong to two subgenera, distinguished as follows:

I. Surface of shell granulose, the pallial sinus obsolete.

Subgenus *Poromya*, s.s.

II. Surface plain, without granules, the pallial sinus well developed.

Subgenus *Dermatomya*

The two species of *Poromya*, herein mentioned and discussed, live in relatively deep waters, and as such, are strictly speaking, not members of the near-shore Panamic-Pacific fauna. They have been included in this work in the possibility that these species or some allied forms may come into the hands of collectors from fish trawlers and shrimpers operating in the off-shore waters along the coasts of Panama and Ecuador.

Subgenus POROMYA s.s.

Poromya (*Poromya*) *perla* Dall

Plate 83, figure 10

Poromya perla Dall, 1908, Bull. Mus. Comp. Zool., vol. 43, No. 6, pp. 428, 429, pl. 18, figs. 2, 5 Gulf of Panama in 1270 fathoms, USNM 122,931.

Shell small, globose, exceedingly thin, whitish, subequivalve, sub-equilateral, with very high, swollen, strongly prosocoelous beaks; no lunule or escutcheon, but the posterior hinge margin of the right valve overlaps that of the left, with a single, strong, radial rib near the edge, which does not appear in the opposite valve; anterior margin of the valves evenly rounded into the nearly semicircular base; posterior slope straight; posterior end short, somewhat compressed and attenuated; surface covered with almost microscopically minute granules arranged in radial lines except where removed by friction; the disk of the shell shows their scars on its otherwise polished surface. Lon. 5.7, alt. 5.3, diam. 4.4 mm.

U.S.S. "Albatross," station 3392, Gulf of Panama in 1270 fathoms, hard bottom, temperatures 36.4° F. (Dall, 1908.)

Subgenus **DERMATOMYA** Dall, 1889

Type species by monotypy, *P. (D.) mactroides* Dall. Recent, off the coast of southern Chile.

Surface smooth, without granulation, the pallial sinus distinct.

Poromya (Dermatomya) equatorialis Dall

Plate 83, figure 8

Poromya (Dermatomya) equatorialis Dall, 1908, Bull. Mus. Comp. Zool., vol. 43, No. 6, pp. 429, 430, pl. 5, figs. 1, 2 Gulf of Panama in 1672 fathoms and also off the coast of Ecuador in 741 fathoms.

Shell subtrigonal, inflated, slightly inequivalve, white covered by a strong dark olive-gray periostracum, paler near the basal margin. Surface smooth except for lines of growth, without granulation or surface striation; form as figured; interior bluish white, slightly pearly; ligament and resilium combined, short, set obliquely, internally, under and behind the beaks; there is no lithodesma; hinge comprising one stout cardinal prominent in the left valve entering a socket in the opposite valve in front of a long, nearly horizontal lamina, which forms the base of the resiliary pit; there is also one strong posterior left lateral, and a feeble anterior one on the same valve, which last is hardly to be distinguished from an angularity of the hinge margin; pallial sinus wide, rounded, rather short. Length of shell, 18, alt. 15, max. diam. 5+6.5 mm., the smaller dimension being that of the left valve, which basally fits inside the other and has a slightly tortuous margin behind.

This species, besides its much greater size, has beaks more inflated and higher, and the posterior end blunter than we find in *P. mactroides* (Dall, 1908).

Family LYONSIIDAE

Shell generally elongated, oblong, thin or heavy, nacreous, regular or markedly distorted in some nestling forms. Hinge edentulous. Ligament internal, the resilium seated in a long, narrow, resilifer under the dorsal margin behind the beak, further reinforced by a large shelly plate or lithodesma. Test smooth or granulose.

Genus **LYONSLA** Turton, 1822

Type species by monotypy, *Mya striata* Montagu, 1822 (= *Mya norwegica* Gmelin, 1790). Northern European seas.

Shell generally elongate, regular, inequivalve, the posterior side longer, more or less flexed and gaping at the end, the texture thin, nacreous, the surface covered with a thin, inconspicuous, yellow or gray periostracum, smooth, concentrically marked or with fine radial threads. Hinge edentulous, the ligament internal, the resilifer in the shape of an elongated, grooved ridge under the dorsal margin behind the beak, similar in each valve. The middle section of the resilium is covered by a large, calcareous plate or lithodesma, the brown or fibrous portion of the resilium developed along its sides or in the contact zone with the resilifer.

Genus **ENTODESMA** Philippi, 1845

Type species by monotypy, *E. chilense* Philippi.

Shell large, coarse, and of irregular shape due to a nestling habit. Periostracum coarse. Lithodesma large.

Subgenus *AGRIODESMA* Dall, 1909

Type species by original designation, *Entodesma saxicola* Baird. Vancouver Island.

Generally large, much distorted shells due to a nestling habit in rock crevices, the surface covered with a coarse, horny periostracum which in drying generally peels off exposing the pearly shell below. The lithodesma is a large plate, and with the resilium, it is inserted obliquely below the hinge margin and between the two valves.

Entodesma (Agriodesma) sechurana Pilsbry and Olsson Plate 83, figure 5

Entodesma (Agriodesma) sechurana Pilsbry and Olsson, 1935, *Nautilus*, vol. 49, No. 1, pp. 18, 19, pl. 1, figs. 6, 7, 8.

The shell is rather large, irregular in form, pearly within and covered externally with a dark-colored periostracum; the beaks are small and terminal. The anterior end is sometimes slightly produced and convex, but more often, it is flattened and truncated. The posterior side is generally broadly expanded, the ventral and dorsal margins nearly parallel, and in the young, there may be a lunular depression below the beak. The anterior-ventral margin has a wide, elliptical gap, the margins of the shell about the gap often much deformed, sometimes producing furrows which extend upward to the beaks. Interior nacreous, the adductor scars conspicuous.

Length 68 mm., height 41 mm., diameter of left valve 18 mm. Holotype, ANSP 164624.

This species attains about the same size as the northern *E. saxicola*. It is a fairly common species in Sechura Bay, probably a migrant from the south. A few small specimens have also been found at Búcaro in Panama.

Range—Panama southward to Peru. Panama: Búcaro. Peru: Bayovar, Bay of Sechura; Lobitos; Mancora; Punta Picos.

Entodesma (Agriodesma) picta (Sowerby) Plate 84, figures 7, 7a

Lyonsia picta Sowerby, 1834, *Proc. Zool. Soc. London*, p. 88. "Hab. ad Insulam Muerte". *Osteodesma picta* (Sowerby), 1875, in Reeve, *Conch. Icon.*, vol. 20, *Mytilimeria*, pl. 1, fig. 6.

Entodesma picta (Sowerby), Dall, 1915, *Proc. U.S. Nat. Museum*, vol. 49, p. 455.

Lyonsia (Entodesma) picta (Sowerby), Lamy, 1928, *Jour. de Conchyl.*, vol. 76, p. 260 (prob. in part).

Lyonsia inflata Conrad, 1837, *Jour. Acad. Nat. Sci. Philadelphia*, vol. 7, p. 248, pl. 19, fig. 10 "Guayaquil".

Shell thin, elongately subovate in shape, convex over the umbonal middle part, depressed over the posterior part. The anterior side is short, somewhat flatly impressed, its margin declining straight or a little rounded, the posterior side narrower, depressed, its dorsal margin straight, sub-truncated and gaping at the end. The surface over the convex portion is narrowly and rather regularly, concentrically undulated except for a line above the anterior-ventral gap where the undulations are wrinkled or sharply bend inward; over the posterior portion, the undulations are weak or missing. Periostracum thin, skinlike and peels off easily revealing a whitish surface underneath. Interior is a pearly white, the muscle and pallial impressions showing faintly. Lithodesma large and prominent.

Length 23.5 mm., height 15.6 mm., diameter 12 mm. Peru, ANSP 55366.

The above description is based on a specimen of *L. picta* in the collection of the Academy of Natural Sciences at Philadelphia purchased by Mr. T. B. Wilson from Sowerby about 1856 and is possibly a syntype. Its locality is given as Peru but since Isla del Muerte in the Gulf of Guayaquil is close to the Peruvian-Ecuadorian border, it could well be from the same place. Both Sowerby and Hanley mention that the surface is painted with wavy black lines which are not seen on the Academy's specimen which is plain light brown in color. The specimen fits the figure of Conrad's *L. inflata* in shape and size (described from Guayaquil) and is probably the same species. (The type of *L. inflata* could not be located at the Academy.)

Range—Ecuador and northern Peru. Ecuador: Isla del Muerte (Gulf of Guayaquil).

Family VERTICORDIIDAE

Family with the characters as described below for the genus *Verticordia*.

Genus VERTICORDIA Sowerby, 1844

Type species by monotypy, *V. cardiiformis* Sowerby. Pliocene of England.

Shell generally small, suborbicular, cardiform, equivalve, the beaks strongly prosogyrate above a deep, entering lunular indentation with thickened margins. Shell texture heavy, nacreous within and with a thin, chalky outer layer minutely shagreened. The hinge of the right valve shows a stout, conical cardinal tooth placed behind the lunular indentation; there are no laterals. Ligament internal, supported by a lithodesma. Pallial line simple. Sculpture is formed by strong, radial ribs.

Subgenus TRIGONULINA d'Orbigny, 1846

Type species by monotypy, *T. ornata* d'Orbigny. Recent, West Indies and eastern Pacific.

Shell similar to *Verticordia*, *s.s.* but with the posterior set of ribs more widely spaced. Right valve with a long, posterior lateral socket.

Verticordia (*Trigonulina*) *ornata* (d'Orbigny)

Trigonulina ornata d'Orbigny, 1846, in de la Sagra, Histoire Physique, Politique et Naturelle de l'Ile de Cuba; Mollusques, (Moll. Cubana), vol. 2, p. 291, pl. 27, figs. 30-33.

Verticordia ornata (d'Orbigny), Maxwell Smith, 1944, Panamic Marine Shells, p. 55, fig. 712.

Verticordia (*Trigonulina*) *ornata* (d'Orbigny), Hertlein and Strong, 1946, Zoologica, vol. 31, pt. 3, p. 102, pl. 1, fig. 7.

Shell small, circular, with small prosogyrous beaks curved over the deep, lunular indentation, brilliantly pearly within, and sculptured externally with eight to ten large, curved, radial ribs which deeply indent the margin; the set of seven anterior ribs are spaced evenly and fairly close together, the others on the middle and posterior side unevenly, the two middle ribs set as a pair bordered on each side by much wider spaces; these ribs may be narrow and sharp, or more or less crudely beaded. Outer shell layer has a fine granular texture, due to its composition and fine shagreening, generally a cream-white color and contrast strongly with the shiny, nacreous luster of the interior.

Maximum length of shell a trifle over 5 mm.

This is a widely distributed species in the West Indian-Caribbean region; the Pacific shell appears to be equivalent but is much less common. It has been recorded from the Pleistocene of California and is also known to occur in the Pleistocene of the Burica Peninsula, Panama.

Range—California to Panama. Also throughout the Caribbean and West Indian region northward to Massachusetts. Panama Canal Zone: Far Fan Beach.

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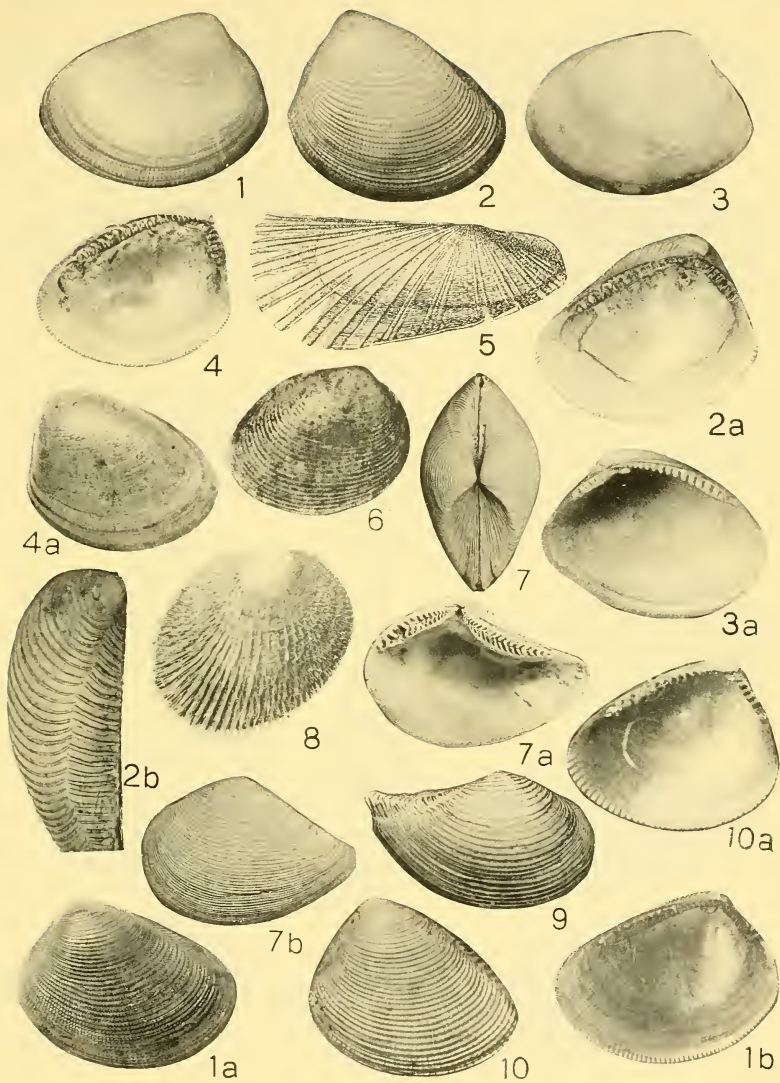
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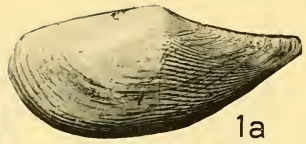




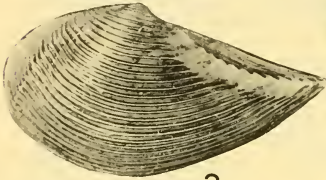
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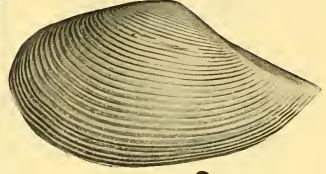
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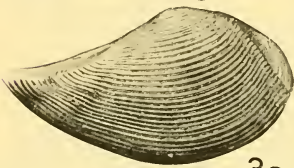
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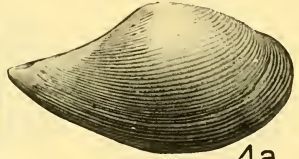
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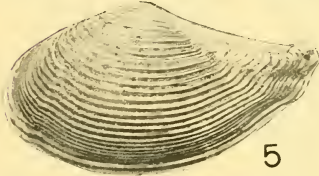
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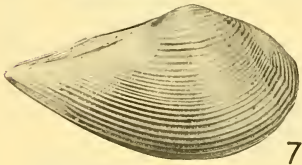
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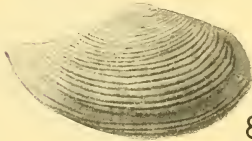
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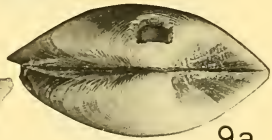
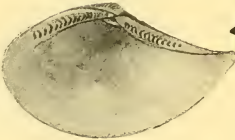
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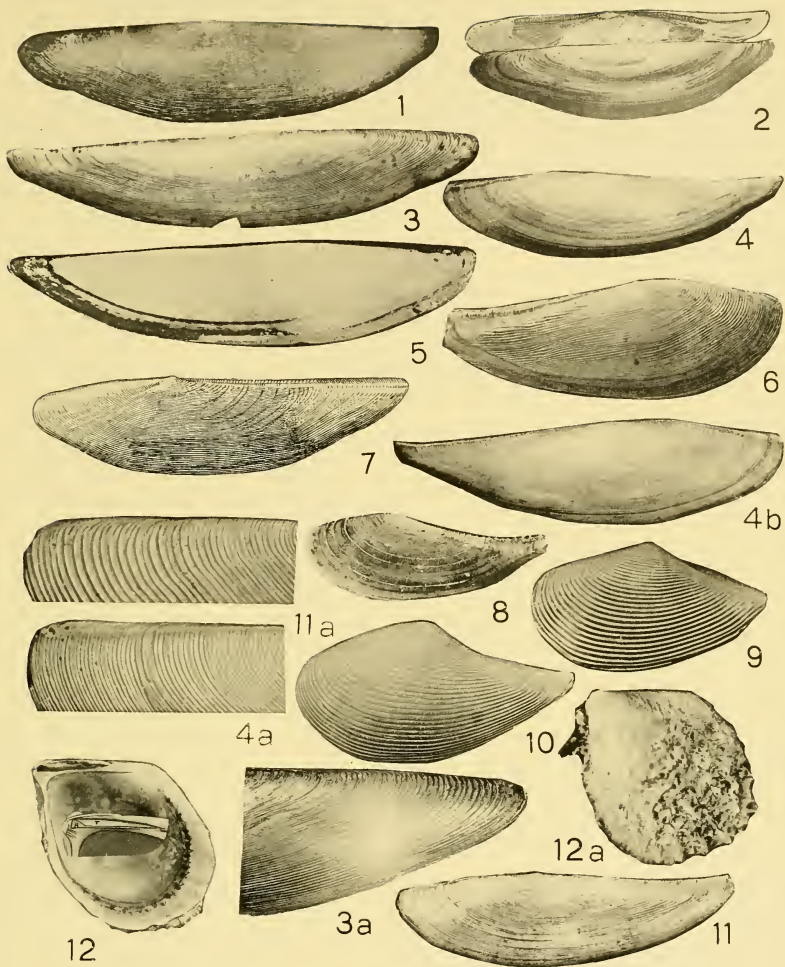
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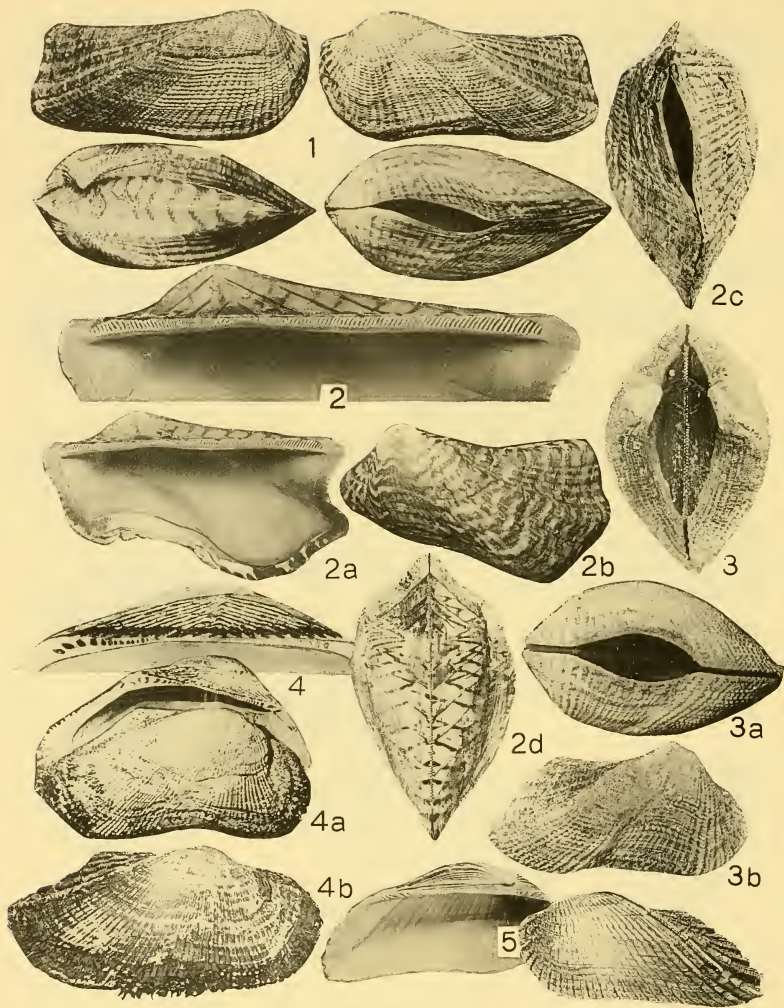
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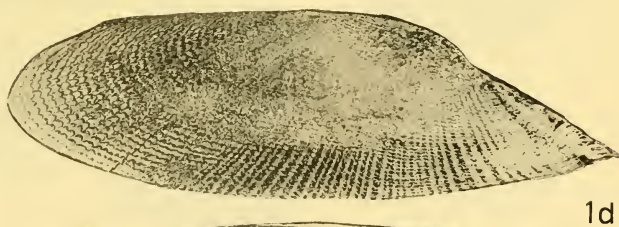
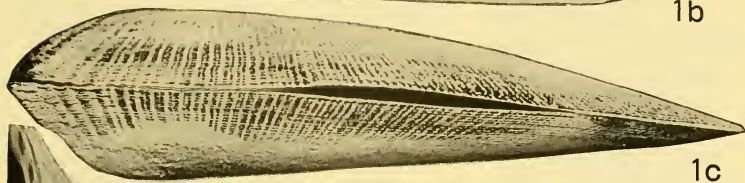
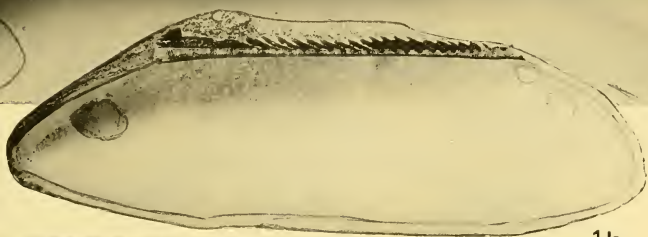
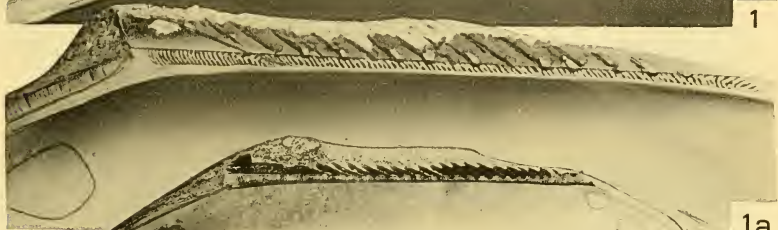
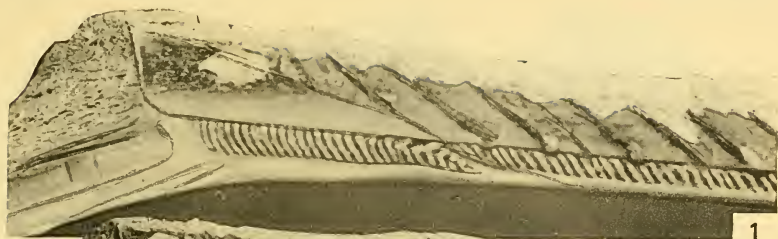
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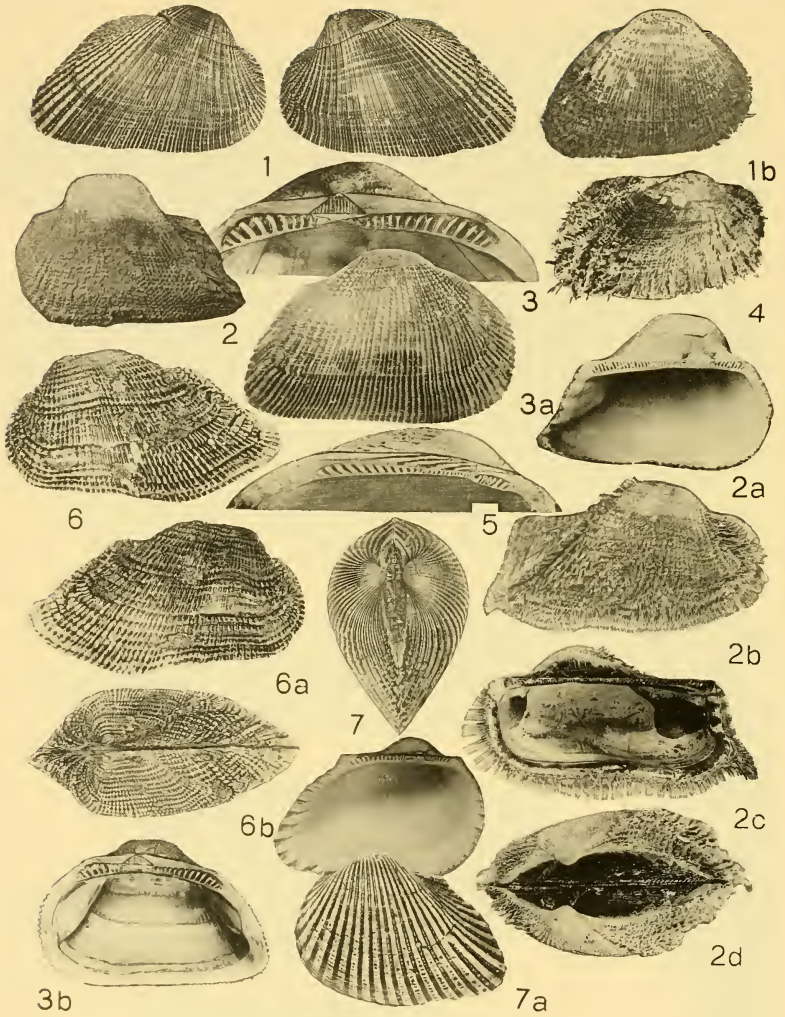
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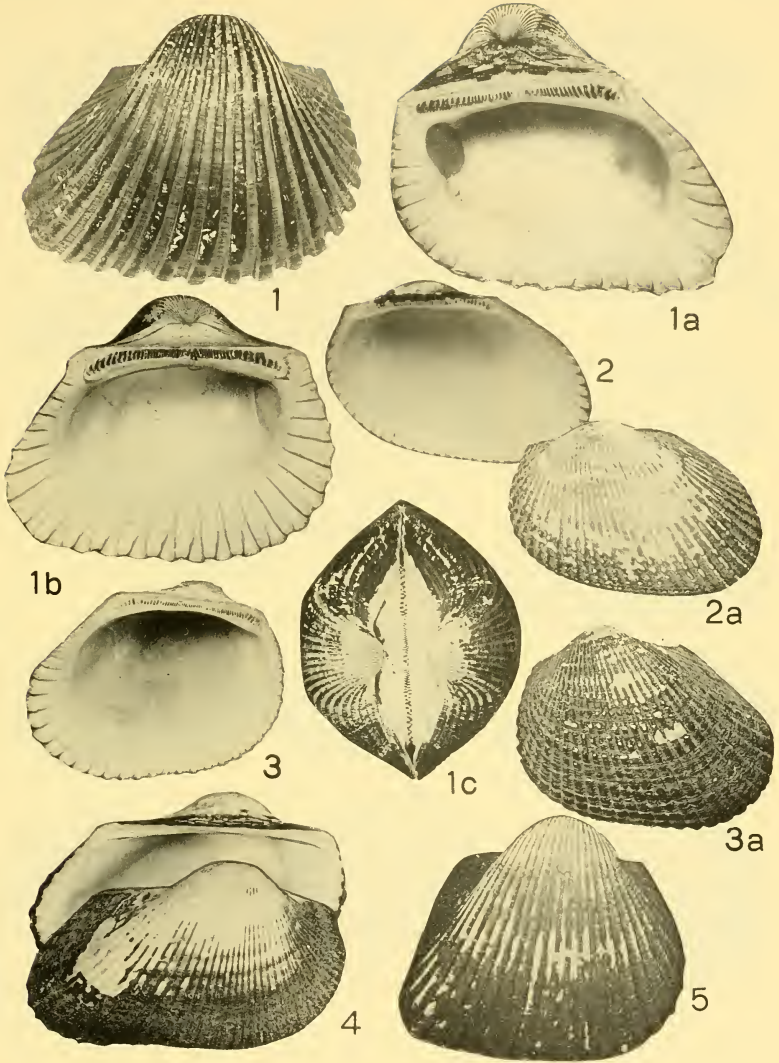


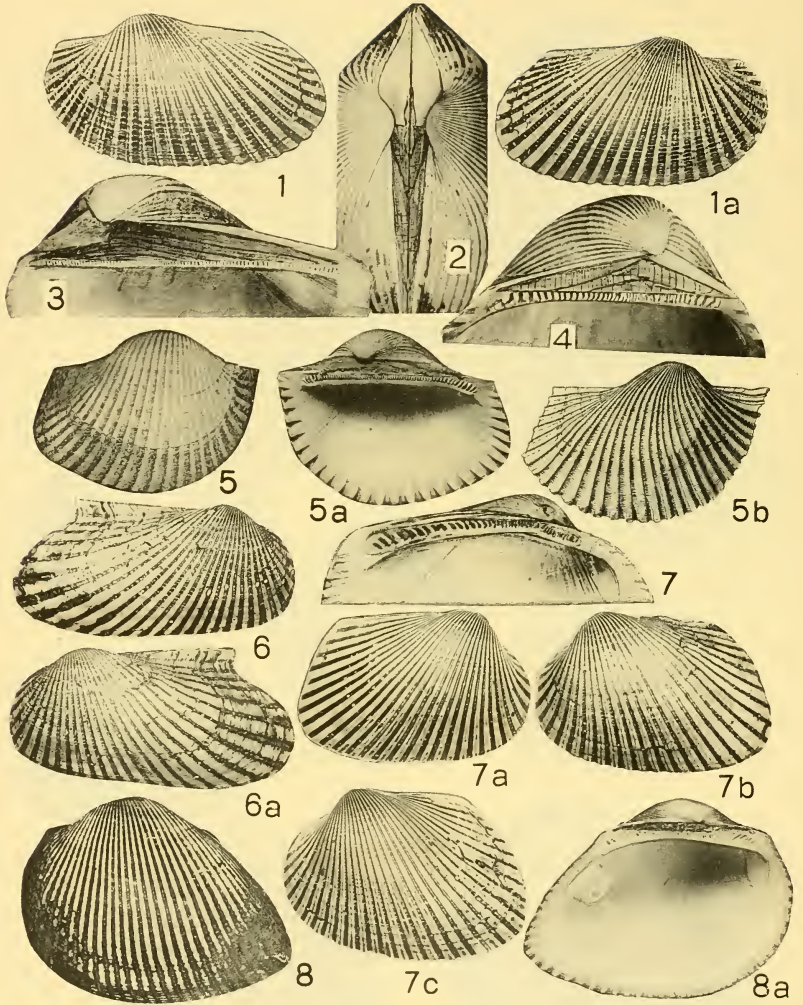
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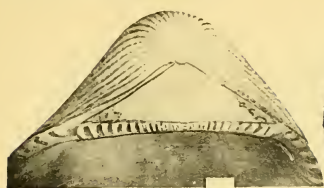


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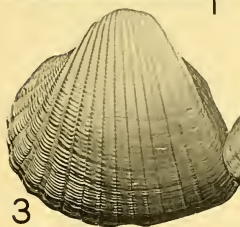
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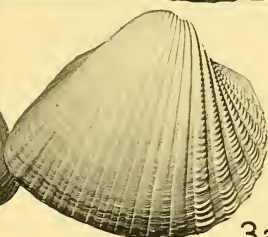
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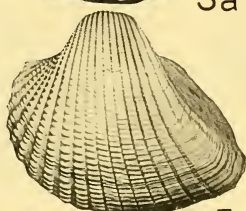
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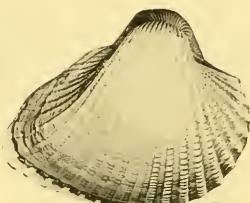
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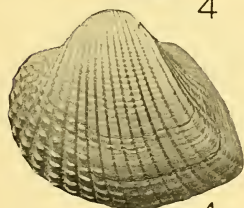
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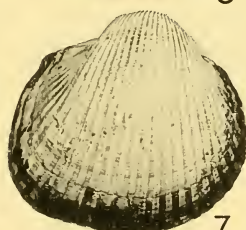
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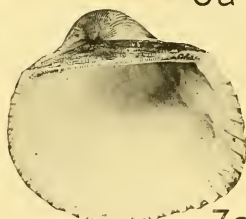
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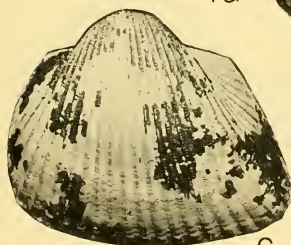
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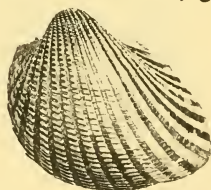
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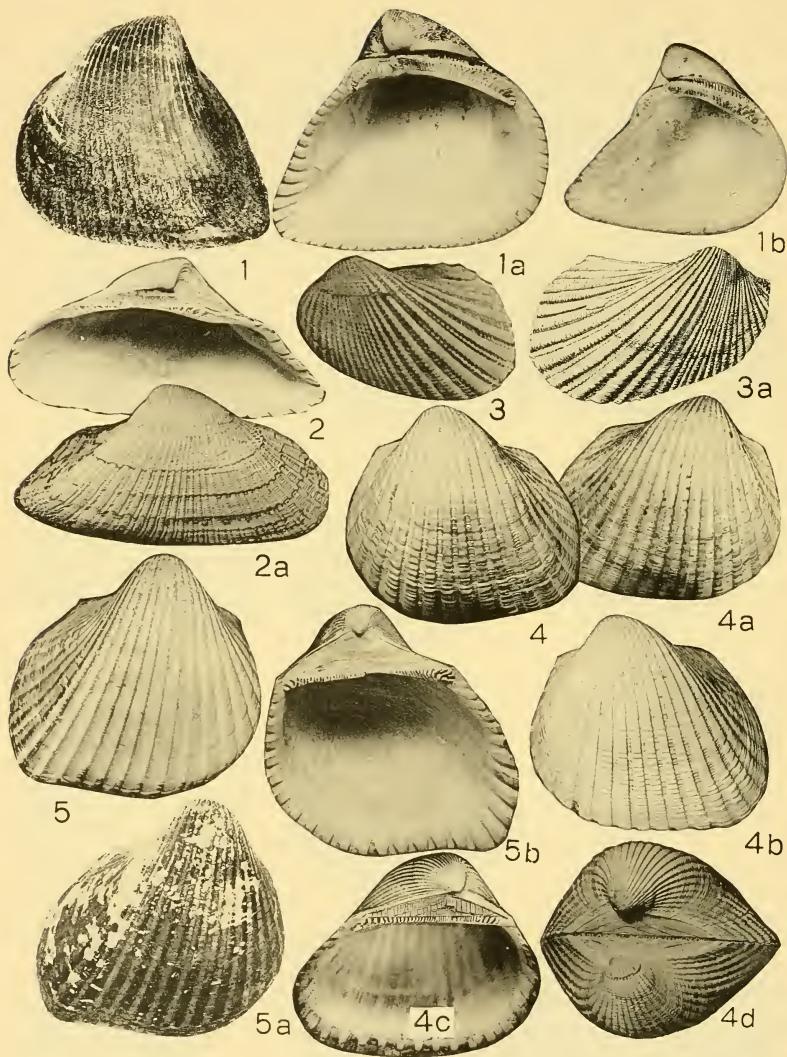
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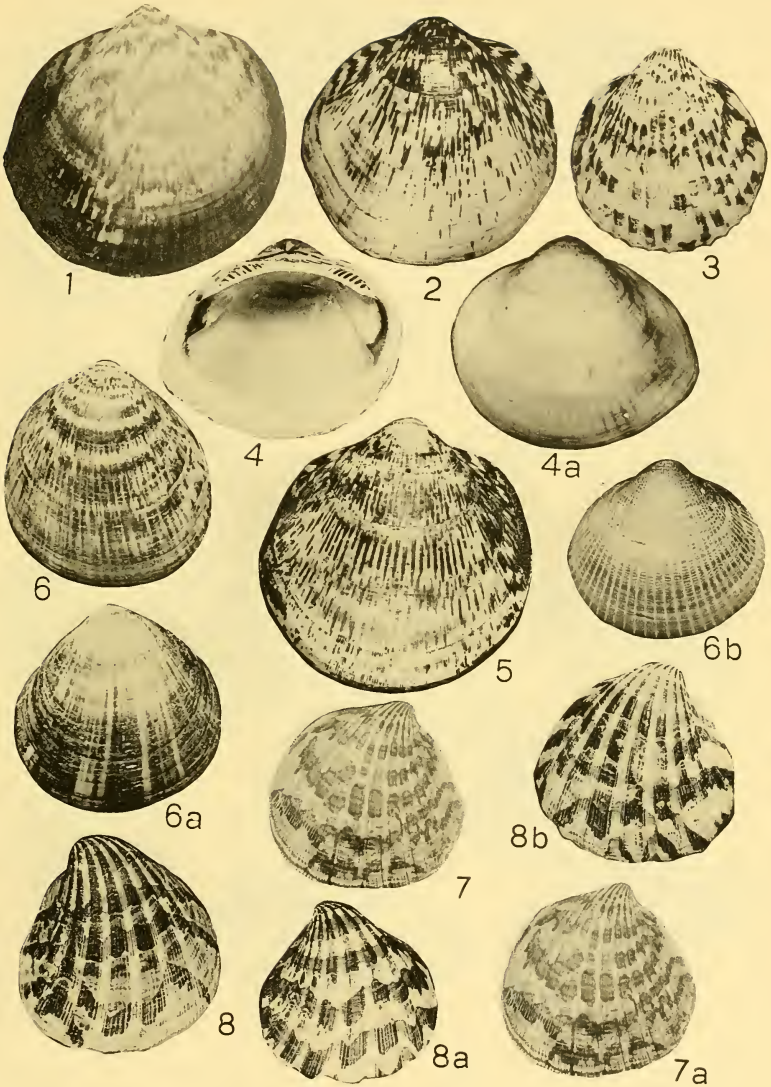


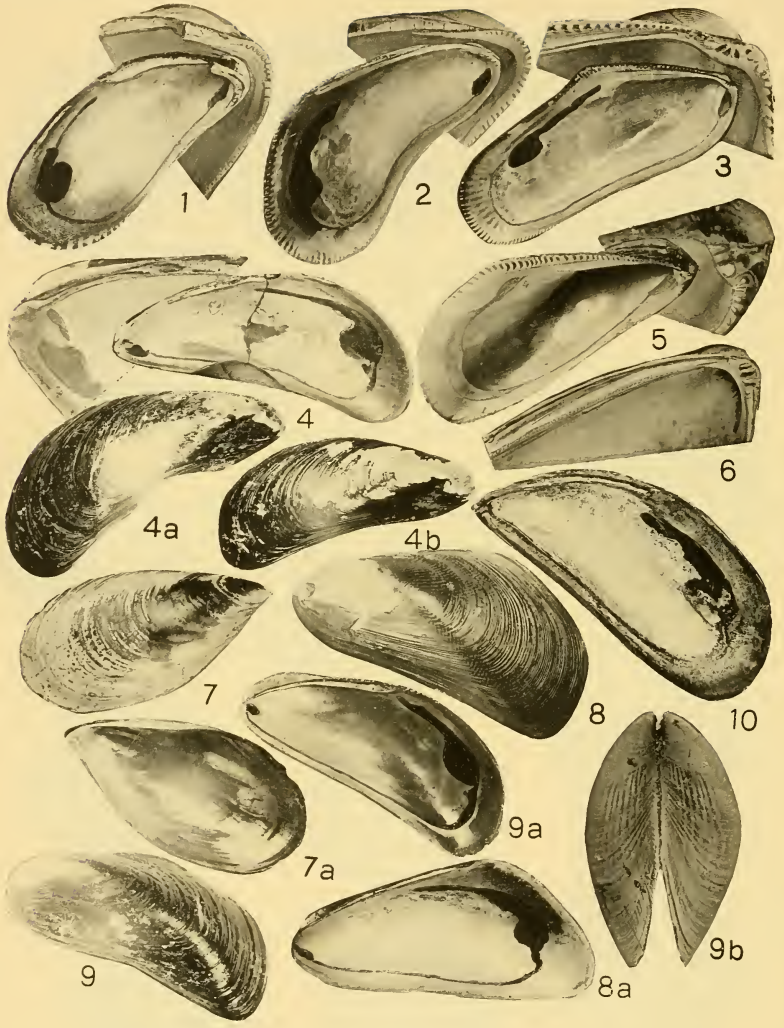
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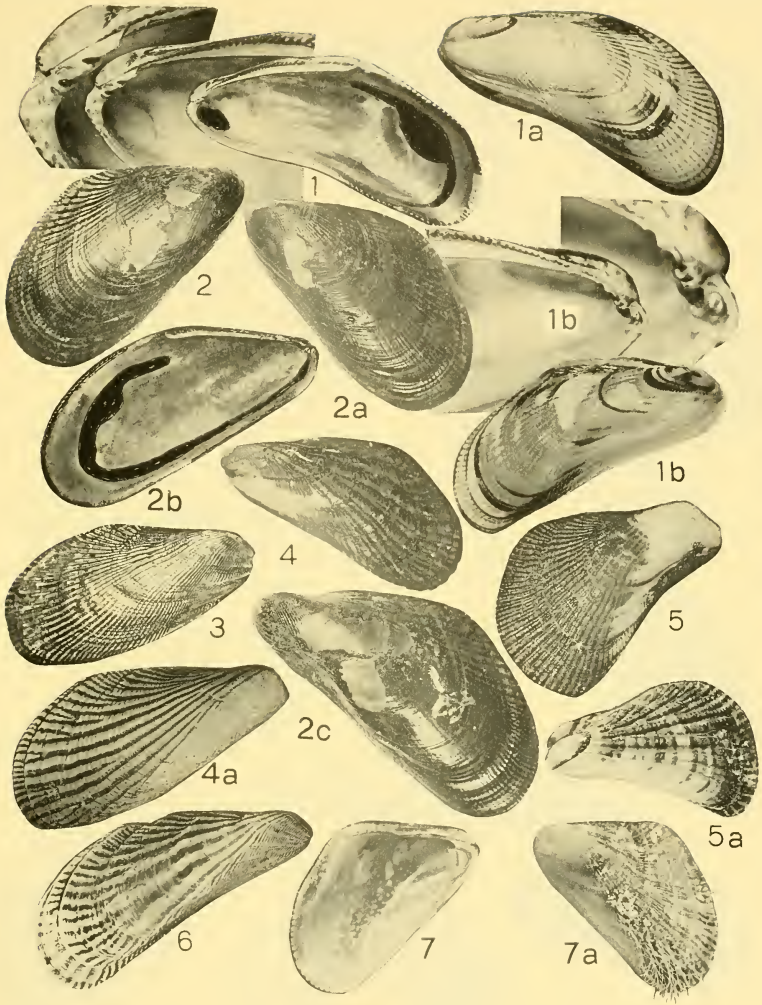


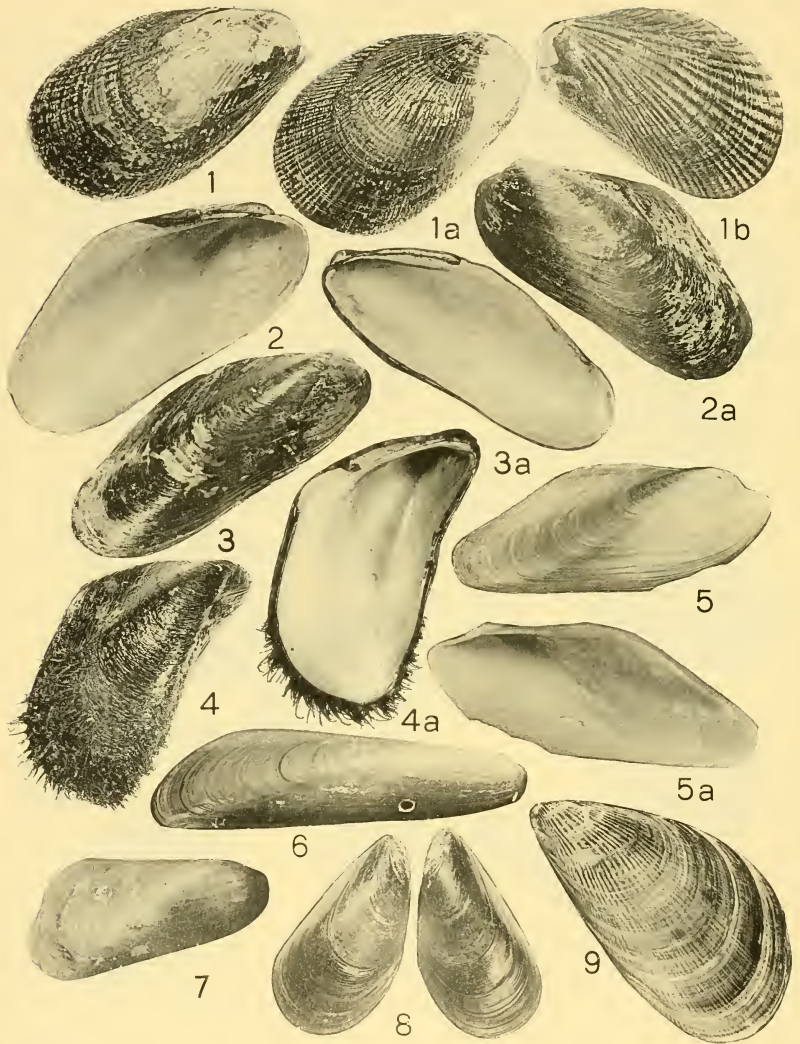
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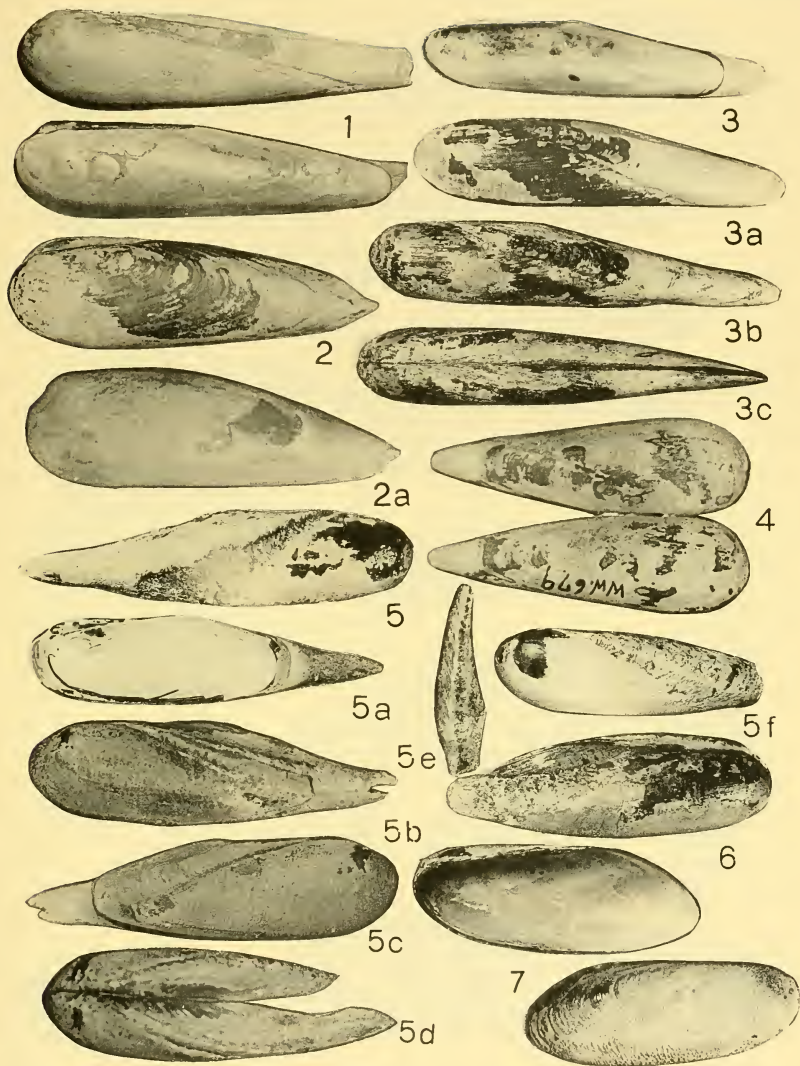


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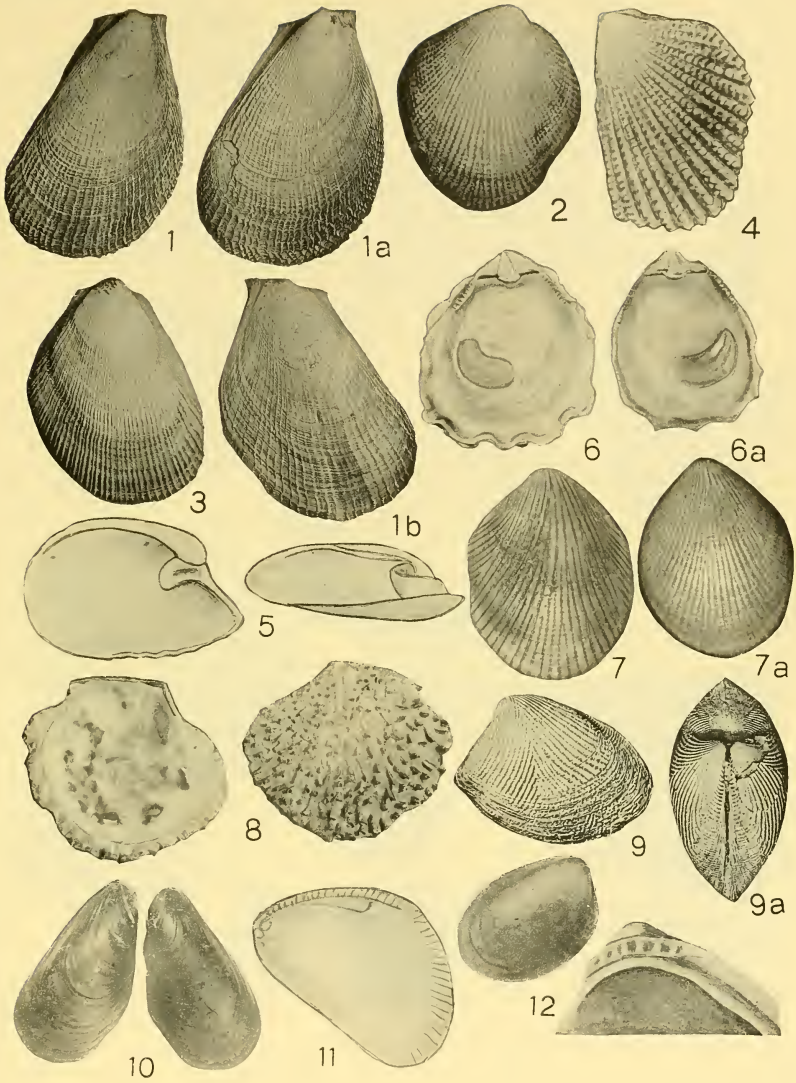


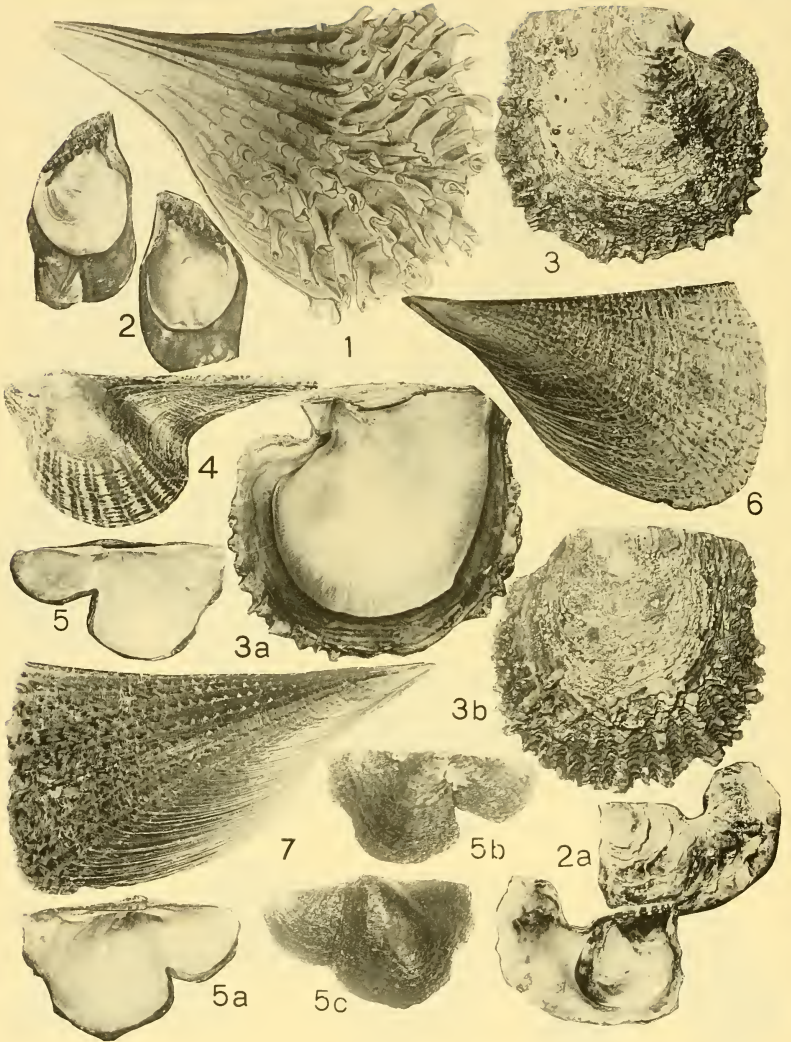
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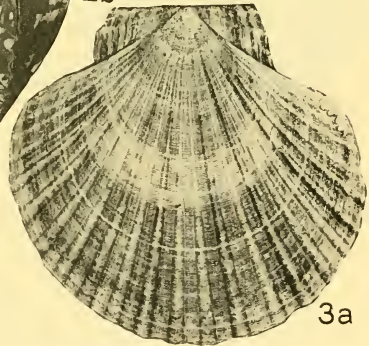
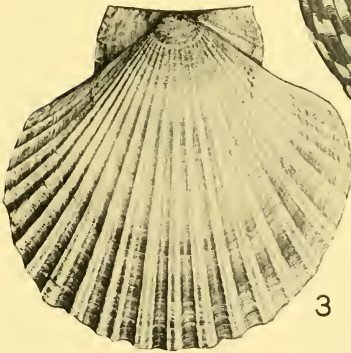
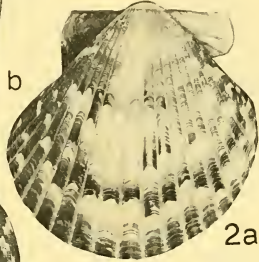
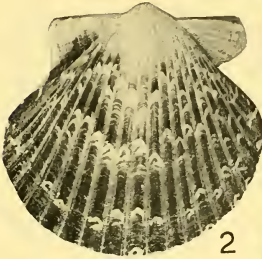
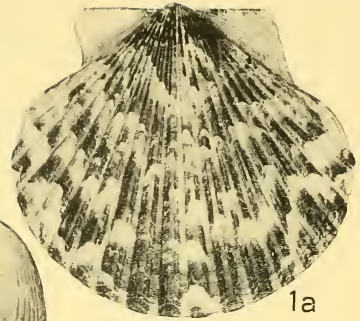
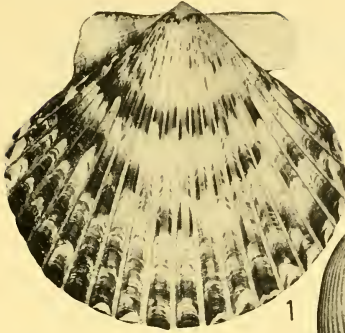


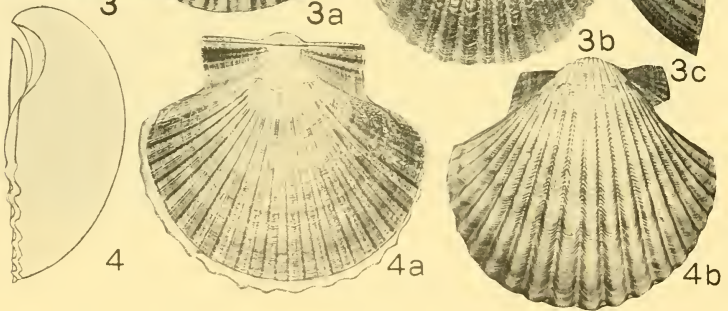
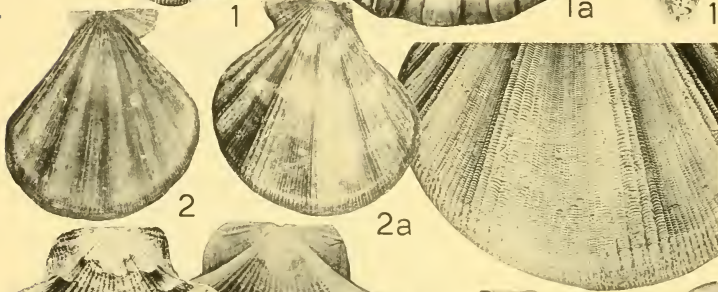
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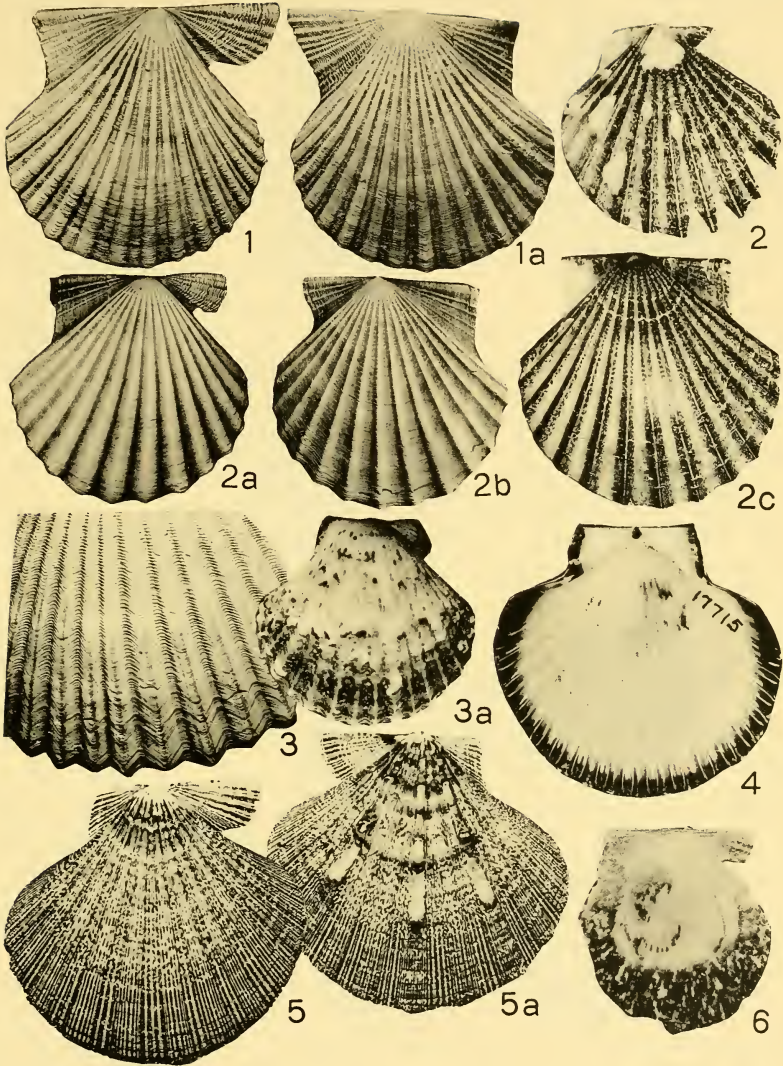


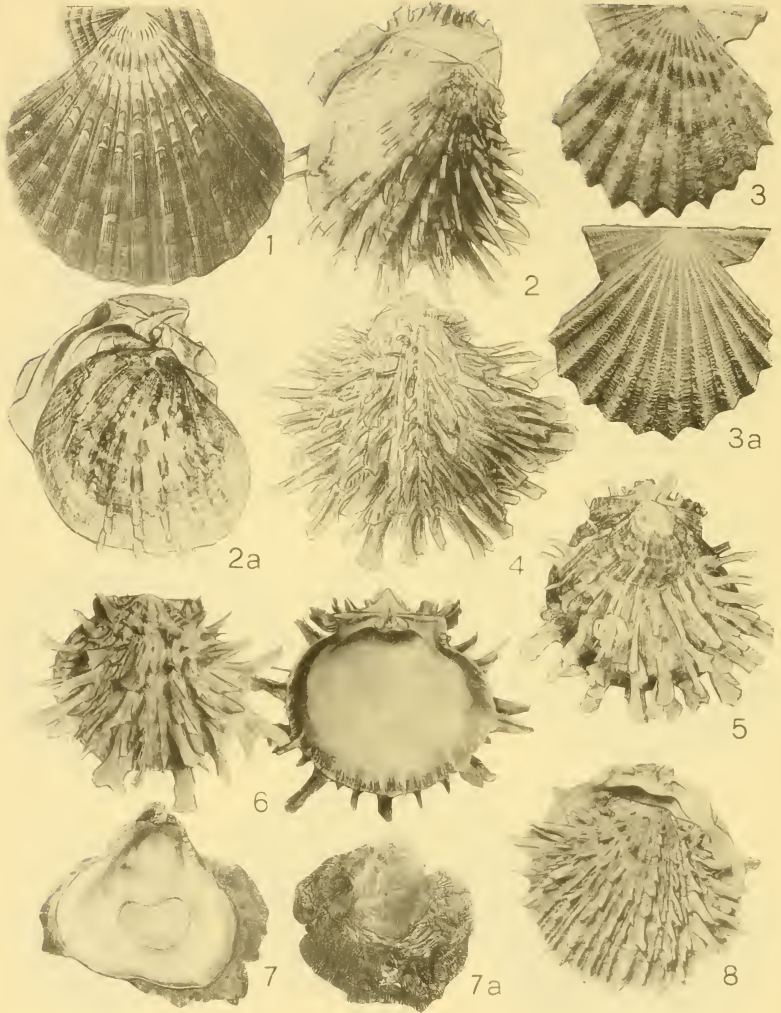
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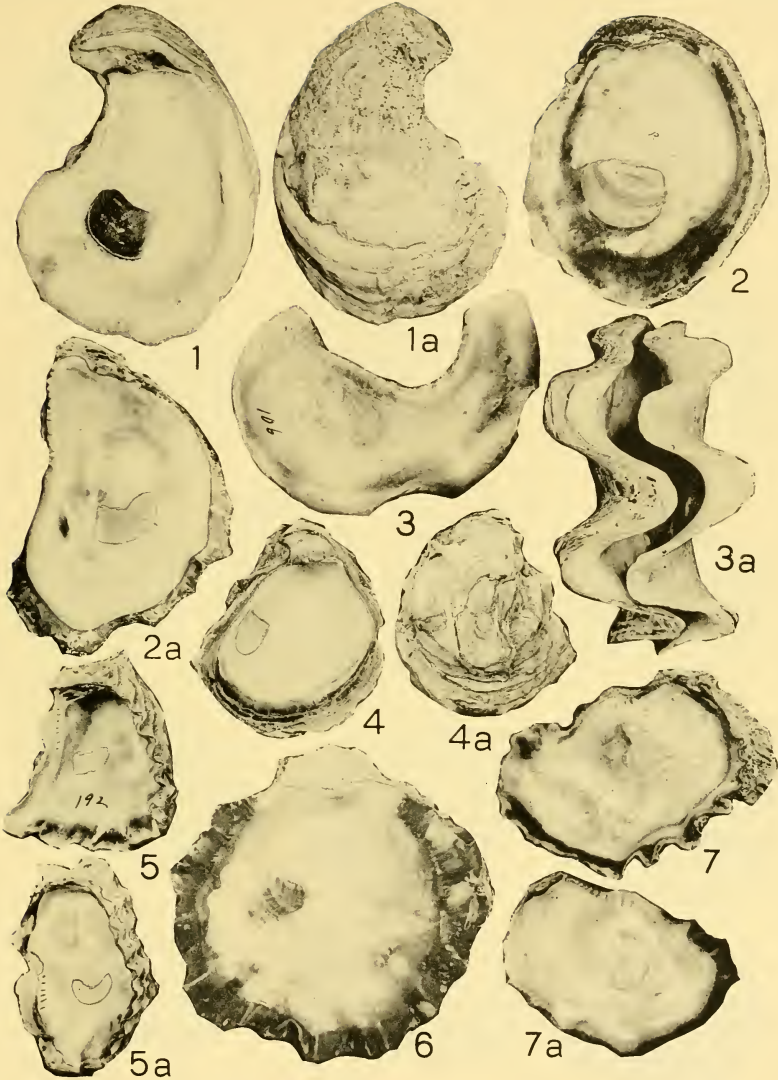


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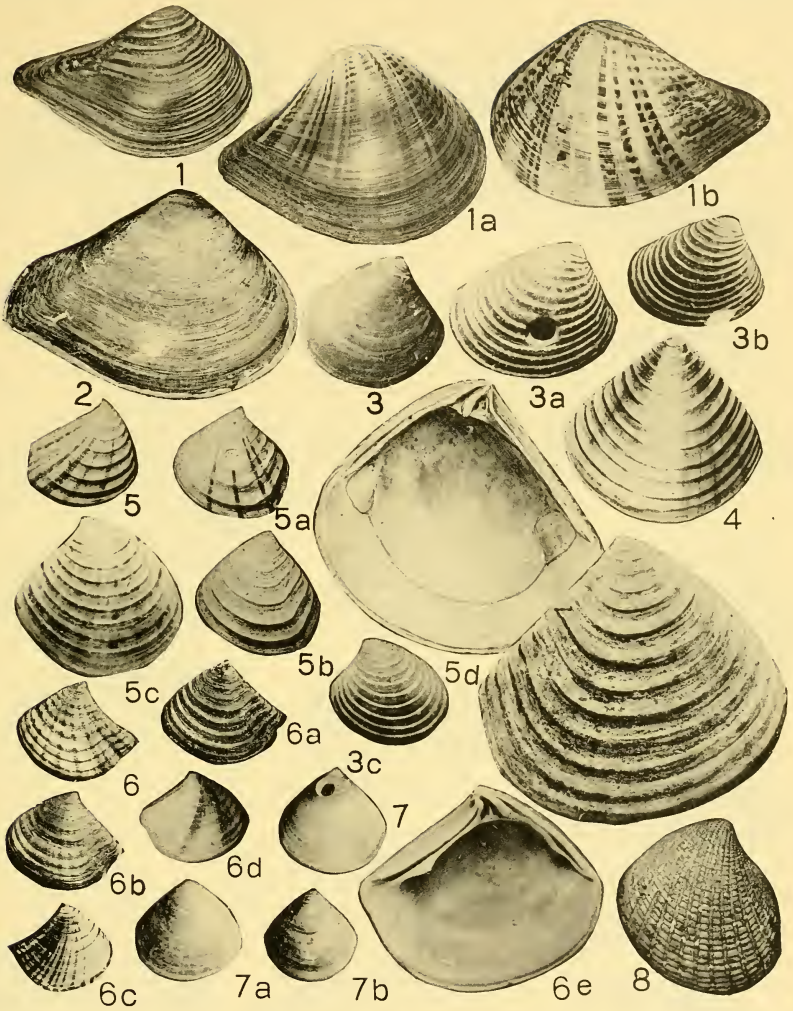


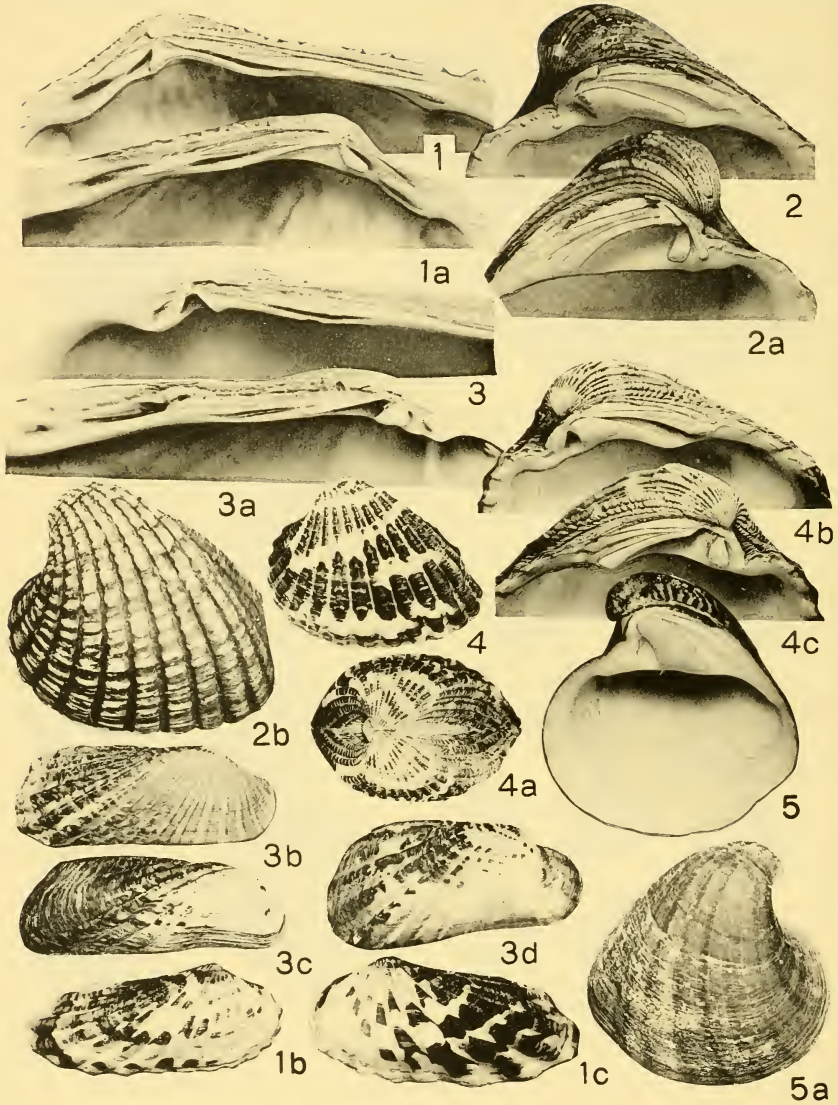
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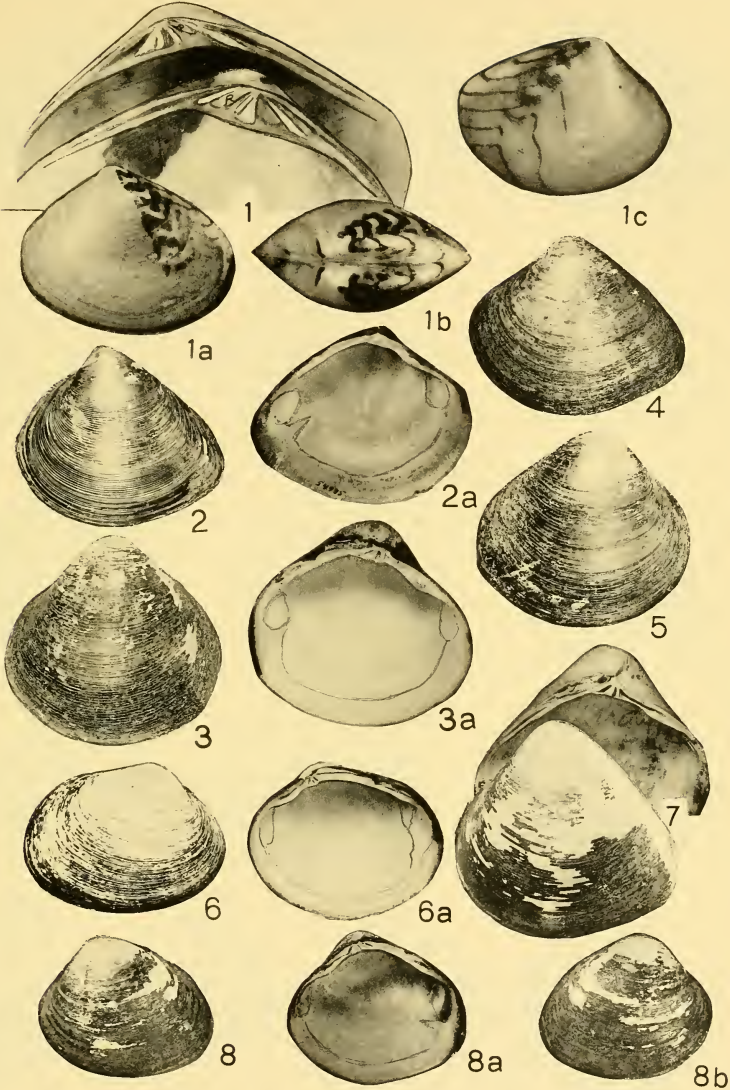


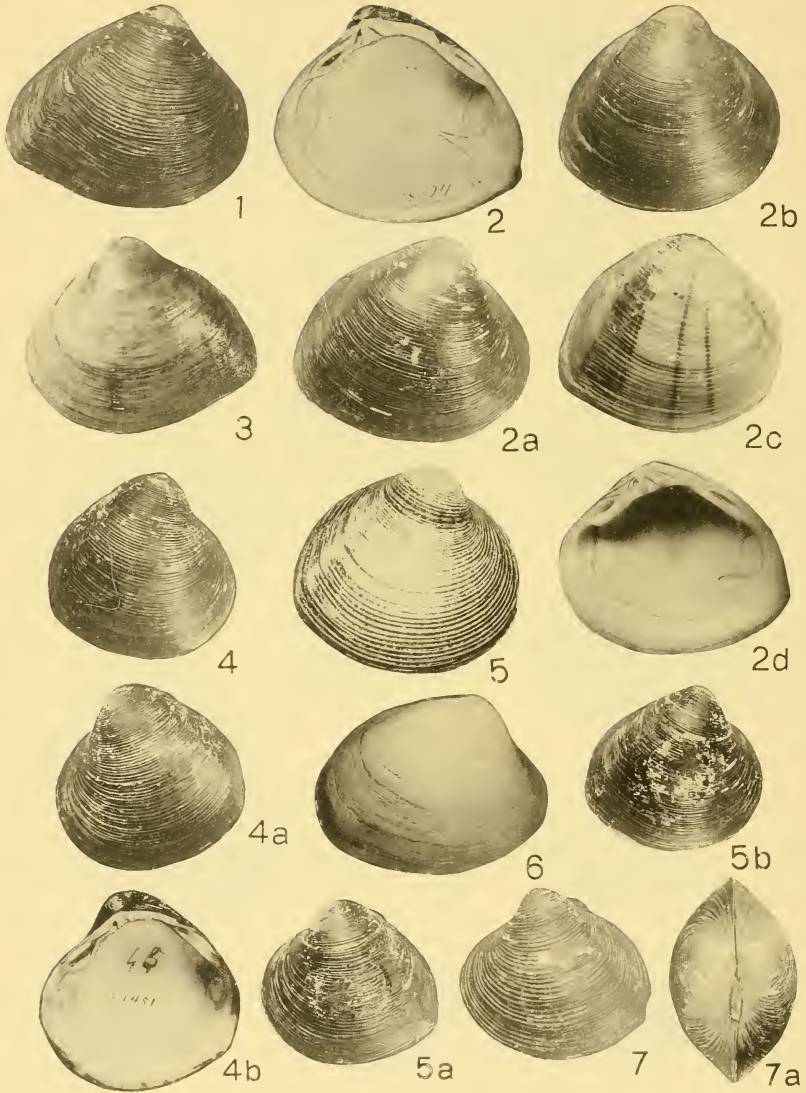
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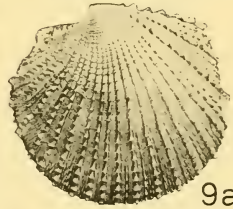
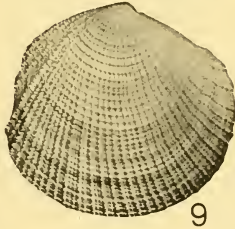
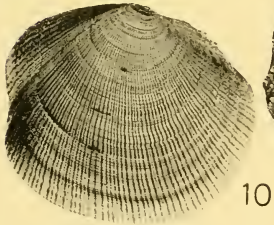
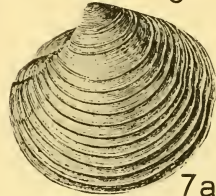
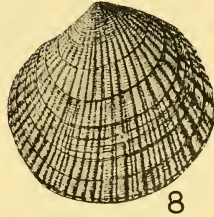
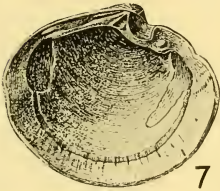
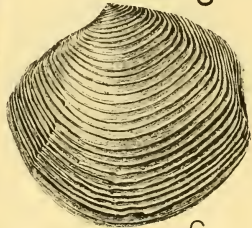
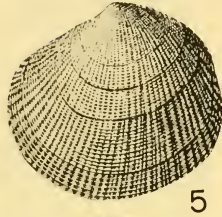
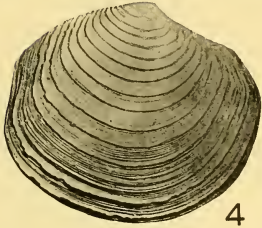
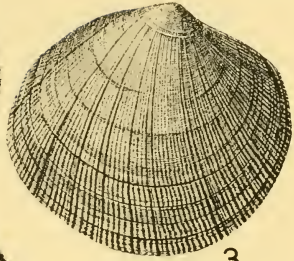
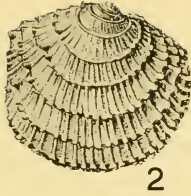
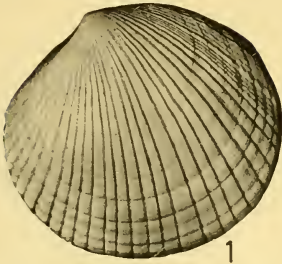


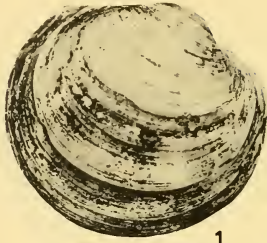
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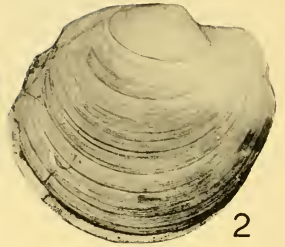




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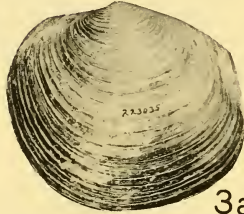
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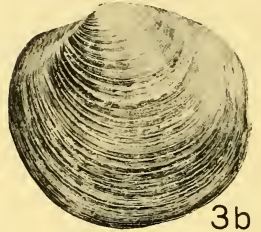
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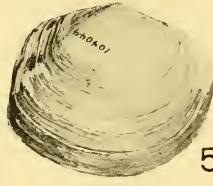
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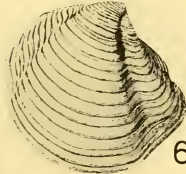
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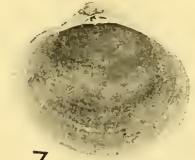
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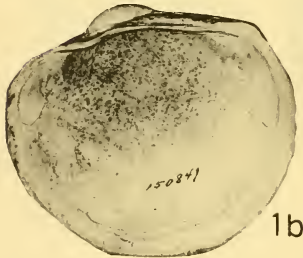
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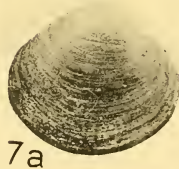
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1b



7a



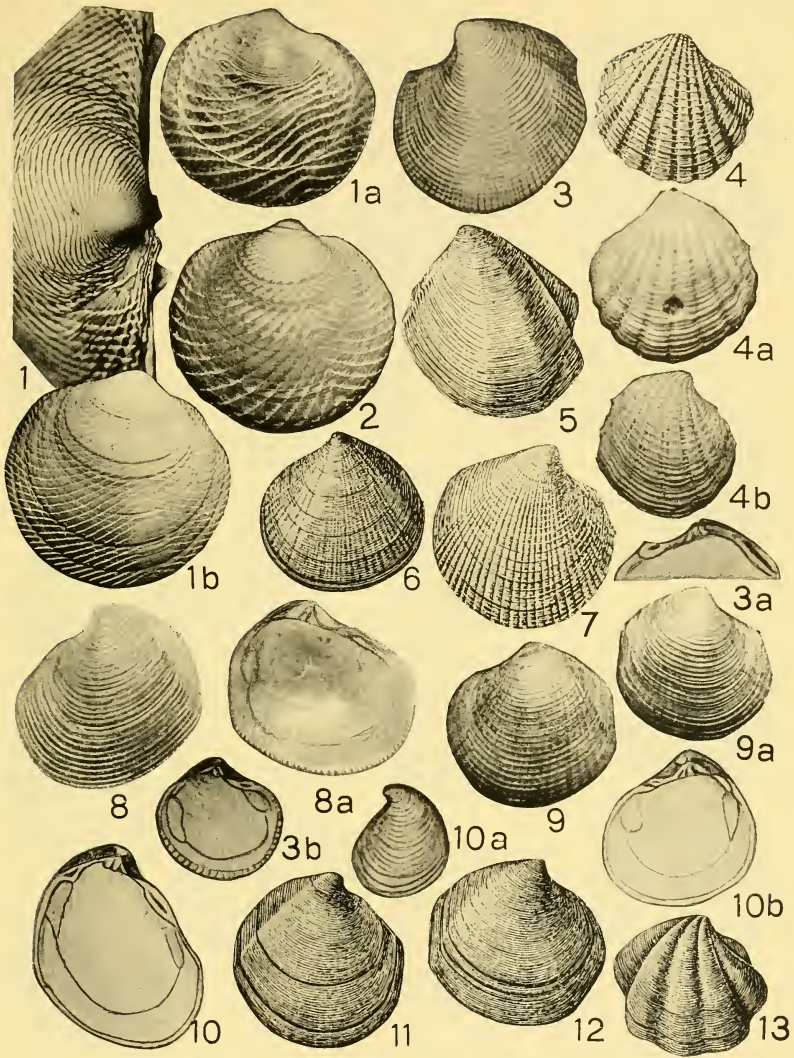
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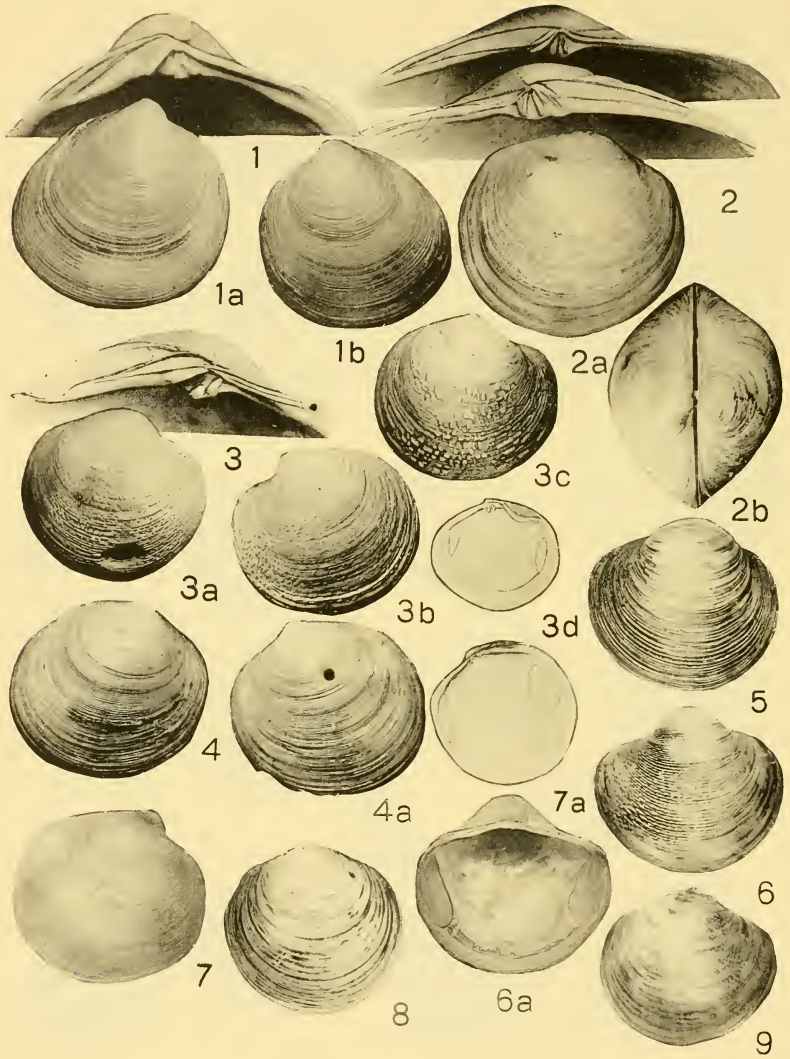
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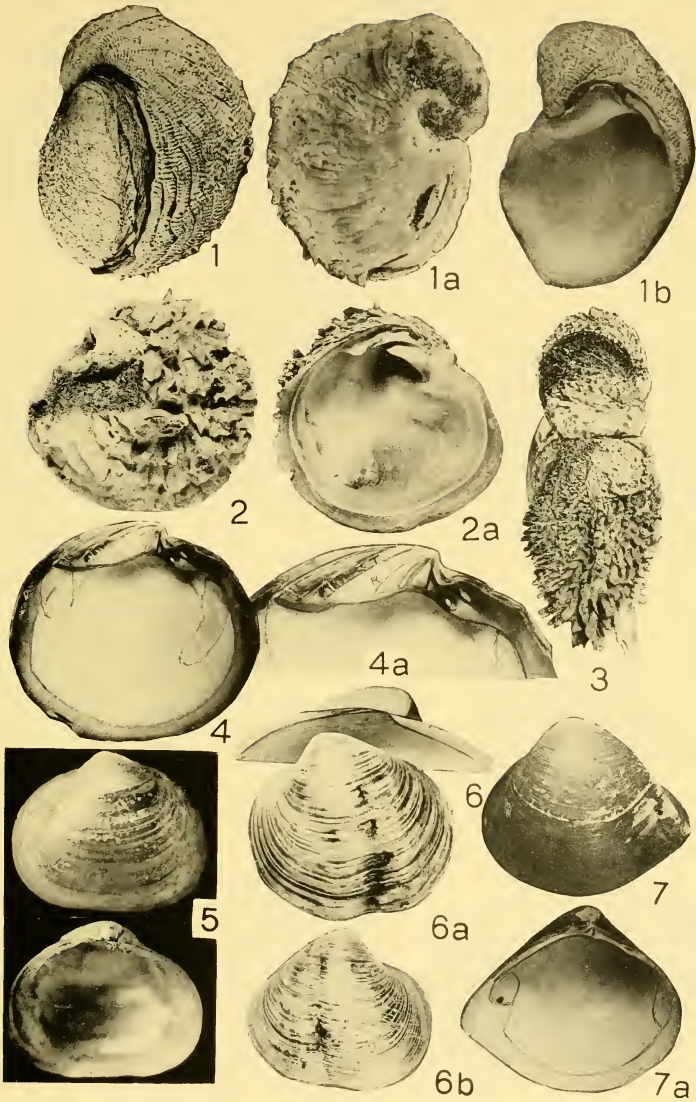


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1



1a



1b



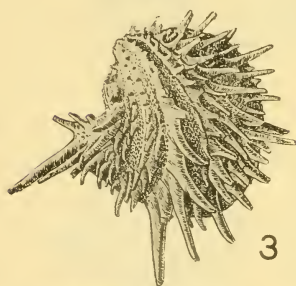
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2a



2b



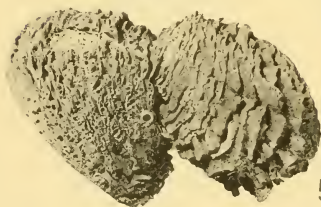
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4



2c



5



4a



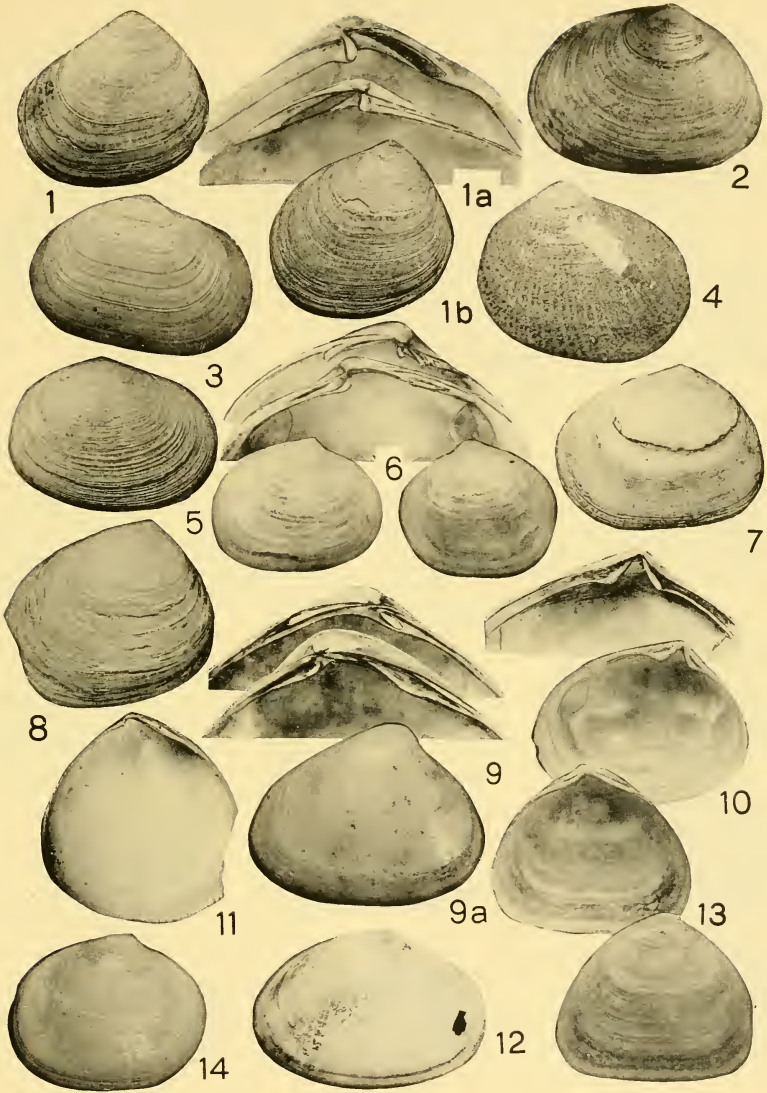
4b

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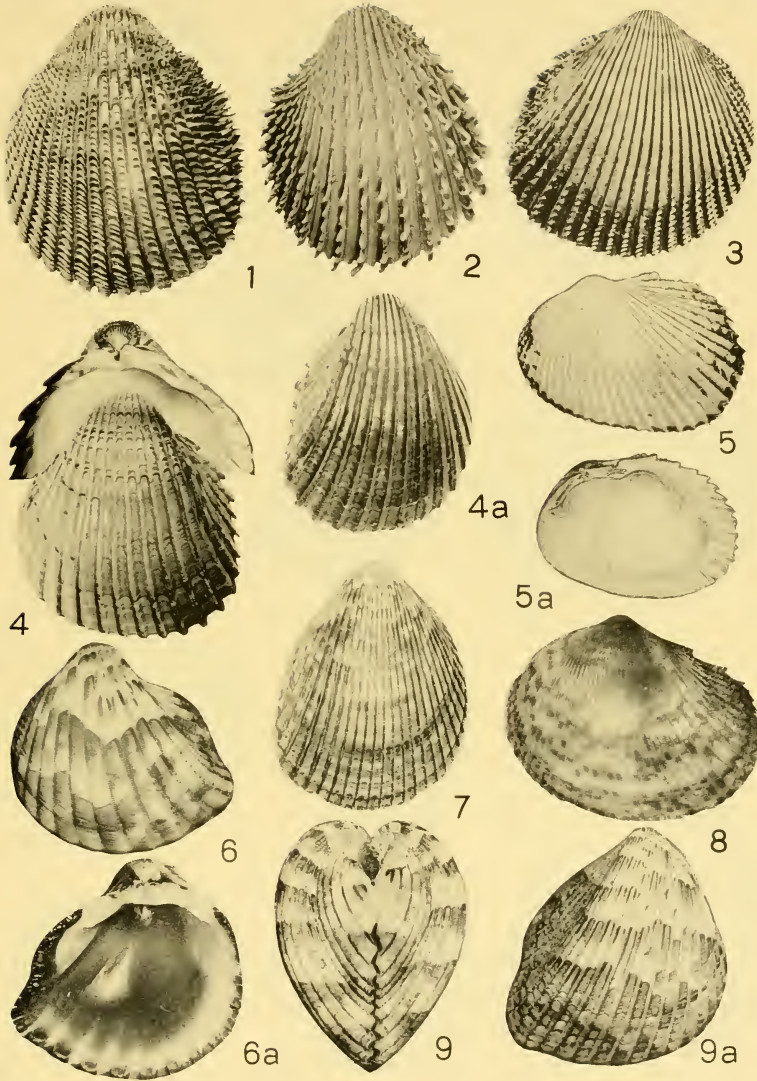


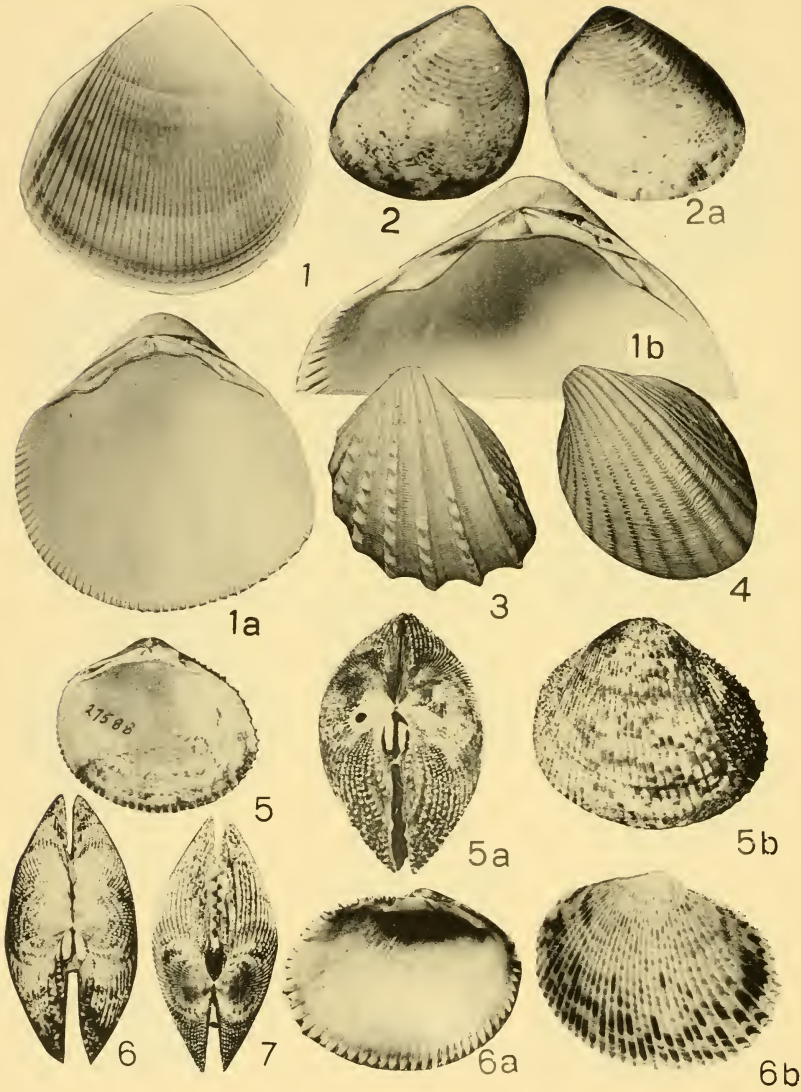
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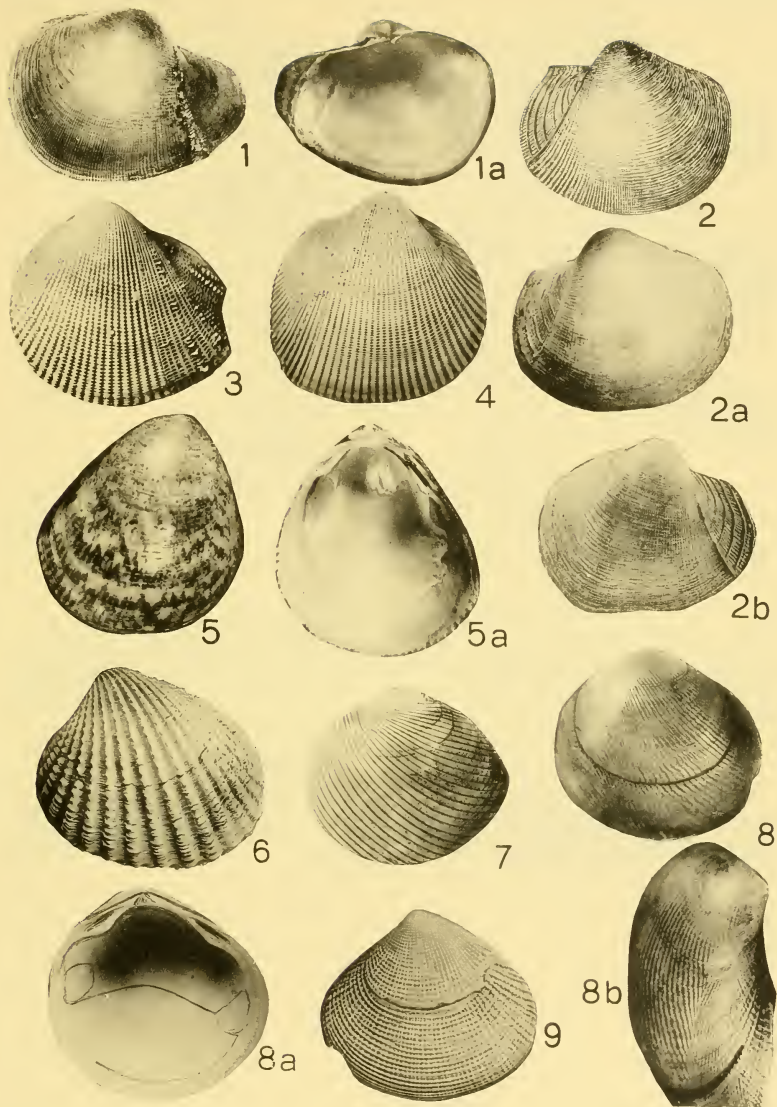


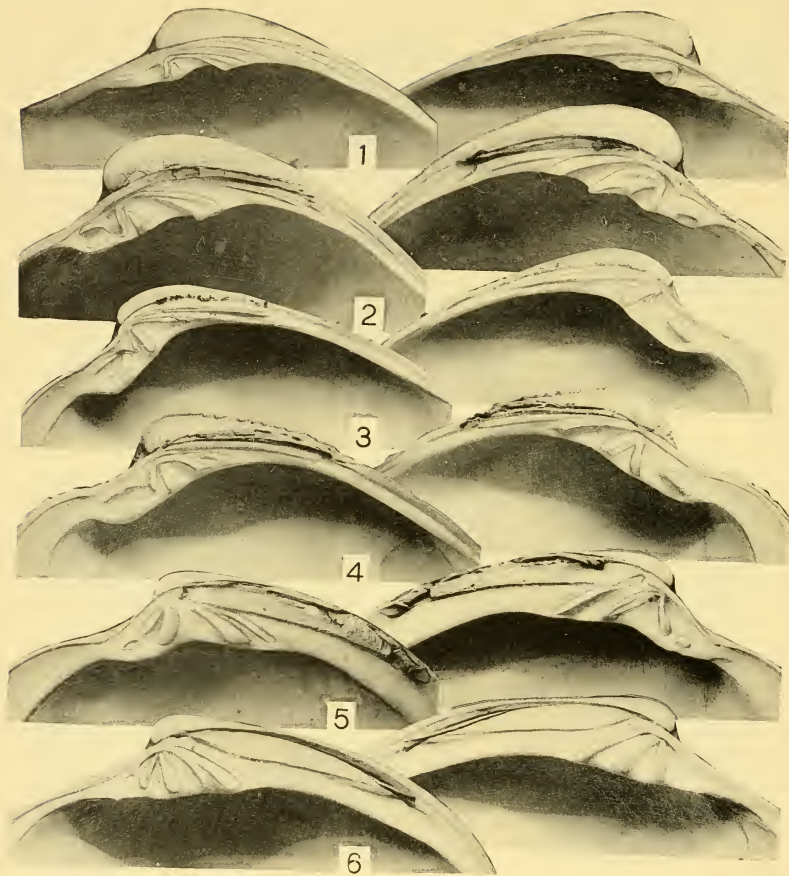
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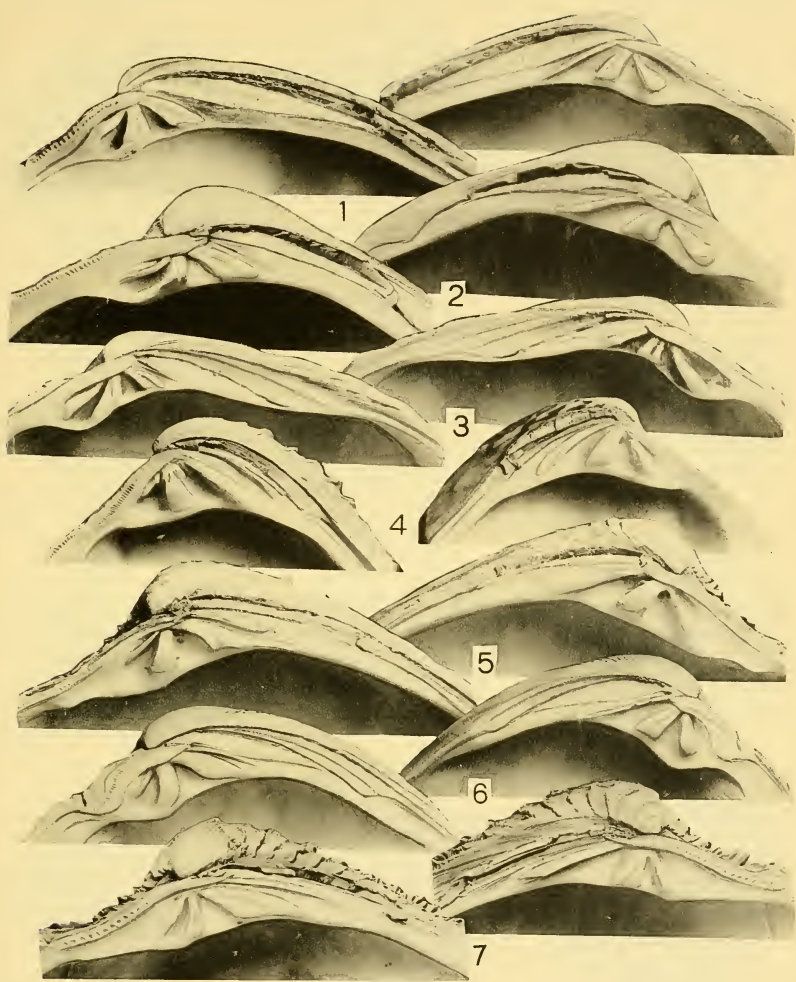


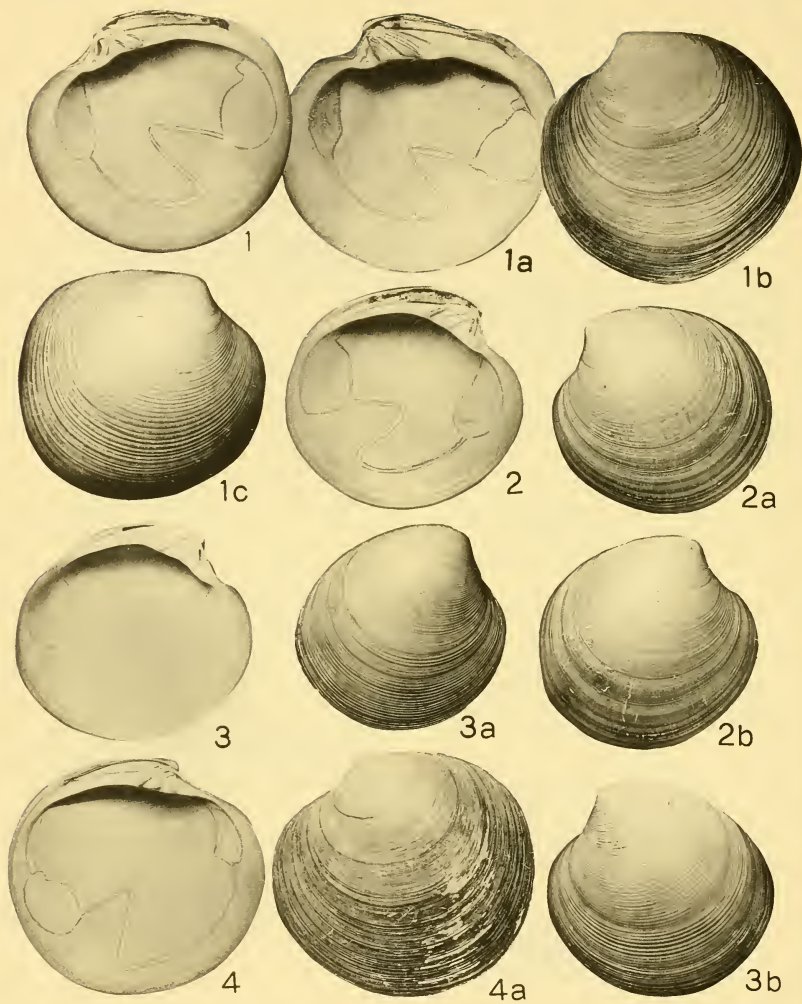
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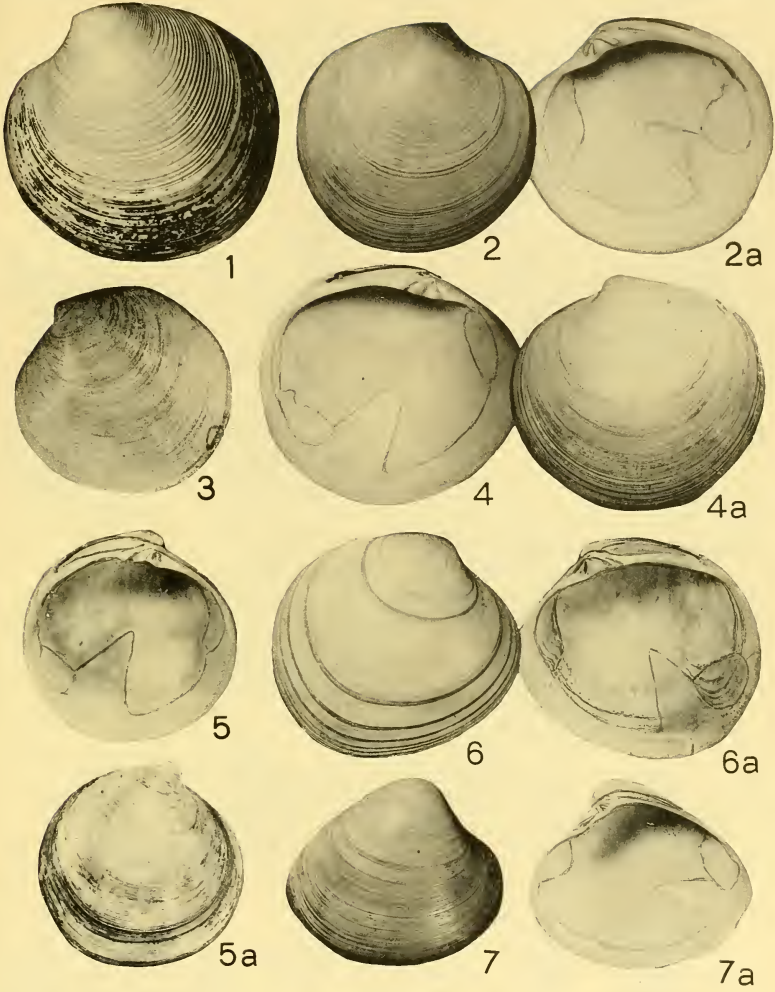


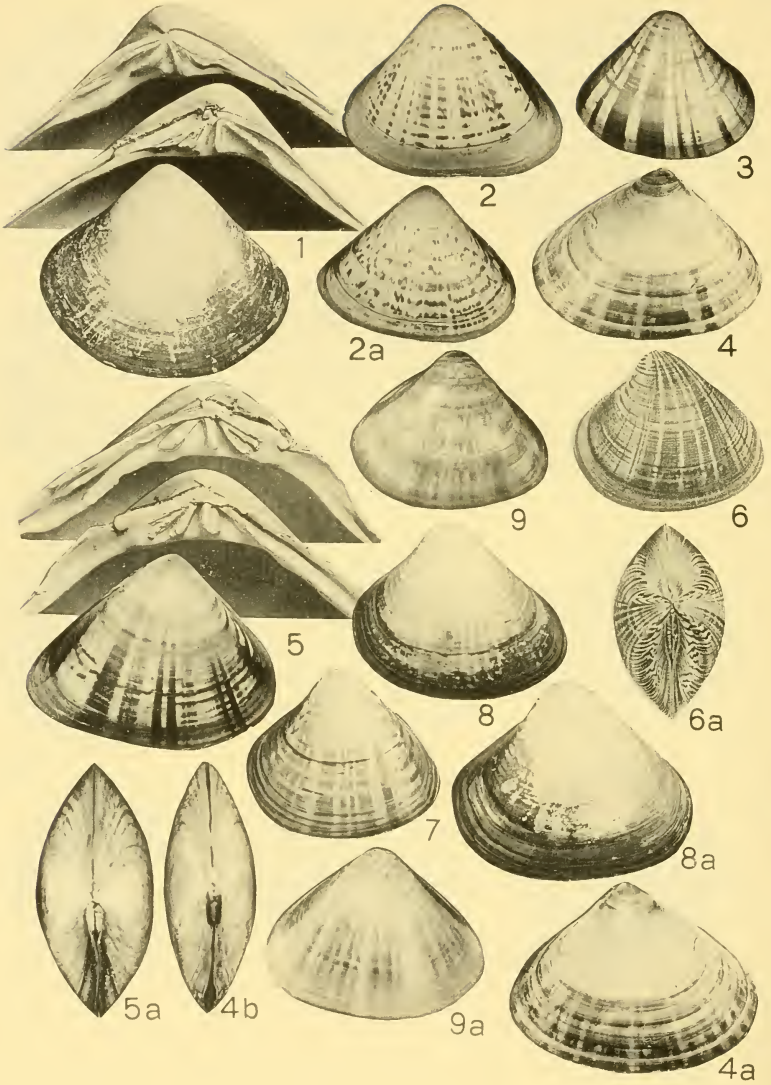
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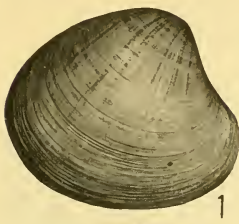


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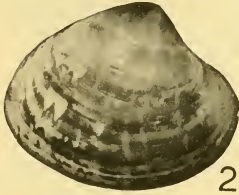
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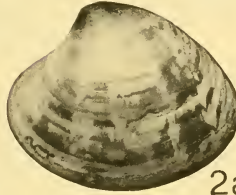
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1b



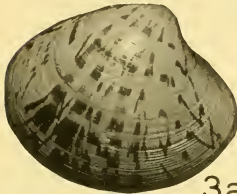
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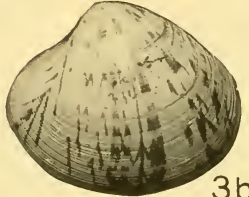
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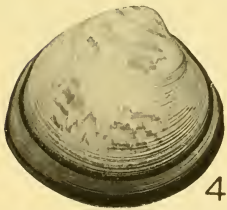
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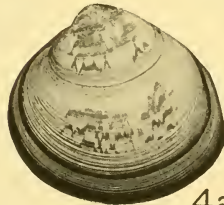
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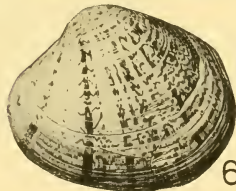
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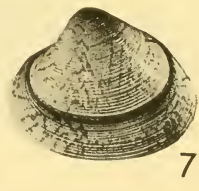
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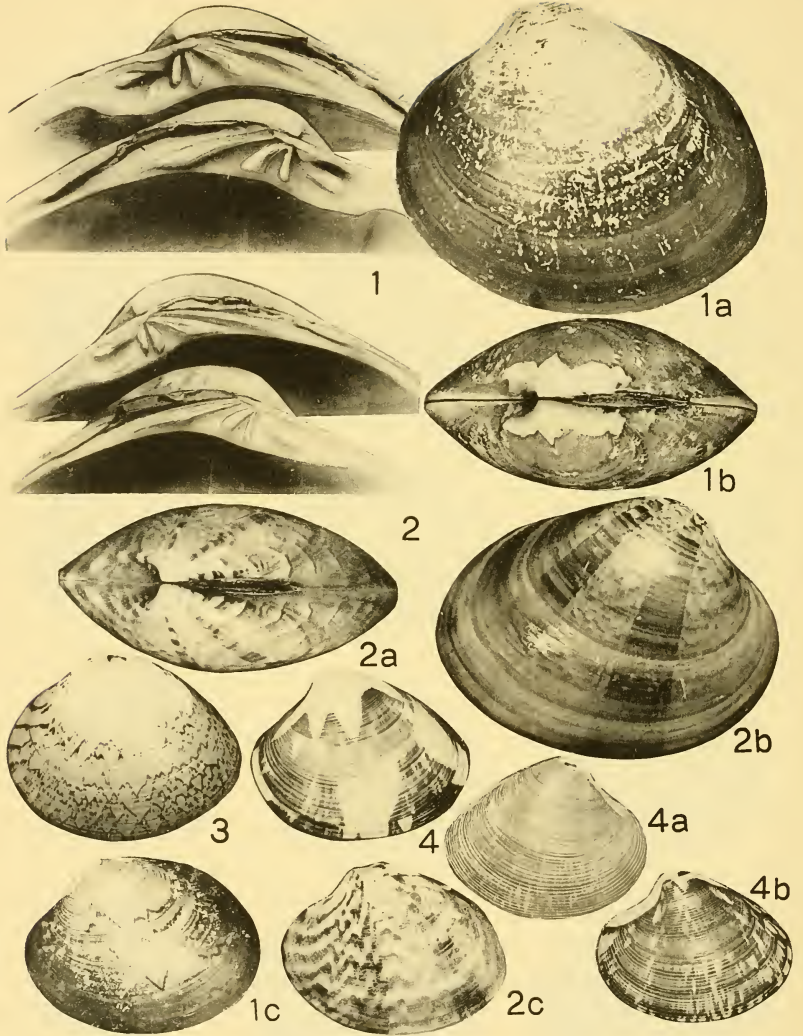
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6a



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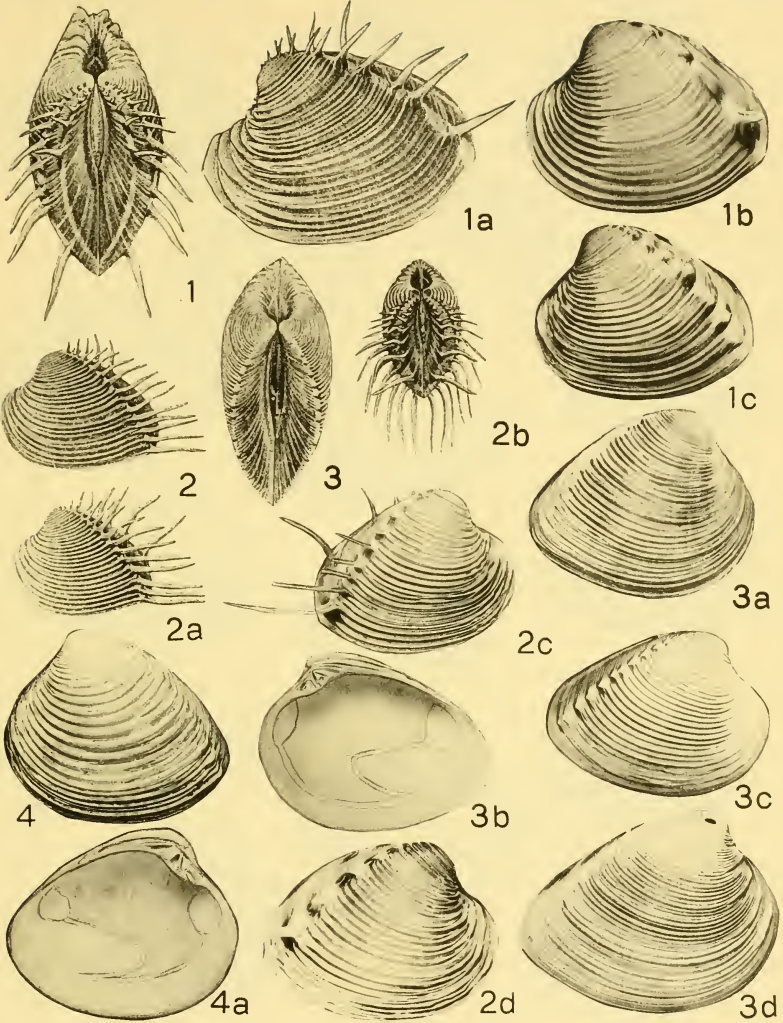


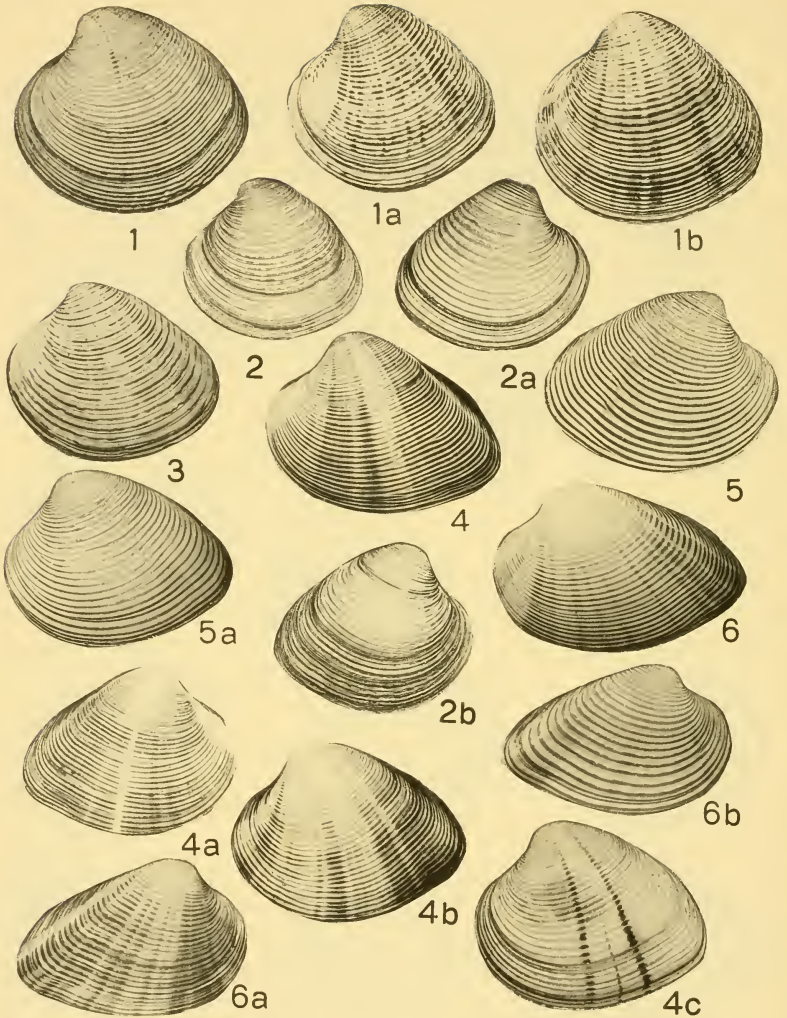
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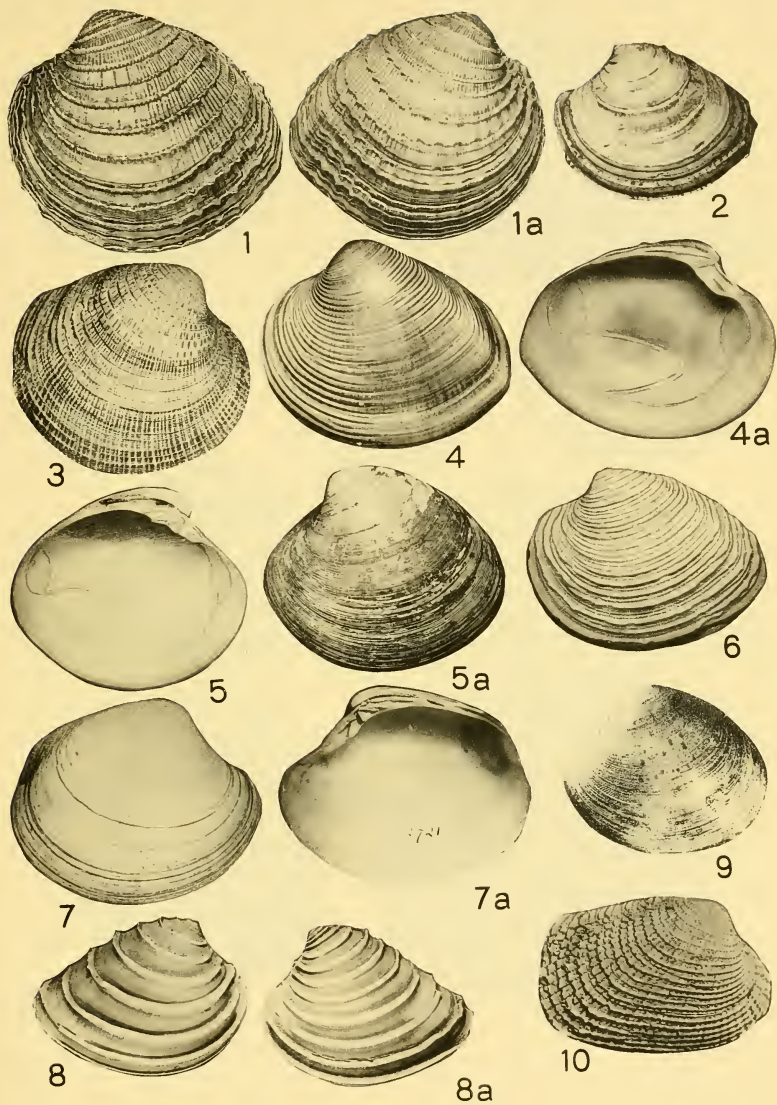


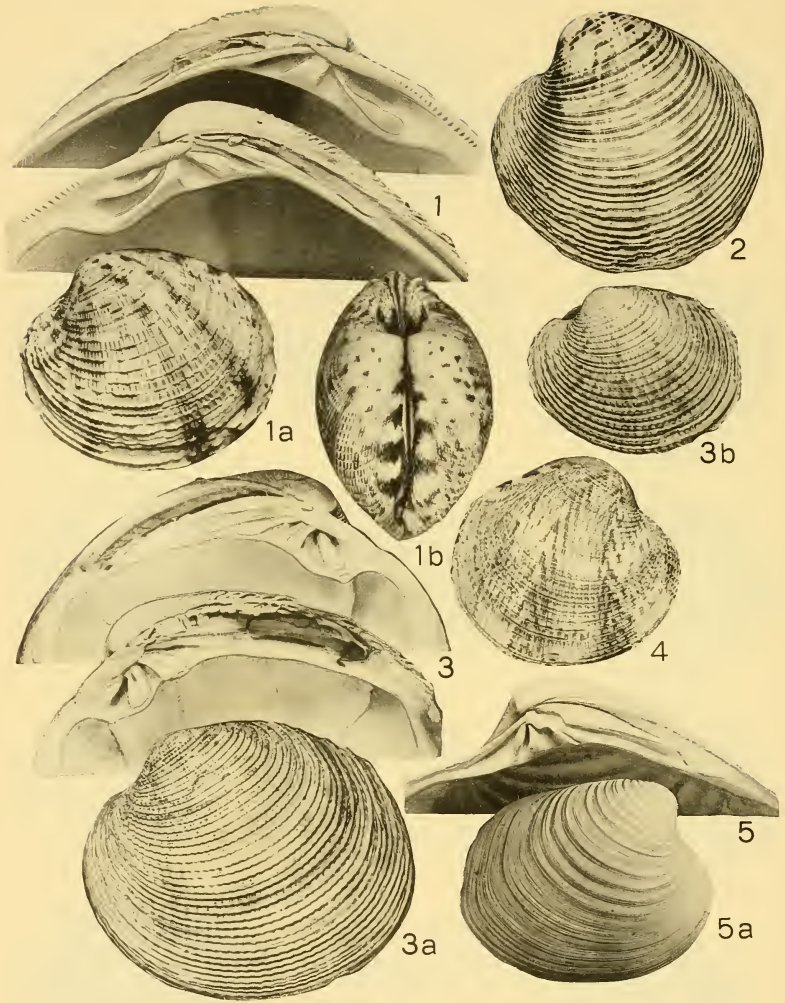
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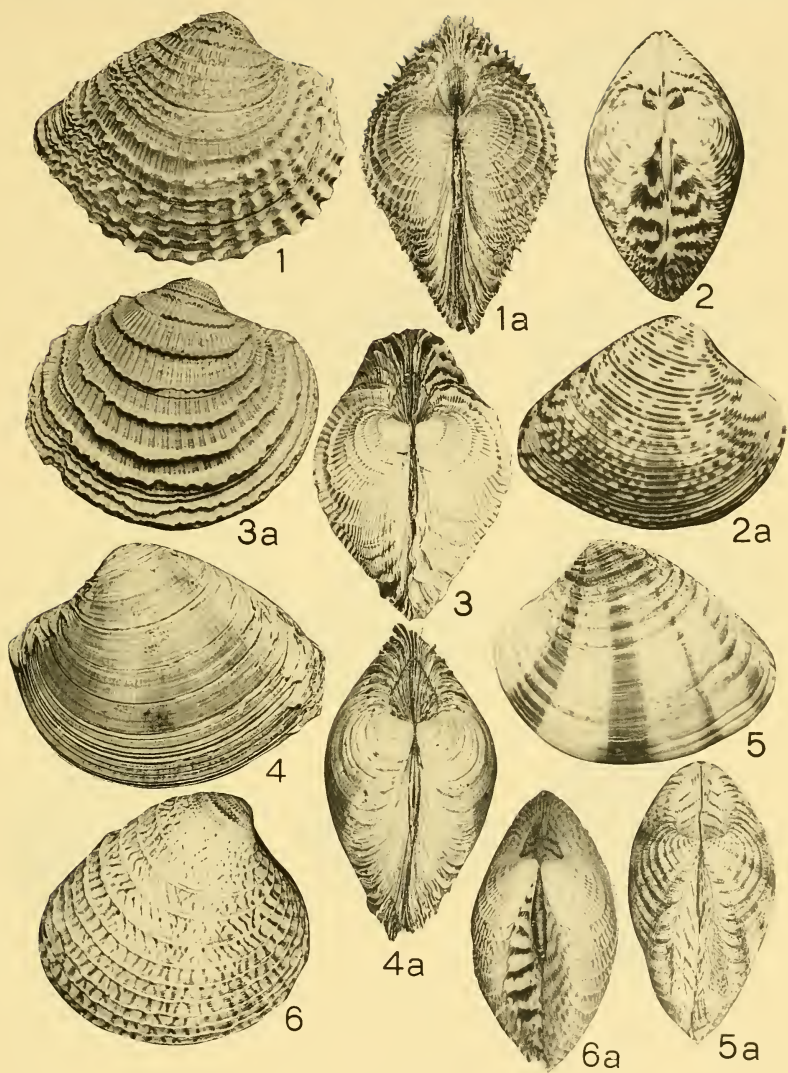


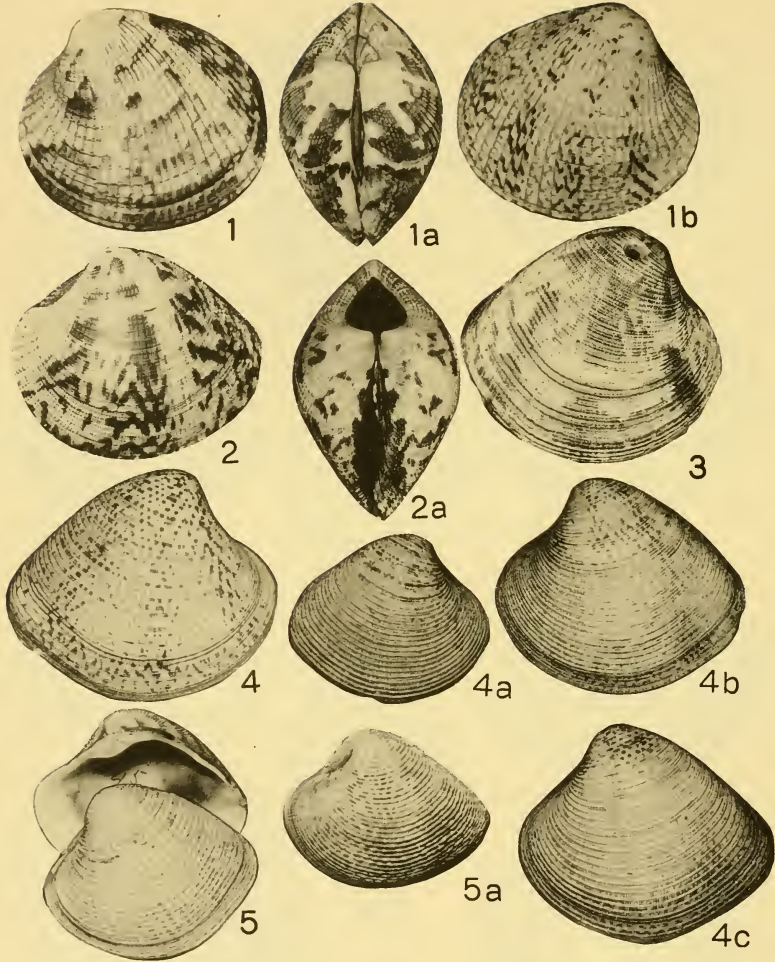
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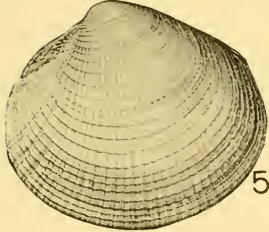
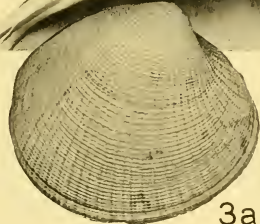
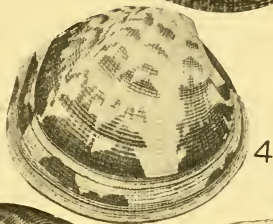
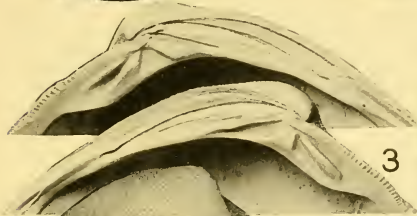
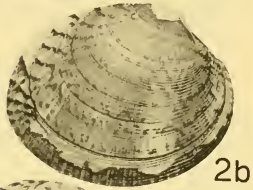
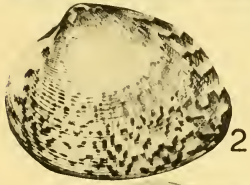
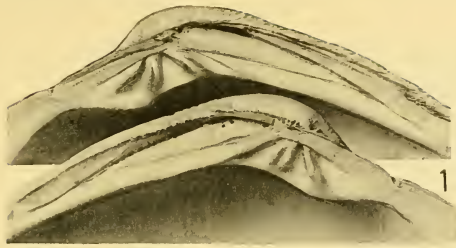


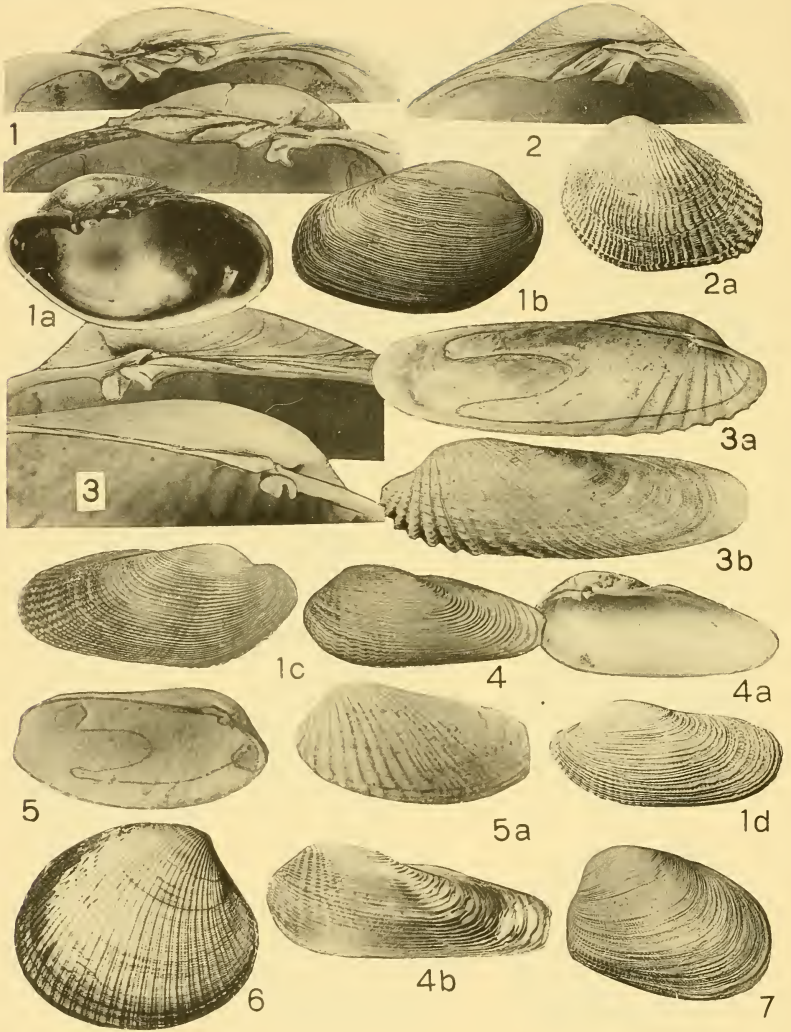
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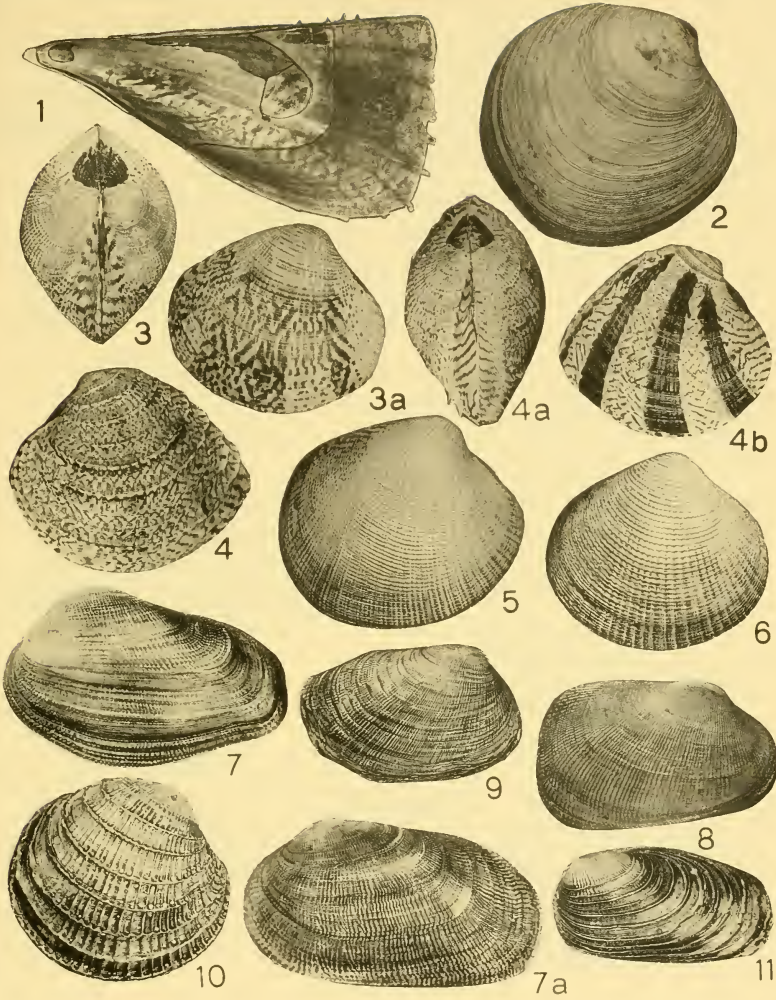


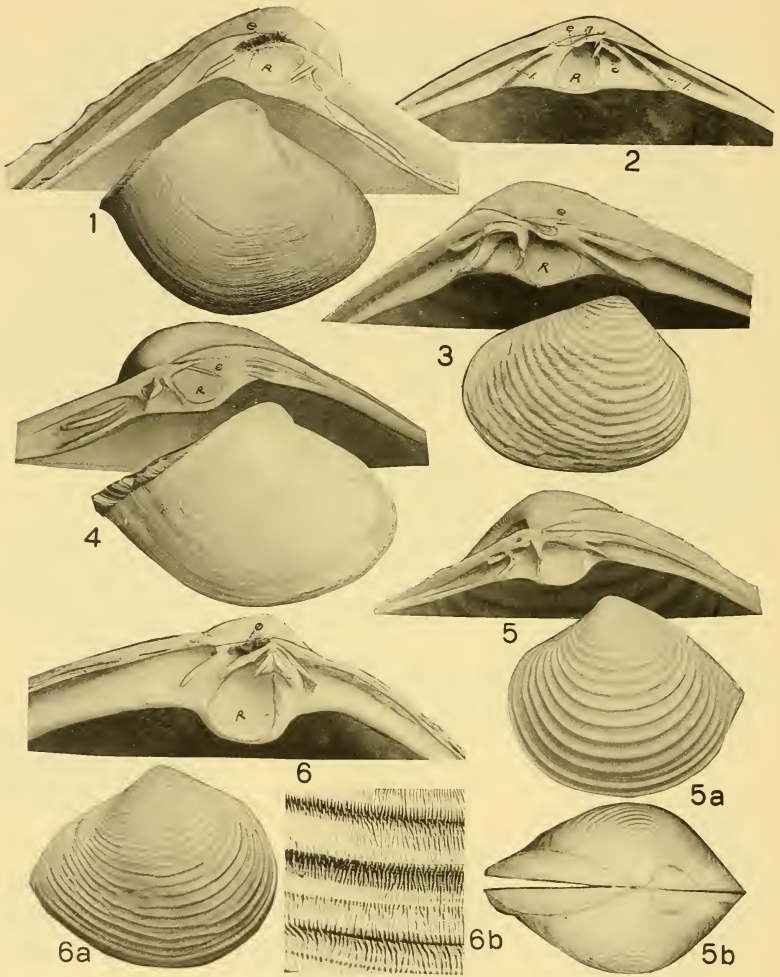
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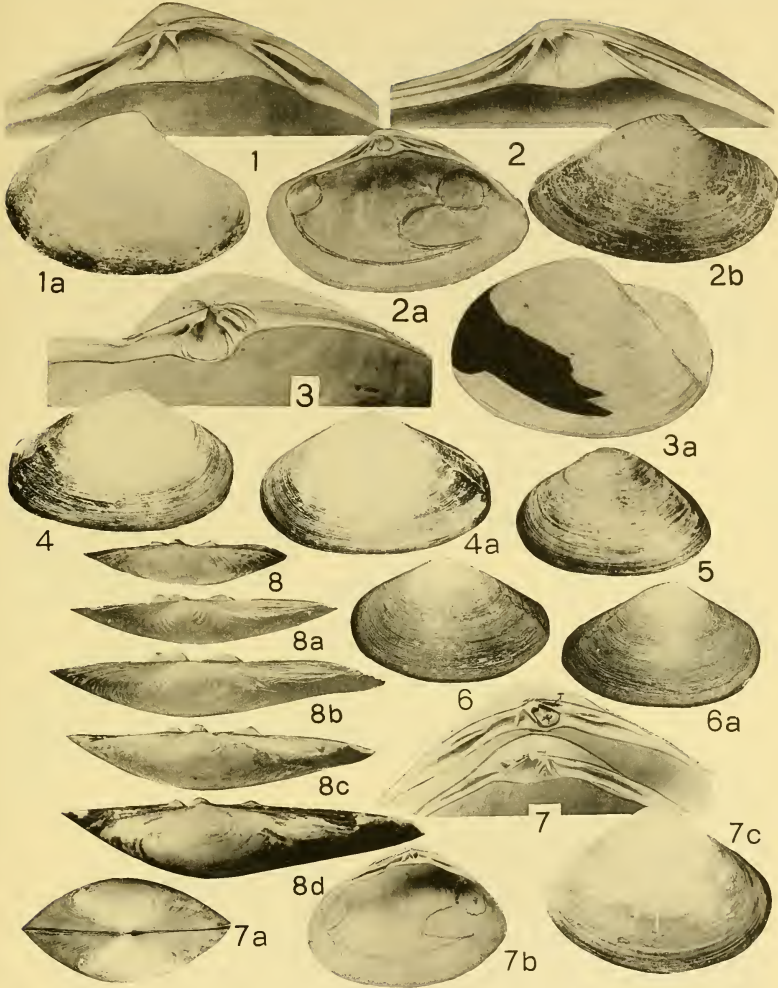


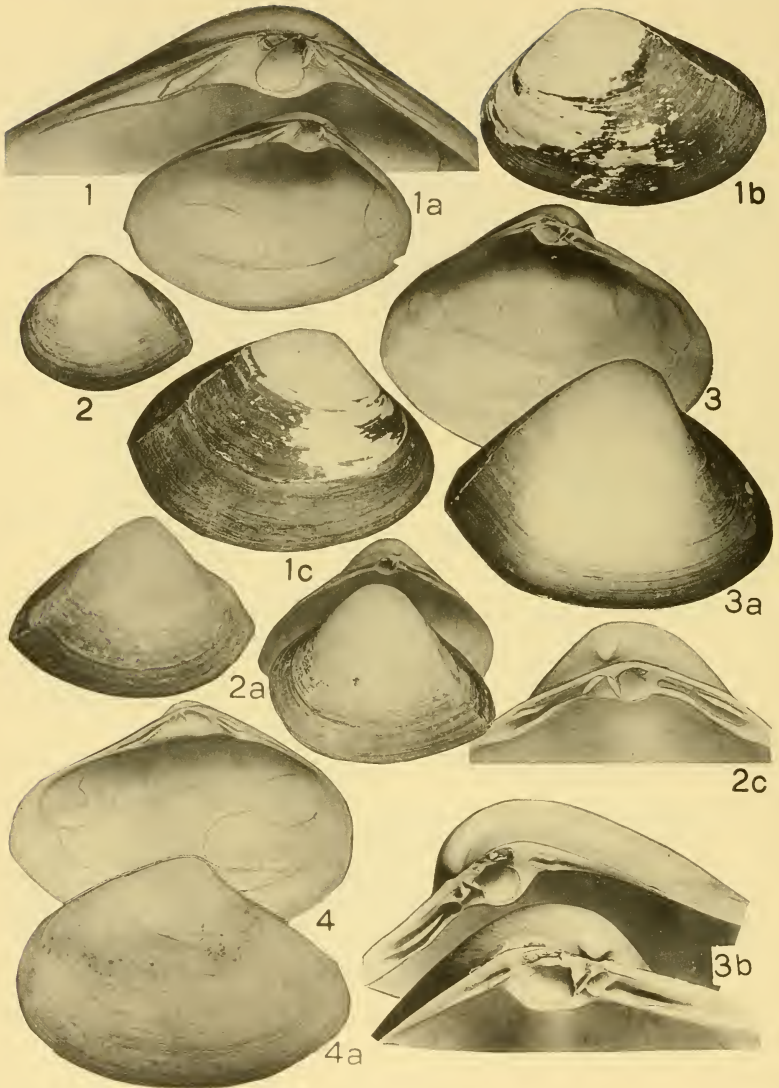
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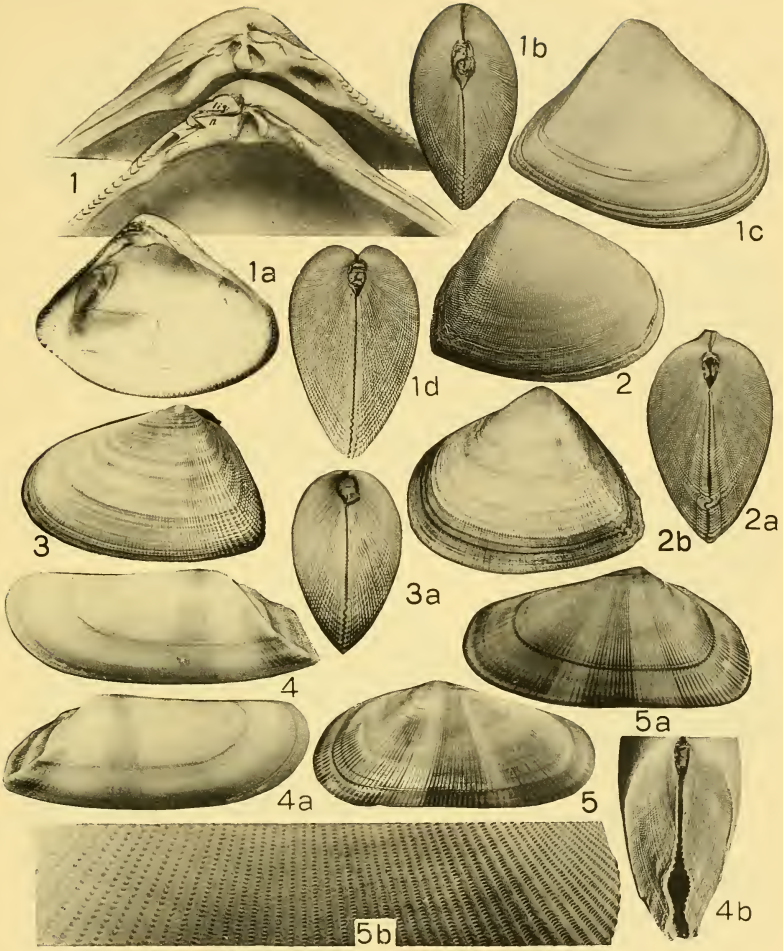


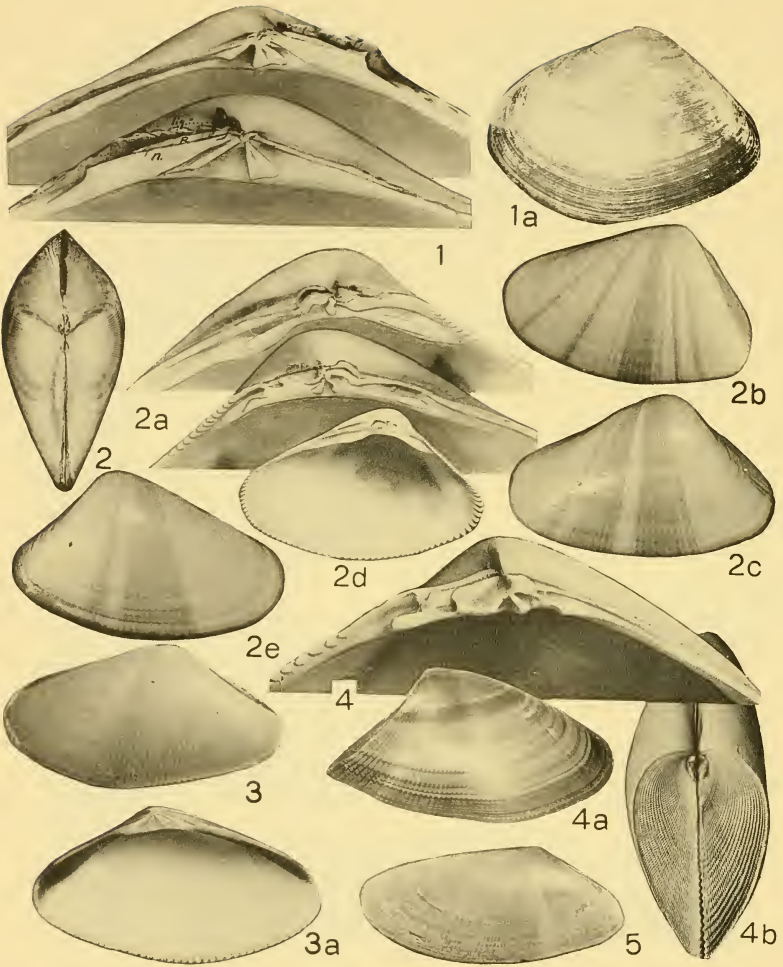
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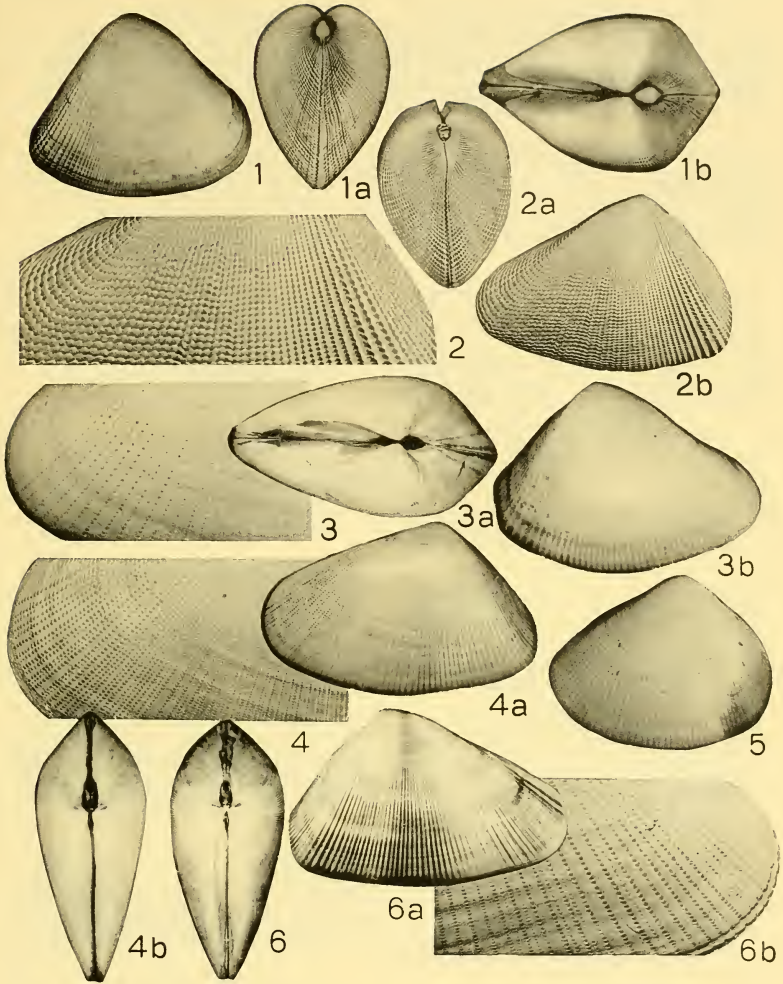


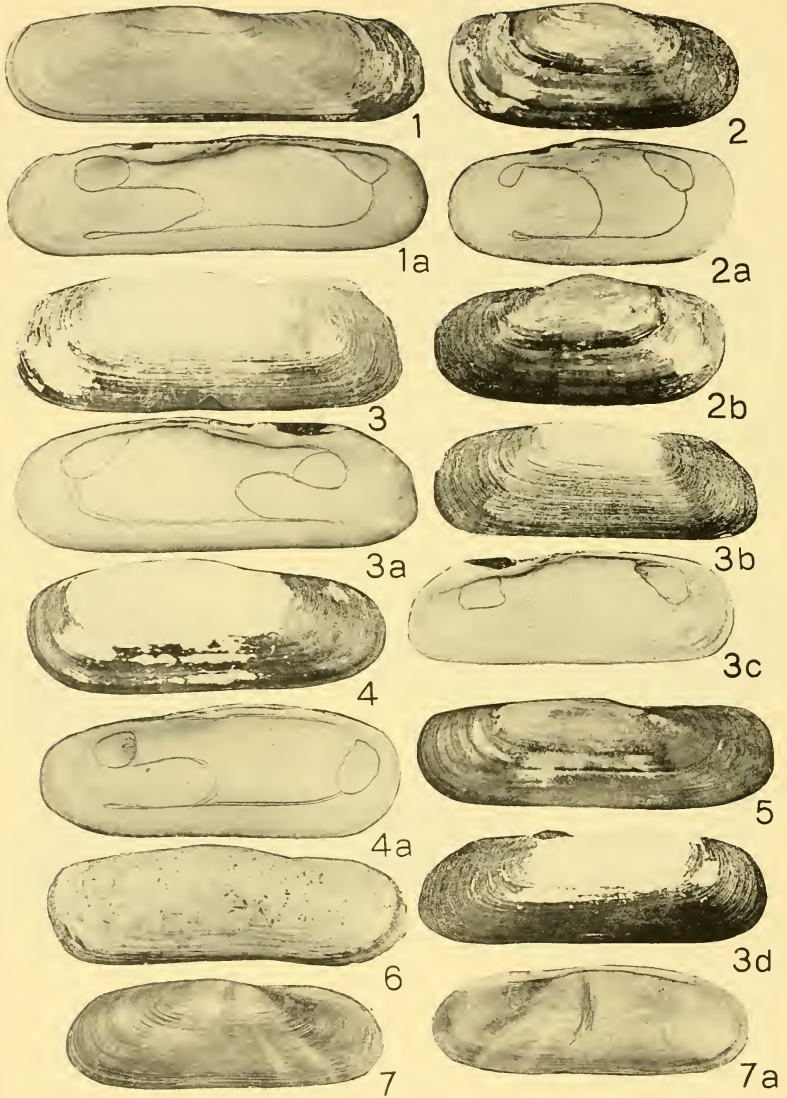
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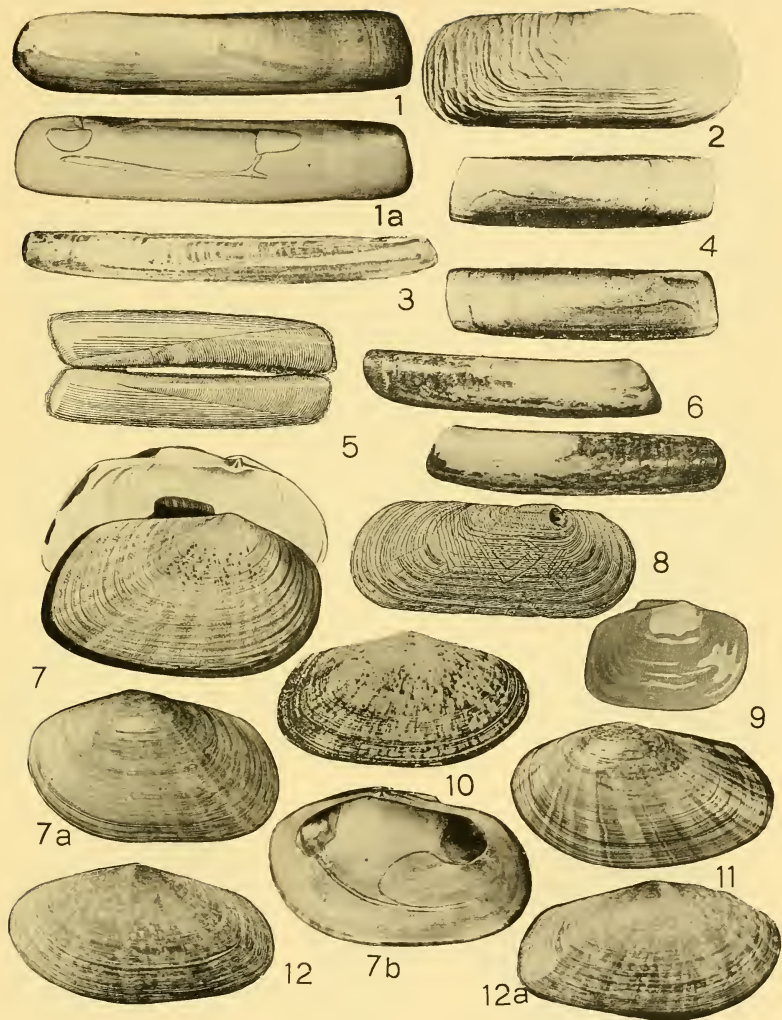


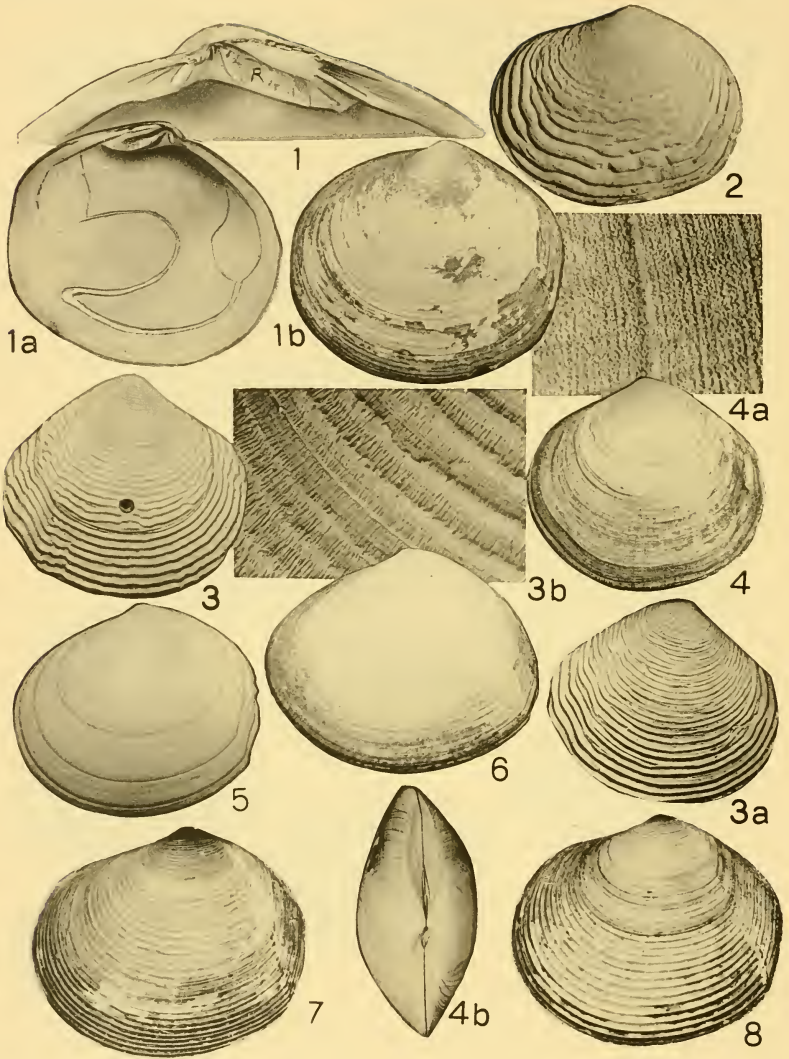
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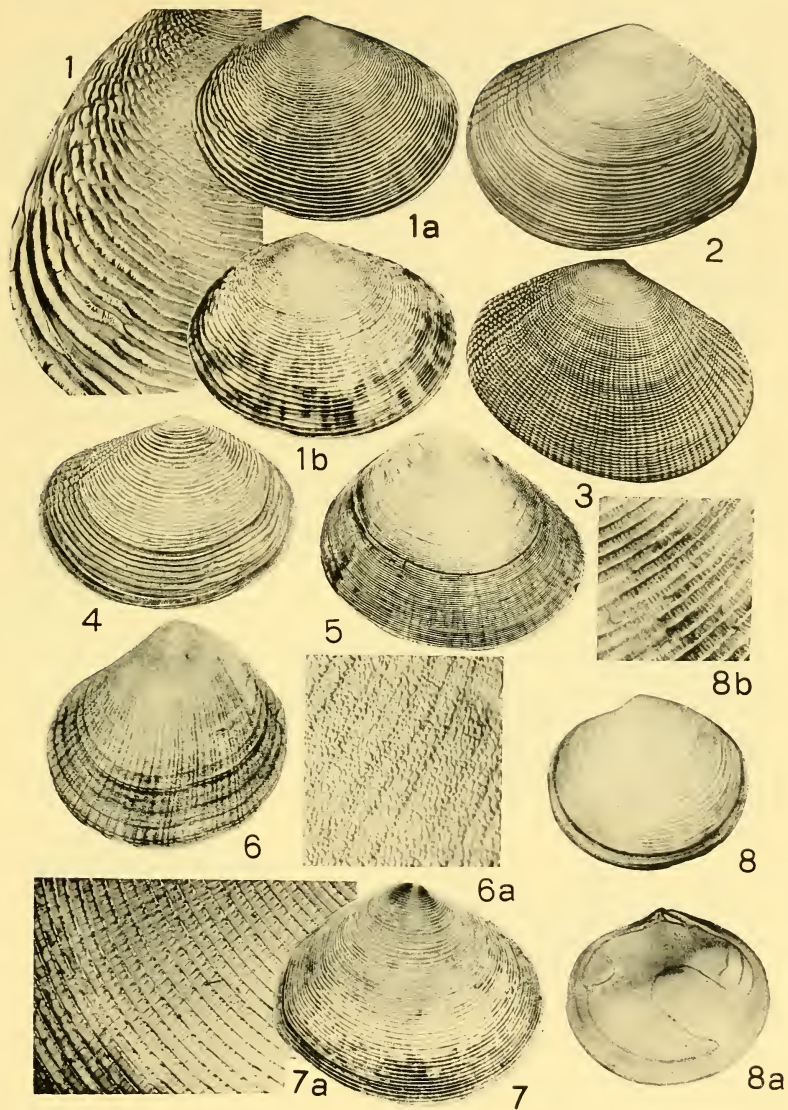


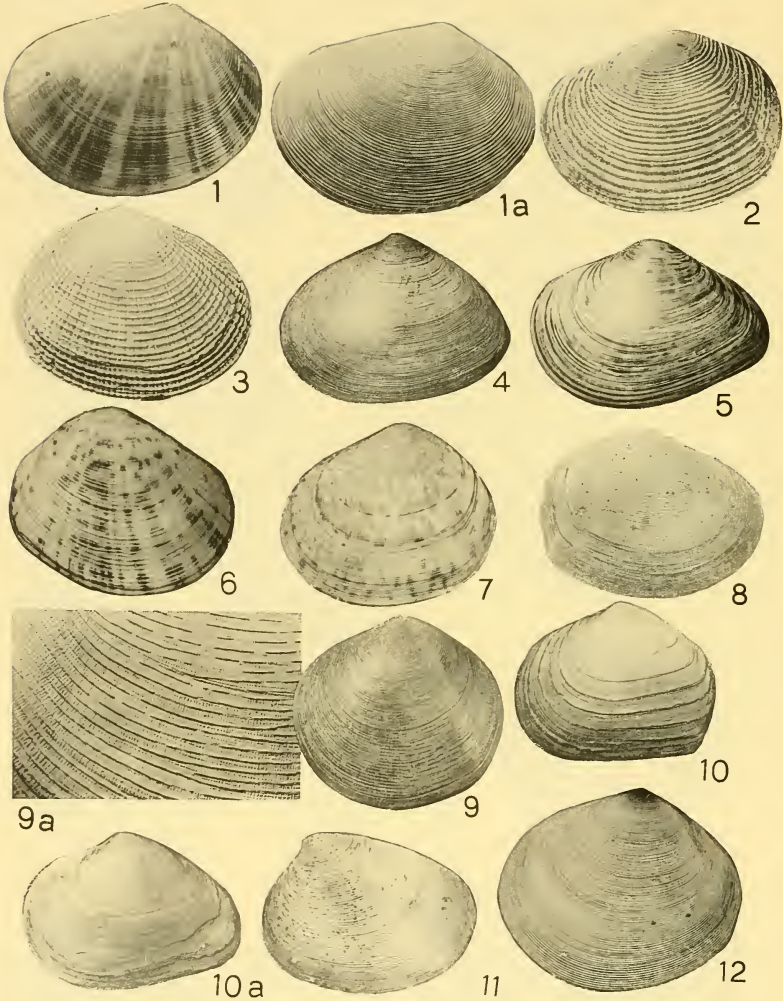
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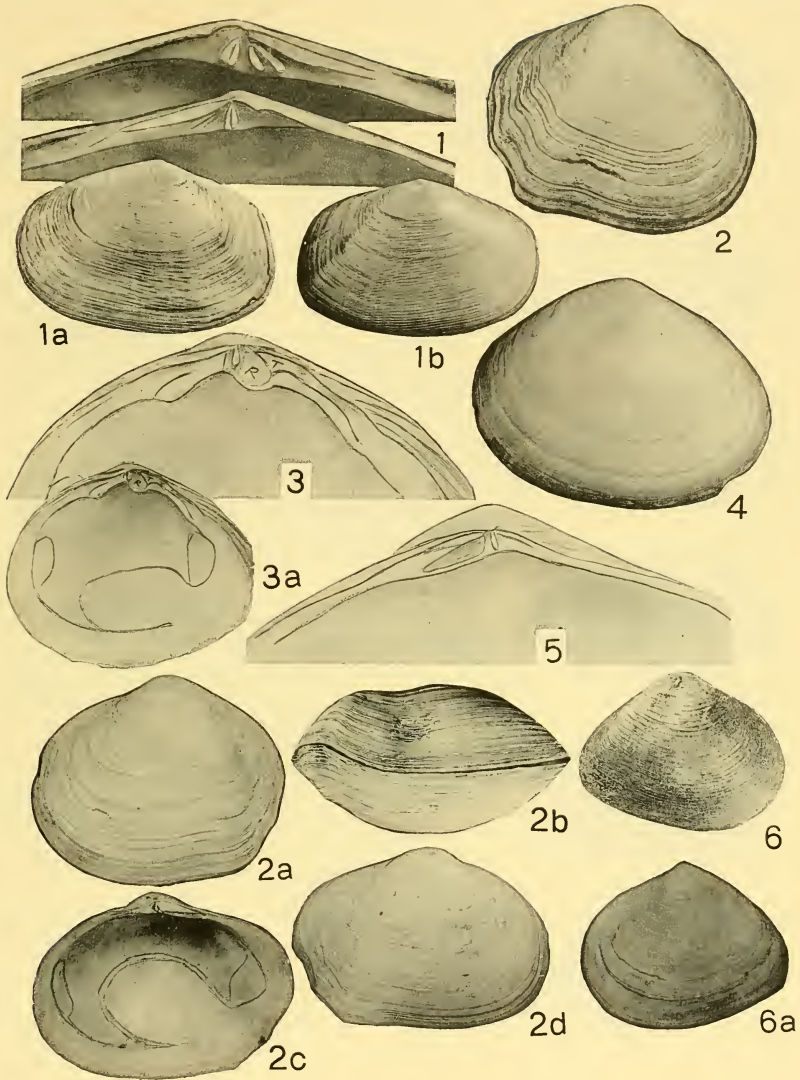


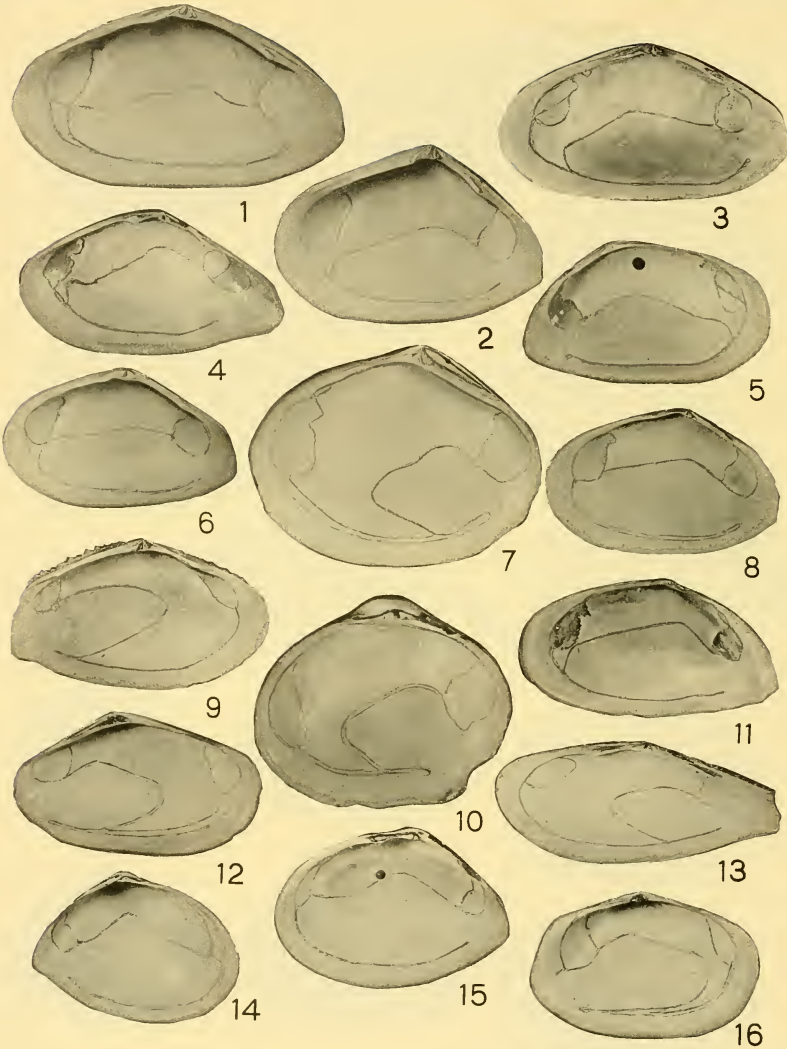
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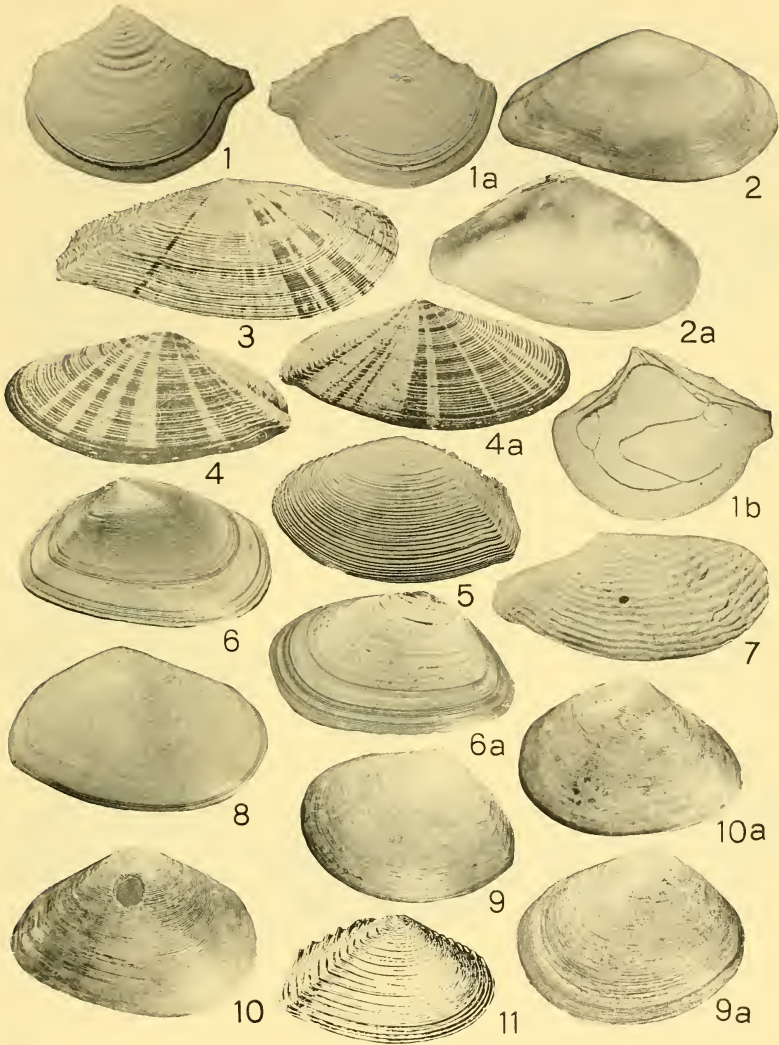
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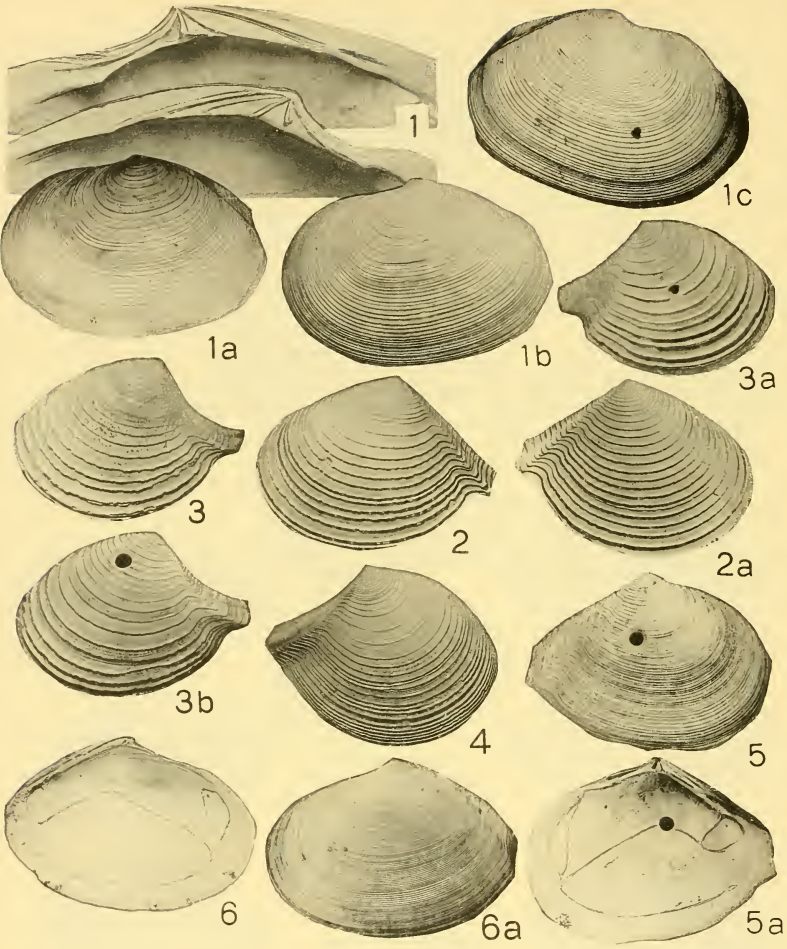
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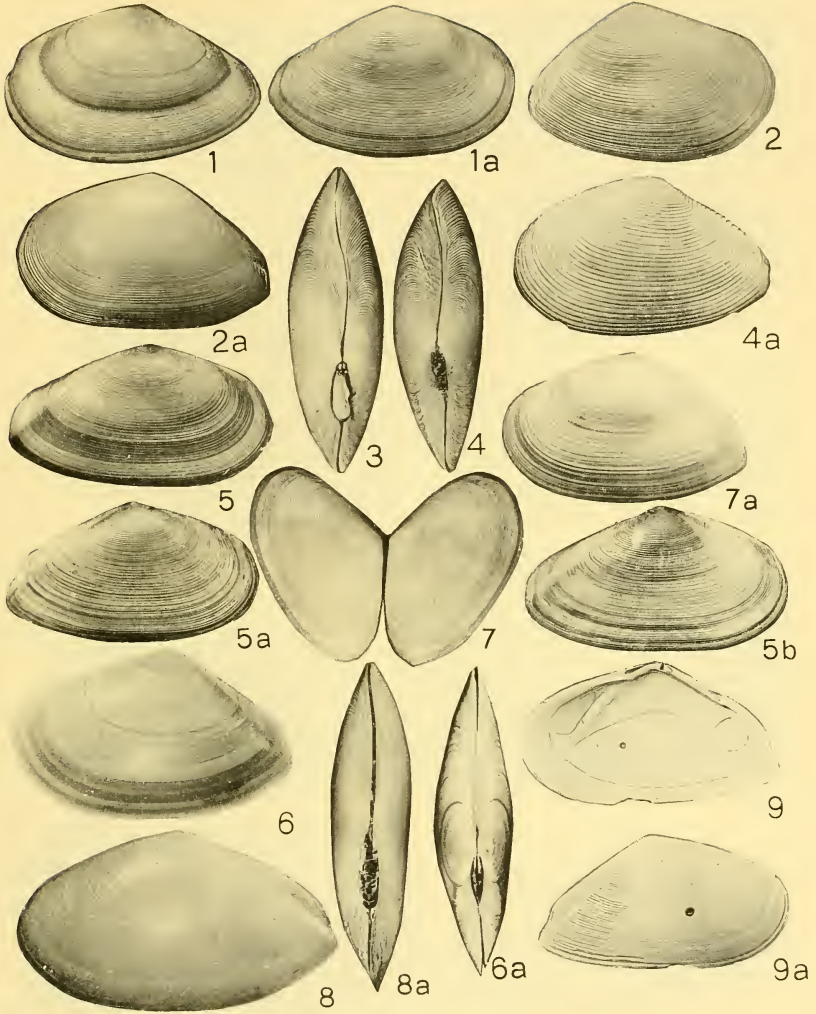


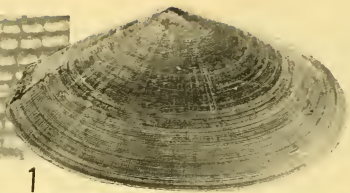
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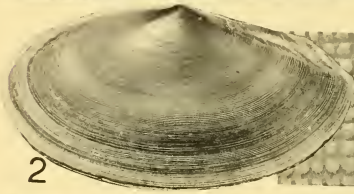
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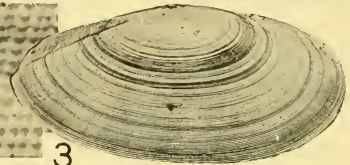
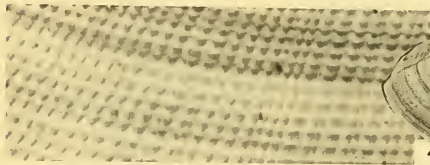
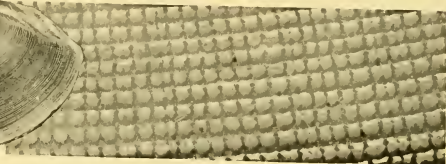




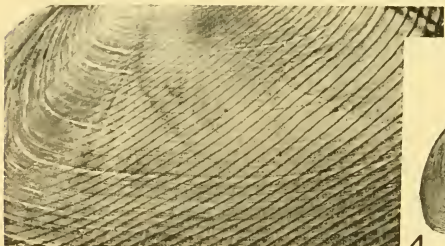
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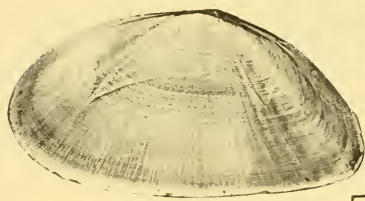
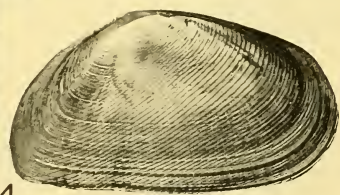
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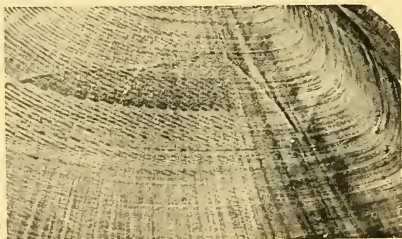
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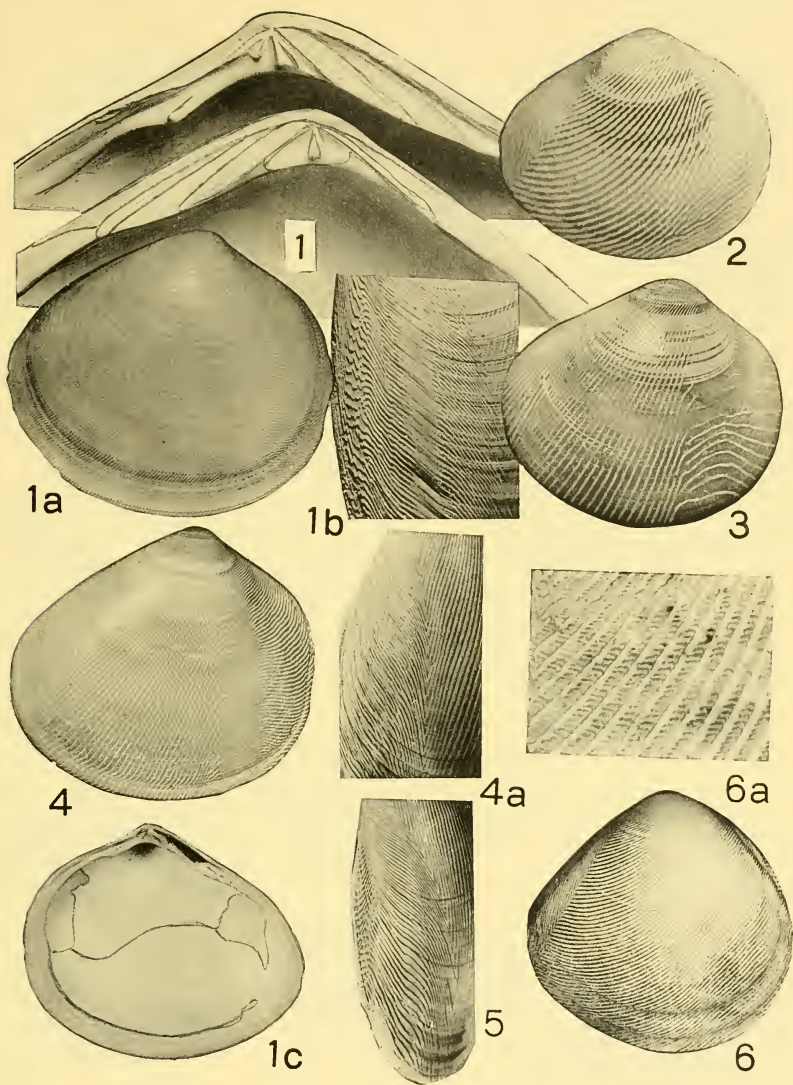


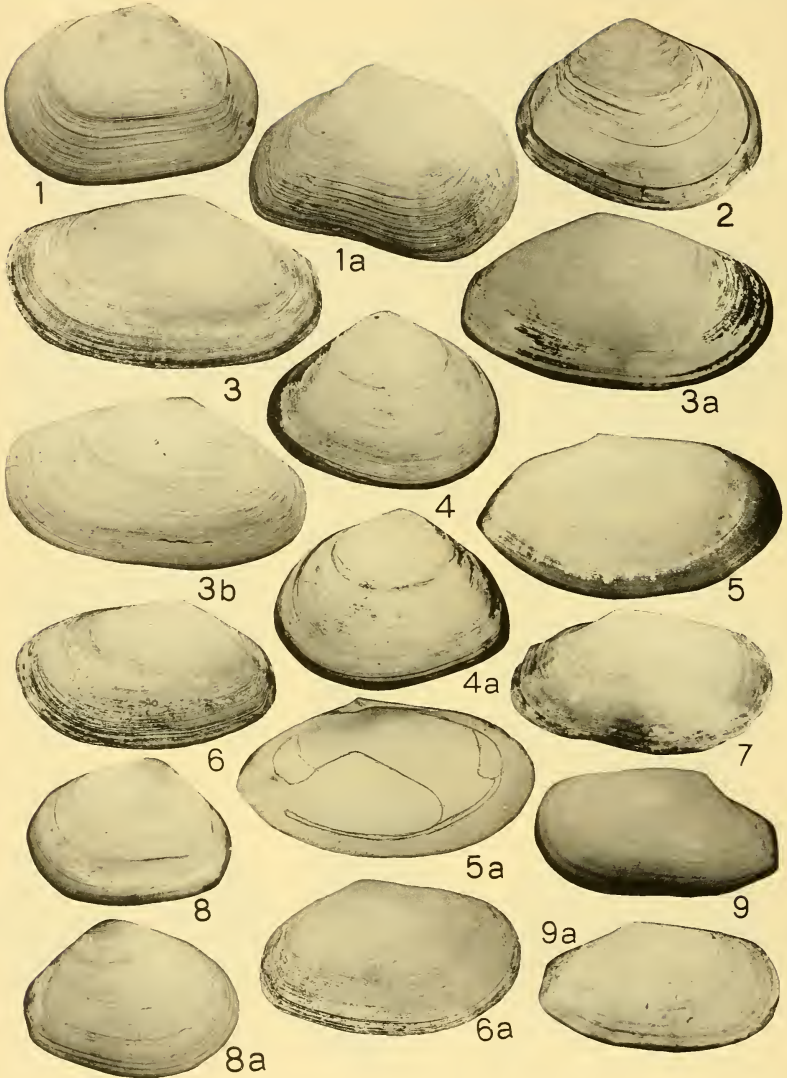
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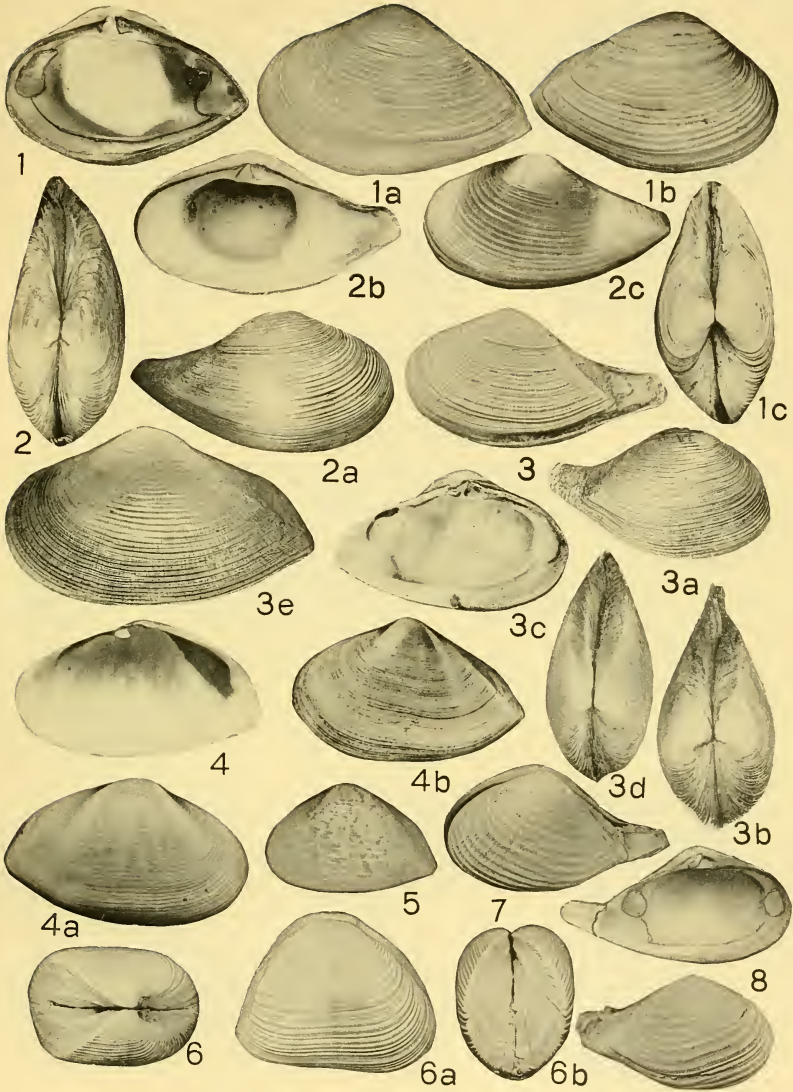


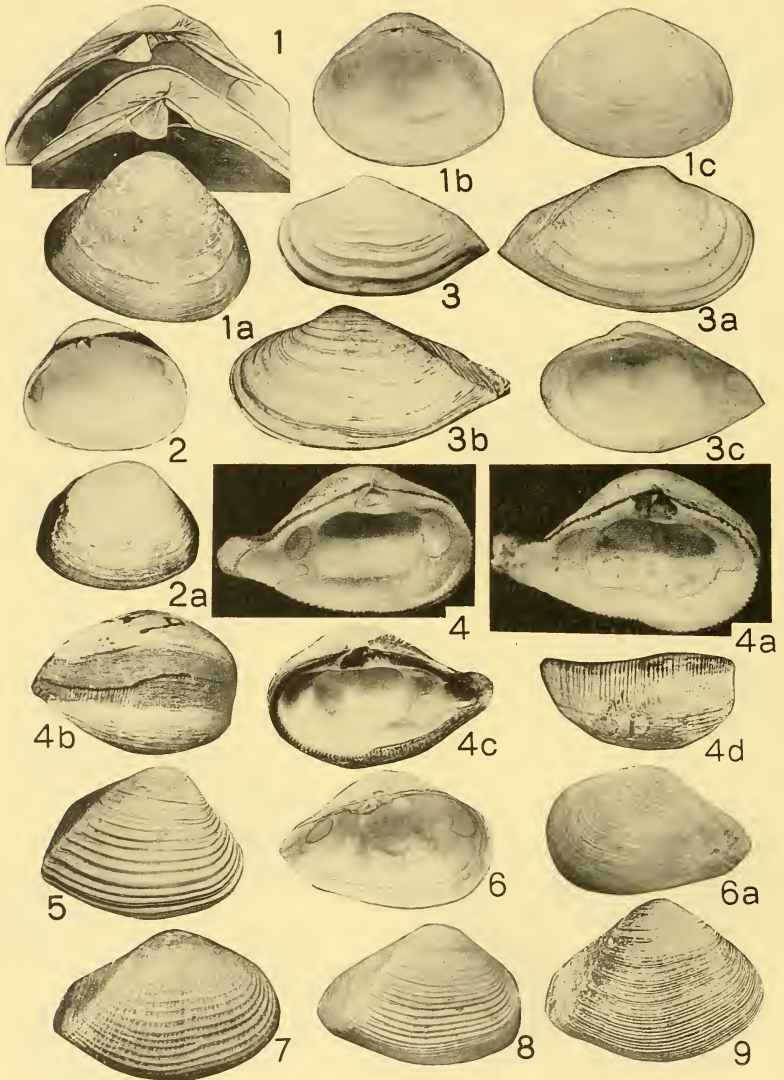
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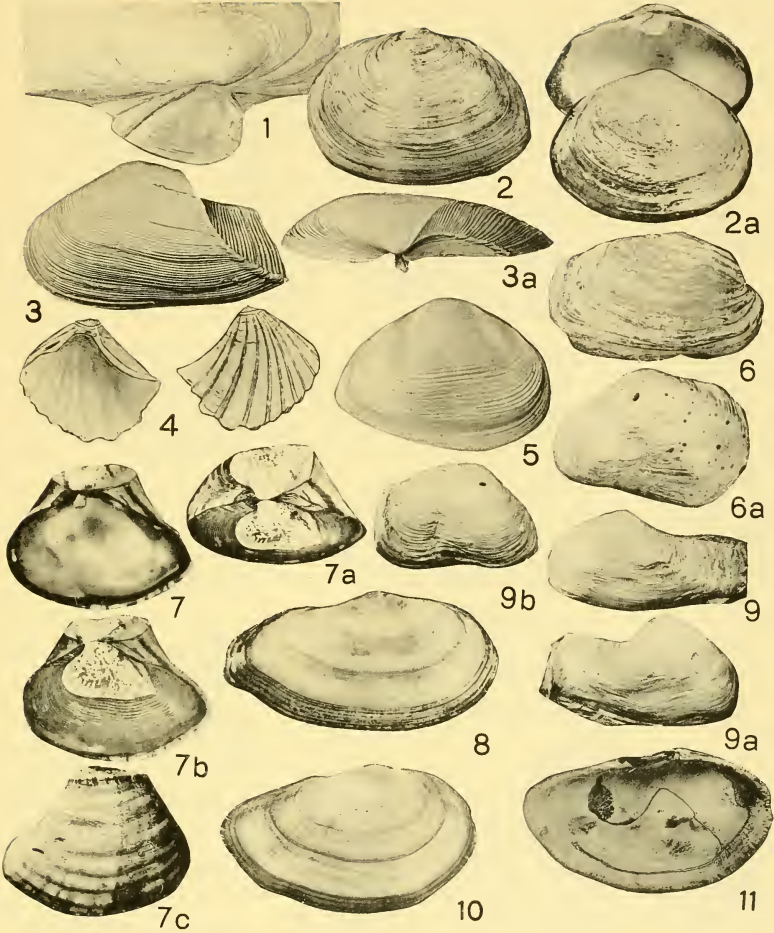


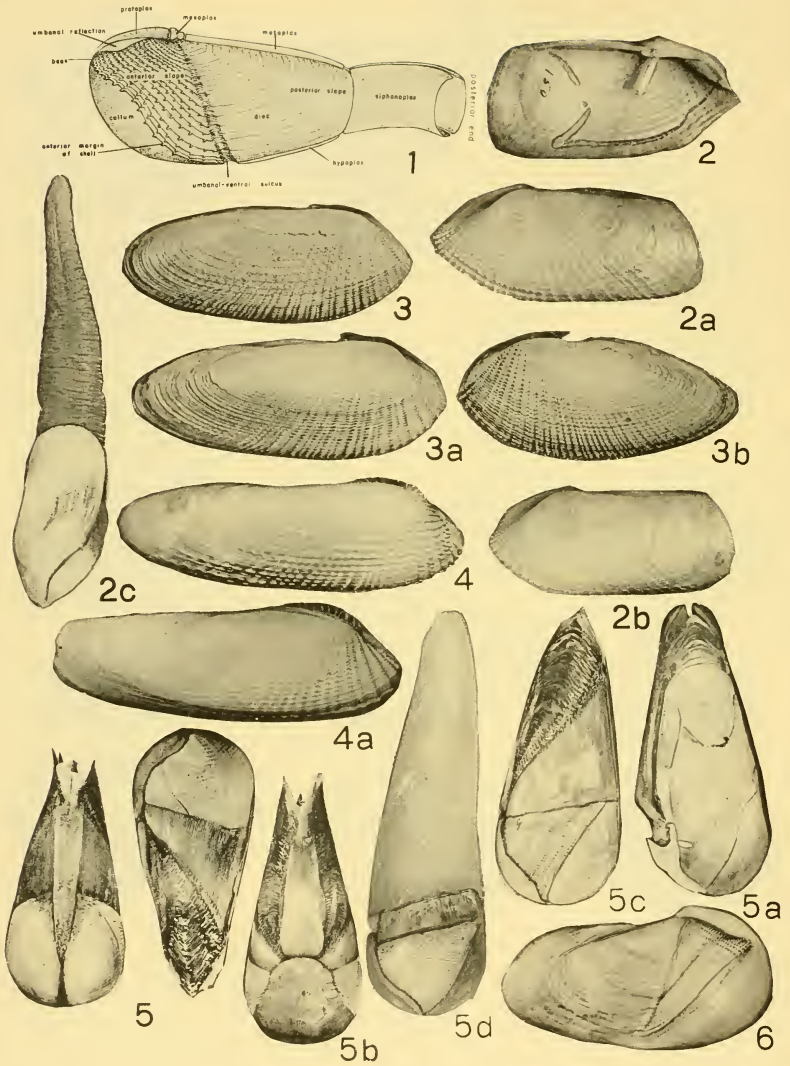
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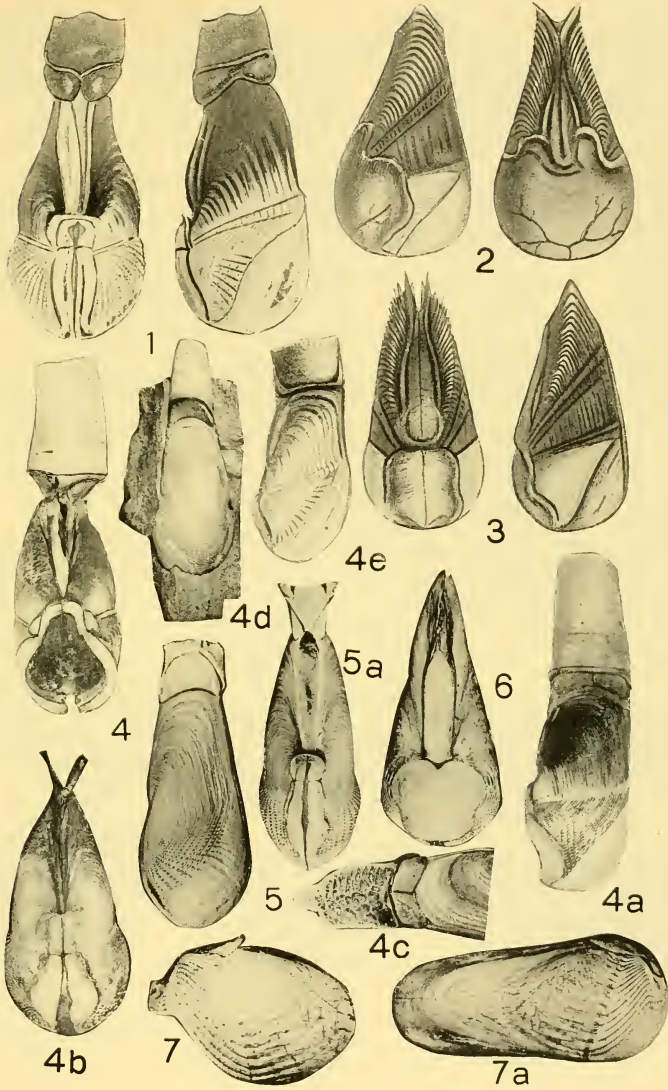


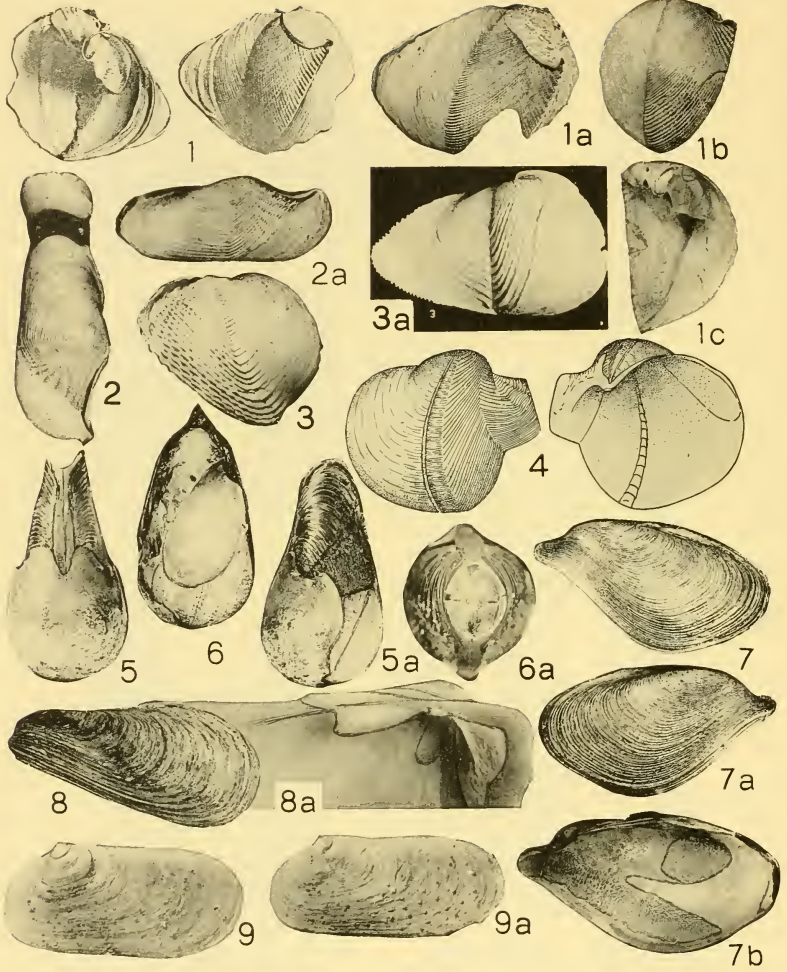
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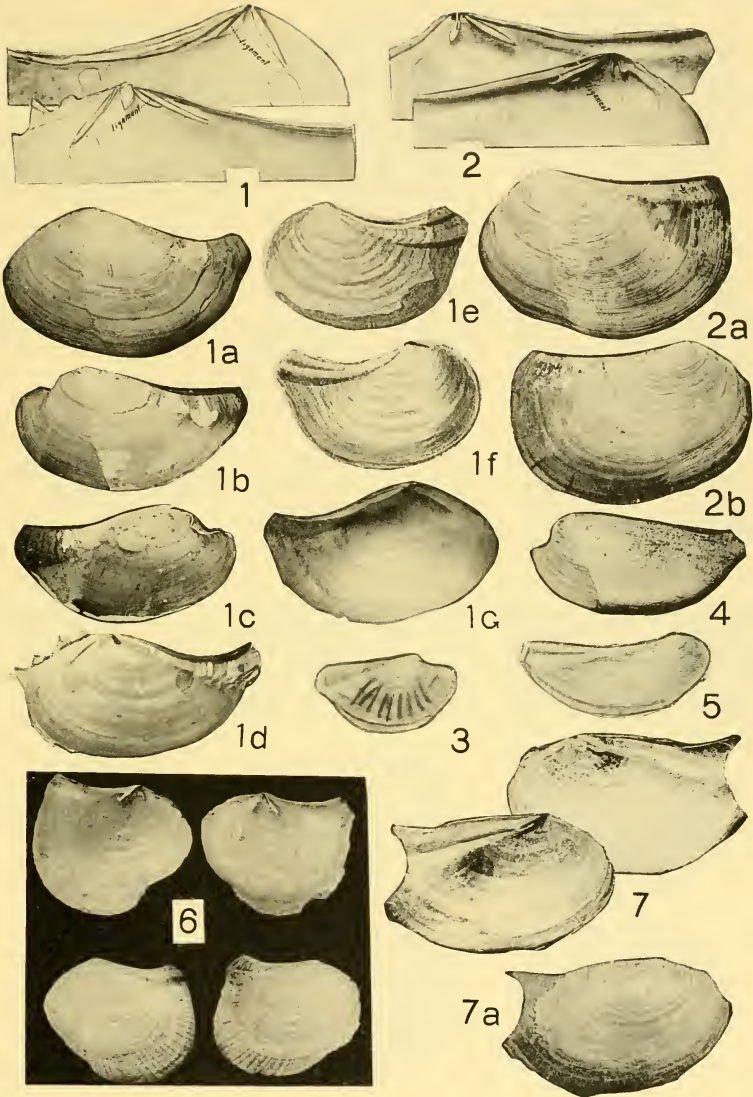


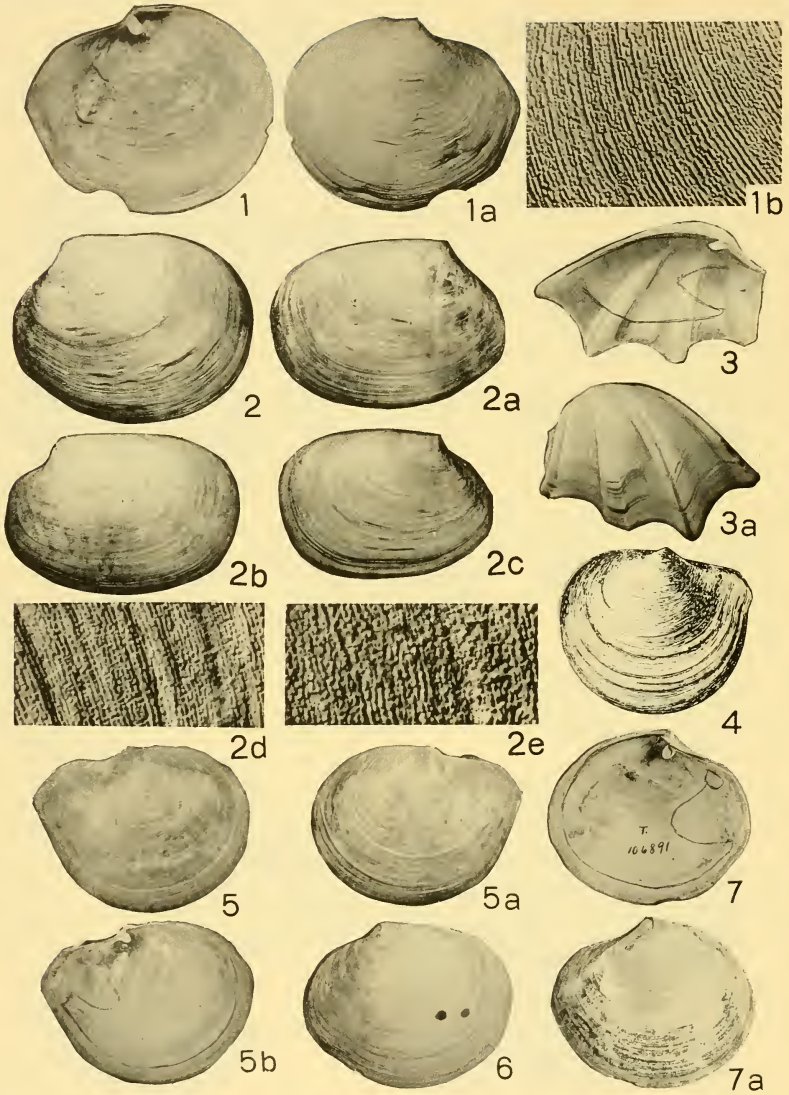
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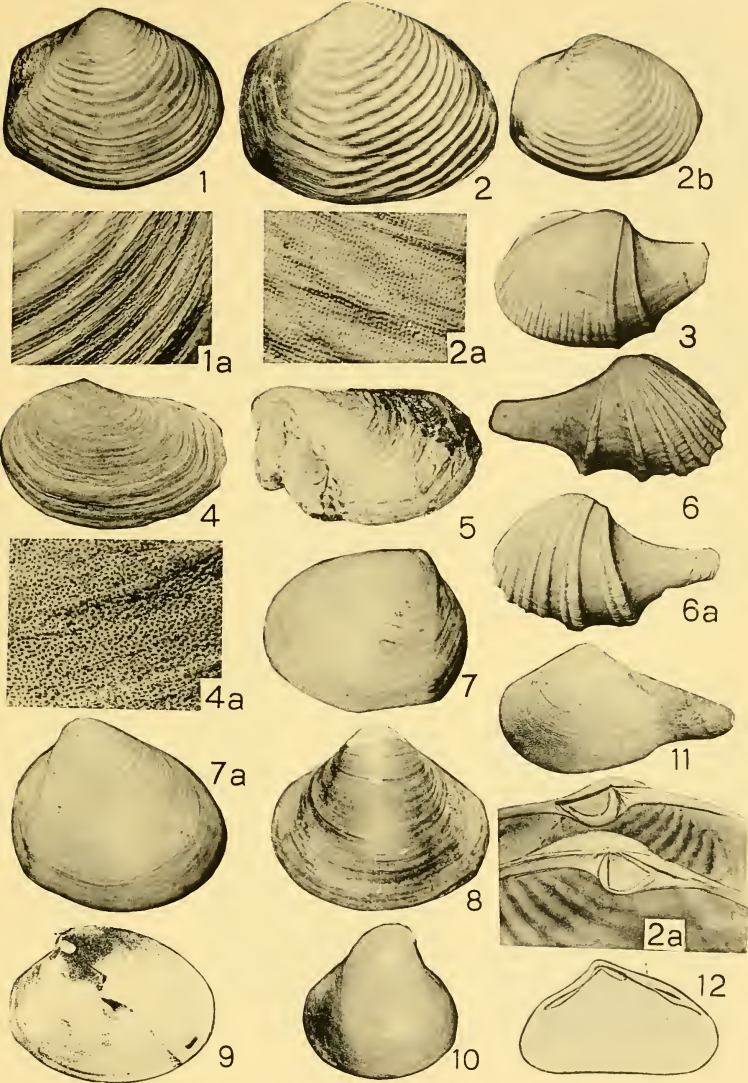


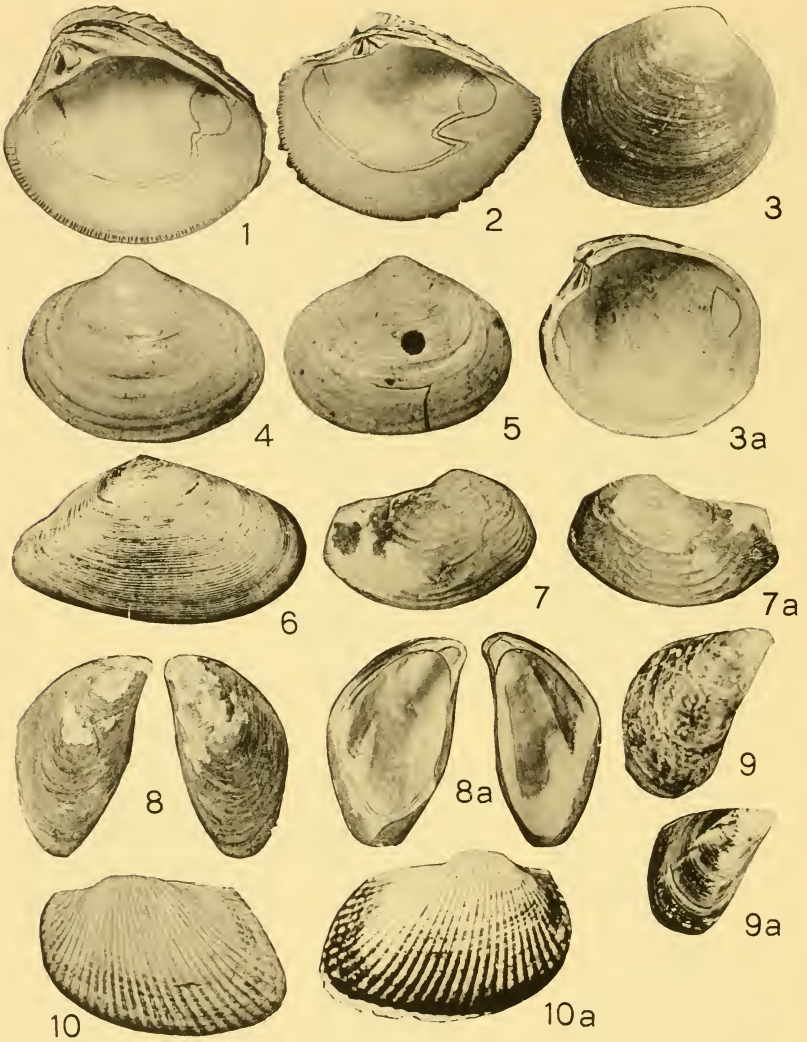
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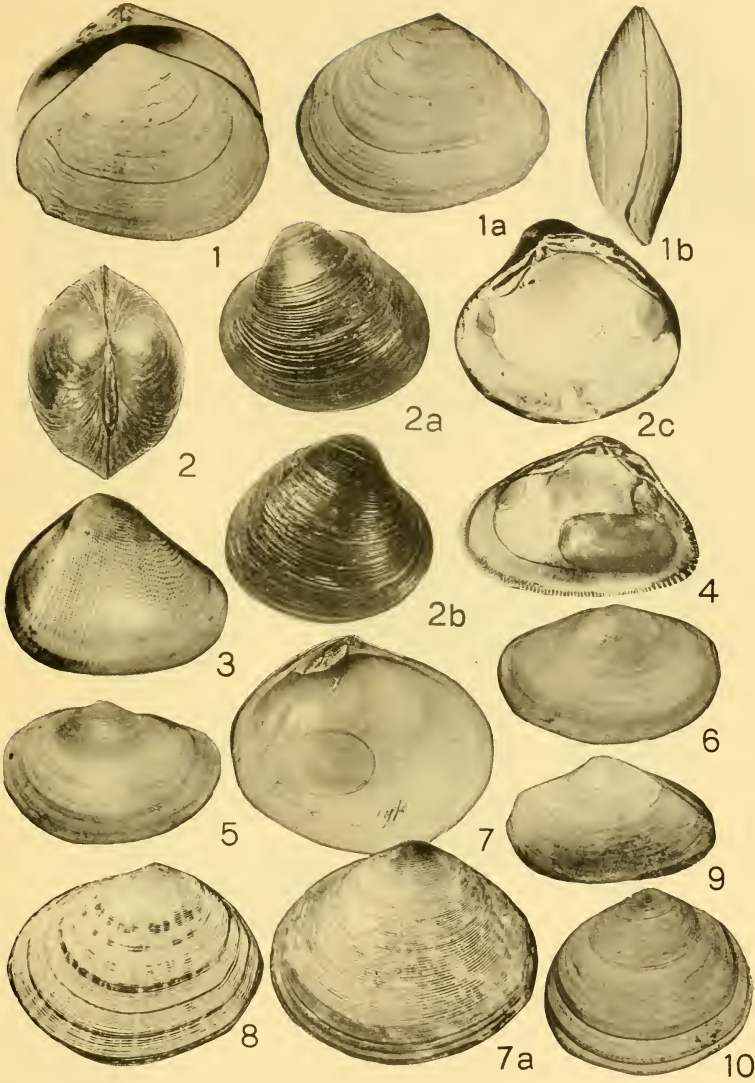


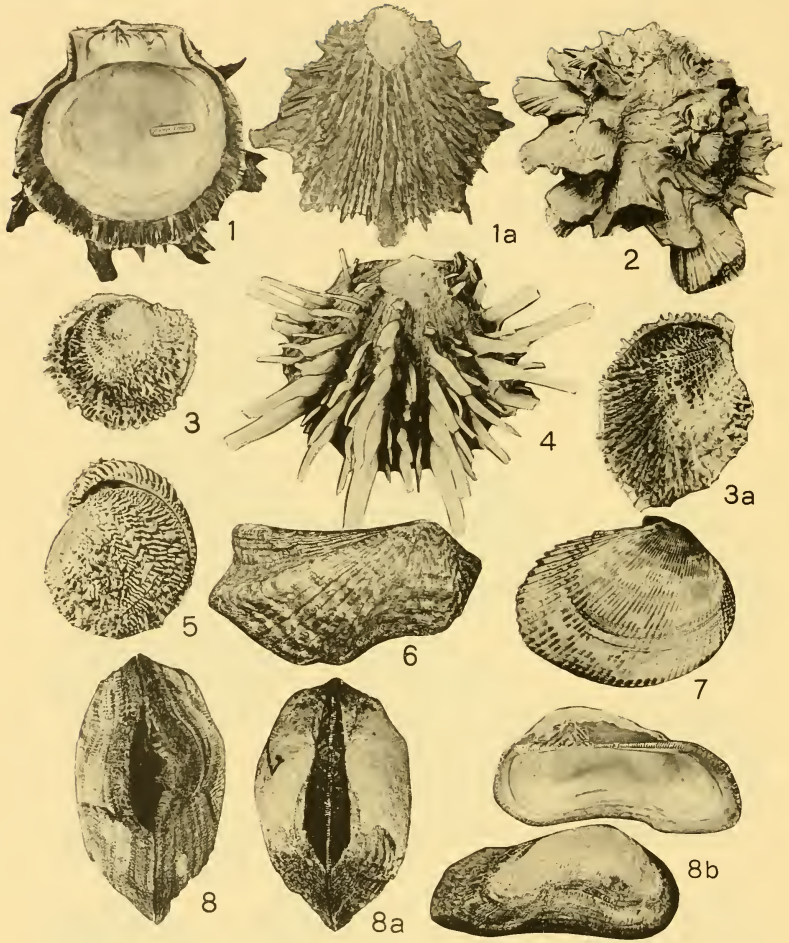
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ERRATUM

Page 83, line 18, read California in place of Florida.

